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CENTRAL UTAH
WATER CONSERVANCY DISTRICT

CUP
COMPLETION ACT

WATER MANAGEMENT IMPROVEMENT STUDIES

REPORT ON THE WATER PRICING POLICY STUDY

To the U.S. Secretary of the Interior
As required under PL 102-575 Section 207(c)

October 1995

WATER PRICING POLICY STUDY

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CUP
CENTRAL UTAH WATER CONSERVANCY DISTRICT
COMPLETION ACT

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ACKNOWLEDGEMENTS

The Central Utah Water Conservancy District (CUWCD) would like to particularly acknowledge a number of individuals and groups whose involvement and assistance have been instrumental in the development and execution of the Pricing Study.

Thanks are due to the staff and management of the water utilities of Salt Lake City, Murray City, South Salt Lake City and Provo City for their participation in the Price Elasticity Case Study. Although not included in the Case Study, thanks are also extended to representatives of the Salt Lake County Water Conservancy District and Sandy City for their early participation and review.

Coordination with the agencies that agreed to participate in the Case Study began in earnest in January, 1993. Resource Management International, Inc. (RMI) and CUWCD staff coordinated and consulted with representatives of each of these agencies on a regular basis. From the outset, it was intended that information would flow both ways, that burdens on agency staff time would be kept to a minimum, and that the agencies would be involved in the planning and execution of much of the study. It has been a truly cooperative effort.

After briefing the agencies on the intent of the Case Study, and the Pricing Study as a whole, all four of the agencies agreed to participate and provided CUWCD with information essential to the study. In the development of the Residential Water Customer Survey, input was received from the agencies, and the agencies all were given the opportunity to exclude questions that they felt were inappropriate to ask their customers. Questions not directly related to the case study were also asked to provide the agencies with information about their customers that would be useful to them. In particular, customer service questions were included. After all survey responses were tabulated in a customized database system, each agency received their customers' responses for their own use.

The Water Management Improvement Studies Coordination Committee (WMISCC) was developed to provide a forum for CUWCD to seek ongoing, active participation of the broad range of interests affected by the Water Management Improvement Studies. With representation from all major interest groups, the WMISCC has been used to provide input and feedback of, primarily, a non-technical nature. The WMISCC has also served as an information conduit for disseminating information on Pricing Study efforts to those who they represent. The WMISCC included the following members:

- Nick Sefakis, Metropolitan Water District of Salt Lake City
- David Ovard, Salt Lake County Water Conservancy District
- LeRoy Hooton, Salt Lake City Department of Public Utilities
- Darrel Scow, Sandy City Public Works Department
- Merril Bingham, Provo City Department of Water Resources
- Bruce Chesnut, Orem City Public Works Department
- Lee Roy Farrell, Wasatch County

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- Reed Bezzant, Wasatch County
- Willard Wall, Uintah Basin Water Conservancy District
- John Swasey, Duchesne County
- Dick Saunders, Southern Utah County area
- Robert Shepherd, Juab County area
- Ken Ashby, Sevier River Basin area
- Dave Frandsen, U.S. Bureau of Reclamation
- Harold Thompson, U.S. Environmental Protection Agency
- Larry Anderson, Utah Division of Water Resources
- Brad Barber, Utah Governor's Office of Planning and Budget
- Jeff Appel, Utah Outdoor Interests Coordinating Council
- Carol Withrow, Audubon Society
- Julie Mack, Sundance Institute
- Randy Horiuchi, Salt Lake County Council of Governments
- Malcolm Beck, Utah County Council of Governments
- Jonas Grant, Ute Indian Tribe

Technical and peer review are important aspects of any technically-oriented study. A Technical Committee of local experts was formed and asked to provide focused review of the Case Study methods and preliminary results. The Technical Committee included the following members:

- Dr. Herbert H. Fullerton, Professor of Economics, Utah State University.
- Dr. B. Delworth Gardner, Professor of Economics, Brigham Young University.
- Dr. Roger D. Hansen, U.S. Department of the Interior, Bureau of Reclamation.
- Dr. R. Thayne Robson, Director, Bureau of Economic and Business Research, University of Utah.
- Mr. Lyle C. Summers, Chief Economist, Utah Department of Natural Resources, Division of Water Resources.

CUWCD thanks all members of the Technical Committee, the WMISCC, and the participating agencies for their valuable assistance on this project. While we greatly appreciate all the help these people have provided in reviewing the study, the final responsibility for the Pricing Study lies with CUWCD and its consultant, RMI. Information presented in this document, or subsequent reports, do not necessarily reflect the views or opinions of any individual committee member or agency representative.

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1 INTRODUCTION

1.1 PURPOSE AND AUTHORIZATION OF THE PRICING STUDY

The Central Utah Project Completion Act (Act) provides for Water Management Improvement Studies (WMIS), which are intended to identify cost-effective and environmentally sound measures which will encourage conservation and the wise use of water. Other purposes of the WMIS are to avoid curtailments, reduce costs, improve water quality and streamflows for environmental and recreation benefits, and make prudent use of currently available water before importing Bear River water into Salt Lake County.

Included within the WMIS is the Water Pricing Policy Study (Pricing Study) which is to examine, in consultation with the State and each petitioner of project water, the wholesale and retail pricing of water as a means of achieving water conservation.

The purposes of the Pricing Study as described in the Act are:

1. To design and evaluate potential rate designs and pricing policies for water supply and wastewater treatment within the Central Utah Water Conservancy District (CUWCD) boundary;

2. To estimate demand elasticity for each of the principal categories of end use of water within the CUWCD boundary;

3. To quantify monthly water savings estimated to result from the various designs and policies to be evaluated; and

4. To identify a water pricing system that reflects the incremental scarcity value of water and rewards effective water conservation programs.

Several key concerns regarding the Pricing Study were identified through extensive consultation with water companies and federal, state and local agencies during Phase I of the study. One concern was the possibility that CUWCD would impose pricing system changes on various water purveyors. In fact, the Act does not grant new authority to CUWCD or petitioners of project water to require the implementation of any policies or recommendations contained in this study. CUWCD has made a commitment to recognizing these concerns. As a practical matter, the best way to promote adoption of pricing policies which encourage conservation is to gain the support of water companies and local agencies, and provide a plan for analyzing, selecting, implementing and evaluating pricing systems which not only recover all costs, but which encourage customers to use water wisely.

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1.2 BACKGROUND AND AUTHORITY OF THE ACT

The Central Utah Project Completion Program is a multi-faceted program of water supply development, conveyance, conservation and environmental mitigation and enhancement. The Central Utah Project will allow the development of some of Utah's share of the Colorado River to the mutual benefit of municipal, irrigation and environmental purposes.

The Completion Program has been divided into five elements. These include the Uinta Basin Replacement Project, the Spanish Fork Canyon-Nephi Irrigation System, the Diamond Fork System, the Wasatch County Water Efficiency Project and the WMIS. The need for coordination between the WMIS and the other elements of the Completion Program is emphasized and embodied in CUWCD's approach to managing the Program, and that coordination is an important premise of this study.

Section 207 of the Act describes the WMIS, which include three programs in addition to the Pricing Study. These programs are the Water Management Improvement Plan, Coordinated Operations Study, and Utah Water Conservation Advisory Board.

CUWCD is required to meet a quantified goal for water conservation by measures identified through a Water Management Improvement Plan. The plan will estimate the savings attributable to each measure, evaluate the cost effectiveness and environmental effects, present an implementation plan, and an evaluation of any measures already completed. The Water Management Improvement Plan will be updated every three years. A total of $50 million in federal appropriations is authorized by the Completion Act for conservation measures implemented pursuant to the Water Management Improvement Plan. The Coordinated Operations Study examines the coordinated operation of independent water systems and the potential modification of operating agreements for reservoirs. Finally, the Utah Water Conservation Advisory Board was appointed by the Governor and, as charged by the Act, has recommended water conservation standards and regulations for promulgation by State or local authorities in the service area of each petitioner of project water.

Section 207(c) of the Completion Act mandates that the CUWCD complete the Pricing Study within the legislatively mandated time period of three years from the passage of the Act. The study together with its conclusions and recommendations has been made available for public review and will be transmitted to the Secretary of the Interior by October 30, 1995.

Although the Pricing Study must be submitted to the Secretary, no action by the Secretary is required. In addition, the Completion Act gives CUWCD no authority to require any agency or petitioner to implement any pricing policy or rate structure. Although CUWCD can not impose pricing policies on any entity, those rate structures which reduce water demand are eligible for consideration in the Water Management Improvement Plan. CUWCD intends that this study be used by water agencies as a tool to assist them as they develop their own future pricing policies and resource plans.

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A credible effort to meeting the purposes of the WMIS is critically important to CUWCD and to the petitioners of project water. There are two significant actions that the Secretary of the Interior may take if CUWCD is found to be in substantial non-compliance with the provisions of Section 207 of the Act. First, Section 207(g) provides for a surcharge of 5 percent of CUWCD's total annual Bonneville Unit repayment obligation if the WMIS are not completed or transmitted to the Secretary. While that surcharge will be refunded if the noncompliance is corrected within one year, it also provides for a surcharge of up to 15 percent if the substantial noncompliance is not corrected.

A second incentive to successfully implement the WMIS is provided by Section 211 of the Act which allows the M&I portion of the CUP completion costs to be repaid in accordance with existing repayment contracts. Any costs in excess of the repayment obligations described in those contracts will be deferred indefinitely, as long as no finding of substantial noncompliance with Section 207 is made. If such a finding were made, then the cost allocated to M&I may be more than the cost to be repaid under the existing repayment contracts, which could increase the cost of water delivered to the petitioners.

1.3 REPORT ORGANIZATION

This report is intended to provide conclusions and recommendations resulting from the Pricing Study and to reflect the study's practical applications as well as to document the technical analysis required to comply with the Act. The report is segmented into three parts, not including a two-chapter introduction to the study and the study area.

Part I focuses on policy analysis by exploring the role of pricing in water agency planning and by evaluating a number of alternative pricing policies based on identified criteria, including water conservation.

Part II contains the technical analysis performed to fulfill the requirements of the Act. In particular, it documents the methods used to develop estimates of price elasticity of demand, quantified conservation potential, and the impact of phasing out ad valorem tax collections by CUWCD and the petitioners of CUP water.

Part III summarizes the conclusions that can be drawn as a result of the study. A step-by-step discussion of how this study meets the requirements of the Act is provided, as are recommendations resulting from the study.

1.4 STUDY LIMITATIONS

As with any study that discusses projections and forecasts, the conclusions of this study are derived under a set of assumptions. When actual conditions deviate from the assumptions that have been made, the results of any analysis that is dependent on those assumptions will deviate from expected results.

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2 THE CUWCD SERVICE AREA

CUWCD is a wholesale water provider whose primary purpose is to manage the CUP and distribute water developed by this project to consumers in a ten county area in central and southern Utah (see Figure 2.1). Although CUWCD is the largest water agency within its service area, it supplies a very small portion of the total water used in the area. Of the more than 2 million acre-feet of water used in the service area in 1990, less than two percent was supplied by CUWCD. The remaining 98 percent was provided from local sources owned and operated by individual water agencies. It is estimated that at full development of the CUP, CUWCD will supply approximately nine percent of the total water used within its service area.

2.1 GEOGRAPHIC AREA

The topography and climate of the CUWCD service area varies considerably. The topography ranges from 13,000 foot peaks in the Wasatch and High Uinta Mountain Ranges to Great Basin desert lowlands. Uintah, Duchesne and Wasatch Counties, along with the small portion of Summit County that is within the CUWCD service area, are to the east of the Wasatch Mountains and drain into the Colorado River Basin. The remaining counties lie to the west of the Wasatch Mountains and drain into the Great Basin.

Severe climatic extremes are evident in the area. Extreme cold temperatures and heavy precipitation can be found in the higher elevations, with more moderate seasonal variations found in some of the central valleys and low precipitation levels found in the arid desert lowlands. Average annual rainfall in the CUWCD service area ranges from 8" in the Vernal area to 15" along the Wasatch Front. Table 2.1 documents regional and seasonal temperature differences in the service area.

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Figure 2.1
CUWCD Service Area

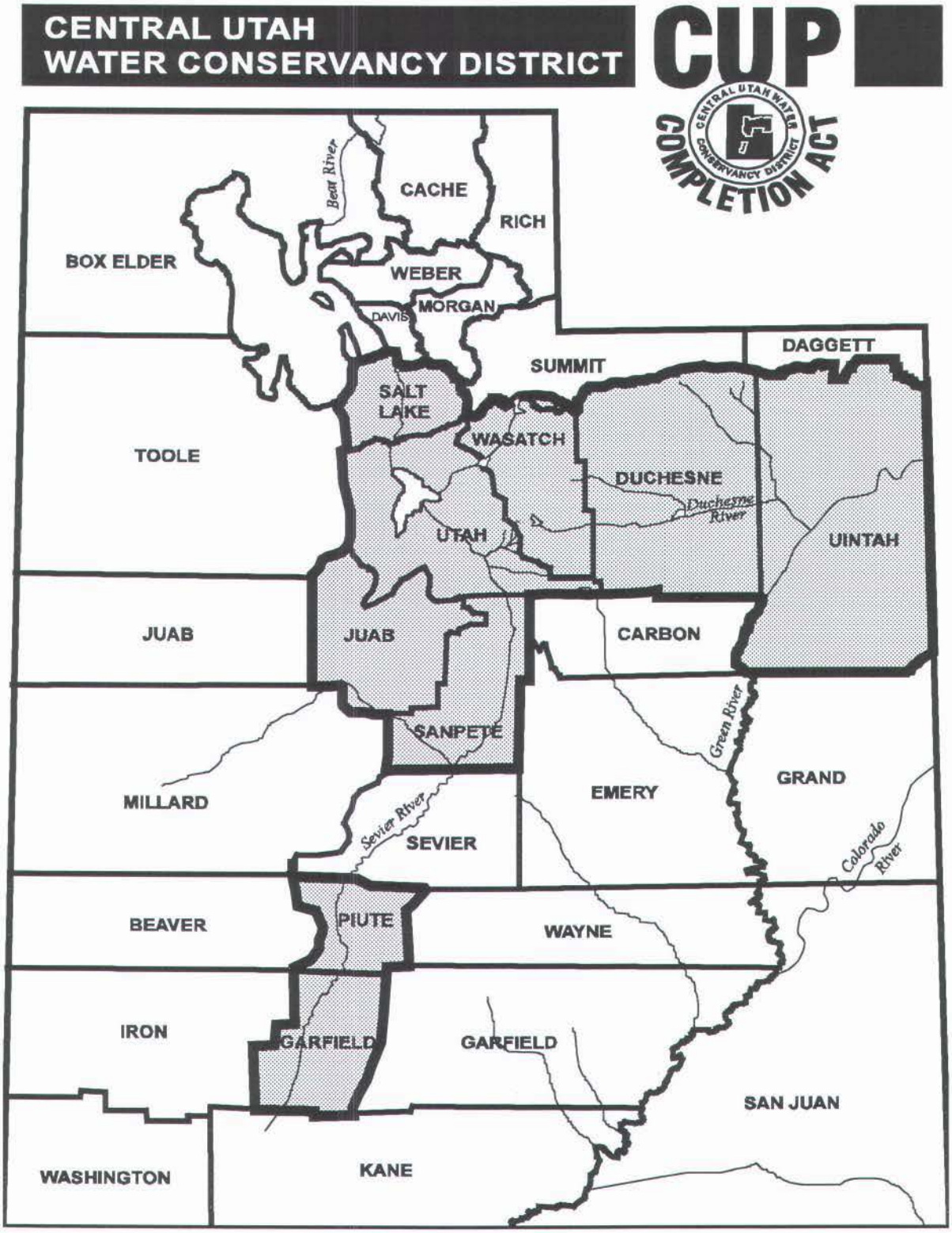

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Table 2.1
Average Temperature Range in CUWCD Service Area[1]

County[2]	City	Maximum Average High Temperature in July (degrees F)	Minimum Average Low Temperature in January (degrees F)
Duchesne	Duchesne	83.9	6.5
Garfield	Panguitch	86.0	12.1
Juab	Nephi	87.6	16.6
Piute	Circleville	84.7	19.1
Salt Lake	Salt Lake City	83.6	16.6
Sanpete	Manti	81.8	16.8
Uintah	Roosevelt	88.9	3.0
Utah	Provo	90.1	20.7
Wasatch	Heber	84.2	7.5

[1] Source: 1993 - National Oceanic and Atmospheric Administration.
[2] Summit County is excluded due to lack of data within CUWCD service area.

2.2 CUSTOMER CHARACTERISTICS

Population and Economic Distribution

The population and economic distribution within the CUWCD service area is also quite broad. Tables 2.2 - 2.12 reflect the economic and demographic diversity of the area by county.

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Table 2.2
Population Projections in CUWCD Service Area[1]

County[2]	1980	1990	1995	2000
Duchesne	12,565	12,600	13,371	13,656
Garfield	3,673	3,950	4,289	4,645
Juab	5,530	5,800	6,446	6,635
Piute	1,329	1,250	1,515	1,535
Salt Lake	619,066	728,000	811,839	875,525
Sanpete	14,609	16,300	18,588	19,613
Uintah	20,506	22,200	24,182	25,307
Utah	218,106	266,000	310,538	340,877
Wasatch	8,523	10,100	11,938	13,228
TOTAL	905,888	1,068,191	1,204,702	1,303,022

[1] Source: State of Utah Economic & Demographic Projections: 1994.
[2] Summit County is excluded due to lack of data within CUWCD service area.

The largest population growth is expected in Utah, Wasatch and Salt Lake Counties. In addition to the high percentage growth, Salt Lake and Utah Counties are by far the most populous counties in the State of Utah. This reinforces the expected need for increased culinary water availability in these areas.

In reviewing Tables 2.3-2.11, interpretive emphasis should be placed on those industrial sectors that traditionally use significant amounts of water. In particular, agriculture, mining, and manufacturing can potentially use very large quantities of water per employee in their production processes. Other sectors, which are more commercial in nature, generally use less water per employee than agriculture, mining and manufacturing.

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Table 2.3
Total Employment Projections - Duchesne County[1]

Industry	1980	1990	1995	2000
Agriculture	870	928	899	903
Mining	1,070	448	492	489
Construction	210	102	159	169
Manufacturing	170	138	268	302
TCPU	240	397	503	560
Trade	890	796	869	915
FIRE	80	136	96	101
Services	300	449	461	506
Government	1,100	1,214	1,474	1,434
TOTAL	4,930	4,608	5,221	5,379

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Duchesne County is led by the transportation, communication and public utilities (TCPU) sector, and the manufacturing and services sector. The agriculture sector is projected to grow slightly. Mining appears to have stabilized after a significant reduction between 1980 and 1990.

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Table 2.4
Total Employment Projections - Garfield County[1]

Industry	1980	1990	1995	2000
Agriculture	290	287	281	281
Mining	210	7	8	8
Construction	380	23	36	36
Manufacturing	250	209	111	117
TCPU	90	59	65	67
Trade	130	189	221	239
FIRE	20	22	20	22
Services	270	510	701	776
Government	460	459	484	498
TOTAL	2,100	1,765	1,927	2,044

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Garfield County is led by the services and trade sectors. The mining and manufacturing sectors appear to have stabilized after significant reductions between 1980 and 1990. Agriculture remains stable.

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Table 2.5
Total Employment Projections - Juab County[1]

Industry	1980	1990	1995	2000
Agriculture	320	297	284	288
Mining	100	107	45	45
Construction	150	109	93	96
Manufacturing	420	250	338	347
TCPU	50	28	58	61
Trade	410	489	555	575
FIRE	40	27	41	42
Services	190	293	473	498
Government	420	462	545	540
TOTAL	2,100	2,062	2,432	2,492

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Juab County is led by the services and trade sectors. The mining sector appears to have stabilized after significant reductions between 1980 and 1990. Manufacturing has shown some substantial recent growth after significant reductions between 1980 and 1990. The agricultural sector appears to have stabilized after minor reductions between 1980 and 1990.

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Table 2.6
Total Employment Projections - Piute County[1]

Industry	1980	1990	1995	2000
Agriculture	160	154	149	151
Mining	30	1	0	0
Construction	20	0	2	2
Manufacturing	30	29	55	56
TCPU	10	12	16	17
Trade	20	18	25	27
FIRE	10	5	8	8
Services	10	8	14	15
Government	140	115	135	134
TOTAL	430.00	342.00	404.00	410.00

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Piute County is led by the manufacturing and TCPU sectors. The mining sector has disappeared. Agriculture has remained stable.

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Table 2.7
Total Employment Projections - Salt Lake County[1]

Industry	1980	1990	1995	2000
Agriculture	1,800	2,295	2,674	3,012
Mining	6,060	2,754	3,151	3,202
Construction	16,440	14,885	19,179	18,144
Manufacturing	46,180	50,580	54,479	59,388
TCPU	22,310	28,293	34,388	37,991
Trade	74,460	93,170	109,464	120,537
FIRE	17,480	24,530	29,806	32,929
Services	52,730	95,389	121,939	140,989
Government	48,960	58,878	70,412	75,062
TOTAL	286,420	370,774	445,492	491,254

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Salt Lake County is strong across all sectors other than mining. While the trade and services sectors provide the largest number of jobs, relative growth in the manufacturing and agricultural sectors is strong.

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Table 2.8
Total Employment Projections - Sanpete County[1]

Industry	1980	1990	1995	2000
Agriculture	1,170	1,070	999	1,014
Mining	10	0	0	0
Construction	140	141	162	172
Manufacturing	890	865	712	741
TCPU	80	126	135	145
Trade	500	823	1,023	1,120
FIRE	90	97	126	136
Services	400	425	616	689
Government	1,230	1,661	2,275	2,460
TOTAL	4,510	5,208	6,048	6,477

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Sanpete County is led by the trade and government sectors. The mining sector has disappeared. Agriculture has remained relatively stable. Manufacturing is rebounding from a reduction in employment between 1980 and 1990.

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Table 2.9
Total Employment Projections - Uintah County[1]

Industry	1980	1990	1995	2000
Agriculture	740	784	773	779
Mining	1,670	1,161	1,039	1,052
Construction	270	197	226	249
Manufacturing	180	195	255	260
TCPU	610	598	643	733
Trade	1,410	1,486	1,858	1,991
FIRE	160	110	109	115
Services	1,460	1,352	1,620	1,831
Government	1,150	1,623	1,787	1,769
TOTAL	7,650	7,506	8,310	8,779

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Uintah County is led by the trade, services, government and manufacturing sectors. The mining sector has stabilized after a significant reduction between 1980 and 1990. Agriculture has remained relatively stable.

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Table 2.10
Total Employment Projections - Utah County[1]

Industry	1980	1990	1995	2000
Agriculture	2,660	2,625	2,866	3,034
Mining	360	40	81	83
Construction	3,320	2,989	5,781	6,210
Manufacturing	12,970	14,089	15,012	16,131
TCPU	2,170	2,518	2,356	2,683
Trade	12,640	21,929	27,040	30,730
FIRE	2,020	2,275	3,032	3,405
Services	19,140	35,640	48,595	55,986
Government	11,130	14,660	17,972	20,236
TOTAL	66,410	96,765	122,735	138,498

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Utah County is strong across all sectors other than mining. Agriculture and manufacturing continue to show steady growth.

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Table 2.11
Total Employment Projections - Wasatch County[1]

Industry	1980	1990	1995	2000
Agriculture	430	436	426	434
Mining	80	0	0	0
Construction	380	276	322	349
Manufacturing	160	121	146	163
TCPU	50	90	103	118
Trade	500	602	859	987
FIRE	70	71	57	65
Services	280	703	899	1,090
Government	630	674	772	849
TOTAL	2,580	2,973	3,584	4,055

[1] Source: State of Utah Economic & Demographic Projections: 1994.

Employment growth in Wasatch County is led by the services, TCPU and trade sectors. The mining sector has disappeared. Manufacturing has rebounded after reductions in employment from 1980 to 1990. Agriculture remains stable.

Table 2.12 shows the marked contrast between high-income, high employment areas such as Salt Lake, Utah and Wasatch Counties, and lower-income, lower-employment areas such as Piute, Garfield and Sanpete Counties.

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Table 2.12
Economic & Demographic Characteristics (1990) - CUWCD Service Area[1]

County[2]	Median Age	Persons Per Household	Per Capita Income	Median Household Income	Median Home Value	Unemploy Rate
Duchesne	24	3.40	$12,245	$23,653	$43,400	8.1%
Garfield	30	3.00	$12,840	$21,160	$49,800	10.5%
Juab	27	3.18	$10,710	$23,569	$43,300	6.4%
Piute	37	2.84	$11,097	$19,125	$45,500	11.4%
Salt Lake	26	2.98	$15,399	$30,149	$71,000	3.8%
Sanpete	23	3.24	$10,733	$20,197	$47,000	9.1%
Uintah	25	3.31	$11,053	$23,968	$44,400	6.3%
Utah	21	3.63	$11,467	$27,432	$70,000	3.7%
Wasatch	26	3.26	$12,603	$27,981	$69,900	6.6%

[1] Source: 1993 Statistical Abstract of Utah, Bureau of Economic and Business Research, David Eccles School of Business, University of Utah.
[2] Summit County is excluded due to lack of data within CUWCD service area.

Survey of Customers for Water Management Improvement Studies
To characterize retail customer characteristics and perceptions, two surveys were performed by CUWCD within the service area. The first survey was a telephone survey intended to be statistically representative of residential customers within the CUWCD service area. (This survey is referred to herein as the "Regional Survey.")

The second survey (referred to as the "Elasticity Study Survey") was a mail survey targeting a random sample of residential customers within the retail service areas of Salt Lake City, Murray City, and South Salt Lake City water departments. This survey was conducted to collect data specifically for the price elasticity study and was, thus, rather limited in geographic coverage.

Copies of the two survey instruments are included in Appendix A.

Regional Survey Results
Survey respondents in the Regional Survey were asked whether they believed that the use of increasing block rates is a fair way to calculate water rates. Four categories were provided

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for responses ranging from Definitely to Definitely Not. Sixty-five (65) percent of the respondents answered Definitely or Probably while only 26 percent responded Probably Not or Definitely Not.

Survey respondents were asked for their response to a number of statements listing ways a water agency can encourage water conservation. The results of these questions are summarized on Table 2.13. The results reiterate the results of the question discussed above, i.e., that respondents believe that customers that use more water should pay more than customers that use less water. The results also indicate that respondents are generally opposed to using higher prices as a means of eliciting conservation.

The question concerning seasonal rate differentials provides interesting but incomplete data. Customers clearly oppose using higher prices to elicit conservation. However, if developed to be revenue neutral, seasonal rates afford customers the opportunity to lower their overall water bill by conserving water relative to the bills they would have otherwise received. The seasonal rate question was phrased in the negative sense, i.e., would you want to pay more in the summer than in the winter, and customers responded accordingly. The survey would have provided more complete information if customers had been asked if they would be willing to pay more in the summer in exchange for the opportunity to lower their total annual bill, or asked if they would be willing to pay higher bills in the summer knowing that their annual bill would remain the same.

Table 2.14 reports the results of questions addressed to the 42 respondents that reported using water for producing crops or livestock for sale. The percentage of irrigators that oppose using higher prices as a means for eliciting conservation (67) matches fairly closely the percentages from the overall body of survey respondents. Forty-three (43) percent of irrigators oppose metering as a means of eliciting conservation while 50 percent of irrigators favor metering.

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Table 2.13
Attitudes Of Respondents Towards Pricing As Conservation Tool[1]

Survey Question	Percent Opposed[2]	Percent Favor[3]
Charging higher rates for water so people use less water	76	23
Charging more for water use in the summer than in the winter	65	31
Restructuring water rates so customers who use less water pay less per gallon than those who use more water	30	65

[1] Numbers do not add to 100 percent because of "Don't Know" or "No Response" categories.
[2] Includes categories "Strongly Oppose" and "Somewhat Oppose."
[3] Includes categories "Strongly Favor" and "Somewhat Favor."

Table 2.14
Attitudes Of Irrigators Towards Pricing As Conservation Tool[1]

Survey Question	Percent Opposed[2]	Percent Favor[3]
Charging higher rates for purchased water	67	21
Metered water use	43	50

[1] Numbers do not add to 100 percent because of "Don't Know" or "No Response" categories.
[2] Includes categories "Strongly Oppose" and "Somewhat Oppose."
[3] Includes categories "Strongly Favor" and "Somewhat Favor."

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Elasticity Study Survey Results

The Elasticity Study Survey was composed entirely of residential customers in the service areas of three utilities in the Salt Lake City area. Thus, the results are not representative of the entire CUWCD service area. The Elasticity Study Survey, however, is the only currently available source for a wide range of attitudinal data. Thus, the results are presented herein with the caveat that the data can be considered anecdotal to the entire region.

The Elasticity Study Survey included a number of attitudinal questions and questions concerning water conserving behaviors. The majority of respondents (63 percent) felt that they were well informed about water supply issues in their community. Seventy-four (74) percent of respondents consider it "Of considerable importance" or "Extremely important" to conserve water in their community. Another 26 percent felt it was "Somewhat important" and only one percent felt that it was "Not Important." This compares to 95 percent of Regional Survey respondents that felt it was either "Very Important" or "Somewhat Important" to conserve water in their community. Ninety-four (94) percent of Elasticity Study Survey respondents either "Strongly agreed" or "Agreed" that it was the utility's responsibility to promote conservation while six percent either "Disagreed" or "Strongly Disagreed."

The Elasticity Study Survey also included numerous questions inquiring about respondents' knowledge of water rates and their water bills. Customers were asked to respond to a number of statements, indicating whether and how strongly they agree or disagree. Table 2.15 provides a summary of responses to a number of rate-related questions. (Note that the order in which questions appear on Table 2.15 is not the same as the order in which they appeared on the questionnaire.) Interesting findings emerge from reviewing questions by related groupings, and results. These are as follows:

- The first two questions ask, essentially, whether customers believe that their bill is under their control. Sixty-nine (69) and 64 percent agreed with statements indicating that the magnitude of their bills is not entirely under their control.

- The response to the third question concerning whether the bill is too high was split almost 50-50.

- The fourth, fifth, and sixth questions ask whether the customers trust their utilities. Two-thirds to three-quarters of the customers agreed with statements indicating that they trust their utilities.

- The seventh question provides ambiguous data. Taken in concert with the fact that the vast majority of respondents think it is the utility's responsibility to promote conservation, the results to question seven indicate that customers believe the responsibility is full-time, not just during drought years. This is not clear from the question, merely implied.

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- The final four questions (8 through 11) indicate that respondents do track water bills and water rates. However, the response to questions 8 and 9 do not match particularly well despite the fact that they are nearly the same question. The differences might indicate that the respondents know what recent bills have been, but do not know how they compare to earlier bills.

In summary, the Elasticity Study Survey indicates that customers:

(1) are concerned about the level of their water bills and the level of their control over their bills;
(2) trust their utilities; and
(3) think it is the utility's responsibility to promote conservation.

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Table 2.15
Elasticity Study Survey Results
For Rate Issues And Water Bills
(Percent)*

Rate Issues / Water Bill Statements	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. I am very concerned that my water bills will be more than I can comfortably afford.	5	10	16	22	19	28
2. No matter how hard I try to conserve water, I only save pennies a day.	5	8	21	36	16	12
3. I think my water bill is too high.	9	15	25	25	13	13
4. The water company controls water rates effectively.	9	8	20	40	16	7
5. The rates I pay for water are reasonable.	7	6	12	33	22	19
6. I trust my water company to provide water at a fair and reasonable price.	6	8	10	28	23	25
7. Rate increases should be made to fund water conservation only during a serious water shortage.	16	11	17	18	17	21
8. I track my water costs pretty closely.	9	18	20	23	16	13
9. I know how much I pay for water each month.	5	6	8	18	25	39
10. What I pay for water influences my level of water use.	9	14	16	29	16	16
11. I am well informed about the rates charged by my water company.	8	14	19	30	17	12

* Percentages may not add to 100 due to rounding of individual numbers.

Conservation Practices

Both the Regional Survey and the Elasticity Study Survey asked questions concerning behaviors adopted or actions taken to conserve water. Table 2.16 summarizes the results of these two surveys.

The results on Table 2.16 provide some interesting information related to customers' water conserving behaviors. First, the most frequently adopted behaviors conserve **heated** water. Saving water in the shower (or bathtub), the dishwasher, and clothes washers save money on the electric or natural gas bills for heating water. On the Regional survey, these actions were the only actions with acceptance rates above 80 percent and the two comparable questions on the Elasticity Study Survey showed similar results. Table 2.17 shows a similar trend insofar as the two most widely adopted appliances save heated water -- efficient clothes washers and efficient dish washers. This finding points to an opportunity to spur yet further water conservation by building an additional awareness of the potential energy bill savings

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available through widespread installation of low-flow showerheads and faucet aerators with shut-off valves.

The numbers on Table 2.17 indicate that there are significant levels of penetration of some technologies into the market, particularly those technologies that conserve heated water. In addition to those mentioned in the earlier discussion, low-flow showerheads and faucet aerators have penetration rates above 50 percent, while other indoor technologies are well under 50 percent. Two outdoor technologies -- shut-off nozzles and timers for sprinkler systems -- also exhibit greater than 50 percent penetration rates.

The numbers on Table 2.17 also indicate that there is significant opportunity for increased penetration of water conserving devices into the existing residential market. This is particularly true for the indoor end-uses that do not impact heated water usage. The large Don't Know and No Response figures indicate that there is a substantial lack of understanding in the market place. In some cases (such as a low-flow faucet), unless the survey respondent installed the faucet, it would be hard for the respondent to actually know. As an example, respondents would need to be sufficiently knowledgeable to perform a timed running of the faucet to measure the gallons per minute and to know whether the result represented low-flow. In other cases, such as the toilet tank displacement dam, the respondent might not know, but it should be simple to find out. Residential water audit programs represent one avenue for assisting customers in determining additional potential for water conservation.

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Table 2.16
Comparative Statistics On Water Conserving Behaviors And Actions
Regional Survey Compared To Elasticity Study Survey
(Percent)*

Behavior Or Action	Regional Survey		Elasticity Study Survey	
	Always or Most of Time	Seldom or Never	Yes	No
Water lawns less frequently than normal	65	26	68	28
Not letting water run when brushing teeth, shaving, washing dishes or washing your car[1]	74	27		
• Turn off water while brushing teeth[1]			79	19
• Turn off water while shaving[1]			78	16
• Wash dishes with the basin filled[1]			55	41
• Wash car with bucket[1]			70	26
Read information on how to conserve water	43	56		
Landscape your yard to require less water	40	50	49	41
Full loads when washing clothes[2]	93	5	96	3
Installed water saving plumbing fixtures such as low flow toilets, or shower heads[3]	56	38		
• Low-flow toilet[3]			31	59
• Low-flow shower head[3]			54	38
Full loads on dish washing[4]	82	10	80	15
Installed automatic sprinkling system[5]	51	40	59	40
Shower rather than bathing[6]	87	14	66	29

[1] The question on the Regional Survey combined four questions. The Elasticity Study Survey asked these questions individually.
[2] The Elasticity Study Survey asked "Match water level to size of laundry."
[3] The question on the Regional Survey combined two questions. The Elasticity Study Survey asked these questions individually.
[4] The Elasticity Study Survey asked "Match cycle time to dishwasher load."
[5] The Elasticity Study Survey asked "Automatic timer for sprinkler system."
[6] The Elasticity Study Survey asked a different question -- "Use less water in tub."

* Percentages do not add to 100 due to exclusion of No Response and Don't Know.

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Table 2.17
Adoption Rates For Water Conserving Appliances And Devices[1]
Among Elasticity Study Survey Respondents
(Percent)

Appliance / Device	Yes	No	Don't Know	No Response
Toilet tank displacement dam	10	81	9	22
Toilet tank displacement bag	9	84	7	21
Low-flow toilet	31	59	10	15
Low-flow showerhead	54	38	7	16
Low-flow faucet	24	65	11	20
Self closing faucet	5	83	13	23
Faucet aerator	56	35	9	18
Efficient clothes washer (adjustable water levels)	90	8	2	9
Efficient dishwasher (adjustable cycle time)	74	24	2	26
Shut-off nozzle for garden hose	56	41	3	18
Automatic timer for sprinkler system	59	40	1	23
Drip irrigation system	13	85	1	28

[1] The question asked "Do you currently use any of the following water conservation appliances / devices?"

Non-Residential Customer Characteristics

At this point in time, very little information is available for non-residential customers on a region-wide basis. Surveys of natures similar to the Regional Survey or the Elasticity Study Survey have yet to be performed. Thus, the only real sources of data are Census Bureau and other State and Federal agencies.

Summary Of Customer Attitudinal And Characteristics Data

Related specifically to water conservation rates and practices, the following summary statements can be made based on residential survey data available at this time.

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1. Residential customers are opposed to the concept of simply raising rates to induce water conservation.

2. Residential customers favor the concept of linking water use and per unit price.

3. Residential customers believe it is the utility's responsibility to promote water conservation.

4. Residential customers have adopted fairly significant levels of water conserving behaviors and appliances / devices. Significant potential remains in the residential sector for installation of additional water conserving technologies.

5. Residential customers have some difficulty responding to questions concerning the installation of water conserving technologies within their residences. Utility water audit or informational programs could assist customers in recognizing whether they have low-flow devices in their home.

2.3 CHARACTERISTICS OF WATER AGENCIES

As part of the Water Management Improvement Studies, a water usage inventory questionnaire was distributed to water agencies in Salt Lake, Utah and Wasatch Counties and the Uinta Basin in May 1992.

Questionnaires were delivered to 324 water agencies. Responses were received from 134 agencies, representing a response rate of 41 percent. Of the 167 questionnaires delivered to Salt Lake County agencies, 61 (37 percent) were completed and returned. Utah County agencies returned 49 of 113 questionnaires for a response rate of 43 percent, and 9 of 14 questionnaires delivered to Wasatch County agencies (64 percent) were returned. In the Uinta Basin, 15 of 30 questionnaires (50 percent) were completed and returned.

The 134 respondents provided information on the size and structure of their agencies, primary sources of supply, pricing systems employed, customer classes served, and water conservation programs in place or planned.

The responding agencies serve a total of 258,409 customers. Total annual water sales are 692,114 acre-feet. Average annual sales per customer is 2.68 acre-feet.

Agency Size and Structure

Respondents most frequently identified themselves as canal or ditch companies, privately owned community water companies, or municipal water utilities (see Figure 2.2). Municipal water utilities easily serve the greatest number of customers, serving more customers than all other agency types combined. Municipal water utilities also supply the greatest amount of water, almost 290,000 acre-feet, although canal or ditch companies also deliver a substantial amount of water (over 204,000 acre-feet).

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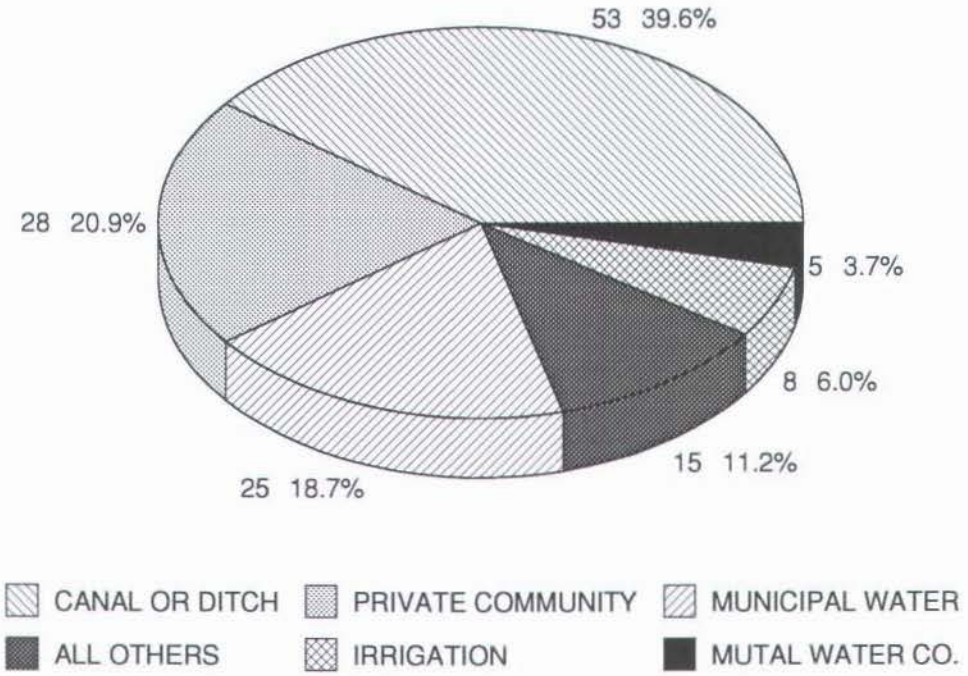
Figure 2.2
TOTAL RESPONDENTS BY AGENCY TYPE



A large number of canal or ditch companies have small customer bases but sell a proportionately large amount of water to each customer. Privately owned community water companies are also characterized by a small customer base, however, they generally sell less than one acre-foot per customer. Customer base varies widely for municipal water utilities, with the vast majority of agencies selling less than two acre-feet per customer.

The presence of irrigation companies in the Uinta Basin appears to be the explanation for the larger proportion of agencies (67 percent) that sell over ten acre-feet per customer. Conversely, the large proportion (46 percent) of agencies in Salt Lake County that sell less than one acre-foot per customer is probably reflective of the high incidence of agencies that serve residential customers in Salt Lake County.

Size of agency is reflected by the number of customers served and the amount of water sold by the respondent. Number of customers is defined as the number of billed customers or connections, not total population served. Amount of water sold is expressed in acre-feet. A number of agencies were not able to provide this information.

The majority of respondents serve less than 100 customers (see Figure 2.3), reflecting the presence of a large number of relatively small water companies.

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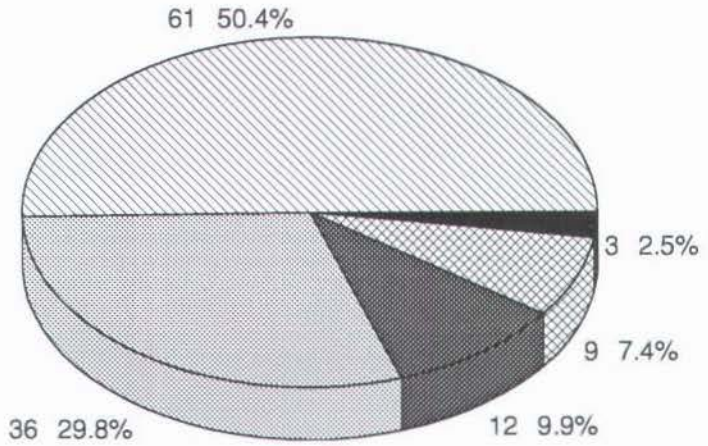
Figure 2.3

AGENCY SIZE BY NUMBER OF CUSTOMERS

 # OF RESPONDENTS IN EACH CATEGORY



OF TOTAL CUSTOMERS SERVED

Average sales per customer were computed using only the information from those agencies that provided both their total water sales and total customers served. Average sales per customer is not the direct quotient of total water sales divided by total customers served. A respondent breakdown of average annual sales per customer is shown in Figure 2.4.

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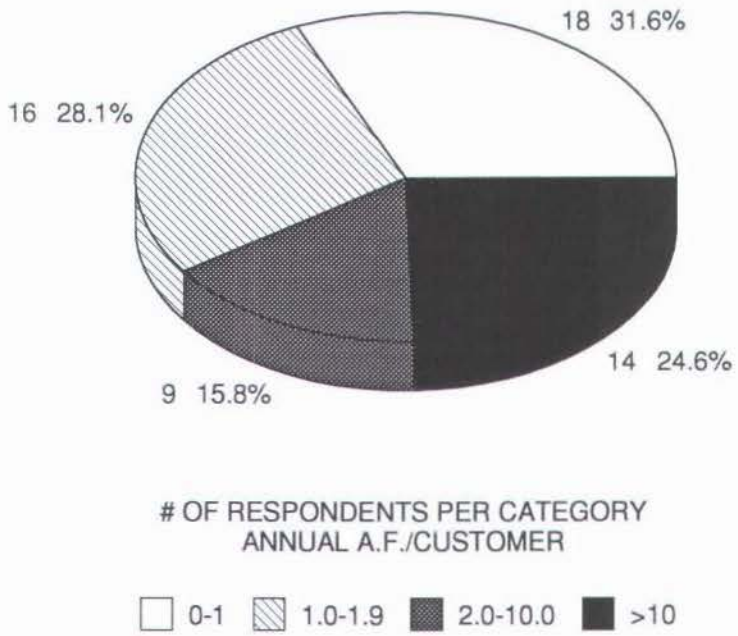
Figure 2.4
CUSTOMER USE
SALES PER CUSTOMER (ACRE-FEET)



Customer Class

Not surprisingly, the majority of customers served are residential customers (see Figures 2.7-2.10). However, almost half of the water sold is to irrigation customers. As would be expected, average sales per customer is lowest for residential customers and highest for wholesale customers (see Figure 2.5).

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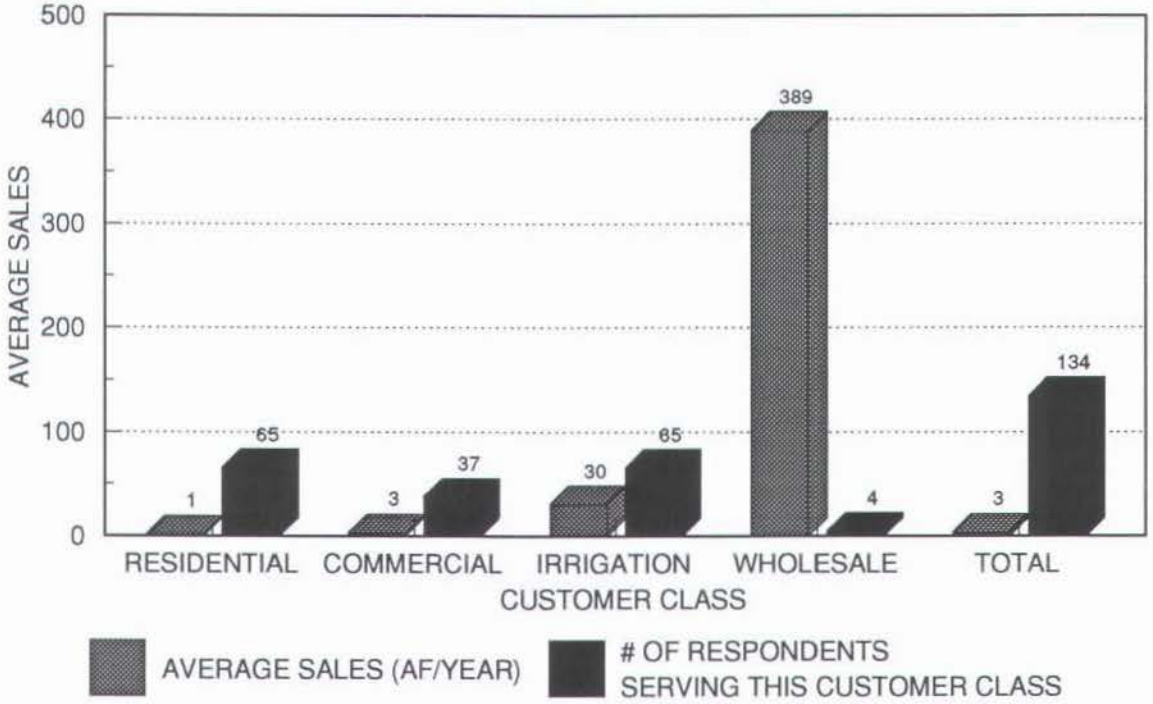
Figure 2.5
AVERAGE WATER DELIVERIES BY CUSTOMER CLASS



Source of Supply

Fifty percent of responding agencies get all of their annual supplies from a single source. Of the agencies that use a single supply source, 49 percent are supplied by a surface water source (see Figure 2.6).

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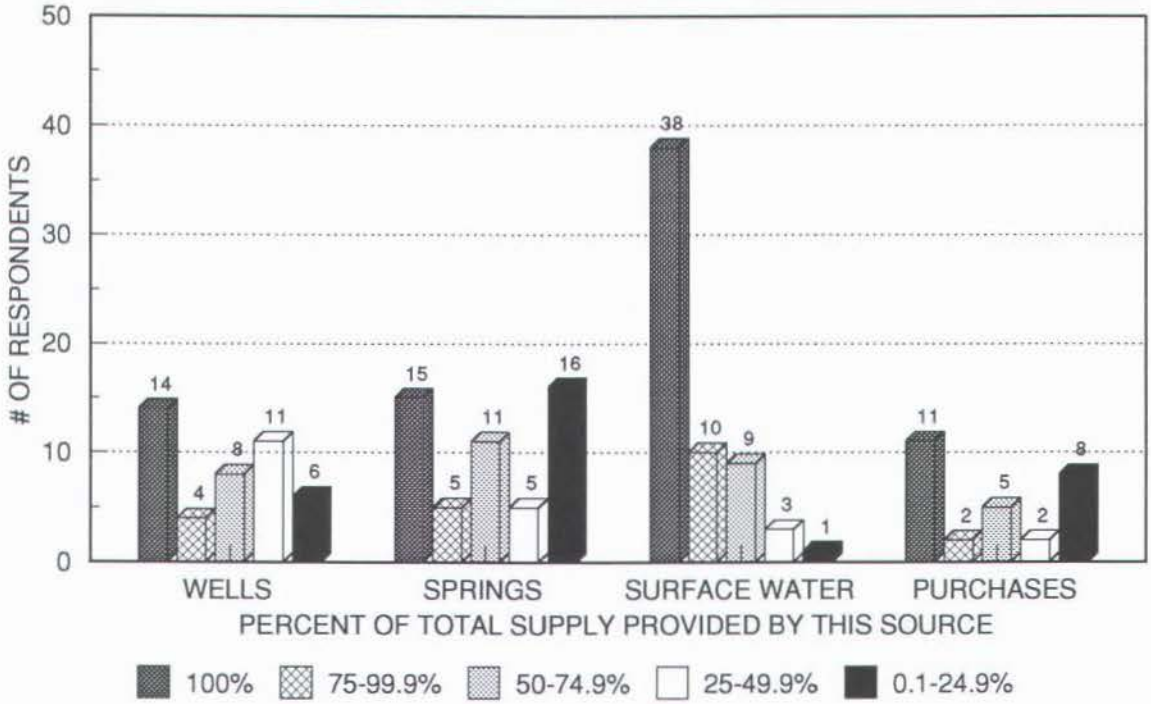
Figure 2.6
WATER AGENCY SOURCES OF AVERAGE ANNUAL WATER SUPPLY



Pricing Structures

A large majority of residential, commercial, and wholesale customers are charged under a minimum charge pricing system (see Figures 2.7-2.10). Pricing structures faced by irrigation customers are more evenly spread between a fixed charge system, a flat rate system, a minimum charge system, and other pricing systems. Only two responding agencies employ an increasing block pricing structure. The number of agencies employing each pricing structure is more evenly distributed that the number of customers served by each pricing structure (see Figures 2.11-2.14). This suggests the use of a minimum charge system by more "large" companies.

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Figure 2.7
NUMBER OF RESIDENTIAL CUSTOMERS SERVED BY EACH PRICING STRUCTURE

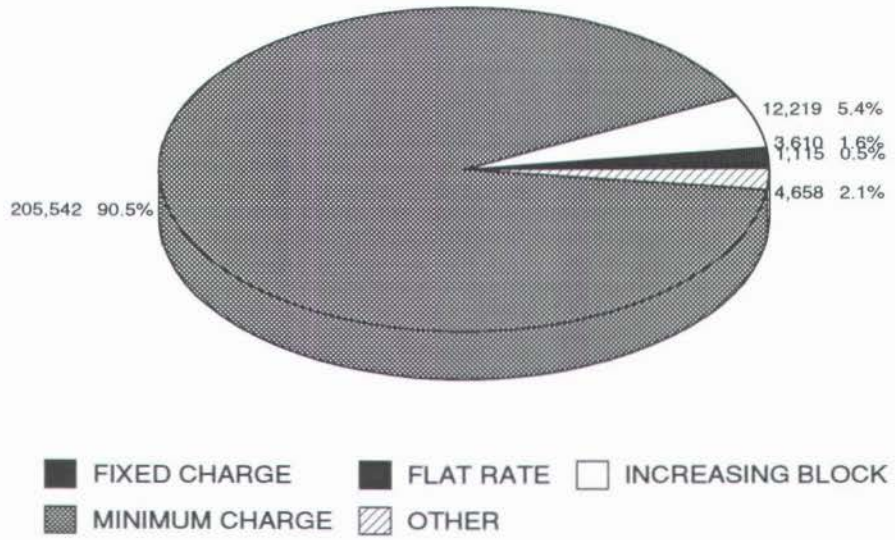

Figure 2.8
NUMBER OF COMMERCIAL CUSTOMERS SERVED BY EACH PRICING STRUCTURE

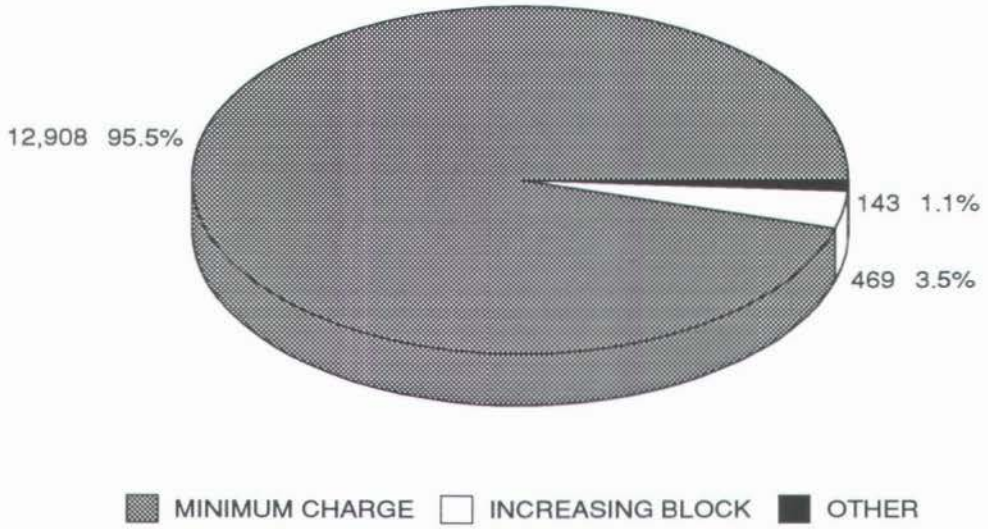

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Figure 2.9
NUMBER OF IRRIGATION CUSTOMERS SERVED BY EACH PRICING STRUCTURE

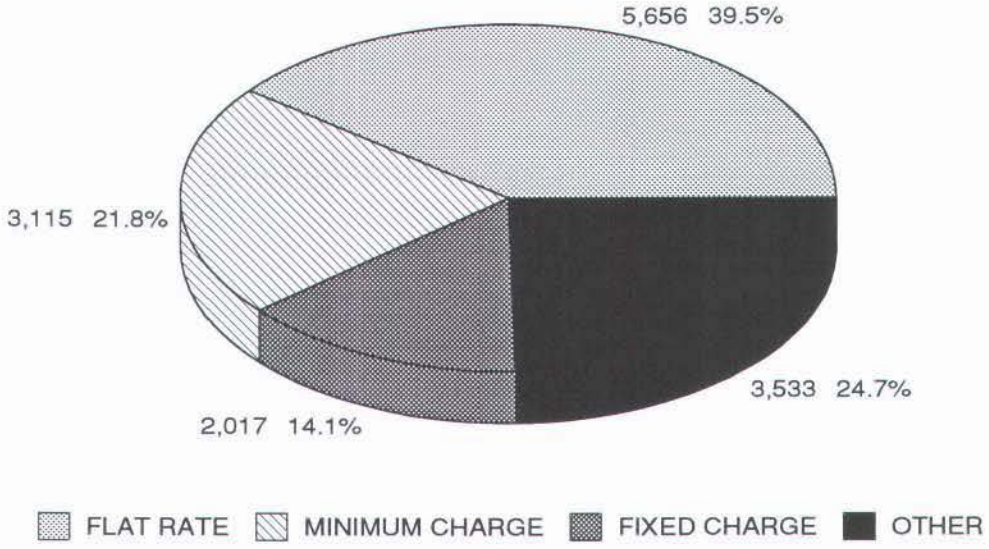

Figure 2.10
NUMBER OF WHOLESALE CUSTOMERS SERVED BY EACH PRICING STRUCTURE

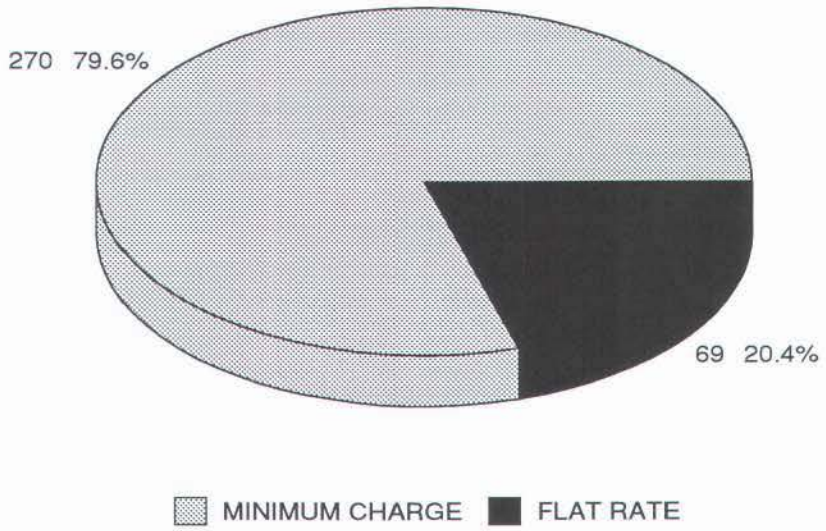

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Figure 2.11
NUMBER OF RESPONDENTS USING EACH RESIDENTIAL PRICING STRUCTURE

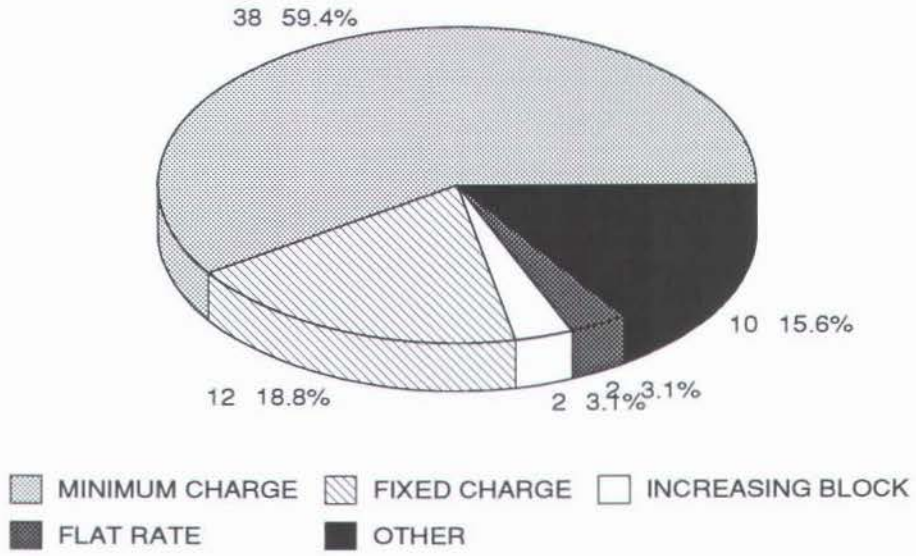

Figure 2.12
NUMBER OF RESPONDENTS USING EACH COMMERCIAL PRICING STRUCTURE

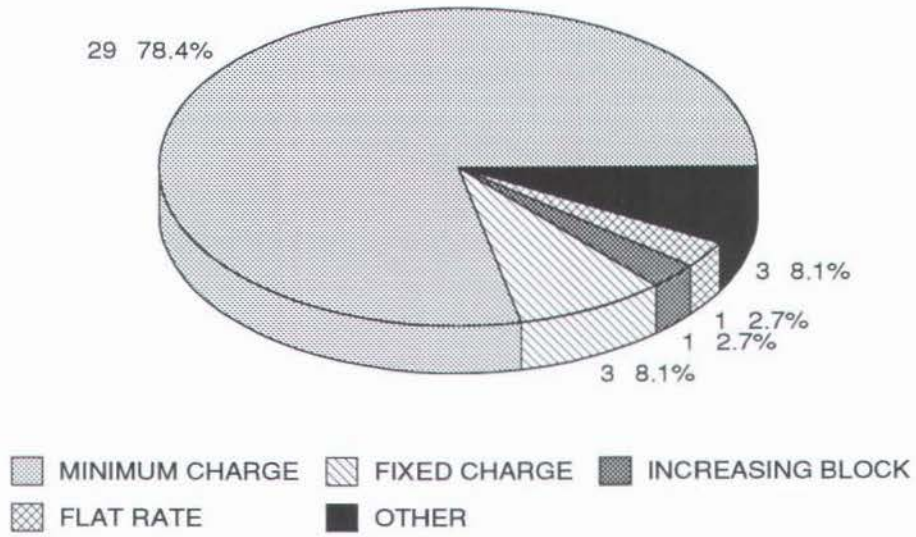

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Figure 2.13
NUMBER OF RESPONDENTS USING EACH IRRIGATION PRICING STRUCTURE

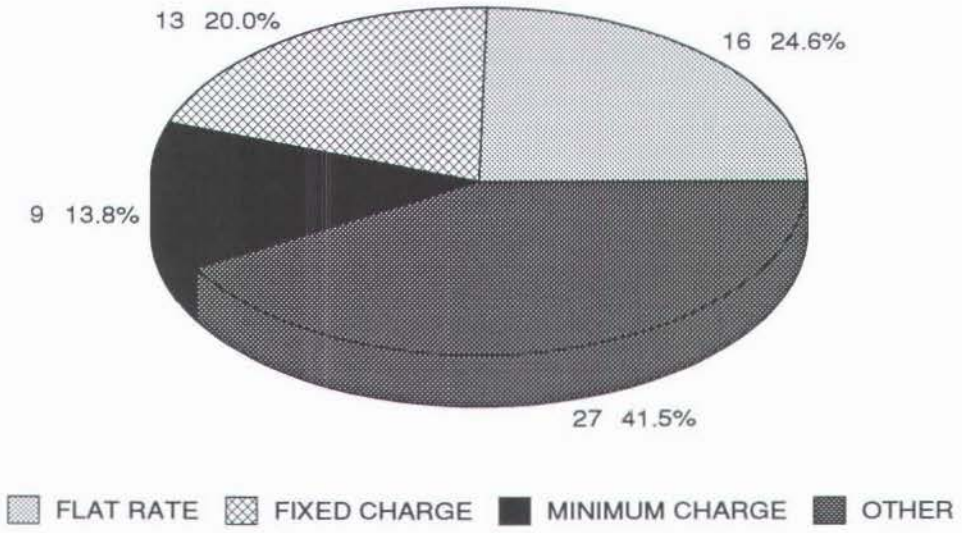
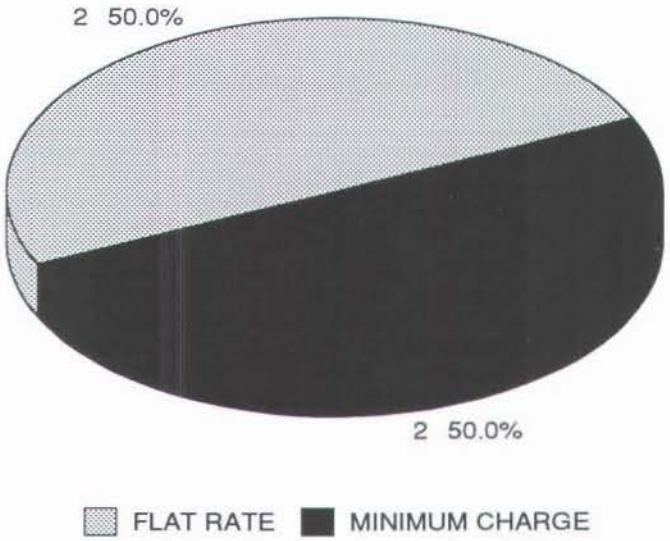


Figure 2.14
NUMBER OF RESPONDENTS USING EACH WHOLESALE PRICING STRUCTURE



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Average Monthly Bills

There appears to be a correlation between average monthly bill and total residential sales. All agencies that sold over 10,000 acre-feet of water reported average monthly bills between $9.50 and $18.50. Average monthly bills for agencies that sold under 10,000 acre-feet varied widely. The average monthly bill for all agencies, weighted by number of customers, is $17.23

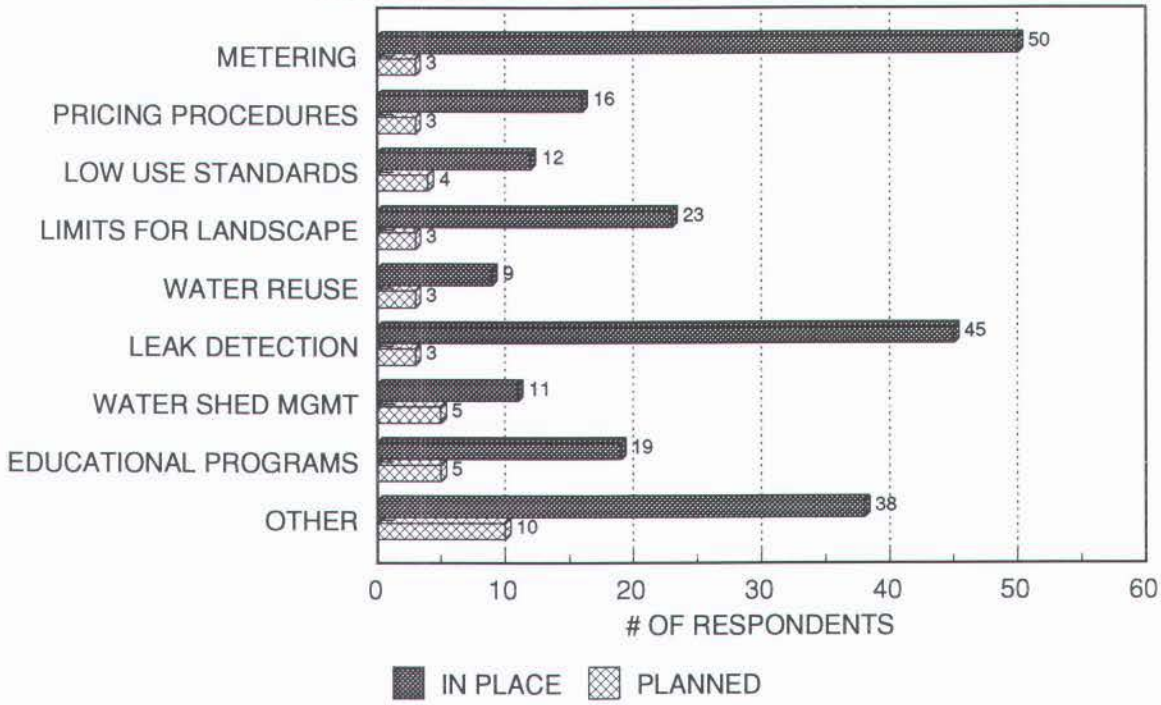
Conservation Programs

Almost one-third of all respondents have metering and/or leak detection and repair programs in place. Metering is in place in 44 of the 64 respondents (69 percent) that serve residential customers. Of the 20 respondents that serve residential customers and do not meter, only two serve over 1,000 residential customers.

Each of the other conservation programs listed is in place in between 9 and 23 responding agencies, with many of these agencies employing a number of different conservation programs. A large number of respondents noted the use of other types of conservation programs and plans (see Figure 2.15).

Figure 2.15

WATER AGENCY USE OF CONSERVATION PROGRAMS



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PART I:

WATER PRICING POLICIES

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3 WATER PRICING

3.1 OVERVIEW

Identifying currently-prevailing rate forms comprises the first step of an analysis of water conservation potential arising from incentive rates. This chapter presents a review of current water pricing practices in Utah. This chapter also compares Utah's current water pricing practices to water pricing practices around the country with an emphasis on the practices of states geographically close to Utah and states with constrained water supplies.

In addition to information gathered through the water usage inventory questionnaire that was distributed in May 1992 (referred to as the "Short-Form Questionnaire" and described in Section 2.3 of this report), a more in-depth request for information was made of fourteen local water agencies in April 1993. This set of water inventory questions provided further background for a discussion of water pricing and is also referred to in this section as the "Long-Form Questionnaire". Copies of both questionnaires can be found in Appendix B.

3.2 RATEMAKING AND PLANNING PRACTICES IN UTAH

The ratemaking process in Utah can be described as following one of two models: the city council/board of directors hearing process model and the cost-share model. While these are not formally accepted terms to describe the process, they appear descriptive of the two major methodologies. These models are explained below with a brief discussion following the explanations. Questions 34 and 35 of the Long-Form Questionnaire provided the primary data sources for characterizing the ratemaking models. These data were supplemented greatly by the Annual Reports provided in response to question 40 and the Cost-Of-Service Reports provided in response to question 36.

City Council/Board of Directors Ratemaking Model

This model describes the utilities that serve most of the customers within the CUWCD service area since it applies to utilities operated by City governments, county governments, and special districts.

The following is a description of "Enterprise Funds" taken from the Riverton City Corporation annual statement:

> Enterprise Funds are used to account for operations (a) that are financed and operated in a manner similar to private business enterprises, where the intent of the government body is that the costs (expenses, including depreciation) of providing goods or services to the general public on a

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> continuing basis be financed or recovered primarily through user charges or (b) where the governing body has decided that periodic determination of revenues earned, expenses incurred, and/or net income is appropriate for capital maintenance, public policy, management control, accountability, or other purposes.

Most municipal water systems in Utah can be defined as follows: they are operated in a business fashion; they report to a governmental body, be it a Board of Directors or a City Council and Mayor; their budgets and their rates are reviewed and adopted in Board or Council Meetings that are open to the public. These systems will also be subject to "Notice" requirements -- requirements to publish notice of proposed rate changes and hearings in local newspapers, giving citizens adequate notice (one or two weeks, generally) that hearings are to be held and that reports and other data are available for review. Notice and public review periods typically range from one week to ten working days.

Of the 14 Long-Form Questionnaire recipients, only one purveyor indicated they did not hold public hearings. Ten purveyors indicate that they do (did) hold public meetings, hearings, or workshops. Three did not respond to this question.

This model is also characterized by a fairly high level of attention to cost-of-service. Of the Long-Form Questionnaire recipients, eight have recently performed, or are currently performing, studies that the respondents consider cost-of-service studies, while five have not conducted such studies in the past five years.

Cost-Share Model

Given the Short-Form Questionnaire results, most Irrigation Districts, Ditch and Canal Companies, and many "neighborhood" water purveyors share the costs among all users. The cost sharing may be denominated by hook-ups, acreage, shares, or some other unit.

Many of the Short-Form Questionnaires had notes indicating that the annual costs were discussed and approved at annual board or member meetings. Thus, while the public involvement process is not necessarily an involved process, the budgets and rates undergo some level of public scrutiny for many of these entities.

The cost-share model is quite simple: Add up all costs and divide by the number of units. Note that while the model is simple, it is not necessarily inferior to cost-of-service based rates since many cost-of-service models are just as simple. The main distinction is that the cost-share model is independent of usage levels and it ignores all cost causation components other than those embodied in the denominator. Thus, while costs are definitely a function of acreage or the number of hook-ups, they are also a function of pumping energy and other factors that can be taken into account and specifically allocated.

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Some irrigation/ditch companies employ a variant of the model that is possibly highly cost-based in orientation. Common operation and maintenance (O&M) costs are shared while individual irrigators pay whatever costs are directly attributable to the irrigator, such as pumping energy and O&M used for pumps on their land.

Discussion of Models

Every water purveyor has an idea of what it costs to provide water, whether a municipal utility serving 700,000 people or a small canal company serving three people. All purveyors receive bills from other entities that provide goods and services. All purveyors pay wages and salaries of their own staff, or outside contract labor. Hence, all purveyors have a basic understanding of the total cost of providing service.

The information level of individual purveyors begin to diverge at the point at which cost information is broken down into cost-causation elements. A standard cost-of-service study will attempt to classify costs into various cost-causation elements, at a minimum into Demand (or Fixed) and Commodity (or Variable) cost components, and generally into other cost components such as Customer Facilities and/or Services and Fire Protection. Thus classified, costs are then allocated to different classes of customers on the basis of the extent to which they cause the particular cost component to be incurred. The cost of service study reports made available in response to question 36 (four studies) seem to rely on American Water Works Association (AWWA) "base-extra" methods, or variants thereof, for accomplishing this cost allocation.

Cost-of-service studies require data and can cost a substantial amount of money. In 1995 dollars, it is unlikely that a study will cost less than $10,000, and that would be the simplest, most basic cost-of-service study which is functionally no different than the cost-share model (outlined earlier) that ignores cost causation. A small canal company with four or five participants cannot justify the expense of a cost-of-service study. If the responses to the Short-Form Questionnaire are accurate indicators of the level of data maintained by small purveyors, they lack the data required to perform such a cost-of-service study, therefore, the purveyor would be required to incur even more expense in the development and maintenance of data bases not currently in existence.

3.3 RECENT TRENDS IN PRICING POLICY

CUWCD Service Area

In the CUWCD service area, the most commonly used water rate form is a fixed fee, under which, consumers receive a minimum level of water at no extra charge, and are assessed additional fees for water used in excess of the minimum. Table 3.1 provides a summary of rate forms reported by purveyors responding to the Long-Form and Short-Form Questionnaires.[1] The fixed fee with a minimum usage allowance and a charge for

[1] Note that numbers presented in this report may not tie directly to results compiled elsewhere from the Short and Long Form Questionnaires. The reason is data

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excess water are used by 65 percent of respondents with residential customers. Among the 36 respondents using a minimum charge system, 16 employed a uniform rate system for water used in excess of the minimum, seven employed an increasing block rate structure for excess water, and one each employed temporal rates and a declining rate structure. Ten of the 36 respondents did not provide sufficient detail to determine how water above the minimum was priced.

A similar table related to commercial and industrial rates can be compiled by extrapolating from residential to commercial/industrial sectors. Many of the utilities have only one rate that is charged to all customers. Given the nature of questionnaire responses, those purveyors with rates that differ by size of customers, the basic rate form appears to remain the same with the fees and charges differing. These generalities appear to apply to the entire set of utilities, with few exceptions.

"cleansing" measures. For purposes of this report, all questionnaires that provided *no* data were deleted. Questionnaires that provided some usable data were retained. Thus, depending on how other analysts treated partially completed and totally incomplete questionnaires, the numbers contained herein may or may not match numbers presented elsewhere.

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Table 3.1
Breakdown of Responding Purveyors by Type of Residential Rate Structure

Description of Rate Form	Number of Respondents	Percent of[a] Respondents
Flat Fee, Either Monthly or Yearly Assessment Regardless Of Usage Level	15	27
Monthly Service Charge with All Water Billed at Uniform Charge	4	7
Fixed Charge, With Pre-Set Level Of Water Consumption Included At No Additional Charge, And Charge For Excess Water [b]	36	65
• Temporal Rates	1	4[c]
• Increasing Block Rate Structure	7	27[c]
• Declining Block Rate Structure	1	4[c]
• Uniform Rate Structure	16	62[c]
• No Detail Provided	10	NA[c]
Responded With Number of Residential Customers, But No Rates Information	7	NA[d]
Number Of Purveyors Responding To Questions On Short- And Long-Form Questionnaires That They Serve Residential Accounts And That Provided The Number Of Residential Accounts	62	NA[d]

[a] Calculated using 55 as the base.
[b] Includes 10 utilities that indicated that they used fixed charges with consumption allowances under the fixed charge, but that provided insufficient information to determine whether rates were declining or increasing under the rate structure.
[c] The percent of those with fixed charge rates (using 26 as the base).
[d] Since the seven respondents providing no information were removed from the calculation of percentage, these two items are Not Applicable.

Nationally

There has been a strong trend across the country towards water conservation oriented rate structures. Since 1986, Ernst and Young has performed a survey of the major water and wastewater utilities serving the 100 largest Metropolitan Statistical Areas in the

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United States. The Ernst and Young results in 1986 showed that 60 percent of water rate structures were declining block rates while in 1992 declining block rates were only 46 percent of the total. During the same time period, uniform rates increased from 32 to 36 percent and increasing block rates increased from 8 to 18 percent of the total.[2]

The *Ernst and Young 1992 National Water and Wastewater Rate Survey* provides additional insights when the data are reviewed on a regional basis. In the West (CA, OR, WA, ID, MT, NV, UT, AZ, AND NM), inclining block rates represent 32 percent of the total and in the South 25 percent. (The states of Texas and Florida account for most -- if not all -- of the increasing block rates in the South.) In the Midwest, inclining block rates are only 10 percent of the total and in the Northeast 4 percent.[3] Hence, the information indicates that water conserving rates are widely used in water constrained areas of the country. The following table illustrates this phenomenon clearly. California's drought, groundwater problems in Arizona, Texas, and Florida, and water/wastewater infrastructure problems in Massachusetts have all been widely discussed in the literature. As Table 3.2 shows, the utilities and regulatory agencies in these states have responded to these problems via water conservation rates.

Table 3.2
States With Widely Publicized Water Shortages Or Other Water Supply Problem

State	Cities Included In Survey	Inverted Rate Structures	Uniform Rate Structures	Declining Block Rate Structures
California	13	5	8	3
Texas	8	7	3	3
Arizona	2	1	2	0
Florida	8	4	6	0
Massachusetts	5	1	4	0

Source of rate information: *Ernst and Young 1992 National Water and Wastewater Rate Survey*, pages 33 through 38.

[2] Raftelis, George A. *Comprehensive Guide to Water and Wastewater Finance and Pricing (Second Edition).* Chelsea, Michigan: Lewis Publishers, 1993. Page 237.

[3] Ibid, page 236, and *Ernst and Young 1992 National Water and Wastewater Rate Survey*, pages 33 - 38.

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3.4 FACTORS INFLUENCING FUTURE PRICING POLICIES

Traditionally, water utilities have based their rate structures primarily on cost-of-service based methods endorsed by the American Water Works Association (AWWA). Recent trends have required the AWWA and water utilities across the country to re-evaluate their rate structures and the goals and objectives of their pricing policies. Concerns about imbalances in supply and demand of water resources and the financial, economic and social costs of closing the supply/demand gap have led to the increased use of conservation-inducing pricing policies.

Increased Demand

High growth regions have been some of the strongest candidates for implementation of alternative rates. In areas such as the Southwest and Southeast, population growth has spurred an increased demand for water that is becoming increasingly difficult to meet with current supply sources.

The Wasatch Front region of Utah is currently one of the most rapidly growing areas in the country. The population of Salt Lake and Utah Counties grew at an average annual rate of 4.0 percent from 1990 to 1995, compared to the U.S. rate of 1.1 percent for the same period. While traditional supply sources have been more than adequate to meet demand in Utah, it is expected that current supply sources will not be able to meet projected demand in less than thirty years.

Depletion of Sources

In addition to increased demand, many water purveyors are facing concerns of diminishing water supplies. Depletion of water sources generally refers to a depletion in the potable water supply of an area. Groundwater overdraft, groundwater and surface water contamination, and increasing environmental regulations can all contribute to the depletion of current water resources.

Cost Recovery Obligations

If a water utility had no costs, rate setting would be a matter of setting rates at a level that would promote a desired level of consumption. As we know, however, water utilities do have costs. Most conservation rates are established to decrease or modify demand; cost of service considerations are secondary. Conversely, most traditional cost of service based rates are established to recover the costs of delivering water first, to equitably balance the cost burden among customers second, and then to consider other goals - including conservation.

Based on comments received through consultation with water petitioners during this study, cost recovery is the single most important issue to be resolved in the successful expansion of the use of conservation pricing techniques in the CUWCD service area. Conservation pricing and cost recovery are not mutually exclusive goals. Any successful pricing structure must consider cost recovery a primary goal.

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Customer Acceptance

Customer acceptance is an important aspect of any utilities' rate structure. That importance grows if the ultimate responsibility (or the perceived responsibility) for setting rates falls on the shoulders of publicly-elected officials. Whenever pricing policies are being altered, it is essential to involve the public in the policy making process through public involvement and information programs.

Legal and Administrative Requirements

In numerous instances utilities have adopted water conserving rate structures due to legal or administrative constraints or requirements. For example, under the guidelines for loans provided through a financing program, the State of Texas' Water Development Board imposes pricing related conditions, such as outlawing declining block rates for all but large industrial facilities with high load factors.[4] During the 1970s and 1980s, the U.S. Environmental Protection Agency provided numerous construction loans for wastewater treatment facilities, a condition for which, was to essentially require a uniform rate structure. Many utilities eventually adopted similar rate structures for water services.[5] A number of states also require water conserving rate forms. For example, most regulated water utilities in Nevada are required to have increasing block rates.[6]

3.5 EXPERIENCE IN OTHER WATER-CONSTRAINED COMMUNITIES

As noted earlier, national trends indicate a shift toward conservation-oriented rates. Nowhere is this more prevalent than in the western United States, where water resources have traditionally been more scarce. According to the 1992 Ernst & Young Water Rate Survey, declining block rates are used by less than 10 percent of the utilities surveyed in the western states.

Black & Veatch performs a similar survey of water rates for utilities in California. Their 1993 survey included 255 water purveyors and showed that less than 5 percent of those surveyed implemented declining block rates, just under 47 percent employ uniform rates, and more than 38 percent employ tiered (increasing block) rates. Recent trends have indicated a shift from uniform rates to tiered rates for California utilities.

Some specific examples of communities that have used pricing as a part of their response to the issue of scarce water resources follows.

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[4] Phone call with Bill Hoffman, Texas Water Development on February 6, 1992.

[5] Woodcock, Christopher. *Alternative Conservation Rates*. Vancouver, B.C.: AWWA National Convention. June 22, 1992.

[6] Telephone conversation with Dr. Stanley, Nevada Public Service Commission staff, February 2, 1992.

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Tucson, Arizona

Tucson has long been considered a leader in water conservation pricing. Since the late 1970s, Tucson has had a multi-tiered inverted block rate schedule with summer/winter price differentials. Until recently, Tucson had seven customer classes, four low-volume and three high-volume classes. The low-volume rate classes faced inverted block rates with seasonal components. The high-volume rate classes faced excess use surcharge rates under which higher summer surcharges were applied to the water use in excess of the customer's average winter usage. For the last several years, Tucson, its consultants, and a 15 member citizen's water advisory committee have reviewed problems with the rate structure. In 1993, Tucson adopted changes in the rate structure to correct deficiencies that had been noted over the years. The deficiencies and the corrections are discussed below.

First, the inverted block rate structure did not adequately reward users for efficiency in water usage. For example, two households that use the same amount of water during the summer months would pay the same amount for water during the summer despite the fact that one household exhibited constant annual water usage while the other used 2.5 times as much water during the summer as in the winter.

A second deficiency arose due to the distinction between large and small users. It was actually advantageous for a commercial customer using 75 to 90 Ccf (100 cubic feet) per month to waste water in order to be reclassified as a large water user. It was also disadvantageous for a large water user to invest in conservation if the reduction in water usage would cause the customer to be reclassified from a large user to a small user.

To correct the deficiencies, Tucson collapsed the seven rate classes into four classes: residential, multifamily (four or more units), commercial, and industrial. Tucson also adopted the summer surcharge pricing mechanism for all rate classes. These changes eliminated the problems of incentives to waste water and disincentives to conserve. The changes also penalize all customers that have high summer season usage relative to their overall annual average, thus providing stronger incentives to conserve water during Tucson's peak summer season.

Phoenix, Arizona

In 1982, Phoenix adopted an increasing block rate structure to promote water conservation. The 1982 rate consisted of three rate classes. The residential and commercial rate classes faced summer/winter rate differentials with a three-tiered inverted rate structure. The industrial class also faced a three-tiered structure but with no summer/winter rate differential.

In 1987, the Phoenix Water Services Department, a Citizen Water Rates Committee, and consultants began to re-examine the water rate structure. Because of this review, new rate structures were proposed and adopted in May 1990.

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The review resulted in the elimination of rate classes. Through an analysis of peaking characteristics by customer class, it was determined that there were larger differences in peaking characteristics within classes than between classes. As a result, Phoenix moved from a three-rate classification to a one-rate classification system.

Cost allocation issues resulted in a system of charges differing by three seasons: low months (December through March), medium months (April, May, October, November), and high months (June through September). Using a base-extra capacity methodology that employed the low season as a base, Phoenix developed rates that encourage conservation by assessing higher charges during those months when higher demands occur necessitating the construction of facilities. Phoenix established a minimum 'lifeline' block that provides the necessary monthly consumption for an average sized single-family household using the latest in water conservation technologies. The minimum level was set at six Ccf during the low and medium months. The minimum level was set at 10 Ccf during the summer months. The minimum levels are provided under the monthly charge. All consumption in excess of the minimum is covered by the volume charge. One charge was determined for each of the three seasons.

The changes are expected to accomplish a number of objectives. The changes will enhance the conservation incentive. They will simplify the rate structure from the customers' perspective and make it easier for the utility to forecast annual revenues. They will maintain stable bills for low water users. They move the City's rates away from embedded cost ratemaking and towards marginal cost ratemaking. They eliminate cross subsidization between customer classes. And the rates reflect the seasonal cost of service differences.

In 1992, the City of Phoenix added an environmental surcharge to recover the costs of meeting new Clean Water Standards. Any additional requirements from the 1987 Safe Drinking Water Act, or later legislation, will be funded through the surcharge. Thus far the surcharge has been favorably received.

Scottsdale, Arizona

Beginning May 1, 1986, the City of Scottsdale initiated a goal billing system. Presently, meeting the goal is voluntary and applied only to single-family residential customers. Roughly 57 percent of residential customers meet the goal and another 10 percent of customers are within 20 percent of the goal.

Goals are set using an inside component that remains constant throughout the year, and an outside component that fluctuates by month. Residential goals are based on the number of persons in the household and lot size, taking into account specified allocations for turf, swimming pools, and non-turf vegetation. Commercial goals will be based on meter readings taken during winter months and lot size.

The current goal system has resulted in a two percent decrease in water usage through the increased awareness of water consumption.

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It is proposed that a rate penalty and incentive program be instituted to encourage customers to meet their goals. A discount would be applied to bills in months during which the customer met their goals, and a surcharge would be applied in months when the customer exceeded their goals. The surcharge would increase proportionately with the level at which usage exceeds the goals. The surcharge would result in a 100 percent rate increase for customers using twice the amount of water set as a goal.

Proceeds from the surcharge would go to pay the rate incentives, to fund research projects in water conservation, to fund water conservation information and rebate programs, and ultimately to purchase water resources to meet the needs of those choosing to use more water than provided in their goals.

Santa Barbara, California

Santa Barbara was hit exceptionally hard by drought in the late 1980s, a situation that led to a drought emergency in the winter of 1989-1990. Given rainfall and water supply conditions, Santa Barbara's water supplies for 1990 were estimated to be 55 percent of normal demand, and getting worse if drought conditions continued.

Santa Barbara's response was to declare a drought emergency. Santa Barbara had changed from a uniform metered rate to an inclining block rate in July 1989 -- a move unrelated to the drought. As part of the drought response, the rates for each block increased by a multiple of 3. In other words, the rate for block one was $1.09 per Ccf, block two was $3.27, block three was $9.81, and block four was $29.43. The amount of water covered by each of the first three blocks was also reduced. The result was that customers using less than five Ccf saw no change in their bills while higher water users saw their bills increase dramatically. Santa Barbara also took numerous (and relatively expensive) steps to augment water supplies including an innovative design-build-own arrangement under which a private entity constructed a water desalination facility and provided water to Santa Barbara. Santa Barbara's residents also voted to connect permanently to the California State Water Project. These and other supply and demand-related measures dramatically increased Santa Barbara's Water Fund Budget.

Rainfall in March 1991 and in the winter of 1991-1992 ended Santa Barbara's drought emergency and all demand restrictions. However, many impacts of the drought continued to be a problem for Santa Barbara. Among the problems faced as a result of the drought were the continuing impact on demand of the emergency measures and the costs of Santa Barbara's efforts to increase supply. Between October 1990 and July 1993, Santa Barbara changed its water rates six times in an effort to reduce rates to levels related to actual expenses while still providing sufficient revenues and revenue stability.

The biggest ongoing problem faced by Santa Barbara was the difficulty in predicting demand, and in turn, in predicting revenues. Penalty rates were clearly depressing demand, but Santa Barbara found it difficult to reduce the penalty rates in the higher

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rate blocks in advance of the recovery of demand. If water use failed to rebound as predicted, revenue shortfalls would occur.

A second problem faced by Santa Barbara was the perceptions of the customers during the period of rate changes. The October 1990 rate change linked the water rates directly to expenses. Rate block two was set equal to the actual expenses, block one equal to half the cost of water, and blocks three and four were multiples of block two. This, however, resulted in an increase in rates in block one and a decrease in the higher blocks. Many customers had the perception that the large users were being given a break at the expense of those conserving water. Paradoxically, Santa Barbara's experience showed that it was easier to raise rates dramatically than it was to lower rates. Communications and information was a major key. During the drought, one of Santa Barbara's major water sources literally went dry -- everyone understood the severity of the situation and supported the City's responses. After the drought the focus shifted towards the more analytical exercise of matching revenues and costs, something that is more difficult to explain and understand.

Hays, Kansas

The City of Hays (City) has faced water shortages since 1985 when one of the City's two major water sources was significantly reduced. The City depends on water from two wellfields. One wellfield, the Smoky Hills wellfield, depends on streamflow in the Smoky Hill River for recharge. Elimination of releases from a reservoir located upstream from the wellfield dramatically reduced the recharge of the underlying Smoky Hill alluvial aquifer. As a result, the wellfield's dependable yield declined from approximately 2,500 to 1,000 acre-feet. The City responded by investigating nearly every possible source of raw water supply within 90 miles of the City, and by instituting ordinances to restrict usage of water for outdoor uses. A progressively more restrictive set of five phases was placed into effect to regulate usage of water for washing cars and other items, landscape irrigation, filling public and private swimming pools, and commercial car washes. The ordinances included a penalty system with graduated fines for violations and termination of water service after four violations -- with a $250 fee for resumption of service.

The ordinances had the effect of reducing per capita water usage. By 1991, per capita usage was 125 gallons per capita per day (gpcd) whereas the average in the surrounding counties was 150 gpcd.

A drought lasting from 1989 to early 1992 worsened the City's water supply condition by causing the Smoky Hill River to dry up completely for periods in 1989 and 1990. In 1991, almost no streamflow occurred past the wellfield. Because of the resulting water shortage, the City developed a water allotment procedure that allowed 100 Ccf per month per household plus 200 Ccf per person per month. Commercial and other users were limited to 85 percent of their 1991 usage. For the first time a customer exceeded their monthly allotment of water, a fine of $10 per each Ccf used in excess of the monthly allotment was levied. The fine increased to $20 per each Ccf for the second

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violation. For each succeeding violation, the fine increased to $30 per Ccf in excess of the monthly allotment. The City also curtailed sharply the allowable outdoor uses of water and began providing rebates for ultra-low flush toilets, providing low-flow showerheads, and providing incentives for the xeriscaping of lawns.

The program was instituted in May 1992. For the remainder of the year, average per capita usage was 90 gpcd.

The drought has since ended and the City has relaxed the water allotment. However, in June 1993 water usage had only rebounded to 93 gpcd compared to 79 gpcd in 1992 and the historical average for June of 195 gpcd. The City expects usage to continue to rebound but to permanently remain 10 to 15 percent below the average.

The City has also adopted permanent drought contingency plans as well as aggressive conservation and water management policies and goals.

3.6 IRRIGATION WATER PRICING

This section discusses two distinct issues, the issue of CUWCD pricing of irrigation water and the issue of purveyor pricing of irrigation water. These issues are discussed separately below.

Pricing Under the CUP Completion Act

Critics of federal water projects have proposed wide ranging ideas concerning pricing applicable to water from federal projects. One such idea was included directly into the Reclamation Project Authorization and Adjustment Act of 1992 (the CUP Completion Act). The Act limits CUWCD's ability to sell water to irrigators growing certain crops by imposing surcharges on CUWCD water used to irrigate "surplus" crops on land covered by acreage limitation programs. This legislatively serves to reduce the possibility of "double dipping" whereby farmers use "subsidized" water to grow "subsidized" crops or crops that U.S. taxpayers are paying farmers elsewhere not to grow. Indirectly, this legislatively "conserves" water by placing a hierarchy of value on crops and, to some extent, redirecting water to "higher value" uses of water.[7]

Central Utah Project Pricing Policies

Historically and currently, the CUWCD policies have been constrained by laws governing the way that water is priced to irrigation, and municipal and industrial customers. One key issue is the fact that the Bureau of Reclamation currently requires CUWCD to purchase all CUP water on a take-or-pay basis. Another issue is the *Ability to Pay* policy that rules over Bureau of Reclamation project water sold to irrigators. A third key issue is the existence of water contracts.

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[7] Reisner, Marc and Sarah Bates. *Overtapped Oasis: Reform or Revolution for Western Water*. Washington, D.C.: Island Press. 1990. Page 126.

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Bureau of Reclamation Pricing

Currently, the Bureau of Reclamation requires CUWCD to purchase all CUP water on a take-or-pay basis. The Bureau issues a Block Notice for a specific block of water. The block price is determined by the Bureau based on the repayment obligation of the facilities required to provide that specific block of water. The Bureau has issued five block notices for Central Utah Project water to date. Block 1 is a block of irrigation water in the Uinta Basin totalling 9,800 A.F. All other blocks are M&I water, and vary in size from 200 A.F. to 20,000 A.F.

When the Bureau issues a Block Notice, CUWCD agrees to purchase all of the water in the block from the Bureau. CUWCD then sells the water within the block to petitioners. Any water within a block that is not sold by CUWCD must still be purchased by CUWCD from the Bureau at the block price. CUWCD currently purchases such unsold water through ad valorem tax collections.

In the case of irrigation water, the block price charged to petitioners is based on their ability to pay. However, the repayment obligation of the facilities required to provide the block of water under the Block Notice is greater (at least in the case of CUP water) than the petitioners ability to pay. The petitioner is only responsible for the block price (which also includes the estimated OM&R charges to CUWCD). The difference between the repayment cost of the block and the block price (as determined by the petitioners ability to pay) is paid through Colorado River Storage Project (CRSP) power sales. To illustrate this process, an example is provided in Figure 3.1. The following example is for illustrative purposes only, the dollar amounts are not intended to represent any actual or estimated costs.

Currently, M&I water petitioners pay 66% of the block price. The remaining 34% is paid by CUWCD through ad valorem tax revenues. M&I petitioners also pay OM&R costs to CUWCD for the treatment and/or delivery of water.

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Figure 3.1
Irrigation Block Pricing Example

Block Price (Ability to Pay) *This is the price paid by the petitioner to CUWCD for the water.*	$10/AF
Less: OM&R Charges *This is the amount of the petitioner's payment retained by CUWCD to pay for OM&R costs.*	$4/AF
Equals: Share of Petitioner's Cost Applied to the Repayment Cost of Water *This is the amount of the petitioner's payment that CUWCD pays to BOR for repayment costs.*	$6/AF
Repayment Cost of Water	$20/AF
Less: Share of Petitioner's Cost Applied to the Repayment Cost of Water	$6/AF
Equals: The Share of the Repayment Cost Borne by CRSP Power Sales	$14/AF

Ability to Pay Pricing of Irrigation Water

Irrigation construction costs are to be repaid through irrigation water sales. Under Reclamation Law, irrigator repayments are limited to the lesser of the irrigator's ability to pay as determined by the Secretary of the Interior, or the cost of serving that irrigator with water. Theoretically, the rate charged to irrigation users are at no time to be less than the annual operation, maintenance, and replacement expenses (OM&R) applicable to and required to provide Bureau of Reclamation water.

Ability to pay imposes a very real limitation on the ability of the CUWCD to utilize irrigation water pricing as a conservation tool. Financial analyses of CUP have confirmed and reaffirmed irrigators' ability to pay for project water. However, OM&R expenses have increased at rates faster than the ability of farmers to pay. The upshot is two-fold. One is that more construction costs not repaid by irrigators will be repaid to the Treasury from apportioned revenues from CRSP power sales.[8] The second is the very real possibility that price response would equate to farmers choosing to not purchase CUP water at all, either by choice, or by ceasing agricultural operations. Since current BOR pricing policy limits irrigation water prices to the irrigator's ability to pay, this latter question may, of course, be moot.

[8] United States Department of the Interior, Bureau of Reclamation. *Central Utah Project: Bonneville Unit-Utah. Supplement to Definite Plan Report.* Department of the Interior, Bureau of Reclamation, Upper Colorado Region. May 1988. Page 123.

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Long-Term Water Contracts
The ability to use water pricing as a conservation tool is further constrained by the existence of long-term contracts. Modification of existing contracts can occur, but is likely not to be a palatable option to current M&I petitioners.

Water Purveyor Pricing Policies
Information on water purveyors was gathered from the "Short-Form Questionnaire" that was distributed in May 1992 and is described in Section 2.3.

Municipal Water Purveyors
Municipal water purveyors were examined apart from Irrigation, Canal, and Ditch companies. Twelve (12) municipal entities reported that they sold water to irrigation customers. Two of these entities charge a fixed annual fee regardless of water usage. This water is, however, non-culinary water used primarily for landscape irrigation. Five reported that they assessed a fixed fee that includes a minimum amount of water with overage charges for any water in excess of the minimum. The other five municipalities did not provide water price information for irrigation (but three served only one or two customers). Thus, for municipalities serving agricultural irrigation water demand, the minimum monthly charge with an overage charge represents the basic pricing structure.

Irrigation Water Purveyors
The irrigation water purveyors were examined as a group, excluding municipalities that serve irrigation customers. Of the purveyors responding to the short-form and long-form surveys, fifty-nine (59) purveyors serve irrigation customers exclusively.[9] Of the 59 irrigation purveyors, five (5) provided no data related to rates. Another five purveyors either consisted of only one customer (2), did not pump or sell any water in 1992 (2), or were primarily water wholesalers (1). This discussion focuses on the remaining 49 completed questionnaires.

All but two of the irrigation water purveyors (47 purveyors) charge a fixed fee. Twenty-nine of the purveyors indicated that costs are simply shared among the "owners" or "stockholders" of the entity, with entities being primarily canal or ditch companies or the irrigation districts. Most of these purveyors indicated that they estimate costs at the start of each year based on the previous years' costs and reconcile costs at the end of the year or, in a few cases, either through mid-year or year-end assessments.

Seventeen (17) purveyors indicate that they charge a fixed fee or assessment independent of the amount of water used.

[9] The numbers presented herein exclude those questionnaires that provided virtually no information.

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Only two purveyors indicated that they had rates that vary by usage. Neither provided further information other than that the charges varied, either in the form of an hourly charge for pumping energy or as a variable rate.

Not all purveyors stated the frequency of billing. Virtually all that did, however, stated their billing frequency as annual or semi-annual.

Only one irrigation water purveyor serves more than 1,000 customers. Most purveyors (54 out of 59 respondents) serve fewer than 500 customers. Forty-three purveyors serve less than 100 customers.

Opportunities for Conservation Pricing

Crop Limitations

Many critics of the Bureau of Reclamation advocate imposing restrictions on the use of water for specific crops, primarily those crops that are covered by acreage limitation, direct subsidy, or other governmental program. As discussed earlier, this policy was included in the CUP Completion Act.

Incentives To Produce Alternative Crops

A variant of the previous pricing policy is provision of incentives targeting specific crops. The idea is that pricing can be used as a means of providing incentives for low-water using or permanent (and presumedly, lower-water using) crops such as orchards or disincentives for high-water using crops. One specific proposal would provide assurances of higher-than-average priority service in terms of water deliveries during drought years.[10] Many critics focus on the fact that irrigators use Bureau of Reclamation water to raise "low-value" crops like alfalfa rather than higher value crops.

This view of water conservation pricing overlooks some basic facts. First, even with low water prices, farmers have an economic incentive to grow crops that provide the greatest net income. Low-cost water allows farmers to earn greater net income than otherwise would have been the case from crops like alfalfa. Low-cost water does not somehow inspire farmers to grow alfalfa rather than more profitable crops. Another overlooked factor is that alternative crops require alternative markets. Thus, if a farmer shifts to production of a lower-water using crop the farmer must also shift to a new marketing chain to sell the crop. A related third element is that alternative crops require alternative factors of production (machinery and equipment, land improvements, and farmer's skill, financial resources, and experience). Different crops also entail different risks, different levels of market price fluctuations, different soils, and different lead times.

Unless alternative crops produce significantly greater net income, shifts are difficult for individual farmers to justify. Clearly, while a pricing policy might influence cropping

[10] Reisner and Bates, page 126.

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patterns, shifts require significant levels of information that go well beyond price signals. Thus, this concept is not proposed herein for further analysis.

Increasing Block Rates

A conservation pricing policy frequently advocated is increasing block rates. The first block would be set at a level representing a per-acre level of irrigation that reflects efficient irrigation technologies.[11] Insofar as it applies to "new" water for which irrigators currently have no vested "water rights," this policy presents the opportunity for cost-effective conservation without intruding into irrigators' decision-making or stripping farmers of water rights.

Fallowing

Interruptible rates have been used successfully by utilities across the country for years. A recent experimental program tested the willingness of farmers to participate in a land fallowing program in exchange for financial incentives.[12] A rate incentive program could be developed under which farmers would receive rate incentives during normal or wet years in exchange for their agreement to leave land idle (and unirrigated) during drought years.

Other Rate Incentives

Rate policies can be used to provide incentives for on-going programs, much as electric utilities provide rate incentives to customers that allow the utility to cycle air conditioners. Utilities could develop special rates applicable to irrigators that agree to use soil moisture probes and evapotranspiration data to minimize over-watering and to time the water application to minimize evaporation losses.

Limitations to Implementation of Pricing Policies

Lack of Regulatory Role

The CUWCD was legislatively required to complete a Water Pricing Policy Study. CUWCD was not granted any specific authority to mandate pricing policy adoption by purveyors or to regulate in any way the purveyors' selection of pricing policies or levels. However, there appears to be nothing to prevent the CUWCD from including contract provisions that require or prohibit certain pricing policies. This option would be most easily implemented in future contracts.

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[11] Reisner and Bates, page 128.

[12] Jones, Stephen M., Ray Ahlbrandt, and Fadi Kamand, "Land Fallowing As A Measure To Conserve Water For Drought Relief," *Proceedings Of Conserv93: The New Water Agenda* (American Water Works Association: Denver, Colorado), 1993, pages 1847 - 1855.

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Contractual Limitations
As discussed earlier, CUWCD water has been traditionally sold through long-term contracts. Thus, for "existing" water, the CUWCD has already signed contracts and therefore is limited in its ability to directly influence the retail pricing of said water, unless these contracts are modified.

Take-Or-Pay Contracts
While the elimination of take-or-pay contracts provides a clear opportunity for water conservation, the existence of such contracts provides an obstacle to current efforts to conserve water.

Water Rights
As is frequently discussed in the literature, western water law provides disincentives for water users or purveyors with water rights to conserve water rather than using the water. This will limit the ability of the CUWCD, through moral suasion, to influence purveyors to employ conservation pricing policies.

A related issue is the lack of metering on the part of irrigators with water rights for water from streams or springs. Quantifying water conservation is impossible without accurate metering.

Conclusions Regarding Irrigation Pricing
Existing contracts will limit the ability of the CUWCD and its purveyors to achieve price-induced conservation on acreage served by currently existing water sources. For acreage served by "new" water, potential exists for cost effective conservation through the use of increasing block rates, with minimum block levels set at levels reflecting efficient irrigation practices. One other form of "price-induced conservation" was built into the CUP Completion Act insofar as surcharges are to be imposed for lands growing surplus crops and lands under acreage limitation programs.

3.7 WASTEWATER PRICING

Wastewater Pricing Policies in the CUWCD Service Area
The majority of wastewater customers are billed under pricing systems that attempt to isolate "indoor" water use, and exclude "outdoor" water use. The peak water usage season in Utah is the summer months. Landscape irrigation is the primary reason for the summer peak. Adding to the summer peak are other factors such as increased tourism, other outdoor activities such as washing cars, and seasonal enterprises such as food processing.

During winter months, landscape irrigation and other residential activities such as car washing cease. Thus, winter water usage is roughly equivalent to summer water usage minus outdoor water using activities. In other words, winter water usage among residential customers provides a rough approximation of indoor water usage.

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Most of the utilities that sell both water and wastewater services in the Salt Lake City metropolitan area incorporate the foregoing approximation in the billing for wastewater services. Seven Long-Form Questionnaire recipients indicated that they provided wastewater (sewer) services and provided information on rates. Five utilities base their sewer charges on average winter monthly water usage. The utilities use three different pricing schemes in conjunction with the average winter usage:

- a minimum charge, or a charge based on the average winter usage, whichever is greater;
- a charge based on a price per 1,000 gallons of average winter usage; and
- a fixed charge plus a flat fee per 1,000 gallons of average usage in excess of an amount that is included under the fixed fee.

Of the two utilities that do not base charges on winter usage, one utility uses a flat fee per residential equivalent, with specific definitions of residential equivalents by customer, building or business type. The other utility uses a set of flat fees for residential and church or county customers, a monthly fee plus a variable water usage fee for water in excess of 10,000 gallons per month for commercial customers, and a different rate schedule for schools.

Only three of the utilities specifically mentioned surcharges or other requirements related to suspended solids, biochemical oxygen demand, and other contaminants such as oil or grease. However, this may be a shortcoming in the survey since surcharge methodologies are federally mandated for all utilities receiving federal grants or loans under certain programs. It may also indicate that the other utilities have not perceived a need for such surcharges.

National Wastewater Pricing Policies

Nationally, wastewater pricing appears to be an unused tool for water conservation. Table 3.3 summarizes findings of the Ernst & Young *1992 Rate Survey*. The numbers show that uniform rates are the most common form of wastewater pricing among the utilities surveyed while declining block rates were the most common form of water rates. Of the 22 utilities with increasing water rates, only three had increasing wastewater rates. The fourth utility with increasing wastewater rates had uniform water rates. Utilities nationally are not linking wastewater rate forms closely with water rate forms. Most utilities tend to link uniform wastewater rates with whatever water rates are utilized.

Without considerably more information, it is impossible to identify the exact reasons for the apparent lack of conservation pricing among wastewater rate structures. It is possible to make a few generalizations. First, although water conservation is a "laudable" goal, for any utility pursuing cost-based rates, cost-of-service results override the causal link between water conservation and wastewater pricing. In other words, to override the cost-

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of-service results, one would have to perform a joint water and wastewater cost-of-service study to "pool" and jointly allocate all expenses. Second, and closely related, water and wastewater utilities have very real and different regulatory and capital drivers. Water utilities' needs may simply lead wastewater utilities' needs, and the apparent lag in pricing may reflect a temporal phenomenon. Third, as necessary as water service is to health, wastewater service is possibly even more necessary insofar as incorrectly handled wastewater is a health hazard. For this reason, some utilities may be loath to use pricing as a "rationing" or conservation tool. Fourth, one of the basic requirements of establishing an effective rate structure that sends a clear price signal to the consumer is the ability to measure consumption. In the case of wastewater, consumption is actually effluent. A true measurement of the amount of effluent produced by a customer is impossible without some form of metering. Because of the inclusion of solids in effluent, metering is a task that has not been undertaken at a customer level.

Table 3.3
Summary of Major U.S. Metropolitan Residential Water and Wastewater Rates

Rate Form	Number of Water Utilities	Number of Wastewater Utilities
Increasing Block Rates	22	4
Uniform Rates	44	100
Declining Block Rates	54	13
N/A -- Other	1	4
TOTAL	121	121

Source: Ernst & Young, *Ernst & Young's 1992 National Water and Wastewater rate Survey*, 1992.

Conclusions Regarding Wastewater Pricing

The impact of wastewater pricing on demand for water appears to be relatively undocumented in the literature. Wastewater prices are generally included as one explanatory variable in water demand functions, and have been found to be significant predictors of water demand. However, most studies have focused on water pricing and thus give short shrift to the price of wastewater services in the discussion of models.

The pricing of wastewater offers one convenient opportunity for seasonal water pricing. One major seasonal rate form is the "base-extra" method in which average off-peak water usage is considered "base" water usage. Water consumption in excess of the base,

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during the peak period, is priced at a higher rate. Hence, the predominant wastewater pricing mechanism could be utilized to implement seasonal rates.

The predominant mechanism could also be utilized to develop uniform pricing mechanisms. Many utilities index wastewater bills to water consumption. For example, the wastewater bill might be $3.00 per 1,000 gallons of wastewater, with wastewater assumed to average 70 percent of monthly water usage. This rate structure clearly links the wastewater bill to water consumption and, if water conservation is the objective, sends a clear price-quantity message. The data maintained by CUWCD service area purveyors could easily be synthesized to calculate the average annual percentage linkages. Care would, of course, need to be exercised to ensure that any resultant price response is factored into the billing determinants used to calculate rates.

As mentioned earlier, wastewater is not metered. Many wastewater rates in Utah, however, are based on average monthly winter water consumption. Because there are very few outdoor uses for water in Utah during the winter, it is expected that all winter usage is indoor, and therefore, is discharged as effluent. Further, it is expected that indoor water usage, and subsequent effluent, will remain constant between seasons. Even though wastewater is not metered, a relatively clear price signal is sent to the individual customer by estimating the amount of wastewater produced by each individual customer, and charging them on a per unit basis accordingly.

3.8 WHOLESALE WATER PRICING

The wholesale water pricing topic encompasses at least three issues. First is the relationship between the level of wholesale water costs and the level of retail water rates. Second is the possible use of wholesale water rates as a water conservation tool unto themselves. Third is the imposition of conditions of service on those purchasing water from the wholesale entity.

Relationship of Wholesale Water Costs to Retail Rates

A change in the price structure of a wholesale agency will ultimately affect the retail agency's customers (assuming no subsidization occurs). A wholesale price increase causes an increase in the operating costs of retail utilities. To meet their revenue requirements, most retailers must pass the increased cost to their customers in the form of increased retail rates. The ultimate increase will be a function of the magnitude of the price increase imposed by the wholesaler and the relative supply provided to the retailer by the wholesaler. The direct impact can vary enormously given that wholesale water purchases can vary, as a percent of total water requirements, from zero percent to 100 percent.

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Wholesale Water Rates as Conservation Tools

Any water pricing scheme that is available to retail water agencies is also available to wholesalers of water. The retail water agencies are the customers of the wholesaler, and water sold to them can be priced in the same fashion as water that is sold to residential, commercial, and industrial customers of retail agencies.

It can be argued that conservation pricing is not the role of the wholesale water purveyor. One frequently asked question is "who actually makes the decision to conserve water?". The answer is that the ultimate consumer of water makes decisions that result in a change in the ultimate consumption of water. Thus, retail water rates effect conservation, not wholesale water rates.

From a practical standpoint, however, wholesale agencies can introduce methods that will induce a reduction in the ultimate consumption of water. Wholesale water purveyors have available a wide range of pricing tools that can be used to shape water demand, including uniform, declining block, increasing block, marginal cost, seasonal, and flat rates.

Wholesale purveyors can also use rates as a means of forcing retail purveyors to use the wholesale water in certain ways. For example, the wholesaler could offer water on the basis of seasonal exchanges, or with "ratchet" factors built in that make it prohibitively expensive for a utility to use the wholesale water for any purpose other than baseload. Wholesale water sales to retail purveyors are generally large enough to justify special metering costs, allowing wholesale purveyors to introduce demand cost components into the pricing structure that would be infeasible in a retail pricing structure.

From the standpoint of rate structure development, the preferred option is to induce conservation at the point of ultimate consumption (the retail level). If retail rates are developed that send the appropriate price signal to consumers, it should not be necessary to consider conservation-inducing rates at the wholesale level. An exception to this is the recommendation that wholesale rates absolutely should not encourage water usage. This recommendation would effectively eliminate declining block rates or fees that are independent of the level of water used.

Conditions of Service as Conservation Tools

Perhaps of greater importance than direct rate impacts are other impacts imposed through conditions of service. Conditions can be imposed -- or pricing incentives provided -- to deal with any and all types of planning or regulatory coordination issues.

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For example, utilities using California Water Project water are required, under state law, to develop water conservation plans for dealing with drought situations.[13]

Contained within the CUP Completion Act are examples of conditions of service that provide incentives (and disincentives). Under the Act, the CUWCD can reduce repayment requirements through increases in the amounts of water left in-stream. The Act also includes requirements for the surcharge of irrigators using project water on lands or for crops covered by land set-aside or crop subsidy programs. These types of (dis)incentives can be provided through wholesale pricing arrangements.

Conditions of service must be carefully developed. Overly stringent conditions could cause retail agencies to bypass the wholesale agency entirely for other supply options. In addition to the negative impact this could have on the wholesaler's revenues, it could also result in an inefficient allocation of the region's water resources by forcing the development of more expensive alternative water sources. If the alternative is to draw more heavily on groundwater resources, it is also possible that groundwater levels and water quality may be negatively impacted.

Another condition of service that merits review is "take or pay" contract provisions. Take or pay provisions state that the buyer will pay for the contracted amount of water whether the buyer uses the water or not. This type of provision does not promote the conservation of water. In essence, as long as you must pay for the water you might as well use it; you definitely do not want to pay for water conserving technologies and then pay for the contracted amount of water anyway. Take or pay contracts are a risk management tool that is attractive to risk averse water wholesalers. Other risk management options should be considered that are likely to be risk neutral, or at least less risk averse, in order to allow retail agencies to more effectively conserve water.

Conclusions Regarding Wholesale Pricing

From the standpoint of rate structure development, the preferred option is to induce conservation at the point of ultimate consumption (the retail level). If retail rates are developed that send the appropriate price signal to consumers, it should not be necessary to consider conservation-inducing rates at the wholesale level. An exception to this is the recommendation that wholesale rates absolutely should not encourage water usage. This recommendation would effectively eliminate flat fees or declining block rates.

A management decision that can be exercised by wholesale agencies is the elimination of take or pay contracts. The use of take or pay contracts can provide a disincentive for retail agencies to conserve water. Other risk management tools should be considered.

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[13] Phone conversation between RMI staff and Jonas Minton, Chief of Water Conservation Office, California Department of Water Resources (916/653-9167). February 3, 1992.

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The imposition of conditions of service is another way that wholesale agencies can promote conservation through policy development. One option that wholesale agencies have is to tie the delivery of water to retail agencies to conditions such as the elimination of pricing policies that discourage water conservation by wholesale customers to their retail customers. This type of an imposition must be carefully developed. An overly stringent imposition could cause retail agencies to bypass the wholesale agency entirely for other supply options. In addition to the negative impact this could have on the wholesaler's revenues, it could also result in an inefficient allocation of the region's water resources by forcing the development of more expensive alternative water sources. If the alternative is to draw more heavily on groundwater resources, it is also possible that groundwater levels and water quality may be negatively impacted.

3.9 RETAIL WATER PRICING

Role of the Retail Customer

As was noted in the previous discussion on wholesale water pricing, the preferred option is to induce conservation at the point of ultimate consumption (the retail level). There is a direct relationship between retail water pricing and water conservation. Because of this relationship, the key to meaningful conservation through pricing is sending the appropriate price signal to ultimate consumers of water through retail rates.

Most discussions of conservation pricing techniques apply directly to retail water pricing policy. Throughout the literature, emphasis has been placed on developing conservation rates for retail water agencies. Recognizing the potential applicability of conservation rate structures, or portions of comprehensive pricing policies, to wholesale, wastewater, and agricultural water users, we will evaluate rate structures and pricing policies from the standpoint of the retail water agency and its customers in Chapter 4.

3.10 CONSERVATION PRICING ISSUES

A number of different issues will come to the surface as purveyors move to implement water conservation rates. Some of these issues are discussed below.

Institutional Issues

Potentially, institutional issues may inhibit immediate movement to water conservation rates. A major institutional issue concerns risk. The most commonly used water rate structure affords a high degree of certainty relative to water conservation rates. Utilities with heavy reliance on ad valorem taxes will be doubly affected by increased risk. To promote conservation, the majority of net revenue requirements should be recovered through variable charges. In one study of a nature similar to this study, the guideline is that 75 percent of revenue requirements should be recovered through variable charges, and that 90 percent of all revenues should be recovered through water rates, impact fees,

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and other non-tax income sources.[14] Risk-averse institutions face the need to change their institutional outlook in order to accomplish these changes.

Another institutional issue surrounds the incidence of costs, revenues, and subsidies. Ad valorem taxes represent a form of subsidization as owners of undeveloped lands subsidize the variable water costs incurred by owners of developed land. Use of ad valorem taxes should be discouraged for purposes other than capital expenditures and prices should be set to recover costs from those causing the costs to be incurred. The price of water should equal the variable cost of supplying the water. This implies the elimination of subsidies, a change that would be welcomed by those providing subsidies but not by those receiving subsidies. A fact of life is that mechanisms providing subsidies (no matter who is receiving the subsidy) generally have constituencies that will oppose any effort to remove the subsidies.

Over-Collection Issues

Irrigation water purveyors generally price water to cover costs, cooperatively, and any pricing policy that raises "excess" revenues would be viewed unfavorably. Municipalities are limited in the level of retained earnings that can be held. Marginal cost pricing might be useful only as a "template" for allocating embedded cost revenue requirements.

Cost-Of-Service Issues

The cost of ratemaking represents another important element of the ratemaking discussion. In 1995 dollars, it is hard to imagine a credible, but basic, cost-of-service study costing less than $10,000. A detailed cost-of-service study can cost $20,000 or more. Consultant costs can easily exceed $100,000 for a cost-of-service study that includes the analysis of marginal costs, and development of models and rates based on marginal costs.

It is easy to say that all purveyors should be performing basic cost-of-service reviews. Many utilities do. However, relatively small utilities of all types (water, wastewater, electric, natural gas, solid waste, and telephone) routinely go for many years without reviewing cost-of-service for reasons that include administrative cost, single customer class pricing, and the institutional issues discussed earlier.

Administrative Cost

Another issue is the cost of data collection and database maintenance. Cost-of-service studies require customer class statistics and detailed cost information. Assuming the Water Usage Inventory Questionnaire responses accurately reflect the level of data maintained by small purveyors, such purveyors lack the data required to perform

[14] Brown and Caldwell. *Definition of Water Conservation Promoting Rates*. Report prepared for the Southwest Florida Water Management District. February, 1993. Page 4-2.

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detailed cost-of-service studies. Small purveyors would incur significant costs to develop and maintain data bases they currently lack.

Study and data base development costs should not be construed as rational reasons for a complete failure to pursue pricing and conservation policies. Cost does, however, impose constraints on the depth at which small utilities can reasonable be expected to review the issues.

Single Customer Class Pricing Structure

A high percentage of water and wastewater utilities across the country bill all customers under the same rate schedule. (This rate structure is frequently called a "postage stamp rate"). Under postage stamp rates, the need for cost-of-service information is minimized, if not eliminated.

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4 EVALUATION OF PRICING SYSTEMS

4.1 HISTORIC WATER PRICING OBJECTIVES

James C. Bonbright's book Principles of Public Utility Rates, written in 1960, is considered the classic work on utility ratemaking. This book is widely quoted, particularly with respect to rate design. Bonbright enumerated eight criteria for a desirable rate structure.[1] Bonbright's criteria essentially state that the rate policies should:

- Be simple, understandable, publicly acceptable, and feasible for application;
- Be easy to interpret (i.e., unambiguous) and noncontroversial;
- Produce sufficient revenues to meet revenue requirements, including a fair return on investment;
- Provide revenue stability for the utility to prevent need for frequent rate changes;
- Provide stable rate structures from year to year to facilitate customer planning and prevent disruptive changes;
- Be based upon the cost of providing service (referred to variously in the literature as "cost-based rates," "cost-of-service based rates," and other labels);
- Avoid undue discrimination; and,
- Encourage efficient use of the services provided.

In an update to Bonbright's original work, Danielsen and Kamerschen added a sense of the 1980s and 1990s by including the idea that rates should reflect all present and future private and social costs and benefits (i.e., all internalities and externalities).[2]

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[1] Bonbright, James C., *Principles of Public Utility Rates*. New York, NY: Columbia University Press. 1961. Page 291.

[2] Bonbright, J., Danielsen, A., and Kamerschen, D. *Principles of Public Utility Rates*. Arlington, Virginia: Public Utilities Reports, Inc., 1988. Pages 383 - 384.

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In addition to these criteria, various sources in the literature provide a number of further considerations in the development of appropriate rate structures. An addendum to Bonbright's list of criteria could include the following:

- Minimize the impact (financial, social, behavioral) to customers or customer classes as a result of the rate structure;
- Achieve compliance and consistency with relevant local, state, and federal laws and regulations; and minimize the potential for legal challenge by customers or special interest groups;
- Minimize the difficulty of implementing the rate structure due to financial, administrative, operational, or procedural constraints to the utility;
- Maintain an effective price level that is competitive with those of similar and adjacent communities; and,
- Promote the optimal use of available water resources through both increased efficiency and water reduction.

In order to evaluate potential rate structures, it is necessary to determine the relevant criteria by which rate structures for potential implementation in the CUWCD service area will be examined. While every water agency will have their own set of objectives and their own value system concerning the importance of each objective, a more thorough discussion of the criteria noted above will provide a selection of a set of criteria that can be used for a general evaluation of basic rate structures.

Revenue Sufficiency

A pricing policy must produce sufficient revenues. Revenue sufficiency is one attraction of pricing policies such as flat rates and property taxes.

Any conservation rate will produce sufficient revenues *unless the underlying revenue requirements and cost-of-service studies are wrong*. Predictability is not, however, a strength of conservation pricing structures. The reason is that revenues depend significantly on the level of water consumption, and consumption is less predictable than the number of customers or the tax base (the bases of flat rates or ad valorem taxes). Conservation rates entail added risk for revenue shortfalls, and also for revenues that greatly exceed predictions. Thus, while conservation rates can raise sufficient revenues, errors in the underlying rate study can lead to insufficient revenues.

Revenue Stability

Can the pricing policy maintain sufficient revenue stability to satisfy long-term operating expenses and capital requirements? Is the long-term planning process unduly hindered

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by the risk and uncertainty involved in the revenue projections that are a result of the pricing policy?

Generally, the more aggressively the utility promotes conservation through rates, the less stable the resulting revenues. A flat rate is the most stable of all. One can reasonably expect very few revenue shortfalls. The opposite is an inverted block, seasonal rate structure. This rate structure produces revenues that vary greatly from one month to the next. Instabilities are exacerbated by the fact that outdoor water usage is highly dependent on weather.

A conservation pricing structure requires the utility to base revenues on expected demand. The increased uncertainty in predicting demand can make revenue estimations and projections less reliable.

Rate Stability

Does the policy promote rate stability? What conditions arise under which the policy promotes instability?

Rate stability is closely related to revenue stability. Unstable revenues can create conditions that cause the utility to revise rates to counteract these instabilities. The better the job the utility does in predicting water usage, the more stable the rates. Ultimately, water conservation rates provide less stability than rates that do not stimulate conservation.

Water conservation rates often use a rate stabilization mechanism of some sort. This can take the form of a reserve fund or a system of emergency surcharges. These rates also require specific policies for dealing with "surplus" revenues received during peak pricing periods to ensure adequate reserves and revenues for the off-peak periods. For purposes of evaluation, revenue instability is the primary cause of rate instability and it is assumed that a pricing policy that exhibits revenue stability will exhibit rate stability.

Economic Efficiency

Does the pricing policy promote the efficient allocation of a societal resource (water)? Does the price accurately reflect the value of water?

An efficiently priced commodity will relay the appropriate societal value of the commodity to the consumer. In the case of water, consumption would be encouraged when the marginal value of the water is greater than the marginal cost of the water and discouraged when the marginal value is less than marginal cost.

Conservation rates are well suited to providing pricing incentives to the customer that alter consumption patterns in a way that reflects the value of water. Flat rates provide no incentive to alter consumption because marginal cost will never be higher than marginal value.

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Equity

Does the pricing policy treat customers that are equal in a fashion that reflects this equality? Does the pricing policy adequately reflect cost of service? Does the policy focus revenue collection on customers that cause the utility to incur the cost?

Generally, conservation rates require the use of two or more different customer classifications. It could be argued, however, that any rate form requires the grouping of customers into customer classes. Equity considerations require that rates be cost-based to the extent possible. If conservation is the primary pricing objective, the cost-based objective might have to be violated to provide price incentives. This does not imply abandonment of the cost-based objective. Unless the utility serves a completely homogeneous customer base, it will be difficult -- if not impossible -- to design one conservation rate that is applicable to all customers. Thus, conservation rates might require that customers be segregated into classes in order to design rates that achieve given objectives without penalizing some customers for characteristics that they do not exhibit.

Ease of Implementation

Does the pricing policy require equipment or expertise that will place a burden on most utilities? Can utilities analyze or implement the pricing policy with data that are readily available to most utilities?

A utility can administer any rate form, as long as the metering technology exists to physically measure the billing units. Billing is little more than a computer programming issue. Once the program is written the system is automated.

Conservation rates depend on price signals to customers. For some utilities, one major issue could be the frequency of billing and/or whether bills are based on usage levels. To effectively send any kind of message, billing must be monthly or at least bi-monthly. For utilities that currently do not bill on the basis of metered usage, or that bill quarterly or less frequently, the adoption of conservation rates imposes significant additional implementation costs.

A related issue is the number of customer classes. A large number of water utilities have a pricing policy imposing the same rate schedule on all customers. Moving to a pricing policy including multiple customer classes will increase the complexity of billing, assigning customers to a rate schedule, and revising rates in future rate proceedings.

Simplicity

Can customers understand the pricing policy easily? Can utility staff understand the policy easily?

Rates designed to influence demand will always be more complex than a flat monthly charge, but it should be possible to explain the structure to customers. Some truly complex rates provide incentives to (1) increase average consumption per unit of peak

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consumption, or (2) reduce peak consumption but not average consumption. Even rate experts can have trouble understanding such structures.

Customer Impact
Does the pricing policy force customers to alter current practices to such an extent that it is considered unacceptable?

If a community is traditionally very desirous of large, lush, green lawns, a pricing policy that forces them to move away from that objective too quickly is likely to be met with public outcry. Also, a rate structure that raises the rate level by a substantial amount in a short period of time can create a financial impact that is unacceptable to customers. If the ultimate goals of the utility imposing the pricing policy are such that customer acceptance is likely to be low if the policy is immediately adopted, the utility should consider a phase-in period.

Competitiveness
Are the rate levels inherent in the pricing policy competitive with those of neighboring communities?

While most water customers do not have a choice of water providers, rate levels that are significantly higher than those of neighboring communities will be met with a lack of public support. This issue has more to do with rate levels and final bill sizes than with the actual structure of the policy. Any type of pricing policy or rate structure can have this problem if the rate levels are considered to be too high. Conversely, any type of pricing policy or rate structure can contain competitive rate levels (if such levels still allow for the recovery of costs).

Legality
Will the pricing policy be accepted readily? Will it be challenged in the court system or face insurmountable regulatory hurdles?

Utilities, like all other public entities, cannot treat individuals or groups in a discriminatory fashion. Thus, any pricing policies adopted by utilities should be based upon objectives and analyses that are applied consistently to all groups. Cost-based rates are one of the best defenses against legal challenge.

Water Conservation
Will the pricing policy effect a reduction in peak water usage? Will the pricing policy effect a reduction in total annual water usage?

A key issue is whether a given pricing policy will *effect the change that the utility desires*. Pricing policies must be selected on the basis of the type of impact expected from the policy. For example, some rate forms will reduce average water usage while leaving the peak water demand relatively unchanged. If peak demand reduction is the

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objective, it should be obvious that the utility should select a different rate form to meet the demand-shape objectives.

Criteria Used to Evaluate Rate Structures

The Pricing Study uses a subset of these criteria as guidelines for evaluating pricing policies. For purposes of this study, some criteria can be assumed to hold true. Any ratemaking policy will produce sufficient revenues if used correctly and with valid data. Any ratemaking policy can be based upon the cost of providing service. Hence, the evaluation focuses on the guidelines that vary in ways that are less apparent. The following criteria will be used to evaluate rate structures in this study.

- Revenue Sufficiency
- Revenue/Rate Stability
- Equity
- Legality
- Simplicity
- Ease of Implementation
- Water Conservation

4.2 EVALUATION METHOD

The evaluation of a particular pricing policy depends on the criteria that are being used to evaluate the policy, the rate structure employed, the rate levels employed, the methods used to communicate the relationship between price and consumption to the customers, and the characteristics of the utility and its customer base. The best evaluation of a pricing policy, therefore, would be specific to a particular agency and would enumerate all aspects of the policy, not just the rate structure.

The Act requires that CUWCD evaluate a specific set of rate structures. It should be noted that any of the rate structures that are evaluated in this study could be implemented with some measure of success by agencies within the CUWCD service area. Conversely, the overall pricing policy developed by an agency could include any of the rate structures that are evaluated in this study, and still not be effective based on the criteria enumerated earlier.

Because it is impossible to evaluate agency-specific pricing policies within this study, the method used to evaluate rate structures will provide qualitative discussions of the rate structures. Each rate structure will be evaluated by examining the advantages and disadvantages that might be expected with the implementation of the rate structure. This evaluation will be carried out for each rate structure using the advantages and disadvantages in satisfying each individual criterion. The rate structures to be evaluated are described in the following section.

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4.3 RATE STRUCTURE DESCRIPTIONS

Uniform Rates

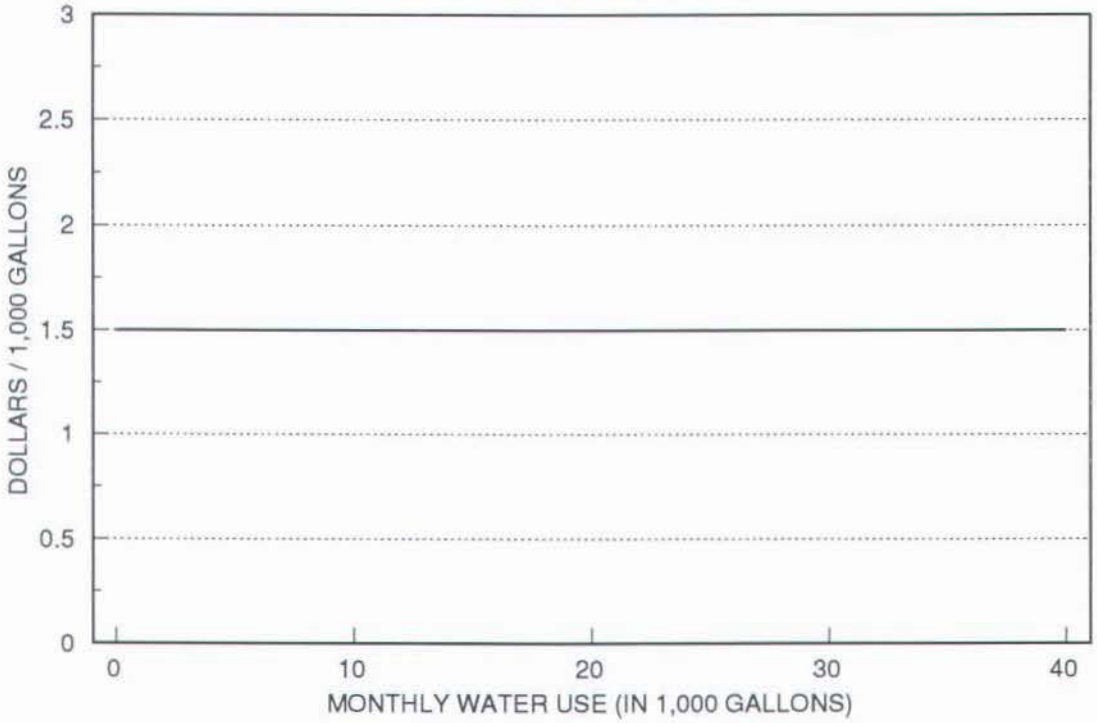
Uniform rates assess the same per unit charge for all water to all customers, regardless of customer class and consumption level. Because the rate does not provide a volume discount or a minimum block of water for no marginal cost, customers can minimize their total bill by avoiding excessive use, thus, there is an incentive to conserve.

Uniform rates will generally fall short of meeting strict cost-of-service principles. In particular, uniform rates create a form of cross-subsidization between peak and off-peak users and between customer classes. They can also create spatial cross-subsidization by ignoring geographic cost differentials.

Cost-of-service and conservation goals are generally not the reasons for adopting a uniform rate structure. Uniform rates are simple to develop, easy to calculate, easy to explain to customers, easy to implement, and widely accepted by customers. Typically, uniform rates are only questioned in areas where they place an unusually harsh burden on industry or institutional customers.

Figure 4.1

UNIFORM RATE EXAMPLE



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Seasonal Rates

Seasonal rates differentiate between peak and off-peak seasons by applying higher rates in the peak season than in the off-peak season. Seasonal rates provide one method of sending price signals to customers that providing water in one season is more expensive than in other seasons.

Seasonal rates can offer simplicity in implementation from the utility's standpoint, and ease of understanding from the customer's standpoint. One form is to have entirely different rates in the peak and the off-peak seasons. The other main form of the rate is adding a surcharge (to the off-peak rate) for high levels of usage during the peak season rates.

In Utah, seasonal peak periods are generally the summer season. Most water utilities experience peak demand during summer months because of increased irrigation, increased evaporation, lower rainfall/runoff, and increased tourist or seasonal activities such as food processing.

The rationale for seasonal rates is peak periods impose higher costs than non-peak periods. Utilities construct many facilities to meet peak demand. To meet peak demand, utilities with numerous sources of supply are forced to use all sources, including the higher cost resources not needed to meet off-peak demand. O&M costs, like pumping, can also be higher during peak periods. Thus, seasonal rates are used to price water in a fashion that parallels peak and off-peak costs more closely.

Mann and Schlenger provide the following list of prerequisites for successful implementation of seasonal rates.

- the utility must experience substantial variation in demand between peak and non-peak seasons;
- the utility's installed capacity requirements must be determined primarily by peak demand;
- the utility's peak demands must occur consistently during the same season of the year; and,
- the utility must be able to determine the difference in costs between meeting peak season and non-peak season water demands.[3]

[3] Mann, Patrick C. and Donald L. Schlenger, "Marginal Cost and Seasonal Pricing of Water Service," *American Water Works Association Journal* 74 No. 1 (January 1982): 6-11.

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A number of factors will govern the success of seasonal rates. The following is a list of considerations regarding the use of seasonal rates.

- Complete and adequate information should be made available to customers to deliver the price signal. Since customers will notice the pricing policy change as a change in their bill, it is important that they be told why and how their bill has changed.

- Administrative and billing procedures should be tailored in such a way that they deliver the price signal in a timely fashion.

- Seasonal rates should be supplemented by other rate forms or conservation programs that limit the burden on lower income customers.

- Seasonal rates should be phased in, with relatively modest seasonal price differentials in the first year and later adjustments to increase the differential.

- Seasonal rates can cause more variations in revenue than uniform annual rates.

- Seasonal rates might cause needle peaks to occur. For a utility seeking to reduce peak demand, seasonal rates (alone) might not be an answer insofar as they tend to reduce water usage on all but the highest peak days, but not necessarily on *the* highest peak day.

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Figure 4.2
SEASONAL RATE
EXAMPLE ONE

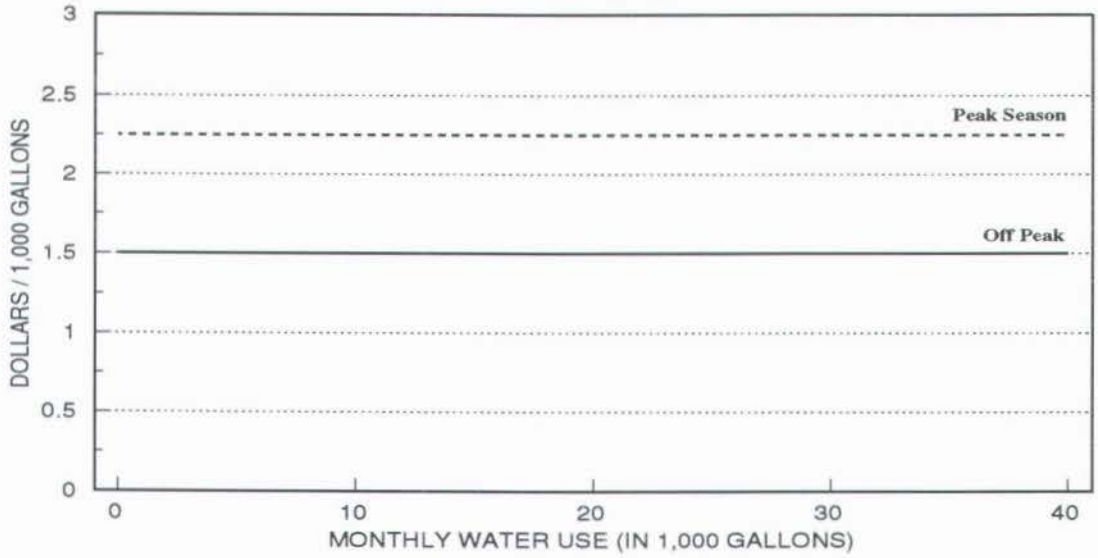
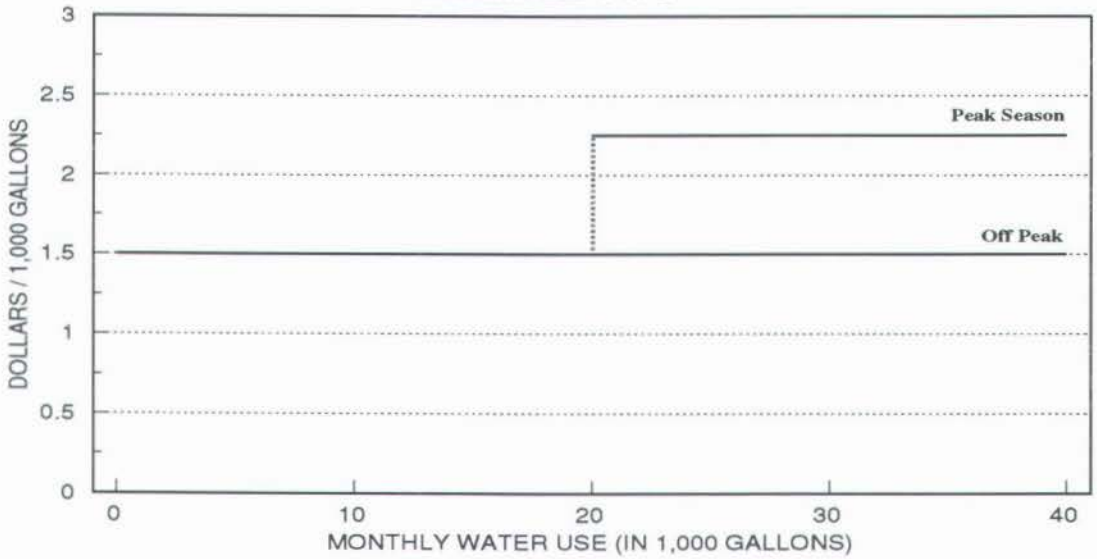


Figure 4.3
SEASONAL RATE
EXAMPLE TWO



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Drought Year Surcharges

Drought year surcharges are surcharges to be assessed in years meeting certain criteria and qualifying as drought years. A key distinction between drought year surcharges and other conservation-inducing rate forms is that the surcharges are temporary. They are imposed during drought years and eliminated when the drought conditions no longer exist.

Surcharges can serve two purposes. First, in severe drought years, utility costs can greatly exceed costs in a normal year as the utility seeks added water sources, such as purchases from other suppliers. Compounding this problem is the fact that water sales may (and hopefully will) be lower than in a normal year due to water conservation efforts by retail customers. Thus, surcharges enable the utility to temporarily increase per-unit revenues to cover normal and extraordinary costs of providing services.

Second, surcharges can be used like a "tax" to transfer the recovery of revenues from customers who conserve water to those who do not conserve water by imposing surcharges on water usage in excess of pre-set limits. However, using surcharges to induce customer conservation efforts can cause revenue instabilities if the customers respond in levels in excess of those predicted by the utility.

Surcharges often cause confusion and anger among consumers. Most surcharges are designed to go into effect if water sales fall below a pre-set level or if certain drought conditions exist. Customers occasionally believe that they conserved water because of the drought, and their reward is a rate increase. To counteract this phenomenon, the purpose of the surcharges must be clearly spelled out. To further counteract customer "backlash", it is best to develop the surcharge policy during a "normal" year rather than during a drought-inspired financial crisis.

Surcharges can be assessed as fixed monthly fees, a commodity rate increase, or a combination of the two. As a commodity rate increase, it can apply to all consumption, or to consumption exceeding certain levels. The surcharge can be used to transfer more of the revenue burden (cost) to high-use customers. Higher charges to high-use customers can generate enough revenue to actually lower rates for those customers who use less.

Generally, surcharges are high enough that they are effective in inducing conservation. Since they are temporary, the surcharges do not induce permanent changes in consumption levels. Many utilities have noted, however, that it can take years for usage to rebound to pre-surcharge levels.

Increasing Block Rates

The increasing block rate is a rate form in which the cost per unit of consumption increases as the number of units consumed increases. Increasing block rates are also known as inverted or inclining rates. Numerous factors need to be addressed in developing increasing block rates, including:

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- Are block rates justifiable given the utility's cost characteristics and the customers' load characteristics?
- How will the utility determine the number of blocks to use, the size of each block, and the price to charge for usage within each block?
- What is the load impact of the rate structure?
- Will the rate structure impact other rate structure elements (e.g., revenue stability) positively or negatively?

Increasing block rates are justified when identifiable cost distinctions exist, such as through the identification of distinct customer groups that impose different levels of cost on the utility.

Any number of consumption blocks can be specified. However, the first block must include a sufficient quantity of water that some customers' water consumption fall entirely within the first block. If the rate is structured such that all customers enter the second block, then the first block does not provide a conservation goal, but rather provides only a price break.

Increasing block rates can offer the advantage of sending clear price signals to high-use customers, particularly in situations where the cutoff lines between blocks are based on real cost differentials. Increasing block rates are easily understood by consumers, but in a society used to "bulk discounts", customers may need to be convinced that the cost structure makes sense.

Increasing block rates are not inherently difficult to implement. It is difficult, however, to estimate the conservation impact of increasing block rates. Customers in the lowest block might pay less than they would under a uniform rate structure, and could therefore increase usage. Customers buying water at the higher block would pay a higher price and would be expected to decrease usage. The net effect depends on whether the decrease in demand by the higher block customers is greater than the increase in demand by the lower block customers. A rate study that attempts to accurately estimate customer response to an increasing block rate structure can be time consuming and expensive.

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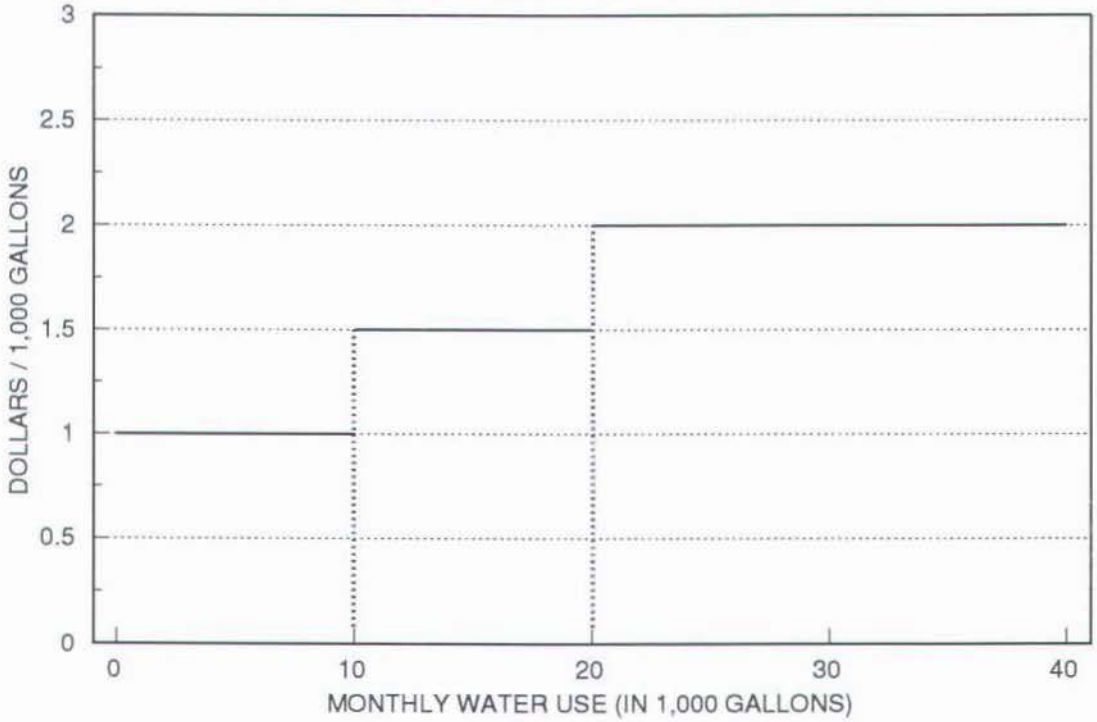
Figure 4.4

INCREASING BLOCK RATE EXAMPLE



Ratchet Rates

This rate structure is a variation of an increasing block structure. As with an increasing block structure, ratchet rates charge higher rates for higher volumes of consumption. The difference is that as the customer enters a new rate block, all consumption is priced at the higher rate level.

The conservation incentive inherent in a ratchet rate is very high. This rate structure appears to be essentially a theoretical one. No examples of water utilities implementing this type of a structure were found. Attempts to calibrate such a pricing system under standard cost-of-service principles would likely be quite difficult due to the large potential swings in collected revenues that could occur if water consumption forecasts were even mildly inaccurate. It is also highly likely that this rate structure would be unpalatable to most customers.

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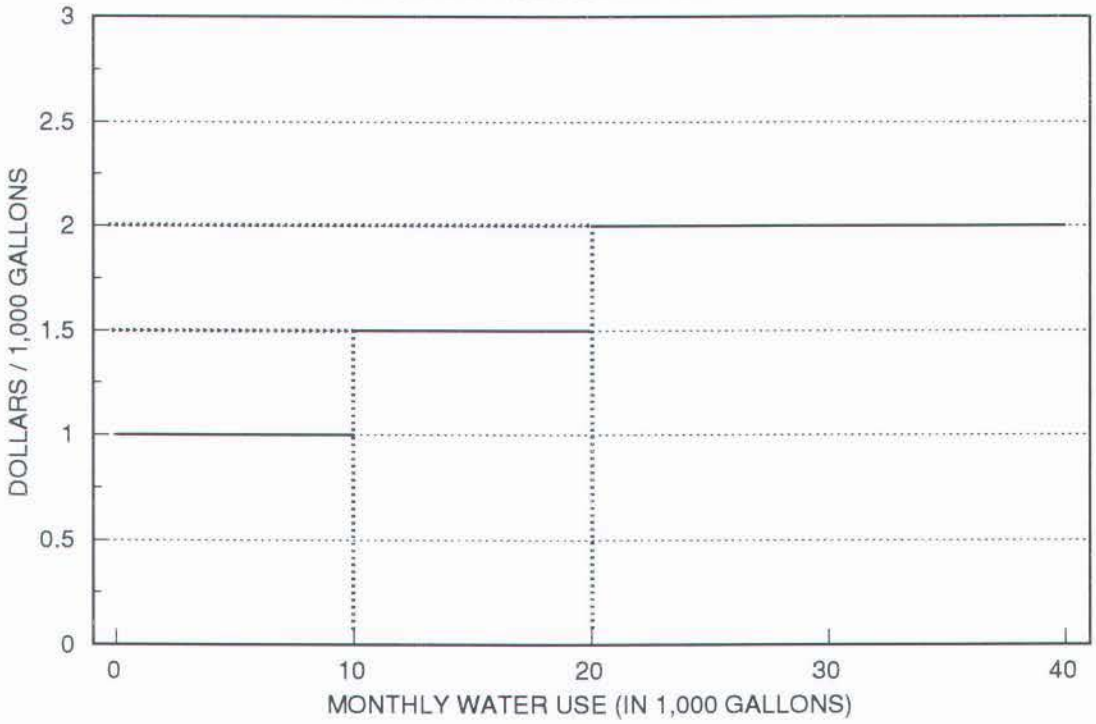
Figure 4.5

RATCHET RATE EXAMPLE



Spacial Rates

Spacial rates take into account the varying cost of delivering water to different pumping zones, specifically the extra energy and facilities costs involved in delivering water to locations beyond the central service district area.

Pumping costs represent one set of costs in a utility's total revenue requirements that can be allocated to specific customers or customer classes. Pumping facilities and energy costs comprise the main components of pumping.

Facilities costs represent a second component of a utility's cost structure that may affect spacial rates. Facilities constructed to serve geographically isolated customers may, equitably, be charged to those customers directly.

Identification and allocation of facilities and pumping costs will generally require special studies at the outset to identify pumping zones, costs of serving the zones, and to assign neighborhoods, subdivisions, or street addresses to each zone. The implementation of the rates will necessarily involve address tracking that might differ from normal billing software. This can make spacial rates more expensive to develop and implement.

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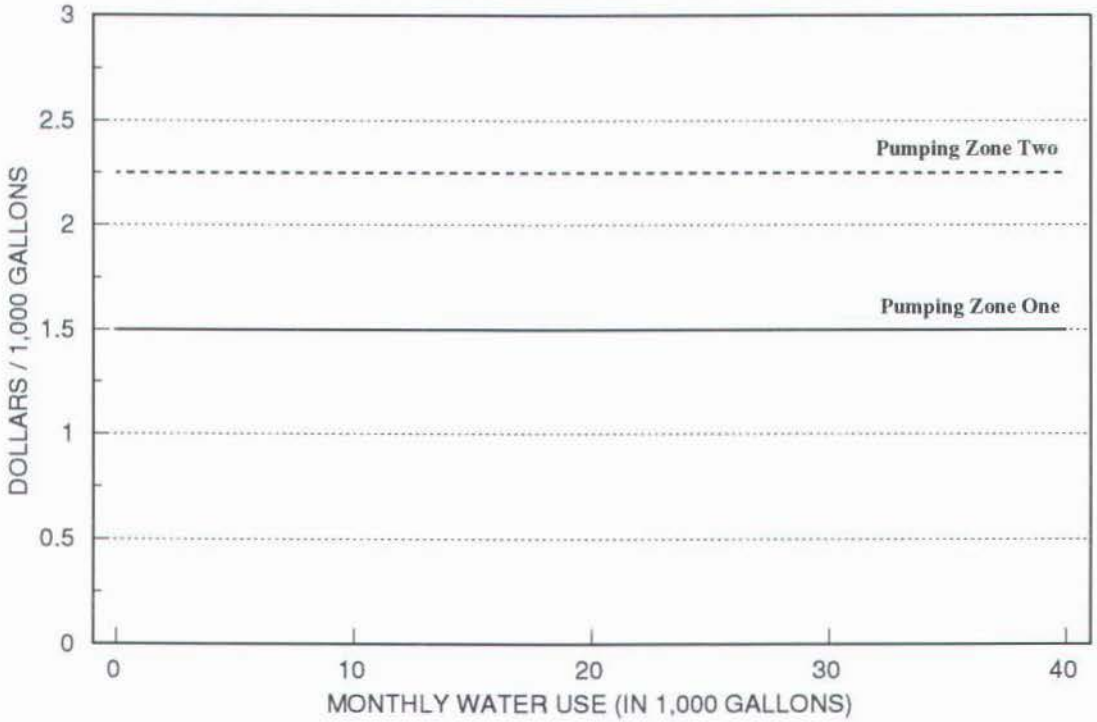
Figure 4.6

SPATIALLY DIFFERENTIATED RATE EXAMPLE



Marginal Cost Pricing

Marginal cost-based rate structures are based on the cost of the marginal resource. This sends signals about the costs imposed by future resources. The signal is especially strong in situations where the utility's major supply or transmission system have been in place for a significant period of time (15 or more years). In such situations, the cost difference between existing facilities and new facilities is generally quite large.

Marginal cost rates are theoretically the most economically efficient way for a utility to price water. In theory, when customers choose to buy and consume water, they are, in effect, equating marginal cost to marginal benefit. The pricing of water at marginal costs should cause consumers to reduce water usage for lower value, inefficient uses of water.

A significant drawback to marginal cost pricing is that marginal costs are not always observable. Marginal costs must be estimated based on the costs of the "next" unit. Thus, project complexity and ratemaking costs increase as the analyst increases the types of marginal cost that are estimated (e.g., marginal supply, transmission, distribution by pressure zone and customer class). Such analyses can expand beyond the reasonably expected analytical and financial capability of most water utilities in the CUWCD service area.

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Some marginal costs, however, are readily observable. The purchase of new water rights and the cost of water purchased from water wholesalers are examples of marginal costs that can be estimated very precisely. The development of new well fields and the construction of additional storage facilities can also be estimated relatively easily by the larger utilities in the service area.

The most important drawback to marginal cost pricing is that public utilities in Utah cannot legally charge rates that raise significantly more revenues than are needed to meet revenue requirements. Marginal costs can only be used as templates to distribute embedded costs in a manner reflective of marginal costs.

Goal-Based Rates

Goal-based rates are based on individual customers water consumption goals. The goals can be determined by previous customer consumption or by expected base consumption for a customer exhibiting specific characteristics. After a customers goal has been determined, a base cost for that consumption is developed. The actual bill received by the customer would then equal the base cost plus or minus the percentage of consumption over or under the consumption goal. The actual discount or surcharge applied may differ by applying different "application rates". In other words, the customer may receive a bill discount of 5 percent for consuming 10 percent below the goal.

This rate structure does provide a conservation incentive through the direct tie between consumption and total cost. It is likely that this pricing system would require a high level of communication of rates and consumption to the customer, further increasing the conservation potential. A concern from the utility's standpoint, however, is the large amount of data necessary to develop and implement goal-based rates. For many water agencies, the expense involved in creating this rate structure may be prohibitive.

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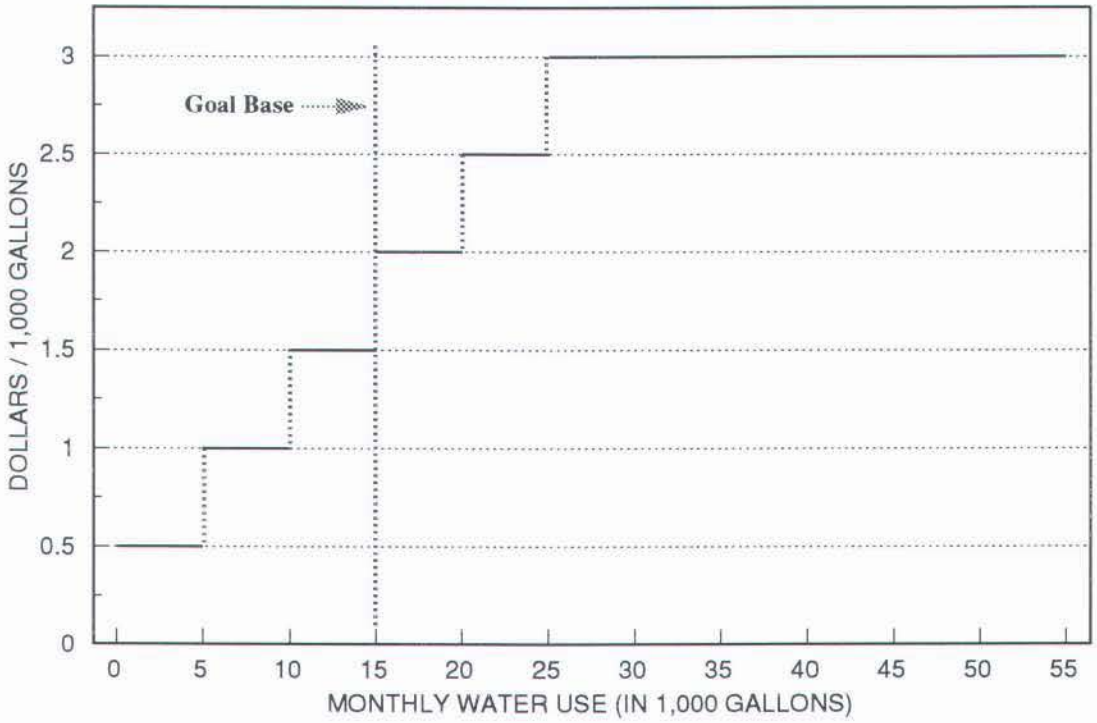
Figure 4.7

GOAL-BASED RATE EXAMPLE



4.4 EVALUATION OF RATE STRUCTURES

Table 4.1 provides an illustrative comparison of the previous evaluation of various rate structures. The determination of whether a rate structure is expected to do an excellent, good, fair, or poor job of meeting each criterion is based on general observation. It is entirely possible, for example, that for a particular utility, an increasing block rate will recover revenues every bit as well as a uniform rate structure. The increasing block rate structure does not receive as high a rating in this evaluation, however, because it has been traditionally observed that revenue uncertainty is more likely to occur using this type of structure than a uniform structure for a majority of utilities. Following Table 4.1 is a detailed discussion of each rate structure using each individual evaluation criterion as a point of discussion.

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Table 4.1
Rate Structure Evaluation

Criterion	Rate Structure							
	Uniform	Seasonal	Drought Year Surcharges	Increasing Block	Ratchet	Spacial	Marginal Cost	Goal Based
Revenue Sufficiency	√√√√	√√√	√√√√	√√	√√	√√√	√√√√	√√√
Revenue/Rate Stability	√√√√	√√√√	√√√√	√√	√√	√√√	√√√√	√√
Equity	√√√	√√√√	√√	√√	√√	√√√	√√	√√
Legality	√√√√	√√√√	√√√	√√√√	√√√	√√√√	√√	√√√
Simplicity	√√√√	√√√	√√√√	√√	√√	√√√	√	√
Ease of Implementation	√√√	√√√	√√	√√	√√	√√	√	√
Water Conservation	√√	√√√√	√	√√√√	√√√√	√√	√√√√	√√√

√√√√=Excellent √√√=Good √√=Fair √=Poor

Detailed Evaluation

Rate Structure: UNIFORM RATES		
Criterion	**Advantages**	**Disadvantages**
Revenue Sufficiency	With the exception of a flat fee system, uniform rates are probably the most conducive rate structure for insuring revenue sufficiency.	The primary cost recovery concern when using a uniform rate is the lack of recognition that certain price-elastic users (perhaps a large industrial user) may resort to self-supply if the rate is considered too high.

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Rate Structure: UNIFORM RATES		
Criterion	**Advantages**	**Disadvantages**
Revenue/Rate Stability	Uniform rates are generally quite stable and should not need to fluctuate greatly from year to year. If a utility is just implementing a uniform rate structure, the initial rate level, and subsequent customer response, will play a key role in determining the need to adjust the rates to recover costs. Once a general equilibrium is found, however, the rates should be easy to keep stable.	The inability of uniform rates to distinguish between seasonal or customer class costs can create some problems in providing stable revenues for the utility. In particular, an unusually cool and wet year can lead to a decrease in the need for water by residential customers, creating a potential revenue shortfall. Conversely, a hot and dry year may force the utility to draw upon more expensive reserves that also can create a revenue shortfall that must be made up by higher rates in the next period. One tool that can assist the utility in maintaining revenue stability is to charge a fixture fee for each customer that covers all fixed costs, and setting the uniform rate to cover only the variable costs of providing water.

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Rate Structure: UNIFORM RATES		
Criterion	**Advantages**	**Disadvantages**
Equity	Most customers perceive uniform rates as fair and equitable.	Inequities can occur between peak and non-peak users and between customer classes. Because peak consumption costs are almost invariably higher than non-peak costs, the non-peak customers are subsidizing the peak use customers. Also, if the per-unit cost of providing residential water is higher than the per-unit cost of providing water to large industrial customers, the industrial customers are subsidizing the residential customers. One option that can assist in decreasing inequities between customer classes is to develop a standard tariff rate for each customer class. This would result in developing a uniform rate structure for each customer class based on the cost of service to each customer class.
Legality	A uniform rate structure should have few, if any, legal concerns.	It is possible that a uniform rate structure could be challenged in an area where the cross-subsidization between customer classes seems unusually large.

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Rate Structure: UNIFORM RATES		
Criterion	**Advantages**	**Disadvantages**
Simplicity	A uniform rate structure is an extremely easy structure for customers and utility staff to understand.	As long as per-unit charges and consumption are clearly noted on the customer's billing, there should be no problems understanding this rate structure.
Ease of Implementation	If the utility has meters in place, uniform rates should be very easy to implement.	If the utility is changing from a flat fee system to uniform rates, there will be a need to read meters on a regular basis (preferably monthly). If meters are not in place, it will be necessary to install meters for all customers. Some formatting on the billing system may also be necessary.
Water Conservation	Because no volume discounts are provided, and because no minimum block of water is provided under a fixed charge, a uniform rate does provide customers with a financial incentive to conserve water.	The aggregation of customer classes into a single rate structure may not be responsive to the demand management objectives of each customer class. The level of conservation will also be very dependent upon the actual rate level. This is particularly true if a fixed charge is used in concert with the uniform rate and fixed costs are a large percentage of overall costs.

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Rate Structure: SEASONAL RATES		
Criterion	**Advantages**	**Disadvantages**
Revenue Sufficiency	Seasonal rates have no advantage relative to flat or uniform rates.	Seasonal rates can cause revenue erosion. Erosion occurs because of water conservation or self supply that is engendered by the rates. Conservation and self-supply should be factored into the analysis up-front to minimize the risk of revenue insufficiency. If politically feasible, drilling restrictions are advisable. For a utility with significant over-supply of water, seasonal rates might reduce sales and revenues, reducing the utility's ability to cover fixed costs such as debt service. If customers are allowed to respond by drilling wells, the revenue erosion problem could be significant if one or two large customers drill wells and cease water purchases from the utility.

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Rate Structure: SEASONAL RATES		
Criterion	**Advantages**	**Disadvantages**
Revenue/Rate Stability	Seasonal rates might actually increase stability relative to uniform rates. Since Utah's summers tend to be dry, the major rainfall risk to water utilities' revenues are in the spring and fall. If revenue recovery is more highly concentrated during the summer months, seasonal rates could increase revenue stability, and consequently, rate stability relative to uniform rate forms. Seasonal rates have no inherent advantage relative to flat rates.	Seasonal rates can cause short-run instability since the impact of rates on consumption must be estimated.
Equity	Seasonal rates increase equity. Uniform or flat rates average all peak and off peak costs, producing a subsidy from off-peak users to peak users. Properly designed, seasonal rates concentrate cost recovery in the season that drives the need for peak capacity. Seasonal rates correctly place the cost recovery on water users placing demand on the system during the peak season, and in the process, send a clearer price signal to customers to conserve water during the peak usage season. Sending correct price signals and reducing subsidization are important elements of seasonal rate policies.	Some people believe that seasonal rates can have a detrimental impact on commercial and industrial customers (with relatively constant loads) who are not the true culprits in the need for peak load capacity. However, if a seasonal rate is revenue neutral relative to the rate form being replaced, the industrial customer faces the same annual bill as before and is not adversely impacted *if the industrial customer does not have a strong seasonal usage pattern*. Obviously, if the industrial customer has a strong seasonal usage pattern, the original observation is invalid.

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Rate Structure: SEASONAL RATES		
Criterion	**Advantages**	**Disadvantages**
Equity (continued)	For utilities with significant seasonal fluctuations in the number of customers, a seasonal rate increases the equity of the rate structure because it places the additional cost burden most directly on those seasonal customers causing the burden. In addition to correctly placing the cost recovery for peaking capacity, seasonal rates allow the utility to recover O&M costs on a differential basis. For example, power costs often differ by season because (1) the power supplier often employs seasonal rates that coincide with the water utility's peak season and (2) pumping costs vary according to usage and the water supply resources utilized to meet demand. Thus, seasonal rates allow greater correspondence between O&M cost imposition and revenue collection.	In addition, some large use customers have the ability to re-use water and thereby benefit from seasonal rates to a greater extent than other large users such as irrigators. Seasonal rates can affect income distribution insofar as long-term conservation efforts on the part of customers requires either on-going behavioral changes or equipment replacement (e.g., replacing a standard toilet with an ultra-low flush toilet or the installation of sprinkling control equipment). Lower income customers also find it more difficult to absorb the higher peak period bills than they do the lower bills that result from non-seasonal rates. To limit the impact on lower income customers, seasonal rates may need to be implemented in concert with budget billing, life-line rates, and rebate programs for equipment replacement, thus limiting the effectiveness of the rate schedule (at least in the case of budget billing).

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Rate Structure: SEASONAL RATES		
Criterion	**Advantages**	**Disadvantages**
Legality	There is little doubt that seasonal rates are legal. Seasonal and other time-differentiated rate forms are common-place among electric utilities, and were in fact a major part of the ratemaking standards set forth in PURPA. Hence, legal challenges should not pose significant problems.	Assuming there is no substantial cross-subsidization between customer classes, there should not be any legal concerns that are endemic to seasonal rates.
Simplicity	The seasonal rate concept is easily understood by customers and utility staff. When only one rate block per month is used, seasonal rates are similar to uniform rates.	This rate form requires annual reminders that the peak season is beginning. Customers find it difficult to remember that rates change between seasons, causing occasional problems when the rate season shifts and the customer fails to modify behavior prior to the beginning of the season. This problem can be particularly pronounced in service areas with two-month or three-month billing periods.

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Rate Structure: SEASONAL RATES		
Criterion	**Advantages**	**Disadvantages**
Ease of Implementation	Seasonal rates do not require special metering. To minimize implementation problems, rate seasons and billing periods should be synchronized to prevent the need for bill proration or estimation. Seasonal rates involve some extra public education work insofar as the utility should thoroughly explain the system to customers as well as notifying customers each year that the peak season is beginning.	Seasonal rates might require more frequent metering than that performed by many Utah utilities. Monthly metering sends better price signals than quarterly or less frequent metering, particularly during the peak season. The base-excess surcharge can involve significant implementation complexities, including how base and excess are defined by the utility. Can the definition be explained to customers so that they understand and can act to change habits in response to the definition? Another potential problem is the extent to which billing systems must be changed. This will depend greatly upon the system already in place by the utility.

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Rate Structure: SEASONAL RATES		
Criterion	**Advantages**	**Disadvantages**
Water Conservation	Seasonal rates can convey a signal to customers that water usage efficiency during peak periods is important. Seasonal rates can encourage conservation by inducing customers to reduce peak season water usage. If structured correctly, seasonal rates penalize water users with high peak demands and low load factors. This aspect can make seasonal rates particularly appropriate for utilities with large residential customer loads. From a customer perspective, seasonal rates provide an opportunity for customers to reduce water bills more than a flat annual rate would provide. Customer water-usage modifications can include both short-lived behavioral changes and long-lived equipment changes. To effectively reduce bills, however, the customer must reduce water usage during the peak season, making the changes valuable to the utility as well as to the customer.	Typically, actual price response occurs after receipt of the first bill which is received at some point in the midst of the following billing cycle. Thus, price response cannot occur until the peak season is 1.5 months old under a monthly billing system, and it might not occur until the peak season is over in a quarterly billing system. Customers respond to seasonal rates, at least in the short-run, by reducing peak season water usage. This could result in fewer peak days and lower peak season water sales, but peak demand that is unchanged. In other words, seasonal rates can transform the existing peak profile into a needle peak profile. If permitted by local regulation of ground water, customers can respond by drilling wells and providing their own water supply. While this accomplishes the utility goal of peak reduction, it might exacerbate other problems, for example, the creation of a needle peak if the customers that resort to self-supply are large, high load factor customers.

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Rate Structure: DROUGHT YEAR SURCHARGES		
Criterion	**Advantages**	**Disadvantages**
Revenue Sufficiency	By definition, drought year surcharges are superior to rate schedules without the set of surcharges because the surcharges exist to ensure revenue sufficiency. Unless an automatic adjustment clause exists, rate schedules are fixed in nature once they have been adopted. An automatic adjustment clause allows rates to change, under certain circumstances, without the time and expense of a rate adjustment process. Drought surcharges fall into the automatic adjustment clause category insofar as they allow utilities to change rates without formal rate adjustment proceedings.	Since surcharges involve (potentially significantly) higher rates under the surcharge than without the surcharge, water sales would be expected to fall as people conserve water to reduce the bill impact. If this conservation effect is underestimated, even with the surcharge revenues could still fall short of requirements.

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Rate Structure: DROUGHT YEAR SURCHARGES		
Criterion	**Advantages**	**Disadvantages**
Revenue/Rate Stability	Drought year surcharges promote rate stability. In the case of severe drought, a utility without such surcharges faces revenue shortfalls which must be made up through rate increases or drawdowns in retained reserves (an action that should ultimately result in rate increases). Once the revenue shortfall has been recouped, the drought influenced rates may in fact need to be reduced again to match cost-of-service in a "normal" water year. Drought year surcharges prevent this scenario from arising.	From the customer's perspective, a surcharge can result in an unexpected higher rate for the period during which the surcharge is in effect. Individual customers (particularly low income) are unlikely to prepare personal budgets that take such an increase into account.
Equity	Surcharges can be structured in a way that equitably spreads the "pain" to those who do not choose to conserve water. This implies that necessary water consumption is not surcharged and that industrial/commercial water users are not prevented from conducting business.	Equity considerations increase the complexity of designing and implementing the surcharge. Using the residential sector as an example, if indoor water usage is not surcharged, a methodology for assessing indoor usage by household must be devised. The methodology must be flexible enough to allow for growth in the household size.
Legality	Cost-based and equitably applied policies should be legal.	The legality of specific formulations of the surcharge policy could potentially be open to legal challenge.

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Rate Structure: DROUGHT YEAR SURCHARGES		
Criterion	**Advantages**	**Disadvantages**
Simplicity	The concept of a surcharge is very easily understood by customers and utility staff.	It is important to notify customers prior to the implementation of a surcharge. In Utah, that probably means that the triggering of a surcharge would occur as a result of lower winter snowpack than is considered acceptable. Once it has been determined that a surcharge is necessary, extensive public information may be needed to explain the upcoming surcharge to customers. A simple reminder on the billing prior to the implementation will probably not be sufficient.

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Rate Structure: DROUGHT YEAR SURCHARGES		
Criterion	**Advantages**	**Disadvantages**
Ease of Implementation	Special metering and billing systems are not required to implement a surcharge.	The initial implementation of surcharges requires some significant analytical work. First, the utility must select a "triggering" mechanism. To reduce the controversy that might otherwise surround the surcharge policy, the utility must specify clearly the condition or set of conditions that will cause the utility to invoke the surcharge. Next, the utility must decide on the level of the surcharges and how to assess the surcharges for each customer class. The utility must decide whether the surcharge will be across the board or applicable only to certain customer classes. The utility must decide whether the surcharge will apply to all water usage or only usage above base consumption levels, and if the latter option is selected, whether there will be adjustment methodologies built into the policy to provide a means for adjusting the base consumption to account for the economic growth or changes in household composition.

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Rate Structure: DROUGHT YEAR SURCHARGES		
Criterion	**Advantages**	**Disadvantages**
Water Conservation	A surcharge policy should result in water conservation purely as price response. If the surcharge is tailored to allow basic culinary, process, or required consumption, the impact should mostly fall on outdoor usage for landscape irrigation.	The exact impact is difficult to predict. Because surcharges have tended in the past to be a last-resort measure, they have often been invoked after customers had already reduced their consumption significantly, thereby causing considerable discontent. In such a situation, if the surcharge is small it is actually possible that the impact would be negative insofar as customers might increase usage out of feeling that their sacrifices are useless.

Rate Structure: INCREASING BLOCK RATES		
Criterion	**Advantages**	**Disadvantages**
Revenue Sufficiency	Increasing block rates have no advantages relative to other rate forms.	Estimating conservation impacts is difficult. Under-estimating the impacts would result in revenue shortfalls while over-estimating the impacts would result in revenue surpluses.
Revenue/Rate Stability	Increasing block rates have no advantages relative to other rate forms.	Implementation of increasing block rates can involve two or three iterative attempts to design rates while maintaining revenue sufficiency. Hence, implementation periods can involve rate instability.

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5 PRICE ELASTICITY OF DEMAND

5.1 BACKGROUND

Several factors influence the demand for water, including the season, weather, persons per household, population growth, price, and irrigated acreage, among others. While price may not be the most important determinant of the demand for water, price is one of the few factors that can be influenced or changed by water managers and planners.

A water demand function quantifies the impact that each of a number of variables has on the demand for water. An example of a demand function could be:

$$D_W = b_0 + b_1X_1 - b_2X_2 + b_3X_3 - b_4X_4$$

Where:

D_W = the residential demand for water as measured in hundreds of cubic feet of water consumed per month by a single household

b_0 = a constant (or intercept)

b_n = the coefficient for variable n.

X_1 = the number of persons in the household

X_2 = the inches of precipitation measured during the month

X_3 = the lot size of the household, in square feet

X_4 = the price of water, in dollars per 100 cubic feet consumed

An understanding of the entire demand function is necessary to estimate the impact that any single factor, including price, will have on the demand for water.

A demand function can be developed through the application of regression analysis. The purpose of regression analysis is to examine historical information in order to determine a causal relationship between variables. This causal relationship is generally used to forecast the expected future value of a particular variable, such as demand.

The primary purpose of developing demand forecasts for the Pricing Study is not to quantify a forecast value, but rather to establish demand functions that explain the relationship of a number of explanatory variables (including price) to the demand for

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water. The influence of price can not be estimated in isolation, but must be estimated in conjunction with all other significant variables which affect the demand for water.

The dependent variable is the object of a regression analysis, the values for which a forecast or an understanding of a causal relationship is desired. In the case of the water demand functions in this particular study, the dependent variable is demand (as measured by consumption per customer).

The independent variables are those which determine the dependent variable. The demand for water depends on several factors including weather, season, lot size or irrigated acreage, soil type, income, persons per household, availability of a dual water system, conservation measures in place, attitudes about water use, and price. The coefficients for each independent variable measure the contribution of the variable to the prediction of the value of the dependent variable.

Each observation includes a historic value for the dependent variable (e.g., household water consumption in January 1989), and values for independent variables (e.g., household income, precipitation, temperature, water price, and persons per household in January 1989). In general, the more observations, the more likely it is that statistically significant relationships can be identified.

Selecting causal relationships depends as much on experience, reasonableness (as supported by theory) and intuitive logic as it does on the statistical relationship between variables. Only a single set of independent variables can be specified for the dependent variable in a particular equation. As a result, it must be appropriate to expect that the same independent variables can reasonably explain changes in the dependent variable. There must be a logical causal relationship, even before there is a statistically significant relationship. Dissimilar dependent variables (i.e., water demand for different customer classes or very different geographic locations) should not be aggregated as a means of gathering more observations.

5.2 CASE STUDY OVERVIEW

Demand Sectors

The Act requires that CUWCD estimate demand elasticity for each of the principal categories of end use of water within the District boundary. While CUWCD and their consultants fully intend to comply with Congressional intent, the actual language of the Act is ambiguous in this requirement. The ambiguity arises from the phrase "categories of end use". This phrase is not a widely used, defined, and accepted industry term. In other words, two professionals within the water industry could not use the term and know exactly what was meant without clarification. The following definitions can assist in removing the ambiguity.

1. End use is the label attached to each appliance, fixture, or process in which water is either consumed or utilized to perform a service or as an input in the production

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of a good or a service. For example, clothes washing is an end use in which water is one input in a process that provides a service -- cleaning of clothing. Similarly, industrial cooling is another end use in which water is one input to a process providing a service -- cooling.[1]

It should be noted that each end use can embody any number of technologies. Landscape irrigation can be accomplished with hoses and sprinklers, buried pipes leading to above-ground sprinkler heads, underground pipes leading to below-ground water applicators, and other technologies. Generally, even though the technologies might be very different in up-front price, operating and maintenance costs (including labor), water usage, and other characteristics, all of the technologies constitute residential landscape irrigation -- an end use of water.

2. Customer classifications (customer classes) are defined as groups of customers that have similar service characteristics and/or demand patterns. Service characteristics may be defined in terms of meter size or requirements for treated or raw water. Demand patterns depend on peak-day and peak-hour rates of demand relative to average demands. Generally, customer classes are (1) residential, (2) commercial, (3) industrial, and (4) public authorities. General classes are frequently subdivided into yet more homogeneous classes (e.g., residential is frequently subdivided into single family and multi-family classes). In some cases, one customer exhibits characteristics that sets them apart from all other customers. Such customers are frequently assigned their own customer class.[2]

   Customer classifications have historically been defined by the Bureau of Reclamation (the Bureau) as municipal and industrial (M&I) and agricultural uses of water.[3] This delineation of customers is frequently observed in trade literature and reports.

3. Sector is a term that is often used interchangeably with class. Generally, the word sector is used to refer to residential, commercial, industrial, or agricultural customers as groups. Thus, customer sectors could coincide with customer classes.

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[1]For lists of residential, commercial, and industrial end uses, see: Planning and Management Consultants, Ltd., *Evaluating Urban Water Conservation Programs: A Procedures Manual*, Carbondale, Illinois, February 1992, pp. 39, 42.

[2]American Water Works Association. *Water Rates*. AWWA Manual M1, Third Edition. Denver, Colorado: American Water Works Association (1983). pp. 23-24.

[3]See for example, United States Department of the Interior, Bureau of Reclamation, *Central Utah Project: Bonneville Unit-Utah. Supplement to Definite Plan Report*, Department of the Interior, Bureau of Reclamation, Upper Colorado Region, May 1988, p. 8.

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4. Weather sensitivity provides an additional dividing line for classification purposes. External water usage is highly weather sensitive. External water usage refers primarily to landscape irrigation and other end uses such as washing cars. While internal water usage is weather sensitive (i.e., most people tend to take shorter showers when the outside temperature is 100 degrees fahrenheit than when it is 20 degrees), it is far less weather sensitive than external usage. Internal water usage refers to water used within the home or business for sanitary or culinary purposes.

   The distinction of major importance is that external usages tend to have greater price sensitivity than internal usages, at least in the short run. People are far more likely to respond to price increases in the short run by restricting the frequency of washing their car than they are the frequency of taking showers.

The exact definition of "categories" intended by the authors of the Act is not known. The definition that will be used for the Pricing Study will be equivalent to customer sectors. Thus, principal categories will include residential, commercial, industrial, and agricultural. This definition is substantially consistent with the long-standing Bureau classifications (M&I and agricultural). Since the Act is intended to refine and complete Bureau-related projects and processes, a definition that is consistent with Bureau classifications could be considered consistent with the intent of the Act. The definition used for the Pricing Study will result in the development of more detailed information than would be derived using the Bureau's M&I classification.

Case Study Focus

The 1993 Pricing Study Work Plan included a case study focusing on the Salt Lake County Water Conservancy District's (SLCWCD) plan to implement conservation pricing. Since the work plan was developed, circumstances have dictated changes in how the case study was expected to be performed. Specifically, SLCWCD postponed plans to change their rate structure and no rate changes are expected by SLCWCD for the immediate future.

While this development has forced a change in planning, it does not eliminate the need for some type of independent analysis of the relationship between water pricing and the demand for water. The case study, as described in this report, is the primary source of that independent analysis.

The case study focused on estimating residential sector demand functions. Developing demand functions for all four end-use categories would be a data-intensive, time-consuming, and expensive process. This level of effort goes well beyond the scope of the Pricing Study.

Estimating residential water demand is reasonable, however, given the availability of reliable customer-level data for residential customers. It is also believed that the attitudes and practices of residential customers in the CUWCD service area (particularly along the heavily-populated Wasatch Front) may differ from those found in other areas of the

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country. If this is correct, then a specific case study is warranted to evaluate potential differences in consumer response to water price from those found in previous studies. This case study focuses on the residential demand for water in the Salt Lake Valley using data acquired from four different retail water agencies in the area.

The analytical framework for the case study is a pooled time series-cross sectional database consisting of at least two years worth of monthly data from approximately 330 households. The analysis pools the households across utilities and demand equations will be estimated using the pooled data.

Agencies Involved in the Case Study

As originally envisioned, the case study intended to include the Salt Lake County Water Conservancy District (SLCWCD) and between one and four adjacent water agencies. This plan was precipitated by SLCWCD's intent to implement an increasing block rate structure for their retail customers.

CUWCD and RMI staff identified four utilities whose service areas are adjacent to the SLCWCD service area and that would potentially be good candidates as comparison groups for qualitative analysis. CUWCD and RMI staff met with representatives of Salt Lake City, Murray City, Sandy City, and South Salt Lake City to discuss those agencies willingness to participate, customer characteristics and customer data availability, rate structures, billing frequency, metering frequency, and other topics of interest such as planned (future) rate changes.

Generally, the following trends emerged from the conversations and the data collected:

- Water rate structures of all five utilities appear to result in fairly similar levels of monthly water bills for an average residential customer. The rate structures differ in terms of minimum charges, customer charges, and variable rates but the resultant bills appear to range from about $12.00 to $15.00 for a residential customer using 16,000 gallons. In absolute dollar terms, the bills are quite similar, although, in percentage terms the difference between the lowest and highest bill is 25 percent of the lowest bill.

- None of the utilities read residential meters in winter months. Thus, to the extent that winter months' water usage form the baseline for determining indoor water usage (as a fraction of total water usage), the data are at the same levels of aggregation.

- Four of the five utilities appear to be able to differentiate residential customers from other customer types within the billing system databases. Sandy City does not distinguish between residential and commercial customers in the billing system.

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- Three of the five utilities bill their residential customers on a monthly basis. Sandy City and SLCWCD bill their customers bi-monthly.

- Based on the meetings with each utility, it appears that the data obtainable from the utilities' information systems will be comparable.

In March of 1993, the SLCWCD Board of Directors determined that a change in the retail pricing structure was not necessary or desirable at the present time. This decision made it necessary to re-evaluate the development of the case study and the method for determining participating agencies.

It was determined that a useful case study could still be performed without a rate change by one of the participating agencies. The impact of price on demand could still be measured using historical data from a number of agencies, keeping the primary purpose of the case study intact. The loss of a price change diminished the availability of some potentially interesting quantitative and qualitative information concerning the impact price, attitudes and education can have on the demand for water. This information, however, is not essential to the Pricing Study or the case study.

Since SLCWCD was no longer an essential participant in the case study, they were evaluated as a potential participant in the same manner as the other utilities. The evaluation of other utilities that were not adjacent to SLCWCD was also considered. This effort was not initially undertaken, however, due to time and budget constraints.

Based on the information summarized above, it was determined that residential customers of Salt Lake City, Murray City, and South Salt Lake City would be included in the case study. The primary reason that both Sandy City and SLCWCD residential customers were not used was the lack of monthly billing cycles. Monthly billing cycles are preferred because they provide the customer with better information to base price-sensitive water use decisions on.

Expanding the Database

In October of 1993 RMI staff met with the members of the Technical Committee to review preliminary study results. As discussed later, preliminary analyses were producing counter-intuitive results for marginal price variables. The committee raised concern over the lack of price variation offered by using only the three agencies mentioned above. Since none of the agencies have changed their rates over the historical time period being reviewed, price variation must come from the cross-sectional analysis between agencies. The committee believed that more variation in water rates would be necessary to allow an econometric analysis to adequately pick up the effect that marginal price has on consumption. The only available option to increase price variation would be to include more agencies, with greater price variation, in the case study. It was decided to include the county customers of Salt Lake City and the city of Provo because of the additional range of prices they offered to the data.

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5.3 DATA COLLECTION

The primary purpose of data collection activities related to the case study was to develop variables to be used in the creation of a residential water demand function. Since the demand function was based on individual customer response, customer-specific information was required. While customer-specific data is preferred to service-area average data, averages can be useful as proxies in variable development, particularly when customer-specific data is unavailable or difficult or expensive to obtain.

In other studies estimating household-level demand functions, the most statistically significant variables have typically included the number of persons in the household, household income (or housing value or rent), the lot size, and weather variables. The following is a list of variables that have been successfully used in previous statistical analyses of household-level demand. The variables are discussed as they apply to Utah.

Dependent Variable

- **Water Consumption/Demand**
  - Average monthly household water consumption (100 cu. ft.)
  - Average monthly household water consumption by summer and winter periods (100 cu. ft.)

Independent Variables

- **Price**
  - Average price ($/100 cu. ft.)
  - Average water bill ($/monthly bill)
  - Average total monthly bill, including sewer, garbage, power ($/monthly bill)
  - Average water plus sewer bills ($/monthly bill)
  - Marginal water price ($/100 cu. ft.)
  - Marginal water plus sewer price ($/100 cu. ft.)
  - Marginal sewer price ($/100 cu. ft.)
  - Nordin bill difference (amount actual bill differs from the bill that would result from all consumption priced at marginal prices in $/monthly bill)
  - Ramped marginal water prices ($/100 cu. ft.)

- **Household Demographics**
  - Household income
  - Number of residents
  - Home ownership
  - Home value or rent
  - Age of home
  - Lot size
  - Building type (structure)
  - Attitudinal data predictive of conservation activity

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- Adjusted Lot Size
- Net lot size

- **Climatological Data**
  - Number of rainy or dry days
  - Total precipitation (inches)
  - Average, high, or low temperatures (degrees fahrenheit)
  - Evapotranspiration (inches)

The water consumption and price data were derived from the water agencies' customer databases. This historical customer data was collected from each of the four participating agencies. Household demographic information was collected from each household through a customer survey. Climatological data was collected from the Utah Climate Center.

Water Agency Customer Databases

Each of the four participating agencies provided information from their customer databases in machine readable format. The approximate number of residential accounts for each of the four agencies was 42,000 in Salt Lake City proper, 27,000 in the outlying county service are of Salt Lake City, 6,500 in Murray, 2,500 in South Salt Lake City and 13,000 in Provo. In order for a residential customer account to be considered for inclusion in the case study, it had to meet three primary requirements.

First, each account had to be verified as being residential. Second, the service address and the billing address had to be the same. This was necessary to insure that the individual who paid for the water was also responsible for determining how much water was used. Third, the account had to be continuous to the same customer and service address for the entire historical period. This allowed us to match demographic information with billing and consumption information. Any account that met these three requirements was deemed suitable for use in the case study.

Information that was available and could be matched across all agencies included:

- A unique account number
- An address
- A billing date
- Monthly water consumption (estimated in winter months)
- Monthly water bill
- Monthly total bill (including water, sewer, garbage, and in some cases storm service and power)

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Only one of the agencies had altered their rate structures over the period to be examined (since September 1991). The residential rate structures for the four utilities were as follows.

- South Salt Lake City
  - $6.00 per month minimum charge
  - Monthly allowance of 8,000 gallons (1069.2 cu. ft.)
  - $.70 per 1,000 gallons (133.65 cu. ft.) over the monthly allowance
  - Sewer rates of $2.60 per 1,000 gallons (133.65 cu. ft.) of average monthly winter water use

- Salt Lake City

  City Customers:
  - $6.45 per month minimum charge
  - Monthly allowance of 1,000 cubic feet
  - $.43 per 100 cubic feet over the monthly allowance
  - Sewer rates of $.80 per 100 cubic feet of average monthly winter water use (not to be less than $3.15 per month)

  County Customers:
  - $8.95 per month minimum charge
  - Monthly allowance of 1,000 cubic feet
  - $.64 per 100 cubic feet over the monthly allowance
  - Sewer services are provided by other entities and are not part of their water bill

- Murray City
  - $3.50 per month minimum charge
  - No monthly allowance
  - $.41 per 100 cubic feet
  - Sewer rates of $1.54 per 100 cubic feet of average winter monthly water consumption

- City of Provo
  - $7.30 per month minimum charge for 5/8 inch pipe, $8.47 for 3/4 inch pipe, and $10.70 for 1 inch pipe
  - Monthly allowance of 500 cubic feet
  - $.31 per 100 cubic feet over the monthly allowance (prior to January 1993)
  - $.33 per 100 cubic feet over the monthly allowance (after January 1993)
  - Sewer rates of $.52 per 100 cubic feet of average monthly winter water use plus a service charge of $4.55

Treatment of Missing Data Points

There were three primary instances of missing data points in the historical customer data sets that were examined. Both South Salt Lake City and Murray City do not record meter reading dates, they record only billing dates. In the case of Murray City, the

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billing dates vary across the entire month, suggesting that customer meters are also read at various dates throughout the month. Murray city officials noted that a customer is typically billed five to seven days after their meter is read. Therefore, the meter read date for Murray City accounts was assumed to be six days prior to the billing date that was recorded.

South Salt Lake City, on the other hand, bills all of their customers on the last day of the month, regardless of when the meter was read. They do, however, prepare a hard copy of all of the meter reading dates for each account for the last month. This hard copy is usually kept for about one month. South Salt Lake City officials noted that the meter reading routes remain stable, and that the meter for a particular account will be read on approximately the same date for each month. Therefore, the meter read date for South Salt Lake City accounts was assumed to be approximately the read date for July 1993, with the same day of the month being used for each previous monthly observation.

As has been previously noted, none of the utilities read residential meters during the winter months. Monthly winter consumption estimates for Murray City and Salt Lake City are prepared by those entities. Murray City assumes monthly consumption of 500 cubic feet per month for billing purposes, with the difference in actual reading being reflected in the first spring month (April) billing. Salt Lake City generally averages total winter consumption over the four month period, but assumes that the monthly consumption for a winter month does not exceed the base consumption allowed under the minimum charge system (1,000 cubic feet). If the actual reading shows that the customer exceeded the base consumption amount for the entire winter, then the overage is charged to the first spring month (April) billing. It must be noted, however, that this does not appear to be consistent for all Salt Lake City accounts. When a deviation does occur, it is uncertain why.

South Salt Lake City, unlike the other two entities, does not estimate winter readings. Because of this, winter month consumption is shown as zero and the first spring month's (April) consumption is actually the consumption for the entire winter. The winter consumption presented a problem in that no previous studies appear to have dealt with this issue, providing no precedent for filling these gaps in the data. This issue was addressed in the following manner.

The South Salt Lake City customers' April consumption reading was evenly spread over April and the previous months where consumption data is missing. The maximum consumption that was attributed to any winter month was the base monthly allowance of 8,000 gallons (1,069 cubic feet). Any consumption recorded over the sum of the base monthly allowance for each month was attributed to April consumption.

This approach is relatively consistent with the approaches used by the other two water agencies. The primary rationale for this approach is the belief that consumption during the winter months will reflect indoor use. As such, consumption should, in most cases,

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stay below a base consumption amount and should also remain relatively flat because it will not be weather sensitive. Overages are attributed to April because it is expected that any outdoor use would occur during that month as a function of early watering habits.

The use of estimated consumption data, whether through this estimation procedure or those used by Murray City and Salt Lake City, make it less likely that an accurate demand relationship for the winter months will be derived. Elasticity estimates for winter consumption have traditionally been more difficult to derive than those for summer months, regardless of the type of data used.

Survey Data

In determining which customer accounts would be used in the study, the collection of survey data was a limiting factor. The number of accounts from each agency that were used in the study, along with the total number of residential accounts in each agency, determined the statistical applicability of the sample to the universe (in this case, the agency service areas).

While consumption and billing data were available for all of the residential accounts in the agency service areas, the collection of customer-specific demographic data for all accounts was not possible. The cost of sending a survey to all available residential customers (even after meeting the three primary requirements noted earlier) and coding the information returned from however many responded to the survey is prohibitive and unnecessary. Sampling techniques can be used to draw inferences about a defined population. Based on the size of the sample relative to the population, we can statistically determine the accuracy of the data collected and the confidence we can have in the data.

Two sample sizes must be determined. The first sample size is the number of accounts that must be examined to reach a level of accuracy and confidence that we are comfortable with for extrapolating the findings of the case study to the study area. After that sample size is determined, the number of surveys that must be sent in order to receive a number of responses equal to, or greater than, the first sample size must be determined by estimating an expected response rate for the survey.

When a sample size determination is based on a desired level of precision, the following formula provides a standard method of estimating the required sample size for an attitudinal survey.

$$n = [t^2 * s^2 * N] / [(E^2 * N)+(t^2 * s^2)]$$

Where:

n = the sample size

t = the appropriate t statistic for a given level of confidence

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s = the estimated standard deviation

N = the population size

E = the required level of accuracy

To apply the sampling formula, certain simplifying assumptions were made. First, since an estimate of standard deviations are needed, either prior information or assumptions are necessary. For a question with "Yes" or "No" (0 or 1) outcomes, the maximum sample size arises when exactly one-half of the sample answers "Yes" and the other half answers "No". Absent prior information, "s" is often assumed to be 0.5, thereby maximizing the sample size. The second has to do with the number of variables in question. A simplifying assumption frequently employed is that the sample is relevant to only one variable.

Each population is defined as the number of billed residential customers served by each of the four agencies. Each of the four agencies, as well as the Salt Lake City county customers, must be considered as a separate population because we can not assume a random distribution of customers across all five agency service areas. This is because customers served by different agencies may receive different prices on different types of billings and may have been subject to varying levels of conservation awareness via their water supplier. The assumption of random distribution is made for each individual agency's residential customer population.

For each population, we have attempted to achieve a confidence level of 90 percent and an accuracy level of 10 percent. Achieving these goals would allow us to state that: 1) For every 100 times a population is sampled, the same estimates should be observed 90 times, and; 2) A numerical estimate that is derived from the sampling should be within 10 percent (plus or minus) of the actual numerical value that would be found if a census of the entire population were available.

Using the formula described earlier, the following number of responses would need to be received in order to achieve a 90 percent confidence level and a 10 percent level of accuracy:

- 66 responses from South Salt Lake City
- 67 responses from Murray City
- 68 responses from Salt Lake City
- 67 responses from the county customers of Salt Lake City
- 68 responses from the City of Provo

This would result in a total sample size for pooled cross sectional analysis of approximately 330 customer accounts. If 24 months of data were available for each customer account, we would have somewhere in the vicinity of 8000 observations for use in the pooled time series-cross sectional analysis.

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The number of surveys to be sent out was determined by dividing the number of responses needed by the expected response rate (in percent form). Response rates for similar surveys have been as high as 65 percent and as low as 25 percent. While there is no typical response rate for this type of a survey, a response rate of 35 percent was assumed for this study. The primary purpose for estimating on the lower end of the range was that no follow-up activities were planned.

Using a 35 percent response rate, the following number of surveys would need to be sent to each of the five agency service areas customer bases:

- 189 surveys to South Salt Lake City
- 192 surveys to Murray City
- 195 surveys to the city customers of Salt Lake City
- 192 surveys to the county customers of Salt Lake City
- 195 surveys to the City of Provo

To meet this requirement, a random sample of 200 residential accounts was taken from each of the five sample groups using the following method:

1. The total number of accounts that were determined to be suitable for use in the case study is represented as "N".

2. "N" was divided by 200 to determine "n", where "n" represents the number of accounts that will not be used before reaching an account in the database that will be chosen to receive a survey.

3. Starting at the first record in the database of available accounts, a random number "r" was chosen that was the first record chosen to receive a survey. Subsequent records were chosen by the sequence: r, r+n, r+2n, r+3n, r+4n, ..., r+200n.

4. "r" was chosen for each group by corresponding the first letter of the agency name with a sequential number (i.e., A=1, B=2, C=3, ..., Z=26).

The survey instrument was developed by RMI with input from CUWCD and the three original participating agencies. The primary intent of the survey was to gather customer-specific demographic and attitudinal data that could be matched with the available billing and consumption data in order to develop variable sets for complete observations. A secondary intent of the survey was to gather qualitative information regarding customer attitudes toward conservation and pricing issues.

The following relevant information was collected through the survey and used to develop variables and useful discussion on customer attitudes:

- Number of residents (adult and youth)
- Building type (house, apartment, townhouse)

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- Number of bedrooms
- Age of home
- Size of home (in square feet)
- Size of lot (in square feet)
- Incidence of lawn
- Lawn watering practices
- Incidence of swimming pool
- Incidence and use of water using appliances
- Incidence and use of water conserving appliances
- Conservation attitudes and practices
- Home ownership
- Home value or rent
- Household income
- Education level
- Water rate attitudes

Variable Development From Survey Data

The following variables were developed from survey data for potential testing in the regression analysis.

Persons Per Household - The number of persons reported as living in each residence was used. There were no instances of missing data.

Age of Home - The year the home was built was asked as a question and recorded directly if the year was written by the respondent. In many instances, the respondent did not give the exact year but noted instead a decade that they believed the home was built in. In that case, the mid-point of the decade was recorded as the year the home was built. For the period noted as "pre-1920", 1910 was recorded as the year the home was built. This variable was not tested extensively because no important changes in building codes were identified to suggest a change in consumption patterns based on age.

Home Ownership - A dummy variable indicating whether a customer was a homeowner or renter was considered. After examining the data, it was determined that there were not enough renters answering the survey to make the variable relevant. It is likely that most renters were excluded in the survey sample selection. This is because most landlords pay the water bill for a residence. In selecting the sample group, only those accounts where the service address and the billing address were the same were considered. This would exclude renters who do not pay the water bill.

Building Type - After examining the data, there was not enough variation in building type to make the variable relevant. Almost all of the respondents described their residence as a single-family detached house.

Incidence of Lawn - After examining the data, there was no variation in incidence of lawn, making the variable irrelevant. All of the respondents noted that they had a lawn.

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Incidence of Swimming Pool - After examining the data, there was not enough variation in incidence of swimming pool to make the variable relevant. Almost all of the respondents did not have a swimming pool.

Home Value - When indicated by the respondent, the actual home value was used. Many respondents did not provide an exact home value, but did note a range of values in which they believed their home fell. In those cases, the mid-point of the range was used. For the range "Less than $40,000", $35,000 was used because it was the median home value of those reported under $40,000. For the range "$200,000 or more", $230,000 was used because it was the median home value of those reported over $200,000. When the respondent did not indicate the value of their home in any fashion, the following measures were taken to estimate home value for each respondent. For each zip code, home size was regressed against home value. For those respondents that provided a response for home size, but not home value, the regression coefficient and the reported home size was used to estimate home value. The same process was performed using lot size, and then number of bedrooms, as regression estimators.

Lot Size - When indicated by the respondent, the actual lot size, in square feet, was used. When the respondent did not indicate the lot size of their home, the following measures were taken to estimate lot size for each respondent. For each zip code, home value was regressed against lot size. For those respondents that provided a response for home value, but not lot size, the regression coefficient and the reported home value was used to estimate lot size. The same process was performed using home size, and then number of bedrooms, as regression estimators.

Household Income - When indicated by the respondent, the actual household income was used. Many respondents did not provide an exact income, but did note a range of values in which they believed their income fell. In those cases, the mid-point of the range was used. For the range "Less than $20,000", the median income by persons per household was used. If the respondent noted there was one resident, $9,000 was used as an estimate. If the respondent noted there were two residents, $12,000 was used as an estimate. If the respondent noted there were three residents, $18,000 was used as an estimate. For the range "$150,000 or more", $150,000 was used because it was the highest income reported. When the respondent did not indicate their household income in any fashion, home value was regressed against household income. For those respondents that provided a response for home value, but not household income, the regression coefficient and the reported, or estimated, home value was used to estimate household income.

Conservation Attitudes and Practices - It is widely believed that the price coefficient in a water demand equation picks up not only the effects of price, but also the effects of conservation attitudes, practices and programs. An attempt to separate the effects of conservation attitudes and practices from those of price was made by constructing a dummy variable that indicates whether a customer is a "conserver" or not. A conserver was defined as a respondent who is strongly concerned about water conservation and

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whose water conservation practices were better than the average of the entire respondent group. Using six attitudinal questions, 57 percent of the respondents were defined as being strongly concerned about water conservation. Using 12 conservation device questions, and 14 conservation practice questions, 41 percent and 51 percent of the respondents, respectively were considered above average. Using all three question sets as criteria, 16 percent of the respondents were identified as conservers. Respondents that are identified as conservers was identified with a "1", and other respondents was identified with a "0".

Adjusted Lot Size - Because the regression runs are based upon time series cross sectional data, and because the lot size and precipitation variables are heavily correlated in determining water consumption, an additional variable was developed to normalize and recognize the relationship of the lot size and precipitation variables. The lot size variable was adjusted by the ratio of the maximum amount of rainfall seen in any given month, net of the precipitation for that month, to the monthly maximum precipitation. The resulting adjusted lot size variable reduces the lot size in a wet month, therefor accounting for the reduction in demand from the rainfall.

Net Lot Size - A net lot size variable was developed to more accurately reflect the actual square footage of vegetation that requires water. The net lot size is equal to the difference of the lot size and the size of the home. This variable assumes that the homes surveyed are single-story.

Qualitative Analysis of Survey Responses

Selected survey questions were analyzed to consider the attitudes of respondents toward conservation and pricing issues. Appendix C provides a response percentage breakdown of the selected questions for the three original agencies that was provided to the WMIS Coordination Committee on August 26, 1993. This brief analysis allows us to make a number of broad statements about customer attitudes.

With respect to water pricing, respondents expressed concern about the size of their water bill and noted that what they pay for water does influence how much water they use. Respondents appear to understand their total bill, but not necessarily their rate structure. In spite of the concern that respondents show toward price, the large majority believe that current rates are fair and they trust their water company to keep them fair.

In general, respondents believe that conservation is important and that it can be effective in delaying the development of new water supplies. While most respondents believe that society in general should do more to enhance conservation, they also are skeptical that they can personally do much more than they currently do. The vast majority of respondents expect their water company to take the lead on promoting conservation.

Conservation behaviors appear to be more prevalent than the use of conservation devices. The devices that are used most often are water efficient major appliances, low-flow showerheads, faucet aerators, and sprinkler systems. Most respondents believe that

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reductions in outdoor water use are very effective compared to reductions in indoor water use. They are not, however, willing to compromise on the appearance of their lawns.

Perhaps the overriding message relayed by respondents is that conservation should be encouraged and strived for, but should not cause financial or aesthetic discomfort.

Climatological Data

Information from four different weather stations in the study area were used. The four stations are the stations closest in proximity to the individual areas that were selected for the study.

One station is located at the Triad Center in downtown Salt Lake City, one is located at the Salt Lake City Airport, another is farther south at Cottonwood Weir at the foot of Big Cottonwood Canyon, and the fourth is the Provo/BYU station. Climatological data was matched to households by proximity of the station to the center of the zip code area that the household is in. Using this criteria, the following zip code areas were matched to each of the four weather stations.

Salt Lake City Airport

- 84104
- 84116

Cottonwood Weir

- 84070
- 84107
- 84109
- 84117
- 84121
- 84123
- 84124

Triad Center

- 84101
- 84102
- 84103
- 84105
- 84106
- 84108
- 84111
- 84115
- 84119

Provo/BYU

- 84604

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Information available from these weather stations include daily maximum temperature, minimum temperature, and precipitation. Daily information was aggregated to develop monthly weather variables that match customer billing periods. The raw daily data was provided by the Utah Climate Center.

The aggregation of daily information is important because of the very different billing periods between customers within a given month. While standard monthly weather data can not be directly applied to each individual observation, daily data can be aggregated for any potential billing period.

An attempt was made to acquire evapotranspiration data for the four weather stations mentioned earlier. The only data available for these stations is average monthly estimated evapotranspiration, as developed over a 30 year normal weather period. Actual daily evapotranspiration data is available from only four weather stations in the state. The closest such station to the case study area is located in Farmington, substantially north of the study area. Because of this, evapotranspiration data will not be used in the case study.

Normalization of Data to Average Monthly Terms

To recognize the time series-cross sectional form of the data being considered, the price and weather variables were normalized into average monthly terms by multiplying each datapoint by the ratio of the number of days in an average month to the number of days between meter readings. This was essential in recognizing that the county customers of Salt Lake City are billed on a bi-monthly basis.

5.4 DEMAND FUNCTION SPECIFICATION

Functional Forms

A wide range of demand function specifications have been identified and tested in the literature, and may be relevant to identifying demand relationships between variables. Potential functional forms were tested as a part of the process of testing and selecting final demand functions for the case study. Each functional form has ramifications as to how the explanatory variables impact the demand for water and on the interpretation of the variable coefficients.

Linear Functions

If we would expect the explanatory variables to have a direct, linear relationship to the demand for water, then a linear function would be an appropriate functional form. In this case, the regression curve is a straight line. If only one explanatory variable were used, an example of a linear function could be:

$$D_W = b_0 - b_1 X_1$$

In a linear function, the slope coefficient, b_1, measures the absolute change in D_W for a given absolute change in X_1. If D_W were the monthly demand for water expressed in

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hundreds of cubic feet and X_1 were the monthly price of water in dollars per 100 cubic feet, b_1 would represent how many hundreds of cubic feet more (or less) would be demanded given a one dollar per 100 cubic foot decrease (or increase) in the price of water.

Double-Log Functions

A double-log function is linear in the logarithms of the variables, D_W and X_1. In this instance, the function would be expressed:

$$\ln D_W = \ln b_0 - b_1 \ln X_1$$

While a linear function measures absolute change, a double-log function measures relative change. An attractive feature of the double-log function is that the slope coefficient, b_1, measures the elasticity of D_W with respect to X_1. Thus, if the variables involved are demand for water and the price for water, b_1 measures the price elasticity of demand. That is, b_1 would represent the percentage change in the demand for water given a one percent change in the price of water.

Semilog Functions

A semilog function expresses the variables on one side of the equation in log form, while expressing the variables on the other side of the equation in linear form.

If the function were expressed in the following manner:

$$D_W = \ln b_0 - b_1 \ln X_1$$

then the slope coefficient, b_1, represents the absolute change in D_W for a given relative change in X_1. This functional form is appropriate in situations where a proportional change in X_1 leads to an absolute change in D_W.

If the function were expressed in the other possible manner:

$$\ln D_W = b_0 - b_1 X_1$$

then the slope coefficient, b_1, represents the relative change in D_W for a given absolute change in X_1. This functional form is appropriate in situations where an absolute change in X_1 leads to a proportional change in D_W. This type of a function is often used in constant growth models to measure the growth rate over time of trend variables such as employment, consumer prices, imports and exports, or labor productivity.

Log-Partial Log Functions

A further variant of the semilog functional form, the log-partial log form includes log transformation for the dependent variable, and some, but not all, of the explanatory variables. An example of this form could be:

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$$\ln D_W = b_0 - b_1X_1 + \ln b_2X_2$$

How the coefficients are interpreted in this type of a function depends on whether the variable, or its logarithmic transform, is linear.

Variable Transformation

Most variables that are developed for use in regression analysis represent a relationship between quantifiable factors that occur in the same time period. For instance, it would be reasonable to postulate that the amount of money an individual saves in the year 1990 is a function of the amount of money earned by that individual in 1990.

It is possible, however, to transform variables to more accurately reflect causal factors in a regression analysis. Two of the more popular and accepted types of variable transformations are the use of "dummy" variables and "lagged" variables.

Dummy Variables

There are times when a discrete, non-quantifiable factor influences the dependent variable. If the qualitative data can be expressed as a "Yes" or "No" response, the data can be included in a regression analysis through the use of a dummy variable. Dummy variables change the intercept term in demand models. The intercept is b_0 if the factor is not present, and b_0 plus the b_M coefficient estimated for the dummy variable. Dummy variables can also be used to change the slope of a model, but must be interactive with other variables to do so.

Examples of qualitative independent variables that could influence the residential demand for water include whether or not a home has a swimming pool or if a customer is or is not considered a "conserver". These types of variables indicate the presence or absence of an attribute. Dummy variables can be constructed for these attributes by assigning a value of 1 or 0 for the presence or absence of the attribute. In the case of the swimming pool, a 1 would indicate that the customer does have a swimming pool, and a 0 would be assigned to those customers who do not have a swimming pool. The coefficient for such a variable would then indicate the expected change in the demand for water given the presence of a swimming pool. If there were no swimming pool present, the variable would be 0 and the coefficient would not be relevant in the equation.

Dummy variables can also be used to broadly group quantitative variables. This can be useful if it is believed that there is a "breaking point" above (or after) which the influence of the independent variable on the dependent variable changes significantly. A classic example of such a variable is the case of "rate shock." When huge rate increases occur, analysts frequently obtain significant results by including a dummy variable indicating pre- and post-rate increase time periods. For this study, there were no obvious candidates for such a variable.

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Seasonality presents the most common use of dummy variables in developing a demand function for water. In geographic areas where there are distinct summer and winter seasons (such as Utah), there is a substantial difference in residential water consumption that is generally attributable to outdoor water use for lawns, car washing, and recreation during the summer. While some of this effect can be captured through the use of climatological variables, the use of a seasonal dummy variable is a common practice. In this case, consumption in certain months is considered summer consumption and is assigned a value of 1. For example, an observation in May, June, July, August, September or October would have a seasonal variable of 1, while an observation in November, December, January, February, March or April would have a seasonal variable of 0. The coefficient would represent the change in water consumption due to the time of year (summer).

Seasonality has been shown to be extremely important in estimating the demand for residential water. Many researchers have felt it is so important that it constitutes an entirely different demand function. Several previous studies have developed demand functions for summer water demand and winter water demand. Often times, these have been extrapolated to represent outdoor and indoor water demand functions.

Lagged Variables

Up to this point we have discussed relationships between dependent and independent variables that occur in the same time period. There can be instances, however, where the dependent variable could be a function of a lagged value of one or more explanatory variables. An example of this might be that the amount of water consumed in December is a function of November's water bill. This is an example of a distributed lag. It is also possible for the dependent variable to be a function of the lagged value of itself. In this case, an example could be that the amount of water consumed in July is a function of the amount of water consumed in June. This is an example of an autoregressive lag.

There are three main reasons that lagged relationships occur.

1. Psychological reasons. People do not always change their consumption habits immediately following a change in price or income. Even though a customer may know that the price of water will rise in June, he may not respond to that price increase until he receives a bill that reflects that change. If billings occurred on a monthly basis, we might expect there to be a relationship between July's consumption and June's price.

2. Technological reasons. Suppose that water is a primary input into an industrial process. If the price of water were to rise substantially, the industrial producer might consider other, less water-intensive, production processes. Such a change in industrial processes would likely take some time. It is also possible that a change in the industrial process might require the expenditure of capital. If the producer believes that the increase in the price of water might be temporary, the producer might not rush to expend capital to change the industrial process.

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3. *Institutional reasons.* Contractual obligations may prevent customers from switching from one source of water to another. This could apply to wholesale customers of a water agency. An example could be that a wholesale water customer with the capability to pump more water from their own wells might do so if their wholesale supplier raised prices. If, however, the customer had a contractual obligation to take a certain amount of water from the supplier, the customer might not be able to respond to the price increase until the contract expired.

Regression functions that employ lagged variables are susceptible to certain estimation problems. One such problem is autocorrelation. When a function is autocorrelated, it means that there is a correlation between the dependent variable and the lag of that variable when it is used as an explanatory variable. By a "correlation", we mean that the errors of the variables are correlated, and therefore they are not randomly distributed. If the errors are not randomly distributed, then the estimators can not be considered efficient and a systematic relationship can not be determined.

A similar problem is that of serial correlation. In this case, the dependent and explanatory variables are different series (i.e., water consumption and lagged price of water) whose error terms are correlated. While there is a technical difference, the terms serial correlation and autocorrelation are often used synonymously in reference to what we have defined as autocorrelation.

Despite the estimation problems, lagged variables have proved useful in empirical economics because they allow an otherwise static relationship to become dynamic by taking into account the role of time. Functions that use long enough lags can also assist in distinguishing between short- and long-run response of the dependent variable to a unit change in the explanatory variable. This can be particularly useful when considering the estimation of short- and long-run elasticities.

The use of lagged variables in a pooled data series is not common because of the difficulty in transforming individual time series "subsets" of data. This study will, however, examine the use of a lagged price variable.

Special Price Variables

The correct specification of price is of fundamental importance in estimating price elasticities. Even where price has been "correctly" specified, however, the characteristics of the rate structure may introduce bias. Many water rate structures send a mixture of price messages to consumers. While analysts specify price variables according to the rate structure, that is not always consistent with real world price response. When decreasing block designs are used, for example, the marginal price decreases as more water is used. This ensures a negative functional relationship between price and use, even if customers are completely insensitive to price. Data collected from individual customers facing such a rate will, therefore, inevitably overestimate price elasticity.

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While many economists will debate the appropriate price variable specification based on economic theory, it appears that price variable specification is an empirical issue that should be addressed differently depending on each individual case.

Average Price

Average price is the simplest, most straightforward way of expressing a price variable. In this case, the price of water is defined as the total water bill divided by the amount of water used.

Average price data is often used in studies where the available water use data is aggregated over a number of users who face block-type rates. In this situation, it is difficult to determine the marginal price associated with water use.

It has also been argued that average price is the most accurate method of describing the price of water. Proponents of this school of thought believe that customers are not aware of marginal price and that they respond to the average price of water over time. Average price has also gained some acceptance as a crude measure of the combined marginal price and fixed charge effect.

Marginal Price

Economic theory states that the price of a commodity which affects the level of consumption of that commodity is the price paid at the margin (i.e., the price paid for the last unit used). Depending on the rate structure, the marginal price may vary from customer to customer, or even from time to time for the same customer. In a multi-block rate structure, the marginal price would be the per-unit price paid for the last unit of water consumed.

There are caveats in using marginal price as a price variable. As noted earlier, some analysts argue that water customers do not respond to the marginal price of water because most consumers are not aware of the marginal price of water. If the customer does not clearly perceive the marginal price of water (through their water bill or other measures), they can not make economic decisions based on the marginal price.

The rate structure will greatly affect the usefulness of marginal price as a price variable. Under a flat rate structure with no service charge, marginal price will equal average price and neither would be preferred over the other. An increasing block rate structure probably provides the best environment for using marginal price as a price variable. There are two primary reasons for this. First it is reasonable to believe that a customer will react to an increasing block rate structure in a manner that is consistent with marginal economic theory. That is, as price rises, consumption decreases. The second reason is that if an increasing block rate structure is employed by a water agency, it is likely that the agency is using such a rate structure to curtail use of water by their customers above the block separation level. If that is the case, the agency would also be expected to clearly communicate the marginal price of water to their customers, via their water bill, public education, and other sources.

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As noted earlier, if a decreasing block rate structure is in effect, the marginal price decreases as more water is used. This ensures a negative functional relationship between price and use, even if customers are completely insensitive to price, and that price elasticity will be overestimated.

Total Bill

Some analysts argue that the only price signal received by the consumer may be the total bill. This is particularly true if a clear per-unit price of water signal is not received by the consumer.

The total bill could be interpreted as the price paid for water, or the price paid for all services that are found on the same bill. Many utilities provide a number of services to a customer and charges for all of these services are found on the same bill. It is common to see sewer, storm water, drain water, and garbage fees on the same bill as water charges. In one instance in this case study, power charges are also found on the same bill, substantially raising the total charges seen on a monthly utility bill.

How total bill is interpreted, and the usefulness of total bill as a price variable, depends greatly on the information provided to the consumer on the actual billing notice.

Sewer Charges

Sewer charges are often based on the amount of water used. Because of this, sewer rates can also impact the amount of water consumed by a residential customer.

Sewer charges can be examined as an entirely separate variable, or by adding the price of sewer service to the price of water. In both instances, the price variable can be constructed as an average price or a marginal price. The advantages and drawbacks to average and marginal sewer price variables are similar to those for water price variables.

Nordin Price Variable

Another characteristic of block-type rate structures is a relatively large gap between marginal price and average price. Customers served by different utilities, on different rate schedules, may pay the same marginal price but quite different total bills or average prices. Such customers would not be expected to exhibit identical water use, other things being equal, either because of different perceptions of price or different residual incomes. If you increased the fixed charges or meter charges and kept marginal price the same, you should still expect some changes in water use.

In order to deal with this problem, a special construct, Nordin's (1976) bill difference variable, is used to measure differences in residual income. The bill difference variable is defined as:

$$B = T - (Q*P_m)$$

Where: B = the bill difference variable

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T = total water bill during the billing period
Q = total quantity of water consumed during the billing period
P_m = effective marginal price of water during the billing period

Early studies which used Nordin's bill difference variable did so assuming that this was the only price variable necessary in the demand function. Howe (1982) purported, however, that while the inclusion of the bill difference variable in the demand function is superior to the use of average price or marginal price alone, it is only correctly used as an approximation of the effects of the intramarginal parts of the rate structure. Thus, when used in concert with a marginal price variable, the bill difference variable can help the researcher capture the influence of rate structure as well as price level. If both are used, the demand function for water shown on page 5-1 could take the following form:

$$D_W = b_0 + b_1X_1 - b_2X_2 + b_3X_3 - b_4P_m - b_5B$$

In this instance, the calculation of price elasticity must be altered, however, since B is itself a function of price. An example of this calculation is provided by Howe (1982). Howe describes a decreasing block rate design with a fixed service charge and a customer whose use extends to the second block, where:

$$B = T - (Q*P_m) = [S + (Q^1*P_{m1}) + \{(Q-Q^1)*P_m\}] - (Q*P_m)$$

Where: S = the service charge per billing period
Q^1 = total quantity of water allowed in the first block
P_{m1} = effective marginal price of water in the first block
P_m = effective marginal price of water in the second block

This simplifies to:

$$B = S + [Q^1 * (P_{m1} - P_m)]$$

If we use this definition of the bill difference variable, and the appropriate price-related coefficients from the demand function equation shown above, the equation for determining marginal price elasticity would be seen as follows:

$$E_D = [(b_4 - (Q^1 * b_5)) * (P_m / Q)]$$

It can be seen in this equation that elasticity will change with a change in quantity demanded, suggesting that the use of a linear demand function is required.

Ramped Marginal Prices

Given the minimum charge/monthly allowance price structure of the four agencies, it is possible that those customers whose consumption falls in the range of the monthly allowance are affected by both the lower and higher price blocks. If a customer reduces consumption so that he falls into the lower price block, he is actually affected by the greater price block. It is just as likely that he has imperfect information on the amount

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of his current consumption and reacts to the lower price when he is actually subject to the greater price. To account for these reactions, ramped marginal prices were developed for the case study. Ramped rates are a set of rates that transform the block rate into a gradual increasing ramp across a set of consumption points. For the case study, three sets of ramped rates were developed - each with different levels of steepness. The variables were developed by using the monthly allowance as the midpoint of the ramp. The first ramp is the steepest with the ramp escalating from the lower marginal price to the higher price over 300 cubic feet of consumption. The second ramp escalates over 500 cubic feet of consumption and the third over 700 cubic feet.

Deflating

Since more than one years worth of data is used in this case study, it is appropriate to adjust price data that is used in developing variables for inflation. While the case study examines a relatively short period of time (approximately two years worth of monthly data), a slight change in the value of the dollar over that period of time can still obscure the true relationship between price and consumption.

Price data has been adjusted using the Consumer Price Index (CPI). CPI data is published on a monthly basis by the U.S. Department of Commerce, allowing for monthly adjustments of price data. Price data is shown in July 1993 dollars.

5.5 TESTING DEMAND FUNCTIONS

Regression Analysis

The development and use of demand functions has been discussed at length in this document. We have also mentioned regression analysis as a tool in developing demand functions. When regression analyses include more than one independent variable, the analysis is termed "multivariate regression". The use of multivariate regression will allow us to estimate the parameters of the demand function. Once the parameters are known, price elasticities can be calculated.

Multivariate regression analysis is designed to minimize the effects of the errors between observed and computed values of a dependent variable (e.g., water consumption). Multivariate regression adjusts the weight that is applied to each of the explanatory variables so the effects of the computational error are minimized. It is important to remember that no exact relationship will exist between water consumption and its explanatory variables. Some degree of error will always be present - the intent is to minimize that error. Error measurement is the primary function of the statistical analysis that will be performed and that is described in the next section.

Multivariate regression is generally an iterative process. A number of functional forms and variables are available for testing. Different functional forms will be tried in order to provide an overall "best fit" of the available data to an equation. A number of potential explanatory variables have been identified and will be inserted, in a variety of

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combinations, into potential equations. The strength of the relationship of the explanatory variable to the dependent variable will generally determine its usefulness in an equation. This process of variable selection is an extremely important part of conducting a multivariate regression analysis.

Statistical Interpretation

There are a number of statistical tests that can be run on the demand functions that are created and on the variables within the demand function. The following statistical tests were run in this case study as applicable.

Coefficient of Multiple Determination (R^2)

The R^2 represents the percentage of the variance in the dependent variable that is explained by the regression equation. An adjusted R^2 (also referred to as R-bar) will be used in this case study. R-bar is the R^2 adjusted for the number of variables used in the equation. R-bar is typically the R^2 statistic that is reported for multivariate regressions. Unless otherwise noted, any reference to R^2 in this document, or the case study, will refer to R-bar.

If the dependent variable were regressed on the explanatory variables using a double log equation (i.e., the log of the dependent variable is regressed on the logs of the explanatory variables), the R^2 statistic, strictly interpreted, measures the percentage of variance in the log of the dependent variable explained by the equation. You would not, however, be misled if you interpreted the R^2 as if it pertained directly to the dependent variable.

An R^2 will be expressed in decimal percent form. This means that an R^2 of 0.897 for an equation would be interpreted to mean that the equation explains 89.7 percent of the variance in the dependent variable. R^2 is 1.0 if the regression fits perfectly, and 0.0 if it fits no better than the simple mean of the dependent variable.

Standard Errors (SE)

These represent the statistical reliability of the independent variable coefficients. The larger the SE, the more statistical "noise" infects the coefficient. According to statistical theory, there are about two chances in three that the true coefficient lies within one SE of the estimated coefficient, and 95 chances in 100 that it lies within two SEs.

Standard Error of the Estimate (SEE)

The SEE represents the standard error of the estimates of the dependent variable produced by a regression equation. The SEE is expressed in terms of the units of the dependent variable. Its size, therefore, would depend on the scale of the dependent variable. The ratio of the SEE to the mean of the dependent variable is often used to put this error statistic into perspective.

In the case of a double log equation, the SEE is interpreted as approximating the percentage error. An SEE of 0.02 for a double log equation, then, implies that the

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standard error is approximately 2 percent of the dependent variable's mean value. The SEE in a double log equation is roughly comparable to the SEE for a linear equation divided by the mean of the dependent variable.

F-statistic (F-stat)

The F-stat is another means of addressing the variance of the dependent variable. The question that is addressed by the F-stat is: Are the variances of the dependent variable significantly different from those that would be found if an actual random sample of the true population were taken? This question is answered on the basis of probability rather than certainty.

The significance of the F-stat will depend on the degrees of freedom of the regression equation and the number of observations. The degrees of freedom of the equation are determined as the number of variables used in the equation, including a constant term, minus 1. The degrees of freedom of the observations is equal to the number of observations minus 1. Thus, an equation with a constant term and five different variables, that is based on 72 observations, would have degrees of freedom equal to 5 and 71, respectively. An F-stat of 23.05 for this equation would be written as F (5, 71) = 23.05.

After referencing an F-stat table, using the appropriate degrees of freedom, we would see that an F-stat of greater than 3.72 would be expected to occur by chance less than 1 time in 100. Since our F-stat of 23.05 is larger than 3.72, we would then be able to state that we have greater than 99 percent confidence that the variance found in the regression equation is random and not systemic. In other words, the probability is at least 99 percent that one or more of the five coefficients is not zero.

T-statistic (T-stat)

The T-stat offers the most commonly used statistical procedure for evaluating estimated parameters (as reflected by variable coefficients). The hypothesis that is tested is the null hypothesis of no relationship between an explanatory variable and the dependent variable. The statistical test is based on principles of probability. The T-stat has a probability distribution - the T distribution.

In practice, the mechanics of the test are as follows. The T-stat is the ratio of the estimated coefficient of the explanatory variable to its standard error, where the null hypothesis is that the true coefficient equals 0. This statistic is compared with the table value of T, which depends on the degrees of freedom of the regression and on the selected level of significance. The selection of level of significance sets the level of type I error (i.e., the probability of rejecting a true null hypothesis), which the analyst is willing to accept. Commonly used levels of significance are 0.01, 0.05, and 0.10.

If the computed T-stat is larger than the critical value of T (as determined from a T distribution table), then the null hypothesis is rejected. In empirical research, a common

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statement is that the coefficient is not statistically significant at a certain percent level (the percent level being the level of significance set by the analyst).

The analyst may be interested in a small probability of type I error. This would give a high confidence that the true parameter is not 0. However, selecting a small level of significance does increase the probability of making a type II error (i.e., accepting the null hypothesis when it should be rejected). It is important to remember that if a variable is logically important in an equation, it should not be lightly discarded.

If we examined a coefficient in a regression equation that had 72 observations and five explanatory variables, and the T-stat for the variable coefficient is 2.10, we could state that the coefficient is statistically significant at the 5 percent level. We could also state that the coefficient is not statistically significant at the 2 percent level.

The T-stat of a coefficient is often used as a criterion for adding or dropping variables from a regression equation. Generally, if a T-stat exceeds 2.0, it is significant at the 5 percent level. This threshold is often considered to be the point at which a coefficient is considered to be a strong estimator of the effect of the independent variable on the dependent variable. A common rule of thumb, however, is to retain variables with T-stats of 1.0 or larger. This is based on the notion that variables, which are a logical part of an equation, should not be dropped on stringent statistical grounds. In any event, the analyst's judgement is important.

5.6 EVALUATING THE PRICE VARIABLE

After demand functions have been developed, the coefficient of the price variable is a reflection of the impact the price of water has on the demand for water. The price coefficient will be used to calculate price elasticity. How it is used to calculate elasticity will depend on the functional form of the demand equation.

The Price Coefficient and Elasticity Calculation

When examining the price coefficient, there are four characteristics of the coefficient to review before we are prepared to use that coefficient to calculate elasticity estimates. Much of this review is a part of the testing and selecting of demand functions. Through the use of statistical tests and a priori reasoning, the specified demand function will include a price variable (and subsequent coefficient) that reflects the impact of price on demand and can be used to calculate price elasticities. The following characteristics will be examined to evaluate the applicability of the price coefficient for estimating price elasticities.

The Sign of the Price Coefficient

The sign of the coefficient (positive or negative) determines whether there is a positive or negative relationship between price and the dependent variable (demand). A priori reasoning tells us that there should be a negative relationship between price and demand. In other words, as the price of water increases, demand for water would decrease.

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If a demand function were tested and the price coefficient were positive, the function as specified would have to be rejected. A relationship must not only be established, it must also be reasonable.

The Magnitude of the Price Coefficient

The magnitude (or numerical size) of the coefficient determines the degree of change in demand that would occur with a specified change in price. This may be interpreted as a percent change or an absolute change depending on the functional form of the demand equation. In reviewing the magnitude of the coefficient, the key again is reasonability.

A priori reasoning, as well as comparing results to previous research, will allow us to make some general statements about the acceptability of the magnitude of the coefficient. Is it reasonable to think that a $20 per 100 cubic foot increase in the price of residential water would result in an average decrease in consumption of less than 100 cubic feet? Probably not. Nor would it be reasonable to expect a one percent increase in price to result in a ten percent decrease in demand.

The Statistical Significance of the Price Coefficient

If the price coefficient meets the criteria of reasonability, it must next be determined if it is statistically significant. Statistical significance of the price coefficient is determined by examining the related T-statistic. A discussion of the T-statistic was presented previously and need not be reiterated here. One point that is worth reiterating is that the selected level of significance is dependent on the analyst's judgement.

The Functional Form of the Demand Equation

The functional form of the demand equation will determine how the price elasticity is calculated from the price coefficient. The following notation will be used:

b = the price coefficient
P = the price of water
Q = the quantity of water demanded
E_D = the price elasticity of demand

If the functional form is linear, price elasticity is calculated as:

$$E_D = b * (P/Q)$$

In this case, elasticities will differ along the demand curve. Elasticities can be calculated at any point on the demand curve by changing the values of P and, subsequently, Q.

If the functional form is semilog or log-partial log, price elasticity is calculated as:

$$E_D = b * P$$

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when the price variable is linear, and as:

$$E_D = b/P$$

when the logarithm of the price variable is linear.

As in the case of the linear form, elasticities will change with a change in price. In this case, however, elasticity is directly proportional to price.

If the functional form is double-log, price elasticity is calculated as:

$$E_D = b$$

Elasticity, therefore, is constant and independent of the values of P or Q. This also holds true if a log-partial log form is used and both the dependent variable and the price variable are linear in their logarithms.

The Relevant Price Range

The price elasticities that are estimated through the case study are a product of the statistical relationships that are observed using available data. If any of the variables, including price, were to change significantly, the statistical relationship (i.e., the demand function) could be expected to change as well. A change in the demand function will also result in a change in the elasticity estimate.

In the case of the price variable, the statistical relationship that has been estimated is based only on the actual prices that have been charged for water. The demand function that is developed from this relationship, however, goes beyond the bounds of the price levels that have been observed. We would expect that the estimated demand function is well-specified within the observed price range, but we can not be as confident of the ability of the estimated demand function to reflect a true demand function outside these price bounds.

It has already been noted that if the estimated demand function is linear in form, price elasticity will change as price changes. If we have less confidence in the shape or slope of the demand curve outside the observed price bounds, we must also have less confidence in the price elasticities that are calculated using the estimated demand function outside the same price bounds. It is important to remember that the farther we stray from the known (the observed price bounds), the less confidence we will have in elasticity estimates that are based on the unknown (unobserved price-demand relationships).

Even if the estimated demand function is non-linear in form, a change in price that is outside the observed price bounds may lie on a segment of the demand curve that is not properly specified. Again, we may have confidence in the segment of the demand curve

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that is constructed between the observed price bounds, but we are less certain of the shape, and subsequent slope, of the demand curve outside this area.

5.7 REGRESSION ANALYSIS

When the price elasticity case study began, the scope of the study encompassed regression analyses based upon the models discussed in the natural resources-related journals. A large number of journal articles have been published to document studies of price elasticity, including articles in the *AWWA Journal*, *Water Resources Research*, and *Water Resources Bulletin*. In addition, the AWWA, the National Regulatory Research Institute (NRRI), the U.S. Army Corps of Engineers' Institute for Water Resources, and the California Department of Water Resources have published reports on the subject. In the course of the study, Masters Degree theses and other studies specific to Utah were also identified as bearing on this topic. These studies, and others, were obtained and reviewed to determine a course of research.

Thus, the price elasticity case study was guided, in part, by the research that had been performed previously by other researchers. This guidance took two forms. One form of guidance was that the studies provided insight into the functional form of demand models. The other form of guidance provided by the studies was insight into the types of variables and variable transformations that have worked in the past.

Two functional forms are generally used in the models reported in the literature: linear and double-log.

The most frequently discussed variables are those that are intuitively correct from the standpoint of economic and engineering theory. Intuitively, it is correct to assume that water demand will be a function of the number of people in the household, the amount of land that will be irrigated, weather, the income of the household, the season, and water prices. These variables are among the most frequently used variables in the literature reviewed for the case study.

Initial Database Runs

In the early fall of 1993, prior to the October 1993 meeting of the Technical Committee, regression runs were prepared on the initial database (pre-expansion). These initial runs looked at linear, double-log and lagged functions. The results of these initial runs showed a positive relationship between marginal price and consumption. These results were intuitively incorrect, and the committee expressed their opinion that the study could be strengthened if the database was expanded to obtain a greater range in water prices. This led to the inclusion of the county customers of Salt Lake City and the customers of the City of Provo.

From the initial runs other conclusions were drawn. The positive relationship of the water plus sewer price and total bill coefficients to consumption indicated that the coefficients of these variables were picking up cross-sectional effects and thus were not

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useful for the analysis. At this point it was evident that, in terms of a price variable, efforts should be focused on the average and marginal prices.

Other poor results were seen from the conservation dummy as well as the lag cases. The conservation dummy coefficient had an incorrect sign. The lagged function showed a decrease from the linear and double-log forms in the adjusted R^2 and T-statistics. Therefore, minimal consideration would be given to the conservation dummy variable and the lagged functional form in the regression runs on the expanded database.

Expanded Database Runs

The database was expanded from 5000 to 7300 observations with the inclusion of the Salt Lake City county customers and the Provo customers. The following documents the results of the regression runs on these observations. The tables in Appendix D summarize the regression case results.

Linear Functions

The adjusted R^2 results of the linear functions ranged from roughly 0.20 to 0.50. The average price function described herein had an R^2 of just under 0.50. The following examines the results for each variable studied.

Price Variables

Average Price

The average price variable had fairly significant results. The sign of the average price coefficient was negative with results ranging from -8.6 to -4.5. This implies that a $1/100 cubic foot increase in the average price yields a decrease in water consumption between 4.5 and 8.6 hundred cubic feet per month, per home. T-statistics ranged from -31.2 to -18.6. In each case the adjusted R^2 was between 0.30 and 0.50. Elasticity estimates were calculated for two average price models, and both estimates were below -0.20. The results for the 'best' model range from -0.13 to -0.18, depending on which of the water agencies are specifically represented by the water agency dummy variables.

Marginal Price

The marginal price coefficient consistently exhibited a positive coefficient, an intuitively incorrect result. To further investigate marginal price response, it was hypothesized that (a) customers have poor information concerning consumption in a billing period and do not adjust in a fashion reflective of the true marginal price, (b) customers simply do not understand the pricing structure, (c) marginal price response is occurring truly at the margin rather than in the totality of water usage, or (d) as explained earlier, since marginal prices are positive functions of consumption for some of the utilities, it is just possible that pooling the utility data without differentiating between utilities will never return a negative coefficient. To investigate these possibilities, ramped marginal price variables and interactive equations with marginal price, the net lot size, and seasonal variables were tested. Models with dummy variables were also tested to differentiate the model for individual utilities.

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Ramped Marginal Price

Three different ramped marginal price variables were tested to capture the impacts of consumers whose consumption approaches the monthly minimum and the change in price blocks. Although the adjusted R^2 improved slightly for these cases, the sign of the coefficient remained positive.

Interactive Marginal Price Variables

Three interactive marginal price variables were investigated to isolate the marginal price response. It can be hypothesized that marginal prices only affect outdoor water usage, and that culinary/sanitary water usage would be much less price sensitive. To test this theory, variables were created through combinations of the marginal price, net lot size, and seasonal variables. The use of the seasonal dummy variable isolates the effects of the marginal price for observation in the summer months. The product of the marginal price and net lot size emphasizes those observations with large marginal price and large lot sizes for determining impacts on consumption. The third variable combines all three raw variables.

This avenue of research was not pursued extensively due to difficulty in model interpretation. The seasonal and lot size variable should have positive coefficients. The combined variables exhibited positive coefficients, and did not improve the explanatory power of the models. Thus, given the difficulty of interpreting results and the lack of model improvement, this approach was not pursued further.

Water Agency Dummies

As outlined above, it is possible that the pooling of data from different utilities causes the counter-intuitive results. Thus binary variables (i.e., dummy variables or dummies) were created for four of the five water agencies and included in the models. The inclusion of the dummy variables did not alter the sign of the marginal price coefficient in the linear models.

Weather and Other Variables

Precipitation

The coefficient of the precipitation variable fell in the range of -4.2 to -1.3 in the linear regression cases. This implies that a one inch increase in monthly precipitation would yield a 130 to 420 cubic foot decrease in monthly consumption per home. The sign of the coefficient coincides with the intuitive negative relationship between precipitation and consumption. The T-statistics showed that the precipitation variable was significant with results ranging between -8.1 and -25.8.

Adjusted Lot Size

The average coefficient of the adjusted lot size was 0.001. Because this variable is a function of both precipitation and lot size, the coefficient cannot easily be interpreted. The adjusted lot size showed significant T-statistics in the 16 to 23 range.

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Persons Per Household

The coefficient of the persons per household ranged from 1.1 to 2.0. Thus, if the number of persons per household increased by 1, a 110-200 cubic foot increase in monthly consumption would be expected. Significant T-statistics were also seen with persons per household.

Seasonal Dummy

The seasonal dummy has coefficients averaging near 20.0 to 21.0 with significant T-statistics in the mid 40s. This agrees with the expectation that water consumption increases with the summer months.

Water Agency Dummies

As discussed, water agency dummies were added as an attempt to capture influences particular to water agencies. In the linear models including marginal price, the dummies did not correct the basic model flaw of incorrect coefficient sign. The dummies were tested in the linear model with average price, using a stepwise analysis, and were individually significant at the 95 confidence level. In addition, with the average price model, a joint F-test indicated that the variables were, as a group, significant at the 99 percent confidence level.

Double-Log Functions

The coefficients of double-log functions measure the elasticity of demand vis-a-vis that variable. The results for the double log cases were marginally better for the marginal price cases but significantly better for the average price cases with adjusted R^2 of approximately 80 percent. The following summarizes the results and impacts of each variable studied under the double-log functions.

For these sets of runs, a stepwise model was introduced that tested a set of variables simultaneously and eliminated those variables that were insignificant. This model allowed for the development of the best-fit equation.

It is important to note that the log of zero is undefined. Observations where one of the variables equals zero, precipitation for example, are eliminated from the analysis. Because dummy variables are composed of either 0 or 1, they were treated linearly so as not to eliminate observations.

Price Variables

Average Price

The double-log function of the average price variable again had more significant results than for the linear equation. The range of the coefficient, or the most likely elasticity range, is from -1.6 to -1.2. This implies that a one percent increase in the average price will lead to a 1.2 percent decrease in monthly water consumption. The T-statistic shows significance at the 99 percent level while the average adjusted R^2 jumped from 39 percent to 80 percent.

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Marginal Price

Similar to the findings in the linear cases, the first set of double-log regression runs on the expanded database turned up positive marginal price coefficients. To test the theory, dummy variables for all but one water agency were developed. When the dummy variables were included, a negative marginal price relationship was found. With the double log specification, a marginal price coefficient of approximately -0.6 was found. This implies a marginal price elasticity of -0.6, or, in other words, that if marginal prices increase ten percent, consumption would decrease six percent.

Weather and Other Variables

Precipitation

The T-statistics of the precipitation variable changed little from that in the linear case. The coefficient ranges from -0.05 to -0.15. Thus a 10 percent increase in precipitation would lead to a 0.7 to 1.5 percent decrease in monthly consumption.

Adjusted Lot Size

The coefficients of the adjusted lot size averaged 0.13 when the variable was measured in square feet. Thus a 10 percent increase in the adjusted lot size would lead to a 1.3 percent increase in monthly consumption. The T-statistics again showed relatively the same significant results as in the linear case.

Net Lot Size

The net lot size, which was studied only in combination with marginal cost in the linear case, showed results comparable with those of the lot size in the initial regression runs. Coefficients were approximately 0.1 (the variable is in square feet, with a general magnitude of 1,000 or greater) with T-statistics averaging 4.0. In the stepwise model, this variable fell out of the equation because it did not meet a 90 percent significance level.

Persons Per Household and Water Agency Dummy Variables

The coefficient of the persons per household was approximately 0.2 with significant T-statistics. This type of result is consistent with theory since most usages of water would not be expected to increase in direct proportion to the number of people. T-statistics showed persons per household to be significant at the 99 percent confidence level.

With the addition of the water agency dummy variables, the persons per household coefficients dropped significantly. In the marginal price models the coefficients dropped from roughly 0.20 to 0.11 while in the average price models they dropped from 0.20 to as low as 0.06. T-statistics for the person per household coefficients also dropped meaning that the inclusion of the water agency dummy variables resulted in an increase in the variance relative to the coefficient. This indicates that the water agency dummy variables, are explaining part of the variation in water usage that would otherwise have been explained by persons per household variable. However, the coefficients retained the 99 percent confidence levels.

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Seasonal Dummy and Average High Temperature

The seasonal dummy and average high temperature variables are highly correlated, with a reported correlation coefficient of 0.86. Thus, these two variables were used interchangeably.

Since the log of zero is infinite, the seasonal dummy variable was included in the log-log models in the zero-or-one form rather than a log form. In the double-log equation, the coefficient is consistently approximately 0.5. The coefficient is significant in all cases.

The coefficient of the average high temperature was approximately 0.8 in the average price models and 1.7 in the marginal price models. The coefficient is highly significant in all cases. These coefficients imply that a ten percent increase in temperature would cause eight to seventeen percent increases in water consumption. When compared to models with the seasonal dummy variable, models using average high temperature generally exhibited higher R^2 results. Given this fact, and the fact that it is easier to interpret the temperature variable than it is to interpret the seasonal dummy, the final models used average high temperature.

Home Value and Income

As would be expected by definition of their development, the home value and income variables are highly correlated with a correlation coefficient of 0.59. Thus, these variables were treated as interchangeable.

The coefficient of home value ranged averaged approximately 0.3. Thus a 10 percent increase in home value would increase consumption by 3 percent. The T-statistics were significant.

The coefficient of income averaged approximately 0.1. Thus a 10 percent increase in income would increase consumption by 1 percent. The T-statistics were also significant for income.

5.8 RECONCILING RESULTS WITH EXISTING ESTIMATES

A number of empirical studies have been performed in which estimates of residential price elasticity of demand for water have been made. These studies have been done on a national and regional basis, for other areas of the country, and in Utah. The range of elasticity estimates is quite wide. This could be attributed to the applicability of the statistical methods used to estimate elasticities, the geographic area for which the elasticities were estimated, the specification of the demand sectors, and other factors.

A limited number of studies were more extensively reviewed. These studies were chosen for various reasons, including geographic proximity or similarity to the case study area, acceptance in the industry as outstanding studies, similarity of end use sectors to those defined in the case study, and use and review of previous research. The assessment

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included a discussion of the statistical validity of the estimates derived and a review of the caveats in applying the findings of the studies to this case study.

In this section of the report, the elasticity estimates developed through the Case Study are compared to those found in selected studies. The following studies were used in the comparison.[4]

1. Boland, John J., Benedykt Dziegielewski, Duane D. Baumann, Eva M. Opitz. *Influence of Price and Rate Structures on Municipal and Industrial Water Use*. Carbondale, Illinois: Planning and Management Consultants, Inc. June 1984. Report submitted to the U.S. Army Corps of Engineers, Institute for Water Resources, Fort Belvoir, Virginia.

2. CH2M Hill, *Water Price Elasticity Study*. Report prepared for the State of Utah, Division of Water Resources. April 1991.

3. Dziegielewski, Benedykt and Eva M. Opitz. *Municipal and Industrial Water Use In The Metropolitan Water District Service Area: Interim Report No. 4*. Carbondale, Illinois: Planning and Management, Ltd., June 1991. Prepared for the Metropolitan Water District.

4. Erickson, Christopher R., *The Effect of Dual Systems on Price Elasticity of Residential Water Demand*, Utah State University: Logan, Utah, 1991. Unpublished Masters Thesis.

5. Gardner, B.D., and S.H. Schick. "Factors Affecting Consumption of Urban Household Water in Northern Utah," *Agricultural Experiment Station Bulletin* No. 449 (1964). Utah State University: Logan, Utah.

6. Hansen, Roger D., and Rangesan Narayanan. "A Monthly Time Series Model of Municipal Water Demand," *Water Resources Bulletin* Vol 17, No. 4 (1981): 578-85.

5.9 RESIDENTIAL WATER

Average Residential Water Price Studies

Table 5.1 compares the price elasticity estimated through the Case Study to price elasticity estimates reported in the literature. The water price embodied in the comparison on Table 5.1 is average water price, or generally, total utility revenues divided by total water sales. The study cited on Table 5.1, Boland, et. al., summarizes results published prior to 1984, and the ranges are compiled from said studies.

[4]See Appendix E for further details on the review of each report.

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As can be seen from Table 5.1, the elasticity range estimated within the Case Study, -0.13 to -0.18, is lower than the other results summarized on the table. The equation that yields this elasticity includes precipitation, average high temperature, income, persons per household, and the water agency dummy variables. Although the equation without the agency dummies produces an elasticity value that is more comparable with the other studies, an F-test found the agency dummies significant at the 99 percent level.

Table 5.1 includes the elasticity estimated by CH_2M Hill for the State of Utah Division of Water Resources. The reported estimate is not, strictly, a residential estimate. Rather, it includes both residential and commercial accounts. It is consistent with the residential estimates reported elsewhere. Interestingly, it is almost identical to the Summer Season estimate reported for the Metropolitan Water District of Southern California.

Based on the literature review, an average price elasticity of -0.20 to -0.40 is more reasonable than the Case Study estimate. The mid-point of the reasonable range, -0.30, is a reasonable estimate to use for residential average price analyses given the results cited on Table 5.1, and given the generally low explanatory power of the average price models developed in the Case Study.

It should be stressed that marginal water price is a theoretically more attractive price concept from an economic theory standpoint.

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Table 5.1
Reported Range of Average Price Elasticity Values for Residential Water Demand in Studies Published Prior to January 1994

End-Use Ssector	Low Range	High Range
Residential Average Water Use		
Long Run[1]	-0.200	-0.400
Short Run[1]	0.000	-0.300
Residential Winter Water Use		
Long Run[1]	0.000	-0.100
Residential Summer Water Use		
Eastern U.S.[1]	-0.500	-0.600
Single-Family Water Use, Metropolitan Water District		
Winter Season Usage[2]	-0.236	N/A
Summer Season Usage[2]	-0.356	N/A
Non-Industrial Usage in Utah and Colorado[3]	-0.344	N/A
Price Elasticity Case Study	-0.13 to -0.18	N/A

[1] Boland, John J., Benedykt Dziegielewski, Duane D. Baumann, Eva M. Opitz. *Influence of Price and Rate Structures on Municipal and Industrial Water Use*. Carbondale, Illinois: Planning and Management Consultants, Inc. June 1984. Report submitted to the U.S. Army Corps of Engineers, Institute for Water Resources, Fort Belvoir, Virginia. Pages 4 and 5.
[2] Dziegielewski, Benedykt and Eva M. Opitz. *Municipal and Industrial Water Use In The Metropolitan Water District Service Area: Interim Report No. 4*. Carbondale, Illinois: Planning and Management, Ltd., June 1991. Prepared for the Metropolitan Water District. Page 26.
[3] CH2M Hill. *Water Price Elasticity Study*. 1991. Report prepared for the State of Utah, Division of Water Resources. Pages 3-7 and 3-8. The estimate reported is an elasticity value estimated using both residential and commercial customer data collected from utilities in Utah and in Colorado.

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Marginal Residential Water Price Studies

Presented on Table 5.2 are marginal price elasticity estimates developed with either time-series or pooled time-series, cross-sectional data. Boland, et. al., concluded, based on the collected evidence that a 'reasonable' estimate of marginal price elasticity is -0.20 to -0.40. Boland's findings are based on a review of a wide range of studies performed prior to 1984.

The reported estimates from Billings and Agthe are of particular interest since they were developed using Tuscon, Arizona data. Billings and Agthe developed both linear and double-log models with the latter providing the lower of the two estimates provided in each range shown on the table.[5] The Case Study estimate of -0.592 falls within the range reported by Billings, and is similar to, albeit higher than, the high end of the ranges reported by Billings and Agthe and by Agthe and Billings.

The Case Study estimate is certainly within the range of reported results, particularly those reported for Utah. Two previous studies focused on data from Utah. Christopher Erickson performed studies indicating price elasticities of -0.487 to -0.593 for marginal price.[6] Roger Hansen[7] estimated price elasticity to be -0.469 for marginal price. Both studies used marginal price variables. Both studies were performed at highly aggregated, rather than household, levels. The marginal price coefficient found in the case study (-0.592) corresponds almost exactly to the high end of the range reported by Erickson.

It should be noted that Hansen used a derived water usage per connection, including non-residential water usage, making comparisons somewhat tenuous. Residential water sales in the CUWCD service area are estimated to account for roughly 75 percent of total municipal and industrial water sales. Thus, Hansen's results would imply that residential elasticity should be somewhat higher than the -0.469 reported by Hansen.

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[5] For a summary of these papers see Boland, John J., Benedykt Dziegielewshi, Duane D. Baumann, Eva M. Opitz, *Influence of Price and Rate Structures on Municipal and Industrial Water Use* (Carbondale, Illinois: Planning and Management Consultants, Inc., June 1984).

[6] Erickson, Christopher R. *The Effect of Dual Systems on Price Elasticity of Residential Water Demand.* Unpublished Master of Science Thesis. Utah State University, Department of Civil and Environmental Engineering. 1991. Pages 58 through 62.

[7] Hansen, Roger D. *A Multivarieate Analysis of Municipal Water Use in Utah.* Unpublished PhD Dissertation. Utah State University, Department of Civil and Environmental Engineering. 1981.

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For purposes of the estimation of price-induced water conservation from water conservation pricing structures, it appears reasonable to use the estimated price elasticity developed through the Case Study.

Table 5.2
Residential Marginal Price Elasticity Estimates
Using Time-Series or Pooled Data

Author/Analyst	Estimated Elasticity	Geographic Region	Year Published
Gibbs[1]	-0.51	Miami, FL	1978
Danielson[1]	-0.27	Raleigh, NC	1980
Billings and Agthe[1]	-0.27 to -0.49	Tucson, AZ	1980
Agthe and Billings[1] Short-Run	-0.18 to -0.36	Tucson, AZ	1980
Long-Run	-0.27 to -0.50	Tucson, AZ	1980
Billings[1]	-0.56 to -0.66	Tucson, AZ	1982
Hanke and de Mare[1]	-0.15	Malmo, Sweden	1982
Erickson[2]	-0.487 to -0.593	Utah	1991
Hansen[3]	-0.469	Utah	1981
Williams & Suh[4] Short-Run	-0.110	Columbus, OH	1986
Long-Run	-0.262	Columbus, OH	1986
Case Study	-0.592	Utah	1994

[1] Boland, John J., Benedykt Dziegielewshi, Duane D. Baumann, Eva M. Opitz. *Influence of Price and Rate Structures on Municipal and Industrial Water Use*. Carbondale, Illinois: Planning and Management Consultants, Inc. June 1984. Report submitted to the U.S. Army Corps of Engineers, Institute for Water Resources, Fort Belvoir, Virginia. Pages 49 to 50.
[2] Erickson, Christopher R. *The Effect of Dual Systems on Price Elasticity of Residential Water Demand*. Unpublished Master of Science Thesis. Utah State University, Department of Civil and Environmental Engineering. 1991.
[3] Hansen, Roger D. *A Multivarieate Analysis of Municipal Water Use in Utah*. Unpublished PhD Dissertation. Utah State University, Department of Civil and Environmental Engineering. 1981.
[4] Williams, Martin and Byung Suh, "The demand for urban water by customer class," *Applied Economics*, Vol. 18, No. 12 (December 1986), pages 1275 through 1289.

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Elasticity Of Demand With Respect To Income And Population

Presented on Table 5.3 are comparisons of elasticity of demand with respect to the number of persons per household, weather variables, and income-related or proxy variables. The table differentiates between coefficients developed as part of the marginal or the average price cases for the Case Study. All Case Study results are annual models as opposed to summer versus winter season models. As can be seen, the results of the Case Study are somewhat comparable to the results found elsewhere. Differences could be attributed to any number of factors such as differing lot sizes and household compositions. Studies have shown, for example, that average water usage per person is lower for children and persons over 50 than for middle aged adults, so larger households with higher ratios of young children would exhibit lower elasticities with respect to household size than smaller households with fewer young children. While no attempt was made to actually check into factors explaining the differences on Table 5.3, they may very well be explainable.

Table 5.3
Comparison of Reported Estimates of Household Size, Weather, and Income Elasticities

Variable / Geographic Region	Reported Value	Case Study
Household Size / Metropolitan Water District[1]	0.287 (Winter) 0.366 (Summer)	0.180 (Marginal Price) 0.193 to 0.220 (Average Price)
Home Value / Metropolitan Water District[1]	0.451 (Winter) 0.386 (Summer)	0.354 (Marginal Price)
Rainfall / Metropolitan Water District[1]	-0.020 (Winter) N/A (Summer)	-0.068 (Marginal Price) -0.090 to -0.144 (Average Price)
Maximum Temp. / Metropolitan Water District[1]	N/A (Winter) 1.173 (Summer)	1.726 (Marginal Price)

[1] Dziegielewski, Benedykt and Eva M. Opitz. *Municipal and Industrial Water Use In The Metropolitan Water District Service Area: Interim Report No. 4.* Carbondale, Illinois: Planning and Management, Ltd., June 1991. Prepared for the Metropolitan Water District. Page 26.

Conclusions

Two best fit equations, one for the average price and another for the marginal price, were identified from the regression analysis. The following describes these two equations.

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Marginal Price

Economic theory states that consumers should respond to marginal price. As taught in every microeconomic theory class, consumers maximize their utility by consuming a particular good up to the point where marginal cost equals marginal utility, subject to income constraints. Thus, considerable effort was expended on specifying a model incorporating marginal price. In almost every model, the coefficient for marginal price came out positive. This implies that an increase in marginal price leads to an increase in demand, clearly an intuitively incorrect result.

It can be hypothesized that culinary and hygienic water usage are not particularly price sensitive (i.e., that people will consume water needed for cooking and cleaning unless water becomes so expensive that it is cost effective to purchase bottled water for cooking and cleaning). This situation would not reasonably be expected to occur in Utah anytime soon. If this hypothesis is true, response to marginal price would occur in outdoor usages for sprinkling, swimming pools, car washing, and other outdoor activities. Thus, models were developed using marginal price interactively with seasonal dummy variables and other variables indicative of outdoor usage such as weather variables. However, the coefficients for these models were suspect and also suffered from the additional difficulty of interpretation. Interpretation is difficult for an interactive variable composed of marginal price, lot size, and a seasonal binary term. Thus, while this approach offered some intuitive appeal, it was not pursued further because of interpretation issues.

Another avenue that was investigated was "ramping" the marginal prices. If they are zero up to a certain level of consumption, and then the prices take on some positive value, it can be hypothesized that due to informational problems, people start responding to the marginal price prematurely out of fear that they are reaching the marginal consumption blocks. As discussed previously, these efforts still did not yield negative coefficients for marginal price.

Finally, after a thorough and exhaustive review of the literature, a plausible hypothesis was found. Because of the limited and contrasting nature of the pricing data, it was possible that a negative relationship existed within each agency, but that the relationship was somehow masked by pooling different data sets without controlling for the individual utilities. To account for this, dummy variables were developed for the agencies. The resulting regression runs showed negative marginal price coefficients in the -0.6 range for the double-log cases.

Through the stepwise model, which excluded variables that did not meet the 95 percent confidence level, the best fit marginal price equation was determined to be:

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log(Avg. Monthly Consumption) = -8.400 - 0.592*log(Marginal Price) - 0.068*log(Precipitation) + 1.726*log(Average High Temperature) + 0.354*log(Home Value) + 0.180*log(Persons Per Household) - 0.706*Provo - 0.735*Murray - 0.292*South Salt Lake City - 0.322*Salt Lake City

All coefficients significant at the 1% level.
Adjusted R^2 was 0.543.

The price elasticity was determined to be -0.592. This result is consistent with other reported results specific to Utah.

Average Price

The best average price model is summarized below. It should be noted, in summary, that a double-log formulation yielded a higher R^2, but an implausible price coefficient. The model presented below is the best model from statistical and plausibility standpoints.

Avg. Monthly Consumption = -14.160 - 4.512*Average Price - 1.603*Precipitation + .00012*Income + 0.611*Average High Temperature + 1.392*Persons Per Household - 6.210*Provo - 3.769*Murray - 7.538*South Salt Lake City - 3.375*Salt Lake City

All coefficients significant at the 1% level.
Adjusted R^2 was 0.45.

The elasticity inherent in the model varies by water agency (since an average or mean value for a binary variable is a meaningless concept). If all dummies are zero, representing the Salt Lake City county customers, the elasticity is -0.13. If South Salt Lake City is analyzed, the elasticity is -0.18.

Future Marginal Price Research

Two additional avenues of research that may also bear fruit, but which were beyond the intended scope of investigation are simultaneous equations and flexible form models. It is possible that marginal price can be estimated simultaneously with demand through simultaneous equations. By specifying marginal price in this fashion, it may be possible to isolate the true marginal prices to which consumers are responding.

Another possible method of model specification is a flexible form model. Transcendental logarithmic (translog) demand functions could be estimated to test the possibility that the true functional form of the model is non-linear in the coefficients. Translog production functions are frequently cited in the literature, with the Cobb-Douglas

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production function being a specific example. It is possible that a translog specification of the demand function would yield better results.

Neither specification was discussed in the industry literature prior to the undertaking of this analysis, although the flexible form model has since been used in a Southwest Florida[8] study.

Applying the Estimates to CUWCD

The estimation of elasticity estimates for residential end use in the CUWCD service area is limited to the case study of four agencies in the Salt Lake and Utah Valleys. It is essential to realize that elasticities vary from individual to individual within a particular area, let alone for individuals in different geographic areas. The CUWCD service area encompasses a large geographic area that could reflect substantial climatological, price, and cultural differences.

It is impractical to assume that elasticity estimates for residential customers in the Salt Lake and Utah Valleys can be simply "plugged" in to other parts of the CUWCD service area. It is also impractical to develop more than one residential case study. Given the intent of the Act to identify pricing structures that will induce conservation in the CUWCD service area, it is not unreasonable to attempt to analyze that area within the CUWCD service area where the most opportunity for residential water conservation exists. Sheer population size makes the Salt Lake City to Provo corridor the most likely candidate.

Using the residential elasticity estimates developed through the Case Study will present some of the same dangers inherent in applying elasticities outside the observed price bounds of the Case Study. A substantial portion of residential water use within the CUWCD service area, however, occurs within the Salt Lake Valley and northern Utah County (primarily Orem and Provo). We might be confident in applying elasticity estimates to all of Salt Lake County, but our confidence will decrease as we move to areas in the CUWCD service area that have less in common with the study area. This may occur due to geographic distance, cultural differences, demographic make-up, or other factors.

A note of caution should be given here to users of this research. It would be entirely incorrect to use these residential elasticity estimates for other parts of the CUWCD service area if the Salt Lake and/or Utah Valleys were not a part of the aggregate area to be studied. The percent of the population in the CUWCD service area that is comprised by this area allows us to make the extrapolation of the estimates to the entire area. If the intent of future research were, however, to estimate residential price

[8] Brown and Caldwell. *Water Price Elasticity Study*. Prepared by Brown and Caldwell Consultants, in association with John B. Whitcomb, Ph.D., for the Southwest Florida Water Management District: Brooksville, Florida. August 1993.

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elasticity in, say, Garfield County alone, the use of elasticity estimates generated in this study would be inappropriate because they would not reflect conditions found in Garfield County.

5.10 COMMERCIAL WATER

Very few studies have been reported in the literature that deal with commercial sector price elasticity. One study was performed using Miami, Florida data and was published in 1978. The Miami study provided estimates ranging from -0.12 to -1.33. The results are provided on Table 5.4. The results show that elasticity varies widely by type of commercial establishment. Motels and hotels showed extremely low elasticities, probably reflective of the fact that hotel visitors make extremely important water usage decisions and they do not directly see the water bill. Eating/drinking establishments also exhibit low elasticities, probably reflective of the fact that water is needed for consumptive and sanitation purposes for which there is limited scope for cost-effective product substitution. The models were specified with some, but not all variables in log format.

Table 5.4
Marginal Price Elasticity Estimates For Commercial Establishments In The Miami, Florida Standard Metropolitan Statistical Area

Customer Description	Number of Customers	Elasticity At Mean Price	Mean Water Price
Department Stores	20	-1.33	$1.24
Grocery Stores	19	-0.76	$1.06
Motels and Hotels	40 / 93[1]	-0.24 / -0.12[1]	$1.00 / $1.02[1]
Eating/Drinking Establishments	24	-0.174	$0.66
Other Commercial	34	-0.48	$0.88

[1] Paper contained two estimates, the first based on primary data from mail questionnaires and the second based on secondary data from a state regulatory agency.

Source: Lynne, Gary D., William G. Luppold, and Clyde Kiker. "Water Price Responsiveness of Commercial Establishments." *Water Resources Bulletin* 14(3). Pages 719-29.

Shown on Table 5.5 are price elasticity estimates derived for the Southwest Florida Water Management District. The models were all linear models. For each customer class, the analysis included a wide range of variables developed from mail surveys,

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weather data, average well depth, and irrigation restrictions. For each class, models were developed and tested, and variables were dropped from models due either to incorrect mathematical sign or insignificance. The analyses were performed using data for individual accounts (as opposed to data aggregated at the level of customer classes or utilities).

Table 5.5
Marginal Price Elasticity Estimates For Commercial Establishments In Southwest Florida

Customer Classification	Number of Accounts	Price Elasticity At Mean	Mean Water Price[1]	Model R-Square
Apartments	174	0	$3.01	0.64
Car Washes	17	-0.70	2.74	0.17
Hospitals	22	0	3.05	0.04
Hotels / Motels	113	-0.48	2.51	0.43
Laundromats	58	-0.14	2.97	0.06
Nursing Homes	54	0	2.67	0.54
Office Buildings	116	-0.33	3.00	0.29
Restaurants	122	-0.28	3.10	0.19
Schools (Elementary)	67	-0.25	3.33	0.32
Universities	9	Indeterminate	2.05	.001

[1] Mean marginal price in dollars ($) per 1,000 gallons.

Source: Winer, Marv, Porter Rivers III, Carolyn Emerson-Price, John B. Whitcomb, and Robert Briggs. *Water Price Elasticity Study*. Report prepared for the Southwest Florida Water Management District by Brown and Caldwell. August 1993. Pages 6-1 through 6-26.

Car washes and hotels/motels showed high price elasticities relative to the other classes. Car washes, however, exhibited a low R^2. None of the models exhibited particularly high R^2 results. This is likely indicative of the fact that water usage is dependent on a large number of factors, many of which are either hard to measure, or hard to obtain from businesses due to obvious competitive reasons.

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The models summarized above provide some useful and interesting results. The most reasonable range of elasticities appears to be from -0.15 to -0.76, with most types of commercial establishments falling between -0.25 and -0.50. The results for apartments and hospitals, while shown as zero, were that the analysts (Winer, et. al.) could not establish negative relationships between price and consumption. In the case of apartments, this is likely because apartment dwellers generally do not explicitly pay water bills. The water costs are included in rent, and the apartment dweller never sees the bill. In the case of hospitals, this is likely because hospitals face stringent health and sanitation requirements. Reducing water usage in response to price increases is likely not an option for hospitals.

Shown on Table 5.6 are results of a study using data from municipal utilities across the United States. As the table shows, the estimated elasticity of demand with respect to average price is approximately -0.360. The marginal price elasticity estimate, -0.141, is at the low end of the range reported in the other two studies cited in Tables 5.4 and 5.5.

Table 5.6
Price Elasticity Estimates Developed Using National Water Data[1]

Customer Description	Price Variable	Number of Customers	Price Elasticity	R^2
Residential	Average	86	-0.484	0.96
	Marginal	82	-0.253	0.95
Commercial	Average	140	-0.360	0.85
	Marginal	137	-0.141	0.84
Industrial	Average	113	-0.735	0.50
	Marginal	112	-0.438	0.45

[1] The data used in the study are utility-level customer class water consumption from utilities across the country that participated in AWWA's 1976 *Survey of Operating Data for Water Utilities*. The analysts matched this data to price and other data from the survey, to income data from *1970 City and County Data Book*, and to NOAA weather data.

Source: Williams, Martin and Byung Suh, "The demand for urban water by customer class," *Applied Economics*, Vol. 18, No. 12 (December 1986), pages 1275 through 1289.

A study performed for the Metropolitan Water District of Southern California, estimated an aggregate commercial/industrial marginal price elasticity of -0.276. The marginal

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price coefficient was not statistically significant, but the elasticity value was within the range expected by the study's authors[9], and within the range shown in the studies cited above.

Using pooled, time series and cross-sectional data from the Columbus, Ohio metropolitan area, Schneider and Whitlatch[10] estimate price elasticity for six categories of metered water demand. The results of this analysis are shown on Table 5.7. The dependent variable used by Schneider and Whitlatch was annual average metered consumption per user account since 1959 for incorporated cities served by the City of Columbus, Ohio. A total of 16 communities have disaggregated water usage data, but for each user class analysis, not all communities could be used. The authors used a marginal price variable that was composed of both water and sewer block rates corresponding to the annual average monthly usage per water account.

The short-run marginal price elasticity of -0.234 is within the range of estimates provided earlier, albeit towards the lower end. The short-run marginal elasticities for schools and governments are also within the range stated earlier.

The Schneider and Whitlatch findings provide additional insight into the differences between short-run and long-run price response. In the flow weighted price elasticities, the long-run response is three times the short-run response. Government and residential estimates are on the order of two times, while long-run commercial response is nearly four times the short-run response. Schneider and Whitlatch estimate the years to long-run response range from three years for government agencies, four years for residential customers, to eight years for industrial and commercial customers. The Total Metered estimate of years to long-run response is seven years.[11]

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[9] Dziegielewski, Benedykt and Eva M. Opitz. *Municipal and Industrial Water Use In The Metropolitan Water District Service Area: Interim Report No. 4*. Carbondale, Illinois: Planning and Management, Ltd., June 1991. Prepared for the Metropolitan Water District. Pages 45 through 47.

[10] Schneider, Michael L. and Whitlatch, E. Earl, "User-Specific Water Demand Elasticities," *Journal of Water Resources Planning and Management*, Volume 117, Number 1, January/February 1991.

[11] Schneider, Michael L. and Whitlatch, E. Earl, "User-Specific Water Demand Elasticities," *Journal of Water Resources Planning and Management*, Volume 117, Number 1 (January/February 1991), page 71.

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Table 5.7
Marginal Price Elasticity Estimates by Category of Metered Demand for Columbus, Ohio

Customer Classification	Number of Cities	Short-Run Price Elasticity	Long-Run Price Elasticity	R^2
Residential	11	-0.110	-0.262	0.566
Commercial	7	-0.234	-0.918	0.156
Industrial	6	-0.112	-0.438	0.169
Government	6	-0.438	-0.781	0.084
School	8	-0.384	-0.956	0.026
Total Metered	13	-0.123	-0.504	-----
Flow Weighted		-0.161	-0.456	-----

Source: Schneider, Michael L. and Whitlatch, E. Earl, "User-Specific Water Demand Elasticities," *Journal of Water Resources Planning and Management*, Volume 117, Number 1 (January/February 1991), pages 52 through 73.

5.11 INDUSTRIAL WATER

Schneider and Whitlatch's results show industrial elasticities to be lower than commercial, school, and government customers (although interestingly, higher than residential). The short-run estimates, however, are lower than the results shown earlier and those that follow.

Schneider and Whitlatch's long-run marginal price elasticity estimate matches the marginal price elasticity reported by Williams and Sun. Shown in Table 5.8 are results from an industrial modeling effort performed using Canadian data. In this study of industrial facilities in British Columbia, Canada, Renzetti found intake water price elasticities ranging from -0.12 in petrochemical industries to -0.54 in light industries including textiles, rubber and plastic, and food and beverages. The results for the four industrial groups defined by Renzetti are provided in Table 5.8. The price variable was significant in all models except the industrial sector model.

The long-run marginal price elasticity of -0.438, found by Schneider & Whitlach, fits well within the range found by Renzetti.

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Table 5.8
Industrial Marginal Price Elasticities[1/]
In British Columbia, Canada Industrial Facilities

Manufacturing Subgroup	Number of Customers	Industry and SIC	Price Elasticity	R^2
Petrochemicals	47	Chemicals (37) Petroleum / Coal (35)	-0.1186	0.63
Heavy Industry	91	Mineral Prod. (35) Transport. Eq. (32) Met. Fabricating (30) Primary Metal (30)	-0.2486	0.23
Forest Industry	104	Paper & Allied (25) Wood Products (25)	-0.5060	0.24
Light Industry	130	Textiles (18) Rubber & Plastic (16) Food & Beverage (10)	-0.5368	0.23

[1/] The marginal price variable was an instrumental variable determined simultaneously with the quantity of input water.

Source: Renzetti, Steven, "An Econometric Study of Industrial Water Demands in British Columbia, Canada," *Water Resources Research*, Vol. 24, No. 10. (October 1988), pages 1569 through 1573.

5.12 IRRIGATION WATER

Price elasticity in the demand for irrigation water has not been extensively examined (at least relative to the extent to which residential price elasticity has been examined). The most recent study uncovered during this study was published in 1991, and reported on

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a study performed in the Saskatchewan River Irrigation District.[12] Using a linear programming approach, the authors estimated demand functions for profit-maximizing farms, subject to resource constraints and prices. Table 5.9 presents estimated point demand elasticities of water with respect to water price.

Table 5.9
Point Demand Elasticities of Water With Respect to Price of Irrigation Water

Water Price (1986 Canadian Dollars/ac-ft)	Elasticity
0.00	-0.00
39.50	-0.24
79.00	-0.67
87.00	-1.00
102.66	-1.91
110.56	-2.06
118.45	-2.65
142.14	-3.20
150.00	-8.65
157.93	-14.93
189.52	-17.91

Source: Kulshreshtha, Suren N., and Devi D. Teware, "Value Of Water In Irrigated Crop Production Using Derived Demand Functions: A Case Study Of South Saskatchewan River Irrigation District," *Water Resources Bulletin* Vol. 27, No. 2 (April 1991), p. 231.

Kulshreshtha and Teware also estimated arc elasticities. Across a range of prices from $7.60 to $15.80 (1986 Canadian Dollars) per acre-foot, the elasticity is -0.05 -- highly inelastic. Across a wider range of $7.60 to $39.50 (1986 Canadian Dollars), the

[12] Kulshreshtha, Suren N., and Devi D. Teware, "Value Of Water In Irrigated Crop Production Using Derived Demand Functions: A Case Study Of South Saskatchewan River Irrigation District," *Water Resources Bulletin* Vol. 27, No. 2 (April 1991), pp 227-236.

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elasticity increases to -0.30. At roughly $87 (1986 Canadian Dollars) demand reaches unitary elasticity and becomes elastic.

Table 5.10 shows that elasticity is directly related to the price paid. The upshot of this is that the elasticity of demand for water for irrigation is low at the level of prices historically paid for federal irrigation water. The elasticity is much higher at higher water prices.

Table 5.10
Elasticities Provided in Water Rights, Scarce Resource Allocation, Bureaucracy, and the Environment

	(1) Moore	(2) Moore and Hedges	(3) Bain, Caves, and Margolis	(4) Heady, Madsen, Nicol, Hargrove	(5) Shumway, King, Carter and Dean	(6) Shumway, King, Carter and Dean
Low Water Price	-0.14 at $5/ac-ft	-0.188		-0.17 at $7/ac-ft	-0.56 at $4.70/ac-ft	-0.48 at $4/ac-ft (1965$)
High Water Price	-1.58 at $25/ac-ft	-0.702		-0.56 at $30/ac-ft	-2.32 at $19.36/ac-ft	-2.03 at $17/ac-ft (1965$)
Average	-0.65	-0.65	-0.64	-0.37		
Area	San Joaquin Valley		34 California Water Districts	Seventeen Western States	California	California
Type of Analysis	Linear Programming	Quadratic Regression Equations	Cross-Sectional Analysis	Linear Programming	Spatial Linear Programming Location Model; 2-equation model	Spatial Linear Programming Location Model; Single-equation model
Page	86	87	87	87	88	88

(1) Charles V. Moore, "Economics of Water Demand in Commercialized Agriculture," *American Water Works Association Journal 54* (August 1962): 913-920.

(2) Charles V. Moore and Trimble R. Hedges, *Economics of On-Farm Irrigation Water Availability and Costs, and Related Farm Adjustments*, pt. 3, University of California, Giannini Foundation Research Report no. 261, March 1963.

(3) Joe S. Bain, Richard E. Caves, and Julius Margolis, *Northern California;s Water Industry*, Resources for the Future (Baltimore: Johns Hopkins Press, 1966).

(4) Earl O. Heady, Howard C. Madsen, Kenneth J. Nicol, and Stanley H. Hargrove, "National and Interregional Models of Water Demand, Land Use, and Agricultural Policies," *Water Resources Research 9* (August 1973): 777-791.

(5)&(6) C. Richard Shumway, "Derived Demand for Irrigation Water: The California Aqueduct," *Southern Journal of Agricultural Economics 5* (December 1973): 195-200.

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5.13 SUMMARY

Residential

Nationally, a range of reasonable marginal price elasticity estimates for residential customers is -0.2 to -0.5. In findings from Utah and Arizona, the reasonable range seems to be somewhat higher. Based on the findings of the Case Study, a residential elasticity of -0.592 appears reasonable.

Commercial

A range of reasonable marginal price elasticity estimates for commercial customers is -0.25 to -0.50. The appropriate value for use in the CUWCD service area is probably between the low end of the range (-0.20) and the mid-point (-0.375). Commercial water use represents roughly 20 percent of CUWCD sales. Reconciling Hansen's findings with the residential elasticity and relative water sales leads to this conclusion. An estimate of -0.25 is proposed.

Industrial

Based on Renzetti's British Columbia findings, an appropriate range of elasticities for industries typical to Utah would be -0.25 to -0.54. It is proposed that the low end of the range, -0.25, be used for the same reason given for commercial elasticities.

Municipal and Industrial, Total

Weighting residential sales (0.75) and commercial and industrial (0.25) yields a composite elasticity of about -0.50.

Agricultural

The elasticity of demand for irrigation water will likely be low, somewhere in the range of -0.20 for irrigation water at prices charged for CUP water.

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6 WATER CONSERVATION ESTIMATES

6.1 OBJECTIVE

The objective of this chapter is to quantify monthly water savings estimated to result from a set of conservation-inducing pricing policies noted in section 207(c)(3) of the Act.

6.2 BASELINE ASSUMPTIONS

Period of Analysis

It was first necessary to determine the time period, the point in time, and the length of time used in the analysis. Since the Act requires the development of monthly estimates of conservation potential, the time period is specified as a single month. The spirit of the Act, however, suggests the examination of the impact of price on a seasonal basis. If seasonal variation is assumed, the minimum length of time would be one year. Because of this, monthly estimates were prepared for each month over a specified time period.

The second time issue is the full length of time that is analyzed. It has been stated that the minimum length of time required to capture seasonal variation is one full year. We know, however, that consumers' response to a price change will vary according to their ability to make cost-effective adjustments in the use of water conserving goods and habits. Such adjustments require the passage of time and can result in different responses in the short-run as opposed to the long-run.

As noted by Boland, et al (1984), it is expected that long-run responses will be more elastic than short-run responses. It is also expected that a number of years may have to elapse before the long-run response can be presumed complete. The short-run response may be evident within weeks or months of the effective date of a price change.

There are exceptions to these generalities. Typically, a price change is announced to be effective for all billings that occur after a specified date. Depending on the meter-reading cycle and the billing lag, it may be a number of months before customers actually receive a bill that is calculated according to the newly announced rates. This can result in an "announcement effect" where the customer may react immediately upon hearing of the new rate, even before it goes into effect on their billings. This effect is based on expected, rather than actual, rate impacts to the customer. To the extent that the perceived impact is greater than the ultimate actual impact, the initial response may be greater than the ultimate net adjustment. Conversely, if the initial expectation underestimates the impact of the new rates, the initial response may be a smaller adjustment than what is later adopted.

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Also, some customers may ignore or be unaware of the announcement, postponing any response until the first bill reflecting new rates is received. After seeing the impact of the new rates, they may undertake a series of short-run, then long-run, adjustments as noted earlier. Prior to the receipt of the first bill, however, there has been no change in water use patterns, even though the new rates are in effect.

In spite of these exceptions, Boland states that we would still expect short-run response (defined as up to one year) to be more inelastic than long run response (defined as on the order of several years or more). This is important particularly from the standpoint of applying elasticity estimates to the potential conservation analysis. The inference being that the applied elasticity should become more elastic as time passes. Performing this analysis over more than one year allows the examination of both short-run and long-run effects of a rate change.

While no guidance beyond "more than one year" or "several years or more" is provided in the literature to define the long-run, it is necessary to limit the length of time analyzed. It is likely that water conserving habits can be altered and small water conserving goods can be purchased and installed within a three year period. Very long-run responses, however, are likely to take on the order of five to ten years to implement because they would include larger capital investments to actualize changes in the stock of major water using appliances and irrigation equipment. For purposes of this study, three years is considered to be representative of long-run response. This provides a three year length of time to analyze monthly data. The first year examines short-run response, the third year examines long-run response, and the second year is considered intermediate and changes in the response rate are assumed to be linear. These changes are reflected in the application of appropriate price elasticity estimates, where short-run elasticity is applied to the first year, long-run elasticity is applied to the third year, and the mid-point of the two elasticity estimates is applied to the second year.

The final time issue is the future dates that are analyzed. Since the study will be completed by October 1995, analysis was initiated in January 1996 and continues through December 1998.

Base Conditions

Certain base conditions were assumed for this analysis. In order to apply the analysis to the entire service area, pricing policies that were analyzed were uniformly applied. It was assumed that all agencies within the service area would adopt this particular policy. Since this is unlikely, it is expected that conservation estimates developed through this study would be somewhat higher than what could actually be realized. In order to examine more likely levels of potential conservation, various "implementation rates" are applied to the analysis.

The present calculations assume a 100 percent implementation rate for the pricing policy being examined. An implementation rate of 25 percent would imply that 25 percent of the retail M&I water sales in the service area would be sold under the new rate

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structure. Such an implementation rate is applied by multiplying the 100 percent conservation estimate by 0.25. Suggested implementation rates of 25, 50, 75, and 100 percent provide a broad picture of conservation potential.

Ideally, an analysis of this type would be performed on a case-by-case basis for each individual agency, allowing the base conditions (current rate structure, price level, consumption) to vary and modeling the implementation of various alternative rate structures. Such an analysis allows the researcher to adequately recognize differences among utilities in implementing alternative rate structures. Because of its aggregate nature and the number of agencies in the CUWCD service area, this level of detail is well beyond the scope of this study. Much of the method proposed in this study could, however, be transferred to individual agency applications.

A pricing policy that is reasonably applied to one end use sector may not be as easily applied to other sectors. In particular, a great deal of agricultural water in the service area is institutionally priced, leaving limited pricing options available. As a result, the conservation estimates that were developed in this study do not include potential conservation due to alternative pricing of agricultural water. It is recognized that there is great potential for water conservation in the agricultural sector, both through pricing and other measures. There are, however, very few incentives for private companies that provide agricultural water to alter their pricing systems. Most irrigation water companies are owned by a limited number of share holders who are also the users of the company's water. The most common method of pricing in these companies is to simply allocate annual company costs on a per share basis. Actual measurement of water use is rarely involved in pricing for these companies. Also, agricultural water that is provided through federal projects is priced on a contractual basis and is unlikely to be altered.

Water consumption estimates and projections for the service area are generally provided in terms of agricultural water and M&I water. Even though it can be quite useful to a particular agency to price water differently for residential, commercial and industrial customers (and often times, to disaggregate even farther), this particular analysis is limited to an aggregate estimate of M&I water delivered through public systems (i.e., self-supplied industrial applications are not included). This means that the conservation estimates that were developed are limited to estimates of conservation potential of M&I water as a result of pricing policies adopted by retail M&I agencies.

Base Consumption

In order to estimate conservation resulting from the adoption of alternative pricing policies, it was necessary to determine what consumption would be expected to occur if no pricing policy changes were made. Current projections of M&I water consumption in the service area for the period of analysis (1996-1998) were based on this premise. Projections of monthly M&I water consumption in the service area for 1996-1998 were developed using the following method.

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Monthly consumption patterns (in percentage terms) were estimated using actual 1992 M&I consumption records for Salt Lake City and Provo. These consumption patterns were then applied to 1993 total M&I water delivered through public water systems within the CUWCD service area. M&I water delivery estimates for 1993 were obtained from the Utah Department of Natural Resources, Division of Water Rights. These estimates of 1993 monthly consumption were then divided by the 1993 service area population (as estimated by the Utah Governor's Office of Planning and Budget) to determine monthly per capita consumption for 1993.

Monthly per capita consumption for 1993 was then assumed to remain constant and was applied to CUWCD service area population projections for 1996-1998 to derive the projected baseline monthly M&I consumption within the CUWCD service area for 1996-1998.

Baseline consumption estimates are shown in Table 6.1.

Subsistence Level

Exceptionally large increases in price were not studied in this analysis. Because of this, and because water is relatively inexpensive and is vital to human life, it is reasonable to assume that there is a monthly subsistence level of water that customers will consume regardless of the change in rate structure or price level. It was necessary to determine this level of consumption because elasticity estimates should not be applied to this block of water if changes in pricing policies do not impact the consumption within this block of water.

The development of an actual subsistence level of consumption could be a substantial study onto itself. Also, the very definition of subsistence level elicits a wide range of responses from customers, purveyors, regulatory agencies, government officials, and others. Instead of attempting to determine the appropriate percentage of total consumption that should be considered "subsistence consumption", the method used was to assume subsistence level consumption to be equal to the lowest monthly projected M&I consumption for the base year of analysis (1993). Consumption during the month of February is used as an estimate of subsistence consumption on this basis. This is consistent with the expectation that subsistence consumption would occur in a winter month with essentially no outdoor water use.

Baseline Pricing Policy

A number of different pricing policies are employed by agencies within the service area. In order to uniformly apply alternative pricing policies, the change in consumption needed to be uniformly determined. This required the assumption that all agencies in the service area currently use the same pricing policy. While this is certainly not the case, it is a manageable assumption under two conditions.

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First, all price level changes were examined on a percentage basis rather than an absolute basis. This alleviates the need to assume that all agencies price their water at the same level.

Second, a baseline pricing policy was developed that is as representative of the majority of M&I customers in the service area as is reasonable. Based on a review of the short-form and long-form questionnaire responses and the AWWA Intermountain rate survey, and on the amount of M&I water provided by particular agencies, a representative rate structure was determined. The key is that only the rate structure was determined, not the price level.

Thirty-two entities provided enough information on their short-form response to determine approximately how much M&I water they deliver and what type of pricing structure they use. Of the total M&I water delivered by these entities, 86 percent is priced under a minimum charge system where a specific block of water is provided for a minimum set charge and all water consumed above that minimum block is charged at a uniform rate (i.e., $0.35 per 1,000 gallons). Nine percent of the water delivered is priced under a uniform rate structure where no block of water is provided with the periodic service charge and all water is priced at the same rate (i.e., $0.35 per 1,000 gallons). Five percent of the water delivered is priced under a minimum charge/increasing block rate (this is one entity). It is assumed that an 86 percent representation of water deliveries is substantial enough to justify the use of a single baseline pricing policy.

The baseline policy is a minimum charge policy where each customer receives a block of water per month for their basic service charge. Any water consumed by the customer, during the month, above that minimum block provided, is priced at a per unit level of consumption (i.e., $X/1,000 gallons). This is a very common pricing policy within the service area.

Based on a review of the AWWA Intermountain Section 1992 Water Rates Survey, the mean level of consumption where marginal price changes from $0 to $X is approximately 8,500 gallons per month, and the median level of consumption where marginal price changes from $0 to $X is 8,000 gallons per month, for 15 entities within the CUWCD service area that employ a minimum charge pricing system. For this analysis, the marginal price breakpoint for the baseline pricing policy will be 8,000 gallons per month.

Weighted Marginal Price

Once the subsistence level was determined, the change in consumption above that subsistence level was to be determined. That change is a function of both the change in price level and the change in rate structure.

Consider the baseline pricing policy. Using the basic economic premise that consumers respond to the price at the margin, we can define two marginal prices for the baseline

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pricing policy: $MP_1 = 0$, $MP_2 = X$. In order to examine the impact that the rate structure will have, it was necessary to make the assumption that any consumption blocks under which the marginal price of water changes for a single customer in a pricing policy that is evaluated has a breakpoint that is the same as the baseline pricing policy. This allows for the use of a "weighted marginal price" method to analyze a relative price level change due to a change in rate structure, as well as an absolute price level change. For this analysis, no pricing policy analyzed contained more than two price blocks.

In order to develop "weighted marginal prices", it was necessary to determine the percentage of consumption, above the subsistence level, in each of the two price blocks. This was done for each calendar month by using the individual monthly residential customer consumption records collected during the price elasticity case study. For each calendar month, approximately 700 observations (sample size of 70 customers per agency multiplied by five agencies multiplied by two years of data) were examined. For each observation, if A were the observed consumption, B were the subsistence level, and C were the breakpoint between the two price blocks, then:

$D = A\text{-}B$; if <0, then 0
$E = A\text{-}B$; if $>(C\text{-}B)$, then $(C\text{-}B)$; if <0, then 0
$F = D\text{-}E$

and: $\Phi = \Sigma E + \Sigma F$
$\Phi_1 = \Sigma E / \Phi$
$\Phi_2 = \Sigma F / \Phi$

where: Φ_1 = percentage of consumption above subsistence level in first price block
Φ_2 = percentage of consumption above subsistence level in second price block

The subsistence level, B, was determined by using the average of the individual consumption totals from the month of lowest total consumption (February).

It was assumed at this point that commercial and industrial customers exhibit the same consumption patterns, both within and between months, as residential customers do. This does not mean that they consume similar quantities of water, only that their consumption patterns are similar. An example of this is that if 7 percent of annual residential consumption occurred in March, 7 percent of annual commercial consumption would also occur in March. Also, if 18 percent of residential consumption above the subsistence level were in the first price block, then 18 percent of commercial consumption above the subsistence level would be in the first price block.

While commercial and industrial customers may not exhibit exactly the same consumption pattern, both within and between months, as residential customers do, the residential consumption pattern is dominant and can be extrapolated to total M&I

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consumption. A review of short-form questionnaire responses showed that 75 percent of M&I consumption is residential. Commercial consumption (whose pattern should be similar to residential) is between 17.5 and 20 percent of total M&I. Industrial consumption (whose consumption pattern can differ depending on the industry mix) is between 5 and 7.5 percent of total M&I. This breakdown suggests that the use of residential consumption patterns for purposes of analysis is reasonable.

Table 6.2 provides an estimate of the percent consumption above the subsistence level in each of the two specified price blocks within the CUWCD service area. The percentages were developed from the database used in the Price Elasticity Study.

It is worth noting the potential revenue implications of increases in price level. If price elasticity is less than unitary (which all studies that have been reviewed suggest), an increase in the price level will increase revenues. This implies that revenue sufficiency is not likely to be a concern. It may imply, however, that a water agency that increases its price level will collect more revenue than is necessary. Particularly in the case of public water agencies, over-collection suggests a misallocation of resources. To avoid over-collection when raising commodity charges, the agency may consider re-examining their service charge and adjusting it accordingly. This analysis does not examine the level of the service charge because the service charge does not impact the marginal price of water, which is what we expect the consumer to respond to.

At this point, the calculations differ depending on the rate structure and price level of the pricing policy being analyzed. For each of the alternative rate structures, the service charge does not include a minimum amount of water.

6.3 ELASTICITY ESTIMATES AND CONSERVATION RATES

Elasticity Estimates

Chapter 5 presents the findings of Schneider and Whitlatch for Marginal Price Elasticity Estimates of Metered Demand. These findings were used to develop elasticity estimates for the study.

Based on their study, elasticity estimates were developed for the first three years following the implementation of the conservation rate structure, 1996 through 1998. Schneider and Whitlatch estimate that it takes four years for residential customers and eight years for industrial and commercial customers to achieve long run responses. Based on an 80 percent residential and 20 percent commercial/industrial estimate of the ratio of customer types, a weighted average of 5 years was used to represent the number of years for a long-run response to a change in the price of water. For the first year, 1996, the short run elasticity estimate of -0.2 was used. The elasticity estimates for 1997 and 1998 were developed using linear interpolation between the short and long term estimates. Based on the 5 years to long run achievement and the long run elasticity estimate of -0.5, a second year estimate of -0.275 and third year estimate of -0.35 were assumed.

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Table 6.1
Consumption Above Subsistence Level

Month	(1) Baseline Consumption (AF)	(2) Subsistence Level (AF)	(3) (1)-(2) Consumption above Subsistence Level (AF)
Jan-96	14,672	13,407	1,265
Feb-96	13,407	13,407	0
Mar-96	15,452	13,407	2,045
Apr-96	28,592	13,407	15,185
May-96	35,382	13,407	21,975
Jun-96	43,348	13,407	29,942
Jul-96	46,068	13,407	32,661
Aug-96	48,378	13,407	34,971
Sep-96	32,734	13,407	19,327
Oct-96	25,539	13,407	12,133
Nov-96	14,591	13,407	1,185
Dec-96	14,690	13,407	1,284
Jan-97	14,894	13,610	1,284
Feb-97	13,610	13,610	0
Mar-97	15,686	13,610	2,076
Apr-97	29,026	13,610	15,415
May-97	35,918	13,610	22,308
Jun-97	44,006	13,610	30,396
Jul-97	46,767	13,610	33,157
Aug-97	49,112	13,610	35,502
Sep-97	33,231	13,610	19,621
Oct-97	25,927	13,610	12,317
Nov-97	14,813	13,610	1,203
Dec-97	14,913	13,610	1,303
Jan-98	15,121	13,817	1,304
Feb-98	13,817	13,817	0
Mar-98	15,925	13,817	2,108
Apr-98	29,467	13,817	15,650
May-98	36,465	13,817	22,648
Jun-98	44,675	13,817	30,858
Jul-98	47,479	13,817	33,661
Aug-98	49,859	13,817	36,042
Sep-98	33,736	13,817	19,919
Oct-98	26,321	13,817	12,504
Nov-98	15,038	13,817	1,221
Dec-98	15,140	13,817	1,323

(1) Based on 1992 Salt Lake City and Provo M&I consumption patterns, 1993 CUWCD consumption and 1996-98 population projections.
(2) Minimum monthly consumption for year.

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Table 6.2
% Consumption Above Subsistence Level 1_/

Month	Price Block 1	Price Block 2
January	60.1%	39.9%
February	57.0%	43.0%
March	35.3%	64.7%
April	36.4%	63.6%
May	26.7%	73.3%
June	20.6%	79.4%
July	15.1%	84.9%
August	11.6%	88.4%
September	15.8%	84.2%
October	18.9%	81.1%
November	36.1%	63.9%
December	54.0%	46.0%

1_/ From Price Elasticity Study; Salt Lake City, Murray, Provo, and South Salt Lake City.

6.4 CONSERVATION PRICING SCENARIOS

Chapter 4 presented an evaluation of alternative pricing systems and outlined the criteria for a desirable rate structure. These criteria included rate stability, economic efficiency, equity, ease of implementation, simplicity, customer impact, competitiveness, legality, and water conservation. Based on the criteria, and the requirements of the Act, four different conservation pricing scenarios were selected as alternatives to the baseline pricing policy. These scenarios include:

1) *Uniform Rates* for their simplicity and ease of implementation;
2) *Seasonal Rates* for their revenue stability, simplicity, and encouragement of conservation;
3) *Increasing Block or Marginal Cost Rates* for the clear signals they give about the value of water; and
4) *Spacial Rates* for their simplicity and ability to reduce water consumption pumped to costly zones.

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Table 6.3
Assumptions

Elasticity: 1_/	
Long Run	-0.5
Years to Long Run Achievement	5
Short Run - 1st Year	-0.2
Intermediate Term - 2nd Year	-0.275
Long Run - 3rd Year	-0.35
Marginal Prices: 2_/	
Seasonal Rates	
Winter to Summer Ratio	1.25
Increasing Block Rates	
Block 2 to Block 1 Ratio	1.25
Spacial Rates	
Non-Base Area to Base Area	1.25

1_/ Based on Schneider and Whitlatch findings as presented in the Price Elasticity of Demand section, pages 5-48 and 5-49. Second and third years are linearly interpolated.

2_/ From Southwest Florida Water Management District Definition of Water Conservation Promoting Rates page 2-5.

Conservation Rate Structures

Following is a description of the approach used to develop the percent change in consumption from the baseline estimate above the subsistence level for the four selected conservation rate structures.

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Uniform Rates

Under this rate structure, all water is priced at the same per unit charge, MP_a, which is equal to MP_2 in the baseline policy. The appropriate calculation is:

$$\delta = (1 - ((\Phi_2 * MP_a) / MP_a)) * E_D$$

where: δ = percent change in consumption
Φ_2 = weighted marginal price under the baseline policy
E_D = price elasticity of demand for M&I water

Seasonal Rates

Under this rate structure, all water in winter months is priced at the same per unit charge, MP_a, which is equal to MP_2 in the baseline policy. All water in summer months is priced at the same per unit charge, MP_b, which is greater than MP_a. In order to develop estimates using MP_b, MP_b is expressed in terms of MP_a when actual calculations are made. For this pricing policy, the appropriate calculations are:

for winter months: $\delta_w = (1 - ((\Phi_2 * MP_a) / MP_a)) * E_D$

for summer months: $\delta_s = (1 - ((\Phi_2 * MP_a) / MP_b)) * E_D$

Increasing Block or Marginal Cost Rates

Under this rate structure, all water in the first price block is priced at the same per unit charge, MP_a, which is equal to MP_2 in the baseline policy. All water in the second price block is priced at the same per unit charge, MP_b, which is greater than MP_a. For this pricing policy, the appropriate calculation is:

$$\delta = (1 - ((\Phi_2 * MP_a) / ((\Phi_2 * MP_b) + ((1-\Phi_1) * MP_a)))) * E_D$$

Spacial Rates

Under this rate structure, all water sold to customers in a base geographical area is priced at the same per unit charge, MP_a, which is equal to MP_2 in the baseline policy. All water sold to customers outside the base geographical area is priced at the same per unit charge, MP_b, which is greater than MP_a. For this pricing policy, the appropriate calculations are:

for base area: $\delta_b = (1 - ((\Phi_2 * MP_a) / MP_a)) * E_D$

for non-base area: $\delta_n = (1 - ((\Phi_2 * MP_a) / MP_b)) * E_D$

To determine a monthly δ for the entire area, it is necessary to weight the percent change realized as a result of each of the two areas by the amount of consumption in each area. For purposes of this study, we have assumed that 50 percent of all consumption takes place within the base area, and 50 percent takes place outside the base area.

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Therefore: $\delta = (\delta_b * .5) + (\delta_n * .5)$

Marginal Price Estimates

The marginal price assumptions used in the study were taken from the Southwest Florida study[1]. The study specifies minimum guidelines with respect to the ratio of one marginal price to another. For the increasing block rates or marginal cost rates, the price of the second block should be at least 125 percent of the price of the first block. For the seasonal rates, the price of water during the peak season should be at least 125 percent of the price of water during the off-peak season. For consistency, it was assumed that the marginal price for the more costly non-base area to that of the base area was 125 percent for the spacial rates. This information is also presented in Table 6.3.

6.5 ESTIMATED PRICE-INDUCED CONSERVATION

Table 6.1 summarizes the baseline monthly consumption estimates for the period of analysis. Tables 6.4-6.7 summarize the estimated reduction in monthly consumption from each of the four pricing structures examined for the period of analysis. Assuming 100 percent implementation, the absolute change in consumption (or, amount of water conserved) is derived for each month through the following calculation:

$$C_{ij} = (Q_i - S_m) * \delta_{ij}$$

where:

C_{ij} = the change in consumption in month $_i$ (in acre-feet) as a result of pricing policy $_j$

Q_i = projected total M&I consumption in month $_i$ without a change in pricing policy

S_m = monthly subsistence level of M&I consumption

δ_{ij} = the percentage change in consumption above the subsistence level in month $_i$ as a result of pricing policy $_j$

Tables 6.4-6.7 also summarize the estimated reduction in monthly consumption from each of the four pricing structures assuming implementation rates of 25, 50, and 75 percent. Figure 6.1 graphically interprets the monthly percent decrease in consumption that would be expected for each of the four pricing structures examined. As can be seen, pricing structures that are traditionally considered to be more aggressive do, in fact, offer the greatest opportunity to decrease water consumption.

[1] Brown and Caldwell. *Definition of Water Conservation Promoting Rates*. Prepared by Brown and Caldwell Consultants, in association with John B. Whitcomb, Ph.D., for the Southwest Florida Water Management District: Brooksville, Florida. August 1993. study.

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Figure 6.1

PERCENT DECREASE IN CONSUMPTION FROM 100 PERCENT IMPLEMENTATION OF CONSERVATION-INDUCING PRICING

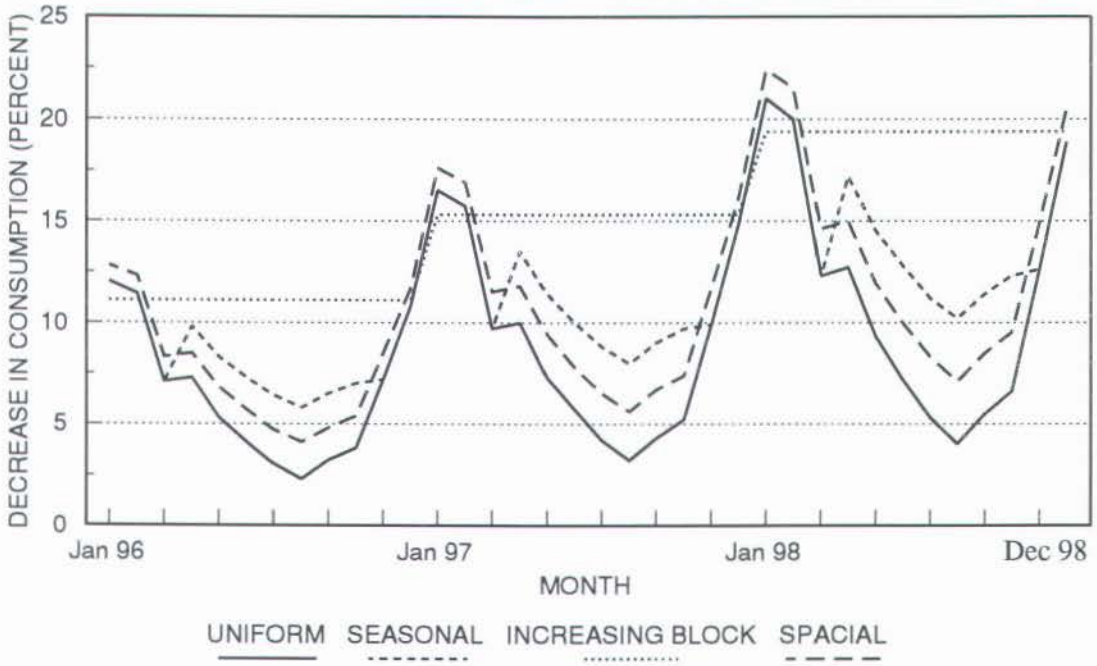

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Table 6.4
Change In Consumption based on Uniform Rates at Various Implementation Rates

Month	(1)	(2)	(3)	(4)	(5)
	% Change in Consumption	Absolute Reduction In Consumption (AF)			
		100% Implementation	25% x (2) 25% Implementation	50% x (2) 50% Implementation	75% x (2) 75% Implementation
Jan-96	-12.0%	152	38	76	114
Feb-96	-11.4%	0	0	0	0
Mar-96	-7.1%	144	36	72	108
Apr-96	-7.3%	1,105	276	552	829
May-96	-5.3%	1,174	293	587	880
Jun-96	-4.1%	1,231	308	615	923
Jul-96	-3.0%	988	247	494	741
Aug-96	-2.3%	808	202	404	606
Sep-96	-3.2%	611	153	306	458
Oct-96	-3.8%	459	115	229	344
Nov-96	-7.2%	86	21	43	64
Dec-96	-10.8%	139	35	69	104
Jan-97	-16.5%	212	53	106	159
Feb-97	-15.7%	0	0	0	0
Mar-97	-9.7%	201	50	101	151
Apr-97	-10.0%	1,542	386	771	1,157
May-97	-7.3%	1,638	410	819	1,229
Jun-97	-5.7%	1,718	429	859	1,288
Jul-97	-4.2%	1,379	345	690	1,034
Aug-97	-3.2%	1,128	282	564	846
Sep-97	-4.3%	853	213	426	640
Oct-97	-5.2%	640	160	320	480
Nov-97	-9.9%	119	30	60	90
Dec-97	-14.8%	194	48	97	145
Jan-98	-21.0%	274	69	137	206
Feb-98	-20.0%	0	0	0	0
Mar-98	-12.3%	260	65	130	195
Apr-98	-12.7%	1,993	498	996	1,495
May-98	-9.3%	2,117	529	1,059	1,588
Jun-98	-7.2%	2,220	555	1,110	1,665
Jul-98	-5.3%	1,782	446	891	1,337
Aug-98	-4.0%	1,457	364	729	1,093
Sep-98	-5.5%	1,102	276	551	827
Oct-98	-6.6%	828	207	414	621
Nov-98	-12.6%	154	39	77	116
Dec-98	-18.9%	250	63	125	188

(1) (1- Price Block 2 Percent Consumption Above Subsistence Level on Table 6.2) x Elasticity on Table 6.3.
(2) (1) x Table 6.1, Column (3).

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Table 6.5
Change In Consumption based on Seasonal Rates at Various Implementation Rates

Month	(1)	(2)	(3)	(4)	(5)
	% Change in Consumption	Absolute Reduction In Consumption (AF)			
		100% Implementation	25% x (2) 25% Implementation	50% x (2) 50% Implementation	75% x (2) 75% Implementation
Jan-96	-12.0%	152	38	76	114
Feb-96	-11.4%	0	0	0	0
Mar-96	-7.1%	144	36	72	108
Apr-96	-9.8%	1,491	373	746	1,118
May-96	-8.3%	1,818	455	909	1,364
Jun-96	-7.3%	2,182	546	1,091	1,637
Jul-96	-6.4%	2,097	524	1,048	1,573
Aug-96	-5.8%	2,045	511	1,023	1,534
Sep-96	-6.5%	1,262	315	631	946
Oct-96	-7.0%	852	213	426	639
Nov-96	-7.2%	86	21	43	64
Dec-96	-10.8%	139	35	69	104
Jan-97	-16.5%	212	53	106	159
Feb-97	-15.7%	0	0	0	0
Mar-97	-9.7%	201	50	101	151
Apr-97	-13.5%	2,082	520	1,041	1,561
May-97	-11.4%	2,538	634	1,269	1,903
Jun-97	-10.0%	3,046	762	1,523	2,285
Jul-97	-8.8%	2,927	732	1,464	2,195
Aug-97	-8.0%	2,855	714	1,427	2,141
Sep-97	-9.0%	1,761	440	881	1,321
Oct-97	-9.7%	1,190	297	595	892
Nov-97	-9.9%	119	30	60	90
Dec-97	-14.8%	194	48	97	145
Jan-98	-21.0%	274	69	137	206
Feb-98	-20.0%	0	0	0	0
Mar-98	-12.3%	260	65	130	195
Apr-98	-17.2%	2,690	672	1,345	2,017
May-98	-14.5%	3,279	820	1,639	2,459
Jun-98	-12.8%	3,936	984	1,968	2,952
Jul-98	-11.2%	3,782	946	1,891	2,837
Aug-98	-10.2%	3,689	922	1,844	2,767
Sep-98	-11.4%	2,276	569	1,138	1,707
Oct-98	-12.3%	1,537	384	769	1,153
Nov-98	-12.6%	154	39	77	116
Dec-98	-18.9%	250	63	125	188

(1) Winter: (1- Price Block 2 Percent Consumption Above Subsistence Level on Table 6.2) x Elasticity on Table 6.3. Summer: (1- (Price Block 2 Percent Consumption Above Subsistence Level on Table 6.2/Winter to Summer Marginal Price Ratio on Table 6.3)) x Elasticity on Table 6.3.

(2) (1) x Table 6.1, Column (3).

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Table 6.6
Change In Consumption based on Increasing Block Rates at Various Implementation Rates

Month	(1)	(2)	(3)	(4)	(5)
	% Change in Consumption	Absolute Reduction In Consumption (AF)			
		100% Implementation	25% x (2) 25% Implementation	50% x (2) 50% Implementation	75% x (2) 75% Implementation
Jan-96	-11.1%	141	35	70	105
Feb-96	-11.1%	0	0	0	0
Mar-96	-11.1%	227	57	114	170
Apr-96	-11.1%	1,687	422	844	1,265
May-96	-11.1%	2,442	610	1,221	1,831
Jun-96	-11.1%	3,327	832	1,663	2,495
Jul-96	-11.1%	3,629	907	1,815	2,722
Aug-96	-11.1%	3,886	971	1,943	2,914
Sep-96	-11.1%	2,147	537	1,074	1,611
Oct-96	-11.1%	1,348	337	674	1,011
Nov-96	-11.1%	132	33	66	99
Dec-96	-11.1%	143	36	71	107
Jan-97	-15.3%	196	49	98	147
Feb-97	-15.3%	0	0	0	0
Mar-97	-15.3%	317	79	159	238
Apr-97	-15.3%	2,355	589	1,178	1,766
May-97	-15.3%	3,408	852	1,704	2,556
Jun-97	-15.3%	4,644	1,161	2,322	3,483
Jul-97	-15.3%	5,066	1,266	2,533	3,799
Aug-97	-15.3%	5,424	1,356	2,712	4,068
Sep-97	-15.3%	2,998	749	1,499	2,248
Oct-97	-15.3%	1,882	470	941	1,411
Nov-97	-15.3%	184	46	92	138
Dec-97	-15.3%	199	50	100	149
Jan-98	-19.4%	254	63	127	190
Feb-98	-19.4%	0	0	0	0
Mar-98	-19.4%	410	102	205	307
Apr-98	-19.4%	3,043	761	1,522	2,282
May-98	-19.4%	4,404	1,101	2,202	3,303
Jun-98	-19.4%	6,000	1,500	3,000	4,500
Jul-98	-19.4%	6,545	1,636	3,273	4,909
Aug-98	-19.4%	7,008	1,752	3,504	5,256
Sep-98	-19.4%	3,873	968	1,937	2,905
Oct-98	-19.4%	2,431	608	1,216	1,824
Nov-98	-19.4%	237	59	119	178
Dec-98	-19.4%	257	64	129	193

(1) (1- (Price Block 2 % Consumption Above Subsistence on Table 6.2/((Price Block 2 % Consumption above Subsistence x Price Block 2 to Price Block 1 Marginal Price Ratio on Table 6.3)+(1-Price Block 1 % Consumption above Subsistence)))) x Elasticity on Table 6.3.
(2) (1) x Table 6.1, Column (3).

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Table 6.7
Change In Consumption based on Spacial Rates at Various Implementation Rates

Month	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Base Area % Change in Consumption	Non-Base Area % Change in Consumption	((1)+(2))/2 Average % Change in Consumption	Absolute Reduction In Consumption (AF)			
				100% Implementation	25% x (2) 25% Implementation	50% x (2) 50% Implementation	75% x (2) 75% Implementation
Jan-96	-12.0%	-13.6%	-12.8%	162	41	81	122
Feb-96	-11.4%	-13.1%	-12.3%	0	0	0	0
Mar-96	-7.1%	-9.6%	-8.3%	171	43	85	128
Apr-96	-7.3%	-9.8%	-8.5%	1,298	325	649	974
May-96	-5.3%	-8.3%	-6.8%	1,496	374	748	1,122
Jun-96	-4.1%	-7.3%	-5.7%	1,707	427	853	1,280
Jul-96	-3.0%	-6.4%	-4.7%	1,543	386	771	1,157
Aug-96	-2.3%	-5.8%	-4.1%	1,427	357	713	1,070
Sep-96	-3.2%	-6.5%	-4.8%	936	234	468	702
Oct-96	-3.8%	-7.0%	-5.4%	656	164	328	492
Nov-96	-7.2%	-9.8%	-8.5%	101	25	50	76
Dec-96	-10.8%	-12.6%	-11.7%	150	38	75	113
Jan-97	-16.5%	-18.7%	-17.6%	226	57	113	170
Feb-97	-15.7%	-18.0%	-16.9%	0	0	0	0
Mar-97	-9.7%	-13.3%	-11.5%	238	60	119	179
Apr-97	-10.0%	-13.5%	-11.8%	1,812	453	906	1,359
May-97	-7.3%	-11.4%	-9.4%	2,088	522	1,044	1,566
Jun-97	-5.7%	-10.0%	-7.8%	2,382	596	1,191	1,787
Jul-97	-4.2%	-8.8%	-6.5%	2,153	538	1,077	1,615
Aug-97	-3.2%	-8.0%	-5.6%	1,991	498	996	1,494
Sep-97	-4.3%	-9.0%	-6.7%	1,307	327	654	980
Oct-97	-5.2%	-9.7%	-7.4%	915	229	458	686
Nov-97	-9.9%	-13.4%	-11.7%	141	35	70	105
Dec-97	-14.8%	-17.4%	-16.1%	210	53	105	158
Jan-98	-21.0%	-23.8%	-22.4%	293	73	146	219
Feb-98	-20.0%	-23.0%	-21.5%	0	0	0	0
Mar-98	-12.3%	-16.9%	-14.6%	308	77	154	231
Apr-98	-12.7%	-17.2%	-15.0%	2,341	585	1,171	1,756
May-98	-9.3%	-14.5%	-11.9%	2,698	675	1,349	2,024
Jun-98	-7.2%	-12.8%	-10.0%	3,078	769	1,539	2,308
Jul-98	-5.3%	-11.2%	-8.3%	2,782	696	1,391	2,087
Aug-98	-4.0%	-10.2%	-7.1%	2,573	643	1,287	1,930
Sep-98	-5.5%	-11.4%	-8.5%	1,689	422	845	1,267
Oct-98	-6.6%	-12.3%	-9.5%	1,182	296	591	887
Nov-98	-12.6%	-17.1%	-14.9%	182	45	91	136
Dec-98	-18.9%	-22.1%	-20.5%	271	68	136	204

(1) (1- Price Block 2 % Consumption Above Subsistence Level on Table 6.2) x Elasticity on Table 6.3.
(2) (1- Price Block 2 % Consumption Above Subsistence Level on Table 6.2/Ratio of Non Base to Base Area on Table 6.3) x Elasticity on Table 6.3.
(4) (3) x Table 6.1, Column (3).

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7 PHASE OUT OF AD VALOREM TAXES

7.1 OVERVIEW

The Act requires an evaluation of rates based on the effect of phasing out the collection of ad valorem taxes by CUWCD and the petitioners of project water over a five-year and ten-year period. Any of the pricing policies evaluated in Chapter 4 can address the elimination of ad valorem taxes by incorporating the revenue currently received through ad valorem tax collections into the rate base revenue requirements. While the precise rate impact this restriction would have on water users would depend on a number of factors and would require a series of actual rate studies by each impacted agency, an average per unit rate impact can be calculated from the perspective of a number of different types of water users. Rate impacts would be felt by wholesale customers of CUWCD, wholesale and retail customers of petitioners, and retail customers of petitioner wholesale customers.

There are a number of examples to illustrate the relationships described. All petitioners of project water are wholesale customers of CUWCD. Orem is a petitioner who has retail customers. Metropolitan Water District of Salt Lake City is a petitioner who has wholesale customers (Salt Lake City and Sandy). Salt Lake County Water Conservancy District (SLCWCD) is a petitioner who has both wholesale customers (such as Sandy, Kearns Irrigation District and Granger-Hunter Irrigation District) and retail customers. Salt Lake City, Sandy, Kearns Irrigation District and Granger-Hunter Irrigation District are all examples of retail agencies that are wholesale customers of petitioners.

The primary focus of this analysis is to determine a quantitative per unit effective price impact resulting from the phase out of ad valorem tax collections by CUWCD and project water petitioners. In addition to this quantitative analysis, the phase out of ad valorem taxes could precipitate a number of other impacts.

One potential impact that could be felt by entities that currently levy ad valorem taxes is a change in their bond rating. Ad valorem taxes are one of the most stable forms of revenue available to a utility or agency. Altering the source of an agency's revenue stream from a partially tax-backed revenue stream to one that is entirely backed by rates may decrease the agency's bond rating. This is important because the higher the bond rating, the lower the interest rate available on any bonds issued by the agency. Thus, the loss of tax-backed revenue may result in higher costs of operation due to higher interest costs on bond issuances for required major capital improvements. Also, if ad valorem taxes are being used to back bonds that are currently outstanding, the taxes must remain in effect until the bonds are defeased. Failure to do so would result in a breach of contract on the terms of the bond issuance.

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Another impact would be the need by petitioners of project water to enter into new contracts. Current petitioner contracts with Metropolitan Water District of Salt Lake City (MWDSLC) and the Salt Lake County Water Conservancy District (SLCWCD) require those entities to collect ad valorem taxes that secure contract payments.

Concerns raised by local water agencies include a potential negative impact on the development of necessary capital improvements due to a less stable revenue stream and greater difficulty in securing bonds with a high rating and low interest rate. Another concern is the potential price shock felt by water customers. While discontinuing ad valorem tax collections would result in a decrease in tax costs to area landowners, it could also result in a substantial increase in the cost of water to the ultimate consumer. The size of such an increase will be estimated in this chapter.

7.2 BASELINE ASSUMPTIONS

Because the purpose of this analysis is to examine the impact to rates of phasing out ad valorem taxes, and because it is assumed that irrigation water rates can not be altered (as will be explained later in this section), the financial impact of phasing out ad valorem taxes is assumed to be entirely absorbed by the petitioners of M&I project water (and ultimately their consumers) through rate increases. It is recognized that this assumption will result in a financial impact that is concentrated on M&I water users in Salt Lake County and, to a lesser extent, Utah County.

Period of Analysis

As stated in the Act, the analysis is to consider the phase out of ad valorem taxes over both a five-year and ten-year period. The actual dates to be used for those periods of analysis are important to define because expected water deliveries and tax collections will not be constant between years. CUWCD has defined the period of analysis as 2009-2013 for the five-year phase out and 2009-2018 for the ten-year phase out. These periods were selected because it is expected that all project water will be developed and contracted for by 2009.

Other Conditions

In addition to defining the period of analysis, some simplifying assumptions were made. It is assumed that ad valorem tax collections will be phased out uniformly over the phase out period. As an example, in the first year of a five-year phase out, 20 per cent of the expected ad valorem tax revenue would no longer be collected. In the second year, this would increase to 40 percent. This linear increase in the phase out would continue until 100 percent was phased out in the fifth year.

It is assumed that all revenues that are expected to be collected by agencies in the analysis are required to meet expenses. This means that all revenues that were expected to be collected through ad valorem taxes must be recouped through other methods (rates).

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It is assumed that wholesale customers will continue to purchase the same amount of water from wholesale suppliers (including CUWCD and other petitioners), regardless of the increase in price. This assumption is based on the concept that the purchased water is still less expensive than the next available block of water to the purchasing agency. It is also based on the belief that continued growth will require the full utilization of the purchased water, regardless of conservation efforts. This assumption is not made for retail customers.

Irrigation water sold by CUWCD is not included in this analysis since charges to irrigators are set through ability to pay pricing. Because of this, an increase in the price charged to irrigators is not an option for CUWCD in recovering lost ad valorem tax revenues.

7.3 METHOD OF ANALYSIS

Calculations of expected rate impacts were developed using a spreadsheet model created in the Lotus 1-2-3 software program. The complete program output is presented in Appendix F.

Rate Impact to CUWCD Customers

Using CUWCD projections, the expected revenue to CUWCD from ad valorem taxes for each of the years in the period of analysis was estimated. From this, the amount of additional revenue that must be recovered in each year through the sale of water was calculated in the following manner:

$$R_i = T_i * (n / N)$$

where: R_i = Additional revenue required in year $_i$ due to phase out of ad valorem taxes
T_i = Expected ad valorem tax income in year $_i$
n = Number of years that have passed in the period of analysis (including year $_i$)
N = Number of years in the period of analysis (either 5 or 10)

Based on this required additional revenue, the rate impact to M&I customers of CUWCD is calculated in the following manner:

if:

$$R_i = Y_i * P_{Mi}$$

where: R_i = Additional revenue required in year $_i$ due to phase out of ad valorem taxes
Y_i = M&I water sold in year $_i$ (in acre-feet)
P_{Mi} = Required average rate increase (per acre-foot) to M&I water in year $_i$

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then:

$$P_{Mi} = R_i / Y_i$$

Rate Impact to Petitioner Wholesale Customers

Wholesale customers of petitioners would be impacted by the phase out of ad valorem taxes by both the petitioner they purchase water from and CUWCD (who is a supplier to the petitioner). In order to determine the combined impact of phasing out ad valorem taxes that are collected by CUWCD and the petitioners of project water, it was necessary to determine the total cost impact that petitioners would absorb from expected cost increases due to the phase out of ad valorem tax collections by CUWCD. The specific impact to each petitioner is a function of the required average rate increase (per acre-foot) of M&I project water and the expected amount of M&I project water (in acre-feet) purchased by the petitioner. Two petitioners, MWDSLC and SLCWCD, levy ad valorem taxes. The specific impact is calculated for each of these petitioners in the following manner:

$$S_{ij} = P_{Mi} * Q_{ij}$$

where: S_{ij} = Specific increase in revenue requirements in year $_i$ to petitioner $_j$, as a result of CUWCD phase out of ad valorem taxes
P_{Mi} = Required average rate increase by CUWCD (per acre-foot) to M&I project water in year $_i$
Q_{ij} = Amount of M&I project water (in acre-feet) to be purchased in year $_i$ by petitioner $_j$

The total lost revenue to a petitioner of project water as a result of the phase out of ad valorem taxes by CUWCD and the petitioner is the sum of the cost increase due to CUWCD's phase out of ad valorem taxes, the necessary increase in revenue through water sales due to the phase out of ad valorem taxes by the petitioner, and the cost increase due to the phase out of ad valorem taxes by CUWCD and other petitioners of project water who also provide water to the petitioner in question. This revenue deficiency can be depicted as:

$$R_{ij} = S_{ij} + \sigma_{ij} + \mu_{ij}$$

where: R_{ij} = Additional revenue required in year $_i$ by petitioner $_j$ due to phase out of ad valorem taxes by CUWCD and petitioners
S_{ij} = Specific increase in revenue requirements in year $_i$ to petitioner $_j$, as a result of CUWCD phase out of ad valorem taxes
σ_{ij} = Specific increase in revenue requirements in year $_i$ to petitioner $_j$, as a result of phase out of ad valorem taxes by petitioner $_j$ (the formula for this calculation is the same as was used to calculate CUWCD's additional revenue requirements earlier)
μ_{ij} = Specific increase in revenue requirements in year $_i$ to petitioner $_j$, as a result of increased costs of water purchased from other petitioners Σ_k

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and:

$$\mu_{ij} = \Sigma\ (R_{ik} / T_{ik})*Q_{ikj}$$

where: R_{ik} = Additional revenue required in year $_i$ by petitioner $_k$ due to phase out of ad valorem taxes by CUWCD and petitioners
T_{ik} = Total acre-feet of water sold by petitioner $_k$ in year $_i$
Q_{ikj} = Acre-feet of water sold by petitioner $_k$ to petitioner $_j$ in year $_i$

Based on the assumption stated earlier that wholesale customers will continue to purchase the same amount of water from wholesale suppliers regardless of the increase in price, the effective price increase to wholesale customers was calculated in the following manner:

$$P_{Wi} = R_{ij} / T_{ij}$$

where: P_{Wi} = Required increase in price per acre-foot to wholesale customers in year $_i$ for water sold by petitioner $_j$
R_{ij} = Additional revenue required in year $_i$ by petitioner $_j$ due to phase out of ad valorem taxes by CUWCD and petitioners
T_{ij} = Total acre-feet of water sold by petitioner $_j$ in year $_i$

Rate Impact to Petitioner Retail Customers

Petitioners may sell their water to wholesale or retail customers. The difference between the rate impact to a wholesale customer and a retail customer is the response that the customer will have to a change in price. Up to this point, only wholesale customers have been addressed and it has been assumed that they will exhibit no response to a change in price.

It is expected that a rational retail customer will purchase less of a good as the price of that good increases. Elsewhere in this study (Chapter 5), we have discussed the concept of price elasticity and estimates of price elasticity were made. This consumer response to a price change is important in determining the price change required to meet additional revenue requirements. The retail price change required to meet additional revenue requirements must be adjusted to account for the behavior of the retail consumer. This adjustment was made in the following manner:

$$P_{Ri} = (R_{ij} / T_{ij}) * (1 / (1- | E_D |))$$

where: P_{Ri} = Required increase in price per acre-foot to retail customers in year $_i$ for water sold by petitioner $_j$
R_{ij} = Additional revenue required in year $_i$ by petitioner $_j$ due to phase out of ad valorem taxes by CUWCD and petitioners
T_{ij} = Total acre-feet of water sold by petitioner $_j$ in year $_i$
$| E_D |$ = The average price elasticity of demand for M&I water, in absolute terms

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The final retail price increase was converted from a dollar per acre-foot measurement to a dollar per 1,000 gallon measurement to permit a more useful retail comparison.

Rate Impact to Non-Petitioner Retail Customers

The actual rate impact that is seen by retail customers of a particular retail agency that is a wholesale customer of CUWCD and/or petitioners of project water depends in large part on the make-up of the retail agency's water resource base. The greater the percentage of water sold by the retail agency that is acquired from CUWCD and petitioners of project water, the more likely the rate impact to the retail customer will be substantially increased. This occurs as a result of increased relative costs to the retail agency due to the need of CUWCD and petitioners to replace lost revenues from ad valorem taxes with increased revenues from water sales. Average rate impacts are calculated in the following manner:

$$P_{Ri} = (R_{ig} / T_{ig}) * (1 / (1-|E_D|))$$

where: P_{Ri} = Required increase in price per acre-foot to retail customers in year $_i$ for water sold by agency $_g$
R_{ig} = Additional revenue required in year $_i$ by agency $_g$ due to phase out of ad valorem taxes by CUWCD and petitioners
T_{ig} = Total acre-feet of water sold by agency $_g$ in year $_i$
$|E_D|$ = The average price elasticity of demand for M&I water, in absolute terms

and:

$$R_{ig} = \Sigma (P_{Wij} * Q_{Wij})$$

where: P_{Wij} = Required increase in wholesale price per acre-foot to retail agency $_g$ in year $_i$ for water sold by petitioner $_j$
Q_{Wij} = Acre-feet of water sold by petitioner $_j$ to agency $_g$ in year $_i$

The final retail price increase was converted from a dollar per acre-foot measurement to a dollar per 1,000 gallon measurement to permit a more useful retail comparison.

7.4 ESTIMATED IMPACTS

Figures 7.1-7.4 graphically depict the effective per unit rate impacts of the phase out of ad valorem taxes by CUWCD, SLCWCD, and MWDSLC over five and ten year periods.

Figure 7.1 shows the rate impact to M&I customers of CUWCD. At present, the impacted agencies are SLCWCD, MWDSLC, and the City of Orem.

Figure 7.2 shows the rate impact to wholesale customers of SLCWCD and MWDSLC. These customers would feel the effect of the phase out of not only SLCWCD and MWDSLC's ad valorem tax collections, but also the phase out of collections from

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CUWCD since CUWCD supplies both SLCWCD and MWDSLC. The rate impacts to the wholesale customers of these two agencies are similar. The rate impacts would be lower than those felt by CUWCD customers because it is assumed that the increased cost from CUWCD purchases will be spread evenly across all of SLCWCD and MWDSLC's customers and will be dampened by smaller cost increases in other current water sources.

Figure 7.1

RATE IMPACT TO CUWCD M&I CUSTOMERS ARISING FROM PHASE-OUT OF AD VALOREM TAXES

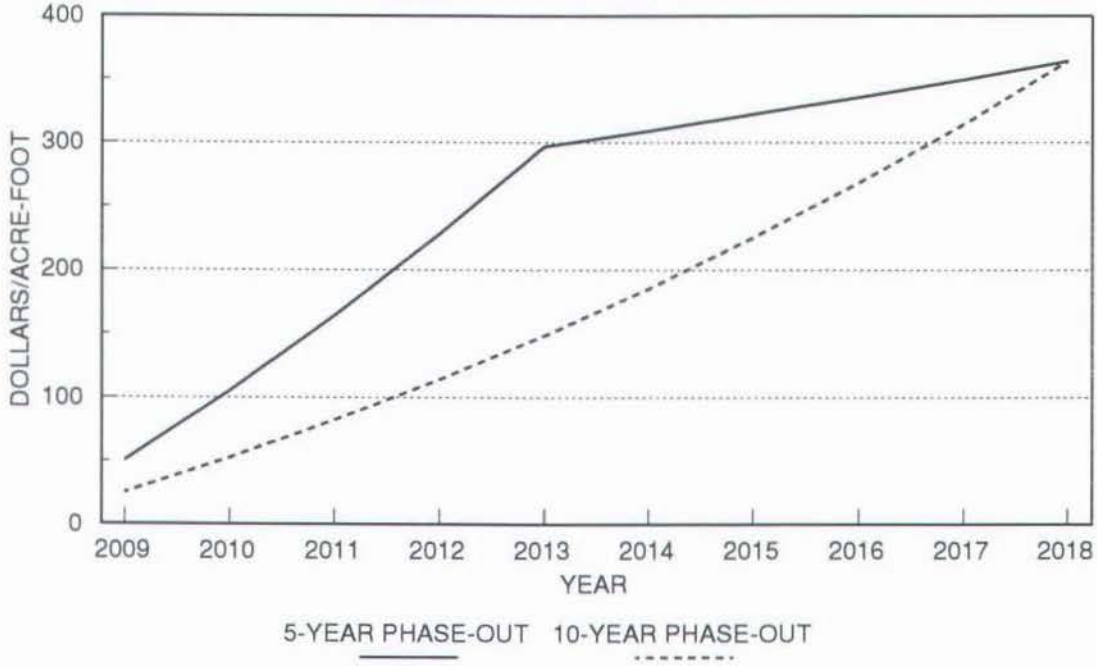

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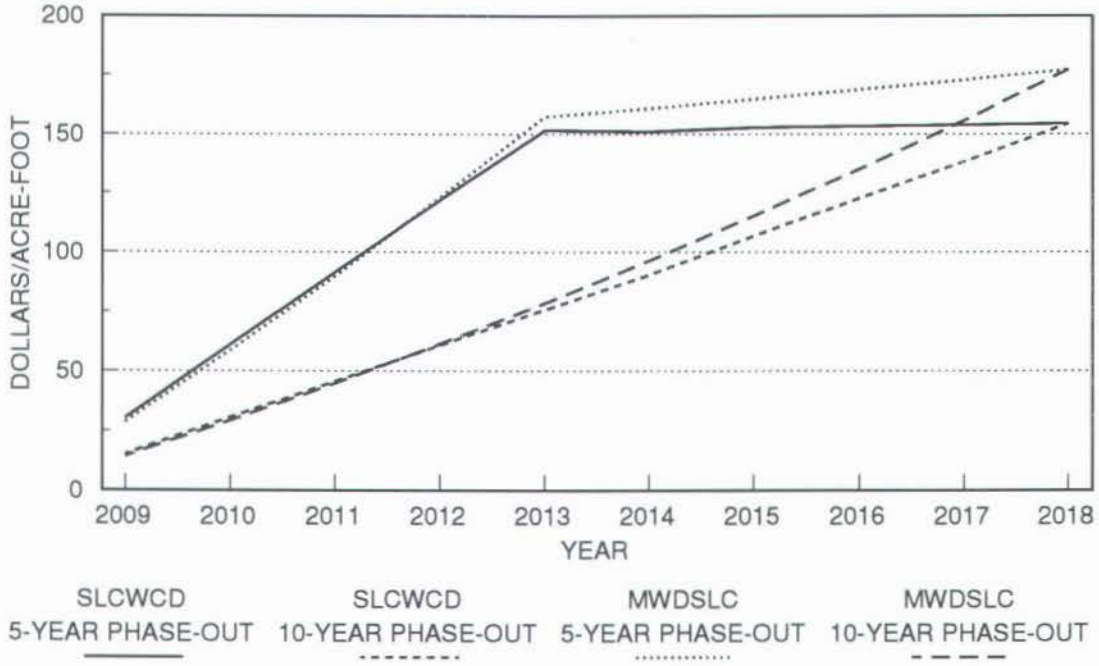
Figure 7.2

RATE IMPACT TO WHOLESALE CUSTOMERS OF SLCWCD AND MWDSLC



In Figures 7.3 and 7.4, rate impacts to retail customers in the area are shown in dollars per 1,000 gallons. Retail customers of SLCWCD and Salt Lake City (the major purchaser of MWDSLC supplies) would be expected to see the greatest impact if the collection of ad valorem taxes were phased out in the CUWCD service area. Sandy would be expected to see the smallest impact of any of the retail agencies examined.

Further detail on the analysis underlying these figures can be found in Appendix F.

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Figure 7.3

RATE IMPACT TO RETAIL CUSTOMERS
FIVE YEAR PHASE-OUT OF AD VALOREM TAXES

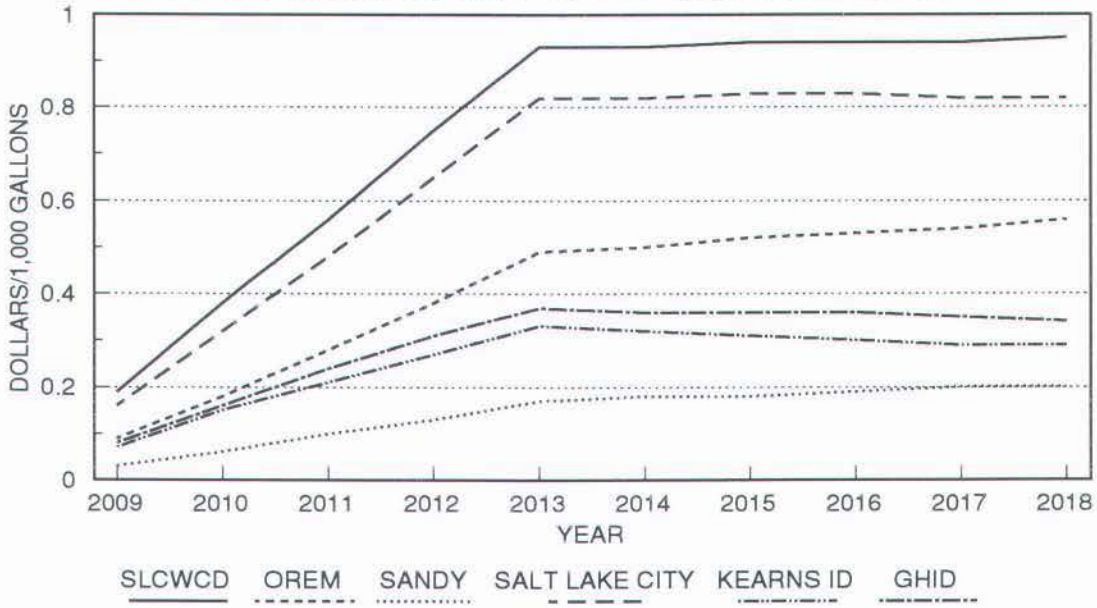
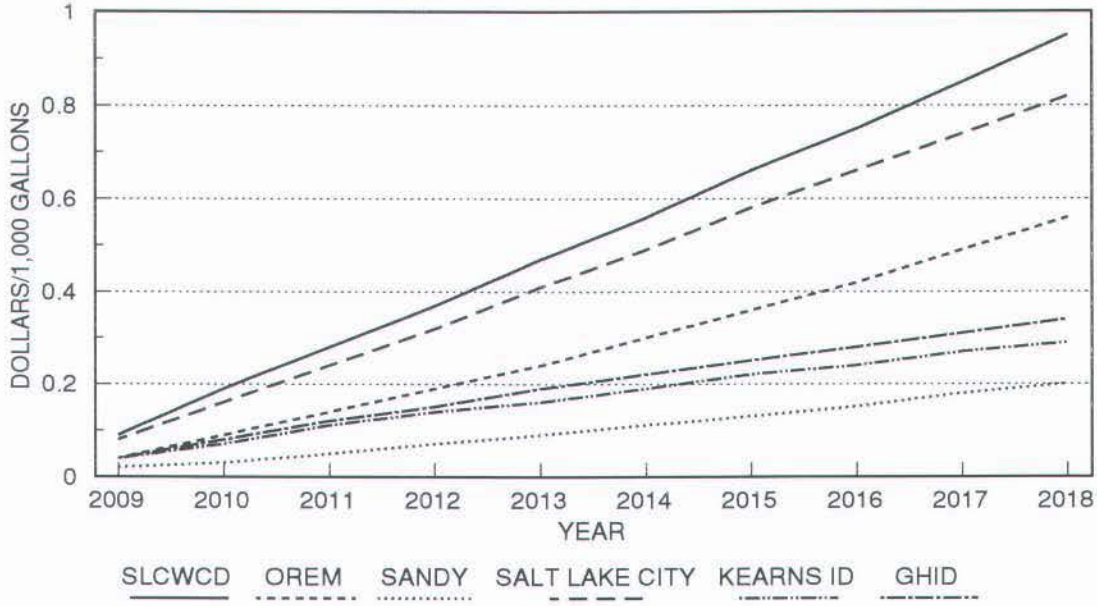


Figure 7.4

RATE IMPACT TO RETAIL CUSTOMERS
TEN YEAR PHASE-OUT OF AD VALOREM TAXES



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PART III:

SUMMARY AND CONCLUSIONS

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8 CONCLUSIONS

As noted in the U.S. Senate Committee reports, Section 207 of the Central Utah Project Completion Act of 1992 (CUPCA) calls for a two-tiered program to improve water management in the area. First is a series of standards and regulations that have since been developed by the Utah Water Conservation Advisory Board (UWCAB) that addresses specific areas enumerated in Section 207(f)(2), including the elimination of declining block rate schedules. The recommendations of the UWCAB are intended to quickly establish a minimum acceptable level of conservation activity throughout the CUWCD service area. The CUWCD is required to move beyond those minimum requirements by completing the Pricing Study, a Study of Coordinated Operations, and a Water Management Improvement Plan.

As the inclusion of the Pricing Study in Section 207 implies, water pricing is an integral part of any discussion of, and plans for, water conservation and management. In addition to this study, pricing issues have been addressed by the UWCAB and in the Study of Coordinated Operations. A coordinated effort between the study teams and the UWCAB has provided a thorough examination of the use of pricing as an incentive to conserve and efficiently manage water in the CUWCD service area. As a result, some discussion of water pricing is common among the various tasks completed for Section 207. This is to be expected, however, and simply acknowledges the important role that pricing plays in water management - not just for a single utility or irrigation company, but for a region.

8.1 COMPLIANCE WITH THE ACT

Section 207(c) of the CUPCA enumerates a number of requirements that the Pricing Study must meet in order for the CUWCD to be in compliance with the Act. Following is a listing of those items *(in italics)* along with notations describing how the Pricing Study meets those requirements.

207(c)(1) *Within three years from the date of enactment of this Act, the District, after consultation with the State and each petitioner of project water, shall prepare and transmit to the Secretary a study of wholesale and retail pricing to encourage water conservation as described in this subsection, together with its conclusions and recommendations.*

The Act was passed on October 30, 1992. This document reports the findings of the study required by the Act. Submittal of this report to the Secretary by October 30, 1995 constitutes fulfillment of the "within three years" requirement.

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Public involvement in the Pricing Study has been designed and implemented to reflect the spirit of the Central Utah Project Completion Act - to promote cooperation and consensus among the diverse groups with interests in Utah's water resources. The Act also requires that the Pricing Study be completed after consultation with the State and each petitioner of project water. Consultation with the State has been accomplished through direct involvement with the Utah Department of Natural Resources, Division of Water Resources (DWRe).

Petitioners of project water have been involved in the development and execution of the Pricing Study, in varying degrees, through a number of activities designed to solicit their input and involvement. Over 99 percent of the Municipal and Industrial (M&I) project water is under petition to three petitioners, the Salt Lake County Water Conservancy District (CUWCD), the Metropolitan Water District of Salt Lake City (MWDSLC), and the Orem City Public Works Department. Frequent meetings were held with representatives of these agencies and they were provided with opportunities to comment on work plans, intermediate products, and draft reports throughout the course of the study. In addition, each of these agencies was represented on the Water Management Improvement Studies Coordination Committee (WMISCC).

Irrigation petitioners, other M&I petitioners and water users throughout the District have been kept apprised of progress on the Pricing Study, and have been invited to discuss its development, through newsletters, annual CUP updates, and inclusion in the Water Usage Inventory Questionnaire and a telephone survey of area water users. Petitioner interests in the Uinta Basin, and future petitioner interests in Wasatch County and the SFN project area, have also been represented through the WMISCC.

207(c)(2) *The purposes of this study are -*

(A) *to design and evaluate potential rate designs and pricing policies for water supply and wastewater treatment within the District boundary;*

Rate structure and pricing policy design is a very agency-specific undertaking. It was determined early in the planning process that this study would not attempt to design specific pricing policies to be used by agencies within the CUWCD service area. Since no one rate structure or pricing policy can be universally accepted as a single best solution to the planning needs of various agencies with different characteristics, one option for meeting this particular requirement of the Act was to present various rate structures, billing and administrative procedures, and educational tools that could be used by agencies to design pricing policies for potential implementation. The actual design of pricing

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policies for agencies in the CUWCD service area would have been a prohibitively expensive exercise and, most importantly, would have been inappropriate since CUWCD has no authority to require the implementation of any of the policies or recommendations contained in this study.

An evaluation of pricing systems, emphasizing retail pricing, is provided in Chapter 4 of this report. Further discussion and review of the issues involved in wastewater, wholesale, and irrigation pricing, along with conclusions, is provided in Chapter 3.

(B) to estimate demand elasticity for each of the principal categories of end use of water within the District boundary;

A thorough evaluation of price elasticity of demand, including a definition of "end use of water", is provided in Chapter 5 of this report.

(C) to quantify monthly water savings estimated to result from the various designs and policies to be evaluated;

Potential monthly water savings for each of four pricing systems are estimated for a three year period and are presented in Chapter 6 of this report.

(D) to identify a water pricing system that reflects the incremental scarcity value of water and rewards effective water conservation programs.

The applicability of water pricing systems to individual water agencies will vary. While no one water pricing system is right for all agencies, a number of pricing systems will accurately reflect the value of water. There are two key requirements that a pricing policy must meet in order to reflect the value of water. First, the customer must be required to pay more for additional water (i.e., no flat fees or large blocks of water under a minimum charge). Second, the customer must not be provided with a decreasing per unit price (i.e., no decreasing block rates). Any of the pricing policies developed and evaluated in Chapter 4, if properly implemented, will reflect the value of water.

A conscious decision was made to review pricing systems based on their ability to reflect the value of water rather than the **scarcity** value of water. Water only has scarcity value if it is in short supply, either due to a decrease in available supply or an increase in demand (probably due to population pressures). This is rarely the case in the CUWCD service area. Were it the case, however, any pricing system that incorporates the

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marginal cost of the next source of water would reflect the scarcity value of water in the area.

207(c)(3) *Pricing policies to be evaluated in the study shall include but not be limited to the following, alone and in combination:*

(A) *recovery of all costs, including a reasonable return on investment, through water and wastewater service charges;*

As discussed in Chapter 4, any conservation rate will produce sufficient revenues unless the underlying revenue requirements and cost-of-service studies are wrong. Cost recovery is a criterion for a successful pricing policy, not a policy in and of itself. As such, all pricing policies examined in this study can be used to design rates sufficient to recover costs.

(B) *seasonal rate differentials;*

This rate structure is evaluated in Chapter 4 and conservation estimates are developed in Chapter 6.

(C) *drought year surcharges;*

This rate structure is evaluated in Chapter 4. Conservation estimates are not developed in Chapter 6 since the occurrence of a drought is an unknown quantity. Also, the purpose of a drought year surcharge is to recover costs when consumption is limited by supply availability, and is not to reduce consumption.

(D) *increasing block rate schedules;*

This rate structure is evaluated in Chapter 4 and conservation estimates are developed in Chapter 6.

(E) *marginal cost pricing;*

This rate structure is evaluated in Chapter 4. Conservation estimates are developed in Chapter 6 that assume marginal costs are communicated through an increasing block structure.

(F) *rates accounting for differences in costs based upon point of delivery;*

Spatially disaggregated rates are evaluated in Chapter 4 and conservation estimates are developed in Chapter 6.

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(G) *rates based on the effect of phasing out the collection of ad valorem property taxes by the District and the petitioners of project water over a five-year and ten-year period.*

As noted in Chapter 7, any of the pricing policies evaluated in Chapter 4 can address the elimination of ad valorem taxes by incorporating the revenue currently received through ad valorem tax collections into the rate base revenue requirements. Chapter 7 provides a full review of the effective per unit price impact of the phase out of ad valorem taxes.

8.2 CONCLUSIONS

Attitudes and Characteristics of Water Users

As a result of surveys taken by CUWCD in its service area, the following statements can be made about residential water users in the service area.

1. Customers are concerned about the level of their water bills and the level of their control over their bills.

2. Customers trust the utility that serves them.

3. Customers think it is the utility's responsibility to promote conservation.

4. Customers are opposed to the concept of simply raising rates to induce water conservation.

5. Customers favor the concept of linking water use and per unit price.

6. Residential customers have widely adopted basic water conserving behaviors, particularly if heated water is conserved. Significant potential remains in the residential sector for installation of water conserving devices such as low-flow toilets, showerheads and faucets.

7. Residential customers have some difficulty responding to questions concerning the installation of water conserving technologies within their residences. Utility water audit or informational programs could assist customers in recognizing whether they have low-flow devices in their home.

Prevalent Pricing Structures

A large majority of residential, commercial, and wholesale customers are charged under a minimum charge pricing system with a uniform per unit rate for water delivered in excess of the minimum. Pricing structures faced by irrigation customers are more evenly spread between a fixed charge system, a flat rate system, a minimum charge system, and other pricing systems. Only two responding agencies employ an increasing block pricing structure. A minimum charge system is used by most "large" companies.

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Administrative Tools

The key to realizing any conservation through pricing policies is to send an effective price signal to the customer that reflects the value of the commodity (water), and allows the customer to make rational decisions regarding the consumption of that commodity based on the customer's personal valuation of the commodity. There are a number of administrative tools available to the utility that will assist the customer in making rational decisions. Without the use of some (if not all) of these tools, no rate structure will effectively promote conservation.

The most important prerequisite to the institution of conservation-inducing rate structures is the installation of meters with which to measure consumption. Meters have been installed for almost all M&I customers by the municipal systems in the CUWCD service area. Metering issues that are present in the area include the metering of outdoor use on dual water systems and the frequency of meter reading by utilities.

The vehicle that sends the price signal to the customer is the water bill. Regular and frequent billings are important. In addition, the water bill can contain a great deal of information to assist the customer in making rational decisions regarding water consumption. Every water bill should provide the customer account number, the meter read dates, the billing date, the amount of water used in the billing period and the current water charge. Other important information that can help the customer understand the relationship between price and consumption would include the per unit price of water (for each applicable price block), consumption within each applicable price block, a breakdown of any fixed charges by cost component (i.e., fire protection, capital facilities), last months consumption, consumption from the billing month for the previous year or monthly consumption records for the previous twelve months (perhaps on a bar graph).

Even with the appropriate rate structure and a billing system that conveys the price of water clearly to the customer, most customers will need some education concerning how their rate structure works and how their consumption will impact their bill. Public information programs should be developed that explain the utility's conservation and pricing goals to customers and that make customers aware of their pricing system, the rationale behind it, and its likely impacts.

Price Elasticity of Demand for Water

Based on the results of the study, the following price elasticities may be used in examination of the CUWCD service area.

1.	Residential	-0.592
2.	Commercial	-0.250
3.	Industrial	-0.250
4.	M&I, Total	-0.500
5.	Agricultural	-0.200

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In all instances, the price elasticity of demand is significantly less than 1.0 (in absolute terms). This suggests that revenues will increase if water rates are increased, and that over a reasonable range of price adjustments, revenue insufficiency should not be an issue impeding the implementation of conservation rates by local water agencies.

Irrigation Pricing

Existing contracts will limit the ability of the CUWCD and its purveyors to achieve price-induced conservation on acreage served by currently existing water sources. For acreage served by "new" water, potential exists for cost effective conservation through the use of increasing block rates, with minimum block levels set at levels reflecting efficient irrigation practices. One form of "price-induced conservation" was built into the CUP Completion Act insofar as surcharges are to be imposed for lands growing surplus crops and lands under acreage limitation programs.

Wastewater Pricing

The pricing of wastewater offers one convenient opportunity for seasonal water pricing. One often-used seasonal rate form is the "base-extra" method in which average off-peak water usage is considered "base" water usage. Water consumption in excess of the base, during the peak period, is priced at a higher rate. Hence, the currently-prevailing wastewater pricing mechanism could be utilized to implement seasonal rates.

The currently-prevailing mechanism could also be utilized to develop uniform pricing mechanisms. Many utilities index wastewater bills to water consumption. For example, the wastewater bill might be $3.00 per 1,000 gallons of wastewater, with wastewater assumed to average 70 percent of monthly water usage. This rate structure clearly links the wastewater bill to water consumption and, if water conservation is the objective, sends a clear price-quantity message. The data maintained by CUWCD service area purveyors could easily be synthesized to calculate the average annual percentage linkages.

Many wastewater rates in Utah are based on average monthly winter water consumption. Because there are very few outdoor uses for water in Utah during the winter, it is expected that all winter usage is indoor, and therefore, is discharged as effluent. Further, it is expected that indoor water usage, and subsequent effluent, will remain constant between seasons. Even though wastewater is not metered, a relatively clear price signal is sent to the individual customer by estimating the amount of wastewater produced by each individual customer, and charging them on a per unit basis accordingly.

Wholesale Pricing

From the standpoint of rate structure development, the preferred option is to induce conservation at the point of ultimate consumption (the retail level). If retail rates are developed that send the appropriate price signal to consumers, it should not be necessary to consider conservation-inducing rates at the wholesale level. An exception to this is the recommendation that wholesale rates absolutely should not encourage water usage. This recommendation would effectively eliminate flat fees or declining block rates.

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A management decision that can be exercised by wholesale agencies is the elimination of take or pay contracts. The use of take or pay contracts can provide a disincentive for retail agencies to conserve water. Other risk management tools should be considered.

The imposition of conditions of service is another way that wholesale agencies can promote conservation through policy development. One option that wholesale agencies have is to tie the delivery of water to retail agencies to conditions such as the elimination of pricing policies that discourage water conservation by wholesale customers to their retail customers. This type of an imposition must be carefully developed. An overly stringent imposition could cause retail agencies to bypass the wholesale agency entirely for other supply options. In addition to the negative impact this could have on the wholesaler's revenues, it could also result in an inefficient allocation of the region's water resources by forcing the development of more expensive alternative water sources. If the alternative is to draw more heavily on groundwater resources, it is also possible that groundwater levels and water quality may be negatively impacted.

Conservation Potential

Pricing structures that are traditionally considered to be more aggressive do, in fact, offer the greatest opportunity to decrease water consumption. Of the structures examined, an increasing block rate structure should provide the greatest opportunity for conservation. Any conservation structure, however, will provide an appropriate signal to the customer that reflects the value of water. In determining which structure best suits a particular agency, a number of criteria must be considered, including, but not limited to, conservation potential.

Impact of Phasing Out Ad Valorem Taxes

The wholesale customers of SLCWCD and MWDSLC would feel the effect of the phase out of not only SLCWCD and MWDSLC's ad valorem tax collections, but also the phase out of collections from CUWCD since CUWCD supplies both SLCWCD and MWDSLC. The rate impacts to the customers of these two agencies would be lower than those felt by CUWCD customers because it is assumed that the increased cost from CUWCD purchases will be spread evenly across all of SLCWCD and MWDSLC's customers and will be dampened by smaller cost increases in other current water sources.

Retail customers of SLCWCD and Salt Lake City (the major purchaser of MWDSLC supplies) would be expected to see the greatest impact if the collection of ad valorem taxes were phased out in the CUWCD service area. Sandy would be expected to see the smallest impact of any of the retail agencies examined.

8.3 RECOMMENDATIONS

Changes in pricing policies are likely to gain greater public acceptance if they are phased in over time. Thus, change should reflect relative priority. With the intent of

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making change in a gradual manner, rather than an abrupt and potentially disruptive manner, a recommended priority ordering for implementing pricing policy change is as follows.

1. Eliminate rate structures (wholesale, retail, or wastewater) that promote water usage. All declining block rate structures should be eliminated.

2. Measure all accounts. A correlation between price and consumption can not be made without an accurate measurement of consumption.

3. Eliminate water and sewer rate structures that provide no ability for customers to reduce their water and sewer bills by reducing their water consumption, i.e., phase out flat fees and rates that include minimum charges covering large amounts of water.

4. Base wastewater rates on winter water usage as a proxy for metering consumption (effluent).

5. Adopt monthly billing to increase the effectiveness of the price signal. In order to further increase the customer's understanding and use of the price signal, utilities should provide information on each bill such as monthly water usage for each of the last 12 months, or water usage during the previous period and the same time period from the previous year, or some other usage data that provides customers with information that can be used to assess water conservation efforts.

6. Adopt water and sewer rate structures that improve the correspondence between incidence of costs and revenue recovery, including the development of additional customer classifications if needed to implement cost-based rates.

7. Implement seasonal rates whenever the difference between peak and non-peak seasonal water usage is large. Large can be defined as peak season exceeding non-peak by more than 50 percent.

   Since inclining block rate structures can be structured to mimic seasonal rates, non-seasonal inclining block rates can be implemented as an alternative.

   Wastewater pricing can be developed in a conjunctive manner with seasonal rates due to the inherent measurement of "indoor" water usage.

8. Eliminate the minimum charge structure, replacing it with one that recovers only customer and accounting charges through a fixed charge, and that recovers variable O&M costs and facility costs through the variable charges.

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9. Consider the use of risk-reducing strategies other than "take-or-pay" contracts, which can provide a disincentive to conserve water, on new water delivery contracts.

10. Incorporate the cost of the next source of water when determining prices for water sources that are diminishing, or where demand is increasing.

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APPENDICES

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APPENDIX A
CUSTOMER SURVEYS

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1993 Residential Customer Water Survey

Thank you for helping us prepare for your future water needs

For each question, please indicate your response by checking the appropriate box or filling in the blank. Please choose only one response unless you are otherwise instructed.

1. **How many people live in your household?**
   ____ Adults
   ____ Youths (under 18 years of age)

2. **What type of residential building category best describes where you live?**
   - ☐ Single-family detached house
   - ☐ Townhouse
   - ☐ Apartment/Condominium
   - ☐ Mobile home
   - ☐ Duplex/Triplex
   - ☐ Other

3. **How many bedrooms does your residence have?**
   _____ Bedrooms

4. **What is the approximate period in which your home was built?**
   _____ (year home was built)

   (if not certain, please use best guess using the categories below)

   - ☐ pre-1920's
   - ☐ 1920's
   - ☐ 1930's
   - ☐ 1940's
   - ☐ 1950's
   - ☐ 1960's
   - ☐ 1970's
   - ☐ 1980's
   - ☐ 1990's
   - ☐ After July 1, 1992
   - ☐ Don't know

5. **What is the approximate square footage of your home, <u>not including</u> garage, outside patios or porches?**
   _____ Square feet
   ☐ Don't know

6. **Does your residence have a lawn for which you are responsible?**
   - ☐ Yes
   - ☐ No - GO TO QUESTION 11

7. **What is your lot size?**
   _____ Square feet ☐ Don't know

8. **How often do you water your lawn in the summer?**
   - ☐ Never
   - ☐ Only during dry periods
   - ☐ About weekly
   - ☐ More than once a week
   - ☐ Don't know

9. **What length of time do you water your lawn per period?**
   - ☐ Less than 10 minutes
   - ☐ 10 minutes to 20 minutes
   - ☐ 20 minutes to 30 minutes
   - ☐ More than 30 minutes
   - ☐ Don't know

10. **What time of day do you usually water the lawn?** *(choose all that apply)*
    - ☐ Before 6:00 am
    - ☐ 6:00 am - 10:00 am
    - ☐ 10:00 am - 6:00 pm
    - ☐ 6:00 pm - 12:00 am
    - ☐ Don't know

11. **Do you own a swimming pool?**
    - ☐ Yes
    - ☐ No - GO TO QUESTION 13

12. **How often do you add water to your pool in the summer?**
    - ☐ Less than monthly
    - ☐ About monthly
    - ☐ Every other week
    - ☐ About weekly
    - ☐ More than once a week
    - ☐ Don't know

13. **Please indicate which of the following you have in your household and describe your family's average usage patterns.**

Appliance	Number of units	Average household usage
Clothes washing machine	_____	____ loads/week
Dishwasher	_____	____ loads/week
Toilets	_____	____ flushes/day
Shower/tub combinations	_____	____ showers or baths/week
Separate showers	_____	____ showers/week
Separate tubs	_____	____ baths/week
Irrigation sprinkler system	_____	____ hours/week

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14(a). Do you currently use any of the following water conservation appliances/devices? (b). Do you think the appliances/devices listed would be effective in saving water?

NO	YES	DON'T KNOW		NO WATER SAVINGS	MINOR WATER SAVINGS	MODERATE WATER SAVINGS	MAJOR WATER SAVINGS
☐	☐	☐	Toilet tank displacement dam	☐	☐	☐	☐
☐	☐	☐	Toilet tank displacement bag	☐	☐	☐	☐
☐	☐	☐	Low-Flow toilet	☐	☐	☐	☐
☐	☐	☐	Low-Flow showerhead	☐	☐	☐	☐
☐	☐	☐	Low-Flow faucet	☐	☐	☐	☐
☐	☐	☐	Self closing faucet	☐	☐	☐	☐
☐	☐	☐	Faucet aerator	☐	☐	☐	☐
☐	☐	☐	Efficient clothes washer (adjustable water levels)	☐	☐	☐	☐
☐	☐	☐	Efficient dishwasher (adjustable cycle time)	☐	☐	☐	☐
☐	☐	☐	Shut-off nozzle for garden hose	☐	☐	☐	☐
☐	☐	☐	Automatic timer for sprinkler system	☐	☐	☐	☐
☐	☐	☐	Drip irrigation system	☐	☐	☐	☐

15 (a). Please indicate if you currently use any of the following water conservation behaviors at home. (b). Do you think these behaviors would be effective in saving water?

NO	YES	DON'T KNOW		NO WATER SAVINGS	MINOR WATER SAVINGS	MODERATE WATER SAVINGS	MAJOR WATER SAVINGS
☐	☐	☐	Use less water in tub	☐	☐	☐	☐
☐	☐	☐	Turn off water while brushing teeth	☐	☐	☐	☐
☐	☐	☐	Turn off water while shaving	☐	☐	☐	☐
☐	☐	☐	Wash dishes with the basin filled	☐	☐	☐	☐
☐	☐	☐	Wash car with bucket	☐	☐	☐	☐
☐	☐	☐	Landscape yard to use less water	☐	☐	☐	☐
☐	☐	☐	Use broom rather than hose for cleaning driveways, patios, and sidewalks	☐	☐	☐	☐
☐	☐	☐	Reduce washing of cars and trucks	☐	☐	☐	☐
☐	☐	☐	Water lawn less often	☐	☐	☐	☐
☐	☐	☐	Don't water in the middle of the day	☐	☐	☐	☐
☐	☐	☐	Check for water leaks in household system	☐	☐	☐	☐
☐	☐	☐	Match water level to size of laundry	☐	☐	☐	☐
☐	☐	☐	Match cycle time to dishwasher load	☐	☐	☐	☐
☐	☐	☐	Use timer for sprinkler system	☐	☐	☐	☐

16. Have you received information with your water bill about specific behaviors, appliances, and/or devices you can use to conserve water?

☐ Yes ☐ No

17. Have you made any changes to conserve water prompted by the information obtained through utility bill inserts?

☐ Yes ☐ No

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18. How important to you is the current need to conserve water in your community?
- ☐ Not important
- ☐ Somewhat important
- ☐ Of considerable importance
- ☐ Extremely important

19. Do you believe you are well informed about issues concerning additional water supplies in your community?
- ☐ Not informed
- ☐ Moderately informed
- ☐ Well informed

20. Do you believe water conservation activities are effective in delaying the need to build new water supply facilities?
- ☐ Not effective
- ☐ Very effective
- ☐ Moderately effective
- ☐ Don't Know

21. Do you agree or disagree that your water company should be responsible for promoting water conservation?
- ☐ Strongly agree
- ☐ Disagree
- ☐ Agree
- ☐ Strongly disagree

22. In general, do you believe your water usage over the past five years has:
- ☐ Decreased
- ☐ Stayed the same
- ☐ Increased

Why?_____

23. How do you envision your level of water usage over the next five years?
- ☐ Decreasing
- ☐ Staying the same
- ☐ Increasing

Why?_____

Now just a few questions for classification purposes only. All responses are strictly confidential.

24. Do you own your home or do you rent?
- ☐ Own
- ☐ Rent - GO TO QUESTION 26

25. If you own your home, what would you estimate the current value of your home to be if it were to go on the market today?

$_____ (home value)

(if not certain, please use best guess using the categories below)

- ☐ Less than $40,000
- ☐ $40,000 - $59,999
- ☐ $60,000 - $79,999
- ☐ $80,000 - $99,999
- ☐ $100,000 - $149,999
- ☐ $150,000 - $199,999
- ☐ $200,000 or more

SKIP TO QUESTION 27

26. If you rent your home, what is the total monthly rent for your residence?

$_____ (monthly rent)

(if not certain, please use best guess using the categories below)

- ☐ Less than $400
- ☐ $400 - $599
- ☐ $600 - $799
- ☐ $800 - $999
- ☐ $1000 or more

27. How long have you lived at this address?

_____ Years

28. What is your highest level of formal education?
- ☐ No formal education
- ☐ Some high school
- ☐ High school graduate
- ☐ Some college
- ☐ College graduate
- ☐ Post Graduate

29. What was your annual household income for the last year?

$_____ (income 1992)

(If not certain, please use best guess using the categories below)

- ☐ Less than $20,000
- ☐ $20,000 - $29,999
- ☐ $30,000 - $39,999
- ☐ $40,000 - $49,999
- ☐ $50,000 - $74,999
- ☐ $75,000 - $99,999
- ☐ $100,000 - $124,999
- ☐ $125,000 - $149,999
- ☐ $150,000 or more

30. Please indicate below how much you agree or disagree with the following statements where "6" means you **Strongly Agree** and "1" means you **Strongly Disagree**.

	Strongly Disagree					Strongly Agree
If everyone in the country tried to conserve water at home, there would be a real impact on the nation's overall water supply.	1	2	3	4	5	6
It's important to conserve water even if it doesn't save much money	1	2	3	4	5	6
Most families could use less water if they tried harder.	1	2	3	4	5	6
It is necessary for the residents of Utah to try to conserve water.	1	2	3	4	5	6
I am very informed about conserving water at home.	1	2	3	4	5	6

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30. (Continued)

How much do you agree or disagree with the following statements:	Strongly Disagree					Strongly Agree
I am very concerned that my water bills will be more than I can comfortably afford.	1	2	3	4	5	6
No matter how hard I try to conserve water, I only save pennies a day	1	2	3	4	5	6
My own conservation practices will help supplies last longer.	1	2	3	4	5	6
I would be very unhappy if I couldn't have a green yard.	1	2	3	4	5	6
It is important to try to conserve water even in non-drought conditions.	1	2	3	4	5	6
My family would be bothered if we were to conserve more water.	1	2	3	4	5	6
Once I've decided to buy or replace an appliance, I don't pay any attention to specials or rebates.	1	2	3	4	5	6
I don't like to spend much of my time looking around when I need to buy or replace an appliance.	1	2	3	4	5	6
Setting regulations to control the time or amount of water use would interfere with my household.	1	2	3	4	5	6
I'd be willing to change my water usage practices to use less if that would save our water supply.	1	2	3	4	5	6
I'd be happy to install water saving devices if it wouldn't cost me any up-front money or higher water bills.	1	2	3	4	5	6
In my clothes washing machine, I believe that a full water level gets clothes cleaner no matter what size the laundry load is.	1	2	3	4	5	6
I believe my dishwasher has to run on heavy cleaning all the time in order to really get the dishes clean.	1	2	3	4	5	6
I like to take long showers.	1	2	3	4	5	6
I think having a home computer can save a lot of time doing things that need to be done.	1	2	3	4	5	6
I believe a home computer can be lots of fun.	1	2	3	4	5	6
I like to play with all the different functions on a VCR or video camera.	1	2	3	4	5	6
I track my water costs pretty carefully.	1	2	3	4	5	6
When I get a new VCR, TV, or car stereo, I want my friends and neighbors to see it.	1	2	3	4	5	6
I want to wait until a new appliance or device is already proven and reliable before I buy it.	1	2	3	4	5	6
My water consumption habits are pretty well fixed and I can't conserve any more than I already do.	1	2	3	4	5	6
Compared to other problems, the water supply problem is not very important to me.	1	2	3	4	5	6
The newest appliances offer the best performance.	1	2	3	4	5	6
When I buy or replace an appliance, I want it to be first class with all the options.	1	2	3	4	5	6
I think its silly to water the lawn in the middle of the day.	1	2	3	4	5	6
It is very important to me to not use more than my fair share of water.	1	2	3	4	5	6
The rates I pay for water are reasonable.	1	2	3	4	5	6
I trust my water company to provide water at a fair and reasonable price.	1	2	3	4	5	6
I read the information in the inserts that come with my water bill.	1	2	3	4	5	6
I am well informed about the rates charged by my water company.	1	2	3	4	5	6
I am provided with enough information about water conservation.	1	2	3	4	5	6
The water company controls water rates effectively.	1	2	3	4	5	6
I think my water bill is too high.	1	2	3	4	5	6
I know how much I pay for water each month.	1	2	3	4	5	6
What I pay for water influences my level of water use	1	2	3	4	5	6
Rate increases should be made to fund water conservation only during a serious water shortage	1	2	3	4	5	6
Overall, I am satisfied with the service from my water agency	1	2	3	4	5	6
The water agency's customer service representatives are courteous	1	2	3	4	5	6

Thank you for your time and cooperation with this survey.
Please return your questionnaire in the postage-paid envelope provided.

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08/93

Conducted August 9-14, 1993
Sample size - 604 interviews
Error = ±4.0%

Hello. I'm ____ with Dan Jones & Associates, an independent public opinion and research firm in Utah. We are conducting research today of residents in this area. May I ask you some of your opinions about your use of water? This should only take about 8-9 minutes of your time.

Water Conservation Questions

*1. Do you feel there is a water shortage in your area now?

Definitely	3%
Probably	15%
Probably not	37%
Definitely not	42%
Don't know (VOL)	3%

*2. Do you feel there will be a water shortage in your area in the next 20 years?

Definitely	34%
Probably	46%
Probably not	10%
Definitely not	2%
Don't know (VOL)	8%

3. Generally speaking, how important is it for people in your community to conserve water: Would you say it is very important, somewhat important, not very important, or not at all important?

Very important	65%
Somewhat important	30%
Not very important	3%
Not at all important	0%
Don't know (VOL)	1%

4. When you hear the term "conserve water" what is the first thing that comes to your mind?

4%	Don't know
26%	Dams/collecting water
1%	Limit outside watering/sprinkler
51%	Use sparingly/don't waste
2%	Rationing/restrictions
4%	Fix leaky taps/toilets/etc.
2%	Running out of water/scarce
7%	Shorter showers/less water in tub
6%	Miscellaneous

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I'd like to read you a list of possible reasons for conserving water. Using a 1-5 scale, with one meaning "not a good reason" and five meaning "a very good reason", please tell me how you feel about each of the following:

	Not a Good Reason				Very Good Reason	Don't Know	Mean
5. Water conservation is the RIGHT thing to do.	2%	3%	9%	16%	68%	1%	4.47
6. Water conservation delays the need to develop new water supplies.	19%	11%	23%	16%	28%	4%	3.24
7. Water conservation is a good way to reduce home water bills.	5%	5%	12%	20%	56%	2%	4.19
8. Water conservation is important because the more efficiently we use water, the more water is available for fish stream flows, wildlife and recreation.	3%	4%	15%	22%	54%	1%	4.21

9. Have you ever been asked to conserve water by your water company?

Yes 40%
No 57%
Don't know/don't recall (vol) 3%

10. Generally speaking, do residents in your area or neighborhood actively try to conserve water?

Yes 48%
No 33%
Don't know (VOL) 19%

I am going to read a list of ways in which people can conserve water. Please tell me how often, if ever, you do the following in an attempt to conserve water. (READ CHOICES)

(ROTATE)	Never	Seldom	Most of the time	Always	Don't know	Mean
11. Water lawns less frequently than normal:	8%	18%	44%	21%	9%	2.84
12. Not letting water run when brushing teeth, shaving, washing dishes or washing your car:	9%	18%	39%	35%	0%	2.99
13. Read information on how to conserve water:	22%	34%	27%	16%	1%	2.38
14. Landscape your yard to require less water:	32%	18%	21%	19%	10%	2.29
15. Full loads when washing clothes:	1%	4%	20%	73%	2%	3.67
16. Installed water saving plumbing fixtures such as low flow toilets, or shower heads:	25%	13%	20%	36%	7%	2.71
17. Full loads on dish washing:	8%	2%	12%	70%	9%	3.58
18. Installed automatic sprinkling system:	39%	1%	4%	47%	9%	2.65
19. Shower rather than bathing:	7%	7%	23%	64%	0%	3.43
20. Other (specify: _____)	10%	0%	1%	4%	85%	1.88

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21. How often, during a normal summer month, do you usually water your lawn or garden: daily, every other day, twice a week, once a week, less than once a week, hardly ever, or never?

Daily	8%
Every other day	36%
Twice a week	34%
Once a week	10%
Less than once a week	1%
Hardly ever	0%
Never	3%
Don't know (VOL)	8%

22. To encourage more water conservation, some water agencies charge for water on an increasing block rate basis: that is a customer pays one rate per gallon up to a certain number of gallons and higher rates for usage over that amount. In your opinion, is this a fair way to calculate water rates?

Definitely	26%
Probably	39%
Probably not	15%
Definitely not	11%
Don't know (VOL)	10%

Where do you get information about water and water conservation?

	Yes	No	Don't know
23. Television:	66%	32%	2%
24. Newspaper Articles:	69%	29%	1%
25. Radio Ads:	26%	72%	2%
26. Bill stuffers from water companies:	46%	52%	3%
27. Seminars/presentations:	11%	87%	2%
28. Exhibits:	17%	81%	2%

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I am going to read you a list of ways a water agency can encourage water conservation. Please tell me whether you favor or oppose each. (Would that be "Strongly" or "Somewhat")

	Strongly Oppose	Somewhat Oppose	Somewhat Favor	Strongly Favor	Don't Know	Mean
29. Educating customers about the wise use of water:	0%	1%	17%	82%	1%	3.82
30. Establishing days and times when lawns and gardens could be watered:	15%	16%	31%	35%	2%	2.89
31. Charging higher rates for water so people use less water:	54%	22%	16%	7%	1%	1.75
32. Charging more for water use in the summer than in the winter:	43%	22%	23%	8%	4%	1.96
33. Restructuring water rates so customers who use less water pay less per gallon than those who use more water:	15%	15%	30%	35%	5%	2.89
34. Ordinances requiring people to use landscaping that requires less water to maintain:	36%	21%	25%	16%	2%	2.22
35. To reuse wastewater that has been treated and meets health department requirements for outdoor irrigation purposes, such as on golf courses, lawns and gardens:	1%	2%	16%	78%	2%	3.75

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Irrigator Questions

36. Do you use water for producing crops or livestock for sale?

Yes	7%
No	93%
Don't know/refuse(VOL)	0%

What type of irrigation method do you use? (number responding - 42)

	Yes	No	Don't know
37. Sprinkler:	49%	51%	0%
38. Flood:	52%	48%	0%
39. Other (SPECIFY)_____	14%	74%	12%

As an irrigator, do you favor or oppose the following measures to conserve water:
(number responding - 42)

	Strongly Oppose	Somewhat Oppose	Somewhat Favor	Strongly Favor	Don't Know	Mean
40. A "call" system rather than a "turn" system	17%	24%	19%	21%	19%	2.56
41. A more efficient delivery system such as a canal lining or piping.	0%	2%	26%	57%	14%	3.64
42. Higher rates for purchased water:	43%	24%	19%	2%	12%	1.78
43. Convert from flood irrigation to sprinkler:	24%	17%	17%	40%	2%	2.76
44. Metered water use:	36%	7%	26%	24%	7%	2.41
45. Reduce your use of high spring-time flows if you could extend your use later in the summer:	0%	2%	33%	52%	12%	3.57
46. Change water laws so you could retain or sell the rights to water you conserved:	10%	14%	36%	26%	14%	2.92

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Now, just a few questions in order to categorize the data

47. Gender:

Male	49%
Female	51%

48. Age category:

Less than 18	1%
18-24	12%
25-29	10%
30-34	11%
35-44	23%
45-54	17%
55-64	12%
65 +	15%
Refuse (VOL)	0%

49. Which of the following categories best describes your total household income before taxes?

Less than $15,000	10%
$15-$25,000	18%
$25-$35,000	17%
$35-$50,000	22%
Over $50,000	21%
Refuse (VOL)	12%

50. What was the last grade you completed in school?

High school or less	27%
Some college/technical	34%
College graduate	38%
Refuse (VOL)	0%

51. Do you or you spouse own property in Utah?

Yes	74%
No	26%
Refuse (VOL)	0%

52. Including yourself, how many people reside in your home?

One	13%
Two	27%
Three	17%
Four	15%
Five	12%
Six	8%
Seven	5%
Eight or more	3%
Refuse (VOL)	0%

53. Length of residence in Utah?

Less than 2 years	4%
2-5 years	6%
6-10 years	5%
Over 10 years	84%
Refuse (VOL)	0%

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54. And, your length of residence in your current county?

Less than 2 years	6%
2-5 years	11%
6-10 years	8%
Over 10 years	74%
Refuse (VOL)	1%

55. Who is responsible for paying the water bill?

Self	44%
Spouse	14%
Both	22%
Other	20%
Refuse (VOL)	0%

56. Area:

Salt Lake County	66%
Utah County	24%
Duchesne	1%
Uintah	2%
Wasatch	1%
Summit	0%
Juab	1%
Sanpete	2%
Millard	1%
Sevier	2%
Piute	0%
Garfield	0%

57. Zip code:
(Salt Lake County ONLY)

8 4 ___ ___ ___

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APPENDIX B
WATER USAGE INVENTORY QUESTIONNAIRES

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CENTRAL UTAH PROJECT COMPLETION PROGRAM
WATER MANAGEMENT IMPROVEMENT STUDIES

WATER USAGE INVENTORY

Your answers to this questionnaire will help the Central Utah Water Conservancy District complete the Water Management Improvement Studies, which are required by the Central Utah Project Completion Act. These studies will help make Utah's share of the Colorado River available to the people of Utah. This is a preliminary questionnaire, and you may be contacted again for additional information. Your assistance is appreciated. Please indicate whether you would like a summary of the results of this survey. Yes __ No __

Organization Name _____

Address _____ *City* _____ *Zip* _____

Contact Person _____ *Title* _____

Telephone _____ *Fax* _____

1. *Which of the following describes your organization? Circle all that apply.*

A. water conservancy district
B. metropolitan water district
C. special service district
D. canal or ditch company
E. wastewater utility
F. commercial water system
G. industrial water system
H. resort/recreation water system
I. privately-owned community water company
J. irrigation district
K. improvement district
L. mutual water company
M. municipal water utility
N. other _____

2. *Please provide the following information on number of customers and water sales for calendar year 1991:*

	Number of Customers	Water Sales (Note units, e.g. acre-feet)
Residential	_____	_____
Commercial	_____	_____
Industrial	_____	_____
Irrigation	_____	_____
Wholesale	_____	_____

If you have residential customers, what is the estimated average monthly residential water bill? $____

3. *Approximately what percent of your organization's total annual water supplies are obtained from each of the following sources?*

	Annual Average	Oct-Mar	Apr-Jun	Jul-Sep
Wells	_____	_____	_____	_____
Springs	_____	_____	_____	_____
Surface Water	_____	_____	_____	_____
Purchases	_____	_____	_____	_____
Totals	100%	100%	100%	100%

Of the water supply you deliver, how much is obtained through exchanges? _____ percent

Please list the suppliers from which you purchase water:

Supplier Name	Contact Person	Phone Number	Volume Purchased in Calendar Year 1991 (Note units, e.g. acre-feet)

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5. ***Please indicate how you charge your customers for water. Note the customer class(es) to which each type of charge is applicable (e.g. residential, commercial, agricultural, wholesale).***

Fixed Charge (water bill is a fixed dollar amount, independent of use) _____

Flat Rate (per unit rate for water is constant) _____

Minimum Charge (with water beyond minimum provided at additional cost) _____

Declining Block (per unit rate for water decreases with volume) _____

Increasing Block (per unit rate for water increases with volume) _____

Other (please specify) _____

6. ***Please check all water conservation programs, plans or activities that apply to your organization:***

	In Place (Existing Program)	Planned	Not Applicable
Metering	_____	_____	_____
Educational Programs for Children	_____	_____	_____
Other Educational Programs (e.g. bill inserts, TV/radio announcements)	_____	_____	_____
Pricing or Billing Procedures (e.g. inverted rates, time-of-use rates, seasonal pricing)	_____	_____	_____
Low Consumptive Performance Standards (e.g. low flow toilets, showerheads, pipe insulation)	_____	_____	_____
Limits on Landscape Watering (e.g. time of day, odd/even scheduling, no runoff)	_____	_____	_____
Water Reuse (e.g. treated water for golf courses, etc.)	_____	_____	_____
Leak Detection and Repair	_____	_____	_____
Industrial/Commercial Programs	_____	_____	_____
Watershed Management	_____	_____	_____
Water Conservation Plan	_____	_____	_____
Other _____	_____	_____	_____

7. ***Have you completed any surveys of your customers regarding conservation practices or attitudes?***
Yes ___ No ___ Comments _____

8. ***Have you completed a Water Industry Data Base questionnaire for the American Water Works Association?***
Yes ___ No ___ Comments _____

9. ***Are you interested in more information on the CUP Completion Program and the Water Management Studies?*** Yes ___ No ___ If "Yes", please specify your preference(s): Newsletter ___ Workshop ___ News Media ___ Telephone Call ___ Other (Please Specify) _____

10. ***Do you have any other comments on the Water Management Improvement Studies or this questionnaire?***

_____
_____
_____
_____

Please fill out the questionnaire as completely as possible, and return it to CUWCD in the enclosed envelope. If you have any questions, please call Karen Ricks at 226-7126. Thank you for your assistance.

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Water Inventory Questions

INTRODUCTION

The Central Utah Project (CUP) will help Utah develop its share of Colorado River water. The CUP has been under construction for many years, but the CUP Completion Act (the Act) will make the Central Utah Water Conservancy District (CUWCD) responsible for completing the CUP. This list of questions is being distributed to selected water companies, and is very important to the successful completion of the Water Management Improvement Studies required by the Act.

The success of the CUP Completion Program hinges on a cooperative effort between water users, environmental interests, industry, agriculture and government at all levels. Your willingness to participate in this data gathering portion of the project is a key to the success of the CUP Completion Program.

WHAT ARE THE WATER MANAGEMENT IMPROVEMENT STUDIES ?

One objective of the Act is to improve water conservation in the CUWCD service area. The Water Management Improvement Studies are intended to identify practical and cost-effective conservation measures eligible for cost-sharing; evaluate water pricing alternatives to encourage conservation; analyze the coordinated operation of independent water systems; and assist with the implementation of a conservation advisory board.

WHY IS THIS DATA NEEDED ?

CUWCD and its consultants are collecting extensive data from multiple sources for the purpose of developing the Water Management Improvement Studies. This data will be the basis for determining the District's water conservation goal and developing Coordinated Operations Proposals. The data will be used to identify existing and planned water conservation activities. The data will also be used as the basis for the pricing study that is being performed as part of the requirements of the Act.

WHEN DOES THIS DATA NEED TO BE COMPILED ?

The Act imposes time constraints and deadlines on most aspects of the CUP Completion Program, including the Water Management Improvement Studies. To meet the aggressive schedule, we have set a target of 9 April 1993 for the collection of the data.

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WHAT KIND OF INFORMATION IS REQUESTED ?

The Water Management Improvement Studies address a broad range of water conservation, pricing and operational issues. As a result, extensive data is required. Questions include background on your company, historic operations, water supply, conservation activities, rates, customers, costs and revenues.

Please review the questionnaire and begin assembling the data requested. You may have some questions about the best format for the data or how detailed the data should be. Past Engineering and Master Plan reports may contain much of the data that is needed. CUWCD recognizes that some water companies will be unable to provide some of the data requested. If the data is not available in a documented format, we would like to discuss the questions and receive your best available feedback.

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Water Inventory Questions

General Information

1. List the name, address, telephone and fax number of your organization.

2. List the key personnel of your organization (Lead contact, manager, engineer, water master, etc.).

3. What incorporated areas are located within your service area ? Please specify in detail whether the entire incorporated area, or only part of it, is contained in your organization's service area (if available, a copy of a detailed map would be preferred). Please also indicate which areas are wholesale and which areas are retail.

4. What unincorporated areas are located within your organization's service area ? Please specify in detail (if available, a copy of a detailed map would be preferred). Please also indicate which areas are wholesale and which areas are retail.

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Water Inventory Questions (continued)

Water Demand (Historic)

5. Please provide your municipal/industrial water demand data for last ten years (on an annual, seasonal, monthly, and peak demand basis). Please also indicate whether water sales are wholesale or retail. If available, both floppy discs and hard copies of the data are requested.

6. Please provide any irrigation records on diversions and deliveries for the past ten years.

7. Have you converted irrigation water to M&I ? If so, when was it converted and how much was converted ? Do you anticipate any more conversions in the future ? If so, please estimate how much water and when it will occur.

8. What is your estimate of unaccounted for water (e.g., transmission losses, unmetered facilities)?

9. How is the percentage of unaccounted for water determined ?

10. List the types of customer classes your organization serves (e.g., residential, industrial, commercial, irrigation, fire protection), including number of connections and the annual volume of water delivered. Please specify any subclasses which are used (e.g., multi-unit residential, single family). Please note if the volumes are metered or estimated. Provide this information for the last ten years, if available.

11. Are there any major water development issues over the last ten years which may have affected water use trends ? (For example, annexations, purchase of water companies, etc.)

Water Demand (Future)

12. Please provide your annual municipal/industrial water use projections for the year 2000 (on an annual, seasonal, monthly, and peak demand basis). Please also distinguish between wholesale and retail. If available, both floppy discs and hard copies of the data are requested.

13. Please describe what plans you have to meet the projected water demand for the year 2000.

14. Please describe your water use projection method(s) and assumptions.

15. Please provide copies of Past Engineering or Master Plan reports with projections (written in the last five years), if available.

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Water Supply

16. Please provide historical water supplies (wholesale supplier, streams, springs, wells) by source over the last ten years, on an annual, seasonal, monthly, and peak demand basis.

17. List the locations and capacities of historical and potential future water supplies (wholesale supplier, surface water, ground water).

Water System

18. Please list the existing and proposed treatment Plant locations and capacities. A map of these facilities is desired, if available.

19. List the various water storage facilities, capacities and locations. A map of storage facilities is desired, if available.

20. Please provide a map of major water conveyance facilities, if available. Please also provide information and maps on ditches and canals.

21. Are there any operational constraints (capacity or seasonal) or facility sharing of the treatment, storage or conveyance systems?

22. Does your organization operate any dual water systems ? If so, how much water do you deliver to your secondary system by customer class ? Please, summarize the data on a monthly and annual basis for the last ten years. Demand projections through the year 2000 are also requested.

23. Have you studied the potential for dual systems in your service area ? If so, how much would it cost (capital and O&M) ? When is it anticipated to be implemented ?

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Water Quality

24. Does your organization use blending for M&I water ? If so, please describe the percentages used.

25. Do you have or have you experienced any water quality problems or concerns ? Are there certain times of the year that you experience water quality problems ? Do you anticipate any future water quality problems ?

26. Are there water users in your service area that could be served with a non-culinary water source?

Water Conservation Measures/Activities

27. Please provide a description of pre-existing (prior to January 1, 1992) water conservation activities, including educational activities. Detail how much water each activity is estimated to conserve and the associated capital and O&M expenditures.

28. Please list existing (from January 1, 1992 to present) water conservation activities, including educational activities. Detail how much each activity is estimated to conserve and the associated capital and O&M expenditures.

29. Please describe future water conservation measures, including educational programs your organization plans to implement. Detail how much water each activity is expected to conserve and the estimated capital and O&M costs. Do you expect that future conservation measures will be submitted to the CUPCA Water Conservation Credit Program ? Do you plan to seek CUP funding for your proposed conservation measure ? How much water do you expect to conserve ? Please estimate the schedule for the project (i.e., submittal to CUP, construction time, begin operation).

30. Please list any water restrictions that have been used to conserve water during droughts over the past ten years and/or describe your drought management plans. Have you implemented drought pricing policies or surcharges in the past ten years ? If so, please provide the details of the surcharges.

31. Please describe your billing cycle. How often are your customers billed, and when do they receive their bills ? What information is included in the bills provided to your customers ? Please provide a sample copy of a typical bill.

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Financial Resources

32. Please detail the repayment schedule and amount of outstanding or planned bonds.

33. Detail the rate structures that have been in effect for each customer class. Note if the structure has changed over the last ten years. Please attach rate schedules which have been in effect for the past ten years. (e.g., flat fee, uniform rate, decreasing block, increasing block, seasonal, or a detailed description of others).

34. What planning considerations and public involvement efforts went into the selection of your organizations rate structures ?

35. Does your organization have concerns with the current rate structures ? Does your organization have concerns with respect to alternative rate structures such as increasing block or seasonal rates?

36. Has your organization performed a cost of service study within the past five years ? If so, please include a copy of the most recent cost of service study.

37. Does your organization differentiate rates by point of delivery or pressure zone ? If so, please describe the method used.

38. Does your organization provide services for waste water ? If so, are your organization's billings for waste water based on different quantities than your billings for water ? Please describe your waste water rate structure. Please attach copies of your organization's waste water or sewer rate schedules for the past ten years (by customer class).

39. Have you made any estimates of the sensitivity of your water revenues to different levels of conservation ?

40. Please provide copies of your organization's annual reports for the last ten years.

41. What dates does your fiscal year begin on ?

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CENTRAL UTAH PROJECT COMPLETION PROGRAM

Operating Agreements

42. Please describe any agreements, conditions, or requirements between your organization and your water suppliers ?

43. Please describe any agreements, conditions, or requirements between your organization and customers to whom you supply water ?

44. Are there any water rights exchanges heid by your organization ? If so, please describe the details (with who, how much, when, and why).

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APPENDIX C
CUSTOMER WATER SURVEY
SELECTED RESULTS

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CENTRAL UTAH PROJECT
COMPLETION PROGRAM

1993 RESIDENTIAL CUSTOMER WATER SURVEY
SELECTED RESULTS

August 1993

Prepared By

RMI

RESOURCE MANAGEMENT
INTERNATIONAL, INC.

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INTRODUCTION

On May 28, 1993, 800 water use surveys were sent to residential customers of the Salt Lake City, Murray City, and South Salt Lake City water departments. The surveys were developed as a part of the Water Pricing Policy Study in an effort to collect household-specific demographic and economic data for use in the price elasticity case study and to collect qualitative data concerning customer attitudes toward residential water pricing issues.

The number of surveys to be sent out was determined by assuming a 35 percent response rate and attempting to secure a 10 percent level of accuracy from each of the three agencies. 291 responses were received for an overall response rate of 36.4 percent. Individual agency response rates varied from approximately 33 to 40 percent.

The following pages represent composite information from all three agencies for selected survey questions. This document has been developed for informational purposes only. It should be recognized that while this information might be representative of a greater area, it can only be considered statistically relevant for the limited area from which random customer accounts were drawn (the three agencies noted earlier).

Please note that "NR" refers to "no response", meaning that no response was given for that particular question. The percentages listed under "NR" are the percentage of the total number of surveys received (291) for which no response was given for that particular question. The remaining percentages refer to the percentage of respondents to <u>each question</u> that provided that particular response. Response percentages for each question, excluding "NR", should equal approximately 100 percent. In some cases, the sum may not equal 100 due to rounding error.

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

PART 1

Do you currently use any of the following water conservation appliances/devices?

	Yes	No	Don't know	NR
Toilet tank displacement dam	10%	81%	9%	22%
Toilet tank displacement bag	9%	84%	7%	21%
Low-Flow toilet	31%	59%	10%	15%
Low-Flow showerhead	54%	38%	7%	16%
Low-Flow faucet	24%	65%	11%	20%
Self closing faucet	5%	83%	13%	23%
Faucet aerator	56%	35%	9%	18%
Efficient clothes washer (adjustable water levels)	90%	8%	2%	9%
Efficient dishwasher (adjustable cycle time)	74%	24%	2%	26%
Shut-off nozzle for garden hose	56%	41%	3%	18%
Automatic timer for sprinkler system	59%	40%	1%	23%
Drip irrigation system	13%	85%	1%	28%

Do you think the appliances/devices listed would be effective in saving water?

	No	Minor	Moderate	Major	NR
Toilet tank displacement dam	7%	38%	45%	10%	34%
Toilet tank displacement bag	8%	41%	43%	8%	38%
Low-Flow toilet	7%	24%	56%	14%	33%
Low-Flow showerhead	5%	27%	53%	15%	29%
Low-Flow faucet	9%	37%	43%	11%	36%
Self closing faucet	18%	40%	33%	10%	39%
Faucet aerator	16%	50%	30%	4%	33%
Efficient clothes washer (adjustable water levels)	3%	22%	52%	24%	25%
Efficient dishwasher (adjustable cycle time)	4%	27%	51%	18%	36%
Shut-off nozzle for garden hose	11%	40%	36%	13%	30%
Automatic timer for sprinkler system	8%	12%	44%	37%	34%
Drip irrigation system	10%	22%	42%	27%	43%

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DESTROY AFTER USE

1993 RESIDENTIAL CUSTOMER WATER SURVEY

Please indicate if you currently use any of the following water conservation behaviors at home.

	Yes	No	Don't know	NR
Use less water in tub	66%	29%	5%	16%
Turn off water while brushing teeth	79%	19%	3%	8%
Turn off water while shaving	78%	16%	6%	23%
Wash dishes with the basin filled	55%	41%	4%	16%
Wash car with bucket	70%	26%	5%	21%
Landscape yard to use less water	49%	41%	9%	18%
Use broom rather than hose for cleaning driveways, patios and sidewalks	80%	19%	1%	9%
Reduce washing of cars and trucks	82%	15%	3%	18%
Water lawn less often	68%	28%	4%	16%
Don't water in the middle of the day	89%	10%	1%	9%
Check for water leaks in household system	91%	5%	4%	8%
Match water level to size of laundry	96%	3%	1%	8%
Match cycle time to dishwasher load	80%	15%	4%	28%
Use timer for sprinkler system	70%	28%	2%	24%

Do you think these behaviors would be effective in saving water?

	No	Minor	Moderate	Major	NR
Use less water in tub	4%	32%	45%	19%	27%
Turn off water while brushing teeth	5%	41%	37%	17%	25%
Turn off water while shaving	7%	40%	38%	17%	31%
Wash dishes with the basin filled	10%	31%	45%	15%	29%
Wash car with bucket	3%	25%	42%	30%	32%
Landscape yard to use less water	5%	18%	40%	37%	31%
Use broom rather than hose for cleaning driveways, patios and sidewalks	3%	20%	41%	36%	24%
Reduce washing of cars and trucks	2%	25%	46%	26%	28%
Water lawn less often	4%	14%	46%	36%	27%
Don't water in the middle of the day	1%	13%	48%	37%	25%
Check for water leaks in household system	4%	23%	37%	37%	27%
Match water level to size of laundry	1%	25%	44%	30%	24%
Match cycle time to dishwasher load	3%	29%	46%	21%	36%
Use timer for sprinkler system	5%	14%	43%	39%	34%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

Have you received information with your water bill about specific behaviors, appliances, and/or devices you can use to conserve water?

Yes	58%
No	42%
NR	16%

Have you made any changes to conserve water prompted by the information obtained through utility bill inserts?

Yes	47%
No	53%
NR	16%

How important to you is the current need to conserve water in your community?

Not important	1%
Somewhat important	26%
Of considerable importance	50%
Extremely important	24%
NR	2%

Do you believe you are well informed about issues concerning additional water supplies in your community?

Not informed	27%
Moderately informed	63%
Well informed	11%
NR	4%

Do you believe water conservation activities are effective in delaying the need to build new water supply facilities?

Not effective	4%
Moderately effective	48%
Very effective	19%
Don't know	29%
NR	4%

Do you agree or disagree that your water company should be responsible for promoting water conservation?

Strongly agree	30%
Agree	64%
Disagree	5%
Strongly disagree	1%
NR	4%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

In general, do you believe your water usage over the past five years has:

Decreased	46%
Stayed the same	41%
Increased	13%
NR	3%

How do you envision your level of water usage over the next five years?

Decreasing	24%
Staying the same	72%
Increasing	4%
NR	4%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

PART 3

PRICE ISSUES / FINANCES

It's important to conserve water even if it doesn't save much money.

Strongly disagree	1%
Disagree	2%
Somewhat disagree	5%
Somewhat agree	14%
Agree	24%
Strongly agree	55%
NR	4%

I am very concerned that my water bills will be more than I can comfortably afford.

Strongly disagree	5%
Disagree	10%
Somewhat disagree	16%
Somewhat agree	22%
Agree	19%
Strongly agree	28%
NR	5%

No matter how hard I try to conserve water, I only save pennies a day.

Strongly disagree	5%
Disagree	8%
Somewhat disagree	21%
Somewhat agree	36%
Agree	16%
Strongly agree	12%
NR	12%

I track my water costs pretty carefully.

Strongly disagree	9%
Disagree	18%
Somewhat disagree	20%
Somewhat agree	23%
Agree	16%
Strongly agree	13%
NR	10%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

PRICE ISSUES / FINANCES

The rates I pay for water are reasonable.

Strongly disagree	7%
Disagree	6%
Somewhat disagree	12%
Somewhat agree	33%
Agree	22%
Strongly agree	19%
NR	8%

I trust my water company to provide water at a fair and reasonable price.

Strongly disagree	6%
Disagree	8%
Somewhat disagree	10%
Somewhat agree	28%
Agree	23%
Strongly agree	25%
NR	8%

Rate increases should be made to fund water conservation only during a serious water shortage.

Strongly disagree	16%
Disagree	11%
Somewhat disagree	17%
Somewhat agree	18%
Agree	17%
Strongly agree	21%
NR	11%

I am well informed about the rates charged by my water company.

Strongly disagree	8%
Disagree	14%
Somewhat disagree	19%
Somewhat agree	30%
Agree	17%
Strongly agree	12%
NR	9%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

PRICE ISSUES / FINANCES

The water company controls water rates effectively.

Strongly disagree	9%
Disagree	8%
Somewhat disagree	20%
Somewhat agree	40%
Agree	16%
Strongly agree	7%
NR	12%

I think my water bill is too high.

Strongly disagree	9%
Disagree	15%
Somewhat disagree	25%
Somewhat agree	25%
Agree	13%
Strongly agree	13%
NR	10%

I know how much I pay for water each month.

Strongly disagree	5%
Disagree	6%
Somewhat disagree	8%
Somewhat agree	18%
Agree	25%
Strongly agree	39%
NR	9%

What I pay for water influences my level of water use.

Strongly disagree	9%
Disagree	14%
Somewhat disagree	16%
Somewhat agree	29%
Agree	16%
Strongly agree	16%
NR	9%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

GENERAL CONSERVATION

If everyone in the country tried to conserve water at home, there would be a real impact on the nation's overall water supply.

Strongly disagree	1%
Disagree	2%
Somewhat disagree	7%
Somewhat agree	15%
Agree	22%
Strongly agree	53%
NR	4%

Most families could use less water if they tried harder.

Strongly disagree	1%
Disagree	2%
Somewhat disagree	6%
Somewhat agree	11%
Agree	22%
Strongly agree	58%
NR	5%

It is necessary for the residents of Utah to try to conserve water.

Strongly disagree	1%
Disagree	2%
Somewhat disagree	4%
Somewhat agree	13%
Agree	22%
Strongly agree	59%
NR	5%

I am very informed about conserving water at home.

Strongly disagree	2%
Disagree	10%
Somewhat disagree	15%
Somewhat agree	32%
Agree	25%
Strongly agree	16%
NR	7%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

GENERAL CONSERVATION

My own conservation practices will help supplies last longer.

Strongly disagree	1%
Disagree	6%
Somewhat disagree	12%
Somewhat agree	23%
Agree	30%
Strongly agree	28%
NR	7%

It is important to try to conserve water even in non-drought conditions.

Strongly disagree	3%
Disagree	2%
Somewhat disagree	4%
Somewhat agree	18%
Agree	27%
Strongly agree	46%
NR	6%

I'd be willing to change my water usage practices to use less if that would save our water supply.

Strongly disagree	5%
Disagree	1%
Somewhat disagree	8%
Somewhat agree	24%
Agree	32%
Strongly agree	29%
NR	7%

My water consumption habits are pretty well fixed and I can't conserve any more than I already do.

Strongly disagree	11%
Disagree	20%
Somewhat disagree	23%
Somewhat agree	22%
Agree	13%
Strongly agree	11%
NR	6%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

GENERAL CONSERVATION

Compared to other problems, the water supply problem is not very important to me.

Strongly disagree	25%
Disagree	25%
Somewhat disagree	20%
Somewhat agree	15%
Agree	9%
Strongly agree	7%
NR	8%

I think it's silly to water the lawn in the middle of the day.

Strongly disagree	4%
Disagree	2%
Somewhat disagree	6%
Somewhat agree	9%
Agree	23%
Strongly agree	56%
NR	5%

It is very important to me to not use more than my fair share of water.

Strongly disagree	4%
Disagree	2%
Somewhat disagree	8%
Somewhat agree	19%
Agree	32%
Strongly agree	35%
NR	6%

I am provided with enough information about water conservation.

Strongly disagree	8%
Disagree	10%
Somewhat disagree	24%
Somewhat agree	28%
Agree	19%
Strongly agree	12%
NR	11%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

PERSONAL PREFERENCES

In my clothes washing machine, I believe that a full water level gets clothes cleaner no matter what size the laundry load is.

Strongly disagree	51%
Disagree	25%
Somewhat disagree	12%
Somewhat agree	6%
Agree	4%
Strongly agree	2%
NR	8%

I believe my dishwasher has to run on heavy cleaning all the time in order to really get the dishes clean.

Strongly disagree	50%
Disagree	24%
Somewhat disagree	10%
Somewhat agree	9%
Agree	5%
Strongly agree	2%
NR	24%

I like to take long showers.

Strongly disagree	32%
Disagree	17%
Somewhat disagree	19%
Somewhat agree	16%
Agree	9%
Strongly agree	7%
NR	10%

I read the information in the inserts that comes with my water bill.

Strongly disagree	7%
Disagree	11%
Somewhat disagree	13%
Somewhat agree	19%
Agree	27%
Strongly agree	22%
NR	8%

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1993 RESIDENTIAL CUSTOMER WATER SURVEY

PERSONAL PREFERENCES

I would be very unhappy if I couldn't have a green yard.

Strongly disagree	5%
Disagree	5%
Somewhat disagree	5%
Somewhat agree	17%
Agree	26%
Strongly agree	43%
NR	5%

My family would be bothered if we were to conserve more water.

Strongly disagree	14%
Disagree	23%
Somewhat disagree	27%
Somewhat agree	17%
Agree	13%
Strongly agree	7%
NR	10%

Setting regulations to control the time or amount of water use would interfere with my household.

Strongly disagree	18%
Disagree	18%
Somewhat disagree	15%
Somewhat agree	22%
Agree	12%
Strongly agree	15%
NR	8%

I'd be happy to install water saving devices if it wouldn't cost me any up-front money or higher water bills.

Strongly disagree	5%
Disagree	1%
Somewhat disagree	8%
Somewhat agree	24%
Agree	32%
Strongly agree	29%
NR	7%

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APPENDIX D
ELASTICITY CASE STUDY REGRESSION RESULTS

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Table D.1
CENTRAL UTAH PROJECT
PRICE ELASTICITY CASE STUDY
REGRESSION ANALYSIS
LINEAR CASES

				Coefficients and T-statistics												Statistical Results	
				Price								Weather	Other		Season		
Case	Dependent	Season	Interc.	Avg. Water	Marg. Water	Marg. Ramp 1	Marg. Ramp 2	Marg. Ramp 3	MP x Season Summ	MPxNLx Season Summ 2	MP x NL Summ 3	Precip-itation in.	Adj. Lot Size sqft	PPH	Season	R^2	F-Stat.
Variable Units:	100 cu.ft.			$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 ft	$/100 ft						
1	Consumption	Full Year	6.3	-5.4									0.0	1.6	21.3	39.1%	1,179
	T-Stat		10.2	-21.6									21.1	14.7	48.5		
2	Consumption	Full Year	11.6	-5.9									0.0		20.9	37.3%	1,457
	T-Stat		22.9	-23.6									23.0		47.0		
3	Consumption	Full Year	11.3	-5.5										1.9	22.0	35.4%	1,341
	T-Stat		19.4	-21.4										17.2	48.6		
4	Consumption	Full Year	18.3	-6.2											21.6	32.8%	1,791
	T-Stat		43.3	-23.8											46.8		
5	Consumption	Full Year	16.4	-5.6								-2.2		1.9	20.3	37.3%	1,092
	T-Stat		24.6	-22.1								-14.9		17.7	44.4		
6	Consumption	Full Year	33.1	-8.6								-3.8		1.7		20.5%	631
	T-Stat		53.1	-31.2								-23.2		13.9			
7	Consumption	Full Year	9.9	-5.5								-1.3	0.0	1.6	20.5	39.7%	965
	T-Stat		13.1	-22.0								-8.1	16.9	15.3	45.6		
8	Consumption	Full Year	-6.6		25.1								0.0	1.7	21.1	39.3%	1,186
	T-Stat		-12.6		22.6								20.9	16.1	47.9		
9	Consumption	Full Year	-2.9		26.6								0.0		20.8	37.2%	1,444
	T-Stat		-5.4		23.6								22.9		46.4		
10	Consumption	Full Year	-2.9		25.8									2.0	21.7	35.7%	1,354
	T-Stat		-5.0		22.6									18.5	47.9		
11	Consumption	Full Year	3.3		27.7										21.4	32.7%	1,776
	T-Stat		6.9		23.8										46.2		
12	Consumption	Full Year	2.2		27.8							-2.5		2.0	19.7	38.1%	1,126
	T-Stat		3.4		24.7							-16.9		19.0	42.9		
13	Consumption	Full Year	10.9		41.8							-4.2		1.9		22.6%	710
	T-Stat		16.1		34.6							-25.8		15.6			
14	Consumption	Full Year	-3.4		26.5							-1.6	0.0	1.8	20.0	40.2%	983
	T-Stat		-4.8		23.9							-10.2	15.9	16.8	44.1		
15	Consumption	Summer	9.0		43.6											15.3%	1,326
	T-Stat		18.6		36.4												
16	Consumption	Summer	15.7		49.4											10.7%	449
	T-Stat		15.1		21.2												
17	Consumption	Full Year	-9.5			35.5							0.0	1.6	19.3	40.8%	1,260
	T-Stat		-15.6			26.5							20.7	15.1	42.5		

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DESTROY AFTER USE

Table D.1
CENTRAL UTAH PROJECT
PRICE ELASTICITY CASE STUDY
REGRESSION ANALYSIS
LINEAR CASES

				Coefficients and T-statistics												Statistical Results	
				Price								Weather	Other		Season		
Case	Dependent	Season	Interc.	Avg. Water	Marg. Water	Marg. Ramp 1	Marg. Ramp 2	Marg. Ramp 3	MP x Season Summ	MPxNLx Season Summ 2	MP x NL Summ 3	Precip-itation in.	Adj. Lot Size sqft	PPH	Season	R^2	F-Stat.
Variable Units:	100 cu.ft.			$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 ft	$/100 ft						
18	Consumption	Full Year	-5.4			37.8							0.0		18.8	38.9%	1,555
	T-Stat		-9.7			28.0							22.5		41.0		
19	Consumption	Full Year	-5.1			36.8								1.9	19.7	37.3%	1,453
	T-Stat		-8.6			26.7								17.5	42.5		
20	Consumption	Full Year	0.4			39.7									19.3	34.7%	1,945
	T-Stat		0.8			28.5									40.7		
21	Consumption	Full Year	-0.0			38.5						-2.5		1.9	17.8	39.7%	1,202
	T-Stat		-0.0			28.5						-16.8		17.9	37.7		
22	Consumption	Full Year	5.5			58.3						-3.9		1.7		27.9%	944
	T-Stat		7.9			42.7						-24.7		14.5			
23	Consumption	Full Year	-5.4			36.9						-1.6	0.0	1.7	18.1	41.6%	983
	T-Stat		-7.5			27.6						-10.1	15.6	15.8	39.0		
24	Consumption	Full Year	-8.7				33.2						0.0	1.6	19.4	40.5%	1,247
	T-Stat		-14.5				25.9						20.7	15.1	42.8		
25	Consumption	Full Year	-4.5				35.4						0.0		19.0	38.7%	1,540
	T-Stat		-8.4				27.4						22.5		41.3		
26	Consumption	Full Year	-4.2				34.3							1.9	19.9	37.1%	1,437
	T-Stat		-7.3				26.1							17.5	42.7		
27	Consumption	Full Year	1.3				37.2								19.4	34.5%	1,923
	T-Stat		2.7				27.9								40.9		
28	Consumption	Full Year	0.9				36.0					-2.5		1.9	17.9	39.4%	1,188
	T-Stat		1.4				27.8					-16.7		17.9	38.0		
29	Consumption	Full Year	6.9				55.0					-3.9		1.7		27.4%	920
	T-Stat		10.1				42.0					-24.6		14.4			
30	Consumption	Full Year	-4.6				34.5					-1.6	0.0	1.7	18.3	41.3%	1,031
	T-Stat		-6.4				27.0					-10.0	15.7	15.7	39.3		
31	Consumption	Full Year	-7.9					30.7					0.0	1.6	19.6	40.2%	1,231
	T-Stat		-13.3					25.1					20.6	15.1	43.3		
32	Consumption	Full Year	-3.6					32.8					0.0		19.2	38.4%	1,519
	T-Stat		-6.9					26.6					22.5		41.7		
33	Consumption	Full Year	-3.4					31.8						1.9	20.1	36.8%	1,417
	T-Stat		-6.0					25.3						17.5	43.2		
34	Consumption	Full Year	2.2					34.5							19.6	34.1%	1,894
	T-Stat		4.7					27.1							41.4		

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Table D.1
CENTRAL UTAH PROJECT
PRICE ELASTICITY CASE STUDY
REGRESSION ANALYSIS
LINEAR CASES

				Coefficients and T-statistics												Statistical Results	
				Price								Weather	Other		Season		
Case	Dependent	Season	Interc.	Avg. Water	Marg. Water	Marg. Ramp 1	Marg. Ramp 2	Marg. Ramp 3	MP x Season Summ	MPxNLx Season Summ 2	MP x NL Summ 3	Precip-itation in.	Adj. Lot Size sqft	PPH	Season	R^2	F-Stat.
Variable Units:	100 cu.ft.			$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 cuft	$/100 ft	$/100 ft	in.	sqft				
35	Consumption	Full Year	1.7					33.3				-2.5		1.9	18.2	39.0%	1,170
	T-Stat		2.7					26.9				-16.5		17.9	38.5		
36	Consumption	Full Year	8.3					51.4				-3.9		1.7		26.6%	886
	T-Stat		12.4					40.9				-24.5		14.4			
37	Consumption	Full Year	-3.8					31.9				-1.5	0.0	1.7	18.5	41.0%	1,017
	T-Stat		-5.3					26.1				-9.8	15.7	15.7	39.8		
38	Consumption	Full Year	2.6		7.1				54.0					2.3		37.7%	1,476
	T-Stat		4.8		5.6				50.6					21.6			
39	Consumption	Full Year			10.3				54.1					2.6		37.5%	5,727
	T-Stat				9.7				50.7					30.4			
40	Consumption	Full Year	3.5		18.9					0.0				2.0		34.3%	1,270
	T-Stat		6.3		15.8					45.2				17.9			
41	Consumption	Full Year			23.4					0.0				2.4		33.9%	5,282
	T-Stat				24.2					45.0				26.9			
42	Consumption	Full Year	5.4		34.2						0.0			1.8		16.7%	487
	T-Stat		5.9		22.7						8.0			14.3			
43	Consumption	Full Year			39.1						0.0			2.2		16.3%	3,654
	T-Stat				31.5						7.7			22.1			
44	Consumption	Full Year	3.4		27.8										21.3	32.8%	1,787
	T-Stat		7.2		24.1										46.0		
45	Consumption	Full Year			33.9										22.2	32.4%	7,656
	T-Stat				43.3										49.4		
46	Consumption	Full Year	4.3						57.2					2.4		37.4%	2,188
	T-Stat		9.2						63.0					22.3			
47	Consumption	Full Year							60.9					3.1		36.7%	8,437
	T-Stat								74.4					47.1			
48	Consumption	Full Year	8.8							0.0				2.1		32.0%	1,723
	T-Stat		19.2							55.4				18.9			
49	Consumption	Full Year								0.0				3.8		28.6%	7,062
	T-Stat									63.8				56.6			
50	Consumption	Full Year	11.8								0.0			1.8		10.7%	441
	T-Stat		21.9								24.5			14.2			
51	Consumption	Full Year									0.0			3.9		4.9%	4,390
	T-Stat										35.1			43.7			

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Table D.2
CENTRAL UTAH PROJECT
PRICE ELASTICITY CASE STUDY
REGRESSION ANALYSIS
DOUBLE-LOG CASES

				Coefficients and T-statistics																
				Price		Weather	Other						Dummy Variables (Linear)					Statistical Results		
Case	Dependent	Season (Linear)	Intercept	Avg. Water	Marg. Water	Precipitation	Average High Temp.	Adj. Lot Size	Net Lot Size	Income	Home Value	PPH	Season	PROVO	MURRAY	SSLC	SLC	R^2	F-Stat.	
Variable Units	100 cu.ft.			$/100 cuft	$/100 cuft	inch	Degrees F	sqft	sqft	$	$									
1 Log Cons	Full Year		1.786	(1.249)		(0.087)						0.230	0.532					80.0%	7,281	
T-Stat			154.848	(117.344)		(17.583)						27.128	44.807							
2 Log Cons	Full Year		0.886	(1.230)		(0.090)				0.090		0.193	0.539					80.4%	5,962	2nd Best Fit Avg.
T-Stat			11.448	(115.319)		(18.265)				11.751		21.422	45.722							Price Equation
3 Log Cons	Full Year		0.064	(1.216)				0.125		0.062		0.188	0.580					80.1%	5,886	
T-Stat			0.693	(113.418)				16.439		7.872		20.848	50.613							
4 Log Cons	Full Year		0.621	(1.405)					0.086			0.100	0.519	0.645	0.536	0.402	0.559	82.7%	4,310	
T-Stat			7.272	(125.289)					9.071			10.981	47.173	35.394	29.815	20.751	31.750			
5 Log Cons	Full Year		0.615	(1.431)					0.094				0.506	0.719	0.579	0.402	0.579	82.4%	4,829	
T-Stat			7.141	(129.721)					9.885				45.875	42.092	32.691	20.563	32.821			
6 Log Cons	Full Year		1.382	(1.410)								0.107	0.512	0.638	0.538	0.376	0.536	82.5%	4,933	
T-Stat			84.083	(125.969)								11.762	46.768	35.160	29.865	19.656	30.794			
7 Log Cons	Full Year		1.452	(1.440)									0.498	0.719	0.584	0.373	0.556	82.2%	5,627	
T-Stat			94.035	(130.704)									45.313	42.405	32.893	19.329	31.771			
8 Log Cons	Full Year		1.445	(1.402)		(0.070)						0.111	0.473	0.609	0.521	0.336	0.493	83.1%	4,461	
T-Stat			86.292	(126.591)		(15.005)						12.408	42.590	33.842	29.315	17.571	28.292			
9 Log Cons	Full Year		1.563	(1.613)		(0.116)						0.072		0.713	0.653	0.449	0.584	78.8%	3,875	
T-Stat			84.751	(145.696)		(23.049)						7.219		35.833	33.358	21.198	30.253			
10 Log Cons	Full Year		0.661	(1.396)		(0.071)			0.088			0.104	0.479	0.616	0.519	0.362	0.515	83.3%	3,967	Best Fit Avg.
T-Stat			7.855	(126.005)		(15.253)			9.499			11.600	42.891	34.108	29.275	18.721	29.307			Price Equation
11 Log Cons	Full Year		0.951	(1.433)		(0.151)			0.049	0.065		0.166						74.7%	4,249	
T-Stat			8.088	(129.880)		(27.707)			4.335	7.229		15.980								
12 Log Cons	Full Year		1.187	(1.470)					0.032	0.053		0.157						72.0%	4,653	
T-Stat			9.639	(127.980)					0.012	5.674		14.385								

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Table D.2
CENTRAL UTAH PROJECT
PRICE ELASTICITY CASE STUDY
REGRESSION ANALYSIS
DOUBLE-LOG CASES

				Coefficients and T-statistics													Statistical Results		
				Price		Weather	Other						Dummy Variables (Linear)						
Case	Dependent	Season (Linear)	Intero.	Avg. Water	Marg. Water	Precip-itation	Average High Temp.	Adj. Lot Size	Net Lot Size	Income	Home Value	PPH	Season	PROVO	MURRAY	SSLC	SLC	R^2	F-Stat.	
Variable Units	100 cu.ft.			$/100 cuft	$/100 cuft	inch	Degrees F	sqft	sqft	$	$									
Stepwise	13 Log Cons	Full Year	0.343	(1.388)		(0.072)				0.109		0.062	0.479	0.646	0.522	0.389	0.486	83.5%		
Model	T-Stat		4.475	(126.651)		(15.643)				14.713		6.600	43.698	36.095	29.790	20.273	28.336		3 /	
Stepwise	14 Log Cons	Full Year	(2.779)	(1.383)		(0.057)	0.823			0.106		0.063		0.605	0.526	0.414	0.502	84.2%		
Model	T-Stat		(27.090)	(129.919)		(12.475)	47.884			14.671		6.880		34.295	30.744	22.090	29.925			
Stepwise	15 Log Cons	Full Year	(4.156)	(1.372)		(0.058)	0.836				0.212	0.071		0.609	0.552	0.473	0.526	84.6%		
Model	T-Stat		(29.907)	(129.827)		(12.865)	48.822				20.395	8.037		34.827	32.452	24.826	31.602			
Stepwise	16 Log Cons	Full Year	0.764		0.304	(0.106)				0.178		0.176	1.001		(0.383)	(0.201)		48.7%		
Model	T-Stat		5.704		7.859	(14.103)				14.615		11.725	58.381		(21.011)	(6.044)				
Stepwise	17 Log Cons	Full Year	(6.148)		(0.618)	(0.067)	1.721			0.174		0.178		(0.734)	(0.799)	(0.407)	(0.374)	52.6%		
Model	T-Stat		(34.132)		(3.659)	(8.885)	63.771			14.670		11.917		(6.233)	(10.259)	(8.293)	(4.852)			
Stepwise	18 Log Cons	Full Year	(8.392)		(0.577)	(0.069)	1.737				0.350	0.180		(0.690)	(0.728)	(0.294)	(0.317)	54.5%		
Model	T-Stat		(36.335)		(3.460)	(9.255)	64.904				21.038	12.702		(5.929)	(9.465)	(6.006)	(4.154)			
1 /	19 Log Cons	Full Year	(8.400)		(0.592)	(0.068)	1.726				0.354	0.180		(0.706)	(0.735)	(0.292)	(0.322)	54.3%	776	Best Fit Marg.
	T-Stat		(36.671)		(3.577)	(9.216)	65.229				21.423	12.824		(6.109)	(9.613)	(5.985)	(4.251)			Price Equation
	20 Log Cons	Full Year			1.124	(0.106)	1.269				(0.145)	0.257		0.289	(0.161)	(0.240)	0.276		15,145	
	T-Stat				6.387	(13.079)	49.028				(13.952)	16.653		2.321	(1.958)	(4.438)	3.365	2 /		
Stepwise	21 Log Cons	Full Year		(1.387)		(0.071)				0.141		0.051	0.482	0.667	0.532	0.418	0.496			
Model	T-Stat			0.011		0.005				0.002		0.009	0.011	0.017	0.017	0.018	0.017		3 /	
Stepwise	22 Log Cons	Full Year		(1.464)		(0.082)	0.505			(0.037)		0.101		0.569	0.526	0.320	0.488			
Model	T-Stat			(136.656)		(17.438)	38.343			(7.141)		10.543		30.824	29.286	16.537	27.757			
Stepwise	23 Log Cons	Full Year		(1.446)		(0.076)	0.580		(0.052)		(0.020)	0.098		0.576	0.521	0.314				
Model	T-Stat			(132.949)		(16.066)	37.151		(5.146)		(2.183)	10.593		31.144	28.990	16.210				
Stepwise	24 Log Cons	Full Year			0.217	(0.104)				0.245		0.151	1.009		(0.384)	(0.153)				
Model	T-Stat				6.091	(13.859)				76.175		10.497	58.889		(21.051)	(4.743)				
Stepwise	25 Log Cons	Full Year			1.494	(0.116)	1.164			(0.101)		0.264		0.519		(0.139)	0.432			
Model	T-Stat				26.579	(14.561)	52.469			(11.015)		16.541		16.779		(3.971)	17.411			
Stepwise	26 Log Cons	Full Year			1.058	(0.105)	1.297		(0.116)		(0.067)	0.247		0.267	(0.170)	(0.251)				
Model	T-Stat				5.975	(12.835)	49.486		(6.711)		(4.222)	15.908		2.134	(2.046)	(4.634)				

1 / The stepwise model begins with variables that are eliminated from the equation through a significance test. Because some of the observations contain zero values for these variables, they are eliminated in the development of the log variables. The elimination of these observations in the stewise model results in coefficients and statistics that differ from those of an independent regression on those same variables. The independent regression has been run to determine the coefficients and statistics based on the largest number of observations available.

2 / The SAS software does not provide a corrected sum of squares nor a corrected adjusted R-squared for the no intercept equations.

3 / The F-statistic is not reported for stepwise function.

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APPENDIX E
COMPARATIVE ELASTICITY ANALYSES

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Boland, John J., Benedykt Dziegielewski, Duane D. Baumann, Eva M. Opitz. *Influence of Price and Rate Structures on Municipal and Industrial Water Use.* Carbondale, Illinois: Planning and Management Consultants, Inc. June 1984. Report submitted to the U.S. Army Corps of Engineers, Institute for Water Resources, Fort Belvoir, Virginia.

This report documents the results of a survey of municipal and industrial water price elasticity studies. The results and methods of more than 50 studies are reviewed. The report was prepared in 1984 and contains reviews of only those studies published before, or during, 1984.

Findings include a statement that the studies surveyed indicate that there are grounds for making general statements concerning price elasticities for general customer classifications, within certain parameters such as season and changes in explanatory variables. It is noted that most of the studies reviewed exhibited at least some statistical deficiencies. These deficiencies originate in sample selection, model specification, choice of explanatory variables, choice of price variable(s), and level of aggregation.

The authors also discuss differences between long-run and short-run elasticity. It takes time to alter the water-using stock of appliances and in landscaping. Short-run responses may involve changes in usage patterns related to appliances or irrigation. Hence, long-run elasticity would tend to be more elastic than short-run. They also note that attempts to observe short-run elasticities by means of time-series analysis over periods of less than one year may be confounded by problems with a potential time lag between a price change and an adjustment in use based on that change.

Billing cycles introduce lags in the date that a change in rates is announced, and the first bill that customers receive based on the higher rates. In addition, some people will make short-run behavioral changes when they hear about the increase, while others will make changes after they get their first bill at the higher rates. Yet further, the responses will probably have an oscillating appearance as people respond, over-respond, under-respond, and finally reach what they consider an appropriate response to the change in price. Therefore, elasticity estimation techniques sometimes yield distorted results.

Another important point made by the authors is that most of the models reviewed omit many relevant variables. When omitted variables are correlated with water use and collinear with price, bias in the price coefficient is likely to result. They state that in many plausible cases, the direction of the bias is upward, resulting in an elasticity estimate that is more elastic than if the model were correctly specified.

Another point the authors believe should be considered is the relation of weather variables to the potential introduction of heteroscedasticity. Regression theory requires an assumption of homoscedasticity. Homoscedasticity occurs when the variance in the dependent variable is unrelated to the values of the explanatory variables. The authors

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state that it is unlikely that this assumption is met when the explanatory variables include weather terms. This is because some water uses are weather dependent, meaning that the variance of water use almost certainly changes with the weather. Data aggregated over time are, therefore, likely to violate the homoscedasticity assumption. The longer the time and the greater the changes in weather, the greater the variance. It is suggested that heteroscedasticity can be minimized (but not eliminated) by analyzing seasonal, rather than annual water use.

The following ranges of price elasticity for various end uses were noted.

Residential Winter (Nonseasonal) Water Use

Of the available studies of residential winter water use, only one (Howe 1982) appears to be substantially free of statistical deficiency. The results of other studies, after consideration of probable errors or deficiencies, are consistent with the Howe result.

MOST LIKELY ELASTICITY RANGE	(LONG RUN)	0.0 to -0.10
	(SHORT RUN)	NA

Residential Summer Water Use

Available studies support the Howe and Linaweaver (1967) finding of significant differences in price response east and west of the 100th meridian, with respect to summer water use. One substantially reliable estimate of summer season elasticity is available for the eastern U.S. (Howe 1982). Other studies, after consideration of probable statistical deficiencies, are consistent with this result. No estimates are available for western U.S. summer season elasticities.

MOST LIKELY ELASTICITY RANGE (LONG RUN)
Eastern U.S. -0.50 to -0.60
Western U.S. NA

MOST LIKELY ELASTICITY RANGE (SHORT RUN)
Eastern U.S. NA
Western U.S. NA

Residential Seasonal (Sprinkling) Water Use

As in the case of summer season use, a significant difference is expected between estimates for the western and eastern U.S. All available studies contain at least some deficiencies. It is believed that most resulting estimates are too high.

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REPORTED ELASTICITY RANGE (LONG RUN)
Eastern U.S. -1.30 to -1.60
Western U.S. -0.70 to -0.90

REPORTED ELASTICITY RANGE (SHORT RUN)
Eastern U.S. NA
Western U.S. NA

Residential Average Water Use

The elasticity of average annual residential use approximately reflects an average of the winter and summer price responses (or, seasonal and non-seasonal responses). Since summer season responses vary spatially, and the importance of the summer season varies with climate, results for average water use are not expected to be as reliable as those for narrower definitions of water use.

Most studies in the literature address residential average water use. Only a few of these are substantially free of error from one source or another, however. The studies which contain statistical deficiencies are consistent, after consideration of the probable direction and magnitude of resulting errors, with the unbiased studies.

MOST LIKELY ELASTICITY RANGE	(LONG RUN)	-0.20 to -0.40
	(SHORT RUN)	0.0 to -0.30

Industrial Water Use

Very little attention has been given to the price response of industrial customers of municipal water systems. Available studies suffer from deficiencies of various types, but do show significant differences among the various categories of industrial users. Studies of aggregate industrial use show, as expected, considerable variation from place to place as the mix of industrial use changes. In general, industrial water use is more elastic than residential use.

REPORTED ELASTICITY RANGE (LONG RUN)
Individual categories -0.30 to -6.71
Aggregate industrial -0.50 to -0.80

REPORTED ELASTICITY RANGE (SHORT RUN)
Individual categories NA
Aggregate industrial NA

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Commercial Water Use

The literature contains a single study (Lynne, et al. 1978) of the price response of commercial water users, based on cross-sectional data from Miami, Florida. That study contains statistical deficiencies of various kinds, but does show significantly different elasticities for various categories of commercial use. This suggests that aggregate commercial/institutional studies, were they available, would show considerable variation in price response from place to place.

REPORTED ELASTICITY RANGE (LONG RUN)

Individual categories	-0.20 to -1.40
Aggregate commercial	NA

REPORTED ELASTICITY RANGE (SHORT RUN)

Individual categories	NA
Aggregate commercial	NA

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CH_2M Hill, *Water Price Elasticity Study*. Report prepared for the State of Utah, Division of Water Resources. April 1991.

The objective of this study was to determine the price elasticity of demand for water in municipalities in Utah. It was intended that by specifying the determinants of water demand, the Utah Division of Water Resources (DWRe) could use the demand equations that would be developed to evaluate potential water development projects. It was also intended that the demand equations would be applicable to different sizes and types of communities so that potential projects in different areas of Utah could be compared accurately and evaluated relative to conservation programs.

Agency-level data was used for this study. One significant problem that such an approach presents is that only a relatively small number of data observation points can be collected. Four Utah water agencies were considered to have adequate data for regression analysis. An attempt was made to develop elasticity estimates by agency. The results generated by agency were not reasonable, however, due to a lack of individual data points (the typical number for an individual agency was 8 to 12 observations).

In an attempt to circumvent this problem, the authors combined useful data from all four Utah agencies. They also developed demand equations using data from two water agencies in Colorado, and then combined the data from both Utah and Colorado water agencies. The following results were obtained.

<u>Best Model for Utah</u>

Total Winter Water Consumption = 2.222 - 0.574*Real Price + 1.055*Total Accounts
All coefficients were significant at the 10% level.
Adjusted R^2 was 0.96.

The price coefficient has the correct sign. Since the model is in log-log format the coefficient can be interpreted as the estimate of price elasticity. This implies that for every one percent increase in price there would be a 0.57 percent decrease in water consumption. The authors state that this is near the upper end of the range reported in the literature, but within the reported range. This is, however, only for winter months. No other specifications for Utah provided reasonable t-values.

<u>Best Models for Colorado</u>

Total Winter Consumption = 4.401 - 0.385*Real Price
Adjusted R^2 was .87
Both coefficients significant at 1% level.

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Total Summer Consumption = 2.814 + 1.192*Total Accounts - 0.277*Real Price + .112*Average Low Temperature during each month

Adjusted R^2 was .997

All coefficients significant at 1% level.

The two equations imply winter elasticity of -.385 and summer elasticity of -.277. Intuitively, one would expect the summer elasticity to be higher.

Best Models for Combined Utah and Colorado Data

The authors attempted to specify models that used weather variables as independent variables for the summer months, but did not do so for the winter months. They could not estimate satisfactory equations for either season using the weather variables in that fashion.

The authors then combined the summer and winter seasons' information and introduced a season dummy (summer=1) and a state dummy (Utah=1). After analyzing data, it was determined that the industrial consumption information was "suspect" because of differences between the states in the industrial users of water. Therefore, the authors specified models without industrial consumption.

Non-Industrial Annual Consumption Per Account = 4.403 - 0.344*Real Price + 0.816*Season - 1.531*State

Adjusted R^2 was .849

All coefficients significant at 1% level.

Total Annual Consumption Per Account = 4.466 - 0.495*Real Price + 0.693*Season - 1.640*State

Adjusted R^2 was .867

All coefficients significant at 1% level.

The results of the two models would indicate that the elasticity of consumption is higher when industrial consumption is added into the equation than when it is left out. This is counter-intuitive. This led the authors to believe the non-industrial consumption model was more reliable. The authors indicated both elasticity estimates were in the range found in the literature, but that the non-industrial estimate was near the upper end of the range. Even though it was not stated, the elasticity found in the model with industrial consumption must, therefore, be at or above the upper end of the reasonable range.

Caveats

While this study is reasonably successful in finding a statistically significant correlation between price and demand, the plausibility of the "best" relationship is suspect due to

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four primary factors. First, the demand equation excludes several factors which are certain to affect demand, including relevant climatological, economic, and demographic characteristics. Also, the equation combines all municipal demand into a single equation, which implicitly assumes that residential, commercial and industrial demand is affected by the same variables. Finally, the equation combines data from entirely different geographic areas and assumes that they are similar.

In a water price elasticity study, the more disaggregated the customer base (while maintaining an adequate number of observations), the greater the explanatory power of the price variable. Price response can be expected to vary widely from one customer class to another. For a residential customer, there is no substitute for water, whereas industrial customers may have viable alternatives to the use of water in their industrial processes. Also, the water consumption patterns of individual classes can be such that they mask the patterns of other classes, making the identification of coefficients difficult to achieve. For example, commercial employment would likely be meaningful in a commercial customer-only demand equation, but if commercial customer water consumption is a small fraction of total water consumption, it may be less meaningful in a total consumption model.

The independent variables will vary depending on the type of customer. For example, demand by single-family residential customers will be more influenced by lot size, season, persons per household and price, while commercial and industrial demand is more likely to be determined by the business cycle (employment), type of business (SIC code), season (to a lesser extent), and price. This study considered only a limited number of variables in the final equations. These included price, binary variables for season and state (Utah or Colorado), and number of accounts.

These simplifications decrease the confidence with which a forecast equation can be used. If all water demand within a community is forecast without recognizing the differences between end uses, and if a limited number of variables are considered, then several important properties of the "estimators" are hidden or masked.

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Dziegielewski, Benedykt and Eva M. Opitz. *Municipal and Industrial Water Use In The Metropolitan Water District Service Area: Interim Report No. 4.* Carbondale, Illinois: Planning and Management Consultants, Ltd., June 1991. Prepared for the Metropolitan Water District.

This report documents the development of a disaggregate water demand forecast for the service area of the Metropolitan Water District of Southern California. Disaggregate, in this instance, refers to spatial disaggregation which allows the analyst to account for different growth trends and pricing policies. The data are still analyzed at the agency level, however, not at the customer level. The demand forecasts include the most recent information and assumptions for estimating the effects of water conservation, including conservation achieved through pricing systems. The MWD-MAIN model was used for the demand analyses.

The study included a listing of reported elasticities that expanded on those noted in the Boland, et al. (1984) report. After reviewing the empirical studies in the literature, the authors suggest that the most likely range of price elasticity for single-family residential use are -0.10 to -0.30 for winter use and -0.20 to -0.50 for summer use.

One of the more recent studies examined was a 1990 study by Boland, et al. using a random sample of 500 single-family residences in Southern California. The results of the Boland, et al. (1990) study indicate that elasticity with respect to marginal price alone was measured in the range of -0.004 to -0.015 for winter water use (November to April) and -0.132 to -0.175 for summer use (April to October). The elasticity with respect to changes in nonmarginal charges (such as service charge) was measured in the range of -0.027 to -0.182 for summer use. These estimates suggest that the overall elasticity of "across-the-board" changes in water rates (which can be viewed as an approximate response to changes in average price) range from -0.03 to -0.16 in winter and -0.29 to -0.36 in summer.

Using the MWD-MAIN model, and an average price variable, the following price elasticity estimates were derived for single-family residential water use. Summer and winter estimates were developed, along with upper and lower limit confidence intervals for the estimates using a 90 percent confidence level. In both instances, the price coefficient was statistically significant at the 5 percent level.

<u>Winter Single-Family Residential Use</u>

Estimate	-0.236
Lower Limit	-0.443
Upper Limit	-0.029

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Summer Single-Family Residential Use

Estimate	-0.356
Lower Limit	-0.492
Upper Limit	-0.220

An analysis of non-residential use was also performed. The price elasticity for non-residential use was estimated as -0.276. This analysis used marginal price rather than average price. The price coefficient was statistically significant at the 17 percent level.

An interesting aspect of this study is the authors' recognition, and treatment, of the interaction of price effects and other conservation effects on water use. Citing studies by Moncur (1987) and Berk, et al. (1981), they suggest that the interaction between price and non-price conservation measures are likely to be somewhere between independent and synergistic, rather than being competitive. The authors note that, in a synergistic relationship, when the effects of non-price conservation programs are not measured, then the price elasticity estimate is likely to capture the combined effect of price changes and these other programs.

The authors attempted to measure non-price conservation effects for a number of Southern California communities. Their findings, and the findings of Berk, et al. (1981) and Moncur (1987, 1989), led them to determine that the actual price elasticities are approximately 50 percent of the values reported by the model. The authors refer to the elasticity estimated by the model as the "estimated parameter", and the conservation program-adjusted elasticity as the "conservation parameter".

The fractional reduction in the use of water from one time period, t-1, to another time period, t, resulting from price changes is calculated by the following formula:

$$R_t = 1 - (P_t / P_{t-1})^e$$

where

R_t = Fraction reduction in water use in year *t*
P_t = Average retail price in year *t* (in constant dollars)
P_{t-1} = Average retail price in year *t-1* (in constant dollars)
e = Price elasticity for user sector and dimension

Caveats

This study is quite comprehensive and raises the important issues of developing a range of potential elasticities and potential upward bias of elasticity estimates that can be a result of interactions with other conservation effects.

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One caveat is the use of agency-level data, as opposed to customer-level data. As noted in other reviews, this level of aggregation can reduce the explanatory power of variables (particularly demographic and economic variables). It is also uncertain how weather data was incorporated into the study.

The residential elasticity estimates for winter may be similar to what we might expect in Utah, if outdoor water use in Southern California is quite limited. We would expect that summer estimates in Southern California, however, could be significantly higher due to increased awareness of water shortage and higher overall prices.

The non-residential elasticity estimate should be used very carefully. This estimate is a composite of commercial, industrial, and agricultural uses. This level of aggregation, and the potential differences in industry mix between Utah and Southern California, will probably only allow us to examine the reported elasticity as a spurious aside to the CUWCD case study.

Care must also be taken in applying the concept of adjusting for upward bias in elasticity estimates. A 50 percent adjustment may be reasonable if no allowances are made for other forms of conservation. If conservation effects are taken into account in a regression equation through the use of conservation-related variables, such a large adjustment would not be warranted. It is also possible that a 50 percent adjustment would be too large for an area with fewer conservation programs than Southern California.

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Erickson, Christopher R., *The Effect of Dual Systems on Price Elasticity of Residential Water Demand*, Utah State University: Logan, Utah, 1991. Unpublished Masters Thesis.

The objective of this study was to develop price elasticities of demand for culinary residential water in the Weber and Davis county areas of Utah. A key consideration of the study was to describe how these elasticities may differ between cities with and without secondary water systems. Both winter and summer seasons were examined. Examination of the price variable was more extensive in this study than has been seen in most of the previous studies. Average price, marginal price, and the Nordin bill difference variable were all examined. Only average and marginal price variables were actually tested, however. Household data, averaged over service entities, was used for this study.

Demand equations were estimated for four different demand sectors: Areas with a dual water system, winter season; areas with a dual water system, summer season; areas without a dual water system, winter season, and; areas without a dual water system, summer season.

Four different refinements of water use data were tested in an attempt to increase the quality of the data. Raw data is data that was used as collected. Adjusted data is data that omitted outliers exceeding three standard deviations from the mean water use. Weighted adjusted data is data where the regression residuals are weighted by the inverse of the variance of the adjusted water use data. Weighted adjusted above marginal price data is the weighted adjusted data, except that only those users who were subject to the marginal price were considered.

Examination of the winter water use equations reveals no correlation between price and the actual water use during the winter season for both dual and non dual areas. These results indicate no measurable price elasticity during the winter season. Two reasons for this are hypothesized. One possible explanation is that customers only use water indoors in the winter months, and the amount of use is seldom above that base amount available with the fixed monthly service fee which is invariant with use level. Another reason for no change in winter water use with respect to price is that no monthly use reading is taken. This information is important to note because the same situation exists for the agencies that are being used for the CUWCD case study.

Regression results for dual areas in the summer season indicate that there is no correlation between price and water use in the summer months. It is suggested that much of the same argument used for the lack of a correlation in the winter months could also apply for the dual areas during the summer. It appears, in these areas, that outdoor water use is entirely supported by the secondary water system and there is no outdoor watering demand placed on the culinary system in the dual areas.

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Of the four primary demand sectors, a priori reasoning would suggest that the relationship between marginal price and water use in the summer months in areas without dual water systems would be most prominent. The research supports this theory. The following results were obtained for this demand sector using different levels of data refinement and different functional forms.

Linear Form

Raw Data

Avg. Monthly Consumption = -0.164 + 0.0005*Assessed Value + 39.778*Lot Size
Adjusted R^2 was 0.4733
Coefficients are significant at the 10% level.

Adjusted Data

Avg. Monthly Consumption = 22.821 - 19.969*Marginal Price + 0.00062*Assessed Value
Adjusted R^2 was 0.5339
Coefficients are significant at the 10% level.

Adjusted Weighted Data

Avg. Monthly Consumption = 17.340 - 20.467*Marginal Price + 0.00073*Assessed Value
Adjusted R^2 was 0.7034
Coefficients are significant at the 5% level.

Double-Log Form

Raw Data

Avg. Monthly Consumption = -5.3579 + 0.8293*Assessed Value
Adjusted R^2 was 0.4522
Coefficient is significant at the 5% level.

Adjusted Data

Avg. Monthly Consumption = -6.011 - 0.4868*Marginal Price + 0.8807*Assessed Value
Adjusted R^2 was 0.5681
Coefficients are significant at the 10% level.

Adjusted Weighted Data

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Avg. Monthly Consumption = -8.122 - 0.5471*Marginal Price + 1.0740*Assessed Value
Adjusted R^2 was 0.7334
Coefficients are significant at the 10% level.

Adjusted Weighted Data (In Marginal Price Block)

Avg. Monthly Consumption = -8.789 - 0.5930*Marginal Price + 1.140*Assessed Value
Adjusted R^2 was 0.7688
Coefficients are significant at the 5% level.

Log-Linear Form

Raw Data

Avg. Monthly Consumption = 2.274 + 0.000018*Assessed Value + 1.363*Lot Size
Adjusted R^2 was 0.4876
Coefficients are significant at the 10% level.

Adjusted Data

Avg. Monthly Consumption = 2.963 - 0.6656*Marginal Price + 0.000025*Assessed Value
Adjusted R^2 was 0.54907
Coefficients are significant at the 10% level.

Adjusted Weighted Data

Avg. Monthly Consumption = 2.733 - 0.7414*Marginal Price + 0.000031*Assessed Value
Adjusted R^2 was 0.7212
Coefficients are significant at the 10% level.

Adjusted Weighted Data (In Marginal Price Block)

Avg. Monthly Consumption = 2.755 - 0.8038*Marginal Price + 0.000033*Assessed Value
Adjusted R^2 was 0.7498
Coefficients are significant at the 10% level.

These findings are significant because they suggest that the price of water is an important factor in determining the level of consumption - but only for metered outdoor use. The lack of a correlation between water price and consumption during the winter, and in the presence of a dual water system, is not surprising. Economic theory would

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tell us that consumers will not adjust their water use when the bill is constant, regardless of the level of consumption.

Another important finding of this study is the improvement in the model that is seen when only observations that are subject to the marginal price are used. This supports the theory that consumers who are subject to the marginal price are most likely to respond to price changes.

Caveats

This study appears to be well-conceived and thoughtfully prepared. It is extremely useful in suggesting direction for further research and for similar research in other geographic areas. The largest caveats are the use of averaged data and the exclusion of some potential key variables.

The averaging of data across entire service areas reduces the explanatory power of the tested variables. Equations that are developed from this level of data aggregation are not as likely to pick up variations in the data that identify correlations between variables. Other studies that have used household-level data have found persons per household and lot size to be highly significant when explaining water use. Assessed value has also been considered relevant as a proxy for household income. These variables were not significant in this study.

This level of aggregation also allows for a much smaller number of observations from which to build demand functions. The equations that were derived in this study were developed using between 12 and 18 observations. Individual household data will allow a researcher to build equations from thousands of observations. This would be expected to substantially increase the statistical significance of the functions and the individual variables.

Finally, climatological variables were not considered in this study. The assumption was made that the small geographic size of the study area would allow the researchers to consider the observations homogeneous with respect to climatological conditions. This might be a reasonable assumption if all of the water agencies involved in the study read meters on the same days. Precipitation and temperature can vary greatly for meter reading periods, causing a great deal of variation in the amount of water consumed by customers for two separate reading periods that are viewed as the same monthly observation period. The effect of climatological variables on water consumption is intuitive and should be considered. It is suggested that daily climatological data be used by aggregating it to individual meter reading periods.

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Gardner, B.D., and S.H. Schick. "Factors Affecting Consumption of Urban Household Water in Northern Utah," *Agricultural Experiment Station Bulletin* No. 449 (1964). Utah State University: Logan, Utah.

The objective of this study was to evaluate the effects of various factors on the consumption of household water. An explanation was offered for the variation in water consumption of average households among 43 water systems in northern Utah in 1962. The study area included six northern Utah counties: Box Elder, Cache, Davis, Salt Lake, Utah, and Weber.

Agency-level data was used for this study. Consumption data was provided in the form of aggregate municipal water sales. The authors note, however, that 90 percent of industrial water was self-supplied, and that almost all of the communities have separate commercial districts. This leads them to assume that their consumption estimates approximate household water use with a slight upward bias. To dampen the effect of upward bias of communities with apartment complexes that are metered at one connection, the dependent variable was measured as per capita consumption.

Regression analysis was used to estimate both a linear and a double-log demand equation.

Linear Model

Per Capita Daily Consumption = 878.93 - 1042.65*Weighted Average Price - 0.1852*Median Per Capita Income in 1960 + 0.033*Median Per Capita Home Value in 1960 + 0.0357*Lot Area Per Capita + 849.03*Percent of Homes with Complete Plumbing + 301.58*Average Monthly Precipitation From May Through October + 2.23*Average Maximum Daily Temperature From May Through October

Plumbing, price, and lot size were significant at the 5% level.
Adjusted R^2 was 0.55

Price and lot size were determined to be important predictors. The plumbing variable was observed to be collinear with lot size. Another linear equation was developed using only price and lot size.

Per Capita Daily Consumption = 302.29 - 1182.49*Weighted Average Price + 0.0229*Lot Area Per Capita

Both coefficients were significant at the 1% level.
Adjusted R^2 was 0.51

Double-Log Model

A logarithmic model was estimated to account for potential nonlinearity of the variables.

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Per Capita Daily Consumption = 5.9504 - 0.7662*Weighted Average Price + 0.1506*Lot Area Per Capita

Both coefficients were significant at the 1% level.
Adjusted R^2 was 0.83

From this equation, price elasticity is estimated at -0.77.

Conclusions

The authors were able to draw the following conclusions from this study.

- Average consumers in communities with high prices purchase less water than those in communities with low prices.
- Conservation of water may be implemented more effectively outside the house in irrigation requirements than within the house.
- People apparently do react to high prices for water in establishing patterns of consumption, allowing price to be used as a public policy tool for altering water consumption.
- Lot size is also amenable to use as a public policy tool for altering water consumption through such actions as zoning regulations and property taxes.

Caveats

This study appears to be a seminal piece of work, particularly for this geographic region. The study has a strong theoretical base, and appears to have been ahead of its time in the consideration of explanatory factors and policy application. Even so, it will be difficult to directly relate the findings of this study with the CUWCD case study because of differences in study area, time period, data application, and use sector.

The elasticity estimate of -0.77 appears to be on the high end of estimates for aggregate municipal or residential use. Since the best model uses only two explanatory variables, it is possible that the price variable is picking up other effects, such as income or weather, as well as price effects on consumption.

One assumption that was made in the study was that the entire study area was considered to be relatively homogeneous with respect to demographics and industrial mix. It is unlikely that this assumption could be made today. The study area also includes many communities that are substantially north of the CUWCD service area.

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The age of the study itself warrants some discussion. First, the potential changes in the study area would suggest that consumption patterns and price response could be significantly different in 1993 than they were in 1962.

Also, a large number of the water agencies in the study area (26 out of 43) employed a decreasing block rate structure. While many of the agencies in this study are not in the CUWCD service area (and, therefore, rate schedule information has not been examined by CUWCD), it is unlikely that such a large percentage of these agencies employ a decreasing block rate structure today. This is important to note because marginal price was, appropriately, not used as a variable in this study. The incidence of decreasing block rate structures can greatly distort the use of marginal price in explaining water consumption.

Advances in data collection and manipulation since the time of this study also allow for the use of more disaggregate data and more observations, including the use of household-level data. Averaged data was used for income, lot size, plumbing, and weather variables. The caveats of using agency-level data and averaged data have been discussed in previous reviews.

The authors note that variation is measured among communities, not within them. This is expected in a true cross-sectional study, but will not reflect the same conditions that will be present in the CUWCD case study, which will use pooled data. Another difference in the two studies is the customer base that is measured. The CUWCD study examined only single-family residential customers. This study received aggregate data that includes some commercial, industrial, and multi-family residential customers. The authors appear to have done a good job of accounting for many these factors by measuring use on a per capita basis, and by noting the large percentage of industrial water users who are self-supplied.

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Hansen, Roger D., and Rangesan Narayanan. "A Monthly Time Series Model of Municipal Water Demand," ***Water Resources Bulletin*** **Vol 17, No. 4 (1981): 578-85.**

The purpose of this study was to develop a multivariate time-series model to examine monthly variations in municipal water demand. Aggregate monthly data from Salt Lake City for the years 1961-1977 were used. The model that was developed as a result of this study displayed extremely strong statistical and theoretical results. In an ex post forecast, the model was found to accurately predict monthly variations in municipal water demand.

The authors note the importance of developing a monthly time-series model. The time-series model that was developed does not assume homogeneity in spatial, climatological, and socioeconomic characteristics - as do many cross-sectional studies that have been performed. The use of monthly data was also considered important because monthly demand patterns are used more often in water resource planning and design than annual demand. Peak monthly demand is noted as being much more useful in planning considerations for reservoir sizing and the securing of water rights.

With respect to price, the authors note that this model can be a very useful tool in evaluating management options. The use of constant price as an explanatory variable allows the effect of a price increase, as well as the effect of a relative decline in the price of water due to inflation, on water use to be estimated.

Another point that was noted by the authors was the effect of voluntary restrictions on outdoor water use in Salt Lake City in 1977. Citing Hughes, et al. (1978), it was noted that drastically reducing water demands did not, as a rule, affect the quality of lawns and gardens. They suggest that since there was no significant deterioration in landscape, outdoor use in the Salt Lake City service area must not be totally efficient. Further, they state that it appears that reductions could be made in summer demands through improved management practices.

Best Model

A number of models were developed using ordinary least squares regression. Each model was evaluated using a t-test for significance, a Durbin-Watson test for serial correlation, and a sign-reversal test for twelfth-order autocorrelation. The following double-log equation was chosen as the equation of best fit.

Gallons per Connection per Day = -2.62 - 0.06*Total Rainfall During Growing Season + 1.56*Average Temperature During Growing Season - 0.47*Average Price in Dollars per 100 Cubic Feet + 0.67*Percentage of Daylight Hours During Growing Season + 7.26*Non-Growing Season Dummy

All coefficients were significant at the 1% level.
Adjusted R^2 was 0.97

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Using this model, price elasticity of demand is estimated as -0.47. This estimate appears to fall within the expected range for aggregate municipal demand.

Caveats

This study may be the most relevant of all of the studies to be reviewed. The study area is very similar to the study area that is examined in the CUWCD case study. The theoretical basis and the statistical relevance of the resultant model are outstanding.

Many of the caveats that should be noted when considering the application of this study have been noted earlier. At this point, therefore, the caveats will only be listed, not discussed. If a discussion of the caveat listed is needed, a quick scanning of previous reviews should provide the necessary comments.

- Agency-level data is used.
- Aggregate municipal demand is examined.
- Demographic and economic variables were not examined.
- Climatological data does not match up with meter-reading period.
- Marginal price was not examined.
- Sewer prices were not examined.
- Use of a seasonal dummy instead of separate winter and summer models.
- Use of time-series data, as opposed to pooled data.
- Time period of analysis is 1961-1977, as opposed to 1991-1993.
- Variation examined is within agency only, not between.

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APPENDIX F
AD VALOREM TAX ANALYSIS

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Table F.1
Analysis of Per Unit Rate Impact Resulting From Phase Out of Ad Valorem Taxes

Estimated Retail Price Elasticity of Demand = -0.5

Expected Ad Valorem Tax Collections by Agency

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CUWCD	$26,251,000	$27,342,000	$28,487,000	$29,680,000	$30,919,000	$32,205,000	$33,539,000	$34,926,000	$36,371,000	$37,880,000
SLCWCD	$4,490,517	$4,602,780	$4,717,849	$4,835,796	$4,956,691	$5,080,608	$5,207,623	$5,337,814	$5,471,259	$5,608,040
MWDSLC	$3,544,315	$3,586,758	$3,630,155	$3,674,532	$3,719,918	$3,766,342	$3,813,833	$3,862,421	$3,912,137	$3,963,014

Lost Revenue as a Result of no Ad Valorem Taxes by Agency

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out										
CUWCD	$5,250,200	$10,936,800	$17,092,200	$23,744,000	$30,919,000	$32,205,000	$33,539,000	$34,926,000	$36,371,000	$37,880,000
SLCWCD	$898,103	$1,841,112	$2,830,710	$3,868,637	$4,956,691	$5,080,608	$5,207,623	$5,337,814	$5,471,259	$5,608,040
MWDSLC	$708,863	$1,434,703	$2,178,093	$2,939,626	$3,719,918	$3,766,342	$3,813,833	$3,862,421	$3,912,137	$3,963,014
10-Year Phase Out										
CUWCD	$2,625,100	$5,468,400	$8,546,100	$11,872,000	$15,459,500	$19,323,000	$23,477,300	$27,940,800	$32,733,900	$37,880,000
SLCWCD	$449,052	$920,556	$1,415,355	$1,934,318	$2,478,345	$3,048,365	$3,645,336	$4,270,251	$4,924,133	$5,608,040
MWDSLC	$354,432	$717,352	$1,089,047	$1,469,813	$1,859,959	$2,259,805	$2,669,683	$3,089,937	$3,520,923	$3,963,014

Expected CUWCD Water Sales (AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Agricultural	133,320	133,320	133,320	133,320	133,320	133,320	133,320	133,320	133,320	133,320
M&I	104,089	104,089	104,089	104,089	104,089	104,089	104,089	104,089	104,089	104,089

Rate Impact to CUWCD M&I Customers ($/AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out	$50.44	$105.07	$164.21	$228.11	$297.04	$309.40	$322.21	$335.54	$349.42	$363.92
10-Year Phase Out	$25.22	$52.54	$82.10	$114.06	$148.52	$185.64	$225.55	$268.43	$314.48	$363.92

Expected CUP Water Purchases of Selected M&I Petitioners (AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SLCWCD	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
MWDSLC	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Orem	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500

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Table F.1
Analysis of Per Unit Rate Impact Resulting From Phase Out of Ad Valorem Taxes

Increase in Purchased Water Costs to CUP Petitioners as a Result of CUWCD Increase (Dollars)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out										
SLCWCD	$2,521,976	$5,253,581	$8,210,378	$11,405,624	$14,852,194	$15,469,934	$16,110,732	$16,776,989	$17,471,106	$18,195,967
MWDSLC	$1,008,791	$2,101,432	$3,284,151	$4,562,250	$5,940,878	$6,187,974	$6,444,293	$6,710,796	$6,988,443	$7,278,387
10-Year Phase Out										
SLCWCD	$1,260,988	$2,626,791	$4,105,189	$5,702,812	$7,426,097	$9,281,961	$11,277,513	$13,421,591	$15,723,996	$18,195,967
MWDSLC	$504,395	$1,050,716	$1,642,076	$2,281,125	$2,970,439	$3,712,784	$4,511,005	$5,368,636	$6,289,598	$7,278,387

Expected Annual Water Sales of Wholesaling Petitioners (AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SLCWCD	112,632	115,600	120,400	125,399	130,606	136,029	139,600	144,300	149,158	154,180
MWDSLC	59,861	60,259	60,657	61,057	61,459	61,861	62,264	62,668	63,073	63,479

Total Increase in Revenue Requirements to Wholesaling Petitioners

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out										
SLCWCD	$3,420,080	$7,094,693	$11,041,087	$15,274,261	$19,808,884	$20,550,542	$21,318,355	$22,114,803	$22,942,365	$23,804,007
MWDSLC	$1,717,654	$3,536,136	$5,462,244	$7,501,875	$9,660,796	$9,954,316	$10,258,126	$10,573,217	$10,900,580	$11,241,401
10-Year Phase Out										
SLCWCD	$1,710,040	$3,547,347	$5,520,544	$7,637,130	$9,904,442	$12,330,325	$14,922,849	$17,691,842	$20,648,129	$23,804,007
MWDSLC	$858,827	$1,768,068	$2,731,122	$3,750,938	$4,830,398	$5,972,589	$7,180,688	$8,458,573	$9,810,522	$11,241,401

Rate Impact to Wholesale Customers of Petitioners ($/AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out										
SLCWCD	$30.36	$61.37	$91.70	$121.80	$151.67	$151.07	$152.71	$153.26	$153.81	$154.39
MWDSLC	$28.69	$58.68	$90.05	$122.87	$157.19	$160.91	$164.75	$168.72	$172.82	$177.09
10-Year Phase Out										
SLCWCD	$15.18	$30.69	$45.85	$60.90	$75.83	$90.64	$106.90	$122.60	$138.43	$154.39
MWDSLC	$14.35	$29.34	$45.03	$61.43	$78.60	$96.55	$115.33	$134.97	$155.54	$177.09

Rate Impact to Retail Customers of Petitioners ($/1,000 gal)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out										
SLCWCD	$0.19	$0.38	$0.56	$0.75	$0.93	$0.93	$0.94	$0.94	$0.94	$0.95
Orem	$0.09	$0.18	$0.28	$0.38	$0.49	$0.50	$0.52	$0.53	$0.54	$0.56
10-Year Phase Out										
SLCWCD	$0.09	$0.19	$0.28	$0.37	$0.47	$0.56	$0.66	$0.75	$0.85	$0.95
Orem	$0.04	$0.09	$0.14	$0.19	$0.24	$0.30	$0.36	$0.42	$0.49	$0.56

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Table F.1
Analysis of Per Unit Rate Impact Resulting From Phase Out of Ad Valorem Taxes

Expected Annual Water Sales of Retail Agencies (AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Orem	26,849	27,140	27,472	27,808	28,148	28,493	28,800	29,156	29,516	29,881
Salt Lake City	106,861	108,018	109,453	110,908	112,382	113,875	115,195	118,482	121,863	125,340
Sandy	34,930	35,500	36,150	36,812	37,486	38,172	38,750	39,400	40,061	40,733
Kearns ID	12,683	12,970	13,384	13,811	14,252	14,707	15,040	15,518	16,011	16,520
GHID	27,670	28,134	28,719	29,317	29,926	30,549	31,060	31,708	32,370	33,045

Expected Annual Water Purchases from SLCWCD (AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sandy	0	0	0	0	0	0	0	0	0	0
Kearns ID	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
GHID	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000

Expected Annual Water Purchases from MWDSLC (AF)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sandy	5,975	6,118	6,300	6,488	6,681	6,880	7,029	7,211	7,398	7,590
Salt Lake City	95,725	95,582	95,400	95,212	95,019	94,820	94,671	94,489	94,302	94,110

Rate Impact to Retail Customers of Selected Non-Petitioner Agencies ($/1,000 gal)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
5-Year Phase Out										
Sandy	$0.03	$0.06	$0.10	$0.13	$0.17	$0.18	$0.18	$0.19	$0.20	$0.20
Salt Lake City	$0.16	$0.32	$0.48	$0.65	$0.82	$0.82	$0.83	$0.83	$0.82	$0.82
Kearns ID	$0.07	$0.15	$0.21	$0.27	$0.33	$0.32	$0.31	$0.30	$0.29	$0.29
GHID	$0.08	$0.16	$0.24	$0.31	$0.37	$0.36	$0.36	$0.36	$0.35	$0.34
10-Year Phase Out										
Sandy	$0.02	$0.03	$0.05	$0.07	$0.09	$0.11	$0.13	$0.15	$0.18	$0.20
Salt Lake City	$0.08	$0.16	$0.24	$0.32	$0.41	$0.49	$0.58	$0.66	$0.74	$0.82
Kearns ID	$0.04	$0.07	$0.11	$0.14	$0.16	$0.19	$0.22	$0.24	$0.27	$0.29
GHID	$0.04	$0.08	$0.12	$0.15	$0.19	$0.22	$0.25	$0.28	$0.31	$0.34

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APPENDIX G
CUP REPAYMENT CONTRACTS

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
BONNEVILLE UNIT
COLORADO RIVER STORAGE PROJECT
COOPERATIVE AGREEMENT
BETWEEN
THE UNITED STATES OF AMERICA AND
THE CENTRAL UTAH WATER CONSERVANCY DISTRICT

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL UTAH PROJECT
BONNEVILLE UNIT
COLORADO RIVER STORAGE PROJECT

COOPERATIVE AGREEMENT
BETWEEN
THE UNITED STATES OF AMERICA AND
THE CENTRAL UTAH WATER CONSERVANCY DISTRICT

THIS AGREEMENT, dated December 29, 1986, between THE UNITED STATES OF AMERICA, acting through the Bureau of Reclamation, Department of the Interior, hereinafter referred to as Reclamation, and the CENTRAL UTAH WATER CONSERVANCY DISTRICT, hereinafter referred to as the District, pursuant to Federal Reclamation Laws, particularly the Acts of February 21, 1911, and December 5, 1924, sets out the following statements by way of explanation:

The Act of Congress approved April 11, 1956 (78 Stat. 105), authorized the planning and investigations of the Central Utah Project (Initial Phase) as a participating project of the Colorado River Storage Project. The Bonneville Unit is a unit of the Central Utah Project (Initial Phase). Reclamation has investigated and is constructing the Bonneville Unit of the Central Utah Project, hereinafter referred to as the Project, for the storage, salvage, and distribution of water for municipal and industrial use, irrigation of water deficient areas, flood control, salinity control, power generation, enhancement of recreation opportunities, conservation of fish and wildlife resources, drainage of project lands, and other purposes.

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Reclamation and the District entered into Repayment Contract No. 14-06-400-4268, dated December 28, 1965, as amended and supplemented, herein referred to as Repayment Contract, that provides in Articles 6, 11, and 12 respectively, for, among other things, a repayment obligation for costs allocated to irrigation and municipal and industrial water use, and transfer of the operation and maintenance of project works to the District.

The project is well under construction and initial use of some facilities has commenced, and construction will be complete in approximately 1995. There will be a great deal of operation and maintenance work necessary to maintain the constructed facilities prior to the completion of the Project. There will also be considerable operation and maintenance and possibly minor replacement of the facilities required prior to official transfer of the facilities to the District as provided for in the Repayment Contract. The District is willing and capable of accomplishing the work with assistance from Reclamation as specified herein with funding provided by Reclamation pursuant to Articles 6 and 7 herein.

This arrangement will be of significant benefit to Reclamation as well as significant benefit to the District in assuring competent, long-term management of the Project.

NOW THEREFORE, in consideration of the above it is mutually agreed as follows:

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PRIOR CONTRACTS

1. The rights and obligations created hereby do not supersede or amend the rights and obligations under Repayment Contract No. 14-06-400-4286 between Reclamation and the District, dated December 28, 1965, as amended and supplemented, or as said contract may be hereafter supplemented or amended.

TERM OF THE AGREEMENT

2. This agreement shall become effective upon date of its execution and shall remain in effect until responsibility for operation and maintenance of all features of the Project have been officially transferred to the District or until this agreement is terminated as provided in Article 13 herein.

RECLAMATION'S RESPONSIBILITY

3. (a) Contingent upon appropriation from Congress, Reclamation will make funds available to the District as provided in Articles 6 and 7 herein, to cover costs of the operation and maintenance of project features as outlined in each master work schedule described in Article 5 herein.

(b) Reclamation will assist in the development and review of the master and quarterly work schedules to assure that the work to be accomplished is consistent with programmed funds and reflects coordination with construction activities being performed on the Project.

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(c) Reclamation will review and assist, if needed, in the operation and maintenance being performed by the District. Such assistance will include, but is not limited to, all technical resources available to Reclamation.

(d) At the District's request, Reclamation may purchase and provide equipment, supplies, and materials for the District's use in carrying out the responsibilities under this agreement pursuant to Article 10 herein.

(e) Reclamation will make construction specifications available to the District for its review prior to invitation for bid.

(f) Reclamation will review the proposed master and quarterly work schedules to assure that the proposed work will be in compliance with all Federal, State, and local environmental laws and regulations.

DISTRICT'S RESPONSIBILITY

4. The District, with Reclamation assistance, will develop work schedules and, following Reclamation approval, will provide the following services in the operation and maintenance of features of the Project.

(a) Recruit, employ, train, and supervise the personnel required to perform the operation and maintenance functions as outlined in the master and quarterly work schedules.

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(b) Procure required supplies and equipment to perform the operation and maintenance as outlined in the master work schedule pursuant to Articles 10 and 12 herein.

(c) Review specifications for construction by Reclamation of various Project facilities. Such review shall be for the purpose of identifying operation and maintenance concerns.

(d) Cooperate with Reclamation and other involved entities to assure that proposed work will be in compliance with all Federal, State, and local environmental laws and regulations.

SCHEDULE OF WORK

5. The District will prepare a master work schedule and detailed quarterly work schedules for review and approval by Reclamation. The schedules will cover the following items:

(a) Master work schedules will, on a continuing basis, cover three (3) full years and show by fiscal years (October through September) the Project facilities to be operated and maintained by the District and the total estimated costs thereof by feature. The master work schedule will be updated and submitted to Reclamation on May 1 of each year for the upcoming three (3) years for all operation, maintenance, and replacement work covered under this agreement. The line items in the work schedules will conform to the financial reporting requirements of Reclamation's books of account.

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(b) The detailed quarterly work schedules will identify the proposed District organization, the Project facilities to be operated and maintained by the District using Reclamation funds, the Project facilities to be operated and maintained by the District using District funds, a detailed description of the work to be performed, equipment, materials and supplies to be purchased, and funds required during each quarter. Submittal to Reclamation of the first detailed quarterly work schedule shall be for the period from the initiation of the work program to the end of the initial quarter. Submittal to Reclamation of subsequent detailed quarterly work schedules shall be made not less than fifteen (15) days prior to the beginning of the quarter covered by each schedule. The line items in the work schedules will conform to the financial reporting requirements of Reclamation's books of account.

(c) Notwithstanding any other provision of this article, the master work schedules and detailed quarterly work schedules shall be submitted sufficiently in advance of the proposed operation and maintenance work to permit an adequate review and approval by Reclamation of the proposed program. The District will not be obligated to do any of the proposed work until Reclamation has approved the master work schedule and the applicable quarterly work schedule and funds are available therefor. Neither party shall change or modify any portion of the work schedules without the written approval of the other party.

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ADVANCES AND ACCOUNTABILITY OF FUNDS

6. (a) Reclamation will make monthly advances to the District, for work to be done under approved master work schedule, the approved quarterly work schedule, but subject to the approval of the monthly financial report described in Article 9. The amount of each advance will be the sum shown as the monthly requirement on the approved quarterly work schedule, less an estimated balance of funds available from prior advances. The advance will be paid within 20 days after the monthly financial report described in Article 9 has been received and approved by Reclamation. Additional sums may be advanced on the basis of a supplemental detailed work schedule approved in like manner as the first. Each advance of funds subsequent to the initial advance shall be dependent upon performance by the District, in a manner safisfactory to Reclamation, of any prior work, but such advance shall not commit Reclamation to approval of performance of such prior work. Reclamation, at its election, may withhold any advance of funds contemplated hereunder at any time when, in its opinion, the District is in default or delinquent with respect to performance of any of the terms or conditions of this agreement; and in the event funds are so withheld, the District may discontinue all disputed maintenance work until the disputes are resolved and the money therefor is released.

(b) If Reclamation, after consultation with the District, determines that the District has failed at any time, or from time to

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time, to perform substantially any provision of this contract, Reclamation may give the District written notice specifying the respects in which the District has failed to so perform, and in the event the District fails to cure or take appropriate steps to cure such default within thirty (30) days after the giving of such notice, Reclamation may, with written notice to the District, take over the operation and maintenance of all or any part of the Project works including equipment of the District paid for with Reclamation funds and used for such purposes. Such operation and maintenance by the United States shall continue until Reclamation determines the District is again capable of operating all or any part of the Project works then being operated and maintained by the United States, and upon written notice to the District, establishing the effective date, may retransfer to the District all or any part of Project works and equipment. Upon receipt of such notice, the District shall accept the care, operation, and maintenance of such Project works in accordance with this contract.

(c) The funds advanced hereunder by Reclamation as defined in the work schedule shall be used only for costs and expenses incurred by the District for work that would otherwise be accomplished by Reclamation in the operation and maintenance of Project facilities. Such costs and expenses may include salaries and benefits of District employees, procurement of necessary materials and equipment and buildings, employee training, tools, supplies, administrative expenses, and all other costs, which, in the opinion of the District and

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Reclamation, are related to this agreement. All costs and expenses of this work program, whether incurred prior to or after execution of this agreement, shall be limited to costs reasonably incurred in the exercise of sound engineering, construction, and business practices and are chargeable or allocable to the work program.

(d) Immediately upon receipt of each advance of funds from Reclamation, the District shall deposit the amount advanced in a separate, special interest-bearing account in a bank that is a member of the Federal Reserve System or, if approved by Reclamation, in any special fiduciary account in the manner provided by laws of the State of Utah. Thereafter, the District may only draw upon said special account from time to time to finance the performance of the work. Interest credited by the depository bank on funds advanced shall be considered as advances by Reclamation. In the event the funds advanced by Reclamation are expended before the end of the quarter, additional funds may be made available by Reclamation as provided for herein. When this agreement is terminated or ends because of its own terms, any remaining funds (remaining after all costs and claims have been paid or settled) will be returned to Reclamation.

(e) If the District uses funds advanced pursuant to this contract for purposes other than those authorized, as reasonably determined by Reclamation, the District shall reimburse said fund account in the amount of funds so misused, together with interest thereon at 6 percent per annum.

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(f) Funds so advanced by this agreement shall be considered a capitalized construction cost to be included as part of the costs allocated to determine the District's repayment obligations as outlined in Repayment Contract No. 14-06-400-4286 between Reclamation and the District.

AVAILABILITY OF FUNDS

7. (a) Contingent upon appropriations, Reclamation shall provide funds to the District for the operation and maintenance functions performed by the District. The District will be notified in writing of the funds available each year. Reclamation shall continue to provide funds in a similar manner subject to receipt of appropriations for this purpose until complete operation and maintenance responsibilities for a specific feature of the Project, or the entire Project, are transferred by Reclamation to the District.

(b) The performance of any work by the District hereunder which requires appropriation of funds by Congress shall be contingent upon such appropriations being made. The District shall not be liable for failure to operate as specified by the work schedule when its contractual obligations as contemplated by the schedule are not complete or operational, due to failure of appropriation of funds, or water is otherwise unavailable. If funds are not made available to the District, Reclamation will assume the responsibilities for operation and maintenance. The District will have no obligation to perform work for which Reclamation has not advanced funds.

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OPERATION AND MAINTENANCE OF PROJECT FACILITIES AFTER DELIVERY OF WATER

8. When Project water becomes available for delivery pursuant to Article 7 or 8 of the Repayment Contract dated December 28, 1965, a charge for the water will be assessed by Reclamation, in accordance with the Repayment Contract, with the objective of collecting from the District an amount sufficient to at least cover the costs of operation and maintenance appropriate for such water delivery. When the facilities are sufficiently completed to deliver water and pursuant to Articles 11 and 12 of the Repayment Contract, the Project facility will be officially transferred to the District and the operation and maintenance costs of that facility will no longer be funded under this agreement. As noted above, such facilities will be identified in the work schedule.

FINANCIAL ACCOUNTS

9. (a) The District shall establish and maintain separate accounts and records for all financial transactions related to this contract. The accounting system will conform to the standards of internal control and accountability required by Reclamation. Representatives of the United States shall have the right to examine the District's books and records relating to matters covered by this contract.

(b) Monthly and quarterly reports pertaining to the financial transactions under this contract shall be submitted by the District to

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Reclamation. The monthly reports shall be due on the 10th day of each month. The quarterly reports shall be due on the 20th day of the month after the end of each calendar quarter. All reports will be in a format approved by Reclamation and will provide the information necessary to properly maintain Reclamation's books of account pertaining to this contract. Attached to the monthly reports will be a copy of the check register and copies of checks with invoices and other supporting material for the previous calendar month.

(c) Reclamation will require the District to submit to examinations in the form of audits or internal audits at the end of each calendar year. Such audits shall be made by qualified individuals who are sufficiently independent of those who authorize the expenditure of Federal funds to produce unbiased opinions, conclusions, and judgments. Audits should be made in accordance with generally accepted auditing standards and the standards published by the General Accounting Office, Standards for Audit of Governmental Organizations, Programs, Activities, and Functions.

ACQUISITION OF PROPERTY, EQUIPMENT, MATERIALS, AND SUPPLIES

10. The District is authorized to acquire with funds advanced by Reclamation, pursuant to the approved quarterly work schedule, property (other than real property), equipment, materials, and supplies necessary to perform the operation and maintenance prescribed in this agreement and further detailed in the master and quarterly work schedules. Any

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property and equipment purchased with funds made available to the District shall be taken in the name of the United States and remain in the ownership of the United States until such time that the title to such property and equipment is transferred to the District pursuant to the aforementioned repayment contract. Any property, equipment, materials, and supplies purchased with Federal funds shall be used by the District only for purposes of work covered by this agreement and cannot be used for personal use by the District employees.

THIRD PARTY CLAIMS

11. The District agrees that it will not seek reimbursement from nor sue the United States nor any office, agent, or employee thereof, for expenses incurred in defending third party claims for personal injury, death, or property damage arising out of the District's own acts or omissions.

PROCUREMENT STANDARDS/CONTRACTS WITH THIRD PARTIES

12. (a) The District may use its own procurement regulations which reflect applicable State laws. The District must conduct all procurement transactions in a manner that will provide free and open competition. This applies to both negotiated and formally advertised contracts. The District may also utilize, at its option, all of the procurement processes and benefits available to Reclamation in obtaining services, equipment, or supplies.

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(b) The District, if it elects not to do the work with its own employees and equipment, shall advertise each construction, equipment, or supply contract exceeding $20,000 for competitive bidding. Upon receipt of bids, any award of contract by the District other than to the lowest responsible bidder shall be subject to approval of Reclamation prior to consummation of the transaction.

(c) Reclamation shall not be a party to or obligated in any manner by contracts entered into between the District and other parties except as provided in this agreement.

(d) The District is the responsible authority, without recourse to Reclamation, regarding the settlement and satisfaction of all subcontractual and admininstrative issues arising out of the subcontracts the District awards in support of this agreement.

TERMINATION

13. Except as provided in Article 6(b), the District or Reclamation may terminate this agreement in whole, or in part, by advance written notice of one (1) year or sooner by mutual agreement. The two parties shall consult with each other upon the termination conditions and, in case of partial termination, the portion to be terminated. Upon termination, all unexpended funds shall be returned to Reclamation and a final settlement and accounting of all costs shall be made.

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RECORDS RETENTION

14. District financial records, supporting documents, and all other records pertinent to this agreement shall be retained for a period of three (3) years from the date of submission of the final financial status report, with the following exception: If any litigation claim, or audit, is started before the expiration of the 3- (three) year period, the records shall be retained until all litigation, claims, or audit findings involving the records have been resolved.

SAFETY REGULATIONS

15. Any work performed by the District pursuant to this agreement shall be done in accordance with all applicable Federal and State safety regulations, including Reclamation's Construction Safety Standards. Employees of the District required to operate Reclamation-owned equipment shall be certified in the same manner as Reclamation employees.

GENERAL PROVISIONS

16. The standard articles applicable to this agreement are listed below. The full text of these standard articles is attached as Exhibit A and is hereby made a part of this agreement.

A. Water and Air Pollution Control

B. Assignment Limited - Successors and Assigns Obligated

C. Equal Opportunity (Federally Assisted Construction)

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D. Title VI, Civil Rights Act of 1964

E. Certification of Nonsegregated Facilities

F. Officials Not to Benefit

G. Rules, Regulations, and Determinations

IN WITNESS WHEREOF, the parties hereto have signed their names this day and year first above written.

UNITED STATES OF AMERICA

Sol. Off.

By

Regional Director
Upper Colorado Region
Bureau of Reclamation

CENTRAL UTAH WATER CONSERVANCY DISTRICT

By

President, Board of Directors

Attest:

Secretary

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WATER AND AIR POLLUTION CONTROL

The District, in carrying out this agreement, shall comply with all applicable water and air pollution laws and regulations of the United States and the State of Utah, and shall obtain all required permits of licenses from the appropriate Federal, State, and local authorities.

ASSIGNMENT LIMITED--SUCCESSORS AND ASSIGNS OBLIGATED

The provisions of this agreement shall apply to and bind the successors and assigns of the parties hereto, but no assignment or transfer of this agreement or any part or interest therein shall be valid until approved by the United States.

EQUAL OPPORTUNITY

(a) During the performance of this agreement, the District agrees as follows:

(1) The District will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The District will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The District agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by Reclamation setting forth the provisions of the nondiscrimination clause.

(2) The District will, in all solicitations or advertisements for employees placed by or on behalf of the District, state that all qualified applicants will receive consideration for employment without discrimination because of race, color, religion, sex, or national origin.

(3) The District will send to each labor union or representative of workers, with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by Reclamation, advising the said labor union or workers' representative of the District's commitments under Section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The District will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations, and relevant orders of the Secretary of Labor.

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(5) The District will furnish all information and reports required by said amended Executive Order and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by Reclamation and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the District's noncompliance with the nondiscrimination clauses of this agreement or with any of the said rules, regulations, or orders, this agreement may be cancelled, terminated, or suspended, in whole or in part, and the District may be declared ineligible for further Government contracts in accordance with procedures authorized in said amended Executive Order, and such other sanctions may be imposed and remedies invoked as provided in said Executive Order, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The District will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of said amended Executive Order, so that such provisions will be binding upon each subcontractor or vendor. The District will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, That in the event a District becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the District may request the United States to enter into such litigation to protect the interests of the United States.

TITLE VI. CIVIL RIGHTS ACTS OF 1964

(a) The District agrees that it will comply with Title VI of the Civil Rights Act of July 2, 1964 (78 Stat. 241) and all requirements imposed by or pursuant to the Department of the Interior Regulation (43 CFR 17) issued pursuant to that title, to the end that, in accordance with Title VI of that Act and the Regulation, no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits or, or be otherwise subjected to discrimination under any program or activity for which the District receives financial assistance from the United States and hereby gives assurance that it will immediately take any measures to effectuate this agreement.

(b) If any real property or structure thereon is provided or improved with the aid of Federal assistance extended to the District by Reclamation, this assurance obligates the District, or in the case of any transfer of such property, any transferee for the period during which the real property or structure is used for a purpose involving the

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provision of similar services or benefits. If any personal property is so provided, this assurance obligates the District for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the District for the period during which the Federal financial assistance is extended to it by Reclamation.

(c) This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts, or other Federal financial assistance extended after the date hereof to the District by Reclamation, including installment payments after such date on account of arrangements for Federal financial assistance which we approved before such date. The District recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall reserve the right to seek judicial enforcement of this assurance. This assurance is binding on the District, its successors, transferees, and assignees.

CERTIFICATION OF NONSEGREGATED FACILITIES

The District hereby certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. It certifies further that it will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The District agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and house facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, creed, color, or national origin, because of habit, local custom, or otherwise.

OFFICIALS NOT TO BENEFIT

(a) No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise herefrom. The restriction shall not be construed to extend to this agreement if made with a corporation or company for its general benefit.

(b) No official of the District shall receive any benefit that may arise by reason of this agreement other than as a landowner within the project and in the same manner as other landowners within the project.

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RULES, REGULATIONS, AND DETERMINATIONS

(a) Reclamation shall have the right to make, after an opportunity has been offered to the District for consultation, rules and regulations consistent with the provisions of this agreement, the laws of the United States and the State of Utah to add or to modify them as may be deemed proper and necessary to carry out this agreement, and to supply necessary details of its administration which are not covered by express provisions of this agreement. The District shall observe such rules and regulations.

2. Where the terms of this agreement provide for action to be based upon the opinion or determination of either party to this agreement, whether or not stated to be conclusive, said terms shall not be construed as permitting such action to be predicted upon arbitrary, capricious, or unreasonable opinions or determinations. In the event that the District questions any factual determinations made by Reclamation, the findings as to the facts shall be made by the Secretary of the Interior only after consultation with the District and shall be conclusive upon the parties.

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RESOLUTION

The Board of Directors of the Central Utah Water Conservancy District has entered into an agreement with the U. S. Bureau of Reclamation to turn over operation and maintenance of completed Central Utah Project facilities to the Central Utah Water Conservancy District. Approval has hereby been authorized for its officers to execute the agreement.

CERTIFICATE

I certify that the foregoing is a true and accurate copy of a resolution unanimously adopted by the Board of Directors of the Central Utah Water Conservancy District on November 13, 1986, at a regularly and duly called meeting after notice given in accordance with the statutes of the State of Utah and the By-Laws of the Central Utah Water Conservancy District and further, that out of a total of nineteen Directors, sixteen were present and voting in favor thereof.

Don A. Christiansen

Don A. Christiansen
Secretary

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October 19, 1965

Memorandum

To: Secretary of the Interior

From: Commissioner of Reclamation

Subject: Proposed Repayment Contract, Central Utah Project, Bonneville Unit, CRSP, Utah

Enclosed for your review and approval is the form of a proposed repayment contract with the Central Utah Water Conservancy District for the Bonneville Unit. The Central Utah Project (initial phase), which includes the Bonneville Unit, was authorized as a participating project of the Colorado River Storage Project by the Act of April 11, 1956 (70 Stat. 105).

The project will provide supplemental irrigation water to about 112,790 acres and a full water supply to about 43,740 acres making a total irrigable area of about 156,530 acres. Benefits, in addition to those accruing to irrigation, will accrue to municipal and industrial water usage, power, flood control, fish and wildlife and recreation, water quality control and area redevelopment.

The cost of the project is estimated at $329,091,000. Cost allocations are as follows:

Reimbursable costs	
Irrigation	$177,605,000
Municipal and Industrial water use	76,268,000
Power	48,152,000
Subtotal	$302,025,000
Nonreimbursable costs	
Flood control	$ 3,474,000
Fish and Wildlife	20,880,000
Recreation	2,712,000
Subtotal	$ 27,066,000
Total Cost	$329,091,000

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Repayment of the reimbursable costs is as follows:

Irrigation costs	
Water Users.....	$ 16,400,000
Ad Valorem Tax Revenues	38,005,000
Upper Colorado River Basin Fund:	
Bonneville Unit, Power revenues	59,695,000
CRSP Power revenues.....	63,505,000
Subtotal.....	$177,605,000
Municipal and Industrial Water Costs	76,268,000 1/
Power costs	
Bonneville Unit, Power revenues	48,152,000 1/
Total.....	$302,025,000

1/ In addition, interest will be paid annually on the unpaid obligation at a rate established when construction is initiated.

The Central Utah Water Conservancy District, embracing all or parts of seven counties within the State of Utah, will be the contracting, administrative, and operating agency for most of the project reclamation and joint-use facilities. The Bureau of Reclamation will operate the project power facilities in order to integrate the power operation with the Colorado River Storage Project and initially will operate other facilities. Specific facilities for recreation and fish and wildlife are expected to be administered by local or State agencies.

The Bonneville Unit includes a transbasin diversion of water from the headwaters of the Duchesne River in the Uinta Basin portion of the Colorado River Basin to the Bonneville Basin. Related developments of local water sources will be made in both basins.

Starvation Reservoir will be formed by a dam on Strawberry River near Duchesne, Utah. The reservoir will receive most of its water from the Duchesne River, diverted through a feeder canal. The stored water will supplement present irrigation supplies of Strawberry and Duchesne Rivers and will replace water presently utilized in the service areas of these rivers that will be diverted to the Bonneville Basin.

Strawberry Aqueduct will collect flows of several tributaries of the Duchesne River and convey the water to the Strawberry Reservoir which will be enlarged. The Upper Stillwater and Currant Creek Reservoirs will be constructed to regulate flow into this aqueduct.

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Water in Strawberry Reservoir will be released to the Bonneville Basin through the Syar Tunnel. From the tunnel the water will flow in succession through the Syar, Sixth Water, and Dyne Powerplants. Part of the power produced at these plants will be used for project pumping, and the remainder will be distributed for commercial use over the interconnected system of private and Federal transmission lines of the Colorado River Storage Project.

Below project powerplants, part of the water will be conveyed to lands in the Peteetneet, Mona-Nephi, and Elberta areas, and part will be distributed by existing works to lands in the Spanish Fork area. Regulation of the water will be provided at the Hayes Reservoir on Diamond Fork, the enlarged Mona Reservoir, and Utah Lake. Drainage facilities, including a dike and pumping plant, will be provided to reclaim part of the lands in the Spanish Fork area. Some project water will be used by exchange for municipal purposes.

Goshen and Provo Bays of Utah Lake will be separated from the lake by dikes to reduce evapotranspiration losses. Arable lands in Provo Bay will be reclaimed by drainage. Water will be pumped from Utah Lake for irrigation in the Provo Bay and Mosida areas. The pelican Point Pumping Plant and Canal will be constructed to facilitate delivery of Utah Lake water to Jordan River under existing rights.

Project water in Utah Lake not used on the Mosida and Provo Bay areas will replace part of the Provo River water that is presently required to flow into the lake. The replaced water will be stored in the Jordanelle Reservoir on Provo River and used for irrigation in the Heber-Francis area and for municipal and industrial purposes in the area extending from Provo to Salt Lake City. The municipal and industrial water will be conveyed from Provo River to points of delivery by an aqueduct system.

Project or Forest Service recreational facilities will be provided at project reservoirs and at 15 existing small reservoirs at the head of Provo River. The conservation function of the 15 reservoirs will be transferred to the Jordanelle Reservoir, permitting them to be maintained at near-constant elevations. Fishery benefits will be provided at all reservoirs and on some stream channels. Certain flows will be bypassed at the Upper Stillwater and Soldier Creek damsites to maintain stream fisheries in the Uinta Basin as agreed to by State and Federal fish and wildlife agencies and Indian interests.

Irrigation benefits from the Bonneville Unit are estimated at an average of $12,163,000 annually over the 100-year period. Of the total benefit value, $6,334,000 would be in direct benefits, $4,946,000 in indirect benefits, and $883,000 in public benefits.

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The proposed contract is consistent with the project plan presented in the August 1964 Definite Plan Report. The repayment obligations for irrigation and for municipal and industrial water are specified in the contract. Repayment by irrigators will be accomplished in 50 annual installments for each block commencing with the year after the expiration of the development period for the block. The municipal and industrial water repayment obligation apportioned to each block will be paid in 40 years beginning with the year water is first made available to the block. The proposed contract in many respects is similar to the executed contracts for several other participating projects of the Colorado River Storage Project. The Bonneville Unit, Central Utah Project, is much more involved and complex and, therefore, several of the contract articles have been modified and other new ones added.

The contract provides:

Article 1--General Definitions - The definitions are standard for Bureau of Reclamation contracts.

Article 2--Project Works - This is a multipurpose project encompassing transbasin water diversions, storage and distribution facilities. The number of identified facilities is greater than in most participating project contracts. Some items are noted in a general manner because at this time the specifications therefor are not known. There is provided, in keeping with the purposes of the project, that the Secretary may enlarge, omit, or change a project feature as he deems desirable.

Article 3--Points of Delivery, Measurement and Use of Project Water - The points of delivery of project water are to be determined by the Contracting Officer, and the installation, care, and operation of measuring devices are to be satisfactory to him. No treatment facilities for municipal and industrial water are included in the project plan or provided as project features in the contract.

Article 4--Conditions Precedent to Construction - This article lists the basic agreements that must be obtained. These agreements will be obtained as appropriate prior to construction of a particular facility. The article provides that the Contracting Officer may by notification in writing to the District require other conditions and agreements not enumerated therein to be met prior to construction of a particular project feature.

Article 5--Acquisition of Lands, Easements and Water Rights - This article contemplates that the United States will acquire the necessary lands and interest in lands, but in situations where the District may obtain lands and interest in lands, owned by the State, under Section 73-9-13(d) of the Utah Code annotated, 1953, the District, when requested by the Contracting Officer, will exercise its right under said statute. This article provides

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further that the District will, if requested to do so, file and diligently prosecute to certificate, applications for water rights as may be needed for project purposes and will assign said rights to the United States. The District will also protect the project water rights in case of dispute.

Article 6--Obligation and Terms of Repayment - This article of the contract, pursuant to the Reclamation Project Act of 1939, establishes a District repayment obligation of $130,673,000 which may be increased by 20 percent because of price increases for construction of project works, enlargement of works, and increases in allotments of irrigation and municipal and industrial water, including changes in use from irrigation to municipal and industrial uses. The project repayment obligation is divided into irrigation repayment obligation, ad valorem tax obligation, and municipal and industrial repayment obligation. In accordance with the suggested payout schedule of the August 1964 Definite Plan Report, ad valorem tax revenues are to be applied first on the municipal and industrial repayment obligation and thereafter on the irrigation repayment obligation until repaid. The municipal and industrial repayment obligation shall accrue interest on the unpaid portion at a rate to be established pursuant to provisions of Section 5(f) of the Act of April 11, 1956 (70 Stat. 105), as amended, by the Act of June 27, 1960 (74 Stat. 227), P.L. 86-529. A provision (subarticle 5(f)) has been included to apply Title III of the Water Supply Act of 1958, as amended, when facts and circumstances show a future anticipated demand for municipal and industrial water as being within the provisions of the Act.

Article 7--Establishment of Development Blocks - A development block notice will be issued as project water sold by the District becomes available. The notice will, among several items, describe the uses to be made of the water, the repayment obligation assigned thereto, annual rates of payment, and the repayment period. The article requires a review of uses made of the water assigned the block at intervals no longer than five years to determine whether changes have occurred which justify an amendment of the notice and, if so, the Contracting Officer shall amend the notice and payment schedules to reflect such changes. However, such amendments shall not reduce the project repayment obligation.

Article 8--Disposal of Project Water by the United States - This article provides that during construction of project works and at any other time, project water not obligated to the District may be disposed of by the Contracting Officer at terms fixed by him. However, the District shall have first opportunity to purchase said water at the price and terms offered.

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Article 9--Use and Allotment of Project Water - Capacities in project reservoirs reserved to the United States are enumerated. The District shall have the permanent right, subject to reservations stated in the article, to use and dispose of project water as such water is made available to it. One important reservation is that the project water supply shall be subject to the September 20, 1965, agreement, identified as Contract No. 14-06-W-194, among the United States (acting through the Bureau of Indian Affairs and the Bureau of Reclamation), the Ute Indian Tribe of the Uintah and Ouray Reservation, and the Central Utah Water Conservancy District. Under the agreement the Indians will defer development of 15,242 acres of potentially irrigable land until no later than year 2005. Unless subsequent phases of the Central Utah Project are available to meet deferred demands before then, equitable adjustment will be made to satisfy such uses from the Bonneville Unit.

Article 10--Irrigation Development Period - A development period for each development block will be announced in the notice issued therefor. Said notice will announce, among several items, when the development period starts, number of years it will extend, costs to be paid in advance, and adjustment to be made in case of under or over payment of development period costs.

Article 11--Operation and Maintenance of Project Works - This is a standard article in repayment contracts. It provides that operation and maintenance of project works will be performed by the United States unless the District is required to do so. If works transferred to the District are not satisfactorily operated and maintained, the United States, after giving due notice, may take over the operation and maintenance of all or any part of the project works including equipment of the District used for such purposes.

Article 12--Cost of Operation and Maintenance of Project Works - This article provides for payment in advance by the District of operation and maintenance costs of project works operated by the United States. However, if the United States resumes care, operation, and maintenance of transferred works, the District shall advance to the United States, within ten (10) days after written demand, 30 percent of the estimated District's share of such costs and the balance within ninety (90) days after said demand. When the District operates project works, it shall be compensated or credited appropriately for costs incurred that are properly chargeable to flood control, fish and wildlife, and commercial power.

Article 13--Electric Power and Energy for Project Pumping - Power features of the project shall be owned and under the control and jurisdiction of the United States. Use of water for power will be junior to use of water for consumptive uses. The project power and energy requirement for irrigation pumping will be available to the District through the Colorado River Storage Project power system.

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Article 14--Other Costs to be Paid by the District - This is a standard article in Bureau of Reclamation contracts.

Article 15--Replacement Reserve Fund - This fund will be created and maintained by the District through a special levy or charge of 10 cents per acre-foot annually of project water made available to the District. This fund will be kept separate from other District funds and shall be available to the United States for purposes specified in the article whenever the United States is operating and maintaining the project works.

Article 16--Emergency Reserve Fund for Operation and Maintenance - This article follows the format for the article used in other repayment contracts, but the fund to be accumulated and maintained has been established at $325,000 because of the size and complexity of the project.

Articles 17 through 46, 48 and 49 are considered standard articles that are included in all repayment contracts. Among these are the excess land articles (27, 28, and 29) which, in recognition of stage development of the Bonneville Unit, over twenty or more years, are substantively patterned after corresponding articles heretofore employed in contracts for the Columbia Basin Project and the Garrison Diversion Unit, Missouri River Basin Project.

Article 47--Water Pollution Prohibited - This is a new article in a repayment contract. It pertains to municipal and industrial water uses. The District agrees to take necessary and reasonable precautions as may be determined by the Secretary to prevent pollution of water by the District.

By resolution of September 20, 1965, the Board of Directors of the Central Utah Water Conservancy District approved the draft of contract designated RO Draft 1/4/65, last revised 9/15/65. One subsection was revised for clarity here and the draft further identified as revised W.O. 9/28/65. We believe the draft of contract as revised is in the best interests of the United States and the District. Accordingly, we recommend you approve the form of contract and authorize the Regional Director, Region 4, to execute the contract on behalf of the United States after it has been executed on behalf of the District, and thereafter, to act as Contracting Officer on behalf of the Secretary of the Interior for the purposes of the contract.

/s/ Floyd E. Dominy

Enclosure

Approved: November 1, 1965
/s/ Kenneth Holum
Assistant Secretary of the Interior
cc:
Regional Director, Salt Lake City, Utah
Regional Solicitor, Salt Lake City, Utah
Project Manager, Provo, Utah

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DRAFT

REPAYMENT SUMMARY

Memorandum To The Secretary

Re: Proposed Repayment Contract, Bonneville Unit, Central Utah Project, a participating project, Colorado River Storage Project, between the United States and the Central Utah Water Conservancy District, Utah

Authorization:

The Central Utah Project (initial phase) which includes the Bonneville Unit, was authorized as a participating project of the Colorado River Storage Project by the Act of April 11, 1956 (70 Stat. 105).

Location:

The Bonneville Unit of the Central Utah Project is located on both sides of the Wasatch Mountains in north-central and northeastern Utah. The portion of the Wasatch Mountains is in the Uinta Basin, a segment of the Colorado River Basin. The portion west of the mountains is a part of the Bonneville Basin.

Description:

The Bonneville Unit will include transbasin diversion of water from the headwaters of the Duchesne River in the Uinta Basin to the Bonneville Basin. Related developments of local water sources will be made in both basins. The project will develop water for irrigation, municipal and industrial use, and power production. Also, benefits will arise from the use of water for recreation, fish and wildlife, flood control, water quality control, and area redevelopment.

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Repayment:

The total cost of the project is estimated at $329,091,000. Reimbursable costs total $302,025,000 with nonreimbursable costs of $27,066,000. Repayment of the reimbursable costs will be accomplished as follows:

Irrigation from:	
Water Users	$16,400,000
Ad valorem tax revenues	38,005,000
Upper Colorado River Basin Fund:	
Bonneville Unit Power Revenues	59,695,000
CRSP Power Revenues	63,505,000
	$177,605,000
Municipal and Industrial Water Costs	$ 76,268,000
Power - Bonneville Unit	$ 48,152,000

Recommendations:

The Central Utah Water Conservancy District Board of Directors, by resolution dated September 20, 1965, approved the proposed contract, and agreed after approval of the form of contract by the Secretary to recommend favorable action on it by the electors, and upon a favorable vote, will direct the President and Secretary of the District to execute said contract. It is recommended that the Secretary approve the form of contract by approving the attached memorandum.

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Ans'd.
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SEP 22 1965

4-400

To: Commissioner
Attention: 400

From: Regional Director, Salt Lake City, Utah

Subject: Proposed repayment contract, Central Utah Project, Bonneville Unit, CRSP, Utah

Enclosed are:

1. Six copies of subject proposed contract designated RO Draft 1/4/65 and last revision 9/15/65.

2. Four copies of a resolution adopted September 20, 1965, by the Board of Directors of the Central Utah Water Conservancy District approving the draft contract as revised 9/15/65, and stating a willingness to call a special election to vote upon such contract when approved as to form by the Secretary.

3. Four copies of a draft memorandum for your use in preparing a transmittal to the Secretary seeking his approval of the form of the repayment contract.

4. Four copies of a repayment summary memorandum.

Your letter, above subject, dated September 10, 1965, and TT W-SU 302 dated September 15, 1965, suggested revisions to be made in the draft contract designated Rev. 8/13/65, which was submitted to your office with our letter dated August 23, 1965. Through telecons with your staff and Mr. Davis of the Solicitor's office by our Regional Solicitor and our staff members, it was decided that some revisions suggested in your September 10 letter should be omitted or adjusted. These understandings were confirmed by TT W-SU 304, dated September 16. The enclosed draft contract, last revision designated 9/15/65, incorporates these decisions. In addition, however, we have revised Article 4(a) by eliminating item 4(a)(1) of the 8/13/65 draft contract. The revision was made pursuant to the suggestion of the Project Manager and was discussed at our meeting with the Chairman of the Contract Negotiating Committee, the Attorney for the District, and the District Manager, September 14, 1965. The Board, during its meeting September 20, 1965, gave unanimous approval to the revision. Item (1) of that article in the 8/13/65 draft contract was deleted because

CENTRAL UTAH WATER CONSERVANCY DISTRICT
P.O. BOX 1405 PROVO, UTAH 84601
TELEPHONE 373 9681

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RESOLUTION

WHEREAS, the Board of Directors of the Central Utah Water Conservancy District with its principal office and place of business at Provo, Utah, has considered a draft of contract proposed to be entered into between the United States of America and the District to repay the reimbursable costs of the Bonneville Unit, Central Utah Project (Initial Phase), authorized pursuant to the Act of Congress of April 11, 1956 (70 Stat.105).

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors hereby approves the draft of contract designated "R. O. Draft 1-4-65, revised 6-1-65, 8-10-65, 8-13-65, 9-15-65", titled "Repayment Contract Between the United States of America and the Central Utah Water Conservancy District," and urgently requests the Secretary of the Interior to approve said draft for execution as soon as possible, and

BE IT FURTHER RESOLVED that, upon such approval, the Board will call an election within the District as provided by law, and will recommend favorable action by the electors, and upon a favorable vote of said electorate, will direct the President and Secretary of the District to execute said contract.

CERTIFICATE

I, Lynn S. Ludlow, Secretary of the Board of Directors of the Central Utah Water Conservancy District, do hereby certify that the foregoing is a full, true and correct copy of a resolution duly adopted by the Board of Directors of the Central Utah Water Conservancy District at a special meeting held on the 20th day of September, 1965. Said meeting having been duly called and being attended by a legally constituted quorum of officers and directors of said District, and

I further certify that 14 directors voted in favor of said resolution and that no directors voted against said resolution.

I further certify that the total number of directors of the Central Utah Water Conservancy District is seventeen (17).

Dated at Provo, Utah this 20th day of September, 1965.

Lynn S. Ludlow

Lynn S. Ludlow, Secretary

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Contract No. 14-06-400-4286
Amendment No. 2 (RRA)

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AMENDATORY CONTRACT BETWEEN THE UNITED STATES OF AMERICA AND CENTRAL UTAH WATER CONSERVANCY DISTRICT FOR CONFORMANCE WITH THE RECLAMATION REFORM ACT OF 1982 (TITLE II, PUBLIC LAW 97-293)

This CONTRACT AMENDMENT, made this 16 day of January 19 86, authorized pursuant to Federal Reclamation laws, the Act of June 17, 1902 (32 Stat. 388), and all acts amendatory thereof and supplementary thereto, is between the UNITED STATES OF AMERICA, represented by the Contracting Officer executing this amendment, and the CENTRAL UTAH WATER CONSERVANCY DISTRICT, hereinafter called the Contractor. This amendment shall be solely to conform the existing contract to Sections 203 through 230 of the Reclamation Reform Act of 1982 and shall become effective as of the date the Contractor's request was submitted to the Contracting Officer - October 4, 1984.

Article Nos. 27, 28, 29, and 30 of the existing Contract No. 14-06-400-4286 (as amended) are hereby deleted. The following article is designated Article 27 of the contract. All other contract provisions shall in no way or manner be affected by this amendment. The Contractor hereby accepts this contract amendment subject to the terms, provisions, and conditions, expressed or implied, herein.

RECLAMATION REFORM ACT PROVISION

The parties agree that the delivery of irrigation water or use of Federal facilities pursuant to this contract is subject to the Reclamation Reform Act of 1982 (Public Law 97-293).

UNITED STATES OF AMERICA

BY Eric Cooper
Regional Director
Upper Colorado Region
Bureau of Reclamation

"Appd. Sol. Off.
W. R. McCorkle"

ATTEST:

Secretary

CENTRAL UTAH WATER CONSERVANCY DISTRICT

BY Don A. Christiansen
President

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT - INITIAL PHASE
(A Participating Project of the Colorado River Storage Project)
BONNEVILLE UNIT
SUPPLEMENTAL REPAYMENT CONTRACT
BETWEEN THE
UNITED STATES OF AMERICA
AND THE
CENTRAL UTAH WATER CONSERVANCY DISTRICT
UTAH

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT - INITIAL PHASE
(A Participating Project of the Colorado River Storage Project)
BONNEVILLE UNIT
SUPPLEMENTAL REPAYMENT CONTRACT
BETWEEN THE
UNITED STATES OF AMERICA
AND THE
CENTRAL UTAH WATER CONSERVANCY DISTRICT
UTAH

THIS SUPPLEMENTAL CONTRACT, made this 26th day of November, 1985, between the UNITED STATES OF AMERICA, acting through the Secretary of the Interior or his designated representative, hereinafter called Contracting Officer, and pursuant to the Federal Reclamation Laws, and the CENTRAL UTAH WATER CONSERVANCY DISTRICT, a water conservancy district organized and existing pursuant to laws of the State of Utah, and particularly the Water Conservancy Act, Section 73-9-1 et seq., Utah Code annotated, 1953, as amended, hereinafter called the Contractor, with its principal place of business and office at Orem, Utah County, Utah,

WITNESSETH That:

WHEREAS, the following statements are made in explanation: The Act of Congress approved April 11, 1956 (70 Stat. 105), authorized the construction, operation, and maintenance of the initial phase of the Central Utah Project as a participating project of the Colorado River Storage Project, of which the Bonneville Unit is a part, which Bonneville Unit is hereinafter called the Project. The Contracting Officer has investigated, planned, and is

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constructing the Project in accordance with the 1964 Definite Plan Report as it has been or may be modified as allowed by the 1965 Repayment Contract for storage, diversion, salvage and distribution of waters of the Colorado River and Bonneville Basin drainage areas for irrigation, municipal and industrial use, generation of electric power, water quality control, flood control, recreation, fish and wildlife purposes, drainage of Project land, and other uses.

The parties hereto entered into a contract on the 28th day of December, 1965, which contract, as amended, is identified as Contract No. 14-06-400-4286, hereinafter referred to as the 1965 Repayment Contract. That contract provides, among other things, for the Contractor to pay the reimbursable costs allocated to irrigation use, up to the irrigators' ability to pay as provided for in the 1965 Repayment Contract, and also to repay the reimbursable costs allocated to municipal and industrial use, up to an amount now agreed by the parties to be $140,408,000, which said sum will bear interest on the unpaid principal balance at a rate to be established under appropriate laws, as outlined in Article 6(c) thereof. It is agreed that the anticipated reimbursable municipal and industrial water costs are going to exceed the $140,408,000. It is also agreed that pursuant to an arrangement negotiated by the parties in 1981, the Contractor has prepaid $10,000,000 of costs of Jordan Aqueduct Reach 4 and Alpine Aqueduct Reach 3.

Due to a lengthened construction period, inflation, and other causes, the Contractor's repayment obligation in the 1965 Repayment Contract now is not adequate to cover the anticipated reimbursable costs to be allo-

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cated to municipal and industrial water upon completion of the Project. It is therefore necessary to supplement the repayment provisions of the municipal and industrial obligation of the 1965 Repayment Contract.

The primary purpose of this supplemental repayment contract is to increase the Contractor's repayment obligation. The obligation hereunder, together with the repayment obligation committed under the 1965 Repayment Contract and the $10,000,000 heretofore prepaid, plus the 66 percent of the cost of the portion of the Jordan Aqueduct system located north of the Utah Valley Treatment Plant which will be paid by Salt Lake County Water Conservancy District and Metropolitan Water District of Salt Lake City under separate contracts, will cover the now anticipated reimbursable costs of the Project to be allocated to municipal and industrial water use.

It is not the intent of this agreement to supersede the 1965 Repayment Contract and that contract shall remain in full force and effect as supplemented herein.

NOW THEREFORE, in consideration of the promises and stipulations herein contained, it is mutually agreed between the parties hereto, that the said 1965 Repayment Contract is hereby supplemented by adding the following:

OBLIGATION AND TERMS OF REPAYMENT

1. (a) Repayment of Project construction costs allocated to supplying municipal and industrial water shall be governed by Federal Reclamation Law, by the 1965 Repayment Contract and by this contract, uti-

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lizing the provisions of the Water Supply Act of 1958 (72 Stat. 320), as amended. The Contractor agrees to pay the reimbursable costs, properly allocated under Federal Reclamation Law to municipal and industrial water use, for the construction of the Project, as outlined in the 1965 Repayment Contract, and an additional amount up to but not exceeding $335,000,000, plus 10 percent ($33,500,000) for cost increases resulting from any, or all, of the following: (1) price increases for construction of Project works; (2) enlargement or changes of Project works; and (3) increases in allotments of municipal and industrial water, including adjustments pursuant to Article 9(d) of the 1965 Repayment Contract.

(1) This $335,000,000 as it may be adjusted, as provided for herein, is intended to supplement the repayment for the allocated reimbursable municipal and industrial costs of the Project works as described in the 1964 Definite Plan Report, as it has been or may be modified or approved as permitted by the 1965 Repayment Contract, using comparable cost and repayment allocations. While the parties hereto anticipate that the remainder of the Project can be completed without a further increase in the reimbursable costs allocated to municipal and industrial water use, this is not guaranteed. Should it appear that the allocated reimbursable municipal and industrial costs will exceed the maximum additional amount to be repaid hereunder, the Contracting Officer shall provide written notice of this finding to the Contractor. The Contracting Officer shall then consult with the Contractor and further commitment of construction funds by the Contracting Officer beyond the supplemental amount covered herein shall be contingent upon implementation of an additional repayment arrangement.

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(2) The parties mutually acknowledge that the total reimbursable costs of the Project to be ultimately allocated to municipal and industrial water use will not be fully known, nor ascertainable, until completion of the Project works. Upon completion, the details of said costs and the allocation thereof which is proposed will be furnished to the Contractor by the Contracting Officer, and the Contractor reserves the right to review the assignment of those costs to the Project and to the Contractor's repayment obligation and the allocation thereof to municipal and industrial water use. Following the review by the Contractor, the final allocation of reimbursable costs will be prepared by the Contracting Officer in accordance with applicable Federal Reclamation Law. The Contractor reserves the right to pursue remedies normally available under law in the event of disagreement over inclusion of any costs or in regard to the final allocation of costs. The Contractor shall have four years from the completion of the final cost allocation to pursue said remedies. The unpaid principal amount thus allocated to municipal and industrial water use will bear interest at a rate established under the provisions of Section 5(f) of the Act of April 11, 1956 (70 Stat. 105), as amended by the Act of June 27, 1960 (74 Stat. 227) P.L. 86-529, as specified in each development block notice, for municipal and industrial water. Each block notice for municipal and industrial water shall provide for repayment over a period as now provided for by Federal Reclamation Law but not to exceed 50 years for each block notice; Provided That, the repayment period for the sixth block notice, providing for the availability of approximately 54,600 acre-feet of water, shall terminate in the same year as the fifth block notice for approximately 19,000 acre-feet of water. The effect of this will

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be to compress the repayment period for the sixth block to a length of time less than 50 years.

(3) The Project repayment obligation is payable by the Contractor in annual installments due on or before February 15th of each year in accordance with payment schedules which will be issued by the Contracting Officer and contained in development block notices provided for in the 1965 Repayment Contract. Payments from the Contractor to the United States through the Contracting Officer will be made by check, wire transfers, or other types of payment specified by the Contracting Officer. The Project repayment obligation will be met by revenues of the Contractor from (1) sales of Project water for municipal and industrial use; (2) ad valorem taxes; (3) class B assessments as provided for in the Utah Water Conservancy Act, Section 73-9-17, Utah Code Annotated, 1953, as amended; (4) annual payment from uses of Project facilities; and (5) miscellaneous revenues, such as Project water rentals, and carriage and storage contracts.

(4) It is further mutually acknowledged that the Contracting Officer intends simultaneously herewith to enter into separate agreements for repayment of 66 percent of the remaining reimbursable costs of Jordan Aqueduct Reaches 1, 2, 3, and 4 north of the Utah Valley Treatment Plant, after application of the $8,300,000 of the $10,000,000 prepayment and for the operation and maintenance thereof and of appurtenant facilities, with the Metropolitan Water District of Salt Lake City and the Salt Lake County Water Conservancy District.

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(5) The payments under this article shall be exclusive of operation, maintenance and replacement costs which are to be paid as provided in Article 12 of the 1965 Repayment Contract.

(6) The 1964 Definite Plan Report contemplated that power features would be constructed on Diamond Fork with Federal funds as part of the Project. The Contractor still desires to have the power features, on Diamond Fork or features in lieu thereof, so constructed, as part of the Project, with capacity sufficient to provide the power necessary for the Contractor as outlined in Article 13 of the 1965 Repayment Contract. Power for Project irrigation purposes will also be made available if said facilities are constructed with non-Federal funds and thus nothing in this supplemental contract stated or implied will change the intent or meaning of Article 13 of the 1965 Repayment Contract.

(7) The Contractor reserves the right to assert its claims as set forth in Subparagraph (b) herein. It is the position of the United States that all provisions of this contract and other actions to which the contractor has requested a reservation of claims were made pursuant to applicable provisions of Reclamation law, and are valid and enforceable.

(b) The Contractor has heretofore requested an adjustment in the total cost to be reimbursed by the Contractor on the basis of (1) certain cost overruns in the construction of the Strawberry Aqueduct and Collection System; (2) relief from paying for any of the costs of the Strawberry Aqueduct and Collection System which were incurred for research, to the extent that

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such research increased the final construction cost or annual operation and maintenance cost; (3) an interest rate of 2.67 percent; and (4) use of Central Utah Project, initial phase, power revenues to assist in reimbursing the costs for municipal and industrial water. The Contractor shall have four years from the date of execution of this contract in which to seek judicial relief on said claims.

(1) However, it is expressly agreed that the Contractor shall not be relieved of its obligation to pay, consistent with the established repayment schedule, the agreed reimbursable costs for municipal and industrial water up to but not exceeding the original amount specified in the 1965 Repayment Contract plus an additional $335,000,000, as might be adjusted by reason of the permitted 10 percent increase therein, plus interest, as provided for herein, because of the failure of the Contractor to obtain judicial relief, or during the pendency of any judicial proceedings regarding the claims, specifically reserved by the Contractor. Such obligation is and shall remain a general obligation of the Contractor, to which the Contractor pledges its full faith and credit.

(c) Notwithstanding the increase in the municipal and industrial repayment obligation provided for herein, it is mutually agreed that the language in Paragraph 6(d) of the 1965 Repayment Contract regarding the minimum amounts and limitations on the ad valorem tax pledge is hereby superceded and the 1/2 mill pledge shall be based upon the actual assessed valuation of property within the Central Utah Water Conservancy District; Provided, however, that such pledge will not exceed the then current annual

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payment. This pledge includes the tax revenue necessary to pay $38,005,000 and $47,000,000 municipal and industrial cost obligation as specified in Article 6 (a) of the 1965 Repayment Contract.

TRANSFER OF MOVABLE PROPERTY

2. Article 2(23) of the 1965 Repayment Contract is hereby supplemented to increase the upper limit by $1,000,000 for value of movable property to be transferred to the Contractor for operation, maintenance, and replacement of Project works for all municipal and industrial water related items, thus increasing the upper limit to $1,500,000.

SEVERABILITY

3. If any provision of this agreement shall, for any reason, be determined to be illegal or unenforceable, the parties, nevertheless, intend that the remainder of the contract shall remain in full force and effect.

RULES, REGULATIONS, AND DETERMINATIONS

4. (a) The Contracting Officer shall have the right to make, after an opportunity has been offered to the Contractor for consultation, rules and regulations consistent with the provisions of this contract, the laws of the United States and the State of Utah, to add to or to modify them as may be deemed proper and necessary to carry out this contract, and to supply necessary details of its administration which are not covered by express provisions of this contract. The Contractor shall observe such rules and regulations.

(b) Where the terms of this contract provide for action to be based upon the opinion or determination of either party to this contract, whether or not stated to be conclusive, said terms shall not be construed as permitting such action to be predicated upon arbitrary, capricious, or unreasonable opinions or determinations. In the event that the Contractor questions any factual determination made by the Contracting Officer, the findings as to the facts shall be made by the Secretary only after consultation with the Contractor and shall be conclusive upon the parties.

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ASSIGNMENT LIMITED--SUCCESSORS AND ASSIGNS OBLIGATED

5. The provisions of this contract shall apply to and bind the successors and assigns of the parties hereto, but no assignment or transfer of this contract or any part or interest therein shall be valid until approved by the Contracting Officer.

EQUAL OPPORTUNITY

6. (a) During the performance of this contract, the Contractor agrees as follows:

(1) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of this nondiscrimination clause.

(2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without discrimination because of race, color, religion, sex, or national origin.

(3) The Contractor will send to each labor union or representative of workers, with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the Contracting Officer, advising the said labor union or workers' representative of the Contractor's commitments under Section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) The Contractor will furnish all information and reports required by said amended Executive Order and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the Contracting Officer and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulation, and orders.

(6) In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules,

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regulations, or orders, this contract may be cancelled, terminated, or suspended, in whole or in part, and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in said amended Executive Order, and such other sanctions may be imposed and remedies invoked as provided in said Executive Order, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The Contractor will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of said amended Executive Order, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions, including sanctions for noncompliance; Provided, however, That in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

TITLE VI, CIVIL RIGHTS ACT OF 1964

7. (a) The Contractor agrees that it will comply with Title VI of the Civil Rights Act of July 2, 1964 (78 Stat. 241) and all requirements imposed by or pursuant to the Department of the Interior Regulation (43 CFR 17) issued pursuant to that title, to the end that, in accordance with Title VI of that Act and the Regulation, no person in the United States shall, on the grounds of race, color, or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Contractor receives financial assistance from the United States and hereby gives assurance that it will immediately take any measures to effectuate this agreement.

(b) If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Contractor by the United States, this assurance obligates the Contractor, or in the case of any transfer of such property, any transferee for the period during which the real property or structure is used for a purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance obligates the Contractor for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Contractor for the period during which the Federal financial assistance is extended to it by the United States.

(c) This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contacts, property, discounts, or other Federal financial assistance extended after the date hereof to the Contractor by the United States, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Contractor recognizes and agrees that such Federal financial assistance will be extended in reliance on the

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representations and agreements made in this assurance, and that the United States shall reserve the right to seek judicial enforcement of this assurance. This assurance is binding on the Contractor, its successors, transferees, and assignees.

WATER CONSERVATION PROGRAM

8. (a) While the contents and standards of a given water conservation program are primarily matters of State and local determination, there is a strong Federal interest in developing an effective water conservation program because of this contract. The Contractor shall develop and implement an effective water conservation program for all uses of water which is provided from, or conveyed through, Federally constructed or Federally financed facilities. That water conservation program shall contain definite goals, appropriate water conservation measures, and time schedules for meeting the water conservation objectives.

(b) A water conservation program, acceptable to the Contracting Officer, shall be in existence prior to one or all of the following: (1) service of Federally stored/conveyed water; (2) transfer of operation and maintenance of the project facilities to the Contractor; or (3) transfer of the project to an operation and maintenance status. The distribution and use of Federally stored/conveyed water and/or the operation of project facilities transferred to the Contractor shall be consistent with the adopted water conservation program. Following execution of this contract, and at subsequent 5-year intervals, the Contractor shall resubmit the water conservation plan to the Contracting Officer for review and approval. After review of the results of the previous 5 years and after consultation with the Contractor, the Contracting Officer may require modifications in the water conservation program to better achieve program goals.

CONFIRMATION OF CONTRACT

9. The execution of this contract shall be authorized or ratified by the qualified electors of the Contractor at an election held for that purpose. The Contractor, after the election and upon the execution of this contract, shall promptly secure a final decree of the proper court of the State of Utah approving and confirming the contract and decreeing and adjudging it and the apportionment of the benefits made thereunder to be lawful, valid, and binding on the Contractor. The Contractor shall furnish to the United States a certified copy of such decree and of all pertinent supporting records.

ADMINISTRATION OF PROJECT LANDS

10. The lands and rights-of-way acquired and needed by the United States for the purposes of care, operation, and maintenance of project works may be used by the Contractor for such purposes. The Contractor shall not, except with prior written permission from the Contracting Officer, issue rights-of-way across project land, issue land rights to project lands, or issue leases, licenses, permits, or special use agreements involving project

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land, rights-of-way, or transferred works. Unless otherwise provided, all such land use instruments shall only be issued by the Contracting Officer. Lands and rights-of-way withdrawn or acquired primarily for, or later determined to be used for, recreation, fish and wildlife enhancement or mitigation, or other special purposes, shall be reserved primarily for those purposes; any other land or rights-of-way use shall be secondary in nature and compatible with said recreation, fish and wildlife, or special purpose uses.

WATER AND AIR POLLUTION CONTROL

11. The Contractor, in carrying out this contract, shall comply with all applicable water and air pollution laws and regulations of the United States and the State of Utah and shall obtain all required permits or licenses from the appropriate Federal, State, or local authorities.

NOTICES

12. Any notice, demand, or request authorized or required by this contract shall be deemed to have been given, on behalf of the Contractor, when mailed, postage prepaid, or delivered to the Regional Director, Upper Colorado Region, Bureau of Reclamation, 125 South State Street, P.O. Box 11568, Salt Lake City, Utah 84147, and on behalf of the United States, when mailed, postage prepaid, or delivered to the Central Utah Water Conservancy District, P.O. Box 427, 335 West 1300 South, Orem, Utah 84057. The designation of the addressee or the address may be changed by notice given in the same manner as provided in this article for other notices.

CHARGE FOR LATE PAYMENTS

13. The Contractor shall pay a late payment charge on installments or charges which are received after the due date. The late payment charge percentage rate calculated by the Department of the Treasury and published quarterly in the Federal Register will be used; Provided, That the late payment charge percentage rate will not be less than 0.5 percent per month. The late payment charge percentage rate applied on an overdue payment will remain in effect until payment is received. The late payment rate for a 30-day period will be determined on the day immediately following the due date and will be applied to the overdue payment for any portion of the 30-day period of delinquency. In the case of partial late payments, the amount received will first be applied to the late charge on the overdue payment and then to the overdue payment.

This provision for a late payment charge shall apply only to the repayment obligation created by this supplemental contract and the delinquency penalty (1/2 percent per month) provided for by Article 23 of the 1965 Repayment Contract as to that repayment obligation shall remain in the same.

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ALL OTHER PROVISIONS TO REMAIN THE SAME

14. All other provisions of the said Government-District 1965 Repayment Contract identified by Contract No. 14-06-400-4286, dated December 28, 1965, as amended not expressly changed or supplemented herein or not in conflict herewith and all rights, claims, and obligations thereunder shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this supplemental contract as of the day first above written.

THE UNITED STATES OF AMERICA

By _____
Regional Director, Bureau of Reclamation
Upper Colorado Region

ATTEST:

CENTRAL UTAH WATER CONSERVANCY DISTRICT

_____
Secretary

By _____
President

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RESOLUTION

RESOLVED, that the Board of Directors of the Central Utah Water Conservancy District, having determined pursuant to the provisions of the Utah Municipal Bond Act, as amended, (Title 11, Chapter 4), and the Utah Water Conservancy Act, as amended, (Title 73, Chapter 9), that a majority of the qualified electors of the District have assented to the District entering into the Supplemental Repayment contract, and the Board, therefore, being authorized to enter into the contract,

NOW, THEREFORE, BE IT RESOLVED, that Robert B. Hilbert, as Chairman of the Board of Directors and Don A. Christiansen, as Secretary of the Board of Directors of the Central Utah Water Conservancy District, are hereby authorized on behalf of the Central Utah Water Conservancy District to execute and deliver to the United States the Supplemental Repayment contract. A copy of said Supplemental Repayment Contract, which has been heretofore approved by the Board, is attached to this resolution and is by this reference incorporated herein.

Dated this 26th day of November, 1985.

Robert B. Hilbert, Chairman

Don A. Christiansen

Don A. Christiansen, Secretary

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CERTIFICATE

I, Don A. Christiansen, Secretary of the Board of Directors of the Central Utah Water Conservancy District, do hererby certify that the foregoing is a full, true, and correct copy of a Resolution duly adopted by the Board of Directors of the Central Utah Water Conservancy District at a special public meeting held on the 26th day of November, 1985.

Said meeting, having been duly called and being attended by a legally constituted quorum of officers and Directors of said District, and, I further certify that 18 directors voted in favor of said resolution, and 1 director voted against said resolution.

I further certify that the total number of Directors of the Central Utah Water Conservancy District is 19.

Dated at Orem, Utah this 26th day of November, 1985.

Don A. Christiansen

Don A. Christiansen, Secretary

5-20-20-12-3

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FILED
FEB 10 PM 1:11

IN THE FOURTH JUDICIAL DISTRICT COURT

STATE OF UTAH

IN THE MATTER OF THE CENTRAL UTAH WATER CONSERVANCY DISTRICT	:	JUDGMENT RE: JUDICIAL EXAMINATION OF PROCEEDINGS AUTHORIZING EXECUTION OF A SUPPLEMENTAL REPAYMENT CONTRACT WITH UNITED STATES FOR CONTINUED CONSTRUCTION OF CENTRAL UTAH PROJECT BONNEVILLE UNIT WORKS, AND FOR DETERMINATION OF THE VALIDITY OF SUCH PROCEEDINGS AND CONTRACT No. 26,924

This matter, having come on for hearing before the above entitled court at 2:00 p.m., on February 7, 1986, with the Honorable Ray M. Harding, Sr., Judge thereof, presiding, and it appearing to the court that notice haS been published and posted as required by law and the order of this Court, and affidavits of posting and of publication having been filed with the court, and

It further appearing that there have been no written protests filed in opposition to the petition and that no one appeared personally in opposition thereto, and the Court having reviewed the allegations of the verified petition on file herein and having considered the documentary evidence introduced at said hearing and being now fully advised in the premises, hereby grants said petition and ORDERS, ADJUDGES AND DECREES as follows:

1. This proceeding was brought pursuant to the provisions of Section 73-9-36, Utah Code Annotated, 1953, as amended.

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2. Petitioner Central Utah Water Conservancy District is a water conservancy district organized and existing under and by virtue of the laws of the State of Utah, and particularly under the provisions of Chapter 9, Title 73, Utah Code Annotated 1953, and as amended, and is vested with the powers as in said chapter provided.

3. Petitioner has heretofore determined that the interest of the District and the public interest and necessity demand that there be constructed what is generally known as the Central Utah Project Bonneville Unit Works, to conserve and make available for beneficial use waters of the Colorado River and its tributaries and other sources of water within the District, for domestic, irrigation, power and miscellaneous purposes, with incidental benefits for flood control, recreation, fish and wildlife purposes. To effect such construction, Petitioner in 1965 negotiated and executed a Repayment Contract with the United States, acting by and through its Bureau of Reclamation, calling for the construction by the United States of said Central Utah Project Bonneville Unit Works for the diversion, storage and distribution of water of the Colorado River, and its tributaries, and water from other sources for irrigation, municipal and industrial use, generation of electric power, flood control, recreation, fish and wildlife purposes, and for drainage of project land, all as set forth in said contract.

Said 1965 Repayment Contract was submitted to the voters for approval and was approved by the voters, and thereafter the Petitioner filed a petition for the judicial examination of the

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proceedings authorizing the execution of that contract and the court, by a judgment entered on February 17, 1966, decreed that said 1965 Repayment Contract is a valid contract binding on and enforceable in accordance with its terms.

4. The repayment amount agreed upon under the 1965 Repayment Contract was not adequate to pay the reimbursable costs of completing the Central Utah Project Bonneville Unit Works and the District and the United States have negotiated a Supplemental Repayment Contract (Contract No. 14-06-400-4286) providing for an additional repayment obligation on the part of the Petitioner of not to exceed $335 million plus 10% thereof for contingencies.

5. Pursuant to a resolution duly adopted on September 12, 1985, and a resolution adopted on October 10, 1985, a special election was called by the Board of Directors to be held on November 19, 1985, for the purpose of submitting to the qualified registered electors of the Petitioner the following proposition:

PROPOSITION

> Shall The Central Utah Water Conservancy District ("the District") enter into a Supplemental Repayment Contract with the United States of America for the continued construction of the Central Utah Project Bonneville Unit works and the acquisition of a municipal and industrial water supply for the District, at an additional reimbursable cost to the District of not to exceed $335,000,000, plus ten percent thereof ($33,500,000) for certain cost increases, for a total of not to exceed $368,500,000 (which sum is in addition to a present repayment obligation allocated to municipal and industrial water use of $140,408,000 committed and authorized under the original Repayment Contract executed December 28, 1965, and is also in addition to the payment of $10,000,000, which payment has heretofore been made by the District in connection with the Jordan and Alpine Aqueduct systems and is in addition to sixty-six percent of the cost of the Jordan Aqueduct which was included in the 1965 Repayment Contract, but which has now been assumed by others) repayable over the installment period provided for under present Federal Reclamation law,

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but, in no event, in excess of 50 years, with interest at a rate to be established pursuant to the provisions of Section 5(f) of the Act of April 11, 1956 (70 Stat. 105), as amended by the Act of June 27, 1960, (74 Stat. 227), not to exceed 3.222 percent per annum, and with a charge on delinquencies at a rate equal to not less than one-half percent (½%) per month, all in accordance with the terms and conditions of the draft of the Supplemental Repayment Contract referred to in the Resolution by which this election is called?

6. Thereafter said election was duly held as called by the resolution of the Board of Directors of the Petitioner as aforesaid, fully in accordance with all applicable statutes, including the Utah Municipal Bond Act, Title 11 Chapter 24 Utah Code Annotated, as amended, and the Utah Water Conservancy Act, Title 73 Chapter 9, Utah Code Annotated, as amended; and on November 26, 1985, in accordance with the aforesaid resolution and in accordance with all applicable law, the Board of Directors of the Petitioner met to determine the results of said election and did determine that at said election the aforesaid proposition had been approved by a majority of the electors of the Petitioner qualified to vote thereon and who had voted at said election; and said Board of Directors thereafter on November 26, 1985, duly adopted a resolution so determining the results of said election and authorized the Board of Directors of the Petitioner to enter into the said Supplemental Repayment Contract with the United States on behalf of the Petitioner, as provided in said proposition. The said Board further authorized and directed the President and Secretary of the Petitioner forthwith to execute such contract on behalf of said Petitioner.

7. Thereafter on the 26th day of November, 1985, and pursuant to the aforesaid Resolution, the President and Secretary

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of the Petitioner duly executed on behalf of the Petitioner and in its name the said Supplemental Repayment Contract with the United States.

8. Petitioner executed said Supplemental Repayment Contract in full compliance with the authority and powers conferred upon the Petitioner by law and pursuant to a resolution duly adopted by the Board of Directors of the Central Utah Water Conservancy District.

9. The whole of the proceedings authorizing the execution of said contract, including the election held November 19, 1985, are lawful and valid and that the execution of the aforesaid contract was and is within the lawful powers of the Petitioner and of its Board of Directors and said powers have in all respects been properly and legally exercised.

10. The proceedings of the Central Utah Water Conservancy District and of its Board of Directors authorizing the execution of the Supplemental Repayment Contract No. 14-06-400-4286 with the United States of America and the execution thereof are valid and enforceable in accordance with its terms.

Dated this 10th day of February, 1986.

BY THE COURT:

District Judge

STATE OF UTAH } SS
COUNTY OF UTAH }

I, THE UNDERSIGNED, CLERK OF THE DISTRICT COURT OF UTAH COUNTY, UTAH, DO HEREBY CERTIFY THAT THE ANNEXED AND FOREGOING IS A TRUE AND FULL COPY OF AN ORIGINAL DOCUMENT ON FILE IN MY OFFICE AS SUCH CLERK.

WITNESS MY HAND AND SEAL OF SAID COURT THIS 10 DAY OF Feb. 1986

WILLIAM F. HUISH, CLERK

BY Marilyn Lindemann DEPUTY

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Central Utah Water Conservancy District Vote
on Supplemental Repayment Contract
November 19, 1985

County	For	Against	Percent For
Duchesne	1,015	941	52
Garfield	212	174	55
Juab	881	129	87
Millard	1,466	401	79
Piute	216	74	75
Salt Lake	42,480	13,812	76
San Pete	1,611	500	76
Sevier	1,849	773	71
Summit	95	54	64
Uintah	658	1,542	30
Utah	16,498	6,090	73
Wasatch	853	1,090	44
Total	67,834	25,580	73

----------ELECTION RESULTS----------

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COUNTY	FOR	AGAINST	TOTAL DISTRICTS	DISTRICTS REPORTED	PERCENT REPORTED
Duchesne	1015	941	7	7	100
Garfield	212	174	4	4	100
Juab	882	129	5	5	100
Millard	1466	401	16	16	100
Piute	216	74	5	5	100
Salt Lake	42480	13812	176	176	100
Sanpete	1611	500	16	16	100
Sevier	1849	773	17	17	100
Summit	95	54	1	1	100
Uintah	658	1542	8	8	100
Utah	16498	6090	43	43	100
Wasatch	853	1090	8	8	100
Total	67835	25580	306	306	100

Time: 09:52:41

Percentage of People Who Voted 19%

Total Number of Districts 307

Districts Against 17

Breakdown of Districts Against

Utah
203 (1 District)

Duchesne
222
223 (3 Districts)
224

Garfield
203 (1 District)

Uintah
291
292
293
294 (8 Districts)
295
296
297
298

Wasatch
299
300 (4 Districts)
301
303

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DIST#	DISTRICT/JUDGE NAME	ADDRESS	CITY	ST	ZIP	PAYMENT	FOR	AGAINST
DU220	DUCHESNE COURT HOUSE	50 EAST 100 SOUTH	DUCHESNE	UT	84021	.00	374	213
DU221	LDS WARD HOUSE		FRUITLAND	UT	84027	.00	20	13
DU222	ALTAMONT CITY HALL		ALTAMONT	UT	84001	.00	117	182
DU223	NEOLA ELEMENTARY SCHOOL		NEOLA	UT	84053	.00	38	97
DU224	MYTON ELEMENTARY		MYTON	UT	84052	.00	77	105
DU225	EAST ROOSEVELT ELEMENTARY	700 E 400 N	ROOSEVELT	UT	84066	.00	329	274
DU226	TABIONA HIGH SCHOOL		TABIONA	UT	84072	.00	60	57
GA227	PANGUITCH COURTHOUSE	55 S MAIN	PANGUITCH	UT	84759	.00	132	101
GA228	LDS WARD HOUSE		ANTIMONY	UT	84712	.00	23	10
GA229	HATCH TOWN HALL		HATCH	UT	84735	.00	38	14
GA230	TROPIC SCOUT HOUSE		TROPIC	UT	84776	.00	19	49
JU231	JUAB COUNTY CENTER	160 NORTH MAIN	NEPHI	UT	84648	.00	301	40
JU232	NEPHI CITY BUILDING	146 NORTH MAIN	NEPHI	UT	84648	.00	313	23
JU233	EUREKA CITY HALL		EUREKA	UT	84628	.00	67	24
JU234	LEVAN COURTHOUSE		LEVAN	UT	84639	.00	105	17
JU235	MONA COURTHOUSE		MONA	UT	84645	.00	96	25
MI236	NATIONAL GUARD ARMORY	35 WEST CENTER STREET	FILLMORE	UT	84631	.00	244	110
MI237	MEADOW TOWN HALL	100 E 50 S	MEADOW	UT	84644	.00	58	22
MI238	KANOSH TOWN HALL	61 N MAIN STREET	KANOSH	UT	84637	.00	79	41
MI239	DESERET WARD		DESERET	UT	84624	.00	45	6
MI240	OAK CITY WARD		OAK CITY	UT	84649	.00	70	33
MI241	LEAMINGTON TOWN HALL	(OLD CHURCH)	LEAMINGTON	UT	84638	.00	57	9
MI242	HOLDEN TOWN HALL		HOLDEN	UT	84636	.00	107	32
MI243	NEW FIRE HOUSE		SCIPIO	UT	84656	.00	46	30
MI244	OASIS WARD		OASIS	UT	84650	.00	56	10
MI245	HINCKLEY CITY BUILDING		HINCKLEY	UT	84635	.00	110	15
MI246	SHERMAN TOLBERT HOME		ABRAHAM	UT	84635	.00	34	6
MI247	GARRISON SCHOOL HOUSE		GARRISON	UT	84728	.00	11	7
MI248	PARKS & RECREATION BLDG	81 MANZANITA AVE	DELTA	UT	84624	.00	324	55
MI249	LAWRENCE BRADFIELD HOME		LYNNDYL	UT	84640	.00	35	0
MI250	SUTHERLAND WARD		SUTHERLAND	UT	84624	.00	140	14
MI251	FLOWELL ELECTRIC BUILDING	500 N 3200 W	FLOWELL	UT	84631	.00	50	11
PI252	MARYSVALE CITY HALL		MARYSVALE	UT	84750	.00	53	32
PI253	JUNCTION COURTHOUSE	HIGHWAY 89	JUNCTION	UT	84740	.00	39	7
PI254	CIRCLEVILLE CITY HALL		CIRCLEVILLE	UT	84723	.00	68	17
PI255	KINGSTON TOWN HALL		KINGSTON	UT	84743	.00	33	14
PI256	GREENWICH TOWN HALL		GREENWICH	UT	84744	.00	23	4
SA257	AXTELL WARD HOUSE		AXTELL	UT	84621	.00	34	12
SA258	ELDORA MARNUM RESIDENCE		CHESTER	UT	84623	.00	14	3
SA259	JOHN L. BIGLER RESIDENCE	9275 N 2200 W	INDIANOLA	UT	84629	.00	10	0
SA260	MACK VANCE HOME	5575 N MILBURN ROAD	MILBURN	UT	84629	.00	14	9
SA261	GUNNISON CITY HALL		GUNNISON	UT	84634	.00	302	54
SA262	EPHRAIM CITY HALL	11 SOUTH MAIN	EPHRAIM	UT	84627	.00	287	66
SA263	FAIRVIEW CITY HALL	85 SOUTH STATE STREET	FAIRVIEW	UT	84629	.00	149	48
SA264	FAYETTE CITY HALL		FAYETTE	UT	84630	.00	23	30
SA265	FOUNTAIN GREEN CITY HALL	84 SOUTH STATE	FOUNTAIN GREEN	UT	84632	.00	53	39
SA266	MANTI LIBRARY	20 SOUTH MAIN	MANTI	UT	84642	.00	230	73
SA267	MAYFIELD CITY HALL		MAYFIELD	UT	84643	.00	61	14
SA268	MORONI CITY HALL	36 NORTH CENTER	MORONI	UT	84646	.00	109	27
SA269	MT PLEASANT CITY HALL	115 WEST MAIN	MT PLEASANT	UT	84647	.00	156	72
SA270	SPRING CITY HALL		SPRING CITY	UT	84662	.00	71	29
SA271	STERLING CITY HALL		STERLING	UT	84665	.00	46	5
SA272	WALES LDS CHURCH		WALES	UT	84667	.00	42	5
SE273	ANNEBELLA TOWN HALL		ANNABELLA	UT	84711	.00	74	39
SE274	AURORA CITY HALL	204 W 220 N	AURORA	UT	84620	.00	112	30
SE275	CLAUDETTE BROWN HOME		CENTRAL	UT	84754	.00	63	19
SE276	ELSINORE TOWN HALL		ELSINORE	UT	84724	.00	81	49

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DIST#	DISTRICT/JUDGE NAME	ADDRESS	CITY	ST	ZIP	PAYMENT	FOR	AGAINST
SE277	LDS CHURCH	225 E CENTER	GLENWOOD	UT	84730	.00	52	20
SE278	JOSEPH TOWN HALL		JOSEPH	UT	84739	.00	58	26
SE279	MONROE CITY HALL	10 NORTH MAIN	MONROE	UT	84754	.00	247	103
SE280	REDMOND TOWN HALL		REDMOND	UT	84652	.00	82	34
SE281	RICHFIELD COURTHOUSE	250 NORTH MAIN	RICHFIELD	UT	84701	.00	151	76
SE282	RICHFIELD SR. CITIZENS CT	890 NORTH 300 WEST	RICHFIELD	UT	84701	.00	165	50
SE283	RICHFIELD ARMORY	620 WEST 200 SOUTH	RICHFIELD	UT	84701	.00	179	78
SE284	SALINA CITY HALL	90 WEST MAIN	SALINA	UT	84654	.00	140	65
SE285	SALINA LEGION HALL		SALINA	UT	84654	.00	93	57
SE286	SIGURD LDS CHURCH		SIGURD	UT	84657	.00	78	27
SE287	KOOSHAREM TOWN HALL		KOOSHAREM	UT	84744	.00	34	14
SE288	VENICE LDS CHURCH		VENICE	UT	84701	.00	76	18
SE289	RICHFIELD FIRE HOUSE	225 SOUTH MAIN	RICHFIELD	UT	84701	.00	136	68
SL001	CENTRAL CITY COMMNTY CTR	615 SOUTH 300 EAST	SALT LAKE CITY	UT	84111	.00	58	42
SL002	LINCOLN SCHOOL	1090 ROBERTA STREET	SALT LAKE CITY	UT	84111	.00	197	85
SL003	SOUTH HIGH SCHOOL	1575 SOUTH STATE ST	SALT LAKE CITY	UT	84115	.00	183	94
SL004	ROOSEVELT BUILDING #1	843 LINCOLN STREET	SALT LAKE CITY	UT	84102	.00	92	61
SL005	HAWTHORNE SCHOOL #1	644 MILTON AVENUE	SALT LAKE CITY	UT	84105	.00	265	149
SL006	EMERSON SCHOOL	1017 HARRISON AVENUE	SALT LAKE CITY	UT	84105	.00	216	139
SL007	ROOSEVELT BUILDING #2	843 LINCOLN STREET	SALT LAKE CITY	UT	84102	.00	168	137
SL008	UINTAH SCHOOL #1	1227 SOUTH 1500 EAST	SALT LAKE CITY	UT	84105	.00	247	108
SL009	EAST HIGH AUDITORIUM	890 SOUTH 1300 EAST	SALT LAKE CITY	UT	84102	.00	284	170
SL010	UINTAH SCHOOL #2	1227 SOUTH 1500 EAST	SALT LAKE CITY	UT	84105	.00	259	114
SL011	FRIENDSHIP MANOR	1320 EAST 500 SOUTH	SALT LAKE CITY	UT	84121	.00	190	111
SL012	CLAYTON INTERMEDIATE SCHL	1471 SOUTH 1800 EAST	SALT LAKE CITY	UT	84108	.00	360	117
SL013	BONNEVILLE SCHOOL	1145 SOUTH 1900 EAST	SALT LAKE CITY	UT	84108	.00	438	176
SL014	POLICE ATHLETIC LEAGUE	855 CALIFORNIA AVENUE	SALT LAKE CITY	UT	84104	.00	171	65
SL015	FRANKIN SCHOOL	1100 WEST 400 SOUTH	SALT LAKE CITY	UT	84104	.00	65	36
SL016	EDISON SCHOOL	466 CHEYENNE	SALT LAKE CITY	UT	84104	.00	104	76
SL017	PARKVIEW SCHOOL	1250 MEAD AVE	SALT LAKE CITY	UT	84104	.00	282	75
SL018	MOUNTAIN VIEW SCHOOL	1415 CALIFORNIA AVE	SALT LAKE CITY	UT	84104	.00	211	94
SL019	WASHINGTON SCHOOL	420 NORTH 200 WEST	SALT LAKE CITY	UT	84103	.00	217	137
SL020	WEST HIGH SCHOOL	241 NORTH 300 WEST	SALT LAKE CITY	UT	84103	.00	182	44
SL021	JACKSON SCHOOL	750 WEST 200 NORTH	SALT LAKE CITY	UT	84116	.00	239	78
SL022	ROSEPARK SCHOOL	1130 STERLING	SALT LAKE CITY	UT	84116	.00	361	169
SL023	BACKMAN SCHOOL	1450 WEST 600 NORTH	SALT LAKE CITY	UT	84116	.00	253	83
SL024	MEADOWLARK SCHOOL	497 N MORTON DR	SALT LAKE CITY	UT	84116	.00	84	44
SL025	NEWMAN SCHOOL	1269 N COLORADO	SALT LAKE CITY	UT	84116	.00	310	101
SL026	CASTLE HEIGHTS APTS	141 FIRST AVE	SALT LAKE CITY	UT	84103	.00	207	65
SL027	LOWELL SCHOOL #1	134 "D" ST	SALT LAKE CITY	UT	84103	.00	130	99
SL028	LOWELL SCHOOL #2	134 "D" ST	SALT LAKE CITY	UT	84103	.00	163	125
SL029	ENSIGN SCHOOL #1	775 TWELFTH AVE	SALT LAKE CITY	UT	84103	.00	203	115
SL030	WASATCH SCHOOL #2	30 "R" ST	SALT LAKE CITY	UT	84103	.00	181	128
SL031	ENSIGN SCHOOL #2	775 TWELFTH AVE	SALT LAKE CITY	UT	84103	.00	345	112
SL032	WASATCH SCHOOL #1	30 "R" ST	SALT LAKE CITY	UT	84103	.00	308	181
SL033	CITY & COUNTY BUILDING	SOUTH END SECOND FLOOR	SALT LAKE CITY	UT	84101	.00	80	27
SL034	SALT LAKE CITY SCHL ADM	440 EAST 100 SOUTH	SALT LAKE CITY	UT	84110	.00	73	48
SL035	M LYNN BENNION SCHOOL	429 S 800 E	SALT LAKE CITY	UT	84102	.00	133	62
SL036	BRYANT INTERMIDATE SCH #1	40 S 800 E	SALT LAKE CITY	UT	84103	.00	110	79
SL037	BRYANT INTERMIDATE SCH #2	40 S 800 E	SALT LAKE CITY	UT	84103	.00	112	89
SL038	EAST VILLAGE COMMNTY CNTR		SALT LAKE CITY	UT	84108	.00	62	24
SL039	COUNTY COMPLEX BLDG #3	135 E 2100 S	SALT LAKE CITY	UT	84115	.00	157	54
SL040	HAWTHORNE SCHOOL #2	644 MILTON AVE	SALT LAKE CITY	UT	84105	.00	181	96
SL041	NIBLEY PARK SCHOOL #1	2785 S 800 E	SALT LAKE CITY	UT	84106	.00	170	88
SL042	WESTMINSTER COLLEGE	SHAW CENTER	SALT LAKE CITY	UT	84105	.00	119	65
SL043	NIBLEY PARK SCHOOL #2	2785 S 800 E	SALT LAKE CITY	UT	84106	.00	242	84
SL044	HIGHLAND PARK SCHOOL #1	1758 E 2700 S	SALT LAKE CITY	UT	84106	.00	363	125

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DIST#	DISTRICT/JUDGE NAME	ADDRESS	CITY	ST	ZIP	PAYMENT	FOR	AGAINST
SL045	GARFIELD SCHOOL	1838 S 1500 E	SALT LAKE CITY	UT	84105	.00	251	137
SL046	HIGHLAND HIGH SCHOOL	2166 S 1700 E	SALT LAKE CITY	UT	84108	.00	267	125
SL047	HIGHLAND PARK SCHOOL #2	1738 E 2700 S	SALT LAKE CITY	UT	84106	.00	395	181
SL048	ROSSLYN HEIGHTS SCHOOL	2291 S 2000 E	SALT LAKE CITY	UT	84106	.00	452	111
SL049	DILWORTH SCHOOL	1653 S 2100 E	SALT LAKE CITY	UT	84108	.00	271	132
SL050	BEACON HEIGHTS SCHOOL #1	1850 S 2500 E	SALT LAKE CITY	UT	84108	.00	260	81
SL051	BEACON HEIGHTS SCHOOL #2	1850 S 2500 E	SALT LAKE CITY	UT	84108	.00	175	56
SL052	INDIAN HILLS SCHOOL #1	2496 ST MARY'S DR	SALT LAKE CITY	UT	84108	.00	310	111
SL053	INDIAN HILLS SCHOOL #2	2496 ST MARY'S DR	SALT LAKE CITY	UT	84108	.00	383	98
SL054	BONNEVILLE GOLF COURSE	954 CONNOR ST	SALT LAKE CITY	UT	84108	.00	331	81
SL055	WEBSTER SCHOOL	9228 W 2700 S	MAGNA	UT	84044	.00	182	52
SL056	MAGNA SCHOOL	8500 W 3100 S	MAGNA	UT	84044	.00	339	105
SL057	LAKE RIDGE SCHOOL	7400 W 3400 S	MAGNA	UT	84044	.00	129	35
SL058	LAKE RIDGE SCHOOL #2	7400 W 3400 S	MAGNA	UT	84044	.00	207	69
SL059	LAKE RIDGE SCHOOL #3	7400 W 3400 S	MAGNA	UT	84044	.00	144	44
SL060	WHITTIER SCHOOL	5975 W 3500 S	WEST VALLEY CITY	UT	84120	.00	331	76
SL061	CARL SANDBERG SCHOOL	3900 S 5525 W	WEST VALLEY CITY	UT	84120	.00	187	41
SL062	JACKLING SCHOOL	3760 S 4610 W	WEST VALLEY CITY	UT	84120	.00	329	85
SL063	PHILO T. FARNSWORTH	3751 ACORD WAY	WEST VALLEY CITY	UT	84120	.00	300	80
SL064	HILLSDALE SCHOOL #1	3275 W 3100 S	WEST VALLEY CITY	UT	84119	.00	75	30
SL065	HILLSDALE SCHOOL #2	3275 W 3100 S	WEST VALLEY CITY	UT	84119	.00	214	79
SL066	REDWOOD SCHOOL	2650 S REDWOOD RD	WEST VALLEY CITY	UT	84119	.00	89	72
SL067	MONROE SCHOOL	4450 W 3100 S	WEST VALLEY CITY	UT	84120	.00	213	98
SL068	PIONEER SCHOOL #1	3860 S 3380 W	WEST VALLEY CITY	UT	84118	.00	112	40
SL069	PIONEER SCHOOL #2	3860 S 3380 W	WEST VALLEY CITY	UT	84118	.00	220	47
SL070	GRANGER ELEMENTARY SCHOOL	2450 W 3800 S	WEST VALLEY CITY	UT	84120	.00	260	67
SL071	MADISON SCHOOL #1	2465 S STATE	SALT LAKE CITY	UT	84115	.00	204	52
SL072	MADISON SCHOOL #2	2465 S STATE	SALT LAKE CITY	UT	84115	.00	137	59
SL073	WOODROW WILSON SCHOOL #1	2852 S 200 E	SALT LAKE CITY	UT	84115	.00	69	25
SL074	WOODROW WILSON SCHOOL #2	2852 S 200 E	SALT LAKE CITY	UT	84115	.00	84	33
SL075	ROOSEVELT SCHOOL	3225 S 800 E	SALT LAKE CITY	UT	84106	.00	285	121
SL076	LIBBY EDWARD SCHOOL	1655 E 300 S	SALT LAKE CITY	UT	84106	.00	228	91
SL077	ROSECREST SCHOOL #2	2420 FISHER LANE	SALT LAKE CITY	UT	84109	.00	237	79
SL078	ROSECREST SCHOOL #1	2420 FISHER LANE	SALT LAKE CITY	UT	84109	.00	243	120
SL079	CANYON RIM	3005 S 2900 E	SALT LAKE CITY	UT	84109	.00	381	108
SL080	GRANITE PARK JR HIGH	3700 S 450 E	SALT LAKE CITY	UT	84115	.00	63	29
SL081	GRANITE HIGH SCHOOL	3305 S 500 E	SALT LAKE CITY	UT	84124	.00	104	41
SL082	LINCOLN SCHOOL	501 E 3900 S	SALT LAKE CITY	UT	84107	.00	118	47
SL083	MILLCREEK SCHOOL	3761 S 100 E	SALT LAKE CITY	UT	84106	.00	228	94
SL084	WILLIAM PENN SCHOOL	1670 SIGGARD DR	SALT LAKE CITY	UT	84106	.00	348	75
SL085	EVERGREEN JR HIGH #1	3401 S 2000 E	SALT LAKE CITY	UT	84109	.00	301	61
SL086	EVERGREEN JR HIGH #2	3401 S 2000 E	SALT LAKE CITY	UT	84109	.00	254	50
SL087	EAST MILLCREEK SCHOOL	2965 E 3435 S	SALT LAKE CITY	UT	84109	.00	252	95
SL088	UPLAND TERRACE SCHOOL #1	3700 S 2860 E	SALT LAKE CITY	UT	84109	.00	253	64
SL089	EASTWOOD SCHOOL	3305 S WASATCH DR	SALT LAKE CITY	UT	84109	.00	237	127
SL090	ACADEMY PARK SCHOOL #1	4580 WESTPOINT DR	WEST VALLEY CITY	UT	84120	.00	213	57
SL091	ACADEMY PARK SCHOOL #2	4580 WESTPOINT DR	WEST VALLEY CITY	UT	84120	.00	317	70
SL092	ROBERT FROST SCHOOL	3444 W 4400 S	WEST VALLEY CITY	UT	84120	.00	354	98
SL093	HARRY S TRUMAN SCHOOL	4639 S 3200 W	WEST VALLEY CITY	UT	84119	.00	247	44
SL094	TAYLORSVILLE SCHOOL	2010 W 4250 S	WEST VALLEY CITY	UT	84119	.00	261	79
SL095	JOHN C FREMONT SCHOOL	4249 S 1425 W	SALT LAKE CITY	UT	84123	.00	281	58
SL096	WESTERN HILLS SCHOOL	5190 HEATH AVE	SALT LAKE CITY	UT	84118	.00	251	76
SL097	WEST HEARNS SCHOOL	4910 S 4720 W	SALT LAKE CITY	UT	84118	.00	249	91
SL098	DAVID GOURLEY SCHOOL	4905 S 4300 W	SALT LAKE CITY	UT	84118	.00	230	93
SL099	ARCADIA SCHOOL #1	3461 W 4850 S	SALT LAKE CITY	UT	84119	.00	220	54
SL100	ARCADIA SCHOOL #2	3461 W 4850 S	SALT LAKE CITY	UT	84119	.00	237	72
SL101	VISTA SCHOOL	4925 S 2200 W	SALT LAKE CITY	UT	84118	.00	324	105

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SL102	CALVIN S SMITH SCHOOL	2152 W 6200 S	SALT LAKE CITY	UT	84118	.00	293	85
SL103	PLYMOUTH SCHOOL	5220 S 1470 W	SALT LAKE CITY	UT	84123	.00	276	70
SL104	SOUTH KEARNS SCHOOL #1	4430 W 5570 S	SALT LAKE CITY	UT	84118	.00	162	46
SL105	SOUTH KEARNS SCHOOL #2	4430 W 5570 S	SALT LAKE CITY	UT	84118	.00	282	99
SL106	WESTLAND SCHOOL #1	2900 W 7180 S	WEST JORDAN	UT	84084	.00	228	43
SL107	WESTLAND SCHOOL #2	2900 W 7180 S	WEST JORDAN	UT	84084	.00	196	48
SL108	MAJESTIC SCHOOL #1	7450 S 1700 W	WEST JORDAN	UT	84084	.00	310	55
SL109	MAJESTIC SCHOOL #2	7450 S 1700 W	WEST JORDAN	UT	84084	.00	259	50
SL110	TERRA LINDA SCHOOL	3400 W 8400 S	WEST JORDAN	UT	84084	.00	252	93
SL111	WEST VALE SCHOOL	8660 S 2300 W	WEST JORDAN	UT	84084	.00	446	85
SL112	SOUTH JORDAN SCHOOL #1	1350 W 10400 S	RIVERTON	UT	84065	.00	307	44
SL113	SOUTH JORDAN SCHOOL #2	1350 W 10400 S	RIVERTON	UT	84065	.00	359	69
SL114	COPPERTON LIONS CLUB		COPPERTON	UT	84006	.00	88	42
SL115	HERRIMAN LIONS CLUB		RIVERTON	UT	84065	.00	123	35
SL116	RIVERTON SCHOOL #1	12830 S 1700 W	RIVERTON	UT	84065	.00	427	75
SL117	RIVERTON SCHOOL #2	12830 S 1700 W	RIVERTON	UT	84065	.00	344	76
SL118	JAMES E MOSS SCHOOL #1	4399 S 500 E	SALT LAKE CITY	UT	84107	.00	157	37
SL119	JAMES E MOSS SCHOOL #2	4399 S 500 E	SALT LAKE CITY	UT	84107	.00	194	67
SL120	HILL VIEW SCHOOL #1	1035 E 4500 S	SALT LAKE CITY	UT	84124	.00	253	99
SL121	HILL VIEW SCHOOL #2	1035 E 4500 S	SALT LAKE CITY	UT	84124	.00	189	63
SL122	CRESTVIEW SCHOOL #1	2100 LINCOLN LANE	SALT LAKE CITY	UT	84124	.00	186	91
SL123	CRESTVIEW SCHOOL #2	2100 LINCOLN LANE	SALT LAKE CITY	UT	84124	.00	303	50
SL124	HOWARD R DRIGGS SCHOOL	4340 S 2700 E	SALT LAKE CITY	UT	84124	.00	314	94
SL125	UPLAND TERRACE SCHOOL #2	3700 S 2860 E	SALT LAKE CITY	UT	84124	.00	182	72
SL126	CHURCHILL JR HIGH #1	3450 OAKVIEW DR	SALT LAKE CITY	UT	84124	.00	152	55
SL127	OAKRIDGE SCHOOL	4325 S JUPITER DR	SALT LAKE CITY	UT	84124	.00	227	62
SL128	MURRAY CITY CENTER #2	5025 S STATE	MURRAY	UT	84107	.00	176	53
SL129	MURRAY CITY CENTER #1	5025 S STATE	MURRAY	UT	84107	.00	266	87
SL130	TWIN PEAKS SCHOOL #2	5325 S 1045 E	SALT LAKE CITY	UT	84117	.00	302	48
SL131	BONNEVILLE JR HIGH	5330 S 1660 E	SALT LAKE CITY	UT	84117	.00	205	74
SL132	HOLLADAY SCHOOL	4580 S 2300 E	SALT LAKE CITY	UT	84117	.00	391	101
SL133	MEADOW MOOR SCHOOL	5315 S 1700 E	SALT LAKE CITY	UT	84117	.00	152	55
SL134	MORNINGSIDE SCHOOL	4170 S 3000 E	SALT LAKE CITY	UT	84124	.00	411	131
SL135	COTTONWOOD SCHOOL	5205 S HOLLADAY BLVD	SALT LAKE CITY	UT	84117	.00	403	114
SL136	CHURCHILL JR HIGH #2	3450 OAKVIEW DR	SALT LAKE CITY	UT	84124	.00	227	79
SL137	VIEWMONT SCHOOL	745 W 5720 S	SALT LAKE CITY	UT	84123	.00	315	88
SL138	HILLCREST JR HIGH	126 E 5300 S	SALT LAKE CITY	UT	84123	.00	322	86
SL139	LIBERTY SCHOOL	140 W 6100 S	MURRAY	UT	84107	.00	356	131
SL140	TWIN PEAKS SCHOOL #1	5325 S 1045 E	SALT LAKE CITY	UT	84117	.00	245	66
SL141	COTTONWOOD HIGH	5715 S 1300 E	SALT LAKE CITY	UT	84121	.00	218	66
SL142	OAKWOOD SCHOOL	5815 S HIGHLAND DR	SALT LAKE CITY	UT	84121	.00	345	85
SL143	LONGVIEW SCHOOL	6240 LONGVIEW DR	MURRAY	UT	84107	.00	523	137
SL144	WOODSTOCK SCHOOL #1	6015 S 1300 E	SALT LAKE CITY	UT	84121	.00	265	55
SL145	WOODSTOCK SCHOOL #2	6015 S 1300 E	SALT LAKE CITY	UT	84121	.00	293	57
SL146	BELLA VISTA SCHOOL	2131 E 7000 S	SALT LAKE CITY	UT	84121	.00	227	102
SL147	MIDVALE SCHOOL	385 E CENTER	MIDVALE	UT	84047	.00	161	51
SL148	EAST MIDVALE SCHOOL	6990 S 500 E	MIDVALE	UT	84047	.00	358	66
SL149	MIDVALLEY SCHOOL	217 E 7800 S	MIDVALE	UT	84047	.00	306	79
SL150	MOUNT VIEW SCHOOL	1651 E 7000 S	SALT LAKE CITY	UT	84121	.00	283	100
SL151	RIDGECREST SCHOOL	7200 S 1800 E	SALT LAKE CITY	UT	84121	.00	232	58
SL152	BUTLER SCHOOL	2700 E 7000 S	SALT LAKE CITY	UT	84121	.00	345	134
SL153	COTTONWOOD HEIGHTS SCHOOL	2415 E 7600 S	SALT LAKE CITY	UT	84121	.00	306	91
SL154	MIDVALE MIDDLE SCHOOL #1	138 PIONEER ST	MIDVALE	UT	84047	.00	229	55
SL155	MIDVALE MIDDLE SCHOOL #2	138 PIONEER ST	MIDVALE	UT	84047	.00	226	38
SL156	UNION MIDDLE SCHOOL	615 E 8000 S	MIDVALE	UT	84047	.00	185	44
SL157	BRIGHTON HIGH SCHOOL	2220 E 7600 S	SANDY	UT	84092	.00	214	54
SL158	CANYON VIEW SCHOOL	3050 E 7800 S	SALT LAKE CITY	UT	84121	.00	335	83

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SL159	SANDY SCHOOL	400 E MAIN	SANDY	UT	84070	.00	323	88
SL160	EAST SANDY SCHOOL	8295 S 870 E	SANDY	UT	84070	.00	316	68
SL161	PERUVIAN PARK SCHOOL	1545 E 8425 S	SANDY	UT	84092	.00	395	69
SL162	BROOKWOOD SCHOOL #1	8640 SNOWBIRD DR	SANDY	UT	84092	.00	268	58
SL163	BROOKWOOD SCHOOL #2	8640 SNOWBIRD DR	SANDY	UT	84092	.00	276	65
SL164	MT JORDAN MIDDLE SCHOOL	9360 S 400 E	SANDY	UT	84070	.00	271	55
SL165	BELL VIEW SCHOOL	800 E 9800 S	SANDY	UT	84070	.00	257	71
SL166	EDGEMONT SCHOOL #1	1085 E 9800 S	SANDY	UT	84092	.00	216	62
SL167	EDGEMONT SCHOOL #2	1085 E 9800 S	SANDY	UT	84092	.00	224	34
SL168	ALTA VIEW SCHOOL #1	10333 CROCUS	SANDY	UT	84070	.00	196	46
SL169	DRAPER CITY HALL CAFTRIA	12441 S 900 E	DRAPER	UT	84020	.00	526	95
SL170	ALTA COMMUNITY CENTER	LIBRARY	SANDY	UT	84092	.00	33	18
SL171	GRANITE SCHOOL #1	9760 S 3100 E	SANDY	UT	84092	.00	173	43
SL172	GRANITE SCHOOL #2	9760 S 3100 E	SANDY	UT	84092	.00	163	42
SL173	SUNRISE SCHOOL #1	1520 E 11265 S	SANDY	UT	84092	.00	243	58
SL174	SUNRISE SCHOOL #2	1520 E 11265 S	SANDY	UT	84092	.00	315	46
SL175	ALTA VIEW SCHOOL #2	10333 CROCUS	SANDY	UT	84070	.00	170	57
SL176	SILVER MESA SCHOOL	8920 S 1700 E	SANDY	UT	84092	.00	314	89
SU290	VERN HUFF HOME	2694 EAST HIGHWAY 35	WOODLAND	UT	84036	.00	95	54
UI291	DAVIS ELEMENTARY	4021 SOUTH 2500 EAST	JENSEN	UT	84035	.00	111	400
UI292	GOLDEN AGE CENTER	155 SOUTH 100 WEST	VERNAL	UT	84078	.00	109	177
UI293	UINTAH COUNTY COURTHOUSE	152 EAST 100 NORTH	VERNAL	UT	84078	.00	70	104
UI294	UINTAH HIGH SCHOOL	161 NORTH 1000 WEST	VERNAL	UT	84078	.00	110	213
UI295	MAESER ELEMENTARY	2670 WEST 1000 NORTH	MAESER	UT	84078	.00	114	251
UI296	LAPOINT ELEMENTARY		LAPOINT	UT	84039	.00	35	143
UI297	WEST JUNIOR HIGH	HIGHWAY 40	FORT DUCHESNE	UT	84026	.00	51	123
UI298	RUTH WINN HOME	1410 NORTH 500 WEST	VERNAL	UT	84078	.00	58	131
UT177	SEGO LILY ELEMENTARY	550 EAST 900 NORTH	LEHI	UT	84043	.00	434	127
UT178	LEHI JUNIOR HIGH	152 NORTH CENTER	LEHI	UT	84043	.00	287	91
UT179	CHAMBERLAIN RESIDENCE	11 CENTER HWY 73	CEDAR FORT	UT	84013	.00	38	17
UT180	ANDERTON RESIDENCE	17870 W 1500 N	FAIRFIELD	UT	84013	.00	9	6
UT181	HIGHLAND ELEMENTARY	10865 N 6000 W	HIGHLAND	UT	84003	.00	310	66
UT182	ALPINE CITY HALL		ALPINE	UT	84003	.00	301	71
UT183	GREENWOOD ELEMENTARY	50 EAST 200 SOUTH	AMERICAN FORK	UT	84003	.00	301	119
UT184	SHELLEY ELEMENTARY	550 NORTH 200 WEST	AMERICAN FORK	UT	84003	.00	365	105
UT185	AMERICAN FORK HIGH SCHOOL	510 NORTH 600 EAST	AMERICAN FORK	UT	84003	.00	418	106
UT186	GROVECREST ELEMENTARY	200 EAST 100 NORTH	PLEASANT GROVE	UT	84062	.00	426	135
UT187	VALLEY VIEW ELEMENTARY	941 ORCHARD DRIVE	PLEASANT GROVE	UT	84062	.00	441	190
UT188	LINDON ELEMENTARY	30 NORTH MAIN	LINDON	UT	84062	.00	298	91
UT189	NORTHRIDGE ELEMENTARY	1660 NORTH 50 EAST	OREM	UT	84057	.00	399	115
UT190	SHAKON ELEMENTARY	525 NORTH 400 EAST	OREM	UT	84057	.00	342	91
UT191	CASCADE ELEMENTARY	150 NORTH 800 EAST	OREM	UT	84057	.00	573	157
UT192	OREM HIGH SCHOOL	175 SOUTH 400 EAST	OREM	UT	84057	.00	665	119
UT193	HILLCREST ELEMENTARY	651 EAST 1400 SOUTH	OREM	UT	84058	.00	336	99
UT194	CHERRY HILL ELEMENTARY	250 EAST 1650 SOUTH	OREM	UT	84058	.00	467	123
UT195	LAKERIDGE JUNIOR HIGH	951 SOUTH 400 WEST	OREM	UT	84058	.00	584	159
UT196	MOUNTAIN VIEW HIGH SCHOOL	645 WEST CENTER	OREM	UT	84058	.00	388	120
UT197	OREM JUNIOR HIGH SCHOOL	765 NORTH 500 WEST	OREM	UT	84057	.00	434	122
UT198	EDGEMONT ELEMENTARY	500 EAST 3600 NORTH	PROVO	UT	84604	.00	596	292
UT199	ROCK CANYON ELEMENTARY	2400 NORTH 650 EAST	PROVO	UT	84604	.00	601	382
UT200	WASATCH ELEMENTARY	1080 NORTH 1000 EAST	PROVO	UT	84604	.00	395	255
UT201	JOAQUIN ELEMENTARY	550 NORTH 600 EAST	PROVO	UT	84601	.00	168	117
UT202	MAESER ELEMENTARY	150 SOUTH 500 EAST	PROVO	UT	84601	.00	257	201
UT203	PROVOST ELEMENTARY	629 SOUTH 1000 EAST	PROVO	UT	84601	.00	211	221
UT204	FRANKLIN ELEMENTARY	355 SOUTH 700 WEST	PROVO	UT	84601	.00	230	199
UT205	SUNSET VIEW ELEMENTARY	525 SOUTH 1500 WEST	PROVO	UT	84601	.00	311	261
UT206	TIMPANOGOS ELEMENTARY	449 NORTH 500 WEST	PROVO	UT	84601	.00	346	261

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APPENDIX H
PUBLIC COMMENT & CUWCD RESPONSE

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The meeting began at 7:00 P.M. Karen Ricks, CUWCD's Project Manager in charge of the Water Pricing Policy Study (Pricing Study), welcomed those attending the meeting and introduced Lee Wimmer, CUWCD's Program Manager in charge of CUPCA activities, and Kreg McCollum of Resource Management International, Inc. (RMI), the consulting firm assisting in the completion of the Pricing Study. The Pricing Study is a study that is required to be completed by CUWCD under Section 207(c) of P.L. 102-575.

Karen stated particular acknowledgements were due to the State of Utah, represented primarily by the Department of Natural Resources, Division of Water Resources (DWRe); the petitioners of CUP water; the members of the Water Management Improvement Studies Coordination Committee (WMISCC); and the members of the Water Pricing Policy Study Technical Committee.

Karen then provided a brief overview of the public involvement process that has been undertaken as a part of the Pricing Study. Consultation and planning meetings were undertaken with the State (through DWRe), petitioners of CUP water, and other identified key publics. Continuing consultation with the State (through DWRe) and petitioners of CUP water, as required in Section 207(c), was accomplished through periodic planning meetings, meetings of the WMISCC, newsletters, CUP updates, and questionnaires provided to petitioners and other area water purveyors. The formal public comment period was initiated on July 28. The date of this public hearing and the availability of the draft report were announced through legal notices in area newspapers, news releases, and flyers sent to a listing of interested parties. A copy of the report was sent to members of the WMISCC, the Technical Committee, and the UOICC Steering Committee. The public review and comment period will run from July 28 through September 8.

Karen stated that comments at the hearing would be recorded and that comments, and CUWCD responses, would be included in the final report on the Pricing Study that will be submitted to the Secretary of the Interior by October 30, 1995. Karen then turned the floor over to Kreg McCollum to make a presentation on the Pricing Study.

Kreg began his presentation by noting that it would be a brief review of the Report. He noted that copies of the report were available for any one who has not yet received a copy. All attendees had a copy. Kreg then outlined the purposes of the study. The primary purposes of the Pricing Study, as described in the Act, are:

- to design and evaluate potential rate designs and pricing policies for water supply and wastewater treatment within the District Boundary;

- to estimate demand elasticity for each of the principal categories of end use of water within the District boundary;

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- to quantify monthly water savings estimated to result from the various designs and policies to be evaluated; and

- to identify a water pricing system that reflects the incremental scarcity value of water and rewards effective water conservation programs.

There are other requirements that also come from the language in the Act that are not listed as study purposes. CUWCD is confident that this Report appropriately addresses the stated purposes and that it meets the requirements of the Act. Within Section 8 (Conclusions) is a thorough enumeration of how the Pricing Study meets the requirements of the Act (Section 8.1 - Compliance With the Act).

Kreg then described the organization of the Report. The Report is segmented into three distinct parts.

- Part I focuses on policy analysis by exploring the role of pricing in water agency planning and by evaluating a number of alternative pricing policies based on identified criteria, including water conservation. Discussion and analysis is provided on water pricing issues at both the retail and wholesale level, and for agricultural water and wastewater.

- Part II contains the technical analysis performed to fulfill the requirements of the Act. In particular, it documents the methods used to develop estimates of price elasticity of demand, quantified conservation potential, and the impact of phasing out ad valorem tax collections by CUWCD and the petitioners of CUP water.

- Part III summarizes the conclusions that can be drawn as a result of the study, and the recommendations resulting from the study.

Kreg then reviewed the recommendations resulting from the study. The recommendations made as a result of the study were developed with the concept of "incrementalism" in mind. Incrementalism refers to the practice of making change in a gradual manner, rather than an abrupt and potentially disruptive manner. Changes in pricing policies are likely to gain greater public acceptance if they are phased in over time. These recommended changes, then, reflect a relative priority.

1. Eliminate rate structures (wholesale, retail, or wastewater) that promote water usage. All declining block rate structures should be eliminated.

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2. Meter all accounts. A correlation between price and consumption can not be made without an accurate measurement of consumption.

3. Eliminate water and sewer rate structures that provide no ability for customers to reduce their water and sewer bills by reducing their water consumption, i.e., phase out flat fees and rates that include minimum charges covering large amounts of water.

4. Base wastewater rates on winter water usage as a proxy for metering consumption (effluent).

5. Adopt monthly billing to increase the effectiveness of the price signal. In order to further increase the customer's understanding and use of the price signal, utilities should provide information on each bill such as monthly water usage for each of the last 12 months, or water usage during the previous period and the same time period from the previous year, or some other usage data that provides customers with information that can be used to assess water conservation efforts.

6. Adopt water and sewer rate structures that improve the correspondence between incidence of costs and revenue recovery, including the development of additional customer classifications if needed to implement cost-based rates.

7. Implement seasonal rates whenever the difference between peak and non-peak seasonal water usage is large. Large can be defined as peak season exceeding non-peak by more than 50 percent.

   Since inclining block rate structures can be structured to mimic seasonal rates, non-seasonal inclining block rates can be implemented as an alternative.

   Wastewater pricing can be developed in a conjunctive manner with seasonal rates due to the inherent measurement of "indoor" water usage.

8. Eliminate the minimum charge structure, replacing it with one that recovers only customer and accounting charges through a fixed charge, and that recovers variable O&M costs and facility costs through the variable charges.

9. Consider the use of risk-reducing strategies other than "take-or-pay" contracts, which can provide a disincentive to conserve water, on new water delivery contracts. One such strategy is for a water wholesaler to require the retail agencies that purchase wholesale water to institute conservation-oriented retail rates that are designed to recover all costs with a minimum of risk.

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10. Incorporate the cost of the next source of water when determining prices for water sources that are diminishing, or where demand is increasing.

At this point, the floor was opened for comments and questions, including any prepared formal statements.

Lyle Summers of the State Division of Water Resources noted that in the presentation, and in the text of the report, CUWCD suggests that, 1) the cost difference between existing and new water sources is almost always enormous, and 2) that estimating the marginal cost of water based on the next available source is an overly difficult and expensive task for most water agencies to undertake. Lyle suggested that the cost difference may or may not be large, and that there are some estimates of marginal cost for specific regions that might be used to develop marginal cost based pricing schemes. In particular, he noted that the cost of Spanish Fork Canyon-Nephi Irrigation Project water could be used as a proxy for marginal cost by communities in southern Utah County and Juab County. Further detail on comments was provided by Lyle in a letter dated August 24, 1995, a copy of which is attached.

Lyle also asked about how a process would be started that would allow for a reexamination of take or pay contracts issued by the Department of the Interior, CUWCD, and other area wholesalers. Reed Murray of the Department of the Interior noted that some internal discussions within the Department have been taking place that are examining the potential of the Department to divest itself of the title to the water, thus eliminating their take or pay contracts. Lee Wimmer and Karen Ricks of CUWCD noted that CUWCD can renegotiate their current contracts if it is felt to be in their interest. Absent a take or pay contract with Interior, CUWCD might be willing to discuss those issues with petitioners.

Neil Cox and Clint Jensen of the Salt Lake County Water Conservancy District (SLCWCD) provided a prepared written statement that Neil read to the attendees. A copy of the statement is attached.

No further comments or questions were raised. The hearing was closed at 8:00 P.M.

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WATER PRICING POLICY STUDY
"Public Hearing"
August 22, 1995 - Sign-In

NAME:	ORGANIZATION:	
Karen Ricks	CUWCD	
Clint Jensen	SLCWCD	
Neil Cox	SLCWCD	
Robert Fillerup	Provo River Canals -	
Wallace Young	South Shore Farms	Rpt
Richard J. Heap	Sp. Fork City	Rpt
W. Lee Wimmer	CUWCD	
Kreg McCollum	RMI, Inc.	
Lyle Summers	Ut. Div. of Water Resource	
Josephine Zimmerman	Daily Herald	Rpt
Reed Murray	DOI	

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SALT LAKE COUNTY WATER CONSERVANCY DISTRICT

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Secretary, Treasurer

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Kng KHC

August 22, 1995

Central Utah Water Conservancy District
355 West 1300 South
Orem, UT 84058-7303

Subject: Water Pricing Policy Study Draft Final Report

Comments prepared by: Neil B. Cox, Assistant Treasurer, Salt Lake County Water Conservancy District
Clinton C. Jensen, Controller and Assistant Secretary, Salt Lake County Water Conservancy District

In response to the Draft Final Report of the Water Pricing Policy prepared by the Central Utah Water Conservancy District (CUWCD), the Salt Lake County Water Conservancy District (SLCWCD) would like to offer comment on this final draft report.

COMMENTS

- Purposes of Pricing Study, as defined by the CUPCA, are:

  1. To design and evaluate potential rate designs and pricing policies for water supply and wastewater treatment within the CUWCD boundary;

  2. To estimate demand elasticity for each of the principal categories of end use of water within the CUWCD boundary;

  3. To quantify monthly water savings estimated to result from the various designs and policies to be evaluated;

  4. To identify a water pricing system that reflects the incremental scarcity value of water and rewards effective water conservation programs.

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In reviewing the purposes of the pricing study it is important to recognize the role of CUWCD as the agency responsible for completing this study, and that the CUPCA does not grant authority to Central Utah or any petitioner of project water to require implementation of any policies or recommendations contained in the pricing study.

- The CUPCA calls for an evaluation of rates based on the effect of phasing out ad valorem taxes. In the chapter seven overview on the discussion of the phase out of ad valorem taxes it states, (quote)

> "One potential impact that could be felt by entities that currently levy ad valorem taxes is a change in their bond rating. Ad valorem taxes are one of the most stable forms of revenue available to a utility or agency. Altering the source of an agency's revenue stream from a partially tax-backed revenue stream to one that is entirely backed by rates *may* decrease the agency's bond rating. This is important because the higher the bond rating, the lower the interest rate available on any bonds issued by the agency. Thus, the loss of tax-backed revenue *may* result in higher costs of operation due to higher interest costs on bond issuances for required major capital improvements." (End quote) (page 7-1)

We feel the significance of this has been severely understated. Altering the stable source of tax revenues available to a utility or agency definitely *will* affect the agency's bond rating by decreasing it, and *will* increase the cost of operation due to higher interest costs on bond issuances.

The discussion continues in chapter seven, (Quote)

> "Also, if ad valorem taxes are being used to back bonds that are currently outstanding, the taxes *must* remain in effect until the bonds are defeased. Failure to do so would result in a breach of contract on the terms of the bond issuance. Another impact would be the need by petitioners of project water to enter into new contracts. Current petitioner contracts with Metropolitan Water District of Salt Lake City and the Salt Lake County Water Conservancy District *require* those entities to collect ad valorem taxes that secure contract payments." (End quote) (page 7-1,2)

Hence, ad valorem taxes need to remain intact until current bonded indebtedness is defeased, or the agency would be in default. Also, a

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restructuring of existing contracts between the CUWCD and petitioners, where ad valorem tax revenue collections are required as a condition of the contract, would be impossible.

- A discussion within the study suggests that wholesale water rates can be used as an effective conservation tool. It states that wholesalers have many pricing alternatives that might be utilized to shape water demand by retail purveyors. The SLCWCD currently bases it wholesale water rates on the recommended AWWA Base-Extra Capacity methodology. Using this methodology, wholesale water rates are determined directly from the usage characteristics and costs they impose on the water system. Users are allocated costs based on the costs of the service provided. Certain costs are incurred to meet average water use levels; other costs are incurred to meet peaking needs of users. Costs incurred to meet average demands are allocated to users based on each user's proportional share of the average annual water use. Costs incurred to meet peaking demands are allocated to users based on each user's proportional share of the total system peaking requirements. To the extent that a wholesale water user can reduce the peaking demands on the water system, the share of peaking costs assigned to the user will decline if all other things are equal. Therefore, users are essentially in competition with each other to reduce peaking demands and lower water rates. We feel this approach provides an incentive to retail water purveyors to effectively manage their systems. It would be difficult, if possible, to force retail purveyors to take or use the wholesale water they purchase in certain ways. Manipulation of this type would be undesirable and could be perceived negatively from a retailer's point of view. We feel, as it is stated within the study, that (quote)

  > "the preferred option is to induce conservation at the point of ultimate consumption (the retail level). There is a direct relationship between retail water pricing and water conservation. Because of this relationship, the *key* to *meaningful* conservation through pricing is sending the appropriate price signal to ultimate consumers of water through retail rates." (End quote) (page 3-24,25)

- Another issue discussed is the provision for "take or pay" contracts. All current outstanding bonded indebtedness of the SLCWCD is secured by two sources; ad valorem taxes (which has already been addressed) and take or pay contracts. These two stable revenue sources enable water utilities to bond at the most favorable rate possible. Without the stability that take or pay contracts afford, it would be impossible to budget revenues that would meet operational needs and meet debt service requirements. It would be difficult, if possible, to meet the continuing needs to upgrade and build

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capital facilities for future water needs. In short, eliminating take or pay contracts would undermine the financial integrity of the water utility. In the discussion of take or pay contracts in the study it states, (quote)

> "Take or pay provisions state that the buyer will pay for the contracted amount of water whether the buyer uses the water or not. This type of provision does not promote the conservation of water. In essence, as long as you must pay for the water, you might as well use it; you definitely do no want to pay for water conserving technologies and then pay for the contracted amount of water anyway. Take or pay contracts are a risk management tool that is attractive to risk averse water wholesalers. Other risk management options should be considered that are likely to be risk neutral, or at least less risk averse, in order to allow retail agencies to more effectively conserve water." (End quote) (page 3-24)

If properly understood and communicated, take or pay contracts with water purveyors do not promote water misuse. Contracts will meet the needs of the purchaser by providing sufficient water to meet demand, and benefit the seller by being a stable, reliable source of revenue. There is always risk involved as water utilities with the constant instability of weather, a fluctuating water supply, unsure demand for future water needs, and the increasing costs to develop future water sources. The elimination of contracts that provide a secure revenue stream would only serve to increase the risk to the water agency and cause problems with revenue sufficiency, revenue stability, and rate stability.

These are some of the major concerns the SLCWCD has perceived in reviewing the Water Pricing Policy Study Draft Final Report. We look forward to additional interaction and comment with the Central Utah staff in its efforts to meet the provisions of the CUPCA.

The Salt Lake County Water Conservancy District (SLCWCD) appreciates the opportunity to comment on the Public Review Draft for Recommendations for Water Conservation Standards and Regulations in Utah by the Utah Water Conservation Advisory Board (UWCAD).

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We believe that the UWCAD has done a commendable job in evaluating water conservation measures and making recommendations. SLCWCD believes, though, two areas deserve further discussion and examination. These are:

1. Subsection 207(f)(2)(B). Elimination of declining block rate schedules from any system of water or wastewater treatment charges; and

2. Subsection 207(f)(2)(I). Standards governing the sale, installation, and removal of self-regenerating water softeners, including the identification of public water supply system service areas where such devices are prohibited, and the establishment of standards for the control of regeneration in all newly installed devices.

Under Subsection 207(f)(2)(B), the recommendation is made that the Central Utah Water Conservancy District (CUWCD), in its water pricing study required by Section 207 of P.L. 102-575, should examine the ability of water wholesalers and federal government funding agencies (Bureau of Reclamation) to revise, take, or pay contracts to achieve more effective water conservation pricing.

We feel that a basic premise may have been missed in making this recommendation. Take-or-pay contracts are the heart and soul of a wholesale agency's financial structure. They represent the security or underlying collateral for financing of capital improvements through bonding or loans. They offer protection against the variability of weather and insulation against changing political forces. Without take-or-pay contracts, agencies would not be able to enter the bond market. Probably all outstanding bonds of wholesale agencies in the State are

currently secured by some form of take-or-pay contracts and these contracts would be untouchable to change because of obligations in the bond documents. Also, we feel the elimination of take-or-pay contracts in the future would be to make it impossible for most agencies to finance any major capital improvements.

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Perhaps it would be helpful to examine what a take-or-pay contract is. It is a contractual obligation to deliver a set amount of water. This water is developed through a water development project financed by a loan or bonds. If the sponsoring agency cannot contract to sell water for a guaranteed amount of revenue, it has no basis for guaranteeing repayment of the loan or bonds by which the project was constructed and which develops the water that is sold. Examples of take-or-pay contracts are those between the U.S. Bureau of Reclamation and the Central Utah Water Conservancy District, the Weber Basin Water Conservancy District, and the Provo River Water Users Association. These projects were financed by the federal government to construct the Central Utah Project, Weber Basin Project, and the Provo River Project, respectively. Another example would be the Welby Jacob Exchange executed by the SLCWCD and financed by municipal bonds. Another example would be the Smith-Morehouse Dam constructed by the Weber Basin Water Conservancy District with a loan from the Board of Water Resources.

Take-or-pay contracts can also be used to pass costs on to other agencies such as the contracts between the CUWCD and its petitioners or between agencies such as the SLCWCD and its customer agencies.

In all cases, a take-or-pay contract represents obligations between two parties. On one hand, a party is obligated to perform in delivering water, to construct facilities to deliver water, or to provide capital or financing to construct facilities to deliver water. On the other hand, the other party is obligated to submit a payment which is received as revenue to fulfil financial obligations that were incurred in constructing facilities and in delivering water. In most cases, the revenue or payment is considered as collateral under the financing provisions and must be guaranteed regardless of any other conditions., In this case, it is much like a home mortgage or a business loan. Failure to make the required payment constitutes a default.

We feel that all loans from State loan programs including those of the Board of Water Resources must be considered take-or-pay contracts. Money is provided by the State loan program to finance a water development project. The loan is secured by the water rights of the project and the projected revenues to be derived from the water sales from the project.

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Another aspect of take-or-pay contracts is that they allocate and guarantee a firm water supply to the receiving agency in times of drought. Without take-or-pay contracts retail agencies would have no assurance that water will be available when needed.

Also, take-or-pay contracts allow water to be developed in blocks to meet growth over an extended period of time. At the beginning, most every water project delivers more water than is needed. As growth occurs over time, more of the water is called upon until it is all utilized. The take-or-pay financing makes this possible.

We are confused at the recommendation of the Utah Water Conservation Advisory Board that take-or-pay contracts should be eliminated. This appears to suggest that there should be no contractual relationships for the development or delivery of wholesale water in Utah.

We do not feel that this recommendation is practical, reasonable, or possible. We do not feel that there are any realistic alternatives to take-or-pay contracts and none have been suggested other than building up reserves, which is an important thing to do, but impractical for financing major projects. The existing contracts that are in place are securing loans and bonds. With regard to future contracts, no one, including the State loan funds would consider making a loan without contractual collateral. The central issue is, who will accept the risk of water development without take-or-pay contracts. Can it be shifted upward to the State? Can it be shifted downward to retail agencies or customers? In either case, there is no net gain in conservation.

We sincerely urge the reconsideration of this recommendation. We urge further discussion and deliberation before this well-intended recommendation goes forward to the detriment of water development in the State of Utah.

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Central Utah Water Conservancy District

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TELEPHONE (801) 226-7100

October 16, 1995

Mr. David Ovard, General Manager
Salt Lake County Water Conservancy District
8215 South 1300 West
West Jordan, UT 84084

Subject: SLCWCD Comments on the Water Pricing Policy Study

Dear Dave:

This is to acknowledge the receipt and review of Salt Lake County Water Conservancy District's (SLCWCD) formal written comments on the Water Pricing Policy Study (Pricing Study). We appreciate the review that you and your staff have provided not only through the formal public review process, but also throughout the entire course of the study. A copy of the comments prepared and provided by Neil Cox and Clinton Jensen will be included in Appendix H of the final Report on the Water Pricing Policy Study that is submitted to the Secretary of the Interior. A copy of this letter will also be included in Appendix H.

Upon review of the comments prepared by your staff, CUWCD does not believe that modifications to the body of the report are required. All of the points raised are, however, valid concerns and we certainly appreciate and understand the position of SLCWCD. As we have tried to convey clearly throughout the course of the study, and as SLCWCD states in the first paragraph on page two of the comments, the CUPCA does not grant authority to CUWCD or any petitioner to require implementation of any policies or recommendations contained in the study. It is the intent of CUWCD to use the Pricing Study as a springboard for area agencies to identify opportunities for all of us to better manage water resources in Utah and to raise issues of concern and interest as we move forward. We look forward to a continued dialogue on the issues raised in the Pricing Study with SLCWCD and other area water purveyors and agencies.

Thank you again for your continued interest and assistance in the completion of the Pricing Study.

Sincerely,

Karen M. Ricks

Karen M. Ricks
WMIS Project Manager

pc: Kreg McCollum, RMI

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File Code: 1.Y.09.128.C0100

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER RESOURCES

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August 24, 1995

Karen Ricks, Project Manager
Central Utah Water Conservancy District
355 West 1300 South
Orem, Utah 84058-7303

Karen:

RE: Comments on the Water Pricing Policy Study Draft Final Report

Mr. Larry Anderson suggested I make my comments on this report directly to you. You and your consultants (RMI) are to be commended for the thorough investigation and analysis presented in the report. As you suggested, a 20-30 page executive summary would be worthwhile for the less technical reader. The full report however, is well organized and, with only a few minor exceptions, addresses the issues directly and succinctly.

Your regional survey is a good example of the kind of research cities and other retail water providers need to undertake in order to choose the most effective conservation methods for their jurisdictions. People's beliefs and attitudes are really what determines how they will respond to pricing policies or any other conservation measure. If water managers do not understand these beliefs and attitudes, they are destined to make many mistakes in bringing about conservation.

Our specific comments and suggestions are as follows:

The Elasticity Study Survey provides a backdrop for understanding the price elasticity analysis in Part II. However, there is no discussion of the survey in the technical analysis, so we must assume the survey data has no direct bearing on the elasticity estimates. Mention of any conclusions arrived at through survey data that may apply to the elasticity numbers could be made in the background statement (5.1) on page 5-1.

On Page 4-12, second full paragraph, the last sentence reads: "In the special case of using the surcharge to transfer revenue recovery, the increased rates at higher usage levels can be used to actually lower rates at lower usage levels, thus transferring revenue recovery from those who conserve to those who waste water." This sentence is uncharacteristically complex and hard to follow. It could be rewritten as follows: "The surcharge can be used to transfer more of the revenue burden (cost) to wasters. Higher charges to wasters can generate enough revenue to actually lower rates for those who use less."

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On page 4-15 the discussion of marginal cost pricing seems to be a bit off track. The third sentence in the first paragraph intimates that the cost difference between existing and new facilities is almost always enormous. This is likely true only in isolated cases. In practice, utilities are adding only another block of water supply which may or may not impose "enormous" costs. For most water utilities in the Central Utah Water Conservancy District, the marginal cost of water is represented by the cost of M&I water from the SFN system, the Alpine Aqueduct or other CUP facilities. For some, the next increment of water supply may be the purchase of water rights, installing a new well field and building additional storage. These costs are significant but they are "observable" and they likely would work as a basis for marginal cost pricing of water in most cases. The last paragraph on this page (ending on the next page) suggests that marginal cost pricing is too complex for the average utility to handle. Most cost of service studies being carried out by the larger local utilities address most of the elements that are required for a marginal cost pricing policy. The discussion in the draft final report dismisses too lightly an approach that may bring a sound rational to the discussion of water conservation pricing.

On page 8-3, the requirement of CUPCA under item (D) refers to "incremental scarcity value of water." The discussion that follows seems to lack a distinction between scarcity value and other values, i.e., value in use etc. Water has scarcity value only when it is in short supply such as when the water level in wells is being drawn down over a large area or population growth is pushing the limits of the developed supply. There are areas in the CUWCD where no scarcity value is discernable because the supply is sufficient for projected growth. In those utility service areas where water is scarce, the scarcity value is most likely equal to the cost of developing the next increment of water supply. The cost to develop or purchase the next block of water (marginal cost) is then the only measure of scarcity value in situations where more water can be obtained. In cases where the last water hole has already been brought on line and demand for water is increasing, the scarcity value could only be equated to the market price that must be paid to move water from a lower economic use (agriculture) to M&I. A market in water rights exists in some parts of the CUWCD service area and market prices include a scarcity value component. Scarcity value is also relevant in places where drought causes temporary shortages in the water supply. In this case the scarcity value can be measured as the cost of crisis conservation measures, or as the cost of purchasing emergency supplies from a nearby utility, or from an irrigator.

Sincerely,

Lyle

Lyle Summers

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Central Utah Water Conservancy District

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TELEPHONE (801) 226-7100

October 16, 1995

Mr. Lyle Summers, Chief Economist
Utah Department of Natural Resources, Division of Water Resources
1636 West North Temple, Suite 310
Salt Lake City, UT 84116-3156

Subject: DWRe Comments on the Water Pricing Policy Study

Dear Lyle:

This is to acknowledge the receipt and review of the Utah Division of Water Resources (DWRe) formal written comments on the Water Pricing Policy Study (Pricing Study). We appreciate the review that you, Division Director Larry Anderson, and the DWRe staff have provided not only through the formal public review process, but also throughout the entire course of the study. A copy of the comments you prepared and provided will be included in Appendix H of the final Report on the Water Pricing Policy Study that is submitted to the Secretary of the Interior. A copy of this letter will also be included in Appendix H.

Upon review of your comments, CUWCD has made some modifications to the body of the report. In particular, elements of your points regarding marginal cost pricing and the definition of incremental scarcity value of water have been included in the final report in Sections 4 and 8, respectively. It is the intent of CUWCD to use the Pricing Study as a springboard for area agencies to identify opportunities for all of us to better manage water resources in Utah and to raise issues of concern and interest as we move forward. We look forward to a continued dialogue on the issues raised in the Pricing Study with DWRe and other area water agencies and purveyors.

Thank you again for your continued interest and assistance in the completion of the Pricing Study.

Sincerely,

Karen M Ricks

Karen M. Ricks
WMIS Project Manager

pc: Kreg McCollum, RMI

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