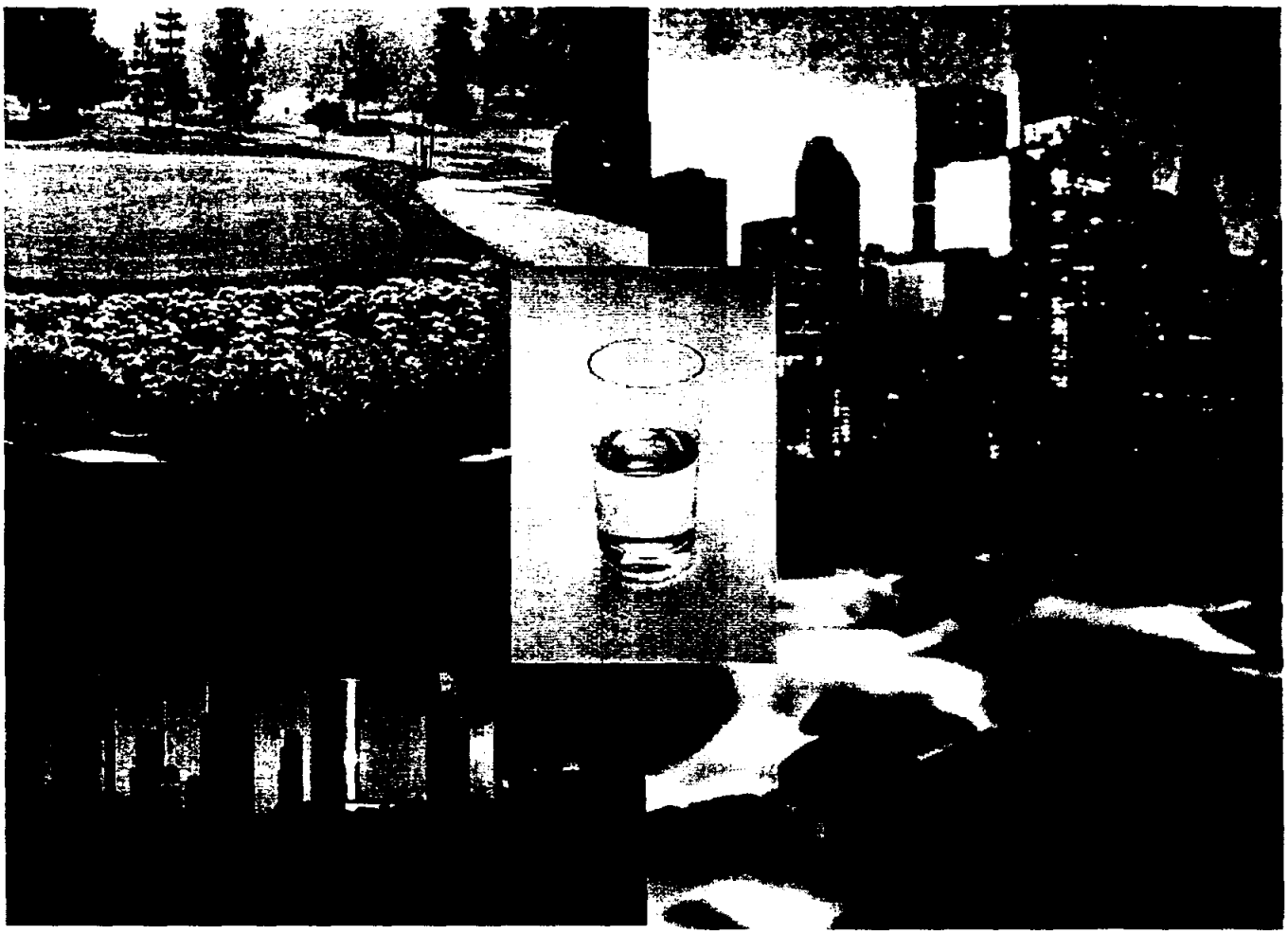

# City of Houston

## Water Conservation Plan

May 1997

MONTGOMERY WATSON

# City of Houston

## Water Conservation Plan

May 1997

MONTGOMERY WATSON

# ACKNOWLEDGEMENTS


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# EXECUTIVE SUMMARY

## BACKGROUND

There are many reasons for the City of Houston to develop and implement a water conservation program - even though the area receives an average of 50 inches of rainfall per year:

1. Although the Houston area is blessed with abundant annual rainfall, it is projected that the City will need additional water supply between 2035 and 2045.

2. Flooding and other serious problems caused by subsidence due to ground water pumpage in the area are well documented. Some areas of the city have dropped as much as ten feet.

3. The city's groundwater pumpage is regulated by the Harris-Galveston Coastal Subsidence District. The city is committed to convert from a predominantly groundwater system to a surface water system by 2020. This conversion process is very costly, requiring construction of water treatment plants and transmission mains throughout the City.

4. In 1993 the Texas Natural Resource Conservation Commission (TNRCC) adopted a new water conservation rule that requires the City to prepare and implement a water conservation plan that meets certain requirements. The City's current plan does not meet several elements of the rule.

5. The City annexes additional land area at frequent intervals. Most of the area surrounding the city currently uses ground water. As the city annexes these areas it not only increases its customer base and resulting water demand, but also intensifies the problem of conversion to surface water.

6. The public expects resources to be used efficiently and utility bills to be kept to a minimum.

7. Conservation is cost-effective.

## CURRENT CONSERVATION PROGRAM

Currently the City has a conservation program which includes an education program, in-house programs for departments whose budgets are derived through the general fund, a program to require all large contract customers to prepare a conservation plan, and conservation planning.

The education program includes a contract to participate as a sponsor with the Harris-Galveston Coastal Subsidence District in Water Wise and Energy Efficient, an education/retrofit program, a school education program, a T-shirt design contest, a retrofit display for use at festivals and celebrations, and speakers for civic associations, environmental groups, etc.

The in-house program consists of irrigation audits at City golf courses, esplanades, and other large turf areas; leak detection and repair of City pools and fountains; and tracking and reporting water use by general fund departments.

Since almost 60 percent of Houston's water is sold on contract, these customers are a good target for water savings. The primary instrument for creating incentives for customers to save water is their contract with the City; therefore, changes were made in the model contract for raw water customers. Three major changes were made in the contract: (1) the take-or-pay provision was taken out of the contract; (2) a penalty for excessive usage during peak months was added; and (3) billing is based on actual usage. Also, to comply with TNRCC requirements, a program to require raw water contract customers to prepare, submit, and implement a conservation plan was put into effect in 1995.

## CONSERVATION PLANNING STUDY AND IMPLEMENTATION RECOMMENDATIONS

In 1994 the City applied for and was awarded a matching funds grant by the Texas Water Development Board (TWDB) to finance a conservation planning study. The City retained Montgomery Watson to assist the City in preparing and implementing a conservation plan. The following is a summary of the findings of the study and recommendations for a comprehensive, cost-effective plan.

### Cost-Benefit Analysis and Recommendations

Over 200 conservation measures were considered. After a screening process, water savings were estimated and costs were developed for twenty (20) conservation programs. Benefits and costs were compared in a formal present worth analysis and conclusions were drawn about which programs produce cost-effective water savings for the City. Cost categories include labor (by the City staff or outside contractors to administer and perform any required field work), expenses, incentives, and one-time setup costs. Benefits from conservation include:

- Current savings in operations and maintenance (O&M)
- Savings from the deferral and/or cancellation of capital projects that would have been necessary in the absence of conservation

Capital savings were estimated by comparing existing treatment capacity with the capacity that would be required through the year 2050. Water demand projections were adjusted for expected demand reductions from long-term implementation of existing plumbing code requirements for water conserving toilets, urinals, faucets, and shower heads. The need for additional capacity was estimated assuming that treatment capacity would be added in 50 mgd increments over the period of the plan (through 2050). Capital costs were estimated based on $1.50 per gallon of water treatment capacity.

### The Recommended Plan

Based on the results of the data analysis, several alternative conservation plans were formulated. From an evaluation of these plans, a recommended plan was developed by Montgomery Watson and City staff using the following criteria:

- Benefit-cost ratio greater than 1.0 (i.e., the program must save more than it costs)
- Reasonable cost (i.e., affordable)
- Significant water savings
- Acceptable non-quantifiable impacts

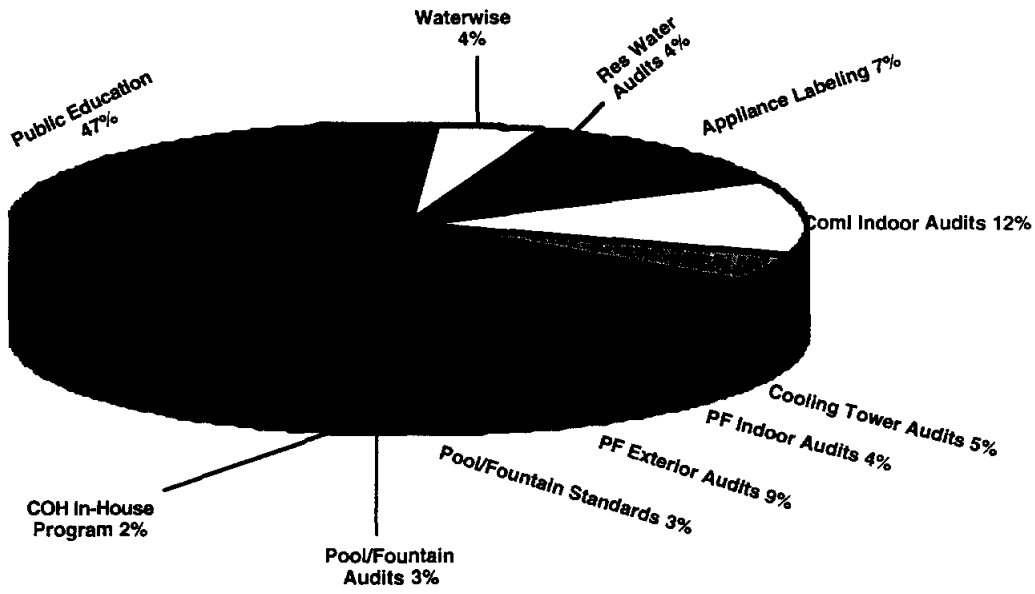
The recommended plan includes residential and commercial/industrial programs, and programs targeted at public buildings and facilities. Several of the programs included in the recommended plan were delayed to reduce the initial costs of the program. A list of the programs, water savings, and total costs (over the first 5 years) of each program included in the recommended plan is detailed in Table ES-1.

**Table ES-1**
**Recommended Plan**

| Sector | Program | Element | 50 Year Avg Water Savings mgd | Water Savings In 2001 mgd | Total Costs Through 2001 $1,000 | Benefit-Cost Ratio (50 years) |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| | Res Water Audits | | 0.42 | 0.18 | $429 | 1.00 |
| | Appliance Labeling | | 0.71 | 0.06 | $75 | 21.70 |
| | | Subtotal | 1.13 | 0.24 | $504 | |
| Commercial | | | | | | |
| | Indoor Audits | | 1.17 | 0.49 | $528 | 2.23 |
| | Cooling Tower Audits | | 0.48 | 0.30 | $210 | 18.60 |
| | | Subtotal | 1.65 | 0.79 | $738 | |
| Public | | | | | | |
| | Indoor Audits | | 0.36 | 0.30 | $313 | 3.03 |
| | Exterior Audits | | 0.86 | 0.72 | $258 | 10.80 |
| | Pool/Fountain Audits | COH | 0.28 | 0.17 | $354 | 6.26 |
| | Pool/Fountain Standards | | 0.25 | 0.04 | $155 | 4.32 |
| | COH In-House Program | | 0.2 | 0.20 | $50 | 54.80 |
| | | Subtotal | 1.95 | 1.43 | $1,130 | |
| Other | | | | | | |
| | Unaccounted-for Water | | 11.65 | 6.40 | $4,400 | 6.28 |
| | Public Education | | 4.51 | 3.62 | $3,925 | 1.78 |
| | Water Wise & Energy Efficient | | 0.42 | 0.41 | $500 | 3.68 |
| | | Subtotal | 16.58 | 10.43 | $8,825 | |
| | | Total | 21.31 | 12.89 | $11,197 | 3.69 |

The plan assumes programs will be implemented by FY2000. Water savings attributable to the recommended plan would increase to 22 mgd of water production by the year 2006 and retail water production would be reduced about 7 percent. The plan would cost about $25 million over the first 10 years. Figure ES-1 shows the distribution of the year 2006 water savings by plan element.

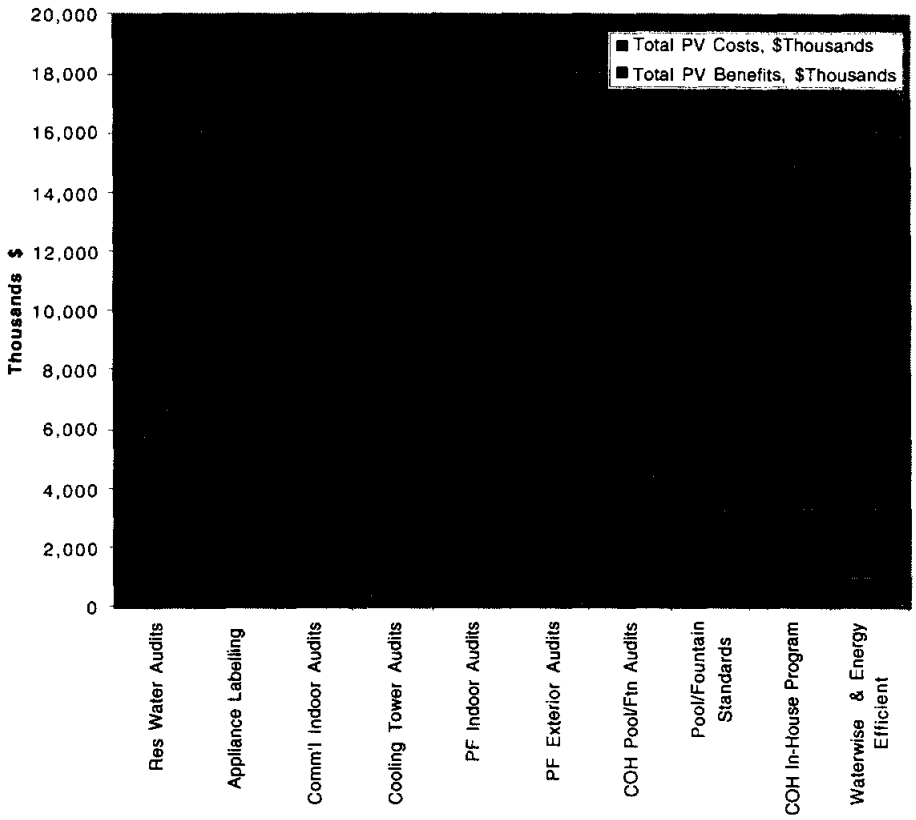
**Figure ES-1**
**Water Savings by Programmatic Element**
**(Excludes Unaccounted-for Water)**




With increased population in the Houston area, and the resulting increased total water demand, the total revenue will continue to increase. However, the amount of increase would be slightly less (approximately 1.5 percent less over the next ten years) with conservation than without.

Benefits from the recommended plan include capital deferrals such as delaying water purification plant expansions 2 to 8 years, and delayed and reduced O&M costs. The recommended programs would provide benefits at the rate of $1.14 per 1000 gallons saved for deferred capital and deferred O&M. An additional $0.27 per 1000 gallons saved would result from producing less water (lower O&M). The total benefit from the recommended plan is $1.41 per 1000 gallons saved. These benefits add up to a significant amount over the study period. The present worth of the total benefits of the recommended plan is approximately $262 million. The plan has an overall benefit-cost ratio of 3.7 to 1, which is very cost-effective. This means that by implementing such a conservation plan, the City of Houston would receive a return of about $3.70 for every $1.00 invested in water conservation. Figure ES-2 shows the benefits and costs of each of the plan elements.

**Figure ES-2**
**Benefits and Costs by Programmatic Element**
**(Excludes Unaccounted-for Water)**




The Recommended Plan is expected to reduce water demand in the City by 21.8 mgd or 7.3 percent of retail water production by the year 2006. Water savings from programmatic conservation (programs other than unaccounted-for water reductions) is about half the total or 9 mgd (3.7 percent). Total revenue for 1995 was almost $500 million, of which about 90 percent was earned from retail sales. By the year 2006 annual revenue reduction from reduced water demand is estimated to be 2.9 percent of projected revenues for that year. The revenue reduction will be much lower in the early years of the program. Overall revenue reduction is predicted to be 1.5 percent of the revenue projected to be collected over the next ten years.

This revenue reduction is small and predictable. The evaluation process proposed as a part of the Recommended Plan will yield quantifiable water savings. This information can be translated into a forecasted rate of revenue growth. The forecast, combined with other factors, such as inflation in system operating costs and weather impacts, will be used in evaluating future rate changes. As the benefits of deferred water treatment plant expansions are realized, bond sales to provide additional treatment capacity will be postponed. Over time, deferral of capital expenditure will result in savings to the rate payers.

In addition to the Recommended Plan, there will be water savings from the 1992 Federal Energy Policy Act that mandates more efficient residential and commercial plumbing fixtures. Adding these savings to the Recommended Plan results in a total savings of 42.4 mgd or 14.2 percent of retail water production by the year 2006.

## Implementation of Plan

The recommended water conservation plan represents a significant commitment and effort by the City of Houston over the next five years to implement existing and proposed new water efficiency programs. In addition to the programs included in the recommended plan, the City will continuously monitor and evaluate its overall water conservation effort in relation to its water supply and water and wastewater facility capacity needs. As the need for major capital investments draw near, the City will consider expanding current programs and/or implementing additional water conservation measures. More aggressive water conservation measures may be implemented throughout the utility service area or targeted to specific sub-areas in order to delay planned capital improvements. Proper timing of future investments by the City in water conservation is essential to maximizing the benefits of such programs to the utility and its rate payers.

It is important that the City design evaluation criteria and water savings tracking methods for each program implemented. The Recommended Plan will require a concerted effort over the next 5 years to manage demand and meet water savings goals. In future years, based on the results of monitoring and continuing evaluation, the City should consider implementing some of the other more aggressive programs which have been evaluated in this study in order to meet established goals.

The following is the recommended plan for phased implementation and the first-year costs associated with each program.

**Current Year - FY97**

| | |
|---|---|
| Public Education Program | $ 300,000 |
| City In-House Program | 300,000 |
| Contract Customer Program | 35,000 |
| Water Wise & Energy Efficient | 100,000 |
| Conservation Planning | 70,000 |
| Unaccounted-for Water Program | 880,000 |
| Total | $1,685,000 |

Note: The Unaccounted-for Water Program is housed in the Maintenance Division. The current Water Conservation Section budget is approximately $805,000. This includes salaries, benefits, overhead, program budgets, and the cost of the planning study. This is currently funded from a combination of CIP and O&M money.

**Second Year - FY98** - In addition to continuing the current program, implementation of the following programs and funding are recommended:

| | |
|---|---|
| Pools and Fountain Standards | $ 31,000 |
| Public Exterior Water Audits | 59,000 |
| Public Indoor Audits | 63,000 |
| Appliance Labeling | 17,000 |
| Total | $170,000 |

**Third Year** - FY99 - The following programs and additional funding are recommended:

| | |
|---|---|
| Commercial Cooling Tower Audits | $ 70,000 |
| Public Pool Audits/Repairs | 118,000 |
| Total | $188,000 |

Of this total, approximately $118,000 could be funded out of the CIP budget.

**Fourth Year - FY00** - The following programs and additional funds are recommended:

| | |
|---|---|
| Residential Water Audits | $214,000 |
| Commercial Indoor Audits | 264,000 |
| Total | $478,000 |

In addition to these new programs, it is recommended that the educational program budget increase by approximately $60,000 annually. This would allow the program to reach out to all 28 school districts in the Houston area, to develop a program geared toward middle and high school students, and to properly support the other new and ongoing programs.

At its peak, the conservation program staff would require approximately 10 to 15 persons. However, staffing levels would need to be refined after detailed program design, including considering program consolidation and economies of scale which might reduce total staffing needs.

# Section 1
# INTRODUCTION

The City of Houston (City) retained Montgomery Watson to prepare a water conservation and reservoir systems operation plan. This report documents the City's water conservation plan. The reservoir systems operation plan report is separately bound.

Montgomery Watson's Scope of Services called for the following tasks:

- Collect and analyze data on historical water use and prepare water use projections (retail service area only) through the year 2050.
- Identify and screen conservation measures.
- Evaluate water savings, and benefits and costs of conservation measures.
- Formulate a recommended conservation plan.
- Participate in a public involvement program.
- Prepare a report containing the recommended plan and background information.

## BACKGROUND ON THE CITY'S NEED TO CONSERVE WATER

Although the Houston area is blessed with abundant rainfall, explosive growth in the 1970s and 1980s has led water planners to conclude that existing developed water resources will need to be supplemented to sustain growth. The planners project that the City will need additional water supply by the year 2030.

Flooding and cracked foundations caused by subsidence due to groundwater pumpage in the Houston area are well documented. In the 1970s the state legislature created the Harris-Galveston Coastal Subsidence District to regulate the withdrawal of groundwater in the eight-county area. Also, according to the terms of Houston's pumpage permit, the City is committed to converting from a predominately groundwater system to a surface water system over the next 25 to 30 years. This is a very costly conversion program requiring construction of water treatment plants and transmission mains throughout the City.

One option for meeting the future water supply needs of the City is to participate in the State's Trans-Texas project. The Toledo Bend Reservoir, partially owned by the State, could make water available to Houston. Transferring the water is problematic and politically controversial, especially in the area around the reservoir. The Trans-Texas Water Program is currently studying the potential Toledo Bend Reservoir transfer, in addition to other transfers, to determine how they would benefit Houston and other areas of the state. Before this diversion is approved, the City is taking a hard look at water conservation and wastewater reclamation.

In 1992 the Texas Natural Resources Commission (TNRCC) adopted a new water conservation rule that requires the City to prepare and implement a water conservation plan that meets certain guidelines and requirements. In 1994, the City applied for and was awarded a matching funds grant by the Texas Water Development Board to finance preparation of the plan. The City has agreed to share the results of the research project with the Trans-Texas Program.

## TEXAS NATURAL RESOURCES COMMISSION WATER CONSERVATION GUIDELINES AND REQUIREMENTS

The TNRCC guidelines for these plans were published in April 1993. There are certain minimum requirements as well as additional requirements that apply to larger cities such as Houston. The requirements are listed below.

### Minimum Requirements

- Utility profile - population and customer water use data and water/wastewater system characteristics
- Conservation goals
- Production source metering and universal metering of customers
- Control of unaccounted-for water
- Public education program
- Non-"Promotional" water rate structure
- Drought management plan
- Reservoir systems operation plan
- Means to implement and enforce plan

### Additional Plan Requirements (cities of more than 5,000 people)

- Leak detection and repair program
- Billing by customer class
- Water conservation provisions in wholesale contracts

### Additional Conservation Strategies (measures to be evaluated in plan)

- Conservation-oriented rate structures
- Plumbing code ordinances
- Plumbing retrofit
- Wastewater recycling
- Pressure control
- Landscape water program and/or ordinances
- Method to monitor effectiveness of the plan
- Other appropriate methods developed by the supplier

## ORGANIZATION OF REPORT

This first section describes the sections in the report and presents the background on this project, the need for conservation in the City, and the state conservation plan requirements.

Section 2 presents the analysis of historical water use by customer class. Water use factors are developed for each class, expressed in gallons per account per day. The percentages of inside usage and outside usage are shown separately.

Section 3 develops the water use projections, based on population projections obtained from several sources. Water use projections were based on the population projections that best met both the geographic boundaries and the time frame for the study. Two separate water use projections are presented, one based on existing city limits and one based on existing boundaries for Harris County. Projections based on the City limits were selected as the basis for the analysis.

Section 4 presents alternative water conservation measures based on the potential identified in Sections 2 and 3. A qualitative screening was used to reduce the number of measures initially considered (over 200) to a more manageable number.

Section 5 combines the measures which passed the screening into a list of 20 alternative conservation programs. Each program is briefly described in more detail in Appendix C.

Section 6 presents the results of the analysis of the 20 programs. Water savings, benefits, and costs are estimated. Included with the results is an explanation of the methodology used by WaterPlan 2.0, a water management planning software.

Section 7 takes the 20 programs and combines them into three alternative plans, then recomputes the overall water savings, benefits, and costs of each plan. A recommended plan was developed, based on input from the City, following a public meeting. The recommended plan was further detailed with an implementation schedule, staffing plan, and budget.

Appendix A contains the results of a commercial/industrial water user survey used to formulate conservation measures that could reduce water use in this sector.

Appendix B presents the result of screening conservation measures against a set of criteria.

Appendix C provides a detailed description of the 20 conservation programs.

Appendix D contains the relevant portions of the WaterPlan 2.0 output for the recommended plan.

## PUBLIC INVOLVEMENT PROGRAM

The general public was given three specific opportunities to provide input while the plan was being developed and was kept generally informed through the City of Houston (the City) Water Conservation newsletter called *Conservation Cents*. The three public meetings were held as follows:

- **Public Meeting No. 1, March 23, 1995, 25 People in Attendance.** The purpose of the meeting was to describe the plan development process and provide an overview of water conservation measures to be evaluated.

- **Public Meeting No. 2, September 27, 1995, 35 People in Attendance.** This meeting was used to familiarize the public with the water conservation opportunities and describe the 20 water conservation programs planned for the evaluation phase.

- **Public Meeting No. 3, June 13, 1996, 55 People in Attendance.** At this meeting the results of the evaluation were presented as well as the three alternative plans. Input was solicited on which plan should be selected..

Comment cards were distributed at the last meeting and for several months afterwards. Comments from the general public were dealt with on an on-going basis. The overall results of the meetings were very positive. No opposition to any of the programs or plans being considered was ever voiced. The public was supportive of the City's efforts to increase water conservation efforts.

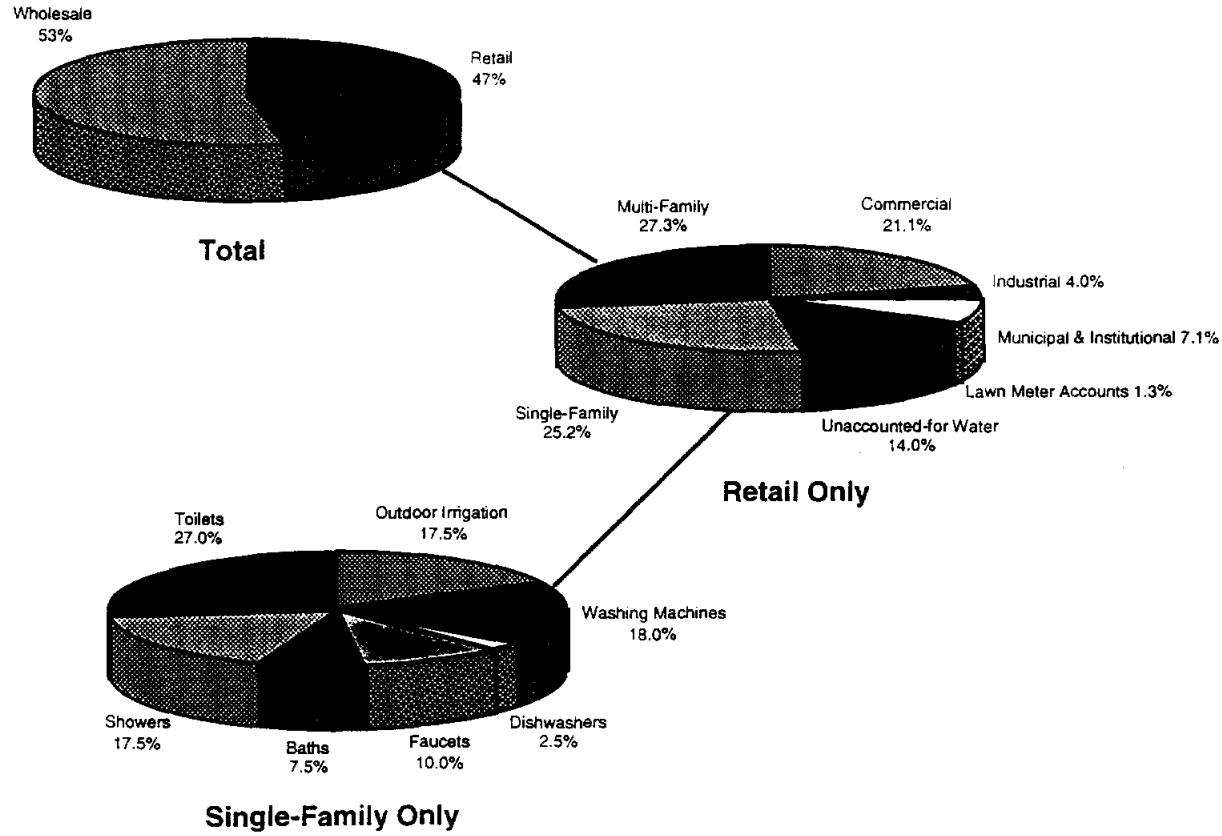
# Section 2
# HISTORICAL WATER USE PATTERNS

A water conservation study requires accurate knowledge of how water is used in the service area. Normally this knowledge is developed by analyzing water billing records and using published studies to quantify end uses of water. This section provides a brief overview of Houston's water use patterns followed by a statistical analysis of the water billing records. The analysis is needed to establish a basis for making detailed water use projections in the Section 3.

## HOW HOUSTONIANS USE WATER

Before reviewing the statistical analysis presented in this section, a brief overview of how water is used in the City is provided to familiarize the reader with the overall use profile. Shown in Figure 2-1 are three pie diagrams that illustrate what is known about water use in the City. The first diagram shows that the retail system bills individual customers for a little less than half of the total water supply. Wholesale customers, mainly large industries and other cities, receive water directly by surface water canals from the City's sources: Lake Livingston and Lake Houston. These wholesale customers have contracts with the City for this water, which also require that they prepare water conservation plans. (This report deals exclusively with the retail water system.)

**Figure 2-1**
**Houston Water Use Profile**



The second pie diagram in Figure 2-1 shows the different categories in the retail water billing system, plus unaccounted-for water. Note that over 50 percent of the water is used for residential purposes, split about equally between single-family and multifamily properties. Commercial and small industrial accounts use another 25 percent. The City and other public/institutional accounts (schools, hospitals, etc.) use 7 percent.

The last pie diagram shows a breakdown of single-family use. (Multifamily use is similar, except for outdoor irrigation which is only 12 percent of multifamily use). The breakdown of indoor use is based on published literature (Water Conservation, AWWA, 1987). Water used in the bathroom accounts for more than half of the indoor use, with toilet use being most significant. Washing machines are a significant use, but dishwashers are not. This information is used to develop water conservation measures in Section 4. Similar data for commercial end uses was developed through a water use survey, the results of which are also presented in Section 4.

## RETAIL SALES ANALYSIS

The purpose of this section is to describe the analytical process and results associated with the development of water use per-account data by customer class. These results were applied to the demographic analysis in projecting future water demand. The per-account usage rates are based on historical consumption and include only the impact of conservation measures in place as of mid-1995. Projecting these rates-of-travel into future years provides the base volume for analyzing conservation opportunities and for measuring performance after the measures have been put in place.

The number of accounts and monthly billed consumption (thousands of gallons) were provided by the City data processing department for the period January 1988 through June 1995 for approximately 40 customer groups. The City also provided the monthly consumption block for single family residential (SFR) accounts, in addition to water rate history, for the purpose of testing the effects of water prices on consumption during the historical period. Wholesale water volume was provided to complete the total demand side of the supply/demand equation. Identifying conservation opportunities for wholesale water volume is not part of this assignment, but the same forecasting methods that were applied to retail water sales were also applied to historical wholesale sales to provide a comparable rate-of-travel perspective. Projections into future years were not made for wholesale accounts or volumes.

Retail water sales were broken down into six relatively homogeneous customer classes for which monthly historical data is available. This data was expressed in terms of gallons per day per account (gpda) so that historical patterns could be evaluated without the volatility of account growth. The six classes were selected on the basis of similar consumption characteristics and the availability of base data to which the results of gpda analysis can be applied. For example, single-family and multifamily residential accounts are relatively homogeneous classes, and their consumption per account or dwelling unit can be forecasted based on projections of census data for single-detached and multifamily dwelling units. Commercial and industrial accounts are much less homogeneous as to water use per account or per employee, but future consumption can be projected based on account or employment growth rates for the city's service area. Table 2-1 lists

the customer categories, by user code, for which data is available and combines the categories into six retail customer classes. The City (General Fund) user code (mostly irrigation accounts) is also tracked separately but remains within the Municipal & Institutional customer class.

**Table 2-1**
**City of Houston - Water System**
**Summary of Accounts by User Code - Average Month, 1994**

| User Code | Description | Number of Accounts | % of Total Retail |
|---|---|---|---|
| | **Single Family Residential:** | | |
| 01 | Residential | 310,874 | 41.5% |
| 02 | Senior Citizens | 12,061 | 1.6% |
| 03 | Public Works Employees | 258 | 0.0% |
| | **Multi-family Residential:** | | |
| 14 | 2 Unit Dwellings | 9,388 | 1.3% |
| 15 | 3 Unit Dwellings | 2,984 | 0.4% |
| 16 | 4 Unit Dwellings | 6,348 | 0.8% |
| 17 | Condos/Townhouses | 23,471 | 3.1% |
| 18 | Apartments | 339,009 | 45.2% |
| 19 | Trailer Parks | 2,315 | 0.3% |
| | **Commercial Accounts** | | |
| 21 | One Commercial Unit Structures | 28,124 | 3.8% |
| 22 | 1 Commercial, 1 Family | 98 | 0.0% |
| 23 | 2 Commercial Units | 59 | 0.0% |
| 24 | 3 Commercial Units | 31 | 0.0% |
| 25 | Strip Shopping Center | 126 | 0.0% |
| 26 | Shopping Center | 59 | 0.0% |
| 27 | Hotel/Motel | 285 | 0.0% |
| 28 | Office/Bank Buildings | 778 | 0.1% |
| 29 | Restaurant or Bakeries | 2,329 | 0.3% |
| 30 | Industrial Laundry | 15 | 0.0% |
| 31 | Laundry Retail | 175 | 0.0% |
| 32 | Laundromat | 219 | 0.0% |
| 33 | Plater | 24 | 0.0% |
| 34 | Mortuary | 74 | 0.0% |
| 35 | Car Wash | 229 | 0.0% |
| 36 | Service Station/Auto Repair | 1,427 | 0.2% |
| 61 | Private Wells (Cycle 50) | 37 | 0.0% |

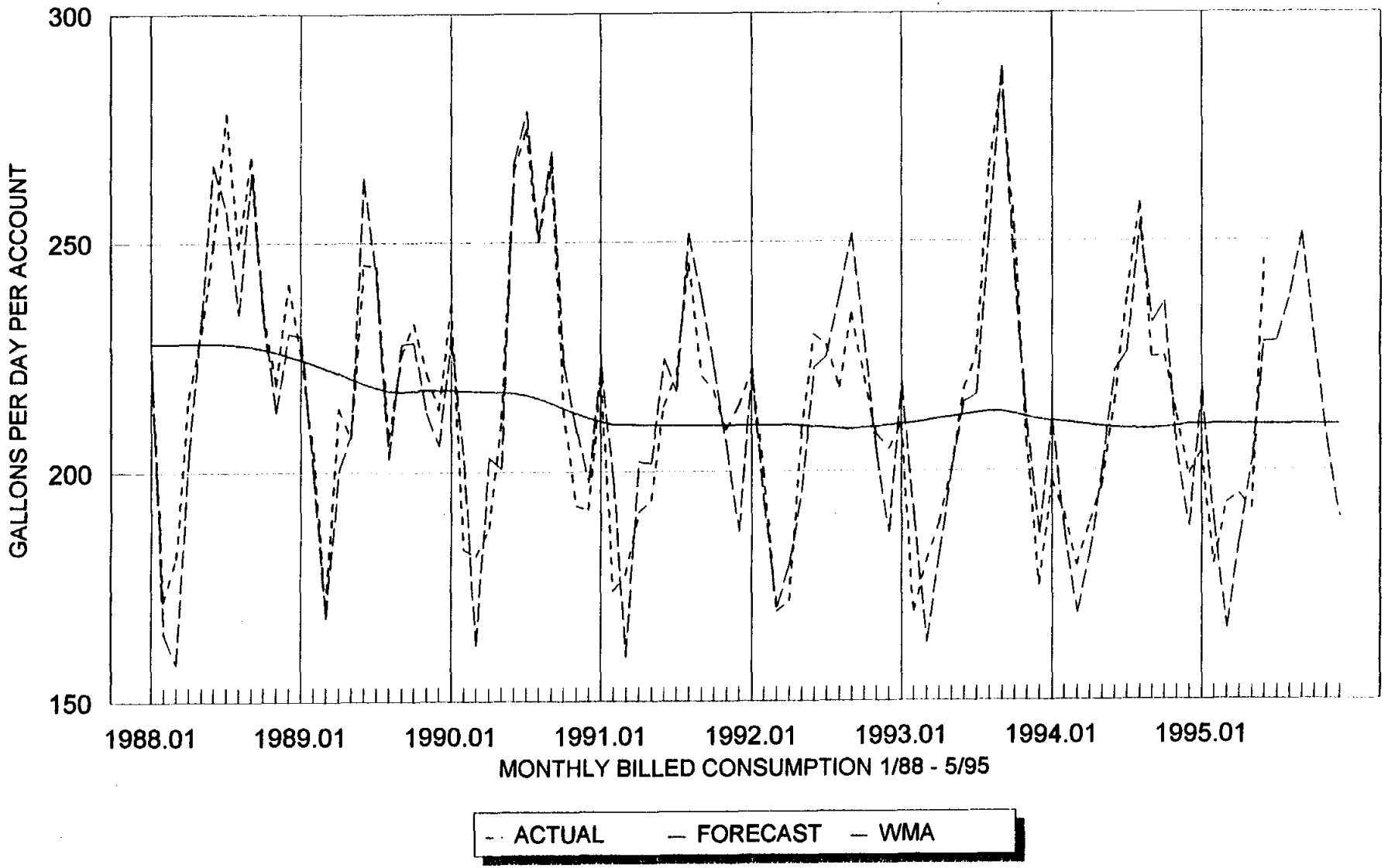
**Table 2-1 *(continued)***
**City of Houston - Water System**
**Summary of Accounts by User Code -- Average Month, 1994**

| User Code | Description | Number of Accounts | % of Total Retail |
|---|---|---|---|
| | **Commercial Accounts *(continued)*** | | |
| 62 | Effluent Only (Cycle 50) | 74 | 0.0% |
| 71 | Construction Meter | 344 | 0.0% |
| 73 | Resale Accounts | 7 | 0.0% |
| 74 | Emergency | 10 | 0.0% |
| 72 | Lawn Meter Accounts | 3,485 | 0.5% |
| | **Municipal & Institutional** | | |
| 37 | Private Schools | 56 | 0.0% |
| 39 | Hospitals | 122 | 0.0% |
| 50 | Churches | 1,868 | 0.2% |
| 51 | City (General Fund) | 1,524 | 0.2% |
| 52 | City (Enterprise Fund) | 83 | 0.0% |
| 53 | City/County Government (Billed) | 122 | 0.0% |
| 54 | State Government | 33 | 0.0% |
| 55 | Federal Government | 82 | 0.0% |
| 56 | Public Schools | 416 | 0.1% |
| 57 | State Colleges | 72 | 0.0% |
| 60 | City (Public Utilities) | 123 | 0.0% |
| | **SUBTOTAL** | **749,218** | **100.0%** |
| | **Industrial Accounts** | **293** | **0.0%** |
| | **TOTAL RETAIL** | **749,511** | **100.0%** |

For projection purposes, a 13-month weighted moving average (see next subsection for a brief description of weighted moving average) of consumption was calculated to reflect the trend or "rate-of-travel" expected for each customer category These trends are illustrated in Figures 2-2 through 2-7. The projected trend becomes the basis upon which conservation performance can be measured. In the process of developing data for analysis, adjustments were made for account reporting changes that occurred in 1991.

# SINGLE FAMILY RESIDENTIAL

## ACTUAL COMPARED WITH FORECAST




WMA = 13 Month Weighted Moving Average

Figure 2-3

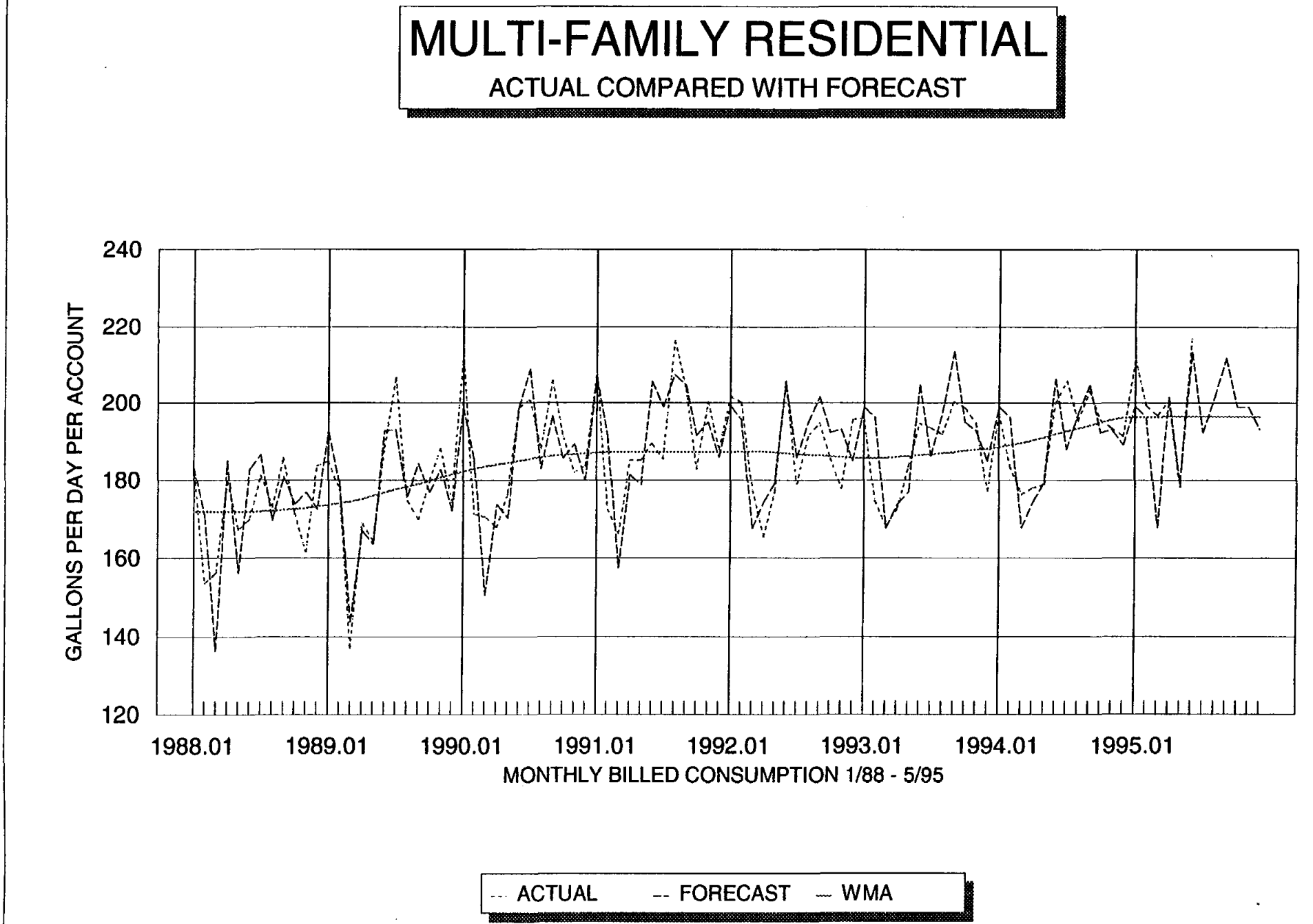

MULTI-FAMILY RESIDENTIAL
ACTUAL COMPARED WITH FORECAST
GALLONS PER DAY PER ACCOUNT
240
220
200
180
160
140
120
1988.01
1989.01
1990.01
1991.01
1992.01
1993.01
1994.01
1995.01
MONTHLY BILLED CONSUMPTION 1/88 - 5/95
ACTUAL
FORECAST
WMA
WMA = 13 Month Weighted Moving Average

Figure 2-4

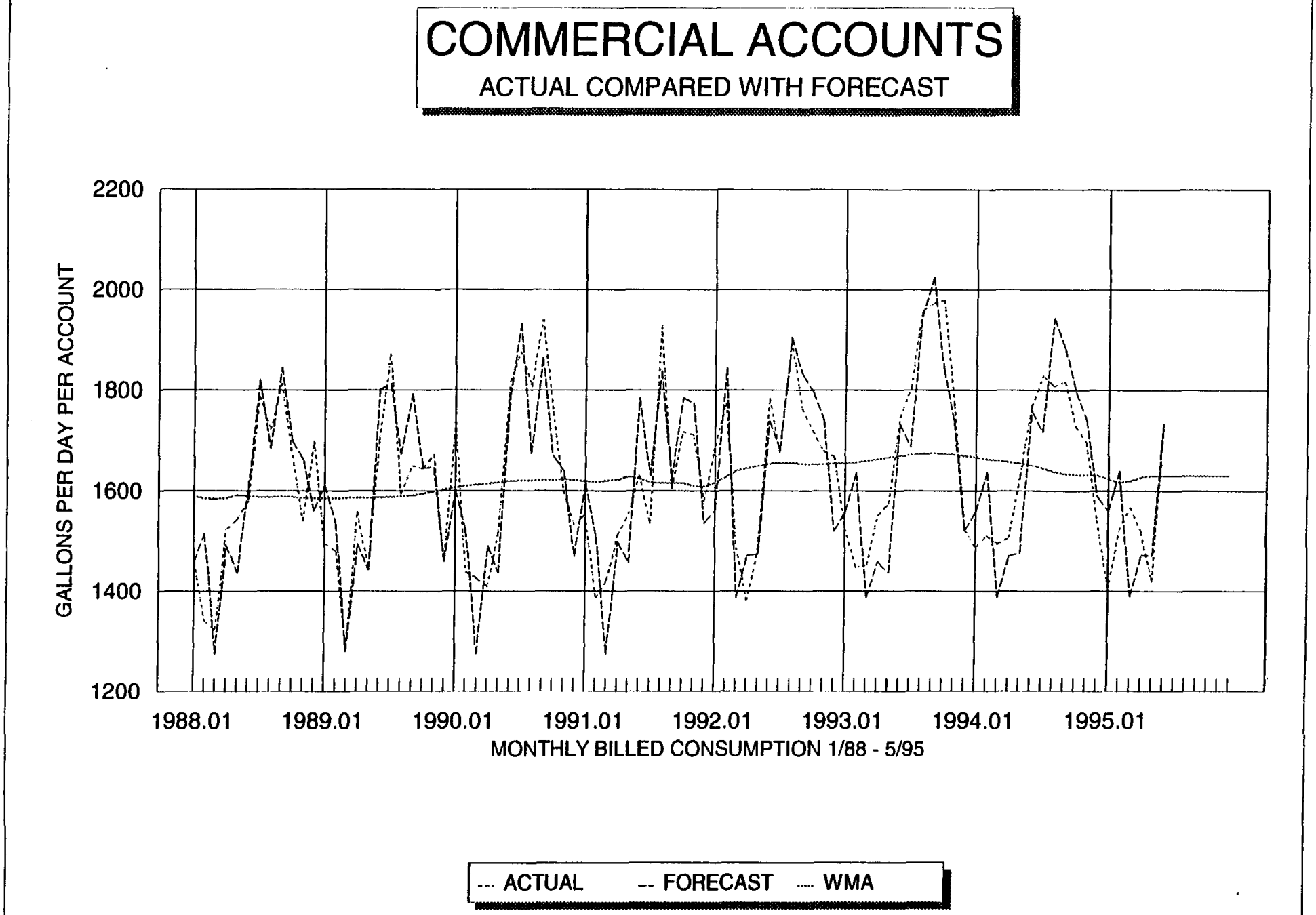

COMMERCIAL ACCOUNTS
ACTUAL COMPARED WITH FORECAST
GALLONS PER DAY PER ACCOUNT
2200
2000
1800
1600
1400
1200
1988.01
1989.01
1990.01
1991.01
1992.01
1993.01
1994.01
1995.01
MONTHLY BILLED CONSUMPTION 1/88 - 5/95
--- ACTUAL
-- FORECAST
..... WMA
WMA = 13 Month Weighted Moving Average

Figure 2-5

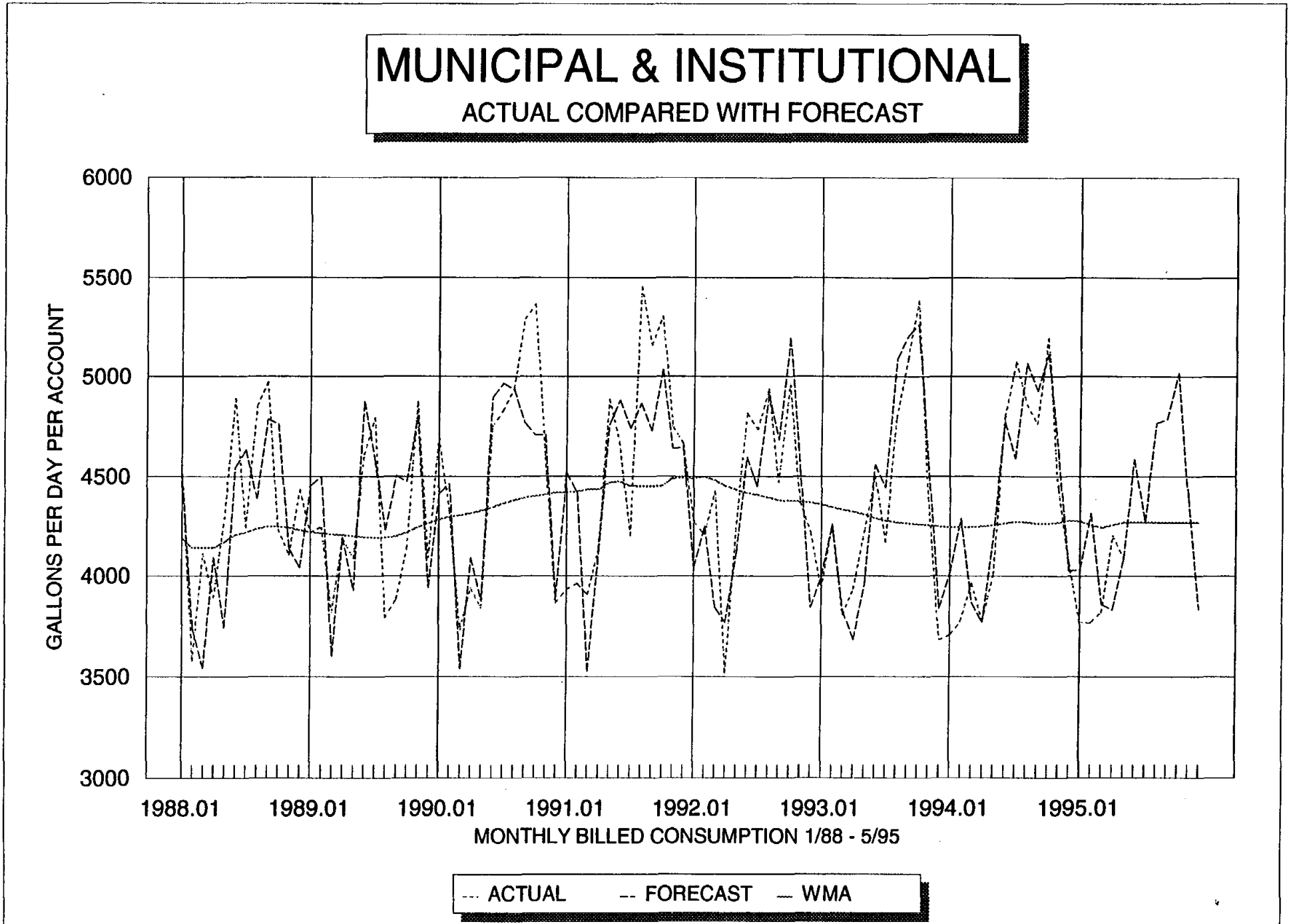

MUNICIPAL & INSTITUTIONAL
ACTUAL COMPARED WITH FORECAST
GALLONS PER DAY PER ACCOUNT
6000
5500
5000
4500
4000
3500
3000
1988.01
1989.01
1990.01
1991.01
1992.01
1993.01
1994.01
1995.01
MONTHLY BILLED CONSUMPTION 1/88 - 5/95
--- ACTUAL
-- FORECAST
— WMA
WMA = 13 Month Weighted Moving Average

Figure 2-6

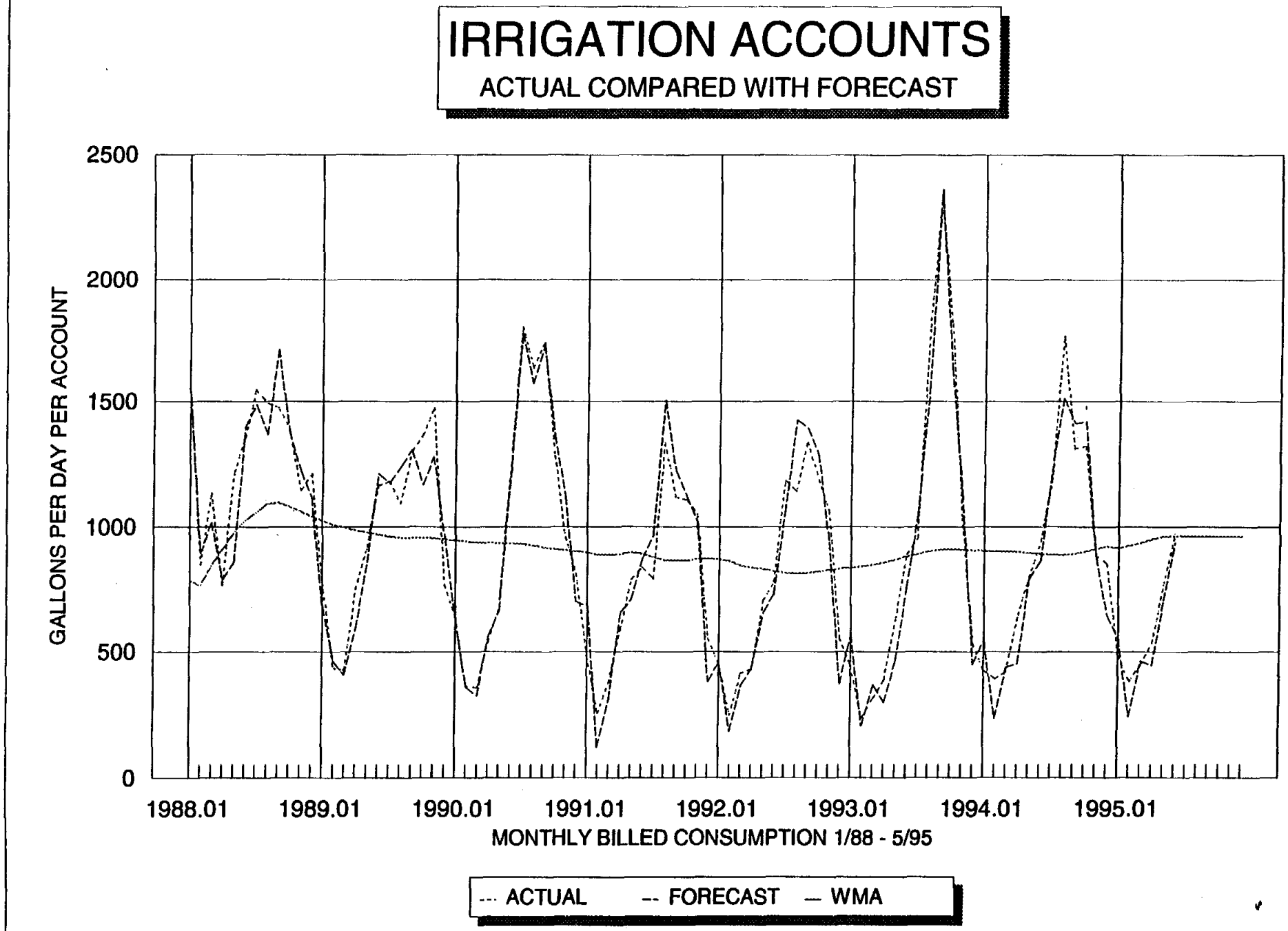
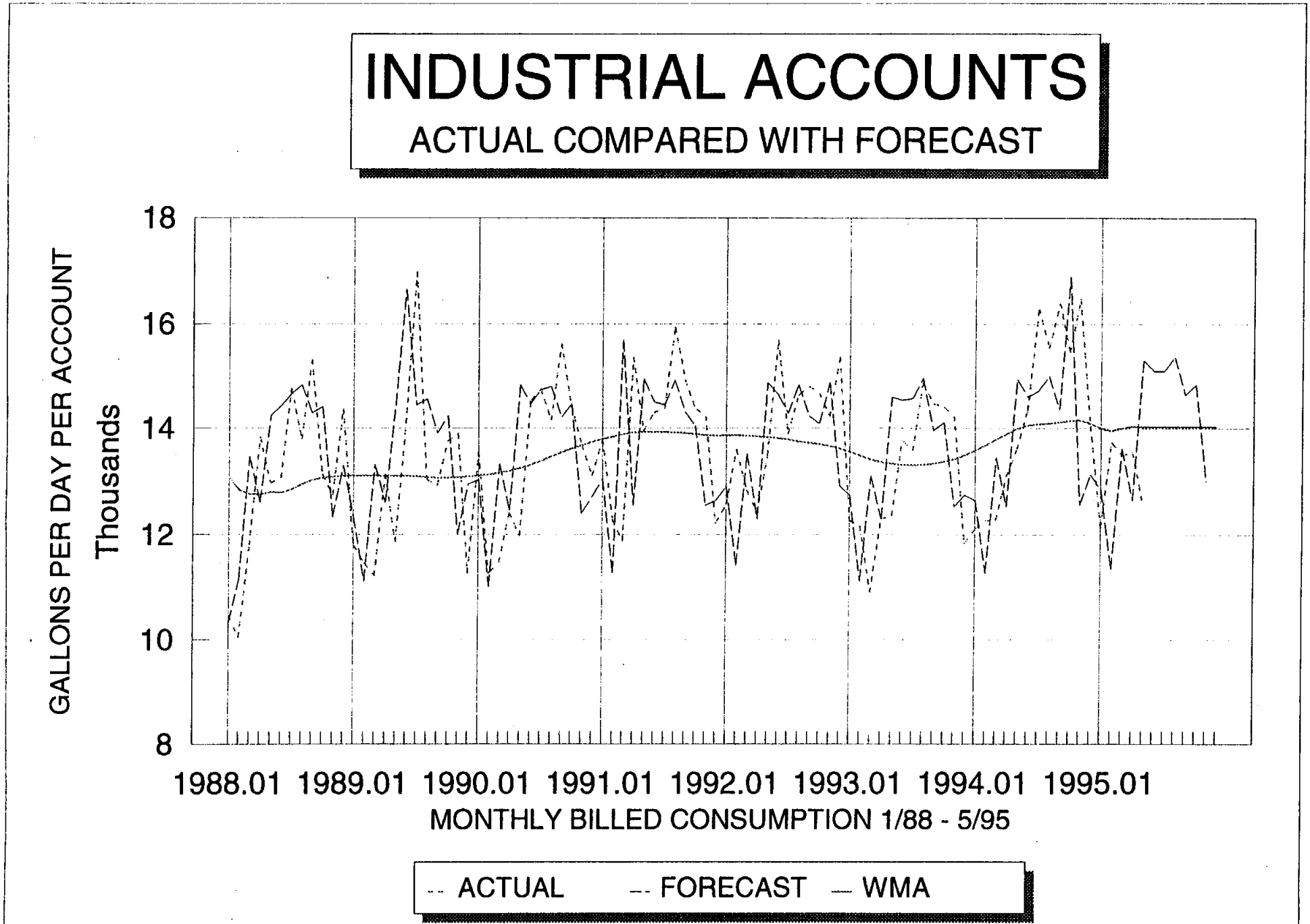

IRRIGATION ACCOUNTS
ACTUAL COMPARED WITH FORECAST
GALLONS PER DAY PER ACCOUNT
2500
2000
1500
1000
500
0
1988.01
1989.01
1990.01
1991.01
1992.01
1993.01
1994.01
1995.01
MONTHLY BILLED CONSUMPTION 1/88 - 5/95
--- ACTUAL
-- FORECAST
— WMA
WMA = 13 Month Weighted Moving Average

Figure 2-7


INDUSTRIAL ACCOUNTS
ACTUAL COMPARED WITH FORECAST
GALLONS PER DAY PER ACCOUNT
Thousands
18
16
14
12
10
8
1988.01
1989.01
1990.01
1991.01
1992.01
1993.01
1994.01
1995.01
MONTHLY BILLED CONSUMPTION 1/88 - 5/95
-- ACTUAL
-- FORECAST
— WMA
WMA = 13 Month Weighted Moving Average

Consumption for each customer class is also expressed in terms of indoor and outdoor use. Indoor water use is derived by multiplying the lowest month's seasonal index (0.825 for SFR) times a weighted moving average (WMA) of monthly sales. For example, if the WMA for SFR is 240 gpda, then the indoor consumption is 0.825 times 240, or 198 gpda. Outdoor consumption is derived by subtracting the indoor gpda from the total gpda. Total indoor and outdoor consumption expressed in millions of gallons is not affected by the reporting change because the lower indoor and outdoor consumption in gpda that results from the larger number of accounts is multiplied by the proportionately larger number of accounts.

## STATISTICAL METHODS

A combination of time series analysis and regression analysis was applied to define the seasonal pattern of each customer group, to weather-normalize the sales data, and to measure the impact of water prices on SFR water demand. Major elements of the statistical process are discussed below. A number of statistical terms are used in this section to describe the methods of analysis. Brief descriptions of some of these terms are provided in the following text to aid the reader who is not familiar with the methods.

### Weighted Moving Average

A 13-month moving average (centered on the 7th month) is frequently used to calculate seasonal indices. Since 13 months exceed the period of a year, the seasonal or monthly pattern is removed in the moving average, and the trend or cyclical patterns of the time series are provided both numerically and visually (Figures 2-2 through 2-7) for evaluating the direction of the consumption time series.

### Seasonal Index

A seasonal index expresses each month's typical consumption as a ratio to average month's consumption (the WMA). For example, the March seasonal index for SFR accounts is 0.825 which means that March's water sales are typically 82.5 percent of average month water sales. Similarly, September's index is 1.198 which means September's water sales are typically 119.8 percent of average month water sales. For the City, 75 percent of all variation in monthly SFR water sales can be statistically explained by this one variable, the seasonal index. The seasonal index is used in Section 3 for forecasting future monthly water sales per account by multiplying the index for each month times the gpda rate-of-travel (the WMA) for each customer group. The total forecast, in millions of gallons, is derived by multiplying the forecast-per-account by the number of accounts and the number of days in the forecast period.

### Regression Analysis

Regression Analysis is a statistical technique that defines the relationship of one dependent variable with one or more independent variables. The dependent variable (monthly water sales) depends on or is caused by the independent variables. All regression programs, in spreadsheets or separate statistical programs, provide a measure (called $R^2$) of how much of the variation in monthly water sales is explained by the regression coefficients derived for each variable. Another measure of

"goodness of fit" provided in most statistical packages is the "standard error of the estimate" which permits building probability confidence intervals around the predicted water sales values for each month. Still another measure of the accuracy of forecasts fitted to historical data is the Mean Absolute Percentage Error (MAPE) which is the average percentage of the absolute value of forecast errors, which is always higher than the simple average of errors that combines both positive and negative errors. These regression results are summarized in Table 2-2 for the seven customer categories analyzed. All of the results are statistically very acceptable using only the variables identified.

**Table 2-2**
**Summary of Regression Analysis Results**

| | SFR | MFR | COMM | M & I | INDUST | IRRIG | PARKS |
|---|---|---|---|---|---|---|---|
| **Goodness of Fit:** | | | | | | | |
| $R^2$ (Ratio to 1) | .89 | .72 | .91 | .69 | .71 | .94 | .85 |
| Std Error (gpd) | 11.2 | 8.6 | 89.2 | 295.3 | 812.0 | 135.9 | 280.2 |
| MAPE (%) | 4.3 | 3.6 | 4.0 | 5.1 | 5.2 | 2.1 | 10.3 |
| **Variables Used:** | | | | | | | |
| Seasonal Index | • | • | • | • | • | • | • |
| Maximum Temp | • | • | • | | • | • | • |
| Cool Degree Days | • | • | • | • | | • | • |
| Rain Days | • | | | | | | |
| Rainfall Inches | | | | | | • | |
| Autoregressive | • | | | | | | • |
| Trend 1988-91 | | • | | | | | |
| Outliers | • | • | • | • | • | • | • |

## Weather Normalization

Five National Oceanic and Atmospheric Administration (NOAA) monthly weather series were used in the regression analyses to define the impact of weather on water consumption: maximum day temperatures, average day temperatures, inches of precipitation, number of rain days, and number of cooling degree days. Because a seasonal index was used that expresses each month in terms of an average monthly or normal weather pattern, the five weather variables were converted to departures from normal weather (a forty-year average provided by NOAA). In this way, the weather departures from normal are associated with consumption departures from normal. For example, the abnormally high temperature in July (actual temperature less normal temperature) explains the abnormally high water usage in July, and similarly for the other weather variables. Table 2-3 shows that one or more weather variables were significant in the regression analyses for every customer class.

**Table 2-3**
**Summary of Weather Impacts by Customer Class**
**Percentage of Water Consumption in Period**

| | SFR | MFR | COMM | M & I | INDUST | IRRIG | PARKS |
|---|---|---|---|---|---|---|---|
| **ANNUAL:** | | | | | | | |
| 1988 | 3.0 | 0.9 | 1.3 | 2.2 | -0.3 | 8.2 | 2.4 |
| 1989 | 0.7 | 0.1 | 0.2 | 0.1 | -0.4 | -2.8 | 0.5 |
| 1990 | 4.8 | 1.7 | 2.7 | 4.0 | 0.9 | 19.8 | 6.7 |
| 1991 | -1.8 | 0.2 | 0.4 | 1.9 | 0.0 | 3.4 | 0.9 |
| 1992 | -0.8 | -0.3 | -0.6 | 0.0 | -0.4 | -3.1 | -1.2 |
| 1993 | 2.6 | 1.5 | 2.8 | 3.4 | 0.5 | 16.7 | 5.4 |
| 1994 | 1.9 | 0.6 | 1.1 | 3.0 | 0.4 | 8.8 | 2.0 |
| **MAX-MONTH:** | | | | | | | |
| 1988 | 3.8 | 2.2 | 3.0 | 4.6 | -3.8 | 16.8 | 5.5 |
| 1989 | -4.1 | 1.5 | 2.3 | 5.4 | -0.9 | -14.6 | 5.9 |
| 1990 | 8.1 | 4.1 | 6.0 | 7.1 | 1.6 | 24.0 | 13.3 |
| 1991 | -3.6 | 0.9 | 1.4 | 5.5 | 0.9 | 11.2 | 2.7 |
| 1992 | -2.3 | -1.4 | -2.6 | -4.1 | -0.7 | -11.1 | -4.6 |
| 1993 | 7.6 | 4.5 | 7.5 | 6.6 | 1.8 | 23.1 | 11.5 |
| 1994 | 4.4 | 1.3 | 2.4 | 4.8 | 0.7 | 12.3 | 3.1 |

Weather is not a major determinant of the level of consumption in most years and most customer classes, but there are some exceptions. The impacts were generally higher in 1988, 1990, and 1993 for all customer classes. Irrigation Accounts have a higher sensitivity to weather than all other classes in all years. Peak month sensitivities are higher than annual sensitivities for all customer classes and all years because there is no offsetting of positive and negative weather impacts. For peak months, weather has had a very significant impact on water use, particularly with irrigation accounts.

Actual water sales were weather normalized by removing the impacts of weather. The WMA for each customer class were then calculated from the weather normalized consumption series. This means that forecasts made with these WMAs reflect normal weather patterns. Consumption can be expected to be lower in abnormally cool and/or wet periods and higher in abnormally hot and dry periods.

## Autoregressive Variables

Serial correlation (or autocorrelation) is very common in a monthly time series analysis such as monthly water consumption. There is a tendency for errors (residuals) in one period to be correlated with errors in preceding periods. If these patterns are predictable, that is, if they can be defined with a regression coefficient just like any other variable, then a coefficient should be

determined and used because its inclusion will make the coefficients of the other independent variables more true to their actual causal influence. The Durbin-Watson (D-W) test is used to determine if serial correlation exists to the extent that an autoregressive term is needed. Generally, it is desirable that the Durbin-Watson statistic be within the range of 1.7 to 2.3. (A D-W value of 2.0 indicates no serial correlation.)

The most efficient means of accounting for serial correlation is to include as an independent variable an autoregressive variable. The process of including the autoregressive term is to find the coefficient (factor) that best measures the forecast error for each period with a specified prior period. This process can be done for any prior period length; the most effective length is usually the immediately prior period (first order autocorrelation.). This was the case in the regression for single-family residential consumption. All other customer classes were within the Durbin Watson statistic bounds and did not require an autocorrelation term.

### Trend

The multifamily customer group demonstrated a significant upward trend during 1989 and 1990 (see Figure 2-3). The trend pattern flattened out in 1991. A trend variable was included in the regression analysis to capture this pattern so that coefficients of other variables are not distorted by the trend. There appears to be a similar but less pronounced pattern in 1994 which had flattened out in 1995. The more conservative, flattened 1995 WMA is being used to project MFR consumption.

### Outliers

Outlier variables were included in the regression analyses for each customer class to capture and remove the effects of extreme monthly sales, that is, sales that are more than 2.5 standard deviations removed from their expected value. These extreme values are usually the result of reporting irregularities. Their removal generally improves the accuracy of the other coefficients.

## IMPACT OF PRICE ON CONSUMPTION

Major changes were made to the water and sewer rate structures during the 1987 through 1993 period that might have had a significant impact on water volumes. For water rates, the changes were primarily to reduce water bills for very low volume customers and increase the cost of water in the upper blocks to induce reduced use. For example, the average bill for customers using 3 units or less decreased from $8.54 in 1987 to $2.95 in 1994, while the monthly bill for customers using more than 20 units increased from $51.92 in 1987 to $69.03 in 1994 (see Table 2-4). For wastewater rates, which are tied to water consumption, the monthly bill for 3 units or less increased from $3.56 in 1987 to $5.55 in 1994, while the monthly bill for 20 units was increased from $46.04 in 1987 to $64.07 in 1994. For combined water and sewer bills, the 1987 bill for 3 units was $14.46 compared to $8.50 in 1994. For 20 units of consumption, the bill increased from $97.96 in 1987 to $133.10 in 1994.

**Table 2-4**
**City of Houston**
**Water & Wastewater Rates and Monthly Bills -1987-1995**

| | | Water Rates and Monthly Bills | | | | Wastewater Rates and Monthly Bills | | | | Total Water & Wastewater | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Water Rates | | Typical Bill/Month | | Wastewater Rates | | Typical Bill/Month | | Typical Bill/Month | |
| Water Use | | Minimum | Rate tgals | Qty tgals | Dollars | Minimum | Rate tgals | Qty tgals | Dollars | Qty tgals | Dollars |
| 1987 | <= 1 | $4.47 | | 1 | $4.47 | $3.56 | | 1 | $3.56 | 1 | $8.03 |
| | <= 2 | $4.47 | $1.86 | 2 | $6.33 | $3.56 | | | $3.56 | 2 | $9.89 |
| | <= 3 | $4.82 | $1.86 | 3 | $8.54 | $3.56 | $2.36 | 3 | $5.92 | 3 | $14.46 |
| > 3 | <= 4 | $4.82 | $1.86 | 4 | $10.40 | $3.56 | $2.36 | 4 | $8.28 | 4 | $18.68 |
| > 4 | <= 5 | $4.82 | $1.86 | 5 | $12.26 | $3.56 | $2.36 | 5 | $10.64 | 5 | $22.90 |
| > 5 | <= 12 | $4.82 | $1.86 | 12 | $25.28 | $3.56 | $2.36 | 12 | $27.16 | 12 | $52.44 |
| > 12 | | $4.82 | $3.33 | 15 | $35.27 | $3.56 | $2.36 | 15 | $34.24 | 15 | $69.51 |
| | | $4.82 | $3.33 | 20 | $51.92 | $3.56 | $2.36 | 20 | $46.04 | 20 | $97.96 |
| 1988 | <= 1 | $4.47 | | 1 | $4.47 | $3.56 | | 1 | $3.56 | 1 | $8.03 |
| | <= 2 | $4.47 | | 2 | $4.47 | $3.56 | | 2 | $3.56 | 2 | $10.27 |
| | <= 3 | $9.25 | $2.02 | 3 | $11.27 | $3.56 | $2.24 | 3 | $5.80 | 3 | $17.07 |
| > 3 | <= 4 | $9.25 | $2.02 | 4 | $13.29 | $3.56 | $2.24 | 4 | $8.04 | 4 | $21.33 |
| > 4 | <= 5 | $9.25 | $2.02 | 5 | $15.31 | $3.56 | $2.24 | 5 | $10.28 | 5 | $25.59 |
| > 5 | <= 12 | $9.25 | $2.02 | 12 | $29.45 | $3.56 | $2.24 | 12 | $25.96 | 12 | $55.41 |
| > 12 | | $9.25 | $3.64 | 15 | $42.10 | $3.56 | $2.24 | 15 | $32.68 | 15 | $74.78 |
| | | $9.25 | $3.64 | 20 | $60.30 | $3.56 | $2.24 | 20 | $43.88 | 20 | $104.18 |
| 1989 | <= 1 | $4.47 | | 1 | $4.47 | $3.56 | | 1 | $3.56 | 1 | $8.03 |
| | <= 2 | $4.47 | | 2 | $4.47 | $3.56 | | 2 | $3.56 | 2 | $10.62 |
| | <= 3 | $9.78 | $2.14 | 3 | $11.92 | $3.56 | $2.59 | 3 | $6.15 | 3 | $18.07 |
| > 3 | <= 4 | $9.78 | $2.14 | 4 | $14.06 | $3.56 | $2.59 | 4 | $8.74 | 4 | $22.80 |
| > 4 | <= 5 | $9.78 | $2.14 | 5 | $16.20 | $3.56 | $2.59 | 5 | $11.33 | 5 | $27.53 |
| > 5 | <= 12 | $9.78 | $2.14 | 12 | $31.18 | $3.56 | $2.59 | 12 | $29.46 | 12 | $60.64 |
| > 12 | | $9.78 | $3.89 | 15 | $42.85 | $3.56 | $2.59 | 15 | $37.23 | 15 | $80.08 |
| | | $9.78 | $3.89 | 20 | $62.30 | $3.56 | $2.59 | 20 | $50.18 | 20 | $112.48 |
| 1990 | <= 1 | $4.70 | | 1 | $4.70 | $3.80 | | 1 | $3.80 | 1 | $8.50 |
| | <= 2 | $4.70 | | 2 | $4.70 | $3.80 | | 2 | $3.80 | 2 | $8.50 |
| | <= 3 | $12.60 | | 3 | $12.60 | $3.80 | | 3 | $3.80 | 3 | $16.40 |
| > 3 | <= 4 | $12.60 | $2.26 | 4 | $14.86 | $3.80 | $2.78 | 4 | $6.58 | 4 | $21.44 |
| > 4 | <= 5 | $12.60 | $2.26 | 5 | $17.12 | $3.80 | $2.78 | 5 | $9.36 | 5 | $26.48 |
| > 5 | <= 12 | $12.60 | $2.26 | 12 | $32.94 | $3.80 | $2.78 | 12 | $28.82 | 12 | $61.76 |
| >12 | | $12.60 | $4.11 | 15 | $45.27 | $3.80 | $2.78 | 15 | $37.16 | 15 | $82.43 |
| | | $12.60 | $4.11 | 20 | $65.82 | $3.80 | $2.78 | 20 | $51.06 | 20 | $116.88 |

**Table 2-4 *(continued)***
**City of Houston**
**Water & Wastewater Rates and Monthly Bills -1987-1995**

| | | Water Rates and Monthly Bills | | | | Wastewater Rates and Monthly Bills | | | | Total Water & Wastewater | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Water Rates | | Typical Bill/Month | | Wastewater Rates | | Typical Bill/Month | | Typical Bill/Month | |
| Water Use | | Minimum | Rate tgals | Qty tgals | Dollars | Minimum | Rate tgals | Qty tgals | Dollars | Qty tgals | Dollars |
| 1992 | <= 1 | $2.95 | | 1 | $2.95 | $5.55 | | 1 | $5.55 | 1 | $8.50 |
| | <= 2 | $2.95 | | 2 | $2.95 | $5.55 | | 2 | $5.55 | 2 | $8.50 |
| | <= 3 | $2.95 | | 3 | $2.95 | $5.55 | | 3 | $5.55 | 3 | $8.50 |
| > 3 | <= 4 | $12.82 | $2.31 | 4 | $15.13 | $5.55 | $2.95 | 4 | $8.50 | 4 | $23.63 |
| > 4 | <= 5 | $12.82 | $2.31 | 5 | $17.44 | $5.55 | $2.95 | 5 | $11.45 | 5 | $28.89 |
| > 5 | <= 12 | $12.82 | $2.31 | 12 | $33.61 | $5.55 | $2.95 | 12 | $32.10 | 12 | $65.71 |
| > 12 | | $12.82 | $4.19 | 15 | $46.18 | $5.55 | $2.95 | 15 | $40.95 | 15 | $87.13 |
| | | $12.82 | $4.19 | 20 | $67.13 | $5.55 | $2.95 | 20 | $55.70 | 20 | $122.83 |
| 1994-95 | <= 3 | $2.95 | | 3 | $2.95 | $5.55 | | 3 | $5.55 | 3 | $8.50 |
| >3 | <= 4 | $12.82 | | 4 | $12.82 | $11.80 | | 4 | $11.80 | 4 | $24.62 |
| > 4 | <= 5 | $15.13 | | 5 | $15.13 | $14.75 | | 5 | $14.75 | 5 | $29.88 |
| > 5 | <= 12 | $18.11 | $2.36 | 12 | $34.63 | $18.02 | $3.07 | 12 | $39.51 | 12 | $74.14 |
| >12 | | $18.11 | $4.30 | 15 | $47.53 | $18.02 | $3.07 | 15 | $48.72 | 15 | $96.25 |
| | | $18.11 | $4.30 | 20 | $69.03 | $18.02 | $3.07 | 20 | $64.07 | 20 | $133.10 |

Since the largest changes in the rate structure affected single-family residential accounts, that category was analyzed in some detail. The price variable used to test the price impact was calculated as the difference between the actual bill for every month and the total bill that would have been charged if the 1989 volume mix had been consumed in each subsequent year, but at the actual price and volumes for those years. This variable defines the actual price difference the customer faces in deciding to use the same volume by block that was used in 1989 at today's prices, or to lower his/her total cost by curtailing use in the current year.

The price of water was not a significant variable in the regression analyses conducted. Nevertheless, there were some effects that are presumed to have resulted from the changed rate structure. Because 1988 was an abnormally hot, dry year with water sales about 3 percent above normal, 1989 was used as a base year to measure the effects of price on volume. 1990 and 1993 were also hot and dry years with sales at 4.6 and 2.6 percent, respectively, above normal so that these years should not be used for measuring results. There are three findings from the analysis that should be highlighted.

- The number of consuming accounts in the two top blocks decreased by about 6,000 accounts in each block (in 1992 and 1994, near normal years) which means that about 4

percent of all accounts reduced their consumption out of the high rate blocks into the 3 units or less block.

- Consumption in the top two blocks decreased (in 1992 and 1994) from 42.3 percent of total consumption to about 39 percent, consistent with the customer shifts described above.

- The changes in the rate structure affected individual customer's water use patterns, but the average bills did not change enough to statistically attribute the results directly to price. A customer using 20 units a month saw his combined water and sewer bill increase from $97.96 in 1987 to $133.10 in 1994, an overall increase of about 36 percent. However, on an annual basis, the increase amounts to only about 5 percent per year, an amount that typically is not likely to cause significant changes in consumption behavior, especially considering that inflation of 2 to 3 percent per year has not been removed from the bill change.

## Price Elasticity of Demand

Price elasticity of demand refers to how the quantity of water used responds to a change in the price. Based on the initial analyses on water prices alone, reported above, there was no significant statistical relationship between water price changes and changes in the level of water demand. However, since single-family residential billings for sewer are also based directly on water consumption levels, there could be some influence from sewer rates as well as water rates. Consequently, additional regression analyses were performed that included both water and sewer rates. Over the entire study period (1988-1995), the results of the analysis indicated that price was still not a significant variable. However, during the sub-period from 1988 through 1991, when most of the significant changes in rate structure occurred, the combined water/sewer price was statistically significant, although of little relative impact.

The analysis indicated that the price elasticity of the combined water and sewer prices was in the range of -0.1 to -0.2 for the sub-period. This means that a 10 percent increase in combined water/sewer prices would lead to a change of 1 to 2 percent in the level on consumption. So while statistically significant, the actual impacts on consumption were minor. Because the primary structural changes in rates occurred during the sub-period of 1988-1991, price was statistically significant as consumers reacted not just to the change in the price but also to the change in the structure of the prices. However, once the main structural changes were in place and customers became accustomed to the structure and determined how their own consumption patterns fit within the structure, the additional impacts of price changes within the rate structure caused little or no impact. Consequently, over the whole period (1988-1995) there is no statistically significant relationship between the combined water/sewer price. Without substantially higher annual rate increases or significant changes in the rate structure, it is unlikely that price will be a significant determinant of consumption for the forecast period.

## CONSUMPTION PATTERNS BY CUSTOMER CLASS

### Single Family Residential

The Single Family Residential (SFR) customer group consists primarily of single-family residential accounts but also includes a small number of senior citizen and public works employee accounts (Table 2-5). The SFR customer group comprises 43 percent of total retail accounts and 30 percent of total retail water sales. Consumption in 1994 (average month) was 210.5 gpd per account based on reported number of accounts. Consumption is also broken down into indoor and outdoor use, expressed in millions of gallons per day, in Table 2.5. The SFR customer group accounts for 25.9 percent of total indoor consumption and 33.8 percent of total outdoor consumption.

**Table 2-5**
**City of Houston - Water System**
**Summary of Accounts and Consumption by User Code -- Average Month, 1994**
**(Billed Consumption in Units of 1,000 Gallons)**

| User Code | Description | Number of Accounts | % of Total Retail | Billed Consumption | % of Total Retail | GPD/ Account | In-door | Millions of Gallons per Day | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % of Total | Out-door | % of Total | Total |
| | **Single Family Residential:** | | | | | | | | | | |
| 01 | Residential | 310,874 | 41.5% | 1,999,626 | 29.1% | 211.5 | | | | | |
| 02 | Senior Citizens | 12,061 | 1.6% | 67,740 | 1.0% | 184.7 | | | | | |
| 03 | Public Works Employees | 258 | 0.0% | 1,696 | 0.0% | 216.1 | | | | | |
| | Subtotal | 323,193 | 43.1% | 2,069,062 | 30.1% | 210.5 | 55.9 | 29.6% | 11.9 | 32.9% | 67.8 |
| | | | | | | | | | | | |
| | **Multi-family Residential:** | | | | | | | | | | |
| 14 | 2 Unit Dwellings | 9,388 | 1.3% | 46,082 | 0.7% | 161.4 | | | | | |
| 15 | 3 Unit Dwellings | 2,984 | 0.4% | 14,458 | 0.2% | 159.3 | | | | | |
| 16 | 4 Unit Dwellings | 6,348 | 0.8% | 29,299 | 0.4% | 151.7 | | | | | |
| 17 | Condos/Townhouses | 23,471 | 3.1% | 146,487 | 2.1% | 205.2 | | | | | |
| 18 | Apartments | 339,009 | 45.2% | 1,990,225 | 29.0% | 193.0 | | | | | |
| 19 | Trailer Parks | 2,315 | 0.3% | 9,321 | 0.1% | 132.4 | | | | | |
| | Subtotal | 383,515 | 51.2% | 2,235,872 | 32.5% | 191.7 | 65.2 | 34.6% | 8.6 | 23.8% | 73.8 |
| | | | | | | | | | | | |
| | **Commercial Accounts** | | | | | | | | | | |
| 21 | One Commercial Unit Structures | 28,124 | 3.8% | 1,203,462 | 17.5% | 1,406.8 | | | | | |
| 22 | 1 Commercial, 1 Family | 98 | 0.0% | 1,098 | 0.0% | 368.4 | | | | | |
| 23 | 2 Commercial Units | 59 | 0.0% | 621 | 0.0% | 346.0 | | | | | |
| 24 | 3 Commercial Units | 31 | 0.0% | 463 | 0.0% | 491.0 | | | | | |
| 25 | Strip Shopping Center | 126 | 0.0% | 10,179 | 0.1% | 2,656.0 | | | | | |
| 26 | Shopping Center | 59 | 0.0% | 6,144 | 0.1% | 3,423.6 | | | | | |
| 27 | Hotel/Motel | 285 | 0.0% | 115,720 | 1.7% | 13,349.1 | | | | | |

**Table 2-5 *(continued)***
**City of Houston - Water System**
**Summary of Accounts and Consumption by User Code -- Average Month, 1994**
**(Billed Consumption in Units of 1,000 Gallons)**

| User Code | Description | Number of Accounts | % of Total Retail | Billed Consumption | % of Total Retail | GPD/ Account | In-door | Millions of Gallons per Day | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % of Total | Out-door | % of Total | Total |
| **Commercial Accounts *(continued)*** | | | | | | | | | | | |
| 28 | Office/Bank Buildings | 778 | 0.1% | 99,572 | 1.4% | 4,207.7 | | | | | |
| 29 | Restaurant or Bakeries | 2,329 | 0.3% | 113,673 | 1.7% | 1,604.6 | | | | | |
| 30 | Industrial Laundry | 15 | 0.0% | 8,593 | 0.1% | 18,834.0 | | | | | |
| 31 | Laundry Retail | 175 | 0.0% | 7,154 | 0.1% | 1,344.0 | | | | | |
| 32 | Laundromat | 219 | 0.0% | 39,534 | 0.6% | 5,934.9 | | | | | |
| 33 | Plater | 24 | 0.0% | 1,017 | 0.0% | 1,393.1 | | | | | |
| 34 | Mortuary | 74 | 0.0% | 990 | 0.0% | 439.8 | | | | | |
| 35 | Car Wash | 229 | 0.0% | 11,261 | 0.2% | 1,616.7 | | | | | |
| 36 | Service Station/Auto Repair | 1,427 | 0.2% | 23,830 | 0.3% | 549.0 | | | | | |
| 61 | Private Wells (Cycle 50) | 37 | 0.0% | 13,561 | 0.2% | 12,049.7 | | | | | |
| 62 | Effluent Only (Cycle 50) | 74 | 0.0% | 69,251 | 1.0% | 30,766.8 | | | | | |
| 71 | Construction Meter | 344 | 0.0% | 8,921 | 0.1% | 852.6 | | | | | |
| 73 | Resale Accounts | 7 | 0.0% | 4,031 | 0.1% | 18,932.3 | | | | | |
| 74 | Emergency | 10 | 0.0% | 1,912 | 0.0% | 6,286.0 | | | | | |
| | Subtotal | 34,524 | 4.6% | 1,740,987 | 25.3% | 1,657.9 | 47.8 | 25.3% | 9.0 | 24.9% | 56.8 |
| | **Municipal & Institutional** | | | | | | | | | | |
| 37 | Private Schools | 56 | 0.0% | 13,547 | 0.2% | 7,953.2 | | | | | |
| 39 | Hospitals | 122 | 0.0% | 132,323 | 1.9% | 35,658.5 | | | | | |
| 50 | Churches | 1,868 | 0.2% | 28,765 | 0.4% | 506.3 | | | | | |
| 51 | City (General Fund) | 1,524 | 0.2% | 122,787 | 1.8% | 2,648.8 | 2.2 | 1.2% | 1.6 | 4.4% | 3.8 |
| 52 | City (Enterprise Fund) | 83 | 0.0% | 19,174 | 0.3% | 7,594.9 | | | | | |
| 53 | City/County Government (Billed) | 122 | 0.0% | 69,195 | 1.0% | 18,646.7 | | | | | |
| 54 | State Government | 33 | 0.0% | 4,463 | 0.1% | 4,446.3 | | | | | |
| 55 | Federal Government | 82 | 0.0% | 9,067 | 0.1% | 3,635.3 | | | | | |
| 56 | Public Schools | 416 | 0.1% | 75,282 | 1.1% | 5,949.6 | | | | | |
| 57 | State Colleges | 72 | 0.0% | 63,055 | 0.9% | 28,792.2 | | | | | |
| 60 | City (Public Utilities) | 123 | 0.0% | 61,246 | 0.9% | 16,370.4 | | | | | |
| | Subtotal | 4,501 | 0.6% | 598,904 | 8.7% | 4,374.6 | 16.4 | 8.7% | 2.8 | 7.7% | 19.2 |

**Table 2-5 *(continued)***
**City of Houston - Water System**
**Summary of Accounts and Consumption by User Code -- Average Month, 1994**
**(Billed Consumption in Units of 1,000 Gallons)**

| User Code | Description | Number of Accounts | % of Total Retail | Billed Consumption | % of Total Retail | GPD/ Account | In-door | Millions of Gallons per Day | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | % of Total | Out-door | % of Total | Total |
| | SUBTOTAL | 749,218 | 100.0% | 6,742,863 | 98.1% | 295.9 | 185.3 | 98.2% | 35.5 | 98.0% | 220.8 |
| | Industrial Accounts | 293 | 0.0% | 127,583 | 1.9% | 14,315.7 | 3.4 | 1.8% | 0.7 | 2.0% | 4.1 |
| | TOTAL RETAIL | 749,511 | 100.0% | 6,870,446 | 100.0% | 301.4 | 188.7 | 100.0% | 36.2 | 100.0% | 224.9 |
| | Wholesale Accounts (ESTIMATED 1994) | | | 8,978,843 | | | 268.1 | | 27.1 | | 295.2 |
| | TOTAL SERVICE AREA | | | 15,849,289 | | | 456.8 | | 63.3 | | 520.1 |

The consumption pattern has been very stable over the last four years at 210 gpda, and it appears reasonable to project this level of consumption into future years as a pre-conservation or base rate of travel to be used in determining the effects of various conservation programs.

## Multifamily Residential

The Multifamily Residential (MFR) customer class is made up of six user groups, with apartments making up about 90 percent of the total category. The MFR class is the largest single customer class with 51.2 percent of total households/accounts served and 32.5 percent of total retail water sales. The MFR group is also the largest category of indoor water use at 34.4 percent but is third, at 24.4 percent, in terms of outdoor water use. This customer class has demonstrated an unexplained upward drift in gpda. The WMA in 1995, 196.5 gpda, was used for future projections.

## Commercial Accounts

This customer class makes up only 4.6 percent of total accounts, but 25.3 percent of total retail consumption. Commercial customers account for 25.2 percent of "indoor" consumption and 25.6 percent of "outdoor" consumption. As with SFR and MFR accounts, summer consumption exceeds winter consumption primarily due to irrigation usage, but for commercial accounts, a significant percentage of summer use is attributable to seasonal volume of product produced or customer activity. The consumption pattern has been quite stable at 1,630 gpda and was used for projections of future demand.

## Lawn Meter Accounts

This customer class is relatively small, but was reported separately because the high summer peaking could be a source of significant potential conservation. This class accounts for only .5

percent of total households/accounts and 1.4 percent of total retail consumption. However, outdoor consumption of lawn meter accounts makes up 8.8 percent of total outdoor water use. This class has demonstrated a stable pattern since mid-1993, at 963 gpda which was used to project future demand.

### Municipal and Institutional Accounts

The M & I customer class makes up only 0.6 percent of total accounts but 8.7 percent of total consumption. This class makes up 8.6 percent of total indoor retail consumption and 8.0 percent of outdoor consumption. The largest subgroup within M & I is hospitals (22.1 percent) followed by the City's parks and other irrigation stations (20.5 percent). The City's parks comprise 4.5 percent of total retail outside water use and over 50 percent of total M & I outside water use. Consumption in gpda has drifted down since 1991 but appears to have leveled off since mid-1993. The current pattern of 4,268 gpda was used for projections.

### Industrial Accounts

This category consists of the 293 commercial and industrial accounts served by the city that have nonstandard sewer agreements. The separate reporting is for monitoring of wastewater activity. Since they are reported separately, they are treated as a separate category, but could be rolled into the Commercial Accounts category for all practical purposes. These accounts use only about 2 percent of indoor, outdoor, and total water. The current WMA of 14,032 gpda was used for projections of future demand. Most of the large industrial users in Houston are in the wholesale account category and not included as part of this plan.

### Wholesale Accounts

Wholesale water sales are not a direct part of the conservation program. They are reported on Table 2-5 and analyzed in the same manner as all other categories simply to complete the analysis of total water production provided by the City. The volume of wholesale water is greater than retail and cannot be slighted in an overall assessment of supply/demand conditions. Wholesale sales increased from 7.6 billion gallons per month in 1988 to 8.9 billion gallons per month in 1993, the latest year for which data was provided. Sales in 1992 and 1993 were essentially the same at about 9.0 billion gallons per month; this level was projected through 1994 and 1995 to provide a basic forecast for these years for total consolidated wholesale and retail water sales.

### Summary

Table 2-6 summarizes the current trends for each of the customer classes, as discussed in the above paragraphs. These trends form the basis for projecting the base water demands for each customer class into the future, as developed in Section 3.

**Table 2-6**
**Summary of Current Weighted Moving Average**
**by Customer Class**
**(Gallons per Day per Account)**

| Customer Class | Current WMA |
|---|---|
| Single Family Residential | 210.5 |
| Multi-family Residential | 196.5 |
| Commercial | 1,630.0 |
| Municipal & Institutional | 4,268.0 |
| Irrigation Accounts | 963.0 |
| City Parks & Irrigators | 2,452.0 |
| Industrial Accounts | 14,032.0 |

# Section 3
# POPULATION AND WATER DEMAND PROJECTIONS

Projections of future water demand are driven by projections of changes in the population served by the City of Houston. This section describes the basis for the population projections used and the translation of population to water demand projections.

## Water Service Area Population Projections

Population projections from a number of different sources were examined to determine the most useful projection for this study. The primary sources for population projections for the City of Houston are:

- Draft Texas Water Development Board (TWDB) 1996 Consensus Texas Water Plan Projections of Population and Municipal Water
- Trans-Texas Water Program Draft Planning Information Update (July 12, 1995)
- Houston Water Recommended Plan (HWMP, 1986)
- City of Houston Planning Department population projections for the City

The Draft TWDB plan listed above presents population projections for the City of Houston to the year 2050. The geographic limits used in the projection are not known; however, they are assumed to be the current City limits. Because the City limits are not exactly coincident with the water service area, the population projections may not be entirely representative of the City's water service area. In addition to projections for the City of Houston, the draft plan also includes population projections to the year 2050 for Harris County.

The Trans-Texas Water Program Draft Planning Information Update provides population projections to the year 2050 for river basins located throughout Texas. While the river basin data does not directly apply to the City, the report provides population projections for the Houston Standard Metropolitan Statistical Area (SMSA), which includes all or parts of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties. The SMSA represents a potential area of future service, as identified in the HWMP discussed below.

Projected water demands to the year 2030 for alternative service area scenarios are provided in the Houston Water Recommended Plan (HWMP). In addition, the HWMP provides three separate projections for the City's water service area boundaries to 2030.

The scenarios presented in the HWMP to project the City's water service area include (1) all of Harris County, (2) all of Harris County plus a five mile radius surrounding Harris County, and (3) the entire Harris County plus the seven surrounding counties. According to data presented in the HWMP, the City's water service area was projected to extend outside the City limits by the year 1990. However, it appears that this has not yet occurred. According to a City provided map showing the locations of water services, all current water services remain within the City limits. The HWMP also provides population projections based on the City's service area expanding to

encompass the entire Harris County area and also extending into Brazoria, Fort Bend, Galveston, and Chambers Counties by the year 2030.

The final reference listed above provides City of Houston population projections to the year 2030 as determined by the City of Houston Planning Department. As with the City's population projections provided by the TWDB, these population projections may not be completely coincident with the population within the City's water service area.

Table 3-1 summarizes the population projections provided for the City of Houston, Harris County, and the Houston SMSA, based on data in the listed references. The population projections presented in these references do not include population increases due to land annexations by the City of Houston. The projections are based solely on net migration, births, and deaths. Based on this information and the growth rate for the City of Houston projected by the TWDB, it is assumed that the City will continue to serve the populace within the City limits through the year 2050. However, the service area may someday extend outwards into portions of Harris County and possibly encompass the entire Harris County area due to future annexations.

**Table 3-1**
**Population Projections**

| Area | 1990 | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | % Change from 1990 - 2050 |
|---|---|---|---|---|---|---|---|---|
| City of Houston (1) | 1,603,524 | 1,796,943 | 2,030,820 | 2,342,906 | 2,528,380 | 2,761,854 | 3,016,887 | 88.1 |
| City of Houston (2) | 1,639,274 | 1,821,953 | 2,068,368 | 2,201,148 | 2,322,213 | - | - | 41.7 (5) |
| Harris County (1) | 2,818,199 | 3,217,689 | 3,707,869 | 4,315,000 | 4,667,749 | 5,109,533 | 5,404,722 | 91.8 |
| Harris County (3) | 3,057,196 | 3,655,949 | 4,246,284 | 4,648,048 | 5,008,047 | - | - | 63.8 (5) |
| Houston SMSA (4) | 3,691,741 | 4,321,813 | 5,080,378 | 6,012,449 | 6,737,796 | 7,551,515 | 8,240,301 | 123.2 |
| Projection to be Used for Base Case Analysis | 1,603,524 | 1,796,943 | 2,030,820 | 2,342,906 | 2,528,380 | 2,761,854 | 3,016,887 | 88.1 |
| Projection to be Used for Comparison | 2,818,199 | 3,217,689 | 3,707,869 | 4,315,000 | 4,667,749 | 5,109,533 | 5,404,722 | 91.8 |

The population of the City of Houston as of April 1, 1990 according to the Census Bureau (as cited by Mr. John Young, City of Houston Planning Department) is 1,630,553.

(1) from TWDB Draft 1996 Consensus Texas Water Plan Projections of Population and Municipal Water Use

(2) from the City of Houston Planning Department (September 1995)

(3) from Houston Water Recommended Plan, Appendix D - Population and Growth Projections, Metcalf & Eddy (May 1986)

(4) from Trans-Texas Water Program Draft Planning Information Update

(4) Houston SMSA (Standard Metropolitan Statistical Area) consists of all or portions of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties

(5) Calculated for 1990 - 2030 only

Two water demand projections have been calculated. The first is based on population projections for the City of Houston, as provided by the TWDB. The second water demand projection is based on the Harris County population projections provided by the same agency. The population

projections provided by the TWDB are used as the basis to determine the water demand projections for both scenarios because the population projections extend to the year 2050, the time period covered by this study. The City limits population will be used as the basis for analysis and the County population will be used for comparison.

It is important to note that the assumed population projections and resulting water demand projections only serve the purposes required to complete the water conservation study and are not intended to be used as a basis for capital improvement projects or other such endeavors by the City of Houston.

## Water Demand Projections

Based on the TWDB population projections, water demands have been calculated for the City of Houston to the year 2050. The last year for which data was fully available was 1994, so it has been selected as the base year for the analysis. Water demand for the base year for all but the multifamily residential category was calculated on a per account basis, utilizing actual consumption and accounts by customer class. Water demand for multifamily was based on a per dwelling unit basis. Total usage per account was then broken into estimated indoor and outdoor use. Indoor base water demand was estimated by multiplying the average month demand by the lowest value of a seasonal index calculated using 1988-1994 consumption data. Subtracting indoor base demand from average month demand for the base year provided the estimate of outdoor demand.

Water demand was forecast in ten-year increments from 2000 to 2050 using the indoor and outdoor consumption per account (per dwelling unit for multifamily) for the base year applied to the projected number of accounts in each period. For the projections based on population in the City of Houston, account growth in each period was based on the growth rate in City population over that same period of time. Growth was assumed to be the same across all customer groups. Per account usage was assumed to remain constant over time. Water demand projections based on Harris County population incorporated both the population growth in the County and a phase-in of Harris County into the water service area evenly over the period to 2050. Again, growth was assumed to be evenly spread over all customer groups and base year consumption patterns were assumed to remain unchanged over time despite the extension into new service areas. If consumption characteristics of customers added through extension of the service area differ significantly from current City water customers, the forecasts may not accurately project future water consumption. Water demand projections do not include water conservation. Water demand projections with conservation due to the recommended plan are given in Section 7.

Water demand projections for each of the two water service area scenarios are shown in Tables 3-2 and 3-3. Table 3-2 shows the water demand projections if the service area remains within the City boundary limits. Table 3-3 shows the water demand projections if the service area extends to include all of Harris County. These water demand projections do not take into account future annexations that would change the boundaries for either the City or the County.

## Table 3-2
## Water Demand Projections
## Using City of Houston Population Projections

| | Base use gpd/acct 1994 | Current no. of accounts 1994 | 1990 | 1994 | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|
| City of Houston Population Projection | | | 1,603,524 | 1,680,892 | 1,796,943 | 2,030,820 | 2,342,906 | 2,528,380 | 2,761,854 | 3,016,887 | Population |
| Retail Accounts: | | | | | | | | | | | |
| Single family residential | 210.50 | 323,193 | | 323,193 | 345,507 | 390,475 | 450,482 | 486,144 | 531,035 | 580,071 | Accounts |
| indoor | 173.56 | | | 55.90 | 59.97 | 67.77 | 78.18 | 84.37 | 92.16 | 100.68 | mgd |
| outdoor | 36.95 | | | 11.90 | 12.77 | 14.43 | 16.64 | 17.96 | 19.62 | 21.43 | mgd |
| Multi-family residential | 191.70 | 383,515 | | 383,515 | 409,993 | 463,355 | 534,561 | 576,879 | 630,149 | 688,338 | Residences |
| indoor | 169.36 | | | 65.20 | 69.44 | 78.47 | 90.53 | 97.70 | 106.72 | 116.58 | mgd |
| outdoor | 22.31 | | | 8.60 | 9.15 | 10.34 | 11.93 | 12.87 | 14.06 | 15.36 | mgd |
| Commercial accounts | 1,657.90 | 34,524 | | 34,524 | 36,908 | 41,711 | 48,121 | 51,931 | 56,726 | 61,964 | Accounts |
| indoor | 1,395.20 | | | 47.80 | 51.49 | 58.20 | 67.14 | 72.45 | 79.14 | 86.45 | mgd |
| outdoor | 262.70 | | | 9.00 | 9.70 | 10.96 | 12.64 | 13.64 | 14.90 | 16.28 | mgd |
| Lawn meter accounts | 924.90 | 3,485 | | 3,485 | 3,726 | 4,211 | 4,858 | 5,242 | 5,726 | 6,255 | Accounts |
| indoor | 289.03 | | | 1.00 | 1.08 | 1.22 | 1.40 | 1.52 | 1.66 | 1.81 | mgd |
| outdoor | 635.87 | | | 2.20 | 2.37 | 2.68 | 3.09 | 3.33 | 3.64 | 3.98 | mgd |
| Municipal & Institutional | 4,374.60 | 4,501 | | 4,501 | 4,812 | 5,438 | 6,274 | 6,770 | 7,396 | 8,078 | Accounts |
| indoor | 3,736.64 | | | 16.40 | 17.98 | 20.32 | 23.44 | 25.30 | 27.63 | 30.19 | mgd |
| outdoor | 637.96 | | | 2.80 | 3.07 | 3.47 | 4.00 | 4.32 | 4.72 | 5.15 | mgd |
| Industrial accounts | 14,315.70 | 293 | | 293 | 313 | 354 | 408 | 441 | 481 | 526 | Accounts |
| indoor | 11,871.56 | | | 3.40 | 3.72 | 4.20 | 4.85 | 5.23 | 5.72 | 6.24 | mgd |
| outdoor | 2,444.14 | | | 0.70 | 0.77 | 0.87 | 1.00 | 1.08 | 1.18 | 1.29 | mgd |
| Total no. of accounts | | 749,511 | | 749,511 | 801,258 | 905,544 | 1,044,704 | 1,127,407 | 1,231,513 | 1,345,232 | Accounts |
| Total Indoor (mgd) | | | | 190 | 204 | 230 | 266 | 287 | 313 | 342 | mgd |
| Total Outdoor (mgd) | | | | 35 | 38 | 43 | 49 | 53 | 58 | 63 | mgd |
| TOTAL RETAIL (mgd) | | | | 225 | 241 | 273 | 315 | 340 | 371 | 405 | mgd |
| Unaccounted-for Water | | | | 38 | 40 | 46 | 53 | 57 | 62 | 68 | mgd |
| Wholesale | | | | 295 | 295 | 295 | 295 | 295 | 295 | 295 | mgd |
| TOTAL (mgd) | | | | 558 | 576 | 614 | 663 | 692 | 728 | 768 | mgd |

## Table 3-3
## Water Demand Projections
## Using Harris County Population Projections

| | Base use gpd/acct 1994 | Current no. of accounts 1994 | 1990 | 1994 | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Harris County Population Projections | | | 2,818,199 | 2,977,995 | 3,217,689 | 3,707,869 | 4,315,000 | 4,667,749 | 5,109,533 | 5,404,722 | Population |
| Retail Accounts: | | | | | | | | | | | |
| Single family residential | 210.50 | 323,193 | | 323,193 | 399,907 | 527,764 | 655,621 | 783,478 | 911,335 | 1,039,192 | Accounts |
| indoor | 173.56 | | | 55.90 | 69.41 | 91.60 | 113.79 | 135.98 | 158.17 | 180.36 | mgd |
| outdoor | 36.95 | | | 11.90 | 14.78 | 19.50 | 24.22 | 28.95 | 33.67 | 38.39 | mgd |
| Multi-family residential | 191.70 | 383,515 | | 383,515 | 474,547 | 626,268 | 777,989 | 929,709 | 1,081,430 | 1,233,150 | Residences |
| indoor | 169.36 | | | 65.20 | 80.37 | 106.07 | 131.76 | 157.46 | 183.15 | 208.85 | mgd |
| outdoor | 22.31 | | | 8.60 | 10.59 | 13.97 | 17.36 | 20.74 | 24.13 | 27.51 | mgd |
| Commercial accounts | 1,657.90 | 34,524 | | 34,524 | 42,719 | 56,377 | 70,034 | 83,692 | 97,350 | 111,008 | Accounts |
| indoor | 1,395.20 | | | 47.80 | 59.60 | 78.66 | 97.71 | 116.77 | 135.82 | 154.88 | mgd |
| outdoor | 262.70 | | | 9.00 | 11.22 | 14.81 | 18.40 | 21.99 | 25.57 | 29.16 | mgd |
| Lawn meter accounts | 924.90 | 3,485 | | 3,485 | 4,312 | 5,691 | 7,070 | 8,448 | 9,827 | 11,206 | Accounts |
| indoor | 289.03 | | | 1.00 | 1.25 | 1.64 | 2.04 | 2.44 | 2.84 | 3.24 | mgd |
| outdoor | 635.87 | | | 2.20 | 2.74 | 3.62 | 4.50 | 5.37 | 6.25 | 7.13 | mgd |
| Municipal & Institutional | 4,374.60 | 4,501 | | 4,501 | 5,569 | 7,350 | 9,131 | 10,911 | 12,692 | 14,472 | Accounts |
| indoor | 3,736.64 | | | 16.40 | 20.81 | 27.46 | 34.12 | 40.77 | 47.42 | 54.08 | mgd |
| outdoor | 637.96 | | | 2.80 | 3.55 | 4.69 | 5.82 | 6.96 | 8.10 | 9.23 | mgd |
| Industrial accounts | 14,315.70 | 293 | | 293 | 363 | 478 | 594 | 710 | 826 | 942 | Accounts |
| indoor | 11,871.56 | | | 3.40 | 4.30 | 5.68 | 7.06 | 8.43 | 9.81 | 11.18 | mgd |
| outdoor | 2,444.14 | | | 0.70 | 0.89 | 1.17 | 1.45 | 1.74 | 2.02 | 2.30 | mgd |
| Total no. of accounts | | 749,511 | | 749,511 | 927,417 | 1,223,928 | 1,520,438 | 1,816,949 | 2,113,460 | 2,409,970 | Accounts |
| Total Indoor (mgd) | | | | 190 | 236 | 311 | 386 | 462 | 537 | 613 | mgd |
| Total Outdoor (mgd) | | | | 35 | 44 | 58 | 72 | 86 | 100 | 114 | mgd |
| TOTAL RETAIL (mgd) | | | | 225 | 280 | 369 | 458 | 548 | 637 | 726 | mgd |
| Unaccounted for Water | | | | 38 | 47 | 62 | 77 | 91 | 106 | 121 | mgd |
| Wholesale | | | | 295 | 295 | 295 | 295 | 295 | 295 | 295 | mgd |
| TOTAL (mgd) | | | | 558 | 622 | 726 | 830 | 934 | 1,038 | 1,142 | mgd |

Total billed retail demand if the water service area remains within the Houston city limits is projected to increase from 241 mgd in 2000 to 405 mgd in 2050. Total retail demand if the water service area is extended to include Harris County is projected to increase from 280 mgd in 2000 to 726 mgd in 2050. In the future, as now, the majority of water use will be for residential purposes, with multifamily use being the largest single usage category.

For wholesale customers, consumption is projected at current levels since no information was available on growth for these accounts. Unaccounted-for water has been projected at the fiscal year 1995 level of 14.3 percent of production (16.7 percent compared to billed consumption).

# Section 4
# ALTERNATIVE CONSERVATION MEASURES

## APPROPRIATE EMPHASIS FOR CONSERVATION

Water conservation should be based on the need for and benefit of conserving water. This need can be driven by the possibility of a water supply shortfall, problems associated with use of groundwater supplies (such as subsidence), or problems transporting and treating an excessive amount of wastewater. In addition to helping to resolve the types of problems listed above, conservation also provides additional benefits through cost savings, particularly from the deferral or avoidance of future capital facilities. As a preliminary step in evaluating whether additional conservation is cost-effective, this section proposes alternative conservation measures. The measures are targeted at those water use sectors that have the highest demand or where savings can be achieved at low cost. A preliminary screening was made on over 200 potential conservation measures. Based on qualitative criteria, the list was reduced to a more manageable number of measures for detailed evaluation. The measures selected for detailed evaluation are described in Section 5.

### Review of Water Demands

Combined single-family and multifamily categories have by far the highest total use, amounting to approximately 53 percent of retail water sales. The next highest category is commercial use, at 21 percent of billed retail sales. The remainder consists primarily of lawn meter, municipal, and institutional accounts.

Water demands increase in the summer due primarily to landscape irrigation. Overall, 16 percent of the billed water use occurs outdoors. The single-family category has the highest contribution to peak demands, 18 percent annually of all water used for exterior purposes. The variation is more extreme in monthly water use; single-family customers use, on average, about 175 gpd/account in the winter and up to 250 gpd/account in the peak summer months. The daily basis variation would certainly be even more extreme, but this data by customer class is not available. It is these peak demands that determine the sizing of capital facilities. If conservation can reduce the peak demands, capital facilities can be either smaller or deferred in time.

Unaccounted-for water, currently running about 40 mgd (14.4 percent of total retail sales plus unaccounted-for), represents a conservation potential that deserves study.

### Growth

The City of Houston and Harris County are growing at an average rate of 1.5 to 2 percent per year. The Texas Water Development Board forecasts an 88 percent increase in population between 1990 and the end of the planning period, 2050. These forecasts ignore the effect of annexations, which have been a major source of growth for the City. The tables in Section 3 show the water use projections for the City increasing at the same rate as population, rising 88 percent for the City by the year 2050. Total average annual billed water use is forecast to rise from 225 mgd in 1994 to 405 mgd by the year 2050. Therefore, water conservation programs for this period must be designed for both existing and future customers.

Water use patterns in the commercial/industrial sector are difficult to determine from billing data and prior studies or published literature. In the City's case much of the heavy industry is served untreated water by contract. Nearly all of the refineries and chemical plants along the Houston Ship Canal are served in this manner. Contract customers have their own requirements to submit water conservation plans.

To gather additional knowledge about commercial and small industrial customers served by the retail system, a water user survey was developed. Appendix A contains the questionnaire and tabulation of 37 responses. Responses were received from hotels, hospitals, office buildings, and a variety of other water users. Questions addressed how customers used water, presence of cooling towers, type of landscaping and irrigation systems, presence of installed water conservation measures, and type of assistance desired from the City. The water conservation programs targeted at this sector directly reflect the survey results.

## Review of the City's Existing Water Conservation Programs

Water conservation programs have been in place in the City of Houston for several years. The program focuses on public education and ensuring the City's water usage, primarily at pools, fountains, and parks, is efficient. A leak detection program is also being instituted. The status of water conservation programs (as of 1994) is listed below.

## Education Programs:

- "Major Rivers" - The Major Rivers Texas Education program is a comprehensive water education curriculum for 4th graders. Packages are provided to teachers free-of-charge. Each package contains materials for 25 students and costs the City $35.

- "Learning to be Water Wise and Energy Efficient" - The City is working with the Harris-Galveston Subsidence District to sponsor 3,500 5th graders in this program, at a cost of $28 per student. The total cost is approximately $100,000 per year. The program is a comprehensive education/retrofit curriculum for 5th graders. Teachers and students learn to be water wise and energy efficient. Parents and students install high efficiency showerheads, sink aerators, and other water saving devices.

- Presentations and Tours - For the past two years the City has conducted mass mailings to elementary schools in the Houston area, marketing the City's school education program and offering presentations and tours. Between 1994 and 1995,the number of attendees at presentations and tours increased from 8,663 to 10,772, a 25 percent increase.

- "The Froggs of Barren Bogg - A Water Conservation Play" - The City contracts with a local children's book author and a troupe of actors to perform this play at local schools. The play addresses water conservation and protection of the environment by use of lively, colorful characters.

- Annual T-shirt design contest - Third through fifth graders are eligible for participation in this contest. The winning design is used on T-shirts which are given to the winner's entire class.

- Water Audit Kits - These kits contain dye tablets, a bilingual conservation tip booklet, and a toilet tank displacement bag. Kits are distributed at special events and to customers who call in requesting conservation information. Over 35,000 kits are distributed annually.

### Efficiency Programs:

- Leak detection audits and repairs at City pools and fountains - The City has 45 pools and 23 fountains, many of which use millions of gallons of water per month. The City is conducting leak detection audits and repairs at these facilities. Also, additional meters are being installed at pools where one meter had been serving more than one major end use.

- Irrigation audits - In 1995 the City began an irrigation audit program for City-owned golf courses, esplanades, and other City-owned turf areas. New irrigation watering schedules have proven effective and the results have been dramatic for some of the first sites audited.

- Conservation planning and surveys - The City is working with Montgomery Watson to complete the water conservation plan. The City has gathered the data needed, reviewed the interim findings, and provided guidance on new programs that may be beneficial to the City. A large water user survey was completed detailing how these customers currently use water, what conservation opportunities have been explored, and what the City can do to further their efforts at reducing demand.

- Leak detection and repair - The City has had a leak detection and repair program for a number of years. Since 1989 the City has surveyed 1,000 to 2,000 miles of pipe every year. Listening devices are followed by leak correlators to pinpoint leaks. Recently the decision was made to assign additional staff to the program and to purchase more leak correlators so that each quadrant (total of four) will have one. The goal is to survey the entire system every four years. The program has contributed to reducing unaccounted-for-water from over 25 percent to less than 15 percent.

- Renegotiation of contracts - The conservation group has assisted in renegotiation of wholesale contracts, including removal of take-or-pay clauses, to promote efficient water use.

### Summary of Where to Concentrate Conservation Effort

From the perspective of deferring proposed water capital improvement projects, the reduction of summer peak-day water use would be effective. Prime targets to reduce peak-day use are the exterior uses by single families and public agencies. Improved efficiency at local government-

owned sites would target concentrations of turf (parks and playing fields) while setting a good example and establishing credibility with the general public. From the perspective of deferring proposed wastewater capital improvement projects, the priority should be to reduce single-family and multifamily interior use, which is the largest interior water use category (64 percent of billed interior consumption and 54 percent of total billed use). Commercial/industrial interior use is also significant at 21 percent of total billed use. Conservation measures focusing on these priorities are presented below.

## PRELIMINARY EVALUATION

As part of the "Identify and Screen Conservation Measures" task, the project team compiled a list of potential demand management measures that may be appropriate for the City service area. This brainstorming process yielded nearly 200 potential conservation measures in the customer categories used by the City.

### Devices, Measures, and Programs

The following terms are used in the screening process:

- **Device** - A physical item of hardware, such as a new toilet, or specific action by individuals, such as cooling tower audits, that would save water if the recommendations are implemented or carried out by the City or some other group.
- **Measure** - A device(s) plus a distribution method and possibly an incentive, such as a rebate, targeted at a particular type of end user that, when implemented, will save water.
- **Program** - A set of one or more measures targeted at one or more customer classes that would be managed by the City as a separate project.
- **Plan** - A set of one or more programs together with an estimated budget, schedule, and staffing plan.

### Screening

Each potential measure was screened based on five non-quantifiable criteria: Technology/Market Maturity; Service Area Match; Customer Acceptance/Equity; Environmental Health/Safety; and Better Measure Available. The criteria were scored on a scale of 1 to 5, with 5 being the most acceptable. Measures with low scores were eliminated from further consideration, while those with high scores were passed into the next evaluation phase (the cost-effectiveness analysis using WaterPlan 2.0).

**Technology/Market Maturity.** This screening criteria indicates whether the necessary technology is available commercially and supported by the local service industry. For example, dual flush toilets may be screened out if they are not yet commercially available in Houston.

**Service Area Match.** This screening criteria seeks to distinguish the technology that is appropriate for Houston's climate, building stock, or lifestyle. For example, low water-use landscape measures for commercial or industrial sites may not be appropriate where water use analysis indicates there is little outdoor irrigation.

**Customer Acceptance/Equity.** Customers must be willing to implement measures or else the market penetration rates (and thus the water savings) would be too low to be significant. Customer acceptance may be based on convenience, economics, perceived fairness, or aesthetics. Measures should also be equitable in the sense that one segment of customers should not benefit while another pays the costs without receiving benefits.

**Environmental Health/Safety.** Any measure accepted for detailed analysis should not compromise the health or safety of the populace or environment. For example, certain water reuse measures (residential gray water use) may not pass the screening if they potentially cause health problems.

**Better Measure Available.** If a choice must be made between two or more measures of equal effectiveness, where one is obviously more appropriate (due to, say, ease of implementation or unit cost), then the more appropriate measure will pass the screening while the other will not.

## Menu of Water Conservation Alternatives

The list of potential measures is provided in the matrix shown in Table 4-1. This table contains all of the more than 200 specific measures that were evaluated. Many of the measures overlap in water savings; that is, they target the same areas for water conservation. This potential overlap will be accounted for, where necessary, during the combination of measures into alternative programs in Section 5.

## Results of Screening

Over 200 conservation measures were evaluated in a qualitative screening process using the criteria described above. Appendix B contains tables that list the ratings on the 1 to 5 scale, with 5 being the highest rating with respect to the criteria. This table shows which measures passed the screening by denoting a "yes" in the far right column. Seventy-eight measures passed the qualitative screen. Section 5 discusses how these measures were combined into a shorter list of programs and gives a brief description of each program that passed the screen.

**Table 4-1**
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| ***RESIDENTIAL*** | | | |
| Residential Water Audits | City Audit | Free; Optional retrofit kit. | This measure targets existing residents in an effort to reduce indoor and outdoor water use, especially during peak use periods. The top 20 percent of single-family and multifamily home water users (on a cubic meters per account per day basis) are offered a free audit that includes indoor water conservation measures and development of an irrigation schedule, where applicable. Indoor water savings are realized from the low-flow shower heads and faucets, toilet water-displacement devices, and leak repair. The audit needs to be repeated every five years to maintain savings. |
| Retrofit Kit | City delivers with bill or audit | Free | During an audit or upon bill collection, a City employee would provide a free retrofit kit to the top 20 percent of existing single-family residential high water users. The kit could contain a low-flow shower head, a shut-off valve, flow restrictor, or timer for the shower; toilet leak-detection dye tablets, displacement device, or early closure device; a faucet aerator, faucet washers to fix leaky faucets, or a faucet shut-off valve; and a pamphlet on how to conserve water. The City employee may offer to help install any of the devices. |
| **SHOWER** | | | |
| New fixed head | Customer purchase;<br>City delivery and installation | Coupon or rebate;<br>Free | To encourage water savings in those residences and businesses with shower heads, the City would provide a coupon or rebate-upon-installation towards customer installation of a new 3.75 L per minute shower head that would be attached near the top of the shower. |
| Flow restrictor | City to mail, or give with bill or audit | Free | The City could provide a small circular plastic device with a hole in the center which could be placed in the shower head. When installed, this flow restrictor would reduce the amount of flow coming out of the faucet to that which flows through the small hole. The flow restrictor could be sent through the mail, or provided with the bill or audit. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **SHOWER *(continued)*** | | | |
| Shut-off valve | City to mail, or give with bill or audit | Free | The City could provide or encourage customers to purchase a shower head with a shut-off valve. The shut-off valve shunts the water to a trickle when turned on, but when it is reversed instantaneously brings the water back on at the same temperature and pressure as before when the shut-off valve is disengaged. This allows the customer to temporarily turn off water with greater convenience when washing. |
| Timer | Public relations giveaway; City to mail, or give with bill or audit | Free | City could provide, as a public relations and educational giveaway, a small sand timer attached to a suction cup which could be placed in the shower for use as a reminder for customers to reduce the length of their showers. |
| **TOILETS** | | | |
| New 6L toilet | Customer purchase | Coupon or rebate;<br>Free | A rebate or coupon program could be provided by the City whereby any customer installing a new 6L per flush toilet would obtain a monetary discount per toilet upon proof of installation. City could also provide free delivery and installation as an incentive to participate. |
| Displacement device<br>(bag or dam) | City to mail, or give with bill or audit | Free | City could mail or provide during bill payment or an audit, a plastic bag device that the customer may fill with water and attach to the inside of the toilet tank to displace tank water and thereby reduce the amount of water during each flush. This measure would only work with toilets that have a toilet tank. |
| Leak detection-dye tablets | City to mail, or give with bill or audit | Free | City could mail or provide during bill payment or an audit, leak detection dye tablets which the customer could place in the toilet tank and determine if the toilet is leaking by seeing if the blue dye enters the toilet bowl. This measure would only work with toilets that have a toilet tank. |
| Replace flapper valve | City to mail, or give with bill or audit | Free | City could offer to replace the flapper valves on any toilets that are leaking, as determined by the leak detection dye tablets, or for those toilets that have been in use for periods surpassing the life of the original flapper valve. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **TOILETS *(continued)*** | | | |
| Dual flush | Create market | Coupon or rebate; Free | Dual flush toilets have two separate amounts of flush volume, with a reduced amount used for urine disposal and a greater amount used for heavier soil disposal. City could contact manufacturer's of dual flush toilets abroad and offer to share the cost of the rebate as an incentive for the manufacturers to create a market in Houston, and for the consumers to use dual flush toilets. A rebate or coupon program could be provided by the City whereby any customer installing a new dual flush toilet would obtain a monetary discount per toilet upon proof of installation. City could also provide free delivery and installation as an incentive to participate. |
| Fill cycle diversion device | City to mail, or give with bill or audit | Free | This small plastic device reduces the flush volume of a toilet by diverting a portion of the water during the fill cycle. The device could be provided by the City to customers through the mail or during bill payment or an audit. |
| Early closure device | City to mail, or give with bill or audit; customer purchase | Free; Coupon | City would mail or provide during bill payment or an audit, an early closure device that the customer would place in the tank to cause the flapper valve to close at lower water volumes than typical. The early closure device serves to reduce the amount of tank water and thereby reduce the amount of water during each flush. This measure would only work with toilets that have a toilet tank. |
| **FAUCETS** | | | |
| Aerator w/restrictor | City to mail, or give with bill or audit; customer purchase | Free; Coupon | City would provide a faucet attachment with mesh that adds air to the water stream, thereby reducing the amount of flow coming out of the faucet. The device would also have a small circular plastic device with a hole in the center to reduce the amount of flow coming out of the faucet. A free aerator with restricter, or a coupon allowing the customer a reduced aerator with restricter purchase price, could be sent through the mail or provided with the bill or audit. |
| Shut-off valve | City to mail or give with bill; customer purchase | Free; Coupon | City would provide or encourage customers to purchase a faucet attachment composed of a faucet aerator with a shut-off valve. The shut-off valve shunts the water to a trickle, but instantaneously brings the water back on at the same temperature and pressure as before when the valve is disengaged. This allows the customer to turn off water with greater convenience when not in use for washing purposes. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **FAUCETS *(continued)*** | | | |
| Fix leaky faucets | City to supply kit and provide plumber | Free | City could provide a leaky faucet repair kit containing new washers, directions, and tools to repair the leaky faucets. For larger leaks or for a small fee to repair smaller leaks, the City could offer to provide a plumber to make repairs. City could be made aware of leaks either through audits or by having customers call in to a leaky faucet hotline. |
| **DISHWASHING** | | | |
| Labeling | In-store advisory | Enforcement | City could contact dishwashing machine manufacturers encouraging them to use bright colored labels to distinguish those dishwashing machines that save money. City could then mount a campaign encouraging customers to buy water saving dishwashers by comparing water bill savings with either handwashing or non-conserving machines. Another implementation method would be for the City to propose a code change requiring such labeling be included on machines. |
| Settings | Advertisement | Education; Save water/ energy/ money | City would educate its customers through bill collection brochures, displays at points of purchase, the media, and school education programs to change the setting controls on their dishwashing machines to save water and energy. |
| New technology | Import; Education to promote | Education; Save water/ energy/ money | City would educate its customers through bill collection brochures, displays at points of purchase, the media, and school education programs on the latest water conserving technology. |
| **HAND WASHING** | | | |
| Turn water off | Education | Education; Save water/ money | City would target a portion of its education program to encouraging their customers to turn off the water when not in use while washing dishes, brushing their teeth or otherwise washing themselves. Television, radio and newspapers public service messages would be provided, along with education of school aged children. Posters could be posted in washrooms to remind customers not to waste water by allowing it to run unused. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **WASHING MACHINES** | | | |
| Labeling | In-store advisory, Advertisement | Education; Save water/ money | City could contact washing machine manufacturers encouraging them to use bright colored labels to distinguish those washing machines that save money. City could then mount a campaign encouraging customers to buy water saving washing machines by comparing water bill savings with either handwashing or non-conserving machines. Another implementation method would be for the City to propose a code change requiring such labeling be included on machines. |
| Settings | Advertisement, Education | Education; Save water/ money | City would educate its customers through bill collection brochures, displays at points of purchase, the media, and school education programs to change the setting controls on their washing machines to save water and energy. |
| New technology | Import, Education to promote | Rebate, Coupon | City would educate its customers through bill collection brochures, displays at points of purchase, the media, and school education programs on the latest water conserving technology. |
| **WATER HEATING** | | | |
| Place hot water heater in center of house. | Building code changes; education, customer purchase | Enforcement; Rebate | For those new residences being constructed with a hot water heater, the City could encourage building code changes to place the hot water heater near the center of the house. City could offer rebates for retrofits of existing homes. City would then encourage the public to look for this feature when purchasing a house as hot water would have less meters of pipes to flow through before reaching the faucet. This allows for less time running cooler water while waiting for it to become hot. |
| Install on-demand point-of-use water heating systems. | Building code changes; education, customer purchase | Enforcement; Rebate | City could encourage building code changes to require placement of point-of-use hot water heating systems and installation of hot water pipe installation on new residences. City could offer rebates for retrofits of existing homes. City would then encourage the public to look for this feature when purchasing a house as less water would need to run before the customer obtains hot water. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **WATER HEATING *(continued)*** | | | |
| Insulate Pipes | Education: media, displays; Building code change; customer purchase | Rebate; Save water/energy/ money | City, in association with the energy department, could encourage building code changes to require placement installation of hot water pipe insulation on new residences. City and the energy department could offer rebates or coupons for retrofits of existing homes while delivering the water or energy bill. City would then encourage the public to look for this feature when purchasing or retrofitting a house as less water would need to be drawn before the customer obtains hot water. |
| **EXTERNAL USES** | | | |
| Trigger Shut-off Valves | City Give-away; Manufacturer include with hose purchase | Rebate, Free | City would encourage manufacturer's to include trigger shut-off valves with hoses, and then encourage customers to purchase these hoses by offering a rebate on the purchase of a new hose with shut-off valves, or a separate valve which the customer could fit on the customer's current hose. This measure would target consumers with high exterior water use. |
| Cleaning: Use bucket | Education | Potential for lower water bills | City would educate its customers to clean their cars, homes, and walkways with a bucket full of water rather than using a continuously running hose. Educational tools would consist of media announcements and school education. |
| Cleaning: Use broom | Education | Potential for lower water bills | City would educate its customers to sweep their walkways, patios, and driveways with broom rather than using a continuously-running hose for cleaning purposes. Educational tools would consist of media announcements and school education. |
| Landscape Use Efficiency | Education | Potential for lower water bills, rebate | City would provide information for planting water-efficient landscaping, including avoiding strip turf sections that are difficult to water-efficiently and using native plants that do not require supplemental watering. Information would be provided in brochures with the water bill, or mailed. Informational displays at City offices and nurseries could also be provided. City may encourage newspaper or magazine articles on the subject as well. |
| Landscape Code | City Regulation, Building Code | Necessary to obtain water connection permit | This measure would require the use of low-water-using or native plants for landscaping purposes. Proof of compliance would be necessary to obtain a water connection permit on all new commercial/ industrial facilities, and government buildings. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| **EXTERNAL USES *(continued)*** | | | | |
| | Pool cover | Customer purchase, Education | Potential for lower water bills; rebate; less cleaning | Pool covers serve to reduce the amount of water in the pool lost to evaporation. City would promote an education program to encourage pool owners to purchase pool covers. City could place educational displays in pool supply stores within the service area and recommend their use during water audits. |
| | Irrigation Advisory Service | City, Education, Newspaper | Potential for lower water bills | Based on the current local weather conditions, the City would advise customers on the appropriate time and amount of water to use for outdoor irrigation. City would use the major local newspapers to disseminate evapotranspiration information to its customers. |
| | Outdoor Water Audits | Newspaper, Bill flyer; City to provide | Free; Potential for lower water bills | City would provide an outdoor audit of residential irrigation practices and check for leaks. City would target audits at the top 20 percent of single and multifamily residential water users. The auditor would determine how irrigation practices are undertaken, present the results of the audit, and provide recommendations for the customer to conserve water and thereby save money on their bill. |
| | Water-Waste Ordinance | City Regulations | Enforcement | City would pass an ordinance against wasteful water use, such as allowing water from sprinklers to run onto the sidewalk. City would provide teams to patrol for water waste. Those customers found wasting water would be given a warning. Repeat offenders would be required to pay higher penalties. |
| | Mandatory Irrigation Times | City Regulations | Enforcement | In this measure, the City would create an ordinance allowing irrigation only in the morning and evening, to reduce the amount of water lost to evaporation. |
| **SUPPLY** | | | | |
| | Cisterns/Rain Water Tanks | Educational, Bill brochure; Customer purchase | Potential for lower water bills | City would encourage customers to collect rain water for non-consumptive use such as outdoor irrigation or clothes washing. |
| | New Home Points Program | Building design regulations | Certain number of points necessary before water connection permit is given | City would not provide a water connection permit, under this measure, without the permitted party having installed demand management plumbing and landscaping fixtures. Each conservation device would be worth a certain number of points, as decided by the City. An ordinance would be implemented requiring that each new residence have conservation devices meeting a certain minimum number of points. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **SUPPLY *(continued)*** | | | |
| Home Leak Detection Repair | City would conduct testing and repair | Free | City would audit residences solely to determine whether and where leaks are occurring on the premises. City would then provide a plumber, free-of-charge, to the customer to repair leaks. |
| Home Leak Detection audit and Repair for low income elderly and handicapped, etc. | City provide | Free | City would audit residences of low income, elderly and handicapped persons solely to determine whether and where leaks are occurring on the premises. City would then provide a plumber free-of-charge to the customer to repair leaks. |
| Reuse gray water | Customer purchase and install; Regulations | Rebates; Enforcement | City would offer rebates to customers who install systems approved by the local health department. The systems would meet certain published standards and would be inspected after installation. |
| ***COMMERCIAL*** | | | |
| **LAUNDRIES** | | | |
| Laundromat Water Audit | City Audit | Potential for lower water bills | City would send water auditors to the top 20 percent of high water-using commercial laundries to examine the washing procedures and fixtures, and offer recommendations to the customers on how to save water and, therefore, money. |
| Recycle for new laundries | City Audit, Education | Potential for lower water bills | Either during the audit or through educational brochures presented with the water bill, the City would provide information on recycling water use in laundries. |
| Leak Detection and Control | City Audit, Plumber | Free, Potential for lower water bills | City would audit laundries to determine whether and where leaks are occurring on the premises. City would then provide a plumber free of charge to the customer to repair the leaks. |
| Water-efficient machines | Customer purchase | Rebate, Discount on water bill | City would offer a rebate or coupon for the purchase of water-efficient laundry machines. The rebate notice or coupon could be provided to the customer with the water bill. |
| **HOTELS** | | | |
| Bathroom Audit<br>• showers<br>• toilets<br>• faucets<br>• urinals | City Audit, Plumber | Free; Discount on water bill; Optional low flow fixtures giveaway and leak repair | City would provide an audit of the bathrooms of the top 20 percent of high water-using hotels for free. The auditor would examine the bathrooms for low flow shower, toilet, faucet, and urinal fixtures; and for any leaks. The auditor would then provide the results along with recommendations for low water-using fixtures. As an optional incentive, the City may provide low-flow fixture giveaways for the hotels to try, as well as send a plumber to repair any leaks found. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| **HOTELS *(continued)*** | | | | |
| | Pool Audit; (cover, filter backwash) | City Audit; customer purchase | Free audit; Rebate or Coupon | City would provide a water audit of the hotel's pool cleaning and upkeep practices, checking for use of a cover, whether a filter backwash system is used, and for any leaks. As in the irrigation audit, the auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| | Laundry Audit | City Audit | Free; Discount on water bill | City would provide a water audit of the hotel's laundry to examine the washing procedure. As in the irrigation audit, the auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| | Restaurant Audit | City Audit | Free; Discount on water bill | City would provide a water audit of the hotel's restaurants. The auditor would examine food preparation, and cleaning practices, and examine the restaurant for any leaks. The auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| | Cooling Tower Audit | City Audit | Free; Discount on water bill | City would provide a water audit of the hotel's cooling towers to determine the type of fixtures and practices being used to operate and maintain the air conditioning system. The auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| | Automatic Shut-off valves | Education; Customer purchase | Rebate, Coupon | The City would encourage hotels to purchase automatic shut off valves for their equipment/fixtures through educational brochures presented with water bills, rebates and coupons. The shut off valve shunts water to a trickle when turned on, but when it is reversed, instantaneously brings the water back on at the same temperature and pressure as before when the shut off valve is disengaged. |
| | No once through cooling | City Audit Education; Customer purchase | Rebate, Coupon | City would educate the customer during an audit of the water bill savings the customer could receive from retrofitting equipment and sponsor a rebate program for those hotels purchasing water conserving cooling equipment. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **HOTELS *(continued)*** | | | |
| Air cool instead of water cool | City Audit Education; Customer purchase | Rebate, Coupon | City would educate the customer during an audit of the water bill savings the customer could receive from retrofitting equipment and sponsor a rebate program for those facilities purchasing water conserving or reusing cooling equipment. |
| Low flow plumbing pictures | Education; City Audit; Customer purchase | City provide, Rebate, Coupon | City would conduct an audit of the top 20 percent of high water-using hotels, the water audit would determine if the water-using fixtures, such as high pressure cleansers, and processes could be upgrade or retrofitted to conserve water. This measure would include auditing the toilet facilities. The auditor would provide the results of the audit, rebate forms for appropriate water savings fixtures, and recommendations for conservation. This measure could be combined with others. |
| Cleaning Methods Audit | City Audit | Free; Discount on water bill | City would provide a water audit of the hotel's cleaning and upkeep practices, checking for efficient water use while cleaning. As in the irrigation audit, the auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| Fountain audit | City Audit | Free; Discount on water bill | City would provide a water audit of the hotel's fountain cleaning and upkeep practices, checking for use of a recycling pump as well as for any leaks. As in the irrigation audit, the auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| **RESTAURANTS** | | | |
| Serve water only when asked | Education, Table brochures | Free | City would provide table placards for placement on all restaurant tables encourage customers to conserve water and informing customers that water would be served only upon request. City would work with restaurants to encourage this change in policy. |
| Dishwashing Practice Audit | City Audit, Education | Free | City would provide an audit of the dishwashing procedure at the top 20 percent of high water-using restaurants. The auditor would provide results and recommendations to the restaurant management. This measure may be combined with others. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| **RESTAURANTS *(continued)*** | | | | |
| | Garbage Disposal Practice Audit | City Audit, Education | Free | For those restaurants in the top 20 percent of high water use and containing a garbage disposal, the auditor would examine the garbage disposal practice. The auditor would provide results and recommendations to the restaurant management. This measure may be combined with others. |
| | Cleaning Method Audit (inc. water softeners) | City Audit, Education | Free | City would conduct an audit of the cleaning methods used in the top 20 percent of high water-using restaurants. The auditor would provide results and recommendations to the restaurant management. This measure may be combined with others. |
| | Toilet Audit | City Audit, Education | Free displacement device | City would conduct an audit determining the flush volume of existing toilets and whether the toilets have leaks. The auditor would install a free displacement device in applicable toilets and provide audit results and recommendations to the restaurant management. This measure may be combined with others. |
| | Leak Detection Audit | City Audit, Education | Free | City would conduct an audit determining whether the plumbing fixtures have leaks. The auditor would provide audit results and recommendations, including directions on leak repair, to the restaurant management. This measure may be combined with others. |
| | Employee Education | Education: seminar, workshop | Free | City would conduct a workshop for restaurant managers explaining the latest water conserving restaurant plumbing fixtures and describing the water savings that could be achieved through implementation. |
| | Change water-cooled ice makers to air-cooled models | City Audit, Education; Customer purchase | Free audit; Rebate, coupon, water bill discount | City would conduct an audit and provide information encouraging restaurants to change from water-cooled icemaker compressors to air-cooled ice makers. City may offer a rebate or coupon to encourage applicable restaurants to upgrade their icemakers with water-efficient models. |
| | Reuse non-contact cooling water for water-cooled machines (frozen yogurt, refrigerators) | City Audit, Education, Customer purchase | Free audit; Rebate, coupon | City would conduct an audit and provide information encouraging restaurants with water-cooled frozen yogurt machines, refrigerators and other water-cooled machines to reuse non-contact water for other uses such as cleaning the floors. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **RESTAURANTS *(continued)*** | | | |
| Install on-demand point-of-use water heating systems; insulate hot water piping. | Customer purchase; City installation, Education | Rebate, coupon | City could encourage building code changes to require placement of point-of-use hot water heating systems and installation of hot water pipe installation in new restaurants. City could offer rebates for retrofits of existing restaurants. City would then encourage potential restaurant owners to look for these features when purchasing a restaurant as less water would need to be bled off before the customer obtains hot water. |
| Spray rinse with trigger control nozzle | Education, Customer purchase | Rebate, coupon | City would inform restaurants with a brochure and rebate or coupon presented with the water bill to purchase a rinse hose trigger control nozzle attachment that automatically shuts off the water when not being used to rinse dishes. |
| Recycle rinse water to next wash | City Audit, Education, Customer purchase | Free audit; Save water/ money | City would provide an audit of the top 20 percent of high water-using restaurants or provide brochures to restaurants to encourage the restaurants to recycle the final rinse water when hand washing to use as the first wash basin in the next wash. City would inform the restaurants how much water they may potentially save by taking this step. This measure may be combined with others. |
| **SCHOOLS** | | | |
| Drinking fountains | Automatic Shut-off valve; Audit, Customer purchase | Ordinance/ building code. Potential to save water/ money | City would create an ordinance requiring new drinking fountains to automatically shut off when not in use. Any versions that stay on continuously would be phased out. |
| Employee Education | City Personnel, Teaching Materials | Free | City would implement a school education program consisting of teaching employees how to conserve water on site, and the importance of conservation. The program would target cafeteria and landscape management personnel especially. (A separate education measure for students is described under education.) This measure could be combined with others. |
| Toilet audit | City Audit | Free audit, devices, rebates | City would audit the toilets of the top 20 percent of high water-using schools and provide recommendations and rebates for the installation of low flow/low flush toilets and leaks. |
| Cleaning method audit | City Audit | Free | City would audit the cleaning method practices of the top 20 percent of high water-using schools and provide recommendations and rebates for the installation of efficient cleaning practices. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| **SCHOOLS *(continued)*** | | | | |
| | Cafeteria use | City Audit, Education | Free | City would audit the food preparation, dishwashing, and garbage disposal practices of the school cafeteria at the top 20 percent of high water-using schools and provide recommendations and rebates for the installation of efficient food preparation and disposal/cleaning practices. |
| | Low flow plumbing fixtures | Customer purchase | Rebate | City would encourage schools to replace old plumbing fixtures with new, low flow fixtures by providing rebates to the schools for the hardware. |
| **OFFICES (INCLUDING GOVERNMENT BUILDINGS)** | | | | |
| | Toilet Audit | City Audit | Free; Save water/money | City would conduct an audit determining the flush volume of existing toilets and whether the toilets have leaks. The auditor would install a free displacement device in applicable toilets and provide audit results and recommendations to the restaurant management. This measure may be combined with others. |
| | Cleaning Method Audit | City Audit | Free; Save water/money | City would audit the cleaning method practices of the top 20 percent of high water-using offices and provide recommendations and rebates for the installation of efficient cleaning practices. |
| | Low Water Use Fixtures | Customer purchase | Free; Save water/money; Rebate | City would conduct an audit of the top 20 percent of high water-using offices. The water audit would determine if the water-using fixtures, such as toilets and faucets, and processes, such as mopping the floor, could be upgraded or retrofitted to conserve water. The auditor would provide rebate forms for appropriate water saving fixtures, and recommendations for conservation. This measure could be combined with others. |
| | Cooling Tower Audit | City Audit | Free; Save water/money | City would provide a water audit of the office's cooling towers to determine the type of fixtures and practices being used to operate and maintain the air conditioning system. The auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| ***COMMERCIAL*** | | | | |
| **HOSPITALS** | | | | |
| | Toilet Audit | City Audit, Education | Free; Rebate; Free devices | City would conduct an audit targeting the top 20 percent of high water-using hospitals to determine the flush volume of existing toilets and whether the toilets have leaks. The auditor would install a free displacement device in applicable toilets and provide audit results and recommendations to the restaurant management. This measure may be combined with others. |
| | Cleaning Method Audit | City Audit, Education | Free | City would audit the cleaning method practices of the top 20 percent of high water-using hospitals and provide recommendations and rebates for the installation of efficient cleaning practices. |
| | Cooling Tower Audit | City Audit, Education | Free | City would provide a water audit of the top 20 percent of high water-using hospitals' cooling towers to determine the type of fixtures and practices being used to operate and maintain the air conditioning system. The auditor would provide the results of the audit and recommendations for conservation. This measure could be combined with others. |
| | X-ray (photos)<br>• Flow to specs<br>• Temperature control valve--less flow when x-rays are not being developed; solenoid valve<br>• Recycle rinse bath effluent for developer/fixer solution<br>• Separate/ recycle rinse from plating solutions using evaporator/ condenser or membrane systems | City Audit, Education; Bill insert; Customer purchase | Save water/ money;<br>Free audit; Rebate | City would conduct an audit of x-ray and other photographic machines at the top 20 percent of high water-using hospitals to determine that the water flows to the specifications on the machines, that less water flows when x-rays are not being developed, and whether the bath effluent for the developer or filter solution is or could be, recycled. The auditor would provide the results of the audit and recommendations for conservation. City could offer rebates for water-efficient equipment upgrades. This measure could be combined with others. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **HOSPITALS *(continued)*** | | | |
| Low Water Use Fixtures | City Audit; Customer purchase; Education | Free; Save water/money; Rebate | City would conduct an audit of the top 20 percent of high water-using hospitals. The water audit would determine if the water-using fixtures (e.g. ice-making machines), and processes (e.g. using reclaimed water for cooling purposes) could be upgraded or retrofitted to conserve water. This measure would include those tasks in the Toilet Audit described above. The auditor would provide the results of the audit, rebate forms for appropriate water saving fixtures, and recommendations for conservation. This measure could be combined with others. |
| Employee Education | City Seminar | Free; Save water/ money | City would conduct a free seminar to hospital staff at the top 20 percent of high water-using hospitals on methods to reduce water consumption within the facilities. |
| Air cool, not water cool icemaking | City Audit, Education; Customer purchase | Rebate; Enforcement | City would educate the customer during an audit of the water bill savings the customer could receive from retrofitting equipment, and sponsor a rebate program for those facilities purchasing water conserving cooling equipment. |
| Automatic Shut-Off valves | City to provide; Customer purchase | Free; Rebate | City would sponsor a rebate program for those facilities purchasing automatic water shut-off valves for their equipment. City would provide rebate forms with the hospital's water bill and encourage the manufacturer's of automatic shut-off valves to support the program with advertising. |
| Leak Detection and Repair | City Audit, Education | Free; Save water/ money | City would provide service personnel or contract out consultants to audit the top 20 percent of high water-using hospitals for leaks in the water-using fixtures and plumbing. City would provide a plumber to repair the leaks for free. This measure could be combined with others, such as Audits. |
| *See Residential*<br>*See Laundries*<br>*See Landscaping* | | | |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **AUTO REPAIR** | | | |
| Reuse cleaning water | Audit | Free, Rebate | City would conduct an audit of the top 20 percent of auto repair shops to determine if any water-using processes could benefit from reusing the cleaning water. The auditor would provide the results of the audit, rebate forms for appropriate water saving fixtures, and specific recommendations for reusing water. This measure could be combined with others. |
| Cleaning Method Audit | City Audit | Free | City would conduct an audit of the top 20 percent of auto repair shops to determine if any cleaning processes could be improved to conserve water. The auditor would provide the results of the audit, rebate forms for appropriate water saving fixtures, and recommendations for conservation. This measure could be combined with others. |
| Leak Detection/ Use and Repair | City Audit, Plumber | Free | City would conduct an audit of the top 20 percent of auto and repair shops to find and repair plumbing and fixture leaks. The auditor would provide the results of the audit, and a plumber to repair the leaks free of charge. This measure could be combined with others. City may contract this audit out to qualified consultants who could be paid on a results basis. |
| Employee Education | City Audit, Education: flyers, workshop | Free | City would conduct a free workshop to repair shop staff on methods to reduce water consumption. City would also provide demand management fliers to repair shops. This measure could be combined with other measures. |
| Automatic shut-off valves | Customer purchase | Rebate | City would sponsor a rebate program for those facilities purchasing automatic water shut-off valves for their equipment. |
| No once-through cooling | Audit, Education | Free, Rebate | City would educate the customer during an audit of the water bill savings the customer could receive from retrofitting equipment, and sponsor a rebate program for those facilities purchasing water conserving cooling equipment. |
| Air cool, not water cool systems | City Audit, Education; Customer purchase | Free, Rebate | City would educate the customer during an audit of the water bill savings the customer could receive from retrofitting equipment, and sponsor a rebate program for those facilities purchasing water conserving or reusing cooling equipment. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **AUTO REPAIR *(continued)*** | | | |
| Low Water Use Fixtures | City Audit, Education | Free, Rebate | City would conduct an audit of the top 20 percent of high water-using auto repair facilities. The water audit would determine if the water-using fixtures, such as high pressure cleansers, and processes could be upgraded or retrofitted to conserve water. This measure would include auditing the toilet facilities. The auditor would provide the results of the audit, rebate forms for appropriate water saving fixtures, and recommendations for conservation. This measure could be combined with others. |
| Air Blowing | City audit; Education; Customer purchase | Rebate | City would conduct an audit of the top 20 percent of high water-using auto repair facilities to determine if current wash-down practices could be replaced with air blowing in order to conserve water. City would provide rebates for the new equipment if the results of the audit show that the air blowing process is feasible at that facility. |
| **CAR WASHES** | | | |
| Recycle water | Education; City Audit | Save water/ money | City would conduct an audit of the top 20 percent of car washes to determine if any water-using processes could benefit from reusing the wash water. The auditor would provide the results of the audit and provide specific recommendations for recycling water. This measure could be combined with others. |
| Leak detection and repair | Education; City Audit | Save water/money, Rebate | City would conduct an audit of the top 20 percent of car washes to detect plumbing and fixture leaks. The auditor would provide the results of the audit, rebate forms for appropriate water savings fixtures, and recommendations for conservation. This measure could be combined with others. |
| Water Audit | City Audit | Free | City would send auditors to the top 20 percent of high water-using car washes to examine the washing procedures and fixtures, and offer recommendations to the customers on how to save water and, therefore, money. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| ***COMMERCIAL EXTERIOR*** | | | | |
| **LANDSCAPING (INCLUDES GOVERNMENT LANDSCAPES)** | | | | |
| | Landscape Codes | City Ordinance | Enforcement | City would draft and encourage adoption of a City ordinance to require landscaping of new construction properties to use only native or water conserving species. City would provide personnel to educate those affected by the ordinance and ensure effective implementation once the ordinance is adopted. |
| | Train landscape managers | City Audit, workshop | Free | City would provide a free workshop to train landscape managers on the amount of water necessary for irrigation; how to find and repair simple leaks; and the importance and potential savings from water conservation and using native or low water-using plants. City would provide audits of the landscapes accompanied by the landscape managers as a training device. |
| | Hire landscape architect to design/redesign efficient landscapes | Education, City regulation | Enforcement | City would create and encourage adoption of an ordinance or regulation requiring the services of a trained landscape architect to approve the design of new large landscapes for water efficiency. |
| | Minimize turf and small uneven turf areas | Education, Building regulations | Enforcement | City would create and encourage adoption of an ordinance or regulation specifying the maximum amount of turf, especially small uneven turf areas. City would provide personnel to educate those affected by the ordinance and ensure effective implementation once the ordinance is adopted. City would provide personnel to educate those affected by the ordinance and ensure effective implementation once the ordinance is adopted. |
| | Promote native plants | Education | Free | City would create an ordinance or regulation specifying that only native or low water-using plants could be planted in landscapes of all new construction. |
| | Automatic Irrigation System<br>- Drip, Microspray, Subsurface<br>- Specific hydrozones<br>- Rain - overrides, smart controls | Education: Bill insert, store displays; media | Rebate | City would create a rebate program encouraging all new construction with outdoor landscaping to install automatic irrigation systems including subsurface drip, controls for specific hydrozones, and rain overrides with smart controls. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| **LANDSCAPING (INCLUDES GOVERNMENT LANDSCAPES)** *(continued)* | | | | |
| | Reclaimed Water use | Regulations, Education, create market | Enforcement | City would sell tertiary treated waste-water to interested large landscape water managers for irrigation of sites such as golf courses. City would seek to create such a market while meeting all health regulations. City would also promote the use of stormwater and bayou reuse for irrigation. |
| | Swimming pool or Fountain repair/ retrofit | Audit | Free; Discount on water bill | City would provide a water audit of the commercial or government facilities' fountain or pool cleaning and upkeep practices, checking for use of a recycling pump as well as any leaks. As in the irrigation audit, the auditor would provide the results of the audit and recommendations for conservation. |
| | Demonstration Gardens | City to provide | Free | City would donate a portion of land to create a demonstration garden displaying living examples of low water-using gardens and landscaping. City would have caretakers at the garden to answer any questions, and would provide signs and brochures to educate those people visiting the garden. City may work with a school or other community group like scouts to implement this measure. |
| | Esplanade Ordinance | City Ordinance | Enforcement | City would draft and encourage adoption of a City ordinance to require water conservation during irrigation of all City esplanades. City would provide personnel to educate those affected by the ordinance and ensure effective implementation once the ordinance is adopted. |
| | Irrigation Audit | City audit, Regulations, Education, Media | Enforcement; Save water/ money | City would provide outdoor audit of top 20 percent of high water-using commercial facilities. The auditor would determine how irrigation practices are undertaken, present the results of the audit, and provide recommendations for the facility to conserve water including irrigating during appropriate times, not irrigating upon pavement and use evapotranspiration programs, if available. City would encourage irrigation conservation methods through the media. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| ***INDUSTRIAL*** | | | |
| **INDUSTRIES USING BOILERS, HOT WATER, STEAM** | | | |
| Recapture/reuse steam | Education, Regulations, Customer purchase | Rebate, Coupon, Enforcement | City would conduct an audit of the top 20 percent of factories using boilers, hot water, or steam. The auditor would examine the system and educate the owner or manager on methods to recapture and reuse hot water vapor. City may regulate the water use of boilers, hot water, or steam products, or the City may provide a rebate/ coupon to encourage the owner to participate. |
| Audit boiler, controls, use | City Audit, Education, Regulations, Plumber | Rebate, Coupon, Enforcement | City would conduct an audit of the top 20 percent of factories using boiler, hot water, or steam processes. City would provide information on efficient boiler and boiler-control usage, would fix any leaks found, and would provide a rebate or coupon to upgrade necessary related equipment. |
| Automatic blowdown and boiler make-up treatment controls | Education, Regulations | Enforcement | City would draft and encourage adoption of a City ordinance requiring that blowdown and make-up treatment controls on boilers be automatic. City would provide personnel to educate those affected by the ordinance and ensure effective implementation once the ordinance is adopted. |
| Fix steam trap leaks | City Audit, Education, Customer purchase | Rebate, Coupon | City would offer rebates to defray the cost of hiring a plumber to implement the audit recommendations related to repairing these leaks. |
| Insulate pipes and vessels | Education, Regulations, Customer purchase | Rebate, Coupon, Enforcement | City, in association with Energy Dept., could encourage building code changes to require industries to install hot water pipe and vessel insulation. City and the Energy Dept. could offer rebates for retrofits of existing facilities while delivering the water or energy bill. |
| **EVAPORATIVE COOLING SYSTEMS** | | | |
| Submeters for make-up and bleed-off water of cooling towers | Education, Customer purchase | Rebates | City would offer a rebate to industries that install submeters to measure the make-up and bleed-off water of the facility cooling towers. City would provide educational brochures and a phone contact of a knowledgeable person at the City to provide conservation information. |
| Recover, treat, reuse filter backwash water; reuse water from other site uses. | Education | Potential to save water and money | City would encourage customers to reuse properly treated filter backwash water and water from other site uses within the cooling systems. City could provide a short informative brochure with the water bill encouraging the reuse. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **EVAPORATIVE COOLING SYSTEMS** | | | |
| Have condenser collection pans larger than drip pans | Education, Customer purchase, Code Changes | Enforcement; Rebates | City would offer a rebate, and could require through a water code change, for collection pans in cooling towers to exceed the circumference of the drip pans thus reducing the waste of water spilling from the drip pans to the ground due to wind. |
| Require vendors to pay for cooling; require performance specification for chemical service vendors | Code changes | Enforcement | City would draft and encourage the adoption of a water code change to require that those vendors using air conditioning be required to pay for the amount of air conditioning they use, rather than having the air conditioning included in a flat renter's rate. The code would also require that performance specifications be carried out by chemical service vendors. |
| **EVAPORATIVE COOLING SYSTEMS** | | | |
| Cooling System Audit; Control bleed-off based on conductivity; cooling system water treatment; Inspect drift losses & minimize scale | City Audits, Education | Free | City would provide an auditor to inspect the cooling towers of the top 20 percent of high water-using industries having air conditioning. The auditor would inspect the control of bleed-off water based on conductivity; cooling system water treatment; drift losses; and would offer suggestions to minimize scale. The auditor would offer suggestions to minimize drift water loss. The auditor would compile the results of the audit and offer recommendations to the operator on methods to improve water efficiency. |
| Eliminate single-pass water use; convert open evaporative systems to closed-loop cooling systems | Code changes; Customer purchase, Education | Rebates, Enforcement | City would institute adoption of a code change for new construction to require and provide education and rebate incentive programs for existing customers to encourage the use of closed-loop cooling systems rather than single-pass water use systems. City would provide personnel to educate those affected by the ordinance and ensure effective implementation once the ordinance is adopted. |
| **PROCESS AND EQUIPMENT** | | | |
| Water Audit | City Water Audit | Free | City would provide a free water audit of process and equipment of the top 20 percent of industrial and commercial water users. The audit would examine both water-using equipment and methods and the auditor would provide recommendations for efficient water use. This measure could be combined with others. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **PROCESS AND EQUIPMENT *(continued)*** | | | |
| Install pressure reducers where high-pressure isn't necessary | Customer purchase | Rebates; Requirement | As part of the water audit or through public education, the City would encourage with rebates or require with regulations that customers purchase pressure reducers for processes that do not require high pressure. If required, the City would provide inspectors to ensure implementation occurs. |
| Reheat from point-of-use or reuse hot water from other applications for tanks and baths | Customer Upgrade | Rebates; Requirement | City would provide rebates for existing customers and change the code to require new customers to provide point-of-use heaters or require reuse of hot water from other applications for certain tanks and baths. City would specify for which uses reuse would be acceptable and would provide necessary information and education to implement this measure. |
| Counter-current rinse and clean; measured rather than continuous rinse and clean water | Customer purchase/ Upgrade | Rebates; Requirement | City would either encourage through rebates or require with regulations that companies use counter-current rinse and clean or measured rinse. This measure is intended to reduce rinse water running continuously. The measure could be combined with water audits, and could be marketed through public education and with the bill as well. |
| Automatic recirculating washers | Customer purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates or require through a water code change the use of water conserving automatic recirculating washers that reuse wash water. |
| Partial water for smaller loads; batch processing | Customer purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates or require through a water code change the installation of washing machines with controls to select water level based on the size of the load. |
| Recycle rinse water to next wash; reclaim wash water | Customer purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates and through public education, or require through a water code change, that customers purchase equipment to recycle rinse water from the last rinse for the first wash of the next load. |
| State-of-the-art process equipment | Customer purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates or require through a water code change, the use of water saving process equipment. This measure could be combined with water audits to help inform customers of water-efficient equipment and provide retrofit forms. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **PROCESS AND EQUIPMENT *(continued)*** | | | |
| Conveyor belt controls to stop wash and lube water when belt not operating | Customer purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates or require through a water code change the use of an automatic water shut-off system that engages when the conveyor belt on a washing apparatus is not operating. |
| **PAPER AND PACKAGING** | | | |
| Water blending | Customer education/ purchase/ upgrade | Rebates; Requirements | City would advocate the use of lower (but acceptable) quality water from local sources, such as recycled water. Rebates would be offered for qualified projects. |
| White water recycling | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | Based on results from the audit, described above, the City would encourage through rebates and possibly require through a code change the most effective water saving devices and process changes. |
| **BEVERAGE BOTTLERS & BREWERS** | | | |
| Recycle and reuse | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates or require through a code change and through public education, that customers purchase equipment to recycle rinse water from the last rinse for the first wash of the next load. City would provide rebates to existing customers seeking to upgrade their cleaning systems. City would also require with a code change that new customers use reclaimed water for use in their cooling systems. |
| Process Design Modification | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | City would encourage through rebates or a code change, that best available technology is used in process design to ensure efficient water use. Machines that increase process design water efficiency could be included in a rebate program to encourage their use. |
| Education | Customer Education; City provide workshops, conferences, brochures | Free | City would provide education to the top 20 percent of high water-using beverage bottlers and brewers by providing brochures and flyers with water saving recommendations, and offering a free water-conservation workshop/seminar in which a representative of the City would travel to the bottler/brewery and provide a demonstration and presentation of efficient water use. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **BEVERAGE BOTTLERS & BREWERS *(continued)*** | | | |
| Automatic shut-off valves | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | City would provide rebates to encourage existing customers to upgrade with shut-off valves that automatically shut off the water when its not in use. City would also change the water code to require the implementation of automatic shut-off valves in all new construction. |
| Process filtering for maximum product recovery | Customer education purchase/ Upgrade | Rebates; Requirements | City would encourage existing customers to improve their product filtering process in order to improve product recovery and decrease the amount of wastewater produced. City would provide rebates for more water-efficient equipment in the filtering process. City would also change the water code to require the implementation of water-efficient product filtering equipment in all new construction. |
| Reclaim cooling water | Customer education purchase/ Upgrade | Rebates; Requirements | City would educate customers of the benefits using reclaimed cooling water for cleaning processes or other uses within their facilities through water bill inserts or City audits. City would provide rebates to facilities for the implementation of cooling water reclamation equipment. City would also change the water code to require that all new facilities reuse cooling water for other purposes. |
| Low Water Use Fixtures | Audit; Purchase; Building Code Regulations | Free; Rebate, Coupons; Enforcement | City would conduct an audit of the top 20 percent of high water-using beverage and brewery facilities. The water audit would determine if the water-using fixtures could be upgraded or retrofitted to conserve water. This measure would include auditing the toilet facilities. The auditor would provide the results of the audit, rebate forms for appropriate water saving fixtures, and recommendations for conservation. City would also change the water code to require the implementation of water-efficient fixtures in all new construction. |
| High pressure air cleaning | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | City would encourage customers to purchase high pressure air cleaning devices rather than water-using cleaning devices. City would encourage this use through rebates, and could implement a code change requiring new facilities to install high pressure air cleaning devices. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| *See Cooling* | | | | |
| **City/County/State Bldgs. Interior** | | | | |
| | Water Audits | City provides | Free | City would send water auditors to the top 20 percent of high water-using government buildings to examine water-using procedures and fixtures and offer recommendations on how to save water and therefore, money. |
| | New fixed head showerhead | Customer purchase, City provides | Free | To encourage water savings in-house government building with showerheads. The City would purchase and install new 2.75 gal per minute showerheads that would be attached near the top of the shower. |
| | New 6L toilet | Customer purchase; City provides | Rebate or free | City would purchase, deliver and install new 6L per flush toilets to the top 20 percent of high water-using government buildings. |
| | Displacement device (bag or dam) for toilets | City provides | Free | City would provide a plastic bag device that may be filled with water and attach to the inside of the toilet tank to displace tank eater and thereby reduced the amount of water during each flush. This measure would only work with toilets that have a toilet tank. |
| | Leak repair - dye tablet for toilets | City provides | Free | City could provide leak detection dye tablets to determine if the toilet is leaking by seeing if the blue dye enters the toilet bowl. This measure would only work with toilets that have a toilet tank. |
| | New 1 gal. unit urinals | City provides; customer or City repair | Free | City would purchase, deliver and install new 1 gallon unit urinals to the top 20 percent of high water-using government buildings. |
| | Repair leaks; Install aerators in faucets | City provide | Free | City would provide education to the top 20 percent of high water-using government buildings by providing brochures and flyers with water saving recommendations, and offering a free water-conservation workshop/seminar in which a representative of the City would travel to the site and provide a demonstration and presentation of efficient water use. |
| | Exterior | | | |
| | See Commercial Exterior | | | |
| | City Parks Dept. Interior | | | |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| | Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|---|
| **City/County/State Bldgs. Interior *(continued)*** | | | | |
| | Swimming pool leak detection and repair | City Audit | Decrease water/money loss | City would conduct a leak detection audit for all public swimming pools and offer recommendations on how to save water and therefore, money. City would detect leaks and repair them. |
| | City departments would be sent a monthly water statement and given a goal of reducing water usage by 10 to 20%. | City policy | Departments save money/ water | City would send a monthly statement to all City departments and assign a goal to reduce water usage by 10 to 20% to each department. This would provide an incentive for each department to use water-efficiently and not waste it. |
| | Low flow shower heads at swimming pools | City provide | Departments save money/ water | City would purchase and install low flow shower heads at each public swimming pool facility. This would save water, and thus, money. |
| | Dead man switch for hoses at swimming pools | City provide | Departments save money/ water | City would purchase and install dead man switches on all water hoses at public swimming pool facilities. This would save water, and thus, money. |
| | Swimming pool repair/retrofit | City provide | Departments save money/ water | City would repair leaks and cracks at public swimming pools and purchase and install low flow fixtures at the facilities. |
| | Secured float valves at swimming pools and fountains | City provide | Departments save money/ water | City would purchase and install secured float valves at all public swimming pools and City-owned/operated decorative fountains. City would also maintain the valves in proper working condition. |
| | Require all pools and fountains to have recirculation pumps | City provide | Departments save money/ water | City would require that all public swimming pools and City-owned/operated decorative fountains have properly sized recirculation pumps. City would maintain the pumps to ensure that they are in proper working order. |
| | Water conservation training for City employees | City provide | Departments save money/ water | City would conduct training to City staff regarding water conservation and water-efficient measures that can be practiced in the workplace and at the home. |
| | Fountain repair/retrofit | City provide | Departments save money/ water | City would repair leaks and cracks at City-owned/operated decorative fountains and purchase and install hardware and fixtures required to maintain the fountains in proper working order. |
| | City Parks Dept. Interior | | | |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| **City/County/State Bldgs. Interior *(continued)*** | | | |
| Bayou reuse for irrigation | City Audit; Education | Departments save money/ water | City would conduct an audit of public recreational facilities such as golf courses and parks to determine if irrigation with bayou water would be feasible. The auditor would provide recommendations based on the evaluation, and the City would purchase and install equipment required to implement the recommended actions. |
| See Commercial Exterior | | | |
| ***SUPPLY-SIDE MEASURES*** | | | |
| Leak Detection and Repair | City provide distribution system audits and leak detection and repair | Increase supply | City would audit the water distribution system for leaks and, upon locating them, would repair the leaks as soon as possible. |
| **Conservation Pricing** | | | |
| Inclining block rates | City change | Encourage conservation | City would change its current rate structure to one that charges the customer a higher rate for a larger volume of water consumed. Consumption of water in the higher rate blocks would be more expensive than the lower volume rate blocks which would discourage inefficient use of water. |
| Seasonal rates | City change | Encourage conservation | The City would change its current rate structure to one that charges the customer a higher rate during the summer months as a disincentive to using water inefficiently, i.e., to discourage constant watering of the lawn/yard. |
| Marginal cost pricing | City change | Encourage conservation | City would change its current water rate structure to one based on the marginal cost of developing new water sources. |
| Computerized billing system | City change | Used to determine high water use; potential leaks | City would convert to a computerized billing system which would monitor monthly water use of each customer. The system could be used in part to determine the high water users and potential leaks if a customer suddenly incurs unusually high water use. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| ***EDUCATION*** | | | |
| Publications: Newspaper, TV, Radio | City to supply | Encourage conservation | City would set up both a public education and school education program to encourage water conservation and provide information on demand management techniques. The education program would work in accordance with other selected conservation measures and thereby increase the implementation rate and savings of the other measures. City would provide information to create and produce articles and segments in the newspapers on the TV, on billboards, and for the radio encouraging and explaining methods and the importance of saving water. |
| Presentations: Tables, booth | City to supply | Encourage conservation | City would also provide presentations to interested community groups and in public places such as shopping malls. This measure may be combined with others. |
| Community events | City to supply | Encourage conservation | City would encourage and organize community events such as participating with teachers to develop school plays on water conservation that are then presented to the public. |
| Displays: Utility, bumper stickers, billboards, posters, restaurant/ bathroom notices | City to supply | Encourage conservation | City would create and distribute displays such as water conservation stickers, posters, billboards, restaurant and bathroom notices regarding the importance of, and encouraging conservation. |
| Evapo-transpiration (ET) Hotline | City to supply | Encourage conservation | City would provide a hotline phone number for customers to call to find out how much water they should use to irrigate, based on the day's evapotranspiration rates. City would need to set up and monitor mini-weather stations at various locations throughout the Bangkok service area. City would place evapotranspiration and irrigation data in the local major newspapers as well. |
| Demonstration Gardens | City to supply; Encourage community groups/ schools to participate | Encourage conservation | City would donate a portion of land to create a demonstration garden displaying living examples of low water-using gardens and landscaping. City would have caretakers at the garden to answer any questions, and would provide signs and brochures to educate those people visiting the garden. |
| Awards | City to supply | Encourage conservation | City would provide a yearly award to the company and individual customer that represented the most dedication to water conservation. City would ensure that the award gained publicity in order to encourage other customers to think about and employ water conservation. |

**Table 4-1 *(continued)***
**City of Houston: Demand Management Project**
**Potential Conservation Measures and Initial Screening**

| Device | Alternative Distribution Methods | Possible Incentives | Measure Description |
|---|---|---|---|
| ***EDUCATION (continued)*** | | | |
| Workshops, Conferences | City to supply | Encourage conservation | City would conduct workshops and conferences to disseminate conservation information and new technology, helping customers realize water savings. |
| In-School training | City to supply teaching materials; perform presentations | Encourage conservation | City would provide school conservation programs with workbooks and presentations; teaching materials and other educational tools to teach the students the importance of conserving water. City would sponsor water conservation poster contests, and other fun, yet educational, activities for the school children. |
| Pressure Reduction | City to require pressure reducers set to 50 psi | Enforcement | City's Building Inspection Department would require a pressure reducer at every new connection. Pressure would be set at 50 psi, rather than the more common 80 psi, in order to save water. |

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# Section 5
# CONSERVATION PROGRAMS SELECTED FOR DETAILED EVALUATION

The 78 measures passing the qualitative screen described in Section 4 were grouped by type of program and targeted customer class. This process enabled a consolidation of the 78 measures into 20 individual programs as shown in Table 5-1. Each program may serve more than one type of customer. This is particularly true with programs such as commercial water audits that will serve many different types of customers through a structured audit procedure. These 20 programs were analyzed for cost-effectiveness using Water Plan 2.0 (see Section 6). The programs are listed below, followed by a brief description. Following review and approval of the programs by the City, detailed descriptions were developed (see Appendix C); specific implementation methods recommended; and benefit-cost analysis performed.

**Table 5-1**
**Alternative Programs Selected for Evaluation**

| | | | |
|---|---|---|---|
| **Residential Properties** | | | |
| 1. | Residential Water Audits | 4. | Appliance Labeling |
| 2. | Retrofit Kits | 5. | Landscape Water Efficiency |
| 3. | Ultra Low Flush Toilet Rebates | | |
| **Commercial and Industrial Facilities** | | | |
| 6. | Commercial Water Audits | 10. | Landscape Codes |
| 7. | Efficient Process Equipment Rebates | 11. | Irrigation Audits |
| 8. | C/I ULF Toilet Rebates | 12. | Fountain/Pool Audit |
| 9. | Cooling Tower Audits | | |
| **City/County/State Facilities** | | | |
| 13. | Public Facility Water Audits | 16. | Standards for New Fountains/ Pools |
| 14. | Toilet/Shower/Urinal Replacement | 17. | City In-House Program |
| 15. | Fountain/Pool Audit and Repair | | |
| **Supply Side Programs** | | | |
| 18. | Leak Detection and Repair | 19. | Conservation Pricing |
| **General Programs** | | | |
| 20. | Public Education Programs | | |
| | a. Public Information | | |
| | b. Water Wise and Energy Efficient | | |
| | c. City Employee Education | | |
| | d. C/I Employee Education | | |

## Residential Properties

**Residential Water Audits.** This measure targets existing residents in an effort to reduce indoor and outdoor water use, especially during peak use periods. The top 20 percent of single-family and multifamily home water users (on a gallons per account per day basis) and elderly and handicapped water users are offered a free audit that includes indoor water conservation measures and development of an irrigation schedule. Indoor water savings are realized from installation of low-flow devices and leak repair. Toilet leaks can be detected by the use of dye tablets disseminated as part of the water audit program. The water audit is estimated to save 6 percent of the total water use for each audited home. The audit needs to be repeated every five years to maintain savings.

**Residential Plumbing Retrofit.** This measure involves the distribution of low-flow showerheads, toilet tank dams, and leak detection tablets to residents who are then encouraged to install the retrofits themselves. These programs were popular in the mid-1980s when low-flow showerheads were still new. Now many homeowners have already replaced their showerheads. The natural replacement rate is likely to cause the remaining showerheads to be converted to low-flow showerheads within the next 10 to 20 years. This measure tends to be expensive for the savings generated unless a critical water or wastewater situation indicates the need for an accelerated replacement rate. A better way to encourage the installation of low-flow showerheads is to promote them through the Residential Water Audit and Ultra Low-Volume Toilet Replacement programs.

**Ultra Low-Flush Toilet Replacement.** This measure would involve the City implementing a toilet replacement program offering rebates to customers who replace their high-water-use toilets with 1.6-gallons per flush (gpf) models. Customers eligible for this program would include the top 20 percent of single-family and multifamily homes, as well as low income, handicapped, and elderly water users. Implementation of this measure would create increased savings in the short term because the low-flow fixtures are installed sooner than the natural replacement rate. The natural replacement covers toilets voluntarily replaced.

**Appliance Labeling.** The appliance labeling program provides customers with point-of-purchase information, including an equipment tag, similar to the Appliance Energy Efficient programs operated by electric utilities. Water efficient appliances would receive a distinguishing label so that they stand out on the retail sales floor. The tag would also show how each appliance compares with others in its category. The City would work closely with appliance manufacturers and electric and gas utilities to develop the equipment tags. Dealers would be trained to use the labels and point-of-purchase materials. The City could then mount a campaign encouraging customers to buy water saving appliances.

**Water Efficient Landscape and Irrigation System Incentives.** This program offers incentives to single-family and multifamily customers for the installation of water-efficient landscaping and irrigation systems. Rebates would apply to (1) new landscaping with 20 percent turf or less, (2) re-landscaping involving the removal of turf, and (3) installation of an efficient irrigation system

on landscaping with 20 percent turf or less. To qualify, customers must have drip irrigation on plant material, timers or controllers, and soil and rain sensors.

### Commercial and Industrial Facilities

**Commercial and Industrial Indoor Water Audits.** This alternative measure targets the top 20 percent of commercial and industrial water users. Building owners would be contacted and offered a free interior audit together with incentives sufficient to achieve customer implementation of audit findings. An interior audit would be conducted by City staff or a consultant. The auditor would perform an on-site interior audit and produce a customized report that describes fixture inspections and retrofit possibilities, leak tests, process water improvements, and recycling opportunities for each site. Audits would be repeated every five years to maintain or improve the conservation level. Potential industrial water savings is difficult to determine because industry is site-specific.

**Efficient Process Equipment Rebates.** This program would offer cash rebates to encourage replacement of existing commercial and industrial process equipment with more water efficient process equipment. The following are examples of the types of equipment purchases that would qualify for the rebates:

- Change from water-cooled equipment to air-cooled equipment
- Change from one-pass cooling and heating systems to recirculating cooling and heating systems
- Improve industrial and commercial washers and rinsers
- Install solenoid and automatic control valves
- Replace submeters
- Purchase equipment to recycle industrial water/separate waste streams

**Incentives for Commercial and Industrial Toilet/Shower Replacement.** This program would offer cash rebates to the commercial/industrial sector to encourage replacement of existing toilets and urinal valves that use more than 1.6 (toilets) and 1.0 (urinals) gallons per flush. Low-flow showerheads could be replaced for all commercial and industrial customers who have significant numbers of showerheads. A ULF toilet is estimated to save 15.0 gpd per employee per toilet replacement and 0.4 gpd per employee per urinal replacement. No savings are assumed for showerhead replacement, although showerheads can be significant water users in certain situations.

**Cooling Tower Audits.** Blowdown is usually the only use of water in a cooling tower that can be reduced as a conservation measure. The City would conduct audits of commercial and industrial cooling towers to determine if the amount of blowdown water discharged from the system is the minimum required without damaging or jeopardizing its operation. Decreasing the amount of blowdown while evaporation remains constant results in a higher concentration ratio (ratio of makeup water volume to blowdown water volume). As the concentration ratio increases, total water consumption decreases. The auditor would produce a customized report that describes the

cooling tower operation, process water improvements, and recycling opportunities for each site. Audits would be repeated every five years to maintain or improve the conservation level.

**Low Water-Use Landscape Ordinances.** Landscape ordinances require low water use plants and efficient irrigation systems, and could also require water conservation for all city esplanades and irrigated right-of-ways. The ordinances apply to new multifamily residential, commercial, and industrial landscaping; they exclude single-family residential landscaping. Full implementation of this measure would require checking plans during the building permit approval process and enforcing the ordinances through random site inspections.

**Commercial and Industrial Irrigation Audits.** This measure seeks to reduce peak demand by conserving irrigation water. Existing commercial and industrial building owners, whose buildings have high summer water use, would be offered an irrigation system audit to improve the water use efficiency of the existing sprinkler system. One of the key areas of this audit is establishing the correct watering rate. Watering schedules and yearly conservation reminders would be sent to the targeted businesses/industries, and an offer would be made to repeat the audit after five years.

**Fountain/Pool Audits.** This measure requires that the City conduct on-site audits of reflection pools, decorative fountains, swimming pools, etc., at commercial and industrial facilities. The audit would include evaluating cleaning and upkeep practices for fountains and pools, checking for use of a recirculation pump, inspecting operating condition of valves, and checking for any leaks. The auditor would provide the results of the audit and recommendations for water conservation. The audit would be repeated every five years.

### City, County, and State Programs

**Public Facility Water Audits.** This alternative measure targets the top 20 percent of public (government, institutional) water users. An interior audit of City-owned buildings would be conducted by City employees. The auditor would perform an on-site interior audit and produce a customized report that describes fixture inspections and retrofit possibilities, leak tests, cooling tower operation, process water improvements, and recycling opportunities for each site. Additionally, existing City-owned properties and recreational facilities, including golf courses and parks, would be provided with an irrigation system audit to improve the water use efficiency of existing sprinkler systems. One of the key areas of this audit is establishing the correct watering rate. Watering schedules and yearly conservation reminders would be sent to the targeted facility managers. Interior and irrigation audits would be repeated every five years to maintain or improve the conservation level.

**Incentives for Public Toilet/Shower Replacement.** This program offers cash rebates to encourage replacement of existing toilets and urinal valves in the public sector that use more than 1.6 (toilets) and 1.0 (urinals) gallons per flush. Low-flow showerheads could be replaced for all public customers having significant numbers of showerheads (like schools). A ULF toilet is estimated to save 12.3 gpd per employee per toilet replacement. Each urinal replacement saves 0.4 gpd per employee. No savings are assumed for showerhead replacement, although showerheads can be significant water users in certain situations.

**Fountain/Pool Audit and Repair.** This measure would require that the City conduct on-site audits of City-owned reflection pools, decorative fountains, and swimming pools. The audit would include evaluating cleaning and upkeep practices for fountains and pools, checking for use of a recirculation pump, inspecting operating condition of valves, and checking for any leaks. The auditor would provide the results of the audit and recommendations for water conservation. The City would then purchase and install the necessary equipment required to make the repairs. The audit would be repeated every five years.

**Standards for New Fountains/Pools.** This standard would adopt a City policy requiring low flow devices be installed on all newly constructed City-owned and operated decorative fountains and swimming pools. These devices include low flow showerheads, toilets, urinals, and aeration faucets at swimming pools; dead man switches for hoses and secured float valves at swimming pools; and recirculation pumps and valves at fountains.

**City of Houston In-House Program.** Departments targeted (e.g., General Fund Departments) would be billed "in-house" (i.e., no actual transfer of funds would take place). Each department would be given a goal to reduce water usage by 10 to 20 percent. For example, the Parks Department would assume responsibility for the water cost associated with irrigating public golf courses, and the Civic Center Department would assume responsibility for the water cost associated with operating Tranquillity Fountain. This policy would encourage each department to use water efficiently and provide a goal of a 20 percent reduction.

## Supply Side Programs

**System Water Audits, Leak Detection and Repair.** This supply-side conservation measure requires an audit of the water distribution system be conducted every four years to reduce UAW. Leak detection and repair would be performed if cost-effective. Preliminary estimates for the study area indicate a UAW of 12 to 24 percent of water production. The goal is to reduce UAW to no more than 10 percent of total use. Leak detection and repairs would be completed by existing City work crews.

**Conservation Pricing.** This conservation pricing measure for water (and wastewater) encourages water users to implement conservation measures on their own or to increase their participation in the other conservation measures that the City is sponsoring. Some communities have adopted inclining block rates or seasonal rates to encourage lower summer (irrigation) use, rapid repair of leaks, and general awareness of water use. Under this measure the City would change its current rate structure to include a greater proportion of the revenue generated from the volume based rates and less from the minimum monthly charges. The number of rate blocks and the size of the rate differences between blocks would be determined through a rate study. The study would analyze the pattern of water use by block, the desired effect on consumption, and the impacts on total revenues. Wastewater rates would be analyzed at the same time since both charges are currently based on water volume used and appear on the same bill. The water rate structure could have different rates applied in the summer months (typically higher) than in the winter months. The new rate structure should be designed to produce the same amount of revenue as is collected today,

but at the lower volumes of use expected (as customers cut back their use in response to the price signals from the new rates).

## General Programs

**Public Information and School Education.** The City has conducted an aggressive public information and school education program since 1992. The City's full-time water quality inspector devotes most of his time to public education, with an emphasis on promoting the use of low flow water fixtures. The City has also hired a full-time community involvement coordinator to implement the school program throughout its service area. The City currently conducts ongoing water conservation educational programs and presentations to school children, adults, and City employees.

Listed below are some of the programs the City has already implemented as part of its public information and education program.

- Conservation conferences
- Advertisement in newspapers
- Major Rivers Education Program
- Water Wise and Energy Efficient program
- Water and energy savings kit distribution
- Design a T-shirt contest
- A water conservation play
- Brochures
- Home water audit kits
- Water treatment plant tours
- Employee training
- Presentations to civic associations, environmental clubs, etc.
- Demonstration gardens

Additionally, a quarterly newsletter will be distributed to organizations such as homeowner associations, City officials, builders, and so forth that will help increase awareness of water conservation. Commercial and industrial customers would be educated on the benefits of water conservation during their facility audits and through water bill inserts.

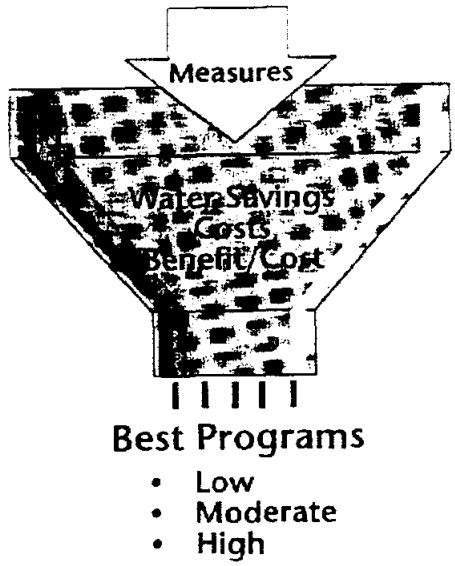
At the request of the City, the Water Wise and Energy Efficient Program was evaluated separately at the current funding level of $100,000 per year. This program is administered by the Harris-Galveston Coastal Subsidence District. The program includes water conservation kits distributed to fourth and fifth grade school children. The kits include low flow showerheads, dye tablets, pamphlets, etc.

# Section 6
# EVALUATION OF WATER CONSERVATION PROGRAMS

## INTRODUCTION

Section 5 presented a description of alternative water conservation programs selected for analysis. In this section, the water savings are estimated and costs for the programs developed. This section also describes how economic benefits are estimated. Benefits and costs are compared in a formal present-worth analysis and conclusions are drawn about which programs produce cost-effective water savings. This process can be thought of as an economic screening process, shown in Figure 6-1, that can be used to help decide which, if any, programs could be recommended.

**Figure 6-1**
**Evaluation Process**




The text that follows assumes the reader is somewhat familiar with benefit-cost analysis as it is used for conservation programs so that the results of the evaluation can be emphasized and the description of the methodology can be brief. Additional background can be obtained from Maddaus et al.'s article "Integrating Conservation into Water Supply Planning" in *Journal AWWA* (November, 1996) and the AWWA publication "Evaluating Urban Water Conservation Programs: A Procedures Manual" (1993).

## OVERVIEW OF THE BENEFIT-COST METHODOLOGY

Benefit-cost analysis has been used by many water agencies to evaluate and help select a water conservation program best suited to local conditions. This analysis requires a locale-specific data base on water use, demographics, and land use.

The methodology, shown graphically in Figure 6-2, can be implemented by the following steps:

1. Develop baseline, detailed water use projections without conservation. Projections should cover each key customer category and be broken down into indoor and outdoor use. These were presented in Section 3.

2. Identify possible water conservation measures and screen the measures qualitatively to identify those which are applicable to the service area. Develop appropriate unit water savings and cost factors for each program (see Sections 4 and 5).

3. Estimate the affected population (or number of accounts) for each conservation program by multiplying the total service area population (accounts) by the program's projected population (or accounts) that implement the program. This factor is called the market penetration or installation rate.

4. Estimate total annual average and peak day water savings. The water savings are computed by multiplying unit water savings, per program, by a market penetration or installation rate, and then multiplying by the number of units in a particular service area (such as dwelling units) targeted by a particular program.

5. Identify types of benefits to the water agency and calculate the unit value of capital project deferrals and reduced operation and maintenance costs. The results are then expressed in unit value form, i.e., dollars per 1000 gallons saved.

6. Quantify total benefits for each year in the planning period by multiplying average water savings by the unit benefit.

7. Determine initial and annual costs to implement the programs based upon pilot projects, local experience, and the costs of goods, services, and labor in Houston. This is multiplied by the number of units participating each year and then added to overall administration and promotion costs to arrive at a total program cost, which may be spread over a number of years.

8. Compare benefits and costs by computing the present worth of costs and benefits over the planning period.

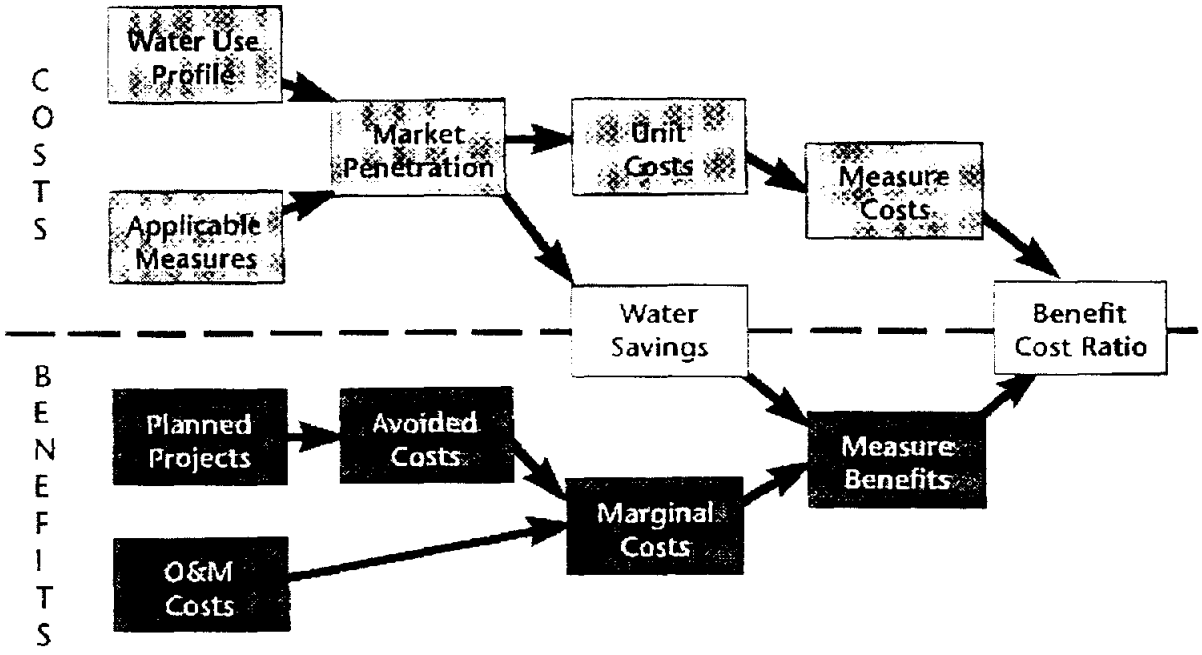
9. Evaluate non-quantifiable environmental, social-political, and consumer relations factors.

10. Select a recommended conservation plan containing cost-effective programs (i.e., benefit-cost ratios greater than one and acceptable non-quantifiable impacts).

11. Evaluate the interaction of the recommended plan programs and develop water savings interaction factors.

12. Develop an implementation schedule for the plan and recompute the water savings over time with all programs interacting together and the benefit-cost ratio for the recommended plan.

Figure 6-2
Benefit-Cost Analysis Methodology




## WATER SAVINGS

Estimated water savings are useful to help utility planners forecast how future demands may be impacted by water conservation. Savings usually develop slowly, reaching full maturity after full market penetration has been achieved. Normally this occurs five to ten years after the start of implementation.

### Methodology and Sources of Data

Data necessary to forecast water savings include locale-specific data on baseline water use, demographics, market penetration expectations, and unit water savings. These are described as follows:

**Base Water Use.** Base water use (without conservation) projections were developed through the year 2050 in Section 3. Base retail water use was projected to increase from 225 mgd in 1994 to 405 mgd in 2050.

**Demographics.** Demographic data were presented in Section 3. Service area population, total dwelling units, and single-family and multifamily dwelling units were used to evaluate programs

targeting residential categories. Projections of nonresidential accounts were used for commercial and industrial and public category water savings analysis.

**Market Penetration.** The market penetration for existing customers is the estimated percentage of customers that will be participating in the program by the end of the program. Estimates are based on program design, the customer survey, and experience from similar programs implemented by other water agencies (see Figure 6-3). Programs are described in detail in Appendix C. Market penetrations adopted for use in this project are shown in Table 6-1.

**Table 6-1**
**Market Penetration of Conservation Programs**

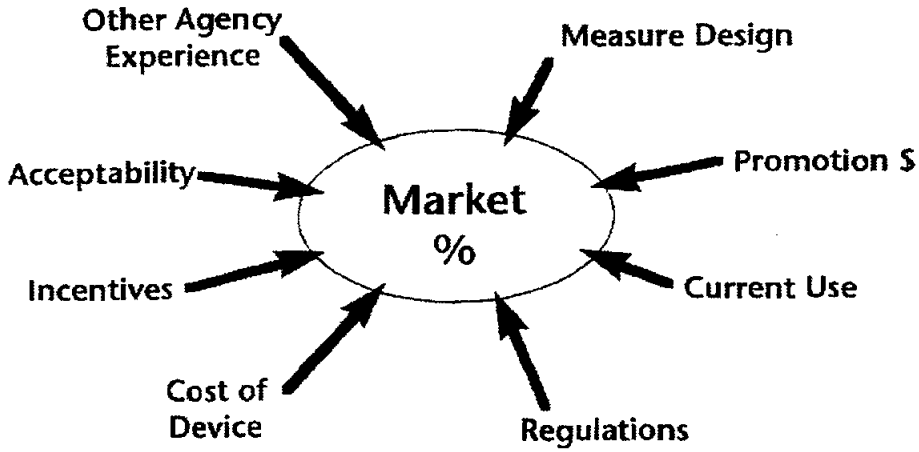
| Program | Applicable Market | Target Market | Market Penetration | Total Installation |
|---|---|---|---|---|
| Residential Water Audits | SFR/MFR | Top 25% | 20% | 5% |
| Res. Plumbing Retrofit Kits | SFR/MFR | 100% | 20% | 75% |
| ULF Toilet Replacement | SFR/MFR | | | 25% |
| Appliance Labeling | SFR/MFR | | | 5-10% |
| Water Efficient Landscape Irrigation Incentives | SFR/MFR | Existing New | | 1-5%<br>5-67% |
| Commercial/Industrial Indoor Water Audits | C/I | Top 10% | 35% | 3.5% |
| Eff. Process Equip. Rebates | C/I | Top 10% | 28% | 2.8% |
| Incentives for C/I Toilet and Shower Replacement | C/I | 100% | 15% | 15% |
| Cooling Tower Water Audits | C/I | 100% | 100% | 100% |
| Low Water Use Landscape Ordinance | C/I/MFR | 100% | 25% | 75% |
| Commercial/Industrial Irrigation Audits | C/I | 25% | 70% | 18% |
| C/I Fountain/Pool Audits | C/I | 30% | 30% | 30% |
| Public Facility Water Audits | PF | 25% | 70% | 12.5% |
| Public Building Toilet and Shower Replacement | PF | 100% | 15% | 15% |
| Public Fountain/Pool Audit and Repair | PF | 100% | 80% | 80% |
| Standards for New Fountains/Pools | PF | 100% | 90% | 90% |
| City In-House Program | PF | 100% | 100% | 100% |
| System Water Audits, Leak Detection and Repair | System | 100% | 100% | 100% |
| Conservation Pricing | System | 100% | 100% | 100% |
| Public Education | System | 100% | 100% | 100% |
| Water Wise and Energy Efficient | SFR/MFR | 100%[a] | 100%[a] | 100%[a] |

[a] of targeted fourth and fifth grade schools.

**Customer Classes:**

| | |
|---|---|
| SFR: | Single Family Residential |
| MFR: | Multifamily Residential |
| C/I: | Commercial/Industrial |
| PF: | Public Facilities |
| System: | All Classes, including Utility |

**Figure 6-3**
**Assess Market Penetration**




The concept of market penetration can be explained by way of an example. If approximately 700,000 residential dwellings exist when the Residential Water Audit program begins in 1996 and the ultimate penetration rate of 5 percent will be reached after five years in the year 2001, then 35,000 customers would have participated by the year 2001. Each year 7,000 new dwellings would be audited until all 35,000 had been audited. Certain programs, such as audits, require that audits be done every year in order to maintain savings because the effects of the audits have a limited life. For example, if water savings from the audits are assumed to last five years (the life of the program), then additional audits (in this case 7,000) must be done every year to ensure the water savings are permanent.

Errors in market penetration estimates for each program can be significant because they are based on previous experience, chosen implementation methods, and projected effort and funds allocated to the program. The potential error can be corrected, however, as the implementation of the program progresses. For example, if the market penetration required to achieve the needed savings turns out to be more or less than predicted, adjustments to the implementation efforts can be made. Larger rebates or more promotions may be used to increase the market penetration, for example. The process is iterative to reflect actual conditions and helps to ensure the market penetration and needed savings are achieved regardless of future variances between estimates and actual conditions.

**Unit Water Savings.** Unit water savings, presented in Table 6-2, are expressed either on percent reduction in water use per account or on a per-capita or per-employee reduction basis. Long-term savings reflect some decline from initial levels due to device removal and reversions to old habits. Long-term savings are those that are sustainable.

**Table 6-2**
**Unit Water Savings Of Conservation Programs**

| Program | Applicable Customer Classes | Percent or Per Capita Reduction | Applies To |
|---|---|---|---|
| Residential Water Audits | SFR/MFR | 6% | Average Residential Use |
| Res. Plumbing Retrofit Kits | SFR/MFR | 9.2 | Gallons per person per day (gpcd) |
| ULF Toilet Replacement | SFR/MFR | 14.7% / 10.8% | Indoor Use |
| Appliance Labeling | SFR/MFR | 6.2 | gpcd |
| Water Efficient Landscape Irrigation Incentives | SFR/MFR | 19% | Outdoor Use |
| Commercial/Industrial Indoor Water Audits | C/I | 13.5% | Indoor Use |
| Eff. Process Equip. Rebates | C/I | 13.5% | Indoor Use |
| Incentives for C/I Toilet and Shower Replacement | C/I | 12.7 | Gallons per employee per day (gped) |
| Cooling Tower Water Audits | C/I | 1,000 | Gallons per day per site |
| Low Water Use Landscape Ordinance | C/I | 20% | Outdoor Use |
| Commercial/Industrial Irrigation Audits | C/I | 14% | Outdoor Use |
| C/I Fountain/Pool Audits | C/I | 150/250 | gpd per fountain/pool |
| Public Facility Water Audits | PF | 10% / 15% | Indoor/Outdoor Use |
| Public Building Toilet and Shower Replacement | PF | 12.7 | gped |
| Public Fountain/Pool Audit and Repair | PF | 20%/15% | COH/Other Public Agency |
| Standards for New Fountains/Pools | PF | 25% | per site |
| City In-House Program | PF | 5% | Average City Department(s) Use |
| System Water Audits, Leak Detection and Repair | System | 4% | System Wide Use |
| Conservation Pricing | System | N/D | N/D |
| Public Education | System | 1.5% | System Wide Use |
| Water Wise and Energy Efficient | SFR/MFR | 23 | Gallons per household per day |

**Notes:**
gpcd = gallons per capita per day
gped = gallons per employee per day
N/D = not determined

## Estimated Water Savings

The projected total water savings associated with the affected market are shown in Table 6-3. Savings are based on the programs described in Appendix C. The snapshot of annual savings is given for four specified years: 2000, 2010, 2020, and 2050. The total savings are cumulative, assuming the programs begin in 1996 and escalate linearly to full implementation, according to the program schedule given in Appendix C.

**Table 6-3**
**Projected Water Savings, 1000 gal/day**

| Program | 2000 | 2010 | 2020 | 2050 |
|---|---|---|---|---|
| Residential Water Audits | 918 | 918 | 918 | 918 |
| Res. Plumbing Retrofit Kits | 8,211 | 9,853 | 9,853 | 9,853 |
| ULF Toilet Replacement | 3,971 | 7,943 | 7,943 | 7,943 |
| Appliance Labeling | 62 | 589 | 930 | 930 |
| Water Efficient Landscape Irrigation Incentives | 597 | 1,759 | 2,043 | 3,361 |
| Commercial/Industrial Indoor Water Audits | 1,217 | 1,217 | 1,217 | 1,217 |
| Eff. Process Equip. Rebates | 243 | 731 | 731 | 731 |
| Incentives for C/I Toilet and Shower Replacement | 2,784 | 2,784 | 2,784 | 2,784 |
| Cooling Tower Water Audits | 500 | 500 | 500 | 500 |
| Low Water Use Landscape Ordinance | 1,020 | 3,570 | 6,121 | 11,476 |
| Commercial/Industrial Irrigation Audits | 56 | 56 | 56 | 56 |
| C/I Fountain/Pool Audits | 178 | 178 | 178 | 178 |
| Public Facility Water Audits | 1,274 | 1,274 | 1,274 | 1,274 |
| Public Building Toilet and Shower Replacement | 449 | 449 | 449 | 449 |
| Public Fountain/Pool Audit and Repair | 373 | 373 | 373 | 373 |
| Standards for New Fountains/Pools | 50 | 150 | 250 | 500 |
| City In-House Program | 202 | 202 | 202 | 202 |
| System Water Audits, Leak Detection and Repair | 6,400 | 12,800 | 12,800 | 12,800 |
| Conservation Pricing | N/D | N/D | N/D | N/D |
| Public Education | 2,856 | 4,005 | 4,665 | 5,820 |
| Water Wise and Energy Efficient | 327 | 491 | 0 a | 0 a |

[a] Program assumed to have a ten-year life so water savings end by 2020.

## COSTS OF PROGRAMS

The costs associated with implementing conservation programs depend upon each program's design. Cost categories include labor by City staff or outside contractors to administer and perform any required field work, expenses, incentives, and one-time setup costs. A mandatory program, such as a new law or regulation, would involve lower costs to the City but higher direct costs to the customer for implementation. Since all water conservation costs are invariably paid for by the customer (either directly or indirectly through rate increases), it is best to minimize total costs while maximizing total benefits.

Nearly all the programs, such as Residential Water Audits and ULF Toilet Replacement, could be implemented through use of shared City staff that could perform work on more than one program at a time and thereby increase efficiency.

### Methodology

Costs were determined for each of the programs based on industry knowledge and past experience. Costs may include incentive costs, usually determined on a per-participant basis; fixed costs, such as marketing; variable costs, such as the costs to staff the programs and to obtain and maintain equipment; and a one-time setup cost. The setup cost is for program design by staff or consultants, any required pilot program, and preparation of materials that will be used in marketing the program. The costs were estimated for each year between 1995 and 2050 for each program. Costs were spread over the time period depending on the length of the implementation period for the program. Some of the costs occur uniformly over the planning period; others occur only in the first five years, after which implementation is finished and only the costs to maintain the program are incurred. Costs for each program are described in Appendix C.

### Plumbing Code Savings

The 1992 U.S. Energy Policy Act will be effective in reducing indoor water use in new construction and natural replacement of fixtures. All customer classes will be affected since the law (essentially a new plumbing code) mandates that only 6-liter toilets and 2.5 gpm showerheads and faucets can be sold in the U.S. Table 6-4 shows the basis of water savings and the total estimated water saved due to new construction and natural replacement (over the period shown). Water savings in 2006 will be 12 mgd in the residential section and 20.6 mgd overall. Since this law is already implemented, the plumbing code savings are assured. Savings from the plumbing code are not further addressed in this plan.

**Table 6-4**
**Water Savings from Plumbing Code**

| Sector | Element | Unit Water Savings | Units | Time to Reach Full Replacement (Years) | Water Savings | |
|---|---|---|---|---|---|---|
| | | | | | @ 2006 mgd | 50 Yr Avg. mgd |
| Residential | | | | | | |
| | Toilets | 14.00% | Indoor Use | 50 | 5.3 | 13.5 |
| | Showers | 7.2 | gcd | 25 | 6.7 | 12.8 |
| | Subtotal | | | | 12.0 | 26.3 |
| Non-Residential | | | | | | |
| Commercial/ Industrial | Toilets | 12.7 | ged | 25 | 7.4 | 13.3 |
| Public | Toilets | 12.7 | ged | 25 | 1.2 | 2.1 |
| | Subtotal | | | | 8.6 | 15.4 |
| TOTAL | | | | | 20.6 | 41.7 |

gcd = gallons per capita per day
ged = gallons per employee per day

Reduced revenue due to reduced water sales is not included as a cost because the conservation programs evaluated herein generally take effect over a span of time that is sufficient to enable timely rate adjustments, if necessary, to meet fixed cost obligations.

The costs were based on the assumed monthly labor costs shown in Table 6-5. These costs include overhead which, for a public agency like the City, was assumed to be 35 percent and is added to the salary costs to get total labor costs.

**Table 6-5**
**Assumed Monthly Salary Costs for Conservation Staff**

| Labor Category | Annual Labor, Dollars |
|---|---|
| Program Administrator | 55,000 |
| Project Manager | 50,000 |
| Landscape Architect (contract) | 60,000 |
| Leak Detection/Repair Staff | 40,000 |
| Interior Water Auditor | 40,000 |
| Irrigation System Water Auditor | 45,000 |

## Total Program Costs

The total costs over the first five years for each program are shown in Table 6-6. Because each program has a different spending stream associated with it, the table also shows the average annual cost over the first ten years of the program. Table 6-6 also summarizes the water savings

achievable from each of the programs. A present worth was computed for the annual values and used in the benefit-cost analysis, as discussed below.

**Table 6-6**
**Comparison of Conservation Elements**

| Sector | Program | Element | Average Water Savings mgd | Water Savings in 2006 mgd | First 10 Year Avg Cost, $1000 | First Five Years Total Cost, $1000 |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| | Res Water Audits | SFR | 0.42 | 0.42 | 214 | 1,071 |
| | | MFR | 0.46 | 0.47 | 172 | 862 |
| | Res Plumbing Retrofit | | 9.36 | 9.85 | 1,533 | 12,775 |
| | Res Toilet Replacement: | Rebates | 6.48 | 7.94 | 2,868 | 14,462 |
| | | CBO | 6.48 | 7.94 | 3,115 | 15,697 |
| | | Giveaway | 12.65 | 13.90 | 280 | 2,800 |
| | | Vouchers | 10.84 | 11.91 | 4,301 | 21,691 |
| | | Direct Install | 18.07 | 19.86 | 8,096 | 40,788 |
| | Appliance Labeling | | 0.71 | 0.28 | 16 | 85 |
| | Landscape Incentives | SFR | 0.61 | 0.40 | 1,103 | 5,519 |
| | | MFR | 1.63 | 0.93 | 2,476 | 12,534 |
| Commercial | | | | | | |
| | Indoor Audits | | 1.17 | 1 | 264 | 1,320 |
| | Process Rebates | | 0.50 | 0.49 | 400 | 2,000 |
| | Toilet/Urinal Rebates | Toilet | 2.21 | 2.70 | 731 | 7,310 |
| | | Urinal | 0.07 | 0.09 | 100 | 995 |
| | Cooling Tower Audits | | 0.48 | 0.50 | 35 | 350 |
| | Landscape Ordinance | | 6.20 | 2.30 | 140 | 700 |
| | Pool Audits | | 0.05 | 0.05 | 19 | 151 |
| | Fountain Audits | | 0.12 | 0.13 | 40 | 234 |
| | Irrigation Audits | | 0.05 | 0.06 | 25 | 150 |

**Table 6-6 *(continued)***
**Comparison of Conservation Elements**

| Sector | Program | Element | Average Water Savings mgd | Water Savings in 2006 mgd | First 10 Year Avg Cost, $1000 | First Five Years Total Cost, $1000 |
|---|---|---|---|---|---|---|
| Public | | | | | | |
| | Indoor Audits | | 0.36 | 0.37 | 61 | 313 |
| | Exterior Audits | | 0.86 | 0.90 | 47 | 293 |
| | Toilet/Urinal Rebates | Toilets | 0.36 | 0.44 | 89 | 885 |
| | | Urinal | 0.01 | 0.01 | 12 | 120 |
| | Pool/Fountain Audits | COH | 0.28 | 0.28 | 59 | 588 |
| | | Other | 0.09 | 0.09 | 138 | 1,383 |
| | Pool/Fountain Standards | | 0.26 | 0.10 | 26 | 155 |
| | COH In-House Program | | 0.20 | 0.20 | 5 | 50 |
| Other | | | | | | |
| | Unaccounted For Water | | 11.65 | 12.80 | 880 | 4,400 |
| | Public Education | | 5.77 | 4.32 | 806 | 3,895 |
| | Waterwise & Energy Efficient | | 0.43 | 0.82 | 100 | 500 |

## BENEFITS

It has been assumed that water conservation will defer all raw water, water treatment, and major treated water pumping programs. Because it is expected that the City will complete the distribution network as quickly as possible to provide surface water to all consumers, it is not anticipated that water conservation will defer expenditure on the distribution system. The lower consumption gained by water conservation will allow those additional consumers to be served without the development of additional raw water, treatment, and pumping facilities. The additional cost of raw water supply development was not available and has been ignored in the analysis. This means that benefits of water conservation are conservative and could be larger.

Regarding raw water supply, the City has ample water rights from existing water sources to supply treated water and the current level of wholesale water throughout its service area. The Texas Water Development Board has projected considerable growth in the Houston metropolitan region, mostly outside the city limits. The City is the logical water provider for this area since there is little new surface or ground water available. One source of water is the Trans Texas project which could supply the Houston region with additional imported surface water. If water conservation programs similar to those being evaluated herein were applied to the entire region, there may be significant benefits. These benefits could involve deferral of the Trans Texas link to Houston for some years, as well as water treatment benefits. In other words the value of water

savings to the region as a whole is probably larger than just to the City, since the City has adequate water to sustain its growth but the region does not. Evaluation of these benefits is beyond the scope of this project, however, the water savings and costs from the programs being evaluated herein could be extrapolated to a larger area and the total benefits recalculated. In all likelihood, the benefits-to-cost ratios in this study are lower than would apply to the entire region.

The benefits from conservation include both current savings in operations and maintenance (O&M) costs and savings from the deferral and/or cancellation of capital projects that would otherwise have been necessary in the absence of conservation. Since new capital projects will require O&M, there are additional benefits from the capital deferrals.

## Operations and Maintenance Savings

Short term savings from operating existing facilities can be realized as a result of conservation. While many costs associated with operation and maintenance of a water system are fixed and will not vary with the level of consumption or production, other costs remain that are directly related to the level of production. For example, energy costs and chemical costs are frequently directly related to production levels.

O&M savings from conservation were not directly calculated for this project. However, a recent study conducted by Montgomery Watson for the American Water Works Association Research Foundation (AWWARF) included an analysis of marginal costs for several water utilities around the US, including Houston. The results from that study indicated that the marginal cost for the City of Houston is $0.268 per 1000 gallons. (Bishop and Weber, "Impacts of Demand Reduction on Water Utilities", AWWARF, 1996).

## Capital Savings

Since the City of Houston is currently in the process of defining its future capital requirements to reduce its groundwater usage and meet future production requirements through surface water supplies, capital savings have been estimated by comparing existing treatment plant capacity with the capacity that would be required over the period of this plan (through 2050). Based on water demand projections developed in Section 3, adjusted for expected demand reductions from long-term implementation of plumbing code requirements for water conserving toilets, urinals, faucets, and showerheads, the need for additional capacity was estimated, assuming that treatment capacity would be added in 50 mgd increments. Capital costs were estimated based on $1.5 million per mgd of capacity.

Table 6-7 shows estimated costs of plants planned to meet future demands.

**Table 6-7**
**Additional Treatment Plant Capacity Required**
**Base Consumption (Without Conservation Program)**

| | Capacity Added | Estimated Cost | Year Needed |
|---|---|---|---|
| Phase 1 | 50 mgd | $75 million | 2007 |
| Phase 2 | 50 mgd | $75 million | 2010 |
| Phase 3 | 50 mgd | $75 million | 2020 |
| Phase 4 | 50 mgd | $75 million | 2034 |
| Phase 5 | 50 mgd | $75 million | 2044 |

Table 6-8 shows the treatment plant capacity projections that were used to develop Table 6-7. Figure 6-4 graphically shows the expected expansion plan.

**Table 6-8**
**Projected Peak Demand And Treatment Plant Capacity Through 2050**
**Base Consumption Less Plumbing Code Reductions**
**Without Additional Conservation**

| Year | Peak Demand | Less Plumbing Code Savings | Net Demand | Wells | Plant Required | Current Capacity | Incremental Capacity | Capacity Shortage (Excess) |
|---|---|---|---|---|---|---|---|---|
| 1997 | 438.82 | 2.06 | 436.75 | 200.00 | 236.75 | 355.00 | | (118.25) |
| 1998 | 443.75 | 4.13 | 439.63 | 200.00 | 239.63 | 355.00 | | (115.37) |
| 1999 | 448.69 | 6.19 | 442.50 | 200.00 | 242.50 | 355.00 | | (112.50) |
| 2000 | 453.63 | 8.25 | 445.38 | 200.00 | 245.38 | 355.00 | | (109.62) |
| 2001 | 459.66 | 10.31 | 449.35 | 187.90 | 261.45 | 355.00 | | (93.55) |
| 2002 | 465.69 | 12.38 | 453.31 | 175.80 | 277.51 | 355.00 | | (77.49) |
| 2003 | 471.72 | 14.44 | 457.28 | 163.70 | 293.58 | 355.00 | | (61.42) |
| 2004 | 477.75 | 16.50 | 461.25 | 151.60 | 309.65 | 355.00 | | (45.35) |
| 2005 | 483.78 | 18.57 | 465.21 | 139.50 | 325.71 | 355.00 | | (29.29) |
| 2006 | 489.81 | 20.63 | 469.18 | 127.40 | 341.78 | 355.00 | | (13.22) |
| 2007 | 495.84 | 22.91 | 472.93 | 115.30 | 357.63 | 405.00 | 50.00 | (47.37) |
| 2008 | 501.87 | 24.76 | 477.12 | 103.20 | 373.92 | 405.00 | | (31.09) |
| 2009 | 507.90 | 26.82 | 481.08 | 91.10 | 389.98 | 405.00 | | (15.02) |
| 2010 | 513.93 | 28.88 | 485.05 | 79.00 | 406.05 | 455.00 | 50.00 | (48.95) |
| 2011 | 521.81 | 30.94 | 490.87 | 80.00 | 410.87 | 455.00 | | (44.13) |
| 2012 | 529.69 | 33.01 | 496.69 | 81.00 | 415.69 | 455.00 | | (39.31) |
| 2013 | 537.58 | 35.07 | 502.51 | 82.00 | 420.51 | 455.00 | | (34.49) |
| 2014 | 545.46 | 37.13 | 508.33 | 83.00 | 425.33 | 455.00 | | (29.67) |

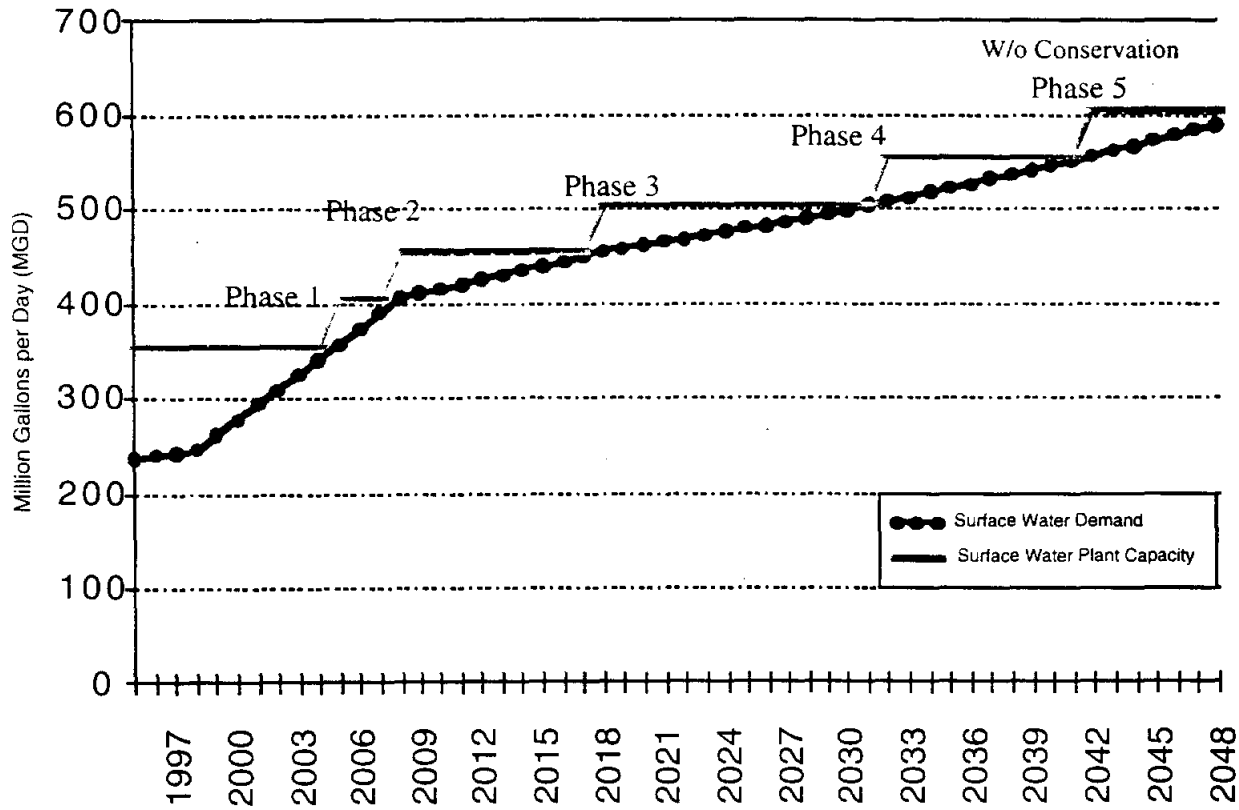
**Table 6-8 *(continued)***
**Projected Peak Demand And Treatment Plant Capacity Through 2050**
**Base Consumption Less Plumbing Code Reductions**
**Without Additional Conservation**

| Year | Peak Demand | Less Plumbing Code Savings | Net Demand | Wells | Plant Required | Current Capacity | Incremental Capacity | Capacity Shortage (Excess) |
|---|---|---|---|---|---|---|---|---|
| 2015 | 553.34 | 39.20 | 514.15 | 84.00 | 430.15 | 455.00 | | (24.85) |
| 2016 | 561.22 | 41.26 | 519.96 | 85.00 | 434.96 | 455.00 | | (20.04) |
| 2017 | 569.10 | 43.32 | 525.78 | 86.00 | 439.78 | 455.00 | | (15.22) |
| 2018 | 576.99 | 45.38 | 531.60 | 87.00 | 444.60 | 455.00 | | (10.40) |
| 2019 | 584.87 | 47.33 | 537.54 | 88.00 | 449.54 | 455.00 | | (5.46) |
| 2020 | 592.75 | 48.53 | 544.22 | 89.00 | 455.22 | 505.00 | 50.00 | (49.78) |
| 2021 | 597.41 | 49.73 | 547.69 | 89.60 | 458.09 | 505.00 | | (46.92) |
| 2022 | 602.07 | 50.26 | 551.82 | 90.20 | 461.62 | 505.00 | | (43.38) |
| 2023 | 606.74 | 50.79 | 555.95 | 90.80 | 465.15 | 505.00 | | (39.85) |
| 2024 | 611.40 | 51.32 | 560.08 | 91.40 | 468.68 | 505.00 | | (36.32) |
| 2025 | 616.06 | 51.85 | 564.22 | 92.00 | 472.22 | 505.00 | | (32.78) |
| 2026 | 620.72 | 52.38 | 568.35 | 92.60 | 475.75 | 505.00 | | (29.25) |
| 2027 | 625.38 | 52.90 | 572.48 | 93.20 | 479.28 | 505.00 | | (25.72) |
| 2028 | 630.05 | 53.43 | 576.61 | 93.80 | 482.81 | 505.00 | | (22.19) |
| 2029 | 634.71 | 53.96 | 580.75 | 94.40 | 486.35 | 505.00 | | (18.65) |
| 2030 | 639.37 | 54.49 | 584.88 | 95.00 | 489.88 | 505.00 | | (15.12) |
| 2031 | 645.23 | 55.02 | 590.21 | 95.70 | 494.51 | 505.00 | | (10.49) |
| 2032 | 651.09 | 55.55 | 595.54 | 96.40 | 499.14 | 505.00 | | (5.86) |
| 2033 | 656.96 | 56.08 | 600.88 | 97.10 | 503.78 | 505.00 | | (1.23) |
| 2034 | 662.82 | 56.61 | 606.21 | 97.80 | 508.41 | 555.00 | 50.00 | (46.59) |
| 2035 | 668.68 | 57.14 | 611.54 | 98.50 | 513.04 | 555.00 | | (41.96) |
| 2036 | 674.54 | 57.67 | 616.87 | 99.20 | 517.67 | 555.00 | | (37.33) |
| 2037 | 680.40 | 58.20 | 622.21 | 99.90 | 522.31 | 555.00 | | (32.70) |
| 2038 | 686.27 | 58.73 | 627.54 | 100.60 | 526.94 | 555.00 | | (28.06) |
| 2039 | 692.13 | 59.26 | 632.87 | 101.30 | 531.57 | 555.00 | | (23.43) |
| 2040 | 697.99 | 59.79 | 638.20 | 102.00 | 536.20 | 555.00 | | (18.80) |
| 2041 | 704.48 | 60.32 | 644.17 | 102.80 | 541.37 | 555.00 | | (13.63) |
| 2042 | 710.98 | 60.85 | 650.13 | 103.60 | 546.53 | 555.00 | | (8.47) |
| 2043 | 717.47 | 61.38 | 656.09 | 104.40 | 551.69 | 555.00 | | (3.31) |
| 2044 | 723.96 | 61.91 | 662.06 | 105.20 | 556.86 | 605.00 | 50.00 | (48.14) |

Table 6-8 *(continued)*
Projected Peak Demand And Treatment Plant Capacity Through 2050
Base Consumption Less Plumbing Code Reductions
Without Additional Conservation

| Year | Peak Demand | Less Plumbing Code Savings | Net Demand | Wells | Plant Required | Current Capacity | Incremental Capacity | Capacity Shortage (Excess) |
|---|---|---|---|---|---|---|---|---|
| 2045 | 730.46 | 62.44 | 668.02 | 106.00 | 562.02 | 605.00 | | (42.98) |
| 2046 | 736.95 | 62.97 | 673.98 | 106.80 | 567.18 | 605.00 | | (37.82) |
| 2047 | 743.44 | 62.97 | 680.48 | 107.60 | 572.88 | 605.00 | | (32.12) |
| 2048 | 749.93 | 62.97 | 686.97 | 108.40 | 578.57 | 605.00 | | (26.43) |
| 2049 | 756.43 | 62.97 | 693.46 | 109.20 | 584.26 | 605.00 | | (20.74) |
| 2050 | 762.92 | 62.97 | 699.96 | 110.00 | 589.96 | 605.00 | | (15.05) |
| | | | | | | | | |
| | | | | | | | 250.00 | |

Figure 6-4
Treatment Plant Capacity Increments without Conservation
(Includes Plumbing Code Reductions)



Major pumping costs planned over the next 50 years are included in the above figures. Marginal costs for capital were initially estimated based upon the impact of a one-year delay in each of capital increments. Based on the net present value of the difference in the two spending streams, the marginal cost for capital was estimated to be $1.40 per thousand gallons.

The initial estimate for marginal costs will be refined in Section 7 to account for actual water savings projected for the recommended conservation plan. The costs presented here provide the basis for making the first-cut evaluation of the possible elements of the overall conservation plan.

### Wastewater Treatment

As Houston progresses toward full treatment of domestic as well as commercial and industrial wastewater, there will be benefits realized through a reduction in water consumption and the resulting generation of wastewater volume. This is particularly significant in Houston, because a relatively high proportion of water is used indoors and converted to wastewater.

The City has completed a large wastewater treatment expansion project. Present capacity is sufficient for the foreseeable future. Operating costs of these new and expanded plants can be reduced if water conservation leads to processing less wastewater flow. It is estimated that conservation at a 10 percent level would delay the need for expansion of wastewater treatment capacity during the planning period. The value of this reduced cost is estimated to be $0.05 per 1000 gallons saved, based on net present values.

### Equivalent Marginal Cost

The marginal cost used for evaluating benefits from the conservation plan consists of the O&M savings and the capital deferral savings. The initial estimate of the capital deferral benefits at $1.40 per thousand gallons represents the bulk of the savings to be expected.

### Non-Quantifiable Benefits

Not all aspects of a water conservation program can be quantified as either a benefit or cost in monetary terms. A water conservation program may have non-quantifiable effects on the following:

- Environment
- Social/political/legal institutions
- Customer equity and acceptability

An approach to evaluating these other effects is to tabulate the environmental and social impacts associated with each program. This analysis allows the consideration of negative social and environmental impacts of mandatory programs. Some negative ratings may be significant enough to stop an economically attractive program from being implemented, because of customer resistance or negative environmental impacts. Non-quantifiable benefits for some programs are shown in Table 6-9.

**Table 6-9**
**Community Impacts Of Typical Conservation Programs**

| Impact | Residential Audits | ULF Replacement | Commercial Water Audit | Low Water Use Landscape Ordinance | Public Education |
|---|---|---|---|---|---|
| **Environmental** | | | | | |
| New source development postponed or reduced | + | + | + | + | + |
| Reduced customer energy consumption | + | + | + | | |
| Reduced City energy consumption | + | + | + | + | |
| Increased life of existing facilities | + | + | + | + | + |
| Increased streamflows | + | + | + | + | + |
| **Social/Political** | | | | | |
| Create new jobs locally | + | + | + | + | + |
| Health & safety | | | | | + |
| Significant customer expense if mandatory | | - | | - | |

+ = positive impact
- = negative benefit

## BENEFIT-COST ANALYSIS

Determination of the economic feasibility of water conservation programs depends on comparing the costs of the programs to the benefits provided. The two previous sections developed the costs and potential benefits associated with the conservation programs. This section brings the two pieces together to determine the economic viability of the programs.

### Methodology

Analysis of the water savings, benefits from the various elements, and the costs to achieve those benefits was performed through the software program Water Plan 2.0. Water Plan is a personal-computer-based program developed for and marketed by AWWA (AWWA, 1996). The version utilized for this project was a pre-market (beta) version provided by AWWA for use by the City of Houston. Reports generated by Water Plan are provided in Appendix D.

Benefit-cost analysis can be performed from several different perspectives, based on who is affected. For conservation programs, the perspectives most commonly used for benefit-cost analyses include Participant, Utility, and Total Resource (Societal). Since it is the City role in

developing a conservation plan that is paramount in this study, the Utility perspective is used to evaluate elements of the plan in this study.

As described above, the costs used for this analysis are the actual costs paid by the City to save water. These include the incentives, program administration, marketing, surveys, evaluations, and other costs detailed previously in this section.

The utility perspective offers two advantages for this analysis. First, it considers only the water saving program costs that will be directly borne by the utility. This enables the utility to fairly compare potential investments for saving and supplying water. Second, because revenue shifts are treated as transfer payments, the analysis is not complicated with uncertainties associated with long-term rate projections and rate design assumptions.

No one evaluation perspective can be used without shortcomings. The principal weakness of the utility perspective is that it does not count the benefits accrued or costs incurred outside of the utility. Costs incurred by customers striving to save water while participating in conservation programs are not considered. Similarly, other factors external to the utility, such as environmental effects, are not included in the benefit-cost analysis from the utility perspective. Because these external factors are often difficult to quantify, they are frequently excluded in economic analyses.

All benefits (avoided costs) and costs used as inputs to this analysis are estimated in 1995 dollars. Although the analysis extends forward for fifty years, neither benefits nor costs are inflated for future years. The simplifying assumption is to ignore inflation, since it will apply to both benefits and costs. While this assumption is appropriate for this study, the effect of not projecting inflation is to undervalue the difference between total benefits and costs.

The time value of money is not ignored, however. The value of all future costs and benefits, even though they are in 1996 dollars to begin with, is discounted to 1996 at the annual discount rate used by the City (3 percent). Cash flows discounted in this manner are referred to as "Present Worth" sums throughout this study.

## Results

Table 6-10 summarizes the water saving and economic performance of the alternative programs, with details shown for each program.

**Table 6-10**
**Benefit-Cost Analysis of Alternative Programs**
**Totals through 2050**

| Program | | Total Water Savings, MG | Total PV Benefits, $Millions | Total PV Costs, $Millions | Net Benefits of Conservation Program, $Millions | Benefit Cost Ratio Through 2050 |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| Res Water Audits | SFR | 21.23 | 6,610 | 5,663 | 947 | 1.17 |
| | MFR | 22.86 | 7,118 | 4,568 | 2,550 | 1.56 |
| Res Plumbing Retrofit | | 468.03 | 144,465 | 14,256 | 130,209 | 10.13 |
| Res Toilet Replacement | Rebates | 317.70 | 101,090 | 25,224 | 75,866 | 4.01 |
| | CBO | 317.70 | 128,622 | 27,396 | 101,226 | 4.69 |
| | Giveaway | 555.99 | 224,689 | 42,242 | 182,447 | 5.33 |
| | Vouchers | 476.52 | 192,934 | 37,837 | 155,097 | 5.10 |
| | Direct Install | 794.26 | 321,556 | 71,206 | 250,350 | 4.52 |
| Appliance Labeling | | 34.86 | 9,149 | 367 | 8,782 | 24.91 |
| Landscape Incentives | SFR | 30.55 | 7,592 | 29,235 | -21,643 | 0.26 |
| | MFR | 81.57 | 22,189 | 43,448 | -21,259 | 0.51 |
| Commercial/Industrial | | | | | | |
| Indoor Audits | | 58.45 | 18,195 | 6,990 | 11,205 | 2.60 |
| Process Rebates | | 19.48 | 6,959 | 6,130 | 829 | 1.14 |
| Toilet/Urinal Rebates | Toilet | 48.55 | 21,931 | 6,895 | 15,036 | 3.18 |
| | Urinal | 1.58 | 713 | 940 | -227 | 0.76 |
| Cooling Tower Audits | | 24.00 | 7,471 | 330 | 7,141 | 22.63 |
| Landscape Ordinance | | 309.85 | 75,975 | 3,710 | 72,265 | 20.48 |
| Pool Audits | | 2.40 | 747 | 319 | 428 | 2.34 |
| Fountain Audits | | 6.12 | 1,905 | 678 | 1,227 | 2.81 |
| Irrigation Audits | | 2.67 | 830 | 588 | 242 | 1.41 |
| Public | | | | | | |
| Indoor Audits | | 17.94 | 5,584 | 1,603 | 3,981 | 3.48 |
| Exterior Audits | | 43.20 | 13,449 | 1,042 | 12,407 | 12.91 |
| Toilet/Urinal Rebates | Toilets | 7.84 | 3,541 | 835 | 2,706 | 4.24 |
| | Urinal | 0.26 | 115 | 114 | 1 | 1.01 |
| Pool/Fnt Audits | City | 13.85 | 4,387 | 580 | 3,807 | 7.56 |
| | Other | 4.43 | 1,404 | 1,344 | 60 | 1.04 |
| Pool/Fountain Standards | | 12.75 | 3,154 | 585 | 2,569 | 5.39 |
| City In-House Program | | 10.10 | 3,257 | 50 | 3,207 | 65.15 |

**Table 6-10 *(continued)***
**Benefit-Cost Analysis of Alternative Programs**
**Totals through 2050**

| Program | Total Water Savings, MG | Total PV Benefits, $Millions | Total PV Costs, $Millions | Net Benefits of Conservation Program, $Millions | Benefit Cost Ratio Through 2050 |
|---|---|---|---|---|---|
| Other | | | | | |
| Unaccounted For Water | 582.40 | 173,941 | 23,321 | 150,620 | 7.46 |
| Public Education | 301.64 | 90,401 | 27,758 | 62,643 | 3.00 |
| Waterwise & Energy Efficient | 8.20 | 3,234 | 879 | 2,355 | 4.37 |

## Performance of Individual Programs

Table 6-10 includes performance statistics for each program. The benefit-cost ratio presented for each program indicates a wide range in cost-effectiveness between programs.

The City In-House program is the most cost-effective of the programs, with a benefit-cost ratio of over 65. Because the costs to implement the program are very low (estimated to be no more than a one-time cost of $50,000) and the potential for savings relatively large, the program would be quite effective. The appliance labeling program is also very effective, particularly since it was assumed that the costs to implement the program would be shared equally with the local power company. Cooling tower audits and development of a landscape ordinance for commercial, industrial, and large multifamily accounts also have high benefit-cost ratios.

Only three programs (the SFR and MFR landscape incentive programs and the C/I urinal replacement program) have a ratio less than 1.0, the break-even point. In other words, the City could save money by implementing all but three programs.

The time stream of benefits and costs for each program are shown in Appendix D. Note that some program benefits decrease after five or ten years because certain measures have a life span of less than 50 years. The benefit details for the individual programs are based on the initial estimate of capital deferrals described above. In Section 7, a recommended conservation plan is developed with water savings specific to that plan. Benefits are then recalculated for the recommended plan to reflect the actual projected water savings.

# Section 7
# RECOMMENDED PLAN

## SELECTION OF RECOMMENDED PLAN

The Recommended Plan is comprised of programs selected from those evaluated in Section 6 combined with resources and implementation considerations. This section describes how the plan was selected and the program elements in the plan, then presents the goals, implementation mechanisms including resources (budget and staffing), schedule, and institutional arrangements necessary to implement the plan.

## PLAN SELECTION CRITERIA

Section 6 presented an evaluation of 20 alternative conservation programs including an analysis of their water saving potential, benefits and costs. Based on the results of that analysis, alternative plans can be formulated. The following criteria were used in compiling the plans:

- Benefit-cost ratio greater than 1.0
- Reasonable (affordable) cost
- Significant water savings
- Acceptable nonquantifiable impacts to the community

Table 7-1 shows a comparison of alternative programs with respect to these criteria. Some programs were subdivided into elements for analysis. The complete detail is presented in Table 7-1 to allow selection of individual program elements. Water savings are expressed two ways: the average over the 50-year planning horizon, and water savings in one year (2006). The percent reduction in the total retail water production for 2006 is also shown. Details on the water savings for each measure and for every year are shown in Appendix D.

**Table 7-1**
**Comparison of Alternative Programs**

| Program | Element | 50 Year Avg Water Savings mgd | Water Savings in 2006 mgd | Reduction in 2006 Base Water Production % | Benefit-Cost Ratio | Acceptable to Community yes/no |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| Res Water Audits | SFR | 0.42 | 0.42 | 0.14% | 1.17 | yes |
| | MFR | 0.46 | 0.47 | 0.15% | 1.56 | yes |
| Res Plumbing Retrofit | | 9.36 | 9.85 | 3.24% | 10.13 | yes |
| Res Toilet Replacement | Rebates | 6.48 | 7.94 | 2.61% | 4.01 | yes |
| | CBO | 6.48 | 7.94 | 2.61% | 4.69 | yes |
| | Giveaway | 11.35 | 13.90 | 4.58% | 5.33 | yes |
| | Vouchers | 9.73 | 11.91 | 3.92% | 5.10 | yes |
| | Direct Install | 16.21 | 19.86 | 6.54% | 4.52 | yes |

**Table 7-1 *(continued)***
**Comparison of Alternative Programs**

| Program | Element | 50 Year Avg Water Savings mgd | Water Savings in 2006 mgd | Reduction in 2006 Base Water Production % | Benefit-Cost Ratio | Acceptable to Community yes/no |
|---|---|---|---|---|---|---|
| Residential *(continued)* | | | | | | |
| Appliance Labeling | | 0.71 | 0.28 | 0.09% | 24.91 | yes |
| Landscape Incentives | SFR | 0.61 | 0.40 | 0.13% | 0.26 | no |
| | MFR | 1.63 | 0.93 | 0.31% | 0.51 | no |
| Commercial | | | | | | |
| Indoor Audits | | 1.17 | 1.22 | 0.40% | 2.60 | yes |
| Process Rebates | | 0.50 | 0.49 | 0.16% | 1.14 | yes |
| Toilet/Urinal Rebates | Toilet | 2.21 | 2.70 | 0.89% | 3.18 | yes |
| | Urinal | 0.07 | 0.09 | 0.03% | 0.76 | yes |
| Cooling Tower Audits | | 0.48 | 0.50 | 0.16% | 22.63 | yes |
| Landscape Ordinance | | 6.20 | 2.30 | 0.76% | 20.48 | no |
| Pool Audits | | 0.05 | 0.05 | 0.02% | 2.34 | yes |
| Fountain Audits | | 0.12 | 0.13 | 0.04% | 2.81 | yes |
| Irrigation Audits | | 0.05 | 0.06 | 0.02% | 1.41 | yes |
| Public | | | | | | |
| Indoor Audits | | 0.36 | 0.37 | 0.12% | 3.48 | yes |
| Exterior Audits | | 0.86 | 0.90 | 0.30% | 12.91 | yes |
| Toilet/Urinal Rebates | Toilets | 0.36 | 0.44 | 0.14% | 4.24 | yes |
| | Urinal | 0.01 | 0.01 | 0.00% | 1.01 | yes |
| Pool/Fountain Audits | City | 0.28 | 0.28 | 0.09% | 7.56 | yes |
| | Other | 0.09 | 0.09 | 0.03% | 1.04 | yes |
| Pool/Fountain Standards | | 0.26 | 0.10 | 0.03% | 5.39 | yes |
| City In-House Program | | 0.20 | 0.20 | 0.07% | 65.15 | yes |
| Other | | | | | | |
| Unaccounted For Water | | 11.65 | 12.80 | 4.21% | 7.46 | yes |
| Public Education | | 5.77 | 4.32 | 1.42% | 3.00 | yes |
| Water Wise & Energy Efficient | | 0.43 | 0.82 | 0.27% | 4.37 | yes |

Table 7-1 also shows the benefit-cost ratio from the utility perspective. A benefit-cost ratio greater than one means the present worth of the benefits over 50 years is greater than the present worth of the costs. Community acceptability is based on the evaluation in Section 6.

The water savings range from a small commercial irrigation audit saving 0.06 mgd to a direct install toilet replacement program saving 19.86 mgd. The unaccounted-for water program will also be effective, saving 12.8 mgd by 2005.

The benefit-cost ratios range from a low of 0.26 for the single-family landscape incentives program to 65 for the program that will reduce water usage of all City departments.

## ALTERNATIVE PLANS

As an initial step, three "generic" alternatives were formulated, comprised of programs that passed the criteria discussed above. These three alternatives feature progressively higher water savings, but also come at an increasing cost. The programs are defined as follows:

- Minimum Alternative - This alternative is based on the continuation of current City programs, plus several additional programs with high benefit-cost ratios.
- Moderate Alternative - This alternative is the minimum alternative plus other programs that pass the criteria and are expected to be affordable.
- Maximum Alternative - This alternative includes all programs from Table 7-1 with a benefit-cost ratio greater than 1.0. It includes a relatively expensive residential toilet replacement program. It also includes landscape codes, which tend to be unpopular.

The essential features of the alternatives are summarized in Table 7-2, and the details of the three alternatives are shown in Tables 7-3, 7-4, and 7-5.

**Table 7-2**
**Key Features of Alternatives**

| Alternative | Water Savings in 2006 (mgd) | Water Savings, % Reduction in 2006 Water Production (mgd) | First Five Years Total Cost (million dollars) | Benefit-Cost Ratio |
|---|---|---|---|---|
| Minimum | 18.8 | 6.2 | 9.8 | 5.46 |
| Moderate | 25.5 | 8.4 | 22.1 | 5.28 |
| Maximum | 42.4 | 14.0 | 28.5 | 4.81 |

Table 7-2 clearly shows the decreasing marginal returns from spending more and more money. Figure 7-1 displays the relation between water savings and costs. Note how the savings per million dollars decline when going beyond the moderate alternative. The major difference between the moderate and maximum alternatives is the residential toilet replacement program which costs $24 million. This program raises the budget requirement to $10 million per year for the first five years. Although this program is cost-effective, the cost increase over the present program (currently funded at about $1 million per year, excluding the unaccounted-for water program) is very large and would be difficult to achieve in a city with tight budgets. Moreover, the water

savings could be achieved through the natural replacement of hardware due to the plumbing codes, albeit at a much later date. The rebate programs enable some savings to be realized within 10 years rather than up to 50 years for the plumbing codes. Following initial review by the City of the alternatives provided, the Recommended Plan was developed reflecting the specific needs of the City.

**Table 7-3**
**Minimum Conservation Alternative**

| Sector | Program | Element | 50 Year Avg Water Savings mgd | Water Savings in 2006 mgd | First Five Years Total Cost $1000 | Benefit-Cost Ratio |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| | Appliance Labeling | | 0.71 | 0.28 | $85 | 24.91 |
| | | Subtotal | 0.71 | 0.28 | $85 | |
| Public | | | | | | |
| | Exterior Audits | | 0.86 | 0.28 | $293 | 12.91 |
| | Pool/Fnt Audits | City | 0.28 | 0.28 | $588 | 7.56 |
| | | Subtotal | 1.14 | 0.56 | $881 | |
| General | | | | | | |
| | Unaccounted For Water | | 11.65 | 12.80 | $4,400 | 7.46 |
| | Public Education | | 5.77 | 4.32 | $3,895 | 3.00 |
| | Water Wise & Energy Efficient | | 0.43 | 0.82 | $500 | 4.37 |
| | | Subtotal | 17.85 | 17.94 | $8,795 | |
| | | Total | 19.70 | 18.78 | $9,761 | |
| Percent of Retail Water Production, 2006 | | | | 6.18% | | |

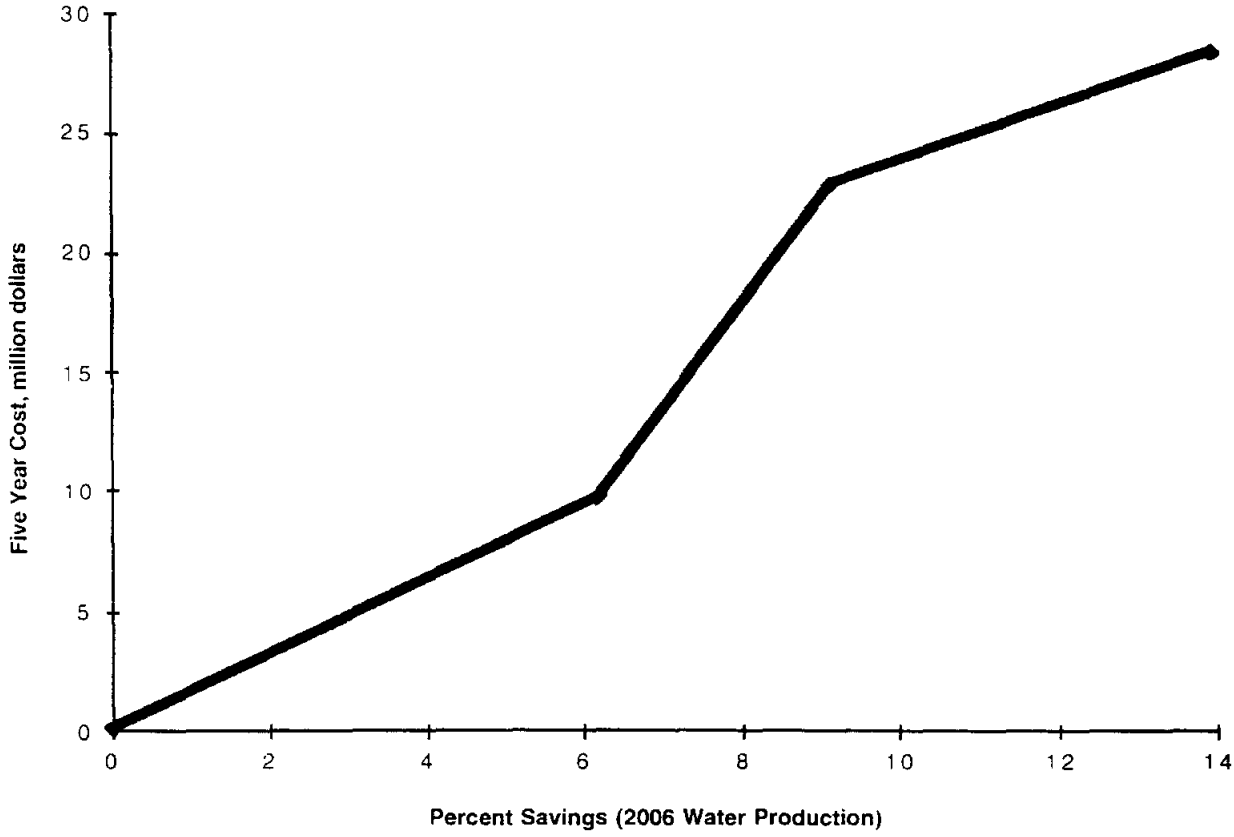
**Table 7-4**
**Moderate Conservation Alternative**

| Sector | Program | Element | 50 Year Avg Water Savings mgd | Water Savings in 2006 mgd | First Five Years Total Cost, $1000 | Benefit-Cost Ratio |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| | Res Water Audits | MFR | 0.46 | 0.47 | $862 | 1.56 |
| | Appliance Labeling | | 0.71 | 0.28 | $85 | 24.91 |
| | | Subtotal | 1.17 | 0.75 | $947 | |
| Commercial | | | | | | |
| | Indoor Audits | | 1.17 | 1.22 | $1,320 | 2.60 |
| | Toilet/Urinal Rebates | Toilet | 2.21 | 2.70 | $7,310 | 3.18 |
| | | Urinal | 0.07 | 0.09 | $995 | 0.76 |
| | Cooling Tower Audits | | 0.48 | 0.50 | $350 | 22.63 |
| | | Subtotal | 3.93 | 4.51 | $9,975 | |
| Public | | | | | | |
| | Indoor Audits | | 0.36 | 0.37 | $313 | 3.48 |
| | Exterior Audits | | 0.86 | 0.90 | $293 | 12.91 |
| | Toilet/Urinal Rebates | Toilets | 0.36 | 0.44 | $885 | 4.24 |
| | | Urinal | 0.01 | 0.01 | $120 | 1.01 |
| | Pool/Fnt Audits | City | 0.28 | 0.28 | $588 | 7.56 |
| | Pool/Fountain Standards | | 0.26 | 0.10 | $155 | 5.39 |
| | City In-House Program | | 0.20 | 0.20 | $50 | 65.15 |
| | | Subtotal | 2.326 | 2.3 | $2,404 | |
| Other | | | | | | |
| | Unaccounted For Water | | 11.65 | 12.80 | $4,400 | 7.46 |
| | Public Education | | 5.77 | 4.32 | $3,895 | 3.00 |
| | Water Wise & Energy Efficient | | 0.43 | 0.82 | $500 | 4.37 |
| | | Subtotal | 17.85 | 17.94 | $8,795 | |
| | | Total | 25.276 | 25.5 | $22,121 | |
| Percent of Retail Water Production, 2006 | | | | 8.39% | | |

**Table 7-5**
**Maximum Conservation Alternative**

| Sector | Program | Element | 50 Year Avg Water Savings mgd | Water Savings in 2006 mgd | First Five Years Total Cost, $1000 | Benefit-Cost Ratio |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| | Res Water Audits | SFR | 0.42 | 0.42 | $1,071 | 1.17 |
| | | MFR | 0.46 | 0.47 | $862 | 1.56 |
| | Res Toilet Replacement | Giveaway | 12.65 | 13.90 | $2,800 | 5.33 |
| | Appliance Labeling | | 0.71 | 0.28 | $85 | 24.91 |
| | | Subtotal | 14.24 | 15.07 | $4,818 | |
| Commercial | | | | | | |
| | Indoor Audits | | 1.17 | 1.22 | $1,320 | 2.60 |
| | Toilet/Urinal Rebates | Toilet | 2.21 | 2.70 | $7,310 | 3.18 |
| | | Urinal | 0.07 | 0.09 | $995 | 0.76 |
| | Cooling Tower Audits | | 0.48 | 0.50 | $350 | 22.63 |
| | Landscape Ordinance | | 6.20 | 2.30 | $700 | 20.48 |
| | Pool Audits | | 0.05 | 0.05 | $151 | 2.34 |
| | Fountain Audits | | 0.12 | 0.13 | $234 | 2.81 |
| | | Subtotal | 10.30 | 6.99 | $11,060 | |
| Public | | | | | | |
| | Indoor Audits | | 0.36 | 0.37 | $313 | 3.48 |
| | Exterior Audits | | 0.86 | 0.90 | $293 | 12.91 |
| | Toilet/Urinal Rebates | Toilets | 0.36 | 0.44 | $885 | 4.24 |
| | | Urinal | 0.01 | 0.01 | $120 | 1.01 |
| | Pool/Fnt Audits | City | 0.28 | 0.28 | $588 | 7.56 |
| | | Other | 0.09 | 0.09 | $1,383 | 1.04 |
| | Pool/Fountain Standards | | 0.26 | 0.10 | $155 | 5.39 |
| | City In-House Program | | 0.20 | 0.20 | $50 | 65.15 |
| | | Subtotal | 2.42 | 2.39 | $3,787 | |
| Other | | | | | | |
| | Unaccounted For Water | | 11.65 | 12.80 | $4,400 | 7.46 |
| | Public Education | | 5.77 | 4.32 | $3,895 | 3.00 |
| | Water Wise & Energy Efficient | | 0.43 | 0.82 | $500 | 4.37 |
| | | Subtotal | 17.85 | 17.94 | $8,795 | |
| | | Total | 44.81 | 42.39 | $28,460 | |
| Percent of Retail Water Production, 2006 | | | | 13.95% | | |

Figure 7-1
Water Savings - Cost Relationship




## RECOMMENDED PLAN

The Recommended Plan was based primarily on the moderate alternative. The plan elements are listed in Table 7-6. Detailed descriptions of each program included in the plan are given in Appendix C and Water Plan Output for the Recommended Plan is given in Appendix D.

**Table 7-6**
**Recommended Plan Elements (Programs)**

| Plan Element | Short Description |
|---|---|
| Residential Water Audits | The top 25% of all residential accounts and low-income elderly, and handicapped will be offered a water audit. |
| Appliance Labeling | Labels advertising water efficiency are placed on new machines for sale in stores. This program will be pursued on a statewide basis. |
| Public Information/Education | A public relations effort is targeted at the general public and a schoo l program is targeted at elementary school children. |
| Water Wise & Energy Efficient | A joint program with the Harris-Galveston Coastal Subsidence District aimed at 5th graders and their parents promotes efficient use of water and energy. |
| Commercial/Industrial Indoor Water Audits | The top 25% commercial accounts will be offered a water audit. |
| Cooling Tower Water Audits | Accounts with cooling towers will be offered a free water audit. |
| Public Facility Water Audits | High water use accounts are offered a free indoor and outdoor audit. |
| Public Fountain/Pool Audit and Repair | Public pool and fountain owners are offered an audit and COH pays for repairs. |
| Standards for New Fountains/Pools | New pools and fountains will have state-of-the-art water saving equipment. |
| City In-House Program | All City general fund departments will have water reduction goals. |
| System Water Audits, Leak Detection and Repair | The planned water audit, leak detection, and repair program will be conducted. |

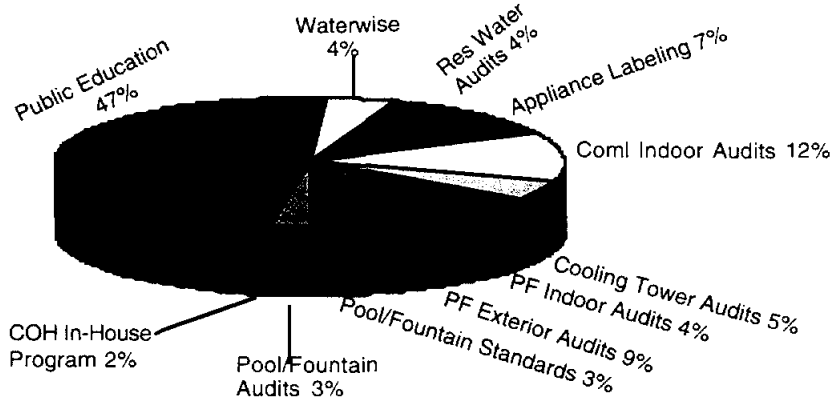
The plan shown in Table 7-7 will have projected water savings of 12.89 mgd by the end of 2001, at a cost $11.2 million over the first five years. Water savings increase to nearly 22 mgd by 2006. The water savings for individual plan elements are shown in Figure 7-2.

**Table 7-7**
**Recommended Conservation Plan**

| Sector | Program | Element | 50 Year Avg Water Savings mgd | Water Savings in 2001 mgd | Total Costs Through 2001 $1,000 | Benefit-Cost Ratio (50 years) |
|---|---|---|---|---|---|---|
| Residential | | | | | | |
| | Res Water Audits | | 0.42 | 0.18 | $429 | 1.00 |
| | Appliance Labeling | | 0.71 | 0.06 | $75 | 21.71 |
| | | Subtotal | 1.13 | 0.24 | $504 | |
| Commercial | | | | | | |
| | Indoor Audits | | 1.17 | 0.49 | $528 | 2.23 |
| | Cooling Tower Audits | | 0.48 | 0.30 | $210 | 18.67 |
| | | Subtotal | 1.65 | 0.79 | $738 | |
| Public | | | | | | |
| | Indoor Audits | | 0.36 | 0.30 | $313 | 3.03 |
| | Exterior Audits | | 0.86 | 0.72 | $258 | 10.84 |
| | Pool/Fountain Audits | City | 0.28 | 0.17 | $354 | 6.26 |
| | Pool/Fountain Standards | | 0.25 | 0.04 | $155 | 4.32 |
| | City In-House Program | | 0.20 | 0.20 | $50 | 54.83 |
| | | Subtotal | 1.95 | 1.43 | $1,130 | |
| Other | | | | | | |
| | Unaccounted For Water | | 11.65 | 6.4 | $4,400 | 6.28 |
| | Public Education | | 4.51 | 3.62 | $3,925 | 1.78 |
| | Water Wise & Energy Efficient | | 0.42 | 0.41 | $500 | 3.68 |
| | | Subtotal | 16.58 | 10.43 | $8,825 | |
| | | Total | 21.31 | 12.89 | $11,197 | 3.69 |

**Figure 7-2**
**Water Savings by Programmatic Element**

**(Excludes UAW)**




The plan is very cost-effective with a benefit-cost ratio of 3.7 to 1, using plan-specific O&M and capital deferral savings. The benefit-cost ratio of the plan is lower than the moderate alternative because some programs are staged, as described in the next subsection.

The most significant difference between the moderate alternative and the recommended plan is the removal of the toilet and urinal rebate programs for the commercial and public facility customer classes. The rebate programs represented over 40 percent of the costs for the first five years, while accounting for about 12 percent of the projected water savings. Also eliminated from the moderate program was the commercial landscape ordinance program. The residential water audit program was targeted at single-family residential housing rather than multifamily in an attempt to target water users with high peak season demands.

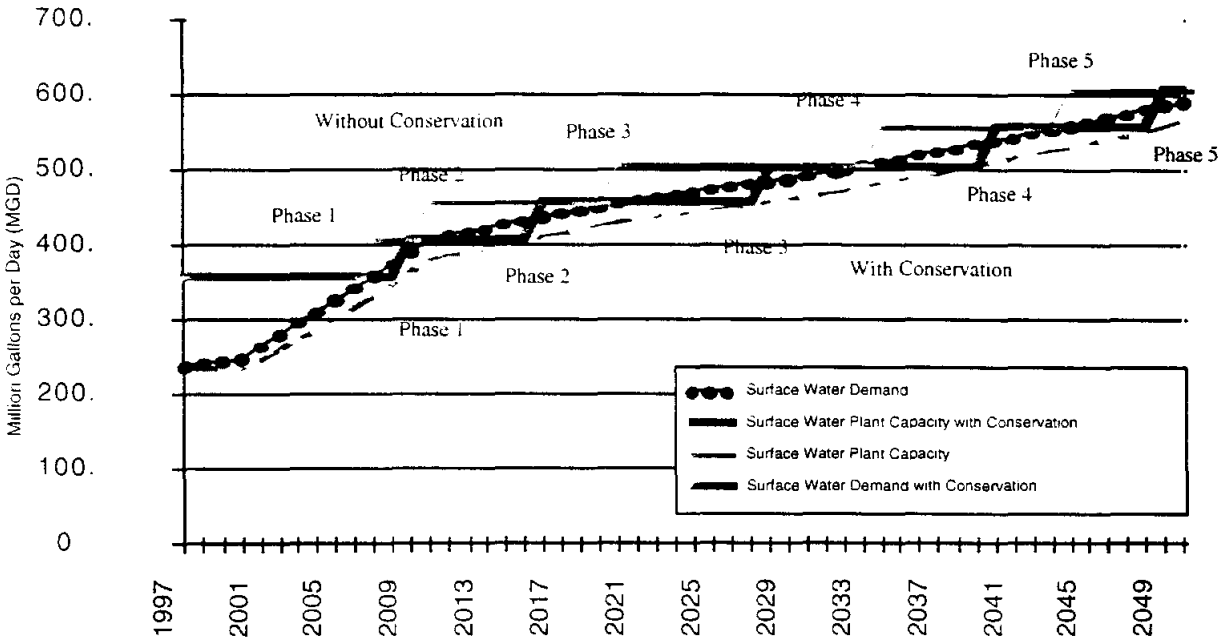
## Benefits of Recommended Plan

The Recommended Plan will defer considerable capital expenditures and the operating costs associated with them (water treatment plant expansions) and save money by reducing annual system operating costs. Water savings expected from the recommended program by 2050, the end of the plan period, total 24 mgd. Overall, the plan will save nearly 381 billion gallons of water, averaging over 7.6 billion gallons per year.

Even with projected water savings from enforcement of plumbing code provisions, total treatment plant capacity projected to be needed in the absence of the conservation program is 655 mgd, compared to the existing 355 mgd of capacity. With implementation of the Recommended Plan, treatment plant capacity in 2050 will not be reduced from the 655 mgd level. However, the Recommended Plan allows delays in the need for each expansion phase. The project deferrals are shown graphically on Figure 7-3, which shows the base water projection and the projection with the Recommended Plan. Note that the water treatment plant expansion phases can all be deferred anywhere from two years for Phase 1 to eight years for Phase 3. Most of the phases are

postponed for five to six years. In addition to the savings from the deferral of capital spending, the City also is able to defer the O&M costs associated with each of the expansion phases.

**Figure 7-3**
**Treatment Plant Capacity Increments with Conservation**




The benefits of the Recommended Plan were computed using the actual deferrals, in contrast to use of an assumed 10 percent deferral applied to programs evaluated in Section 6. The present worth analysis of the capital deferrals is shown in Table 7-8, which indicates the net present value of the capital deferrals attributable to the recommended conservation program is over $103 million. The reduced operating benefits are added to these benefits to calculate the total benefits. Appendix D shows the time-stream of costs and benefits for each program element used by Water Plan. This analysis results in the overall benefit-to-cost ratio of 3.7 to 1, reported above. This is very cost-effective and allows the City to realize a return of about $3.70 for every $1.00 invested in water conservation.

## Table 7-8
## Capital Deferral Savings Due to Recommended Conservation Plan
## City of Houston Water System
## Water Treatment Facilities

Inflation Factor: 0.00%
Discount Factor: 3.00%
Interest Rate: 6.50%
Bond Period= 25
Debt Service= 8.20%

| | Planned | | Revised | | Escalated | | Future | Present | |
|---|---|---|---|---|---|---|---|---|---|
| | Capital Expansion Costs | Debt Service @ 8.20% | Capital Expansion Costs | Delayed Debt Service | Operating Costs @ 0.00% | Delayed Operating Costs | Value of Cash Saving | Value of Cash Saving @ 3.00% | |
| 1996 | $0 | $0 | $0 | $0 | $0 | 0 | | | |
| 1997 | $0 | $0 | $0 | $0 | $0 | 0 | | | $0 |
| 1998 | $0 | $0 | $0 | $0 | $0 | 0 | | | $0 |
| 1999 | $0 | $0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 |
| 2000 | $0 | $0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 |
| 2001 | $0 | $0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 |
| 2002 | $0 | $0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 |
| 2003 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 2004 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 2005 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 2006 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 2007 | $75,000,000 | $6,148,611 | $0 | $0 | $0 | $0 | $6,148,611 | $4,441,887 | $4,441,887 |
| 2008 | $0 | $6,148,611 | $0 | $0 | $4,891,000 | $0 | $11,039,611 | $7,742,961 | $12,184,849 |
| 2009 | $0 | $6,148,611 | $75,000,000 | $6,148,611 | $4,891,000 | $0 | $4,891,000 | $3,330,533 | $15,515,382 |
| 2010 | $75,000,000 | $12,297,222 | $0 | $6,148,611 | $4,891,000 | $4,891,000 | $6,148,611 | $4,064,956 | $19,580,338 |
| 2011 | $0 | $12,297,222 | $0 | $6,148,611 | $9,782,000 | $4,891,000 | $11,039,611 | $7,085,906 | $26,666,244 |
| 2012 | $0 | $12,297,222 | $0 | $6,148,611 | $9,782,000 | $4,891,000 | $11,039,611 | $6,879,521 | $33,545,765 |
| 2013 | $0 | $12,297,222 | $0 | $6,148,611 | $9,782,000 | $4,891,000 | $11,039,611 | $6,679,146 | $40,224,911 |
| 2014 | $0 | $12,297,222 | $0 | $6,148,611 | $9,782,000 | $4,891,000 | $11,039,611 | $6,484,608 | $46,709,519 |
| 2015 | $0 | $12,297,222 | $0 | $6,148,611 | $9,782,000 | $4,891,000 | $11,039,611 | $6,295,736 | $53,005,255 |
| 2016 | $0 | $12,297,222 | $75,000,000 | $12,297,222 | $9,782,000 | $4,891,000 | $4,891,000 | $2,708,028 | $55,713,283 |
| 2017 | $0 | $12,297,222 | $0 | $12,297,222 | $9,782,000 | $9,782,000 | $0 | $0 | $55,713,283 |
| 2018 | $0 | $12,297,222 | $0 | $12,297,222 | $9,782,000 | $9,782,000 | $0 | $0 | $55,713,283 |
| 2019 | $0 | $12,297,222 | $0 | $12,297,222 | $9,782,000 | $9,782,000 | $0 | $0 | $55,713,283 |
| 2020 | $75,000,000 | $18,445,833 | $0 | $12,297,222 | $9,782,000 | $9,782,000 | $6,148,611 | $3,024,709 | $58,737,992 |
| 2021 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $5,272,580 | $64,010,572 |
| 2022 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $5,119,009 | $69,129,581 |
| 2023 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $4,969,912 | $74,099,494 |
| 2024 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $4,825,157 | $78,924,651 |
| 2025 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $4,684,619 | $83,609,270 |
| 2026 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $4,548,174 | $88,157,443 |
| 2027 | $0 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $9,782,000 | $11,039,611 | $4,415,703 | $92,573,146 |
| 2028 | $0 | $18,445,833 | $75,000,000 | $18,445,833 | $14,673,000 | $9,782,000 | $4,891,000 | $1,899,356 | $94,472,502 |
| 2029 | $0 | $18,445,833 | $0 | $18,445,833 | $14,673,000 | $14,673,000 | $0 | $0 | $94,472,502 |
| 2030 | $0 | $18,445,833 | $0 | $18,445,833 | $14,673,000 | $14,673,000 | $0 | $0 | $94,472,502 |
| 2031 | $0 | $18,445,833 | $0 | $18,445,833 | $14,673,000 | $14,673,000 | $0 | $0 | $94,472,502 |
| 2032 | $0 | $12,297,222 | $0 | $18,445,833 | $14,673,000 | $14,673,000 | ($6,148,611) | ($2,121,470) | $92,351,032 |

## Table 7-8 *(continued)*
## Capital Deferral Savings Due to Recommended Conservation Plan
## City of Houston Water System
## Water Treatment Facilities

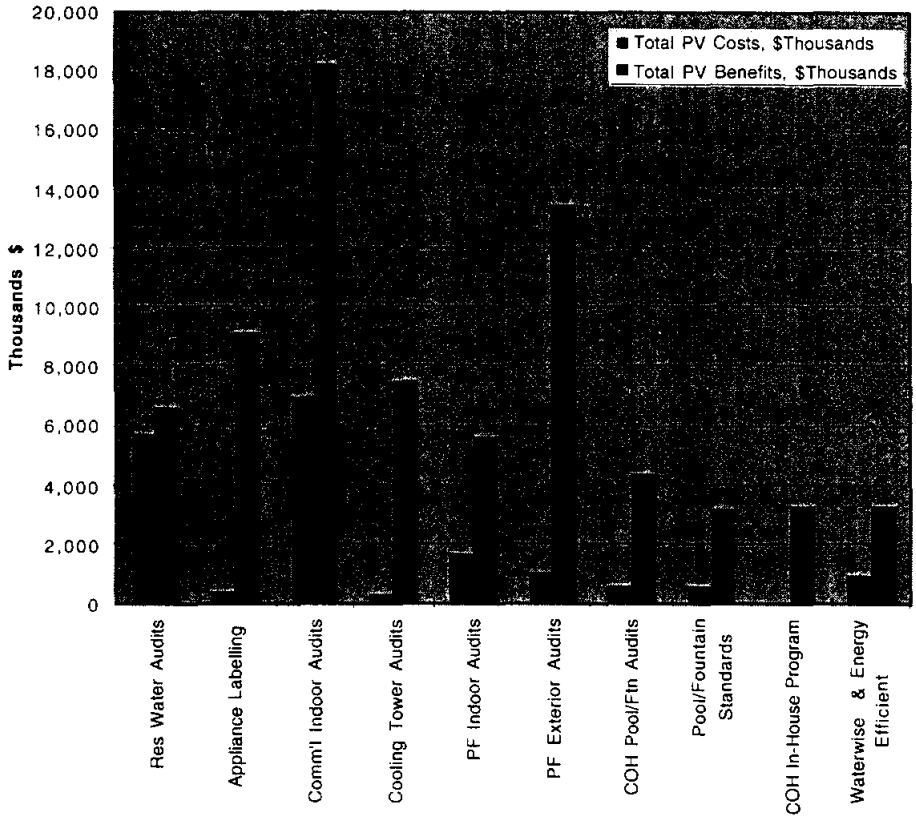
Inflation Factor: 0.00%
Discount Factor: 3.00%
Interest Rate: 6.50%
Bond Period= 25
Debt Service= 8.20%

| | Planned | | Revised | | Escalated | | Future | Present | |
|---|---|---|---|---|---|---|---|---|---|
| | Capital Expansion Costs | Debt Service @ 8.20% | Capital Expansion Costs | Delayed Debt Service | Operating Costs @ 0.00% | Delayed Operating Costs | Value of Cash Saving | Value of Cash Saving @ 3.00% | |
| 2033 | $0 | $12,297,222 | $0 | $18,445,833 | $14,673,000 | $14,673,000 | ($6,148,611) | ($2,059,680) | $90,291,352 |
| 2034 | $75,000,000 | $18,445,833 | $0 | $12,297,222 | $14,673,000 | $14,673,000 | $6,148,611 | $1,999,689 | $92,291,041 |
| 2035 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $14,673,000 | $4,891,000 | $1,544,351 | $93,835,392 |
| 2036 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $14,673,000 | $4,891,000 | $1,499,370 | $95,334,762 |
| 2037 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $14,673,000 | $4,891,000 | $1,455,699 | $96,790,460 |
| 2038 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $14,673,000 | $4,891,000 | $1,413,300 | $98,203,760 |
| 2039 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $14,673,000 | $4,891,000 | $1,372,135 | $99,575,895 |
| 2040 | $0 | $12,297,222 | $75,000,000 | $18,445,833 | $19,564,000 | $14,673,000 | ($1,257,611) | ($342,538) | $99,233,357 |
| 2041 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $19,564,000 | $0 | $0 | $99,233,357 |
| 2042 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $19,564,000 | $0 | $0 | $99,233,357 |
| 2043 | $0 | $12,297,222 | $0 | $12,297,222 | $19,564,000 | $19,564,000 | $0 | $0 | $99,233,357 |
| 2044 | $75,000,000 | $18,445,833 | $0 | $12,297,222 | $19,564,000 | $19,564,000 | $6,148,611 | $1,487,957 | $100,721,314 |
| 2045 | $0 | $12,297,222 | $0 | $12,297,222 | $24,455,000 | $19,564,000 | $4,891,000 | $1,149,142 | $101,870,456 |
| 2046 | $0 | $12,297,222 | $0 | $12,297,222 | $24,455,000 | $19,564,000 | $4,891,000 | $1,115,672 | $102,986,127 |
| 2047 | $0 | $12,297,222 | $0 | $12,297,222 | $24,455,000 | $19,564,000 | $4,891,000 | $1,083,176 | $104,069,304 |
| 2048 | $0 | $12,297,222 | $0 | $12,297,222 | $24,455,000 | $19,564,000 | $4,891,000 | $1,051,628 | $105,120,932 |
| 2049 | $0 | $12,297,222 | $75,000,000 | $18,445,833 | $24,455,000 | $19,564,000 | ($1,257,611) | ($262,527) | $104,858,405 |
| 2050 | $0 | $12,297,222 | $0 | $18,445,833 | $24,455,000 | $24,455,000 | ($6,148,611) | ($1,246,140) | $103,612,265 |
| | | | | | | | | | |
| | $375,000,000 | $608,712,497 | $375,000,000 | $528,780,553 | $660,285,000 | $528,228,000 | $211,988,944 | $103,612,265 | |

Net Present Value of Savings $103,612,265
Incremental Consumption (mgd) 250.00
Estimated Capital marginal cost $1,135.48 per mg, based on treatment plant expansion delays
$0.849 per Ccf
$1.135 per thous gals.

Figure 7-4 shows the relative costs and benefits for each of the program elements.

**Figure 7-4**
**Benefits and Costs by Programmatic Element**
**(Excludes Unaccounted-for Water)**




## Impact on Revenue

Although the benefits of the Recommended Plan will exceed the costs, the City will sell less water with a conservation program, resulting in lower revenues than if no conservation program existed. When the benefits exceed the costs, the revenue needed by the City to expand and maintain a larger system will be lower; hence, over the long run, the City will not be in a deficit situation. Nevertheless, revenue reduction is of concern to those responsible for City finances. Generally, the revenue reduction from conservation programs are predictable and small, and develop slowly over time. They are a consideration, similar to inflation and climate variations, that should be factored into financial planning. This section provides estimates of revenue reduction resulting from conservation achieved through the Recommended Plan and describes how some other utilities have dealt with similar situations.

**Estimated Reduction.** The Recommended Plan is expected to reduce water demand in the City by 21.8 mgd or 7.3 percent by the year 2006. Will revenues be 7.3 percent lower than they otherwise would be by 2006? Not exactly. First, the Recommended Plan includes a significant

component of reducing unaccounted-for water, which is not sold and produces no revenue. The actual water savings from programmatic conservation is about half the total, or 9 mgd (3.7 percent). The associated revenue reduction depends on which customer class saves the water, since billing rates vary. Table 7-9 provides a revenue impact analysis by customer category. The second column shows water and sewer revenues for the various categories. The total revenue for 1995 was almost $500 million. Almost 90 percent was earned from the retail sales. The third column projects this revenue to the year 2006, assuming revenue rises in proportion to increasing water sales (see Section 3). Programmatic conservation savings (in mgd) are shown in column 4 and the unit billing rate in column 5. The annual revenue reduction in 2006 is shown in column 6 and as a percent in column 7. By the year 2006, the annual revenue reduction will build up to $17 million, or 2.9 percent of total revenues. The reductions will be much lower in the early years of the program. Revenue reduction is predicted to total 1.5 percent of the revenue projected to be collected over the next ten years.

**Table 7-9**
**Revenue Impact Analysis**

| Customer Class | Water/Sewer Sales w/o Conservation | | 2006 Water Savings, mgd | Unit Billing Rate, $/1000g | Annual Revenue Reduction in 2006 | | Cumulative Reduction to 2006, |
|---|---|---|---|---|---|---|---|
| | 1995, million $ | 2006, million $ | | | million $ | percent | percent |
| Residential | | | | | | | |
| Water | 72.90 | 83.11 | | 2.31 | | | |
| Sewer | 70.30 | 80.14 | | 2.95 | | | |
| Total | 149.10 | 163.25 | 2.90 | 5.26 | 5.57 | 3.41 | 1.71 |
| Multi-Family | | | | | | | |
| Water | 54.60 | 62.24 | | 1.43 | | | |
| Sewer | 82.10 | 93.59 | | 2.24 | | | |
| Total | 136.60 | 155.84 | 2.50 | 3.67 | 3.35 | 2.15 | 1.07 |
| Commercial | | | | | | | |
| Water | 52.50 | 59.85 | | 2.22 | | | |
| Sewer | 75.60 | 86.18 | | 3.96 | | | |
| Total | 128.10 | 146.03 | 1.72 | 6.18 | 3.88 | 2.66 | 1.33 |

**Table 7-9 *(continued)***
**Revenue Impact Analysis**

| Customer Class | Water/Sewer Sales w/o Conservation | | 2006 Water Savings, mgd | Unit Billing Rate, $/1000g | Annual Revenue Reduction in 2006 | | Cumulative Reduction to 2006, |
|---|---|---|---|---|---|---|---|
| | 1995, million $ | 2006, million $ | | | million $ | percent | percent |
| Government | | | | | | | |
| Water | 10.60 | 12.08 | | 2.22 | | | |
| Sewer | 13.30 | 15.16 | | 3.96 | | | |
| Total | 23.90 | 27.25 | 1.84 | 6.18 | 4.15 | 15.23 | 7.62 |
| Sewer/Other | | | | | | | |
| Water | 9.20 | 10.49 | | 2.22 | | | |
| Sewer | 17.50 | 19.95 | | 3.96 | | | |
| Total | 9.20 | 30.44 | 0.00 | 6.18 | 0.00 | 0.00 | 0.00 |
| Total Retail | 446.90 | 522.80 | 8.96 | | 16.95 | 3.24 | 1.62 |
| Wholesale | 51.20 | 58.37 | | | 0.00 | | |
| Grand Total | 498.10 | 581.17 | 8.96 | | 16.95 | 2.92 | 1.46 |

As stated previously, revenue reduction is small and predictable. The evaluation process proposed as a part of the Recommended Plan will yield quantifiable water savings. This information can be translated into a forecasted rate of revenue growth. The forecast, combined with other factors, such as inflation in system operating costs and weather impacts, will be used in evaluating future rate changes. As the benefits of deferred water treatment plant expansions are realized, bond sales to provide additional treatment capacity will be postponed. Over time, deferrals of capital expenditure will result in savings to the rate payers.

**Examples of Mitigating Revenue Reduction from other Utilities.** Houston will not be the first utility to deal with how to finance a stepped-up water conservation and mitigate the revenue reduction the program will cause over time. Although the program costs and revenue reduction are small in the big picture, they should be planned. The experiences of three water utilities will be summarized as example of what can be done to finance the program and make up for the revenue reduction. The City can consider these approaches the next time it contemplates a water/sewer rate change.

**City of San Antonio, Texas.** The water problems of the City of San Antonio are well known. The City has a goal of reducing pumpage from the Edwards Aquifer by 10 percent by the year 2000. For a number of years the City of San Antonio, like the City of Houston, has had a three-tier water rate structure. However, the steepness of the inclining block rates and the magnitude of the charges had not resulted in significant water savings. In 1994, the City decided to add a fourth tier and use 50 percent of the extra revenue generated to finance conservation and reuse programs. The fourth-tier rate, at $2.50 per 1000 gallons, is twice the third-tier rate. With a population approximately two-thirds the size of Houston, the fourth tier has generated over $5 million per year of revenue for the conservation programs in 1995-1996. Designed to be revenue neutral, the

new rate structure is producing more revenue than before. This excess has occurred despite the presence of a strong conservation program. Apparently some residents can afford to use excessive amounts of water and it is probably fair that they pay for conservation programs that save water so they can have an uninterrupted, albeit expensive, supply.

**Irvine Ranch Water District, California.** Irvine Ranch Water District (IRWD) uses a more refined and involved approach compared to San Antonio. IRWD enacted a five-tier rate schedule in 1991. This corresponded to a statewide water shortage and was readily accepted by the customers. The approach involves setting up a water budget for each account. A customer staying below the water budget is rewarded with a rate below the average cost of water to the District. If use is above the water budget, the customer is penalized through increasing block rates.

Water budgets were established for two classes of customers by assuming, or knowing, lot sizes and irrigated areas. The five tiers were established as follows:

| Tier | Residential Accounts | Landscape Accounts |
|---|---|---|
| Low Volume | 40% of budget | 40% of budget |
| Conservation | 60% of budget | 60% of budget |
| Penalty | 100-150% of budget | 101-110% of budget |
| Excessive | 151-200% of budget | 111-120% of budget |
| Abusive | over 201% of budget | over 121% of budget |

Residential customers are given more leeway in managing their water use. Landscape accounts, most of which have professional managers and irrigation controllers, are expected to do a better job and are only given a 20 percent leeway until the highest rates apply. Water budgets are recomputed weekly using actual weather. Water bills reflect actual weather, and the budget changes each billing period. For example, if it is hot and dry, customers can expect a larger water budget and can increase irrigation without fear of a stiff penalty.

The water budgets were established initially by staff, with complaints from customers handled through a variance process. The single-family allocation, identical for all accounts, assumed four persons per household and a reasonable amount of landscaping. Approximately 80 percent of customers accepted these budgets. The remaining 20 percent were adjusted based on the variance process. For example, a lot with a large amount of landscaping was given a higher allocation.

The IRWD Board of Directors was supportive from the beginning. The IRWD staff credits the water budget approach with reducing water consumption by 10 percent. The penalty tiers are used to fund revenue losses from under-budget consumers, conservation programs, and other water supply needs such as purchasing additional imported water supplies. Conservers are amply rewarded and the public has been supportive of the overall approach.

**East Bay Municipal Utility District, California.** East Bay Municipal Utility District (EBMUD), which serves some 1.3 million people in two counties east of San Francisco Bay, utilized an approach similar to that employed by San Antonio to help achieve reduced consumption

levels during the drought period from 1988 to 1993. In order to achieve reductions ranging from 25 percent for single-family residential customers to 50 percent for irrigation customers, EBMUD employed a four-tier increasing block rate structure. At the end of the program in 1993, rates ranged from $1.10 per 100 cubic feet (Ccf) to $4.14 per Ccf. At $1.37 per Ccf, the second tier of the rate structure was considered to be the break-even rate, the amount needed to be collected from each Ccf in order for the District to be in a revenue neutral position. For water sold in the upper two tiers, revenues were divided into normal charges (based on $1.37) and excess use charges (the amount in excess of $1.37). For example, for each unit sold in the highest tier, revenue was recognized as $1.37 of normal revenue and $2.77 ($4.14 minus $1.37) of excess use revenue. Excess use revenues, which totaled nearly $9 million for 1993, were designated to be used to fund the extra expenses associated with both drought-specific costs and conservation program costs.

## WATER CONSERVATION GOALS

Table 7-10 shows overall water saving goals broken down by type of customer. Table 7-11 shows periodic goals on a per capita basis. In the year 2006, the plan establishes a goal of reducing total per capita demand by 11 gallons per capita per day (7 percent). The goals will decline slightly thereafter unless new programs are started. These goals will enable demand tracking to be done periodically to compare achievements with the plan. Goals exclude the effect of the 1992 Federal Energy Policy Act (see Table 6-4).

**Table 7-10**
**Recommended Plan Water Saving Goals, mgd**

| Sector | Program | Element | 50 Year Avg | Year | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2005 | 2015 | 2025 | 2050 |
| Residential | | | | | | | |
| | Res Water Audits | | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 |
| | Appliance Labeling | | 0.71 | 0.22 | 0.80 | 0.93 | 0.93 |
| | | Subtotal | 1.13 | 0.64 | 1.22 | 1.35 | 1.35 |
| Commercial | | | | | | | |
| | Indoor Audits | | 1.17 | 1.22 | 1.22 | 1.22 | 1.22 |
| | Cooling Tower Audits | | 0.48 | 0.50 | 0.50 | 0.50 | 0.50 |
| | | Subtotal | 1.65 | 1.72 | 1.72 | 1.72 | 1.72 |

**Table 7-10 *(continued)***
**Recommended Plan Water Saving Goals, mgd**

| Sector | Program | Element | 50 Year Avg | Year | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2005 | 2015 | 2025 | 2050 |
| Public | | | | | | | |
| | Indoor Audits | | 0.36 | 0.37 | 0.37 | 0.37 | 0.37 |
| | Exterior Audits | | 0.86 | 0.90 | 0.90 | 0.90 | 0.90 |
| | Pool/Fountain Audits | City | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 |
| | Pool/Fountain Standards | | 0.25 | 0.08 | 0.18 | 0.28 | 0.50 |
| | City In-House Program | | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| | | Subtotal | 1.95 | 1.83 | 1.93 | 2.03 | 2.25 |
| Other | | | | | | | |
| | Unaccounted For Water | | 11.65 | 11.52 | 12.80 | 12.80 | 12.80 |
| | Public Education | | 4.51 | 3.81 | 4.35 | 4.88 | 5.82 |
| | Water Wise & Energy Efficient | | 0.42 | 0.74 | 0.08 | 0.00 | 0.00 |
| | | Subtotal | 16.58 | 16.07 | 17.23 | 17.68 | 18.62 |
| | | Total | 21.31 | 20.26 | 22.10 | 22.78 | 23.94 |

Differences due to rounding

**Table 7-11**
**Recommended Plan Water Savings Goals**

| Year | Water Savings mgd | Water Use w/o Conservation mgd | Projected Population | Per Capita Use w/o Conservation gpcd | Per Capita Use with Conservation gpcd | Percent Reduction |
|---|---|---|---|---|---|---|
| 1996 | 0 | 269 | 1,719,576 | 156.43 | 156.43 | 0.00% |
| 2001 | 10.04 | 285 | 1,820,331 | 156.56 | 151.05 | 3.52% |
| 2006 | 21.76 | 304 | 1,937,726 | 156.88 | 145.66 | 7.16% |
| 2016 | 22.18 | 348 | 2,218,072 | 156.89 | 146.89 | 6.37% |
| 2050 | 24.26 | 473 | 3,016,887 | 156.78 | 148.74 | 5.13% |

Note: Water Use w/o Conservation Includes Retail Water Sales and Unaccounted-for Water

## WATER DEMAND PROJECTION WITH CONSERVATION

Table 7-12 updates the water demand projection provided in Table 3-2 for the City of Houston to include the effect of all future water conservation efforts. These include programmatic conservation by the City (Recommended Plan) plus the projected water savings due to the new plumbing code associated with the 1992 Federal Energy Policy Act. Total water savings will grow to 75 mgd by 2030 and level off. The total reduction in retail water sales plus unaccounted-for water will peak at 20 percent in 2020 and decline slightly thereafter, unless the City undertakes new programs not included in the plan.

**Table 7-12**
**Retail Water Demand Project with Conservation**

| Year | Total Water Savings[a] (per mgd) | Water Use without Conservation[b] (per mgd) | Water Use with all Conservation (per mgd) | Percent Reduction |
|---|---|---|---|---|
| 2000 | 24 | 281 | 247 | 12% |
| 2010 | 55 | 319 | 264 | 17% |
| 2020 | 74 | 368 | 294 | 20% |
| 2030 | 75 | 397 | 322 | 19% |
| 2040 | 75 | 433 | 358 | 17% |
| 2050 | 75 | 473 | 397 | 16% |

Notes: a. City programmatic conservation plus effects of 1992 Federal Energy Policy Act
b. Retail water sales and unaccounted-for water

## MANAGEMENT OF PLAN ELEMENTS

In order to increase efficiency, the individual programs can be consolidated into a fewer number of plan elements. The following consolidation is suggested:

- Water Audits
- Residential Water Audits
- Commercial Indoor Water Audits
- Cooling Tower Audits
- Public Indoor/Exterior Audits
- Regulatory Programs
- Appliance Labeling
- New Pool/Fountain Standards
- City of Houston In-House Program
- Unaccounted-for Water Program
- Public Education/School Education

It is suggested that the City appoint one person in charge of the above plan elements. Additional staff for each element would be hired, as needed. A program manager would be in charge of the program and supervise each of the element managers.

# APPENDIX A

## Water User Survey

## Survey Results

**CITY OF HOUSTON**
**WATER USER SURVEY**
**June 1995**

Customer Name: _____

Service Address: _____

City_____Zip Code_____

Phone No._____Fax No._____

Completed by:_____

Title: _____

Signature: _____Date_____

GENERAL INFORMATION

(1). Briefly describe the services or goods provided or produced at this establishment.
_____
_____
_____

(2). Briefly describe your facility's production process._____
_____
_____
_____
_____

(3). Standard Classification Code of your business:_____

(4). Year building structure originally built_____

(5). Total (annual average including part-time) number of employees._____

(6). Average occupancy rate: winter_____% spring_____%
summer_____% fall_____%

WATER USES AND APPLIANCES

7. Please note if the establishment has any of the specified water uses/appliances listed below and note the quantity of units.

| Type of Water Uses/Appliances | | No. of Units |
|---|---|---|
| Facility Cooling and Heating | | |
| **(7ct)** | Cooling towers | _____ |
| **(7ec)** | Evaporative coolers | _____ |
| **(7aw)** | Air washers | _____ |
| **(7h)** | Humidifiers | _____ |
| **(7b)** | Boilers | _____ |
| Laundry | | |
| **(7cwm)** | Commercial washing machines | _____ |
| **(7sswm)** | Self-service washing machines (for public use) | _____ |
| **(7dc)** | Dry cleaning | _____ |
| Kitchen Facilities | | |
| **(7dm)** | Dishwashing machines | _____ |
| **(7gd)** | Garbage disposals | _____ |
| Ice-Making Machines | | |
| **(7wcim)** | Water-cooled icemaking machines | _____ |
| **(7acim)** | Air-cooled icemaking machines | _____ |
| Landscape and Decorative Uses | | |
| **(7sp)** | Swimming pools | _____ |
| **(7j/s)** J | acuzzis / spas | _____ |
| **(7f)** | Fountains | _____ |
| **(7li/ss)** | Lawn irrigation / sprinkler system | _____ |

Washing and Sanitation

(7gwac) General washdown and cleanup _____

(7se/a) Sterilization equipment / autoclaves (primary hospitals) _____

(7vw) Vehicle washes _____

Process Water Purification Equipment

(7ws) Water softeners _____

(7wf) Water filters _____

(7rou) Reverse osmosis units _____

(7d/ieu) Deionization / ion exchange units _____

Miscellaneous Water Use

(7p/xp) Photographic / X-ray processing (primarily hospitals)_____

(7l) Laboratories (primarily schools and hospitals) _____

(7du) Dialysis units (primarily hospitals) _____

(7ms) Maintenance shops _____

(7hs) Hairdressing salons _____

(7lgv) Liquid gas vaporizers _____

(7f/gs) Fume / gas scrubbers _____

(8). Are there any other purposes/appliances for which water is used at this facility?___

_____

_____

_____

(9). Does this facility recycle water for any purpose? For what purpose?_____

_____

_____

_____

(10). If treatment of incoming water is necessary at your establishment, briefly describe the principal water treatment measures now in use and why they are necessary.

_____

_____

_____

(11). What is the number of bathroom facilities at this location?_____

Number of:

(11t) Toilets _____

(11u) Urinals _____

(**11bf**) Bathroom faucets _____
(**11kf**) Kitchen faucets _____
(**11uf**) Utility faucets _____
(**11l/msf**) Lab / maintenance shop faucets _____
(**11s**) Showers _____
(**11df**) Drinking fountains _____

(**12**). What is the gallons per flush (gpf) for the toilets?_____

(**13**). What is the gallons per flush (gpf) for the urinals?_____

AIR CONDITIONING

(**14**). Does the facility have any evaporative coolers?_____
(**14a**) How many?_____

(**15**). How many months per year are the evaporative coolers most commonly used?____

(**16**). Which months are the evaporative coolers most commonly used?_____
_____

(**17**). Does this facility use any chilled-water central air conditioning units with a cooling tower?_____

(**18**). Which month(s) is/are the cooling tower(s) operating at full capacity?_____
_____

(**19**). What was your estimated water use each month during 1994?

Jan_____ Feb_____ Mar_____ Apr_____ May_____
June_____ July_____ Aug_____ Sept _____ Oct_____
Nov_____ Dec_____

LANDSCAPING

(**20**). What type of landscaping is present at the facility?_____
_____

(21). How large is the irrigated area of the facility (in acres)_____

(22). What is the facility's normal irrigation schedule? Is it seasonal?_____

_____

_____

(23). Is the facility's irrigation schedule automatically or manually controlled?_____

WATER CONSERVATION

(24). What level of significance (considering all cost and technical factors) does the cost of water and of effluent charges (or treatment) have for your business at this location? A low of 0 up to a high of 10.

0 1 2 3 4 5 6 7 8 9 10

(25). How important, in your opinion, is the current need to conserve water in your industry/business? Please check one.

Urgent_____ Of considerable importance_____
Somewhat important_____ Unimportant_____

(26). What measures for water efficiency are you planning, or would you like to implement during the five years? What are their anticipated savings and costs?

_____

_____

_____

_____

_____

(27). Has your facility developed a water conservation plan?

_____

(27a) Date of original water conservation plan _____
(27b) Date of latest revision to the plan _____
(27c) Are you currently implementing conservation strategies? _____
(27d) Is the plan for a single site or for multiple sites? _____

(28). Why did your facility develop a water conservation plan?_____ Check one.

Required by TNRCC _____
Required by company policy _____
To address a water or wastewater problem _____
To address a financial problem _____

Other _____

(29). Do the conservation strategies within your plan address specific problems?_____
Please check those that apply.

Water supply limitations _____
Wastewater limitations _____
Financial limitations _____
Need to reduce transportation and treatment costs _____
Need to reduce production costs; increase efficiency _____
Environmental need for additional fresh water _____
Environmental need for water quality _____
Community public relations _____
Cooperative effort within region/basin _____
Other _____

(30). Does your water conservation plan establish quantitative goals?_____ Please fill in the appropriate spaces.

**(30a)** Reduce volume of water delivered to the site by_____

**(30b)** Reduce volume of water consumed in the production process by_____

**(30c)** Increase efficiency by reducing losses/unnecessary uses of water by_____

**(30d)** Increase the reuse of water by_____

**(30e)** Increase the volume of water returned as flow_____

**(30f)** Other_____

(31). Indicate the approximate dates of water efficiency measures you have adopted at this facility.

| Year Saved | Water Efficiency Measure | Quantity |
|---|---|---|
| _____ | Recycle cooling or process water | _____ |
| _____ | Reuse sequentially in processes or between process and cooling | _____ |
| _____ | Improve control systems | _____ |
| _____ | Dry cooling or other processes | _____ |
| _____ | Changed clean-up procedures | _____ |
| _____ | Changed to/from continuous processing | _____ |
| _____ | Changed/reduced nozzles and flow rates (could be for process or cleanup) | _____ |
| _____ | Use automatic shut-offs | _____ |
| _____ | Smaller tanks and sinks | _____ |
| _____ | Changed to low flow toilets | _____ |
| _____ | Changed to low flow showers | _____ |
| _____ | Installed more efficient cooling system | _____ |

| | | |
|---|---|---|
| _____ | Lower flow settings | _____ |
| _____ | Leak monitoring and/or repair | _____ |
| _____ | Changed landscape/irrigation practices | _____ |
| _____ | Production shutdowns/relocation | _____ |
| _____ | Switched water sources | _____ |

Comments and additional measures_____

_____

_____

_____

(32). What percentage reduction do you estimate you have achieved by adopting these efficiency measures?_____

(33). How much annually have you invested in your water conservation plan/strategies?

_____

(34). How is your water conservation plan funded?_____

_____

(35). How much water has been conserved annually due to water conservation efforts?

1994_____million gallons per year
1993_____million gallons per year
1992_____million gallons per year
1991_____million gallons per year
1990_____million gallons per year

(36). Describe benefits derived from your conservation efforts._____

_____

_____

_____

_____

(37). What is the payback period, investment rate or other numerical yardstick you apply to expenditures for water supply and efficiency?_____

_____

(38). What direction is your facility taking in water use efficiency and reduction?_____

_____

_____

_____

(39). If cost was not an issue, what water conservation technology would you like to see implemented at your facility and why?_____

_____

_____

_____

(40). What additional assistance does your facility require in order to be able to implement an aggressive water conservation plan? Check those that apply.

Additional funding _____
Additional staff _____

(41). What type of assistance would the City of Houston need to provide in order for your facility to be able to implement an aggressive water conservation plan? Please check those that apply.

Rebate programs _____
Financial assistance _____
Increased technical assistance _____

(42). What else could the City of Houston do to assist your water conservation efforts?

_____

_____

_____

(43). Any additional comments?_____

_____

_____

_____

| NAME | 1 | 2 | 3 | 4 | 5 | 6 win | 6 spr | 6 sum | 6 fal | 7ct | 7ec | 7aw | 7h | 7b | 7cwm | 7sswm | 7dc | 7dm | 7gd | 7wclm | 7aclm | 7sp | 7j/s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wyndham Hotel | Hotel | | | 1984 | 325 | 78 | 78 | 60 | 65 | 4 | 0 | 0 | 0 | 5 | 3 | 1 | 0 | 1 | 1 | 4 | 18 | 1 | 0 |
| Memorial Senior Service DBA: Univ. Pl | nursing facility | | retirement center | 1989 | 60 | 95 | 95 | 95 | 95 | | | | 30 | 1 | | 186 | | 186 | 186 | 100 | | 1 | 1 |
| Metropolitan Transit Authority | public transpor. | bus wash, bus maintenance | ? | various | | 50 | 50 | 50 | 50 | 2 | | | | | | | | | | | | | |
| Columbia West Houston Medical Center | patient care acute hospital | NA | acute care facility | 1985 | | | | | | 1-2 cell | 0 | 0 | 2 | 6 | 1 | 0 | 0 | 1 | 3 | 0 | 11 | 0 | 0 |
| United States Gypsum Company | gypsum wallboard, paper | produce wallboard, paper | 2631, 3275 | 1756 | | 100 | 100 | 100 | 100 | 4 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| St. Luke's Episcopal Hospital | health care | | | 1954,1970s | 4000 | | | | | NA | NA | NA | NA | NA | 2 | NA | NA | 6 | 13 | NA | 85 | NA | NA |
| Reynolds Metals Co. | aluminum cans for beverage | manufacture aluminum cans | 3411 | 1969 | 210 | 100 | 100 | 100 | 100 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Northwestern Steel & Wire Company | rolling structural "I" beams | manufacture "I" beams | 3312 | 1970 | 300 | 100 | 100 | 100 | 100 | 1 | | | | | | | | | | | | | |
| Memorial Hospital Southeast | | | | | | | | | | 1 | | | 10 | 2 | | | | 1 | 4 | | 20 | | 4 |
| Johnston Middle School | middle school education | teaching 6-8 grade students | education | 1959 | 1655 | 100 | 100 | 15 | 100 | 2 | 2 | 0 | 0 | 5 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 1 | 0 |
| Memorial SW Prof. Health Care Facility | medical professional | doctors office | commercial | 1987 | 300-400 | 90 | 90 | 90 | 90 | 1-2 cell | NA | NA | NA | NA | NA | NA | NA | 1 | 1 | 0 | 2 | NA | NA |
| First Interstate Bank Plaza | multi-tenant office bldg | NA | Class A office bldg | 1983 | 2900 | 70 | 70 | 70 | 70 | 1 | | | 5 | 2 | | | | 20 | 5 | | 25 | | |
| Houston Chronicle | newspaper publishing | newspaper publishing | | 1991 | 2000 | 100 | 100 | 100 | 100 | 6 | | | | 3 | | | | 2 | | 8 | | | |
| Hormel Food Corp. | food products | manufacture meat products | 2013 | 1975 | 90 | 100 | 100 | 100 | 100 | | 2 | | | 1 | | | | | 1 | | | | |
| Hines Interest Limited Partnership | office building | NA | | 1975 | 15 | 98 | 98 | 98 | 98 | 5 | 5 | | | 2 | 1 | | | 3 | | | 70 | | 1 |
| Goodyear | rubber | | 322 | 1943 | 750 | 100 | 100 | 100 | 100 | | 558 | | 36 | | 52 | | 4 | | | | | | |
| Goodman Manufacturing Co. L.P. | HVAC | manufacture air conditioners | 3585 | | | 100 | 100 | 100 | 100 | | | | | 1 | | | | | | | 1 | | |
| Four Seasons Hotel | hotel | NA | | 1981 | | | | | | 1 | 0 | 0 | 0 | 8 | 3 | 0 | 1 | 3 | 0 | 21 | 1 | 1 | 1 |
| Doubletree Guest Suites Houston | hotel/restaurant/bar | 7 day/wk; 24 hr/day service | | 1981 | 175 | 80 | 80 | 80 | 80 | 1 | 0 | 0 | 0 | 2 | 4 | 5 | 0 | 2 | 339 | 1 | 3 | 1 | 1 |
| Doctor's Hospital Airline | healthcare | none | | 1954 | 490 | | | | | 1 | 0 | 0 | 0 | 2 | | | | 1 | 3 | 0 | 7 | | |
| Clarion Inn | food, beverages, etc. | food service | hotel | 1978 | 100 | 50 | 70 | 70 | 70 | 4 | | 0 | 0 | 4 | 4 | 4 | NA | 1 | 1 | 8 | 6 | 3 | 1 |
| CINTAS Corporation | industrial uniform rental laundry | wash industrial laundry | 2300 | 1950 | 337 | 100 | 100 | 100 | 100 | | | | | 1 | 9 | | | | | | 2 | | |
| Cal-Tex Citrus Juice, Inc. | fruit juices (portion pack containers) | reconstituted juices to final product | | 1950s-80s | 140 | | | | | | | 2 | | 2 | | | | | | | | | |
| Bayer Corporation | chemical manufacturing | manufacture rubber | | | | | | | | 3 | | | | 1 | | | | | | 1 | 4 | | |
| Mutual Benefit Life | multi-tenant office building | NA | unknown | 1982 | 900 | 80 | 80 | 80 | 80 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 3 | | 1 | | |
| YMCA Downtown | excersize, fitness, rooming | office space, meeting rooms, excersize | B-2 | 1942 | 154 | 95 | 95 | 95 | 95 | 2 | 0 | 0 | 0 | 2 | 4 | 4 | 0 | 1 | 1 | 0 | 2 | 1 | 4 |
| Jacob Stern & Sons, Inc. | process, export tallow (beef fat) | batch filtration of tallow | 2077 | 1955 | 38 | 100 | 100 | 100 | 100 | | | | | 2 | | | | | | | | | |
| Holiday Inn | 300 room hotel and convention center | | | | 200 | 80 | 80 | | | 1 | | | | 6 | 3 | | | 1 | 3 | 14 | 14 | 1 | 1 |
| Angelica Healthcare Services Group, Inc. | provide laundry services for hospitals | provide laundry services for hospitals | | 1964 | 90-99 | 100 | 100 | 100 | 100 | NA | NA | NA | NA | 2 | yes | NA | NA | NA | NA | | | NA | NA |
| Westchase Equities | commercial office space | NA | | 1980 | NA | 90 | 90 | 90 | 90 | 1 | 2 | | | | | | | | | | | 2 | |
| Holiday Inn Select | hotel services | cooking, cleaning, laundry services | hotel | 1983 | 135 | 66.2 | 66.5 | 54.6 | 62.2 | 2 | 0 | 0 | 0 | 5 | 4 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Owens Corning | manufacture roofing, asphalt products | roofing operation | 2952 | 1940 | 120 | 20 | 30 | 30 | 20 | 1 | 2 | NA | NA | 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Unifirst - Texas Industrial Services | industrial uniform sales, rental, lease | industrial uniform sales, rental, lease | | 1991 | 97 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| THM Medical Office Building | medical professional building | NA | medical prof. bldg. | 1988 | 750-1000 | 95 | 95 | 95 | 95 | 1-3 cell | 4 | 0 | 0 | 5 | 1 | 0 | 0 | 40-50 | 40-50 | 0 | 15-20 | 0 | 4-Jan |
| Radisson Suite Hotel Houston West | hotel | | | 1970 | 72 | 65 | 50 | 65 | | | | | | | 2 | | | 1 | 1 | | 15 | 1 | |
| Baylor College of Medicine | medical school and research | medical school and research facility | | 1988 | 3900 | 100 | 100 | 100 | 100 | 7 | | | | 4 | | | | 2 | 2 | | 50 | | |
| Reed Tool Company | down hole drilling equip; drill bits | forge raw steel to drill bits/parts | 3533 | 1975 | 322 | 99 | 99 | 99 | 99 | 3 | 3 | 3 | 0 | 0 | no | | | 1 | 1 | | 1 | no | no |

| NAME | 7f | 7fl/ss | 7gwac | 7se/a | 7vw | 7ws | 7wf | 7rou | 7d/leu | 7p/xp | 7l | 7du | 7ms | 7hs | 7lgv | 7f/gs | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wyndham Hotel | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | no | no |
| Memorial Senior Service DBA: Univ. Pl | 7 | 1 | 20 | 1 | | 1 | 1 | | 1 | | | | 1 | 1 | | | | no |
| Metropolitan Transit Authority | | | <10 | | 6 | 2 | | | 6 | | | | | | | | NA | bus wash reclaim syst. |
| Columbia West Houston Medical Center | 0 | 1 | 0 | 6 | 0 | 4 | 11 | 0 | 0 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | no | no |
| United States Gypsum Company | 0 | 2 | 1 | 0 | 0 | 2 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | wallboard, paper production | yes, reuse water in paper production |
| St. Luke's Episcopal Hospital | NA | 284 heads | 5 | 14 | NA | 8 | 85 | 20 | NA | 18 | 400 | 16 | 6 | 1 | NA | 2 | fire protection | yes, clean sterilization equip. |
| Reynolds Metals Co. | 0 | 0 | 3 | 0 | 2 | 1 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | washers for cans | yes, vacuum pump cooling |
| Northwestern Steel & Wire Company | | | | | | | | | | | | | 1 | | | | yes, steam clean, roll and sawblade cooling | yes, roll and sawblade cooling, floor cleaning, mill stands |
| Memorial Hospital Southeast | | 1 | | 4 | | 2 | 20 | | | 3 | 1 | | 1 | | | | liquid ring medical vacuum pumps | no |
| Johnston Middle School | 0 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 1 | 0 | 0 | 0 | no | no |
| Memorial SW Prof. Health Care Facility | NA | 12 zones | NA | NA | NA | NA | NA | NA | NA | 2 | 0 | NA | 1 | NA | NA | NA | no | no |
| First Interstate Bank Plaza | 1 | 1 | 1 | | | | 20 | 5 | | | | | 1 | | | | no | no |
| Houston Chronicle | | | | | | | 40 | | | 17 | | | 1 | | | | yes, develop photopolymer plates | no |
| Hormel Food Corp. | | 1 | 1 | | | 1 | 1 | | | | | | 1 | | | | water showers in processing ovens | no |
| Hines Interest Limited Partnership | | | NA | NA | NA | NA | NA | NA | NA | | | | 2 | | | | NA | NA |
| Goodyear | | | | | | | | | | | | | | | | | | |
| Goodman Manufacturing Co. L.P. | | | | | | | | | | | | | 1 | | | | parts washer | no |
| Four Seasons Hotel | 0 | 2 | | | 1 | 3 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 residential washers | no |
| Doubletree Guest Suites Houston | 0 | 0 | 1 | 0 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | water cooled condensers and heat exchangers | no |
| Doctor's Hospital Airline | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | | no |
| Clarion Inn | 2 | 2 | 3 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | no | no |
| CINTAS Corporation | | | | | | 1 | | | | | | | | | | | no | yes, reuse small %age for processing of certain items |
| Cal-Tex Citrus Juice, Inc. | | 2 | 1 | 1 | 1 | 2 | 1 | | | | 1 | | 1 | | | | no | no |
| Bayer Corporation | | 1 | | | | | | | | | | | 3 | | | | process operations | no |
| Mutual Benefit Life | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | no | no |
| YMCA Downtown | 0 | 1 | | 0 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | cleaning | no |
| Jacob Stern & Sons, Inc. | | 1 | 1 | | | | | | | | 1 | | | | | | no | yes, use recovered condensate to wash tank interiors |
| Holiday Inn | 1 | 1 | | | | 1 | | | | | | | 1 | | | | steamers in the kitchen | NA |
| Angelica Healthcare Services Group, Inc. | NA | NA | yes | NA | NA | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | boilers, hot water tanks, washers, ironers | first flush to remove soil and control BW flow |
| Westchase Equities | | 1 | | | | 2 | | | | | | | | | | | | |
| Holiday Inn Select | 1 | 2 | NA | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | none | none |
| Owens Corning | NA | NA | NA | NA | NA | 1 | NA | NA | NA | NA | NA | NA | 1 | NA | NA | NA | cool product, restrooms, general washdown | to cool shingle sheet |
| Unifirst - Texas Industrial Services | 5 | yes | 13 | 0 | 24 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | heat exchangers absorb temp from ww prior to discharge | heat exchangers absorb temp from ww prior to discharge |
| THM Medical Office Building | 0 | 3 | 1 | 30-50 | 0 | 0 | 30-40 | 0 | 2 | 20 | 4 | 0 | 1 | 0 | 0 | 0 | general, toilets, sinks | no |
| Radisson Suite Hotel Houston West | 2 | | | | | 1 | | | | | | | | | | | no | no |
| Baylor College of Medicine | 1 | 4 | | 30 | | 5 | | 5 | 6 | 27 | 500 | | 5 | | | | no | yes, cooling tower evaporation |
| Reed Tool Company | no | no | | | no | no | no | no | no | 1 | 1 | 0 | 3 | 0 | 0 | 0 | process water for machines and cooling equipment | no |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | **13 say no** | **22 say no** |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

| NAME | 10 | 11 | 11t | 11u | 11bf | 11kf | 11uf | 11Vms | 11s | 11d | 12 | 13 | 14 | 14a | 15 | 16 | 17 | 18 | 19-Jan | 19-Feb | 19-Mar | 19-Apr | 19-May | 19-Jun | 19-Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wyndham Hotel | no | | 510 | 14 | 519 | 24 | 5 | 1 | 485 | 7 | 1.5 | | no | | | | yes | May-Sept | 1,891,000 | 1,983,000 | 2,422,000 | 2,704,000 | 2,423,000 | 2,946,000 | 2,526,000 |
| Memorial Senior Service DBA: Univ. Pl | | | 240 | 1 | 240 | 186 | 20 | | 240 | 2 | 1.5 | | no | | | | yes | 10 | | | | | | | |
| Metropolitan Transit Authority | deionization, softening | various | >50 | >50 | >50 | >10 | >10 | >50 | >10 | >50 | ? | ? | | 0 | 0 | 0 | yes | summer | 7,100,000 | 5,800,000 | 5,200,000 | 5,800,000 | 6,500,000 | 7,300,000 | 6,700,000 |
| Columbia West Houston Medical Center | softening | | | | | | | | | | | | no | 0 | 0 | 0 | yes | Jun-Aug | | | | | | | |
| United States Gypsum Company | NA | 12 | 19 | 10 | 15 | 6 | 0 | 11 | 8 | 10 | 3 | 2 | no | NA | NA | NA | NA | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| St. Luke's Episcopal Hospital | | | 2100 | 98 | 3700 | 45 | 176 | 400 | 1350 | 116 | 3.5 | 1.6 | no | | NA | NA | NA | NA | | | | | | | |
| Reynolds Metals Co. | NA | 5 | 13 | 8 | 7 | 0 | 1 | 1 | 4 | 8 | ? | ? | no | 0 | NA | NA | no | NA | 3,996,000 | 4,751,000 | 4,560,000 | 5,732,000 | 5,743,000 | 5,916,000 | 6,132,000 |
| Northwestern Steel & Wire Company | NA | | 31 | 16 | 16 | 2 | 1 | 1 | 6 | 17 | 5 | 1 | no | | NA | NA | no | all | 6,500,000 | 4,400,000 | 4,000,000 | 6,100,000 | 5,100,000 | 6,600,000 | 6,300,000 |
| Memorial Hospital Southeast | | 294 | 298 | 0 | 294 | 4 | 15 | 6 | 219 | 20 | 4 to 6 | NA | no | | | | yes | Jun-Sept | 1,501,000 | 1,220,000 | 1,951,000 | 2,781,000 | 2,399,000 | 2,612,000 | 2,523,000 |
| Johnston Middle School | | 18 | 45 | 9 | 35 | 6 | 7 | 11 | 86 | 25 | 3 to 5 | 3 to 5 | no | | | | yes | apr-oct | 0,846,000 | 0,903,000 | 0,389,000 | 0,490,000 | 2,208,000 | 1,076,000 | 0,902,000 |
| Memorial SW Prof. Health Care Facility | NA | 102 | 71 | 23 | 46 | 2 | 9 | 234 | 2 | 11 | 3, 1.6 | 2.5 | no | NA | NA | NA | yes | Jun-Sept | | | | | | 0,580,000 | 0,635,000 |
| First Interstate Bank Plaza | no water tretmnt | 144 | 1152 | 140 | 420 | 140 | 70 | 2 | 6 | 142 | 3.5 | 2 | no | | | | yes | jun-sept | 2,480,000 | 1,895,000 | 1,908,000 | 2,046,000 | 2,344,000 | 3,359,000 | 3,158,000 |
| Houston Chronicle | scaling reduction | 42 | | | | 22 | 17 | 1 | 5 | 32 | 0.5 | 0.5 | no | | | | yes | apr-oct | 1,870,000 | 2,570,000 | 2,830,000 | 3,183,000 | 2,180,000 | 2,920,000 | 2,790,000 |
| Hormel Food Corp. | NA | 8 | 16 | 5 | 10 | 1 | 2 | 1 | 0 | 3 | 4 | 1.5 | yes | 2 | 12 | year round | no | NA | 3,018,000 | 2,748,000 | 2,500,000 | 1,224,000 | 3,000,000 | 3,200,000 | 3,200,000 |
| Hines Interest Limited Partnership | NA | 160 | 510 | 220 | 500 | 70 | 80 | 4 | 20 | 160 | 1.5 | 1.3 | NA | | NA | NA | yes | Apr-Nov | 2,676,000 | 2,342,000 | 2,614,000 | 2,993,000 | 3,843,000 | 3,937,000 | 4,416,000 |
| Goodyear | | | | | | | | | | | | | | | | | | | | | | | | | |
| Goodman Manufacturing Co. L.P. | NA | 18 | 50 | 11 | 25 | 0 | 17 | 0 | 0 | 15 | unknown | unknown | NA | | | | | | 1,824,766 | 1,629,255 | 1,433,744 | 1,727,010 | 1,401,159 | 1,596,670 | 1,433,744 |
| Four Seasons Hotel | no | | 584 | 16 | 554 | 163 | 12 | 0 | 538 | 8 | 4.5 | 1.5 | no | | | | yes | 6 | 3,943,000 | 3,765,000 | 3,799,000 | 3,848,000 | 3,898,000 | 4,508,000 | 4,155,000 |
| Doubletree Guest Suites Houston | softening | 400 | 400 | 3 | 400 | 400 | 5 | 2 | 2 | 1 | 3.5 | 3.5 | no | | NA | NA | yes | Jun-Sept | 2,200,000 | 2,000,000 | 2,400,000 | 2,400,000 | 2,700,000 | 2,700,000 | 3,200,000 |
| Doctor's Hospital Airline | softening | | 89 | 2 | 88 | 2 | 7 | 6 | 62 | 7 | 1.6 to 5 | ? | no | | NA | NA | yes | Jun-Aug | 1,697,000 | 1,425,000 | 1,345,000 | 1,389,000 | 1,447,000 | 1,679,000 | 1,630,000 |
| Clarion Inn | softening | | 235 | 4 | 235 | 4 | 2 | 0 | 235 | 2 | 4 | 2 | no | | | | yes | Jun-Aug | 0,140,000 | 0,150,000 | 0,160,000 | 0,160,000 | 0,170,000 | 0,150,000 | 0,160,000 |
| CINTAS Corporation | softening | 7 | 15 | 4 | 9 | 2 | 1 | | | 6 | 1.5 | unknown | yes | 1 | 9 | Mar-Dec | no | NA | 2,579,000 | 2,486,000 | 2,239,000 | 2,506,000 | 1,342,000 | 2,198,000 | 2,138,000 |
| Cal-Tex Citrus Juice, Inc. | carbon filters | | 7 | 4 | 8 | 1 | 2 | 3 | 1 | 5 | 2 | 1 | yes | 2 | 12 | year round | yes | NA | 0,002,260 | 0,002,389 | 0,002,167 | 0,002,687 | 0,002,732 | | |
| Bayer Corporation | demineralization | 22 | 54 | 35 | 50 | 15 | 10 | 12 | 32 | 18 | 3 to 5 | 3 to 5 | no | | | | | | | | | | | | |
| Mutual Benefit Life | Nalco treatment | 55 | 145 | 47 | 122 | 83 | 1 | 0 | 4 | 23 | 3 to 3.5 | 2.5 to 3 | no | | | NA | yes | year round | 0,276,690 | 0,252,420 | 0,249,140 | 0,292,230 | 0,691,600 | 0,491,100 | 0,601,620 |
| YMCA Downtown | NA | 22 | 55 | 19 | 77 | 3 | 9 | 1 | 89 | 20 | 4.5 | 1.5 | no | NA | NA | NA | yes | 12 mos | 1,526,000 | 1,784,000 | 1,762,000 | 1,655,000 | 1,601,000 | 1,877,000 | 1,756,000 |
| Jacob Stern & Sons, Inc. | | | 8 | 3 | 7 | 1 | 20 | 2 | 4 | 3 | unknown | | no | | | | no | | 2,184,000 | 1,526,000 | 1,373,000 | 1,488,000 | 1,409,000 | 1,014,000 | 0,554,000 |
| Holiday Inn | softening | | 20 | 8 | 13 | 10 | 6 | 1 | 300 | 4 | 3 | 1 | | | | | yes | Mar-Nov | 0,908,000 | 0,976,000 | 1,168,000 | 1,074,000 | 1,300,000 | 1,300,000 | 1,484,000 |
| Angelica Healthcare Services Group, Inc. | softening | 8 | 15 | 2 | 14 | 0 | 2 | | 4 | 3 | 3 | 3 | no | NA | NA | NA | no | NA | 3,791,000 | 4,904,000 | 2,549,000 | 3,295,000 | 3,220,000 | 3,527,000 | 3,358,000 |
| Westchase Equities | scaling prevention | | 120 | 48 | 120 | | | | | 24 | standard | standard | yes | 2 | 12 | Jun-Sept | yes | Jun-Sept | 0,954,000 | 0,609,000 | 0,784,000 | 0,879,000 | 0,818,000 | 1,397,000 | 1,229,000 |
| Holiday Inn Select | NA | 356 | 383 | 8 | 356 | 9 | 20 | 1 | 356 | 1 | 4.5 | 1.5 | no | | 0 | 0 | yes | Jul-Aug | 0,001,600 | 0,001,600 | 0,001,600 | 0,001,600 | 0,001,600 | 0,001,600 | 0,001,600 |
| Owens Corning | NA | | 12 | 7 | 9 | 2 | NA | 1 | 5 | 6 | unknown | unknown | no | NA | NA | NA | no | NA | 0,774,000 | 0,595,000 | 0,782,000 | 1,090,000 | 0,868,000 | 0,901,000 | 1,090,000 |
| Unifirst - Texas Industrial Services | softening | | 11 | 5 | 9 | 1 | 1 | 0 | 2 | 5 | | | | no | | | no | NA | 1,196,110 | 1,010,170 | 1,218,715 | 1,278,679 | 1,311,911 | 1,379,683 | 1,311,001 |
| THM Medical Office Building | acid, algacide, bioside | | 200 | 40 | 400 | 75 | 30-40 | 30-40 | 20 | 50 | 1.5, 3 | 1.5, 3 | no | NA | | NA | yes | Jun-Sept | 1,323,000 | 1,275,000 | 1,363,000 | 1,417,000 | 1,679,000 | 1,775,000 | 2,009,000 |
| Radisson Suite Hotel Houston West | softening | | 180 | 4 | 179 | 5 | 4 | | | 1 | 2 | 0.5 | no | | | | no | | | | | | | | |
| Baylor College of Medicine | | | 400 | 200 | 175 | 7 | 65 | 1100 | 15 | 65 | 1.9 | 1 | no | | | | yes | May-Sept | 6,500,000 | 6,500,000 | 6,600,000 | 7,500,000 | 8,200,000 | 1,000,000 | 9,400,000 |
| Reed Tool Company | NA | | 38 | 19 | 19 | 4 | 6 | 5 | 45 | 25 | 3 to 5 | 3 to 5 | yes | 4 | 12 | all | yes | all 12 | 2,500,000 | 4,040,000 | 3,430,000 | 3,700,000 | 4,210,000 | 6,170,000 | 3,900,000 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 17 treat | | ### | ### | ### | ### | 593 | 1807 | ### | 845 | | | 5 yes | | | | 23 yes | | 66,198,426 | 63,542,834 | 61,033,366 | 68,754,206 | 72,011,002 | 74,111,053 | 78,692,965 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
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| NAME | 19-Aug | 19-Sep | 19-Oct | 19-Nov | 19-Dec | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| Wyndham Hotel | 2,781,000 | 2,563,000 | 2,457,000 | 2,166,000 | 2,460,000 | groundcover, flowers, shrubs, grass | 2 | Mar-Sept as needed | manual | 4 | considerable |
| Memorial Senior Service DBA: Univ. Pl | | | | | | Bedding | 8 | yes, 2-3 X wkly | auto | 9 | urgent |
| Metropolitan Transit Authority | 9,400,000 | 9,600,000 | 12,500,000 | 10,400,000 | 9,700,000 | general | >15 | yes | manual | 10 | urgent |
| Columbia West Houston Medical Center | | | | | | grassy turf | 21 | every day | auto | | urgent |
| United States Gypsum Company | 0 | 0 | 0 | 0 | 0 | yard, shrubs | 1 | no, 2X/wk | auto | 5 | somewhat |
| St. Luke's Episcopal Hospital | | | | | | lawn, shrubs | 1 | yes, 3 days/wk | auto | 8 | considerable |
| Reynolds Metals Co. | 5,810,000 | 4,651,000 | 3,623,000 | 3,661,000 | 4,584,000 | grass, shrubs | NA | NA | NA | 6 | somewhat |
| Northwestern Steel & Wire Company | 8,400,000 | 6,800,000 | 6,800,000 | 4,500,000 | 5,900,000 | no deliberate landscaping | NA | NA | NA | 4 | somewhat |
| Memorial Hospital Southeast | 2,967,000 | 2,479,000 | 1,842,000 | 2,105,000 | 1,657,000 | flowerbeds, trees, grounds | 10 | Mar-Oct | auto | | somewhat |
| Johnston Middle School | 1,770,000 | 0,282,000 | 0,840,000 | 0,761,000 | 0,000,735 | flowerbeds, shrubs, St. Augustine grass | 3 | as needed | auto | 6 | considerable |
| Memorial SW Prof. Health Care Facility | 0,579,000 | 0,569,000 | 0,448,000 | 0,437,000 | 0,308,000 | grass, trees, shrubs | <1 | yes,every other day | both | 1 | somewhat |
| First Interstate Bank Plaza | 3,530,000 | 3,372,000 | 3,523,000 | 2,147,000 | 2,098,000 | trees, shrubs, planters | 0.5 | yes, moisture detectors | auto | 7 | somewhat |
| Houston Chronicle | 2,823,000 | 2,976,000 | 3,000,000 | 2,400,000 | 2,300,000 | potted shrubs | | | | 4 | considerable |
| Hormel Food Corp. | 3,200,000 | 2,500,000 | 2,000,000 | 1,125,000 | 0,957,000 | grass, lawn, shrubs | 2 | June-Sept | auto | 4 | somewhat |
| Hines Interest Limited Partnership | 4,106,000 | 3,881,000 | 2,747,000 | 2,956,000 | 2,580,000 | NA | NA | NA | NA | 7 | considerable |
| Goodyear | | | | | | | | | | | |
| Goodman Manufacturing Co. L.P. | 1,173,064 | 1,401,159 | 1,857,351 | 2,020,276 | 2,118,032 | none | none | none | none/ | 0 | somewhat |
| Four Seasons Hotel | 4,081,000 | 4,291,000 | 3,925,000 | 3,925,000 | 4,213,000 | flower beds | <1 block | every morning | auto | 6 | considerable |
| Doubletree Guest Suites Houston | 3,100,000 | 2,300,000 | 2,300,000 | 2,200,000 | 1,970,000 | trees, grass, flowerbeds | 1.5 | every 2-3 days | auto | 10 | somewhat |
| Doctor's Hospital Airline | 1,633,000 | 1,800,000 | 1,700,000 | 1,400,000 | 1,400,000 | grass, shrubs, trees | | | auto | | considerable |
| Clarion Inn | 0,170,000 | 0,160,000 | 0,160,000 | 0,160,000 | 0,160,000 | | | | | | |
| CINTAS Corporation | 2,145,000 | 2,322,000 | 2,305,000 | 2,602,000 | 2,178,000 | grass, shrubs, trees | NA | NA | NA | 8 | somewhat |
| Cal-Tex Citrus Juice, Inc. | | | | | | | | | | | |
| Bayer Corporation | | | | | | minimal | <10000 sf | 4x/wk @ 20 min/x | manual | 9 | considerable |
| Mutual Benefit Life | 0,614,220 | 0,571,310 | 0,549,580 | 0,400,980 | 0,316,660 | grass, trees, flowers | 1 to 2 | every 3 days | auto | 6 | somewhat |
| YMCA Downtown | 1,996,000 | 1,823,000 | 1,639,000 | 1,837,000 | 1,492,000 | grass, bush | 0.5 | mornings for 10 mins | auto | 3 | somewhat |
| Jacob Stern & Sons, Inc. | 1,037,000 | 1,240,000 | 1,489,000 | 2,032,000 | 2,129,000 | grass, bushes | 0.25 | yes, daily | auto | 2 | somewhat |
| Holiday Inn | 1,417,000 | 1,306,000 | 1,425,000 | 1,161,000 | 1,138,000 | all | 3 | yes | auto | | considerable |
| Angelica Healthcare Services Group, Inc. | 2,954,000 | 3,728,000 | 2,967,000 | 2,905,000 | 2,095,000 | sod | NA | rain water only | NA | 8 | considerable |
| Westchase Equities | 1,554,000 | 1,040,000 | 1,082,000 | 0,976,000 | 0,755,000 | | 3 | rainfall dependent | manual | 7 | somewhat |
| Holiday Inn Select | 0,001,600 | 0,001,600 | 0,001,600 | 0,001,600 | 0,001,600 | small trees, grasses, bushes | 1.5 | no, turns on as needs | auto | 8 | somewhat |
| Owens Corning | 1,317,000 | 1,234,000 | 1,369,000 | 1,063,000 | 0,710,000 | sparse | 0 | NA | NA | 4 | somewhat |
| Unifirst - Texas Industrial Services | 1,407,613 | 1,399,677 | 1,091,799 | 1,101,913 | 1,119,001 | commercial landscape | 0.5 | yes, 1-in/wk set up | manual | 8 | urgent |
| THM Medical Office Building | 1,956,000 | 1,680,000 | 1,487,000 | 1,268,000 | 1,372,000 | grass along one side of building | 0.25 | no, timer, weekly | auto | 6 | somewhat |
| Radisson Suite Hotel Houston West | | | | | | shrubs and bushes | 1 | daily May-Sept; 3x/wk Oct-Apr | auto | 8 | considerable |
| Baylor College of Medicine | 9,500,000 | 9,500,000 | 7,100,000 | 6,900,000 | 6,900,000 | grass, flowerbeds, trees | 2 | 2x/wk at late spring/early fall | auto | 6 | urgent |
| Reed Tool Company | 5,450,000 | 4,380,000 | 4,440,000 | 4,280,000 | 3,730,000 | trees, shrubs | 0.21 | no | | 4 | somewhat |
| | | | | | | | | | | | |
| | 86,872,497 | 79,850,746 | 76,668,330 | 68,891,769 | 66,342,028 | | | | 19 auto | 19 say | 16 say |
| | | | | | | | | | | 6 or higher | considerable or urgent |
| | | | | | | | | | | | |
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| NAME | 26 | 27 | 27a | 27b | 27c | 27d | 28 | 29 | 30 | 30a | 30b | 30c | 30d | 30e | 30f |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| Wyndham Hotel | | | | | | | | | | | | | | | |
| Memorial Senior Service DBA: Univ. Pl | take irrigation off main water | no | | | | | | | | | | | | | |
| Metropolitan Transit Authority | water conserv. team in prgrss | yes | Aug-94 | current | yes | multiple | 3 | 3,4,10 | yes | 30% | | | | | |
| Columbia West Houston Medical Center | no plan | no | | | | | NA | NA | NA | NA | NA | no | | | |
| United States Gypsum Company | none | no | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| St. Luke's Episcopal Hospital | faucet flow restrictors; cost=$300/floor | no | | | | single | | | NA | | NA | | | | |
| Reynolds Metals Co. | use ww effluent for lime/polymer slurry makeup | no | NA | NA | NA | NA | NA | 4,5,6 | | | | | | | |
| Northwestern Steel & Wire Company | increase recycling, reduce sys. blowdown. Save 10-20% of wtr bill | no | | | no | no | NA | NA | NA | | | | | | |
| Memorial Hospital Southeast | replace vacuum pumps | | | | | | | | | | | | | | |
| Johnston Middle School | would like low flow showers, toilets, urinals; timely response to leaks | yes | Aug-93 | | yes | multiple | 4 | 5 | yes | | | 50% | | | |
| Memorial SW Prof. Health Care Facility | open to ideas | no | | | yes | | no | NA | NA | | | | | | |
| First Interstate Bank Plaza | no plans at this time | no | | | | | NA | NA | NA | | | | | | |
| Houston Chronicle | conversion to water saving fixtures | | | | | | | | | | | | | | |
| Hormel Food Corp. | metering for effluent. saving=15-20% | no | | | | | NA | NA | NA | | | | | | |
| Hines Interest Limited Partnership | install new bathroom faucets end of 1995 | NA | | | | | NA | NA | NA | | | | | | |
| Goodyear | | | | | | | | | | | | | | | |
| Goodman Manufacturing Co. L.P. | the elimination of spotwelders | no | | | | | | | | | | | | | |
| Four Seasons Hotel | we are considering recycling our laundry water | yes | ongoing | ongoing | yes | single | 3 | no | no | | | | | | |
| Doubletree Guest Suites Houston | complete: showers, flappers, heat exchangers, cooling tower makeup changes | no | | | yes | single | 3 | 3 | no | | | | | | |
| Doctor's Hospital Airline | | no | | | | | | | | | | | | | |
| Clarion Inn | | | | | | | | | | | | | | | |
| CINTAS Corporation | increase water reuse | no | | | yes | single | NA | NA | NA | | | | | | |
| Cal-Tex Citrus Juice, Inc. | | | | | | | | | | | | | | | |
| Bayer Corporation | none at this time but water conservation is a growing issue | no | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mutual Benefit Life | good P.M. schedule and keep all leaks repaired | NA | | | | | no | NA | NA | | | | | | |
| YMCA Downtown | change to low flow toilets (24) cost $1,5000 save 1,089.84 per year | no | | | | | NA | NA | NA | | | | | | |
| Jacob Stern & Sons, Inc. | none | no | | | | | | | | | | | | | |
| Holiday Inn | no plan at this time | yes | 1988 | | | | 2 | | | | | | | | |
| Angelica Healthcare Services Group, Inc. | presorting by soil classification and loading properly in conventional washer | | | | yes | single | 5 | 1,2,5,9 | | | 2/10/96 | 2/10/96 | | | |
| Westchase Equities | we have already increased the efficiency to current affordable technologies | | | | | | 5 | | no | | | | | | |
| Holiday Inn Select | NA | yes | 1990 | 1993 | yes | multiple | 3 | 3,5,7 | yes | | replacement equip. use air cool | | | | |
| Owens Corning | review feasibility of recycling converter jacket water for asphalt operations | no | | | | | NA | NA | NA | | | | | | |
| Unifirst - Texas Industrial Services | no savings is anticipated in the cost factor | no | NA | NA | yes | multiple | NA | 1,2,3,4,9 | no | | titration | microprocessors | filtration | | |
| THM Medical Office Building | considering filtration on incoming water from the city to reduce sediment/silt | no | | | | | NA | NA | NA | | | | | | |
| Radisson Suite Hotel Houston West | | no | | | | | | | | | | | | | |
| Baylor College of Medicine | none | no | | | | | | | | | | | | | |
| Reed Tool Company | flow restrictive devices on sinks and toilets | no | NA | | | | NA | | NA | | | | | | |
| | | | | | | | | | | | | | | | |
| | 7 have no plans | 22-no | | | | | | | | | | | | | |
| | | 5-yes | | | | | | | | | | | | | |
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| NAME | 31 | 32 | 33 | 34 | 35 94 | 35 93 | 35 92 | 35 91 | 35 90 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Wyndham Hotel | | | | | | | | | |
| Memorial Senior Service DBA: Univ. Pl | | | | | | | | | |
| Metropolitan Transit Authority | | 29% | NA | operating | started | | | | |
| Columbia West Houston Medical Center | | NA | 0 | NA | | | | | |
| United States Gypsum Company | NA | NA | NA | | 36.7 | 32.5 | 32.8 | 28.1 | 33 |
| St. Luke's Episcopal Hospital | 1994-change to low flow toilets and showers | NA | NA | NA | NA | | | | |
| Reynolds Metals Co. | 1994-rcycle cooling/prcss wtr sved $100,000/yr | | 0 | | | | | | |
| Northwestern Steel & Wire Company | 1990-rcycl cooling/prcs wtr; 1994-imprv cntrl syst svd 5% wtr cst & leak mntrng, repair svd10% wtr cst | 5-10% | $13,000 | | | | | | |
| Memorial Hospital Southeast | 1994-changed/reduce nozzles and flow svd 3,950,000; 1987 change to low flow showers | 5% | | not funded | | | | | |
| Johnston Middle School | automatic shutoffs, changed to low flow showers, changed landscape irrigation practices | 40-50% | $ spent on repairs | energy consum. dept | 7 | | | | |
| Memorial SW Prof. Health Care Facility | NA | NA | NA | NA | | | | | |
| First Interstate Bank Plaza | 1994-changed to low flow toilets; 1993-changed landscape/irrigation practices | 15% | 0 | NA | NA | NA | NA | NA | NA |
| Houston Chronicle | | | | | | | | | |
| Hormel Food Corp. | | | | NA | NA | NA | NA | NA | NA |
| Hines Interest Limited Partnership | 1975-cooling towers | | | NA | NA | NA | NA | NA | NA |
| Goodyear | | | | | | | | | |
| Goodman Manufacturing Co. L.P. | 1990-changed clean-up procedures and saved 4000 gal/mo | 20% | 0 | | | | | | |
| Four Seasons Hotel | | | | | | | | | |
| Doubletree Guest Suites Houston | 1993-changed to low flow showers | 250,000 gal/mo | $4,000 | one time capital cost | 3 | 3 | | | |
| Doctor's Hospital Airline | | | | | | | | | |
| Clarion Inn | | | | | | | | | |
| CINTAS Corporation | 1990-recycle cooling/process water saved 1,040,000/yr; 1992-changed to low flow toilets, daily meter readings | 5% | | NA | 1 | 1 | 1 | 1 | 1 |
| Cal-Tex Citrus Juice, Inc. | | | | | | | | | |
| Bayer Corporation | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mutual Benefit Life | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| YMCA Downtown | NA | NA | NA | NA | | | | | |
| Jacob Stern & Sons, Inc. | NA | | | | | | | | |
| Holiday Inn | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Angelica Healthcare Services Group, Inc. | as owners since 9/29/94 we continue to review and upgrade wash formula per soil classification | 5% | NA at this time | plant budget | NA | NA | NA | NA | NA |
| Westchase Equities | 1992-leak monitoring, repair w/ substantial savings; changed landscape/irrigation practices saved 1000s | | | | | | | | |
| Holiday Inn Select | 1993-change low flow toilets, lower flow settings, leak monitoring and/or repair; 1990-switched water sources | 10-20% | NA | annual budget | | | | | |
| Owens Corning | 1977-recycle cooling or process water saved 20M; 1993-installed more efficient cooling syst. saved 10M | 10% | limited manhours | capital plan | NA | NA | NA | NA | NA |
| Unifirst - Texas Industrial Services | 1991-improve control syst saved 1%; 1992-leak monitoring and/or repair saved 2% | 0.16% | $1,000 | corporate | 0.44 | | | | |
| THM Medical Office Building | 1993-changed to low flow toilets | NA | NA | NA | NA | NA | NA | NA | NA |
| Radisson Suite Hotel Houston West | 1992-changed to low flow showers | | | | | | | | |
| Baylor College of Medicine | 92-rcyc coling/prcs wtr, reuse prcs or bwn prcs & coling, chng ldscp/irrg; 93-imprv cntl sys, chng nzls, flw rtes & sel | 5% | $50,000 total | operating budget | 2.5 | 1.5 | 0.5 | 0 | 0 |
| Reed Tool Company | NA | NA | NA | NA | NA | NA | NA | NA | NA |
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| NAME | 36 | 37 | 38 | 39 | 40 |
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| Wyndham Hotel | | 12 mos ROI | | | funding |
| Memorial Senior Service DBA: Univ. Pl | | | | | |
| Metropolitan Transit Authority | water savings | 1 year | positive | o.k. as is | NA |
| Columbia West Houston Medical Center | NA | NA | none | | None |
| United States Gypsum Company | reduce fresh water use | 2 years | continuous effort | none | |
| St. Luke's Episcopal Hospital | NA | NA | | no technology available for design of our bldg | funding |
| Reynolds Metals Co. | | ROI | looking at wtr cnsmptn at wshrs and using effl wtr for lime/polymer slurry makeup | | funding, staff |
| Northwestern Steel & Wire Company | | | | | |
| Memorial Hospital Southeast | | 12-24 mos | | | |
| Johnston Middle School | 50% decrease in water consmp. | 2-5 yrs | low cost retrofitting, education, replace obsolete/inefficient HVAC equipment | durable, efficient water fixtures | funding, staff |
| Memorial SW Prof. Health Care Facility | | | | | |
| First Interstate Bank Plaza | NA | NA | replace restroom fixtures as needed with low flow fixtures | low flow toilets, urinals, sinks, automatic/sensored fixtures | funding |
| Houston Chronicle | | | conversion to more efficient fixtures | | funding, staff |
| Hormel Food Corp. | NA | NA | | education for employees on why water should be conserved | |
| Hines Interest Limited Partnership | NA | NA | NA | NA | funding |
| Goodyear | | | | | |
| Goodman Manufacturing Co. L.P. | lower water bill | NA | the operation is stable. no changes planned in near future. | | funding, staff |
| Four Seasons Hotel | | | check faucets daily to ensure they are in good working order | recycle laundry water | funding |
| Doubletree Guest Suites Houston | lower water/sewer bills | <12 months | trying to use as little as possible | recycle laundry wash water | funding, staff |
| Doctor's Hospital Airline | | | | | |
| Clarion Inn | | | | | |
| CINTAS Corporation | small reduction in water costs | 30 months | water is our only raw material, we constantly evaluate its usage and re-use | 100% reuse; cost to buy, treat, dispose of water is large part of production cost | funding |
| Cal-Tex Citrus Juice, Inc. | | | | | |
| Bayer Corporation | NA | NA | NA | NA | NA |
| Mutual Benefit Life | NA | NA | keep all devices repaired | NA | NA |
| YMCA Downtown | NA | NA | plan to change toilets to conservation type | | funding, staff |
| Jacob Stern & Sons, Inc. | | | | | |
| Holiday Inn | cut cost | 6 mos | | auto towel, auto flush to save water | funding |
| Angelica Healthcare Services Group, Inc. | reduced water use | gal/clean lb served | tighten valves, check lines, presort by wash classification | reduce water/sewer costs based on conservation methods of operation | NA |
| Westchase Equities | lower operating cost | | | | |
| Holiday Inn Select | reduce operation costs | NA | use water and energy saving at high efficiency without affecting our business | NA | funding |
| Owens Corning | reduced operating costs | <1 year | projects that increase water efficiency and are financially viable are implemented | limited knowledge of current water conservation technology | funding |
| Unifirst - Texas Industrial Services | meet budget requirements | % of volume | confusion about conservation versus water rationing | our next 10 years has been keyed toward water reuse and filtration | |
| THM Medical Office Building | NA | NA | NA | would have to know what is available | |
| Radisson Suite Hotel Houston West | | | | | |
| Baylor College of Medicine | cost savings | NA | try to become more efficient | NA | |
| Reed Tool Company | NA | no investment | separation of consumption and sanitary ww from process water before leaving plant | water purification plant onsite that will recycling 100% plant process water | funding, staff |
| | | | | | |
| | | | | | |
| | | | | | **16 say fundin** |
| | | | | | **7 say staff** |
| | | | | | |
| | | | | | |
| | | | | | |

| NAME | 41 | 42 | 43 |
|---|---|---|---|
| | | | |
| Wyndham Hotel | 1,2,3 | | |
| Memorial Senior Service DBA: Univ. Pl | 1,2 | | |
| Metropolitan Transit Authority | 1,2,3 | innovative ideas | |
| Columbia West Houston Medical Center | | | |
| United States Gypsum Company | | nothing at this time | none |
| St. Luke's Episcopal Hospital | 1 | | |
| Reynolds Metals Co. | 1,3 | COH do wtr audit and provide suggestions | |
| Northwestern Steel & Wire Company | | | |
| Memorial Hospital Southeast | | | |
| Johnston Middle School | 1,3 | rebates based on efficient water use; incentives to replace inefficient fixtures | need tech assist. to locate major underground water leaks and additional landscaping and construction work |
| Memorial SW Prof. Health Care Facility | | | |
| First Interstate Bank Plaza | 1,3 | published literature to property owners/mgrs; water audits | none |
| Houston Chronicle | 1,3 | | |
| Hormel Food Corp. | 1,2,3 | | |
| Hines Interest Limited Partnership | 1,3 | | |
| Goodyear | | | |
| Goodman Manufacturing Co. L.P. | 1,3 | unknown | |
| Four Seasons Hotel | 1 | | none |
| Doubletree Guest Suites Houston | 1,3, | provide lower M alkalinity and lower calcium water | The city of Houston, as far as I know, has the second highest water/sewer rates (only to Boston) |
| Doctor's Hospital Airline | 1,3 | | |
| Clarion Inn | | | |
| CINTAS Corporation | 1,3 | | |
| Cal-Tex Citrus Juice, Inc. | | | |
| Bayer Corporation | NA | | |
| Mutual Benefit Life | | | |
| YMCA Downtown | 1,2,3 | perform audit and make recommendations regarding this bldg's water use. | |
| Jacob Stern & Sons, Inc. | | | |
| Holiday Inn | 1,2,3 | visit more often just to check the permits | |
| Angelica Healthcare Services Group, Inc. | 1 | | would like rebate for doing laundry for indigent patients. Houston sewer discharge cost exceeds other utilities |
| Westchase Equities | 3 | allow evaporation credit on water used in decorative fountain | |
| Holiday Inn Select | 1,3 | provide more technical info and ideas to save water at high efficiency level | NA |
| Owens Corning | 1 | water conservation seminars similar to the annual treatment seminars | |
| Unifirst - Texas Industrial Services | 3 | explain difference between water conservation versus water rationing | |
| THM Medical Office Building | 1,2,3 | rebates for low flow toilets and urinals | we have always had a lot of sand, silt, sediment in our domestic water system. |
| Radisson Suite Hotel Houston West | | | |
| Baylor College of Medicine | 1,3 | | |
| Reed Tool Company | 1,2,3 | develop decentralized water service depts. based on geographic areas | |
| | | | |
| | | | |
| | 7 say | | |
| | 1,2,3 | | |
| | | | |
| | 11 say | | |
| | 1,3 | | |

# APPENDIX B

## Conservation Measure Screening

# CITY OF HOUSTON (COH) WATER CONSERVATION PLAN
## POTENTIAL CONSERVATION MEASURES AND INITIAL SCREENING

| | DEVICE | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| *Residential Interior* | | | | | | | | | |
| | **Residential Water Audits** | COH provide | Free. Optional retrofit kit. | 5 | 5 | 5 | 5 | 5 | YES |
| | **Retrofit Kit** | COH deliver with bill or audit | Free | 5 | 5 | 4 | 5 | 4 | YES |
| | **Shower** | | | | | | | | |
| | • New fixed head | Customer purchase; COH deliver & install | Coupon or rebate Free | 5 | 5 | 5 | 5 | 1 | NO |
| | • Flow restrictor | COH mail, or give with bill or audit | Free | 5 | 5 | 3 | 5 | 1 | NO |
| | • Shut-off valve | COH mail, or give with bill or audit | Free | 5 | 5 | 2 | 5 | 1 | NO |
| | • Timer | COH public relations giveaway; COH mail or give with bill or audit | Free Free | 5 | 5 | 1 | 5 | 2 | NO |
| | **Toilets** | | | | | | | | |
| | • New 6L toilet | Customer purchase | Coupon or rebate Free | 4 | 5 | 4 | 5 | 5 | YES |
| | • New 6L toilet for low income, elderly and handicapped, etc. | COH provide | Free | 4 | 5 | 4 | 5 | 4 | YES |
| | • Displacement device (bag or dam) | COH mail, or give with bill or audit | Free | 5 | 5 | 1 | 3 | 1 | NO |
| | • Leak repair -dye tablet | COH mail, or give with bill or audit | Free | 5 | 5 | 2 | 5 | 4 | YES |
| *Residential Interior* | | | | | | | | | |
| | • Replace flapper valve | COH mail, or give with bill or audit | Free | 5 | 5 | 3 | 5 | 1 | NO |

1 On a scale of 1 through 5 with 5 being the most acceptable

| DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| • Dual flush | Create market | Coupon or rebate; Free | 2 | 3 | 1 | 3 | 4 | NO |
| • Fill cycle divertor | COH mail, or give with bill or audit | Free | 2 | 5 | 2 | 4 | 3 | NO |
| • Early closure device | COH mail, or give with bill or audit; customer purchase | Free; coupon | 2 | 4 | 1 | 3 | 1 | NO |
| **Faucets** | | | | | | | | |
| • Aerator w/restrictor | COH mail, or give with bill or audit; customer purchase | Free; coupon | 5 | 5 | 4 | 5 | 1 | NO |
| • Shut-off valve | COH mail or give with bill; customer purchase | Free; coupon | 5 | 5 | 1 | 5 | 1 | NO |
| • Fix leaky faucets | COH supplied kit COH provide plumber | Free | 5 | 5 | 2 | 5 | 2 | NO |
| **Dishwashing** | | | | | | | | |
| • Labeling | In -store advisory | Enforcement | 4 | 4 | 3 | 5 | 4 | YES |
| Settings | Advertisement | Education; potential save water/ energy/ money | 4 | 4 | 2 | 4 | 1 | NO |
| New technology | Import, education to promote | Education; potential save water/ energy/ money | 2 | 4 | 2 | 3 | 4 | NO |
| *Residential Interior* | | | | | | | | |
| **Hand washing** | | | | | | | | |
| Turn water off | Education | Education; potential save water/ money | 5 | 4 | 1 | 2 | 3 | NO |

| DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| **Washing Machines** | | | | | | | | |
| Labeling | In -store advisory, Advertisement | Education; potential save water/ money | 4 | 4 | 2 | 4 | 4 | YES |
| Settings | Advertisement, Education | Education; potential save water/ money | 4 | 4 | 2 | 4 | 1 | NO |
| New technology | Import, Education to promote | Rebate, Coupon | 2 | 4 | 1 | 3 | 4 | NO |
| **Water Heating** | | | | | | | | |
| Place hot water heater in center of house. | Building code changes; education, customer purchase | Enforcement ; rebate | 5 | 2 | 1 | 4 | 1 | NO |
| Install on-demand point-of-use water heating systems; insulate hot water piping. | Building code changes; education, customer purchase | Enforcement ; rebate | 4 | 2 | 2 | 4 | 1 | NO |
| Insulate pipes | Education: media, displays; Building code change; customer purchase | Rebate; lower water/ energy bills | 5 | 2 | 3 | 4 | 2 | NO |
| *Residential Exterior* | | | | | | | | |
| **Exterior Uses** | | | | | | | | |
| Trigger shut-off valve | COH Give away Manufacturer include with hose purchase | Rebate, Free | 5 | 5 | 3 | 5 | 3 (w/ addl) | YES |
| Cleaning: Use bucket | Education | Potential for lower water bills | 5 | 4 | 2 | 4 | 1 | No |
| Cleaning: Use broom | Education | Potential for lower water bills | 4 | 3 | 2 | 3 | 1 | NO |
| Landscape use efficiency | Education | Potential for lower water bills, rebate | 4 | 3 | 2 | 5 | 5 | YES |

| | DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| | Pool cover | Customer purchase, education | Potential for lower water bills; rebate; less cleaning | 5 | 3 | 2 | 2 | 1 | NO |
| | Irrigation advisory service | COH, Education, Newspaper | Potential for lower water bills | 3 | 2 | 1 | 5 | 4 | NO |
| | Outdoor water audits | Newspaper, bill flyer; COH provide | Free; Potential for lower water bills | 4 | 4 | 3 | 5 | 5 | YES |
| | Water waste ordinance | COH Regulations | Enforcement | 4 | 2 | 1 | 3 | 1 | NO |
| | Mandatory irrigation times | COH Regulations | Enforcement | 3 | 2 | 1 | 4 | 1 | NO |
| *Residential* | | | | | | | | | |
| | Supply | | | | | | | | |
| | Cisterns/Rain Water Tanks | Education Bill Brochure; Customer purchase | Potential for lower water bills | 3 | 4 | 1 | 2 | 2 | NO |
| | New Home Points Program | Building design regulations | Certain number of points necessary before water connection permit is given | 3 | 2 | 2 | 5 | 2 | NO |
| | Home Leak Detection and Repair | COH testing and repair | Free | 4 | 4 | 2 | 4 | 2 (audit) | NO |
| | Home Leak Detection and Repair for low income, elderly and handicapped | COH provide | Free | 4 | 4 | 2 | 4 | 4 | YES |
| | Reuse gray water | Customer purchase and install; regulations | Rebates; enforcement | 3 | 3 | 2 | 2 | 3 | NO |

| DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | ASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| *Commercial* | | | | | | | | |
| **Laundries** | | | | | | | | |
| Laundromat Waste Audit | COH Audit | Potential for lower water bills | 4 | 5 | 3 | 5 | 5 | YES |
| Recycle for new laundries | COH Audit, Education | Potential for lower water bills | 4 | 5 | 2 | 3 | 3 | YES |
| Leak detection and control | COH Audit, Plumber | Free, Potential for lower water bills | 2 | 4 | 2 | 4 | 2 | NO |
| Water efficient machines | Customer Purchase | Rebate, Discount on water bill | 5 | 5 | 1 | 4 | 2 | NO |
| **Hotels** | | | | | | | | |
| Bathroom audit<br>• showers<br>• toilets<br>• faucets<br>• urinals | COH audit | Free; Discount on water bill; optional low flow fixtures giveaway | 5 | 5 | 3 | 4 | 5 | YES |
| Pool audit; (cover) | COH audit; customer purchase | Free audit; Rebate or Coupon | 5 | 3 | 3 | 5 | 5 | YES |
| Laundry audit | COH audit | Free; Discount on water bill | 4 | 5 | 3 | 5 | 2 | NO |
| Restaurant use audit | COH audit | Free; Discount on water bill | 3 | 4 | 2 | 4 | 3 | NO |
| Cooling tower audit | COH audit, EDUCATION, PERSONNEL TRAINING | Free; Discount on water bill | 4 | 5 | 3 | 5 | 5 | YES |
| Automatic shut-off valves | Education, Customer Purchase | Rebate, Coupon | 4 | 3 | 2 | 4 | 2 | NO |
| No once through cooling | Education, Customer Purchase | Rebate, Coupon | 5 | 1 | 3 | 4 | 1 | NO |

| DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Air cool instead of water cool | Education, Customer Purchase | Rebate, Coupon | 4 | 4 | 1 | 4 | 1 | NO |
| Low-flow plumbing fixtures | Education, Audit, Customer Purchase | COH provide; Rebate, coupon | 5 | 5 | 3 | 4 | 4 | YES |
| Cleaning method audit | COH audit | Free; Discount on water bill | 5 | 4 | 4 | 4 | 2 | NO |
| Fountain audit | COH audit | Free; Discount on water bill | 5 | 5 | 3 | 5 | 5 | YES |
| *See Residential* | | | | | | | | |
| *See Landscaping* | | | | | | | | |
| *See Laundries* | | | | | | | | |
| *See Restaurants* | | | | | | | | |
| **Restaurants** | | | | | | | | |
| Serve water only when asked | Education, Table brochures | Free | 4 | 3 | 1 | 5 | 2 | NO |
| *Commercial* | | | | | | | | |
| Dishwasher practice audit | COH audit, Education | Free | 4 | 4 | 2 | 3 | 1 | NO |
| Garbage disposal practice audit | COH audit, Education | Free | 2 | 4 | 2 | 3 | 1 | NO |
| Cleaning method audit (inc. water softeners) | COH audit, Education | Free | 2 | 4 | 2 | 2 | 1 | NO |
| Toilet audit | COH audit, Education | Free displacement device | 5 | 4 | 4 | 4 | 4 | YES |
| Leak detection | COH audit, Education | Free | 4 | 4 | 4 | 4 | 4 | YES |
| Employee education | Education: seminar, workshop | Free | 4 | 4 | 3 | 4 | 4 | YES |
| Change water-cooled ice makers to air cooled | COH audit, Education; Customer Purchase | Free audit; Rebate, coupon, water bill discount | 3 | 5 | 1 | 4 | 3 | NO |

| DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | ASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Reuse non contact cooling water for water-cooled machines (frozen yogurt, refrigerators) | COH audit, Education, Customer Purchase | Free audit; rebate, coupon | 3 | 5 | 2 | 3 | 2 | NO |
| Install on-demand point-of-use water heating systems; insulate hot water piping. | Customer Purchase; COH installation, Education | Rebate, coupon | 2 | 4 | 2 | 4 | 2 | NO |
| Spray rinse with trigger control | Education | Rebate, coupon | 5 | 4 | 2 | 4 | 2 | NO |
| *Commercial* | | | | | | | | |
| Recycle rinse water to next wash | COH Audit, education, Customer Purchase | Rebate, Free audit; Potential to save water/ money | 4 | 4 | 1 | 2 | 2 | NO |
| **Schools** | | | | | | | | |
| Drinking fountains | Automatic Shut-off valve; COH Audit, Customer Purchase | Potential to save water/ money | 5 | 5 | 4 | 4 | 4 | YES |
| Employee education | COH Personnel, Teaching Materials | Free | 4 | 5 | 3 | 5 | 5 | YES |
| Toilet audit | COH Audit | Free audit, devices, rebates | 5 | 5 | 3 | 3 | 5 | YES |
| Cleaning method audit | COH Audit | Free | 3 | 4 | 2 | 4 | 2 | NO |
| Cafeteria audit | COH Audit, Education | Free | 3 | 4 | 3 | 4 | 4 | YES |
| Low flow plumbing fixtures | Customer purchase | Rebate | 5 | 5 | 3 | 4 | 5 | YES |
| **Offices (Including Government Buildings)** | | | | | | | | |
| Toilet audit | COH Audit | Free; Potential to save water/ money | 5 | 5 | 4 | 5 | 5 | YES |

| DEVI | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Cleaning method audit | COH Audit | Free; Potential to save water/ money | 4 | 4 | 3 | 4 | 2 | NO |
| Low flow plumbing fixtures | Customer purchase | Rebate | 5 | 5 | 4 | 5 | 5 | YES |
| *Commercial* | | | | | | | | |
| Cooling tower audits | COH Audit | Free; Potential to save water/ money | 4 | 5 | 3 | 5 | 5 | YES |
| **Hospitals** | | | | | | | | |
| Toilet audit | COH Audit, Education | Free; Rebate, free devices | 5 | 5 | 3 | 3 | 5 | YES |
| Cleaning method audit | COH Audit, Education | Free | 4 | 5 | 1 | 2 | 2 | NO |
| Cooling tower audits | COH Audit, Education | Free | 4 | 5 | 4 | 5 | 5 | YES |
| X-ray (photos) | COH Audit, Education | Potential to save water/ money | 3 | 5 | 3 | 4 | 2 | NO |
| • Flow to specs | Education; bill insert | | | | | | | |
| • Temp control valve- -less flow when x-rays are not being developed; solenoid valve | COH Audit; Education; customer purchase | Free audit; Rebate | | | | | | |
| • Recycle rinse bath effluent for developer/fixer solution | COH Audit, Education; Customer Purchase | Free; Potential to save water/ money; Rebate | | | | | | |
| • Separate/ recycle rinse form plating solutions using evaporator/ condenser or membrane systems | COH Audit, Education; Customer Purchase | Free; Potential to save water/ money; Rebate | | | | | | |

| DE\ | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | 'ASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| *Commercial* | | | | | | | | |
| Employee Education | COH Seminar | Free; Potential to save water/ money | 4 | 4 | 4 | 3 | 4 | YES |
| Leak Detection and Repair | COH Audit, Education | Free; Potential to save water/ money | 2 | 4 | 3 | 4 | 2 | NO |
| Automatic shut off valves | COH provide; Customer Purchase | Free; Potential to save water/ money; Rebate | 4 | 4 | 2 | 3 | 2 | NO |
| Air cool, not water cool | COH Audit, Education; Customer Purchase, | Potential to save water/ money; Rebate; Enforcement | 3 | 5 | 3 | 4 | 2 | NO |
| Low-flow plumbing fixtures | COH Audit, Education; Customer Purchase | Rebate | 5 | 5 | 2 | 3 | 4 | YES |
| *See Residential* | | | | | | | | |
| *See Laundries* | | | | | | | | |
| *See Landscaping* | | | | | | | | |
| **Auto Repair** | | | | | | | | |
| Cleaning audit | COH Audit | Free | 3 | 4 | 2 | 4 | 2 | NO |
| Leak detection/ use and repair | COH Audit | Free | 4 | 4 | 3 | 4 | 4 | YES |
| Air Blowing | COH Audit; Education; Customer Purchase | Rebate | 3 | 4 | 2 | 3 | 2 | NO |
| *Commercial* | | | | | | | | |
| Employee education | COH Audit, Education: flyers, workshop | Free | 4 | 5 | 3 | 5 | 5 | YES |
| Automatic shut-off valves | Customer Purchase | Rebate | 4 | 4 | 2 | 4 | 2 | NO |

| DEV. | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Reuse cleaning water | COH Audit, Education | Free, Rebate | 2 | 4 | 2 | 4 | 2 | NO |
| Air cool, no water cool | COH Audit, Education | Free, Rebate | 3 | 5 | 3 | 4 | 2 | NO |
| Low flow plumbing fixtures | COH Audit, Education | Free, Rebate | 5 | 4 | 2 | 4 | 2 | NO |
| *Car Washes* | | | | | | | | |
| Recycle Water | Education, COH Audit | Save Water/money | 4 | 5 | 2 | 4 | 2 | NO |
| Leak Detection and Repair | Education, COH Audit | Save water/money Rebate | 4 | 4 | 3 | 4 | 2 | NO |
| Water Audit | COH Audit | Free | 4 | 4 | 4 | 4 | 4 | YES |
| *Commercial Exterior* | | | | | | | | |
| **Landscaping** | | | | | | | | |
| Landscape codes | City ordinance | Enforcement | 5 | 3 | 3 | 5 | 5 | YES |
| Train landscape managers | COH Audit, workshop | Free | 4 | 3 | 3 | 5 | 5 | YES |
| Hire landscape architect to design/redesign efficient landscapes | Education, COH regulation | Enforcement | 5 | 3 | 2 | 5 | 2 | NO |
| Minimize turf; small uneven turf areas | Education, Building regulations | Enforcement | 4 | 3 | 2 | 4 | 2 | NO |
| Promote native plants | Education | Free | 4 | 3 | 2 | 4 | 2 | NO |
| Automatic irrigation system<br>-Drip, Microspray, subsurface<br>-Specific hydrozones<br>-Rain-overrides, smart controls | Education: Bill insert, store displays; media | Rebate | 4 | 2 | 3 | 4 | 2 | NO |
| *Commercial Exterior* | | | | | | | | |
| Water Waste Ordinance | Regulations, Education, Media | Enforcement Potential to save water, money | 5 | 3 | 1 | 3 | 1 | NO |
| Reclaimed water use | Regulations, Education, create market | Enforcement | 4 | 2 | 2 | 2 | 1 | NO |

| DEV | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Swimming pool and Fountain repair/retrofit | COH Audit | Free; Discount on water bill | 4 | 5 | 3 | 5 | 5 | YES |
| Demonstration Gardens | COH provide | Free | 5 | 3 | 3 | 5 | 5 | Yes |
| Esplanade Ordinance | COH Ordinance | Enforcement | 4 | 3 | 3 | 5 | 4 | Yes |
| Irrigation Audit | COH Audit, Regulation, Education, media | Enforcement Save Water/money | 5 | 3 | 3 | 5 | 5 | YES |
| *Industrial* | | | | | | | | |
| **Boilers, Hot Water, Steam** | | | | | | | | |
| Recapture/reuse steam | Education, Regulations, Customer Purchase | Rebate, Coupon, Enforcement | 4 | 2 | 4 | 4 | 2 | NO |
| Audit boiler, controls, use | COH Audit, Education, Regulations | Rebate, Coupon, Enforcement | 4 | 3 | 4 | 4 | 4 | Yes |
| Automatic blowdown and boiler make-up treatment controls | Education, Regulations | Enforcement | 3 | 3 | 3 | 4 | 2 | NO |
| Fix steam trap leaks | COH Audit, Education, Customer Purchase | Rebate, Coupon | 5 | 2 | 3 | 4 | 2 | NO |
| Insulate pipes and vessels | Education, Regulations, Customer Purchase | Rebate, Coupon, Enforcement | 4 | 2 | 3 | 4 | 2 | NO |
| *Industrial* | | | | | | | | |
| **Evaporative Cooling Systems** | | | | | | | | |
| Submeters for make-up and bleed-off water of cooling towers | Education, Customer Purchase | Rebates | 5 | 5 | 3 | 5 | 5 | YES |
| Recover, treat, reuse filter backwash water; reuse water from other site uses | Education | Potential to save water/ money | 4 | 3 | 2 | 3 | 2 | NO |
| Have condenser collection pans larger than drip pans | Education, Customer Purchase, Code Changes | Rebates, Enforcement | 4 | 5 | 2 | 4 | 2 | NO |

| DEV E | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Require vendors to pay for cooling; require performance specification for chem. service vendors | Code changes | Enforcement | 3 | 5 | 2 | 4 | 2 | NO |
| Cooling system audits: Control bleed-off based on conductivity; cooling system water treatment; inspect drift losses; minimize scale | COH audits, Education | Free | 5 | 5 | 4 | 5 | 5 | YES |
| *Industrial* | | | | | | | | |
| Eliminate single-pass water use; convert open evaporative systems to closed-loop cooling systems | Code changes; Customer purchase, Education | Rebates, Enforcement | 5 | 3 | 3 | 4 | 5 | YES |
| **Process and Equipment** | | | | | | | | |
| Water audit | COH Water Audit | Free | 5 | 5 | 4 | 4 | 5 | YES |
| Install pressure reducers where high-pressure isn't necessary | Customer Purchase | Rebates, Requirement | 3 | 3 | 3 | 3 | 2 | NO |
| Reheat from point-of-use or re-use hot water from other applications for tanks and baths | Customer Upgrade | Rebates; Requirement | 4 | 3 | 4 | 4 | 4 | YES |
| Counter-current rinse and clean; measured rather than continuous rinse and clean water | Customer Purchase/ Upgrade | Rebates; Requirement | 5 | 3 | 4 | 4 | 4 | YES |
| Ultrasonic container and degreasing cleaning equipment | Customer Purchase/ Upgrade | Rebates; Requirement | 4 | 2 | 3 | 4 | 2 | NO |
| Automatic recirculating washers | Customer Purchase/ Upgrade | Rebates; Requirement | 5 | 4 | 3 | 4 | 4 | YES |
| Partial water for smaller loads; batch processing | Customer Purchase/ Upgrade | Rebates; Requirement | 4 | 4 | 2 | 4 | 2 | NO |

| | DEV | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| | Recycle rinse water to next wash; reclaim wash water | Customer Purchase/ Upgrade | Rebates; Requirement | 5 | 4 | 3 | 4 | 4 | YES |
| *Industrial* | | | | | | | | | |
| | State-of-the-art process equipment | Customer Purchase/ Upgrade | Rebates; Requirement | 5 | 5 | 4 | 5 | 5 | YES |
| | Conveyor belt controls to stop wash and lube water when belt not operating | Customer Purchase/ Upgrade | Rebates; Requirement | 4 | 2 | 3 | 4 | 2 | NO |
| | **Paper and Packaging** | | | | | | | | |
| | Water blending | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 3 | 2 | 3 | 3 | 2 | NO |
| | White water recycling | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 4 | 2 | 3 | 3 | 2 | NO |
| | **Beverage Bottlers & Brewers** | | | | | | | | |
| | Recycle and reuse | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 5 | 4 | 3 | 3 | 4 | YES |
| | Process Design Modification | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 4 | 4 | 2 | 3 | 2 | NO |
| | Education | Customer Education; COH provide workshops, conferences, brochures | Free | 4 | 4 | 3 | 5 | 5 | YES |
| | Automatic shut-off valves | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 4 | 4 | 2 | 3 | 2 | NO |
| *Industrial* | | | | | | | | | |
| | Process Filtering for maximum product recovery | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 4 | 3 | 3 | 2 | 2 | NO |
| | Air cool, not water cool | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 3 | 3 | 2 | 3 | 2 | NO |

| DEV | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Reclaim cooling water | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 3 | 3 | 1 | 3 | 2 | NO |
| Low-flow plumbing fixtures | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 4 | 4 | 3 | 4 | 4 | YES |
| High pressure air cleaning | Customer Education/ Purchase/ Upgrade | Rebates; Requirement | 3 | 3 | 1 | 2 | 1 | NO |
| *City/County/State Bldgs. Interior* | | | | | | | | |
| **Water Audits** | COH provides | Free. | 5 | 5 | 4 | 5 | 5 | YES |
| **Shower** | | | | | | | | |
| New fixed head Showerhead | Customer purchase; COH provides | Free | 5 | 5 | 4 | 5 | 5 | YES |
| **Toilets** | | | | | | | | |
| New 6L toilet | Customer purchase; COH provides | Rebate or free | 5 | 5 | 4 | 5 | 5 | YES |
| Displacement device (bag or dam) | COH provides | Free | 4 | 4 | 3 | 3 | 2 | NO |
| Leak repair - dye tablet | COH provides; customer or COH repair | Free | 4 | 5 | 3 | 5 | 5 | YES |
| New 1 gal. urinals | Customer purchase; COH provides | Free | 5 | 5 | 4 | 5 | 5 | YES |
| Repair leaks; Install aerators in Faucets | COH Provide | Free | 5 | 4 | 3 | 5 | 5 | YES |
| Cooling | | | | | | | | |
| See Industrial-Cooling | | | | | | | | |
| **Exterior** | | | | | | | | |
| See Commercial-Exterior | | | | | | | | |
| *City Parks Dept. Interior* | | | | | | | | |
| See City/County/State Interior | | | | | | | | |
| **Exterior** | | | | | | | | |
| Swimming pool leak detection and repair | COH Audit | Decrease water/money loss | 5 | 5 | 4 | 5 | 5 | YES |

| DEV | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Fountain repair/retrofit | COH provide | Department save money/water | 5 | 5 | 3 | 4 | 4 | YES |
| Require all COH departments to pay for water | COH policy | Departments save money/water | 5 | 5 | 3 | 5 | 5 | YES |
| Low flow showerheads at swimming pools | COH provide | Departments save money/water | 5 | 5 | 4 | 5 | 5 | YES |
| Dead man switch for hoses at swimming pools | COH provide | Departments save money/water | 5 | 5 | 4 | 4 | 5 | YES |
| Secured float valves at swimming pools and fountains | COH provide | Departments save money/water | 5 | 5 | 3 | 4 | 5 | YES |
| Require all pools and fountains to have recirculation pumps | COH provide | Departments save money/water | 5 | 5 | 4 | 4 | 4 | YES |
| Water conservation training for COH employees/POOL PERSONNEL | COH provide | Departments save money/water | 4 | 4 | 3 | 5 | 5 | YES |
| Bayou reuse for irrigation | COH Audit, Education | Department save money/water | 4 | 4 | 3 | 3 | 4 | YES |
| See Commercial Exterior | | | | | | | | |
| *Supply-Side Measures* | | | | | | | | |
| Leak Detection and Repair | COH provides distribution system audits and leak detection and repair | Increase supply | 4 | 4 | 3 | 5 | 5 | YES |
| Pressure Reduction | COH requires pressure reducers set at no more than 50 psi | Enforcement | 5 | 2 | 1 | 3 | 2 | NO |
| *Conservation Pricing* | | | | | | | | |
| Inclining block rates | COH change | Encourage conservation | 4 | 3 | 3 | 5 | 5 | YES |
| Seasonal rates | COH change | Encourage conservation | 4 | 2 | 4 | 5 | 2 | NO |

| DE\ E | DISTRIBUTION METHOD | POSSIBLE INCENTIVE | SCREENING CRITERIA | | | | | PASS |
|---|---|---|---|---|---|---|---|---|
| | | | Technology/ Market Maturity | Service Area Match | Customer Acceptance/ Equity | Environmental Health/ Safety | Better Measure Available | |
| Marginal cost pricing | COH change | Encourage conservation | 4 | 2 | 4 | 5 | 2 | NO |
| Computerized billing system | COH change | Used to determine high water use, potential leaks | 4 | 4 | 4 | 5 | 5 | YES |
| *Education* | | | | | | | | |
| Publications: Newspaper, TV, Radio | COH to supply | Encourage conservation | 5 | 5 | 4 | 5 | 5 | YES |
| Presentations: Tables, booth | COH to supply | Encourage conservation | 5 | 5 | 5 | 5 | 5 | YES |
| Community events | COH to supply | Encourage conservation | 5 | 5 | 5 | 5 | 5 | YES |
| Displays: Utility, bumper stickers, billboards, posters, restaurant/ bathroom notices | COH to supply | Encourage conservation | 4 | 5 | 4 | 5 | 5 | YES |
| ET Hotline | COH to supply | Encourage conservation | 3 | 2 | 2 | 4 | 1 | NO |
| Demonstration Gardens | COH to supply | Encourage conservation | 5 | 3 | 3 | 5 | 5 | YES |
| Awards | COH to supply | Encourage conservation | 5 | 3 | 3 | 5 | 2 | NO |
| Workshops, Conferences | COH to supply | Encourage conservation | 4 | 3 | 2 | 4 | 4 | NO |
| In school training | COH to supply | Encourage conservation | 5 | 4 | 3 | 5 | 2 | YES |

# APPENDIX C

## Description of Water Conservation Programs

## APPENDIX C

## DESCRIPTION OF WATER CONSERVATION PROGRAMS

Twenty-one programs were selected for further review. The 21 programs are listed below and discussed in detail in this appendix.

## FORMAT FOR PROGRAM DESCRIPTIONS

This appendix provides the water savings and costs associated with each program. Both factors are dependent on how the measure is implemented, such as marketing and customer delivery, and the resulting participation rates. Each measure description follows the format below.

**Description**

- Target market (customer class)
- Technology or hardware devices employed
- Overall approach to ensure participation

**Marketing Strategies**

- Target audience
- Marketing techniques

**Delivery**

- Delivery approach
- Technical assistance
- Financial incentives

**Participation Rates**

- Eligible customers
- Initial and long-range participation

**Costs**

- Staffing requirements
- Design /start-up costs
- Delivery costs
- Administrative costs

**Water Savings**

- Basis and available documentation
- Indoor or outdoor water savings factors

References for costs and water savings will be provided for the draft report.

## RESIDENTIAL WATER AUDITS

### Description

The City of Houston (COH) would offer an indoor and outdoor water audit to existing single-family and multifamily residential customers with high water use. Audits should target the top 25 percent of water users to ensure significant water savings. It is important to target high water users otherwise the audit may not produce the savings needed to justify the program. The auditors would focus most on outdoor water use, identifying water waste, offering information to improve water use efficiency, and preparing a customized lawn irrigation schedule. Auditors would also conduct a brief indoor audit and install low-cost conservation devices such as low-flow showerheads. Each single-family audit would last approximately one and one-half hours; multifamily audits would last longer, depending upon the building size and the complexity of the irrigation system.

### Marketing Strategies

Three marketing strategies will be investigated. The first involves scheduling appointments with high water users. The second involves canvassing neighborhoods with known high water use and offering audits door-to-door. The third is a combination of the two methods. The top water users would be solicited and asked to call in and make an appointment for an audit. In addition the auditors would canvass homes as time permits. This would keep the auditors busy and efficient and increase participation.

**Scheduled Appointments:** The COH would evaluate water bills to identify the top 25 percent of water users in the single-family and multifamily classes, on an annual average gallons per dwelling unit per day basis. The COH would then mail to these customers a letter offering a free water audit, and schedule an audit for all those that respond. The COH would also do a telephone follow-up for customers who do not respond to the letter offer. The multifamily audit program would target building owners and management companies. The program would be marketed through direct contact with major management companies or landlords and direct mail for the smaller building owners. This method has been used since 1988 to market audit programs.

**Door-to-Door Marketing.** A more recent innovation is canvassing neighborhoods known to have high water use. The COH would identify these neighborhoods through visual inspection confirmed by billing system inquiries. Areas with large landscaped lots, or low income areas with indoor leaks or areas with poorly managed landscaped areas would be targeted. The COH would provide advance notice that auditors will be in the area (usually by a door hanger, postcard or letter). Auditors would then canvass the area offering the audit service. Canvassing is usually conducted in the afternoons, evenings, and on Saturdays. If customers are not home, notices are left explaining how the customer can schedule an appointment. Because this method has not been used in Houston before and because of the lack of zoning which has made neighborhoods be less uniform than in other cities this method would need to be piloted before proceeding with a large program.

**Combined Appointments and Canvassing.** The top 25 percent of water users would be solicited as in the first method. In addition the COH would identify suspected high water use neighborhoods for canvassing. The scheduling for canvasses would be more flexible allowing the auditors to canvass when they are not busy with appointments. The

advantage of this method is that the high water users are targeted but the auditors will always be busy if the response rate is problematic.

**Delivery**

Trained in-house staff or an outside contractor would perform the audits. Audits would be conducted during the peak irrigation season, from May to October. Before the audit begins the auditor would provide material explaining the services to participants. Additionally, the COH would encourage customers to accompany the auditor during the site visit. Specific activities for each indoor audit would include:

- Locate meter and teach customers how to read it;
- Check for faucet and toilet leaks and recommend repair;
- Adjust toilet tank float arms, as necessary, to eliminate any waste overflow;
- Install toilet displacement devices, early closure flappers, or fill cycle regulators, as appropriate;
- Install faucet aerators and low-flow showerheads in bathroom; and
- Identify opportunities to replace toilets, washing machines, etc., with water-conserving models.

The outdoor audit would consist of the following:

- Provide basic literature and guidance about irrigation and landscaping (e.g., mulching, water-efficient plant material, soil, water and plant relationships);
- Recommend adjustments to the irrigation system to correct identified leaks, over spray, and runoff;
- Collect information about grass type, soil type, precipitation rate of existing irrigation system, and develop a customized irrigation schedule in minutes of watering time per week for spring, summer, and fall.
- Collect information about landscaping to assist with the design of other landscape conservation programs; and
- Advise the customers about the benefit of low-water-use landscaping.
- Provide irrigation schedule.

The auditors would describe the audit findings and recommendations to the customers orally and in a written report. They would give the customer water-conservation tips and information on other conservation programs offered by the COH. In addition, the COH would mail an annual follow-up letter to all participants at the start of the irrigation season to remind them to irrigate efficiently. The COH would provide follow-up audits every five years to ensure continued savings. The measure incentives are the free audit, water conservation literature, and giveaways such as low-flow showerheads, aerators, and watering schedules. These incentives would be advertised in the program literature used to publicize the program.

## Participation Rates

This program would target the top 25 percent single and multifamily accounts. Using scheduled appointments experience has shown that approximately 20 percent of the contacted customers would participate in the audit.[1,2] Overall, about 5 percent of the single- and multifamily accounts are expected to participate. When door-to-door canvassing is used, and depending on the ratio of people at home in the neighborhood, participation rates of 40 to 50 percent have been reported (Barbara Jordan personal communication). For a combined program, where half of the audits are done by appointments and half by canvassing, a participation rate of 25 percent can be expected.

## Costs

The COH would manage and market the program with in-house staff. It is assumed that the COH would use contract labor for the audits. Marketing expenditures would cover the costs of developing, printing, and mailing or distributing program brochures. Precipitation rates for hose-end sprinklers, commonly sold in local garden supply stores, should be determined in advance to optimize audit costs.

Each auditor can audit about four single-family homes per day during the summer season, provided other staff is assisting with scheduling and reporting. Multifamily audits take longer, depending on the size of the complex. It is not necessary to visit every unit unless a prearranged retrofitting is planned. To complete the initial audits within a five-year period, the COH would hire sufficient auditors to audit one-fifth of the participating homes each summer season. Audits will be repeated every five years to ensure continued savings.

Costs of the marketing strategies are reported to be similar, with audits by appointments more expensive because of extra driving time plus an uneven workload. Based on these assumptions, total costs to implement the measure are estimated to be:

**TABLE C-1**

**RESIDENTIAL WATER AUDITS FIRST-YEAR COSTS**

| Summary of First-Year Costs (1995$) | |
|---|---|
| Fixed Costs for Marketing | $3,000 to develop two brochures<br>$5,000 to train auditors |
| Variable Costs | |
| Marketing | $1.00 to print and mail brochure to target |
| Audit by Appointment | $60 per single-family participant<br>$40 per multifamily dwelling unit participant. Assume 6 units per account. |
| Canvass/Combined Audit | $50 per single-family participant<br>$35 per multifamily dwelling unit participant |
| Participant Costs | $0 |

## Water Savings

Water savings for this program are given below.[3]

- Retrofit of service area homes built before 1980 saves approximately 9.6 gcd (presumes a low-flow showerhead installation and leak repair). Retrofit of homes built after end-year 1979 saves about 3.4 gcd. No long-term toilet dam savings are assumed. Not all homes would achieve savings if existing homes have received retrofits through earlier kit distribution programs.

- Water savings from the retrofit of 1.6 gpf toilets are provided for in the toilet replacement program.

- The outdoor water audit would save an average of 5 to 10 percent of exterior water use for the audited homes.

Recent studies using the schedule appointment method by three California water agencies have resulted in savings of 25 to 30 gallons per household per day.[4] The water agencies and their savings were: Contra Costa Water District-31 gpd; City of Pasadena-28 gpd; and Novato (North Marin Water District)-25 gpd. These water savings are assumed to be permanent if follow-up audits are conducted at least every five years. The average of these savings, 6 percent, is used in this study, for scheduled appointments. Savings from the canvassing could be less because the auditor may end up spending time at home that do not have high water use, even though the neighborhood does. A savings of 5 percent for the canvassing or combined audits is used. In all cases the savings apply to the average water use by a user in the top 25 percent of all COH residential users.

## RESIDENTIAL PLUMBING RETROFIT KITS

Homes built before 1980 generally do not have low flow showerheads, low flush toilets or faucet aerators. Even some homes built after 1980 may not have these devices because of a lack of plumbing code enforcement. In Texas, the state has required 1.6 gpf toilets, 3.0 gpm showerheads, and 2.5 gpm faucets since 1992. To promote indoor water conservation, the COH would give homeowners retrofit kits with sufficient equipment and instructions to retrofit two bathrooms. Retrofit kits would contain easy-to-install low flow showerheads, faucet aerators, and toilet tank retrofit devices. The kits would be distributed to and, if requested, installed at all single family and multifamily residential homes. This is an alternative program to Residential Water Audits and seeks to get a high installation rate of retrofit devices for less money than the cost of an audit.

### Marketing Strategies

The program would be patterned after the successful San Jose, California retrofit program which delivered kits door-to-door. The water provider would first publicize the program through bill stuffers and news media coverage in the target area, and purchase sufficient retrofit kits to cover the entire service area (pre-1980 homes). As an option, the COH may want to coordinate their conservation effort with the local energy utility company.

### Delivery

After publicizing the program, the COH would contract for delivery of the kits, providing three attempts to contact the owner via phone and door-to-door canvassing with a free installation offer. Installation requests in the canvassing program are in the range of 2-5 percent.

The service area sections built before 1980 would be given kits; newer areas would be omitted. Newer homes built since 1980 but before 1990, as well as older homes, could qualify for a toilet rebate program as described in another program. In areas where it is uncertain what fixtures are in the home a direct installation method may work best. This could be used in areas where home have been built over a number of years, before and after plumbing code changes.

Retrofit kit and an offer of free installation would be advertised as an incentive. The kit delivery is normally contracted to a private company with specialized experience in implementing large scale retrofit programs. In large programs a delivery rate of 5000 homes per week has been achieved.[5] The COH program would be planned to deliver a kit to all single family and multifamily residents over a five year period. One-fifth of the service area would be covered each year.

**Participation Rates**

This program has been implemented extensively and successfully in homes in Arizona, California, Florida, Texas, and Washington. Installation rates of 75 percent are achievable[5,6] According to a study for the Environmental Protection Agency, installation rates range from 59 to 80 percent for showerheads, and one study for the City of Tampa, Florida had an 80 percent installation rate on faucet aerators.[7] The percent retention after one year for those devices installed range from 70 to 90 percent; 85 to 96 percent, and 88 percent respectively. The range is caused by differences in location and distribution technique. Other studies have assumed a penetration rate of 34 percent for aerators not including a natural replacement rate of three to four percent per year.[6]
The participation rate assumed for this project is 75 percent.

**Costs**

The program would require one administrator. The administrator would prepare a request for proposal for contract services and either pre-purchase the retrofit kits or have them provided by the contractor. The administrator would select a contractor (usually on a low bid basis) and supervise program and contract implementation. The cost of the administrator would be $55,000 per year including overhead.

The cost to purchase and deliver the kits through a properly publicized neighborhood canvas program is about $25 per household.[3] This includes about $10 for the retrofit kit and $15 for labor, including fulfilling the offer of free installation which is usually not requested.

**Water Savings**

The devices in the kit have varying lives. The showerhead lasts at least ten years (when it would most likely be replaced by another low flow model) and is considered permanent. The toilet tank displacement device has a life of about three to five years and is not considered permanent. The faucet aerators last approximately five years when they would be replaced by another low flow model and are thus considered permanent.

Studies have been done on the water savings showing that homes that install the kits save about 10.5 gcd.[5,6] This includes a 2 gcd savings for faucet aerators which have savings ranging from 1.4 to 3.6 gcd depending on the age of the faucet being retrofitted. About 1.3 gcd of the savings are due to the toilet tank displacement device used but these devices have a limited useful life. Taking these factors into account, a 20 year planning savings of 9.2 gcd is a good assumption and is used herein. There would be overlap

between this measure and the natural replacement rate resulting from the new Texas Plumbing Fixture Requirements that would need to be considered in the overall water savings evaluation.

## ULTRA LOW-FLUSH TOILET REPLACEMENT

### Description

The COH would implement a toilet replacement program offering incentives to existing residential customers who replace their high water-use toilets with ultra low-flush (ULF) toilets. ULF toilets reduce toilet-flushing water to about 1.6 gallons per flush (gpf). This is a significant water savings from an average of 5-7 gpf for regular toilets, and from 3.5 gpf for low-water-use toilets. Texas state law has required 1.6 gpf toilets, 1.0 gpf urinals, 2.5-gallons-per-minute (gpm) showerheads, and 2.2-gpm faucets since January 1, 1992. Starting January 1, 1994, the federal Energy Policy Act of 1992 will limit toilets sold for residential use to 1.6 gpf.

Sometimes the toilet replacement program also includes shower and faucet retrofit. This is most convenient when the program includes installation by a licensed plumber under contract to the COH.

This program, could be applicable to all existing residential dwellings or could be targeted at one sector, such as multifamily buildings. It would have an overall goal, such as, replacing approximately 25 percent of existing targeted residential toilets with ULF toilets within ten years, or by the year 2005. Other programs could deal with nonresidential toilets. This replacement rate amounts to about five percent per year. The COH would develop an application procedure for those dwelling owners intending to replace toilets. Those who would install the toilets as part of new construction or remodeling requiring a permit would not be eligible since these customers should not be given an incentive for complying with the new laws. Applicants would have to apply before changing toilets, not after the fact. The program could be limited to say two toilets per year (single family) and 200 toilets per account per year (multifamily).

### Marketing Strategies

Three marketing strategies will be investigated:

- Toilet Rebate
- Toilet Giveaway
- Distribution by Community Based Organization (CBO)

**Toilet Rebate.** To promote a rebate program the COH would provide bill stuffers describing the rebate offer. Assuming the program applies to all residential dwellings a kick-off news conference would be held, and the rebate offer would be publicized in the local media. Marketing to one segment, such as multifamily building owners would need to be more focused and use direct mail and trade and association publications.

Trade allies involved in selling and installing toilets would be solicited to advertise the program and provide point-of-purchase displays. The COH would maintain a list of available plumbing supply houses and plumbing contractors who could install the toilets.

**Toilet Giveaway.** Marketing can be targeted or general. Recipients would have to sign an agreement and either pay a deposit or authorize the COH to charge the cost of the toilet through the water bill if the customer does not install the toilet within a specified period of time. The COH would contract with plumbers who would agree to install the toilets for a specified price. If deposits are collected they are used to pay the plumber. If the customer arranges for installation on their own then deposits are refunded when the customer presents proof of installation.

**Community Based Organization (CBO).** CBO programs have been successful in areas where funding for the program is secure and the program continues for multiple years. The COH may hire a contractor to administer the program. CBO's are also contracted to participate. The CBO hires market people to canvass door-to-door or market the program to the general public. Participants who sign up for the program receive the toilet free of charge and pay for installation. CBO's can arrange for installation.

### Delivery

The COH would target all customers who do not already have ULF toilet models, estimated to be about 95 percent of the total market. Application forms would be available through trade allies or the COH or distributed by the COH or the contractor in targeted programs. As noted above, no incentives would be provided for new dwelling units or construction involving a building permit. The COH requirement for having a permit to replace a toilet would need to be waived for this program to work. Toilet giveaway programs would be coordinated with suppliers or through a COH warehouse. All of the above methods would employ installation verification by mail-in of a form or random inspections for self-installed toilets. Installation verification could be handled by in-house staff or by plumbing contractors. Customers would mail completed rebate forms to the COH for processing and payment.

Rebates given in other completed or ongoing programs range from $40-100. The first rebate for one dwelling is often $100, with subsequent rebates of $40-75. Ideally the rebate would be set at the COH avoided costs. For the replacement level in this program, the assumed rebate is $75 per toilet to stimulate acceptance.

### Participation Rates

A typical goal is to replace 25 percent of all toilets with the incentive program. This is in addition to the estimated 2-3 percent per year natural replacement rate from voluntary early replacement. A 2 percent rate is based on an assumed toilet life of 50 years.[8] Approximately 1,236,000 residential toilets are installed in the COH service area, assuming 2.4 toilets per single-family unit and 1.2 toilets per multifamily residential unit. Replacing 25% of the City's toilets through this program would involve 309,000 toilets. Replacing this number of toilets over ten years would mean replacing about 31,000 toilets per year or 600 toilets per week. Targeting just one sector, such as multifamily buildings would involve less, approximately 11,500 toilets per year or 200 per week.

The different programs will have different rates of success, i.e. how many toilets could be replaced in ten years. One of the largest toilet rebate programs is the City of Los Angeles' program which has rebated 411,000 toilets and distributed 181,000 toilets through CBO's.[9] The rebate program has been in existence 5 1/2 years and have replaced 20.5 percent of the total residential toilets. The CBO program has been in existence 3 1/4 years and replace 9.5 percent of the residential toilets. The City's goal is to replace all the toilets. The rebate offered is $100 per toilet for single family and $75 for multifamily. All single family customers will save about $35 annually per year on their

water bill. Multifamily owners will save an average of $55 per toilet per year. In other words the residential payback for out of pocket costs (for installation since the rebate covers the cost of the toilet) is under 1 1/2 years.

Using the Los Angeles experience as a model the following percentages could be achieved by running programs for ten years in Houston using a uniform $75 rebate:

- Rebate - 20%
- Voucher - 30%
- Giveaway - 35%
- CBO - 20%
- Direct Install - 50%

It can only be estimated how much of the funded replacement would have occurred anyway due to natural replacement, i.e. what percent of the above will be so-called free riders. It is impractical to screen out applicants based on their intentions. It is better to assume that part of the natural replacement rate is being funded. For this project it is assumed that the natural replacement rate over and above the above percentages is one percent per year or 10 percent after 10 years. For example, the Rebate program will achieve a 2 percent replacement rate of which have would have occurred anyway due to natural replacement. The total replacement with the Rebate program plus natural replacement will be 3 percent per year or 30 percent after 10 years. In other words the total replacement rate after ten years will be the above percentages plus 10 percent.

### Costs

An estimate of the capital cost, installation cost, operations and maintenance cost, and life expectancy of this measure was obtained by contacting manufacturers, consultants, and vendors who work with ULF toilets. The retail cost of a ULF toilet is about $70 and up.[10] Installation costs vary but can usually be negotiated in the range of $35-50.

Costs would be as follows.

**TABLE C-2**

**ULTRA LOW-FLUSH TOILET REPLACEMENT COST**

| Program Type | Payment/ Toilet | Inspection | Marketing or CBO | Contract Admin. | Contractor Install | Recycle | Total |
|---|---|---|---|---|---|---|---|
| Rebate | 75 | 3 | 5 | 27 | | 5 | 115 |
| Voucher | 75 | 3 | 5 | 27 | | 5 | 115 |
| Giveaway | 65 | 3 | 5 | 32 | | 5 | 110 |
| CBO | 65 | 3 | 25 | 27 | | 5 | 125 |
| Direct Install | 65 | 0 | 5 | 30 | 25 | 5 | 130 |

Recycling of toilets costs more than disposing of the toilets in a landfill. All costs in the above are for recycling which includes: storage, stripping, delivery to a recycler, crushing to aggregate, and delivery to a contractor who will use them for road base.

Inspection costs are based on a 10 percent inspection of all installs at $30 per inspection, included with the contract for the distribution. The purpose of the inspection is to deter fraud. If the COH were to decide that toilet replacement requires a plumbing permit, then 100 percent inspection will be necessary.

Staff time depends partly depends on the size of the program, i.e. the number of toilet replacements processed each week. Assuming the program is contracted out then a program for the size of the COH will require one full-time employee for contract administration for the life of the program (which varies depending on how long it takes to reach the goal).

There will be an initial start-up cost to set up the office in-charge of the above program. The cost can be figured at $10 per toilet replaced in the first year and is only incurred for one year.

**Water Savings**

Water savings depend on the scope of the program. The following assumes toilet replacement. Shower and faucet retrofit, if included, would add to the savings.

The Metropolitan Water District of Southern California (MWD) recently evaluated toilet replacement programs in the Cities of Los Angeles and Santa Monica. The range in water savings was 30-45 gpd per retrofitted toilet.[11] Expressed on a per-person basis, the saving for multifamily dwellings was considerably higher than for single-family dwellings. This result is counterintuitive. For this reason the decision was made not to use these findings directly, even though they are widely used in conjunction with evaluating BMPs in California.

Assuming an indoor use of 77 gallons per person per day (gcd), and converting the MWD numbers to a percentage reduction basis, the reported savings can be expressed as 19.7 percent of indoor use. The savings are about 20 percent less when replacing a 3.5 gpf toilet with a 1.6 gpf toilet.[11] Other studies by EBMUD and the City of Tampa have shown considerably lower savings ranging from 6-8 gcd.[12,13] The base water use for these latter two studies was very low because the homes were small and water shortages in the EBMUD's area had depressed use. Also, project participants may have used less water because they knew their water use was being recorded. When the water savings from these latter two studies are expressed on a percentage basis, EBMUD reported a 14 percent savings and Tampa a 12 percent savings for replacing a 5-8 gpf toilet with a ULF toilet. The savings from these latter studies are closer to the MWD reports when expressed on a percentage basis. The MWD study is the most complete toilet replacements study ever undertaken; however, the results cited were from the first year after installation. Therefore it is doubtful that leaks from the new toilets had occurred. When a leakage factor of 5 percent [14] is subtracted from the MWD savings, the result is a net savings of 14.7 percent. For this study, a 14.7 percent savings of indoor use upon replacement of a 5-7 gpf toilet with a ULF in both single and multifamily dwellings was selected. Similarly a savings of 10.8 percent should be used when replacing 3.5 gpf toilets.

## APPLIANCE LABELING

### Description

An appliance labeling program is intended to encourage residential customers to purchase water-efficient washing machines and dishwashers. The program provides customers with point-of-purchase information, including an equipment tag, similar to the Appliance Energy Efficiency programs operated by electric utilities. Efficient appliances receive a distinguishing label so they stand out on the retail sales floor. The tag also shows how each appliance compares with others in its category. The program targets all residential customers who are likely to purchase new appliances in the near future, and major vendors/dealers.

Horizontal-axis clothes washers are more water-efficient than conventional vertical-axis top-loading models. Rather than agitate clothes in a tub full of water, as with vertical-axis machines, the horizontal-axis washer lifts clothes up and plunges them down (like a dryer), tumbling clothes in a small amount of water. Horizontal-axis washers can be either top loading or front loading. Although they generally hold up to 50 percent less clothes, they are still 33 percent more water-efficient on the basis of water used per pound of laundry washed.[7] However, recent models have been relatively expensive and were not rated highly by *Consumer Reports* magazine, November 1993.[15] New models are scheduled for production in 1994. Manufacturers project their market share to increase from 5 percent in 1999 to 35 percent by 2003.[16]

Dishwashers currently sold use about 12 gallons of water per completed cycle. Older models use about 14 gallons per cycle. Water-efficient, domestic models are available that use 7.5 gallons per cycle. *Consumer Reports* rates several models of these water-efficient dishwashers highly.[17] The water savings also results in energy savings because these water-efficient models use less hot water.

### Marketing Strategies

The COH would work closely with manufacturers and utilities (e.g., water, wastewater, and electric utilities) to develop the equipment tagging program. Dealers would be trained to use labels and point-of-purchase materials.

Point-of-purchase displays would be set up in retail outlets that carry dishwashers and washing machines. Other retail advertisements, such as posters, could also be employed.

A program brochure would be sent to customers in a direct-mail or bill-stuffer campaign. The brochure would describe the advantages of water-efficient appliances and list retailers that sell water-efficient appliances. Similar brochures would be sent to companies that lease washing machines to multifamily residential complexes. These companies, in turn, could develop a shared savings program with the complex owner/management company.

### Delivery

The COH would work with other utilities and retailers to promote this program. Coordination with these entities would be necessary for several reasons. First, joint utility partnerships allow greater economies of scale; the utilities can share a single plan for marketing, advertising, and evaluation. Furthermore, the appliances promoted in this program could reduce the customers' monthly water, wastewater, and energy bills. A

multi-utility message would be stronger because the customer would be presented with greater savings potential.

Activities directed at encouraging horizontal-axis washing machine purchases should begin slowly. Full-scale implementation is not recommended until 1997. Promotion of low-water-use dishwashers could begin now, although it might be preferable to run a combined program.

**Participation Rates**

All residential customers purchasing new appliances would be considered participants. The number of participants in each year is derived by multiplying the number of appliances eligible for retirement by the program penetration rate for that year. The experience of other utilities that offer rebates on high-efficiency appliances has shown that a participation rate of between 40 percent and 65 percent can be achieved after the program is up and running.[18] However because this program will not offer rebates the participation rate will be much lower. Also there are very few horizontal-axis washing machines currently available, nor are they widely accepted, therefore the washing machine component of the program may increase slowly to a 5 percent penetration rate over the next ten years. The program for dishwashers is estimated to increase to 10 percent participation in ten years because water efficient models are more widely available and advertised as such.

**Costs**

Administration of this program would require coordination with other utilities to market the program, and development of the equipment tags. These administrative tasks could be performed in-house or through the use of a contractor hired to handle these responsibilities. Marketing expenditures would be used to develop brochures, bill inserts, direct mailings, mass media advertising, and training seminars to familiarize dealers, vendors, and retailers with the program. It is assumed that the appliance manufactures would absorb the extra cost of the equipment tags.

Costs, shown below, assume that a multi-agency (e.g. water, wastewater, and energy utility) consortium implements the measure for the entire the COH area. They include the cost of a training seminar, which would be conducted by program staff. For the purposes of this project it is assumed that the COH water department shares the cost with the local energy company 50:50. Therefor the COH would incur one-half of the costs shown. They can take credit for all the water savings just the way the energy savings will go to the energy company.

## TABLE C-3

## APPLIANCE LABELING FIRST YEAR COSTS

### Summary of Initial Annual Costs (1995$)

| | |
|---|---|
| **Fixed Costs:** | |
| Administration: | Years 1&2: $27,400 (0.5 administrator) |
| | Years 3+: $13,700 (0.25 administrator) |
| Marketing: | $6,000 to develop 4 brochures (one for each appliance and residential sector) |
| | $10,000 general advertising |
| | $4,000 training seminar |
| **Variable Costs:** | |
| Marketing: | $0.15 per brochure for printing - sufficient for providing one copy to estimated 12 percent of single family, condominium households or apartment building owners that purchase a new washing machine or dishwasher per year |
| | $2.00 per store for point of purchase information (assume 500 stores) |

### Water Savings

Water savings are based on engineering estimates. A 1984 HUD study profile of interior water use indicated conventional clothes washers use 16.5 gallons per person per day.[14] A thirty-three percent savings, or 5.4 gallons per person per day, can be expected from use of water-efficient units.[14]

Replacing a 12-gallon dishwasher with a 7.5-gallon unit would save 4.5 gallons per cycle. The HUD study indicates that dishwasher use is 0.17 cycles per person per day.[14] Thus 0.8 gallons of water per person per day could be saved by purchasing water-efficient models.

## WATER-EFFICIENT LANDSCAPING AND IRRIGATION SYSTEM INCENTIVES

### Description

This program offers incentives to new and existing single- and small multifamily customers to install water-efficient landscaping and irrigation systems. Multifamily customers with more than three acres of turf could qualify for one of the other nonresidential audit/rebate programs. Incentives could take the form of rebates for replacing turf with water-efficient landscaping. Suggested rebates could be made available for each of the items below.

- New landscaping with a limit on the amount of turf.
- Relandscaping involving the turf removal.
- If the customer chose to install an in-ground irrigation system to serve new turf areas, the system would be designed with low-precipitation-rate sprinkler heads that achieve 100 percent coverage and include a controller that allows three irrigation cycles per day.
- If the customer was removing turf to earn a rebate, and if an in-ground irrigation system was already in place, the system would be modified so the valves serving any remaining turf and the valves serving the new low-water-conserving landscaping would be on separate stations.

Specific standards for a water-conserving landscape could be patterned after North Marin's incentive program, with turf areas defined as follows.

**TABLE C-4**

**TURF AREA FOR WATER-EFFICIENT LANDSCAPES**

| Type of Dwelling Unit | Maximum Amount of Turf |
|---|---|
| Single-family | 800 square feet |
| Townhouse/Condo | 400 square feet |
| Apartment | 130 square feet |
| Senior Citizen Unit | 95 square feet |

The standards would require that not more than 20 percent of the total landscaped area could be turf, and the more restrictive of the above limits would apply. In addition a surface layer of four inches of mulch would have to be applied to non-turf landscaped areas.

### Marketing Strategies

All single-family and multifamily dwelling owners and trade allies would be eligible to participate in the program. It is essential that the appropriate parties be informed of the program early in the planning process so the efficient landscaping and irrigation equipment could be incorporated into landscaping plans. New customers could be

reached when they apply for water service for the first time. The applicant would learn about the rebate or discount on the connection fee at that time. Customers who wished to relandscape could be reached by direct contact using bill stuffers and ads placed in the newspaper or through trade allies.

Trade allies such as landscape architects/designers/contractors, nurseries/garden centers, and irrigation equipment vendors and installers would be informed of the program through direct mail, articles and advertising in trade publications, home and garden shows, and trade associations. Meetings and seminars would be conducted with trade allies to inform them about the program and provide them with promotional materials such as brochures and point-of-purchase displays for their customers. An estimate of 200 trade allies operating in the COH service area was used in the analysis.

**Delivery**

The program would primarily be delivered through the COH who would make the offer, and trade allies who would assist the customer with landscaping. Rebates would be processed by the COH. The COH would make random inspections to verify that new landscapes were installed in a manner consistent with the application, and that rebates were not applied for after the fact.

**Landscaping Incentive**

In new housing developments, the builder or developer would be offered a cash discount on the water connection fee. In occupied single- or multifamily dwellings, the rebate would be paid directly to the owner or tenant, provided the owner agreed.

The new dwellings landscaping incentive could be set to equal the value of the water saving between standard landscaping and water-efficient landscaping. Relandscaping by replacing turf with water-conserving plants could be similarly set and be capped by the unit rebate shown in the table below. For this evaluation, the landscaping incentive for new dwellings would be set to equal no more than half the incremental cost difference; the maximum amount paid under this program would be as follows.

TABLE C-5

WATER-EFFICIENT LANDSCAPE REBATES

| Type of Dwelling | Rebate per Unit |
|---|---|
| Single-family detached unit | $200 |
| Single-family attached units up to four units per building | $150 |
| Apartment buildings (five units or more) | $100 |

Relandscaping would be rebated at the rate of $35 for each 100 square feet of turf removed.

**Irrigation System Incentive**

When labor costs are included, all-sprinkler systems are more expensive to install than drip/sprinkler systems, therefore, contractors may find installing an all-sprinkler system

more profitable, even though such a system is less efficient. To encourage contractors to install drip/sprinkler systems, the incentive would be offered directly to them rather than to the customers. Depending on the square footage of the system installed, drip/sprinkler systems on average are $200 less expensive than all-sprinkler systems. To encourage participation, the irrigation system incentive to contractors would be 50 percent of this cost difference, or $100. The maximum rebate would be the same schedule as shown above for landscaping.

**Participation Rates**

All single-family and multifamily dwelling owners and trade allies would be eligible to participate in the Water-Efficient Landscaping and Irrigation System Incentive Program. Based on data gathered from similar programs conducted by North Marin Water District for a landscape-only rebate, the following number of participants are estimated.[19]

TABLE C-6

WATER-EFFICIENT LANDSCAPE/IRRIGATION INCENTIVE PROGRAM
ESTIMATED PARTICIPANTS

| New Construction | Annual Percent of Existing Dwellings Participating | Percent of New Construction Units Participating |
|---|---|---|
| **Landscaping** | | |
| Single-family | 1 | 5 |
| Multifamily | 5 | 67 |
| **Irrigation System** | | |
| Single-family | 1 | 5 |
| Multifamily | 5 | 67 |

**Costs**

Program management, marketing, and rebate processing would be performed by the COH, who could perform these functions in-house or hire a consultant to perform them. Fixed and variable costs are as follows. Of 10,000 brochures assumed to be printed, all but 1000 are expected to be mailed. The costs are summarized briefly below.

## TABLE C-7

## WATER-EFFICIENT LANDSCAPE PROGRAM COSTS

**Summary of Costs (1995$)**

| | | |
|---|---|---|
| **Fixed Costs:** | | |
| **Staffing:** | | For the COH service area, one full-time program administrator is required for administrative duties including rebate processing, (assume full-time employee (FTE) at $55,000 per year including fringe benefits and overhead). |
| **Marketing:** | | |
| • | Brochure | $1,500 first year to design<br>$5,000 each year to print 10,000 |
| • | Display | $1,500 first year to design<br>$5,000 first year for 200 displays |
| **Evaluation/Monitoring:** | | |
| • | Evaluation | $10,000 after first year |
| • | Monitoring | $25 per inspection (assuming 25 percent of sites inspected) |
| **Variable Costs:** | | |
| **Marketing:** | | |
| • | $1.00 per brochure to mail each year | |
| **Rebates:** | | |
| • | $200 average rebate for water-efficient landscaping | |
| • | $100 average rebate for irrigation system | |

### Water Savings

Although low-precipitation-rate sprinkler heads and drip irrigation systems are believed to save water, little water savings documentation is available, so a five percent value is assumed. The combined savings equate to the savings recorded by North Marin, East Bay Municipal Utility District, and the City of Austin for their efficient landscaping pilot studies. The savings apply to summer (exterior) water use; total annual savings would be

lower. The estimated average savings per dwelling for Water-Efficient Landscaping and Drip Irrigation System assumed in this analysis is 19 percent of exterior use.

## COMMERCIAL/INDUSTRIAL INDOOR WATER AUDITS

### Description

This conservation audit targets existing commercial, and industrial customers. The top 10 percent of water users in this class would be offered a free interior audit and periodic follow-up to encourage customer implementation of audit findings. Incentives could be offered in a related program. Site-specific audits are an efficient way to lower water use in this category, since industrial customers usually use more water per account than any other customer category. This audit would be repeated every five years to maintain or improve the conservation level.

An interior audit would be conducted by COH staff or a consultant. The auditor would perform an on-site interior inspection and produce a customized report that describes fixture inspections, leak tests, retrofit possibilities, cooling tower operation and improvements, process water improvements, and recycling opportunities for each site. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. The participant's actions and water use would be tracked over time. Standards would be based on previous experience and the performance of the latest technology.

The audit report would consider, when appropriate, the following measures:

- Change from water-cooled to air-cooled equipment;
- Change from one-pass to recirculating cooling and heating systems;
- Improve industrial and commercial washers and rinsers;
- Install solenoid and automatic control valves;
- Analyze whether recycling industrial water and separating waste streams are feasible; and
- Determine placement of submeters.

### Marketing Strategies

The COH would compile a list of nonresidential owners who have indoor water use in the top 10 percent of all accounts in their respective category. The billing categories targeted would include categories 26,27,28,30,32 and all industrial accounts. After targeting existing high water-use customers, the COH would mail indoor water conservation brochures offering a free water audit to the owners. Telephone follow-up would raise the participation rate. Using contractors and equipment manufacturers to market certain water conservation technologies to targeted customers would further increase participation.

### Delivery

COH staff would be trained, or consultants would be hired to conduct the audits. Appointments would be set with those owners accepting the audit. Since the audits would be site-specific, a pre-audit telephone survey would be performed to get general water use information about each site.

To implement the information program, the COH would promote on-site audits or plan reviews to assess water conservation opportunities. The auditor would encourage an appropriate company employee to attend the audit, and teach the employee how to read meters and fine tune process control devices to minimize water use. In addition, the COH could motivate other similar businesses to participate by promoting successful case studies demonstrating water savings.

**Participation Rates**

Business response to an offer of a free commercial/industrial water audit has traditionally been low because water bills are not usually a significant cost, except to the large water users. The top 10 percent of commercial/industrial water users in the service area (including restaurants, office buildings, hotels/motels, laundries, research and development firms, manufacturers, and other accounts with significant water use) would be offered a free interior audit. This would be about 3,500 accounts. It is assumed that 35 percent of those contacted or about 1200 accounts would agree to participate in the audit program. Completing the project over a five year period would mean that 250 audits would need to be done each year.

**Costs**

The costs per customer being audited would vary widely, depending on the complexity level of the audited site. A study performed in San Jose, California,[20] of 15 large commercial/industrial customers showed that implemented water conservation practices cost the customer about $100,000.

The City of Phoenix estimates that its audit costs range from $1,000 to $7,000 per audit; MWD of Southern California estimates $3,000 to $10,000 per customer.[21] Customer cost to retrofit with water-efficient equipment varies as well. The payback period for most customers should be less than 18 months, a period short enough to encourage participation.

One auditor could perform an estimated 50 audits per year. Appropriate follow-up would be provided by trained staff to ensure that the audit savings are permanent.) The program would be budgeted to complete the audits within five years. Five auditors would be required. In-house staff could be trained to do the job. Assuming in-house staff is used, a COH cost of $1,000 per existing site can be assumed for the small and medium size sites. This value reflects costs for COH staff to conduct these audits as well as a one quarter-time staff person to administer the program. Larger sites are generally wholesale accounts and would be more complex and are excluded from this program.

**Water Savings**

For commercial conservation, a 12 percent indoor water savings is assumed for the audited sites based on estimates used with the California BMPs.[22] Potential industrial water savings are difficult to determine because industry use is site specific. San Jose and other California Water Agencies/contractors have reported savings of 15 to 50 percent. A 15 percent indoor savings is assumed for the industrial portion of this measure. Thus, assuming a 50-50 split between commercial and industrial uses, a 13.5 percent indoor savings was used for the commercial/industrial category. A 20-year lifetime is also assumed, since it represents the average lifetime of the equipment used.

## EFFICIENT PROCESS EQUIPMENT REBATES

### Description

This conservation program targets existing commercial, and industrial customers. It is similar to the commercial/industrial water audit program except it goes a step further and offers the customer a cash rebate (low or no interest loans have also been used). The top 10 percent of water users in this class would be offered a free interior audit and incentives sufficient to achieve customer implementation of audit findings. Site-specific audits are an efficient way to lower water use in this category, since industrial customers usually use more water per account than any other customer category.

An interior audit would be conducted by COH staff or a consultant. The auditor would perform an on-site interior inspection and produce a customized report that describes fixture inspections, leak tests, retrofit possibilities, cooling tower operation and improvements, process water improvements, and recycling opportunities for each site. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. Process equipment that would qualify for a rebate would be identified for the owner and payback analyses conducted with and without financial assistance from the COH. The rebate level would be set at the COH's avoided costs with a maximum set, depending on the annual COH budget for the program. Since process equipment is expensive the maximum will need to be relatively high, possibly on the order of $10,000. The participant's actions and water use would be tracked over time.

The audit report and rebate evaluation would consider, as appropriate, the following measures:

- Change from water-cooled to air-cooled equipment;
- Change from one-pass to recirculating cooling and heating systems;
- Improve industrial and commercial washers and rinsers;
- Install solenoid and automatic control valves;
- Industrial water recycling and separating waste streams where feasible

This program would be targeted after successful programs currently being conducted by the City of Seattle, City of San Jose, East Bay Municipal Utility District, and Los Angeles Department of Water and Power. These programs have been running for the last two-four years and all pay a rebate based on the amount of water saved. The rebate amount is set at the utility's avoided cost and has been on the order of $0.75-$1.25 per hundred cubic feet saved.[23,24] In the case of San Jose the rebate is based on reduced sewer flow and is set at $2.00 per hundred cubic feet of flow reduction.[25] The volume of water saved is calculated by estimating the water savings rate, in gallons per day, multiplied by an assigned life of the project. Usually two to five years is a sufficient to generate a rebate with an attractive payback to the business for the project. Some utilities have a cap on the rebate amount of $20,000 to $50,000. Each utility has an application procedure and the project is checked out by an engineer before the rebate is granted, since it is paid based on projected water savings.[24]

### Marketing Strategies

The COH would compile a list of nonresidential owners who have indoor water use in the top 10 percent of all accounts in their respective category. The billing categories targeted would include categories 26,27,28,30,32 and all industrial accounts. After targeting existing high water-use customers, the COH would mail indoor water conservation

brochures offering a free water audit to the owners. The offer of an incentive to qualifying customers would be highlighted. Telephone follow-up would raise the participation rate. Using water audit and shared savings contractors and equipment manufacturers to market certain water conservation technologies to commercial/industrial customers would further increase participation.

**Delivery**

COH staff would be trained, or consultants would be hired to conduct the audits. Appointments would be set with those owners accepting the audit. Since the audits would be site-specific, a pre-audit telephone survey would be performed to get general water use information about each site. Only sites with the potential for an equipment rebate would be visited in this program.

Implementing this program would require an information program as well as an incentive program. To implement the information program, the COH would promote on-site audits or plan reviews to assess water conservation opportunities. The auditor would encourage an appropriate company employee to attend the audit, and teach the employee how to read meters and fine tune process control devices to minimize water use. For the incentive program, the COH would stimulate interest by providing a customer rebate based on the water saving amount. In addition, the COH could motivate other similar businesses to participate by promoting successful case studies demonstrating water savings.

A rebate based on the amount of water saved could be made available. Toilet rebates would be addressed in a separate toilet rebate program. The rebate amount should be calculated based on the water savings rate, an appropriate project life and the COH's avoided costs. A maximum $25,000 per audit rebate is suggested so the available budget could be spread among applicants. Rebates would be given after proof of installation of approved more efficient equipment.

**Participation Rates**

The top 10 percent of commercial/industrial water users in the service area (including restaurants, office buildings, hotels/motels, laundries, research and development firms, manufacturers, and other accounts with significant water use) would be offered a free interior audit and incentives sufficient to achieve customer implementation of audit findings. This would be about 3,500 accounts. Most existing programs are attracting about 50 applications per year. It is assumed that over a twenty year period 1,000 projects would be funded.

**Costs**

One person could process and accept an estimated 50 applications per year. Additional sites will probably apply but not all projects will meet the criteria for funding. Program marketing (preparation of a flyer mailed to top water users, with telephone follow-up), site visits, application processing would be handled by this individual. An engineering consultant would be retained to check out each application. For the purposes of this report, a COH cost of $3,000 per existing site is assumed. It is assumed that 50 sites will qualify for a rebate averaging $5,000. Thus the total cost will be about $8,000 per site.

### Water Savings

For commercial water audits, a 12 percent indoor water savings has been used for preparing estimates based on the California BMPs.[22] Potential industrial water savings are difficult to determine because industry use is site specific. San Jose and other California Water Agencies/contractors have reported savings of 15 to 50 percent. A 15 percent indoor savings is assumed for the industrial portion of this measure. Thus, assuming a 50-50 split between commercial and industrial uses, a 13.5 percent savings was used for the commercial/industrial category. The water savings apply to average use by the top water users. A 20-year lifetime is also assumed, since it represents the average lifetime of the equipment used.

## INCENTIVES FOR COMMERCIAL/INDUSTRIAL TOILET AND SHOWER REPLACEMENT

### Description

Cash rebates would be offered to encourage replacement of all toilets, urinal valves, showers and aerators presently installed on the premises of nonresidential customers that do not comply with the current plumbing fixture requirements. The program targets replacement of toilets with commercial ULFs in commercial, industrial, buildings as well as other fixtures. Complete replacement of flushometer-type toilets would be required over retrofit of the valve alone because the geometry of the bowl is critical to achieving a satisfactory flush with 1.6 gallons.[8]

### Marketing Strategies

The toilet replacement program would be directed at nonresidential building owners and managers, and at plumbing contractors and suppliers. The program would be announced through water bill stuffers and mailed to plumbing industry trade allies. The COH would need to conduct meetings with major employers and commercial/industrial facilities owners to explain program specifics and to solicit participation in the program.

### Delivery

The COH would target all customers not already fully equipped with low-volume fixtures. Customers who purchase qualifying fixtures would complete a rebate application and return it to the COH with proof of purchase. Rebates would be paid following verification of replacements. The verification could be handled as a part of the COH permit process for the replacement of commercial toilets.

Commercial/Industrial toilet rebate values would be designed to produce saved water at a unit cost roughly equivalent to that provided by a residential toilet replacement program. The residential water savings is about 30-45 gal/toilet/day.[11] A residential rebate is usually $75/unit. Commercial toilets are generally used with a higher frequency (3:1 ratio) than residential toilets, so a ULF toilet replacement program offers higher water savings. The equivalent commercial/industrial rebate for the tank-type toilet is actually $225 but could be capped at the installed cost of the toilet. As more unit usage information is available, these average rebates could be refined into several levels that more closely reflect actual usage; for example, a low rebate for motel room toilets, mid-level for those in offices or schools, and a high rebate for fixtures serving public areas of hotels and restaurants. Retail costs and suggested rebates are shown below.

## TABLE C-8

## C/I ULTRA LOW-FLUSH TOILET/URINAL REBATES

**C/I Retail Costs and Rebates** [25,26]

| Retrofit | Equipment (w/accessories) | Labor | Subtotal | Rebate |
|---|---|---|---|---|
| ULF Toilet (gravity type) | $105 | $50 | $155 | $150 |
| ULF Toilet (flushometer) | $150 | $50 | $200 | $200 |
| 1.0 gpf Urinal Flush Valve | $68 | $40 | $108 | $75 |

Showerhead rebates would have to be developed for each situation. These rebates would be based on avoided costs and capped at the installation costs. Showerhead rebates could range from $5-10 per unit, if installed the same time as toilets.

### Participation Rates

The commercial/industrial toilet replacement participation rate is similar to or better than that achieved by residential rebate/replacement programs which convert approximately 3-5 percent per year of the total market over 5 years. Commercial/industrial customers would be expected to get a plumbing permit from the COH to replace toilets. The extra time and trouble to get this permit would reduce the participation rate. Offering a higher rebate than for residential replacements would tend to nullify this drawback. Commercial/industrial customers are expected to convert at the rate of at least 3 percent per year because they would receive a higher rebate than for residences and relatively greater water and sewer cost savings for each fixture. In the case of replacing tank-type toilets, the customer would incur no out-of-pocket cost.

### Costs

Unit costs for the COH would include the replacement rebate plus 30 percent for overhead (administration, marketing, and recycling). Commercial/industrial rebate program costs would therefore be approximately $200 for toilets, $75 for urinal flush valves, and $10 for showerheads

The number of fixtures in the commercial sector is not directly known. It can be estimated using employees per fixture (from the large commercial/industrial survey) and employment data from the census. The survey results showed that the number of employees per toilet at 18 sites averaged six employees per toilet. The number of employees per urinal averaged 22. This can be used to estimate the number of fixtures qualifying for a rebate each year. Showerhead replacements will be taken as 10 percent of the toilets. Fixtures will increase over time as employment rises.

Customer costs would include equipment and labor assuming installation by a plumber, less the rebate. Complete replacement of the urinal valve is also assumed.

### Water Savings

Until recently there has not been definitive data on the water saved by replacing non-residential bathroom fixtures. Two new reports provide a basis for estimating water savings for replacement ULF toilets. The first, "Ultra Low Flush Toilet Programs" cited a water savings of 73.6 gpd per ULF toilet replaced at 250 commercial sites.[28] The second, "Public Facilities Toilet Retrofit," cited a water savings of 76.8 gpd per ULF toilet replaced at 70 public facilities.[29] Most of the latter sites had been using 3.5 gallons per flush toilets. Although employees at these sites probably only flush the toilet 2-3 times while at work, the large water savings should be due to walk-in public, guests, or students, such as occurs in restaurants, hotels, or schools respectively.

It is convenient to express water savings on a per employee basis because the number of employees in a city is known much more accurately than the number of nonresidential toilets. To use the above data the number of employees per toilet must be known. The COH commercial/industrial water user survey provided data on employment and number of toilets per site.

Using these values of employees per fixture replacement with ULF toilets saves 73.6 ÷ 6 or 12.3 gallons per employee per toilet. An allowance for replacement of urinals with ultra low-flush models is 0.4 gpd per employee.[26] The total water savings used in the study was 12.7 gallons per employee per day.

## COOLING TOWER WATER AUDITS

### Description

This conservation audit targets existing commercial, and industrial customers. It is similar to the commercial/industrial interior audit program except that it just focuses on cooling towers. Cooling towers consume a large amounts of water, depending upon the climate and the efficiency of the unit. Assuming that the largest water users have cooling towers, the top 10 percent of water users in this class would be offered a free interior audit and periodic follow-up to encourage customer implementation of audit findings. Incentives could be offered in a related program. Based on the results of the COH commercial/industrial user survey it is estimated that there are on the order of 1,000 commercial/industrial cooling towers in Houston. There could be others associated with large apartment buildings but these were not analyzed as a part of this program. This number will grow as growth continues and an expected trend of densification and redevelopment also grows.

The purpose of the audit would be to measure the existing number of cycles of concentration (ratio of makeup to bleed water) and suggest improvements in operations, such as the addition of a chemical feed system, to increase the cycles of concentration. The goal of the program would be to raise those sites with less than three cycles of concentration to 5-8 cycles. This audit would be repeated every five years to maintain or improve the conservation level.

The cooling tower audit would be conducted by COH staff or a consultant. The auditor would perform an on-site inspection and produce a customized report that describes system inspections, leak tests, retrofit possibilities, operation changes and improvements,

and recycling opportunities for each site. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. Standards would be based on previous experience and the performance of the latest technology. If the cooling tower is not separately metered and water use is significant and appears to be inefficient, placement of submeters would be suggested. The participant's actions and water use would be tracked over time.

**Marketing Strategies**

The COH would compile a list of nonresidential owners who have indoor water use in the top 10 percent of all accounts in their respective category. After targeting existing high water-use customers, the COH would mail indoor water conservation brochures offering a free cooling tower water audit to the owners. Telephone follow-up would raise the participation rate. Using contractors and equipment manufacturers to market certain water conservation technologies to targeted customers would further increase participation.

A cooling tower training seminar could be offered to site managers and service companies to increase awareness, encourage self-audits, and test market the concept of site audits with technical people.

**Delivery**

COH staff would be trained, or consultants would be hired to conduct the audits. Appointments would be set with those owners accepting the audit. Since the audits would be site-specific, a pre-audit telephone survey would be performed to get general water use information about each site and ascertain the number of cooling towers.

The auditor would encourage an appropriate company employee or service contractor to attend the audit, and teach the employee how to read meters and fine tune cooling tower control devices to minimize water use. In addition, the COH could motivate other similar businesses to participate by promoting successful case studies demonstrating water savings.

**Participation Rates**

Audits strictly targeted at cooling towers are a novel concept with little track record at other utilities. Traditional industrial audit program participation has been very low because water/sewer bills are not usually a significant industry cost. The top 10 percent of commercial/industrial water users in the service area (including restaurants, office buildings, hotels/motels, laundries, research and development firms, manufacturers, and other accounts with significant water use) would be contacted first to identify cooling towers. A water use of at least 10,000-gpd is considered significant. If there are approximately 1,000 cooling towers in Houston then auditing 200 per year would mean the program could be completed in about five years. As there are about 2-3 cooling towers per site on average, this would mean visiting 65-100 sites per year.

**Costs**

The costs per customer being audited would vary widely, depending on the complexity level of the audited site. Costs would be somewhat less than a complete interior water audit. The City of Phoenix estimates that its audit costs range from $1,000 to $7,000 per audit; MWD of Southern California estimates $3,000 to $10,000 per customer.[21] Customer cost to retrofit with water-efficient equipment varies as well. The payback

period for most customers should be less than 18 months, a period short enough to encourage participation.

One auditor could perform an estimated 100 cooling tower site water audits per year. The program would be budgeted to complete the audits within five years. One auditor would be required to complete the work. The auditor could be an in-house staff person trained for the work. For the purposes of this report, a COH cost of $700 per existing site is assumed. This value reflects costs for existing COH staff to conduct these audits as well as a one quarter-time staff person to administer the program plus expenses.

### Water Savings

Cooling tower water audits would save somewhat less than a complete interior water audit. For commercial conservation, a 12 percent indoor water savings is assumed for the audited sites based on estimates used with the California BMPs.[22] Approximately one-half of the commercial outdoor water use is estimated to used for cooling or about 4 mgd. If there are 1000 cooling towers in Houston the average water use per tower is 4000 gpd. This would be about 10,000 gpd per site, assuming 2.5 towers per site. The water audit should result in an increase in efficiency, i.e. the concentration ratio should be raised. If a typical audit raises the concentration ratio from 3 to 4 then the water savings will be 11 percent. The water savings from this audit program is assumed to be 10 percent for audited sites or 1,000 gpd per site audited.

## LOW WATER-USE LANDSCAPE ORDINANCE

### Description

This measure targets new commercial, industrial, multifamily and public customers. The goal is to reduce peak demand and promote overall conservation. The COH would enforce an ordinance requiring low water-using plants and efficient irrigation systems in new landscaped areas. The COH is currently drafting an ordinance that applies to city esplanades and right-of-ways. The ordinance would apply to all new landscapes except for single family homes. The form of the ordinance could be the same as the current ordinance, but the target for the ordinance would be much larger as all new landscapes would be affected. This purpose of this measure is to ensure enforcement and compliance by all new nonresidential development. The ordinance would be spearheaded by the COH conservation group and they would sponsor staff to assist with implementation and enforcement. Implementation and enforcement will normally fall to the city/county planning and building departments who conduct plan review and construction inspection. Because some developments are built in the county and later annexed to the city, the COH staff would attempt to have the ordinance adopted by all government entities in the region where future water service by the COH is likely.

This measure is similar to a statewide low water use ordinance adopted several years ago in the state of California (known as AB 325). California cities and counties could either adopt their own ordinance or use a model ordinance developed by the state. Inaction meant that the state's ordinance applied. Some agencies developed and ordinance based on low water use plant lists and maximum allowable percentage of turf. Others used a water budgeting approach that specified that the amount of water that could be applied to irrigate the site was no more than 75 percent of the amount of water used by turf grass. This is a more theoretical approach and more difficult to check compliance than just specifying that say no more than 25 percent of the landscaped area, for example, could be turf. Compliance with adopting the ordinance in California has been good but follow

through and enforcement has been spotty. Some agencies just do not have the staff to check designs and compliance. For this reason the role of the conservation group would be to provide the staff that these other city/county departments could not supply themselves.

**Marketing Strategies**

The COH ordinance would be adopted by the city and then used as a model and marketed to all affected local government entities. The COH staff would draft appropriate language and make presentations to governing councils and boards to explain the benefits of the ordinance and secure passage. Once adopted the provisions of the ordinance would be publicized positively and intensively in trade journals and through direct contact with landscape architects. Direct mailings and landscape workshops would be offered to landscape designers and contractors. Low water-use demonstration gardens would be created at COH parks and facilities. Brochures illustrating efficient irrigation systems and low water-use vegetation would be created and made available at the building department. The COH would ensure that the existing ordinance is implemented, review landscape plans as necessary, and recommend ordinance modifications as needed for maximum effectiveness over time.

**Delivery**

Low water-use landscaping includes steps to increase water-use efficiency. For turf, a low water-use variety turf grass is preferable in the COH service area. Generally, the user should ensure that soil conditions are favorable for growth, that fertilizers are applied to assure availability of proper nutrients and that the appropriate watering schedule for the age, vegetation type, and weather conditions is followed. The landscape architect would help the user achieve these goals.

The COH would sponsor one or more landscape architects to review developer plans submitted to the city planning department. The architect(s) would also provide information about the best landscape turf and plantings, and how to install the water-efficient turf, plantings, and irrigation equipment. The architect would check plans for compliance with the ordinance. Larger projects would be field inspected to ensure compliance. Additionally trained staff would enforce the landscape ordinances and train landscape contractors and maintenance employees to develop irrigation schedules.

No incentives, other than the free consulting by the landscape architect, would be provided. Ordinances and other regulations are enforceable by law.

**Participation Rates**

This measure would target 100 percent of the new multifamily residential, commercial and industrial, and public development in the COH area. About 5,000 new applications for nonresidential water service with significant landscaping (more that 500 square feet) per year are anticipated. Eventually a 75 percent acceptance rate is assumed for this measure. In the beginning, some resistance to this concept is expected. The acceptance rate is expected to increase 25 percent per year for three years until 75 percent is reached.

**Costs**

The COH's implementation cost, including plan checking and field inspection, would be equivalent to hiring one or more landscape architects. The average cost per architect for the program would be approximately $65,000. This includes an architect hired as a

private contractor plus expenses. This person could review plans and inspect about 500 applications for new water service per year. The pace of development approvals in the communities would determine actual staffing. It is assumed that two full-time landscape architects on contract would be needed to staff the program. They would inspect about 20 percent of the total number of applications, prioritizing their time just to focus on the large developments or working with a developer for the first time. A budget of $10,000 per year would be needed for expenses.

Since this measure applies to new customers, no additional customer costs are assumed for using low water-use as opposed to traditional landscaping. There would be some additional costs to developers to comply with the ordinance. Annual maintenance was also considered to be the same as for conventional landscaping.

### Water Savings

The lifetime of a commercial or industrial landscape varies, but 10 years is assumed. This is less than the expected lifetime of a residential landscape because commercial and industrial companies are probably more likely to change their landscaping more often than residential homeowners. We assume that if a development was landscaped with low water use landscaping that it will be replaced in 10 years but with low water use material.

Using low water-use landscaping and efficient irrigation in single family settings has been shown to save about 20 to 50 percent of the water used for highly maintained blue grass.[30,31] For the purpose of this report, a 20 percent savings would be assumed for those areas that would otherwise use blue grass lawns and are not heavily shaded.

Very little experience exists concerning how much of the theoretical savings can be achieved with an ordinance. This program is equivalent to California BMP No. 6, which assumes a 20 percent reduction in the outdoor use for new development.[22] This value will be used in this study.

## COMMERCIAL/INDUSTRIAL IRRIGATION WATER AUDITS

### Description

This measure reduces peak demand by conserving irrigation water. Existing commercial and industrial building owners, and managers with high summer water use would be offered an irrigation system audit to improve their existing sprinkler systems water-use efficiency. This program would be restricted to sites having less than three acres to avoid overlap with the Public Facility Water Audit program. Although this program could be run in conjunction with that measure, it is evaluated separately because the target market may be different and the water auditors would require different training.

A key goal of this audit is to establish the correct watering rate. Trained auditors would visit each site and perform a water audit using techniques similar to those employed in the Public Facility Water Audit Program. Watering schedules and yearly conservation reminders would be sent to the targeted businesses/industries. Watering schedules would detail the number of minutes per week for each station and each month of the year. The auditor would explain the schedule to the facility manager or professional landscape maintenance company's representative. In addition, the facility manager would be provided information about new irrigation technology and low-water-use landscaping for use in possible retrofitting. A repeat audit would be offered after five years.

## Marketing Strategies

The COH would compile a list of the existing facilities owners that have summer water use in the top 25 percent of all accounts. The COH would mail letters offering a free audit to owners of the targeted facilities. Telephone follow-up would be done to raise the participation level. Auditors would be trained and appointments set with those customers accepting the audit.

Since the field audit would be free, the audit value, about $500 per acre, would be advertised in the program incentive. In addition, the water bill savings potential from conservation would be highlighted.

## Delivery

Irrigation system maintenance, sprinkler placement, and scheduling by such methods as a landscape watering audit offer easy techniques for applying accurate irrigation amounts throughout the year. These techniques are useful for permanent in-ground systems with automatic controllers, as well as for hose-end sprinkler systems used by smaller businesses.

An auditor would conduct a preliminary telephone survey to obtain basic information about the extent of the landscaping, type of irrigation system, and customer's watering practices. Upon making an appointment with the customer, an auditor would perform an on-site audit of the irrigation system. Sections of the sprinkler system that irrigate shrubs and trees would also be tested for their efficiency. To establish the correct watering rate, an auditor would measure the sprinkler system's precipitation rate and then apply locally provided information to determine minutes of watering time for the three main irrigation periods of the year (spring, summer, fall). Assuming one auditor could complete one commercial/industrial/public audit per day, and a five day work week, about 100 appointments per auditor could be made from May to September when water use and audits are in highest demand.

All customers receiving an audit would receive an oral and written audit report, including a landscape watering schedule and water saving literature. A five year water savings lifetime is assumed. The COH would mail each participant a yearly follow-up letter at the start of the watering season as a reminder to save water, and would spot check a number of businesses to evaluate water savings and implementation of audit findings. Landscape site managers would make the adjustments, not the auditor. Additional flyers describing the causes and cures of maintenance problems in irrigation systems could be distributed at the same time.

## Participation Rates

Nonresidential customers with the highest 25 percent of exterior water use would be approached and offered an audit. Experience has shown that 70 percent of the customers contacted (of the top 25 percent) would agree to have an audit performed.[32] With these assumptions, this measure applies to 18 percent of the total market. It is further assumed that 70 percent of the audited sites would implement the landscape watering schedule. Sufficient auditors would be hired to audit the complete market in three to five years. Audits would be repeated every five years to maintain savings.

Based on the amount of exterior water use for irrigation (one-half of the total commercial exterior use), approximately 3,000 acres can be irrigated at the rate of 1.5 feet of water applied per year. Most of the sites will be small, averaging 3 acres so there are 1000

potential sites to audit. Assuming a 70 percent acceptance rate a five year program there will be 140 sites to audit each year. The number of sites will grow each year as the water use in this category increases in accordance with the projections.

### Costs

No costs are assigned to the customer for this measure. Changes to the watering schedule would be handled as routine maintenance.

A one-time program set-up cost of $50,000 would be needed to develop marketing materials, train auditors, and target customers to be audited. This work would be done in-house. Auditors could be hired and trained each year at an hourly cost of 15 dollars. Total labor cost would be approximately $20,000 per auditor for a five-month employment, since demand for these audits is typically greatest during the summer. This cost includes an overhead rate of 50 percent to cover expenses such as car mileage, telephone, and preparing audit reports. The auditor's irrigation testing equipment would include washers, pliers, screwdrivers, pressure gauge, and catchment cups and their stands.

The auditor could audit two three acre sites per day. One auditor working for five months per year could handle this program.

### Water Savings

The water savings from this type of irrigation audit are estimated to be 14 percent of exterior irrigation use. Based on the analysis of cooling water use described above approximately one-half of the exterior, seasonal use goes to landscape irrigation. The total amount of this water is 4.5 mgd. This estimate is based on a number of landscape water use studies.[30, 33-38]

## COMMERCIAL/INDUSTRIAL FOUNTAIN/POOL WATER AUDIT

### Description

This conservation audit targets all fountains and pools owned by commercial/industrial accounts. Based on the COH commercial/industrial large water user survey, for commercial accounts there are an estimated 1,500 fountains and 400 pools in the COH service area. Many of the pools are at hotels. Most of the fountains are at small commercial buildings, hotels and office buildings. The qualifying facility owners/managers would be offered a free fountain/pool audit and periodic follow-up to encourage implementation of audit findings. This audit would be repeated every five years to maintain or improve the conservation level.

The audit would be conducted by COH staff or consultant. The auditor would perform an on-site interior inspection and produce a customized report that describes fixture and valve inspections, leak tests, retrofit possibilities, fountain/pool cleaning and backwashing operation and improvements, and recycling opportunities for each site. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. Potential city water and sewer cost savings would be displayed. The participant's actions and water use would be tracked over time. Standards would be based on previous experience and the performance of the latest technology.

The audit report would consider, when appropriate, the following measures:

- Changes in operation including cleaning and backwashing;
- Leak detection and repair
- Replacement of recirculation pump
- Install solenoid and automatic float (overflow) valves;
- Analyze whether recycling water and separating waste streams are feasible; and
- Determine placement of submeters.

**Marketing Strategies**

The COH would compile a list of commercial/industrial buildings with fountains or pools, targeting first those that have water use in the top 10 percent of all accounts in this category. The survey would be completed by telephone. After targeting existing high water-use customers, the COH would contact owners by mail with telephone follow-up offering a free water audit to the owners. The program would also be promoted among maintenance companies and equipment manufacturers to further increase participation.

**Delivery**

COH staff would be trained, or consultants would be hired to conduct the audits. Appointments would be set with those owners accepting the audit. Since the audits would be site-specific, a pre-audit telephone survey would be performed to get general water use information about each site. The COH would conduct on-site audits to assess water conservation opportunities. Companies involved in leak detection would be used as needed. The COH would pay for the audit and the leak detection but not the cost of repairs to the pool or fountain.

Water use tracking and follow-up audits will be used to maintain water savings.

**Participation Rates**

Although the program is free, the participation rate may be relatively low because the scope is limited. It is estimated that 30 percent of all fountains and pools will be audited. The program will be conducted over a three year period. This means that each year 40 pools and 170 fountains would be audited.

**Costs**

The costs per fountain/pool being audited would vary widely, depending on the complexity level of the audited site. The cost in staff time to arrange the audit, conduct the audit, is estimated to take about two person-days per site. The total annual labor cost for implementing this program over a three year program is (#sites/3*two days* labor rate per day plus expenses). The cost for leak detection is about $750 per site checked. [39] is assumed that this would be initiated on 75 percent of the sites. The cost of follow-up audits is one staff day per site every five years, or about 130 sites per year. The labor cost for the first three years would be $100,000 per year for two staff persons. The subsequent follow-up cost would be one-half time person or $25,000 per year. Leak detection cost would be $120,000 spread over the first three years.

**Water Savings**

The water savings potential of the COH owned pools and fountain was found to be very high, partially because the facilities are large and fallen into disrepair and partially

because the City departments responsible for these facilities have not been paying for the water. Expected savings at city pools were estimated to be 40 percent and 20 percent for fountains if repairs were made (funded by the city).

This program has a lower potential because the pools and fountains are expected to be in better condition and because the customers have been paying for water. Also the program only offers an audit, and if warranted, leak detection. Repairs are funded by the customer. If 30 percent of the pools accept the audit then there may be more of a commitment on the part of the owner to follow through and make the recommended repairs. It is estimated that the audited pools will save 10 percent of the pool/fountain use on a permanent basis, as long as the COH does the periodic audit follow-up.

End use data is not available for the commercial sector so, based on COH facility data, the following base pre-audit uses for pools and fountains is assumed:[39]

- Pools - 2,500 gpd
- Fountains - 1500 gpd

Water savings for audited pools would be 250 gpd and 150 gpd each for audited fountains.

## PUBLIC FACILITY WATER AUDITS

### Description

This measure is designed to reduce interior and peak demand by improving indoor water use and outdoor irrigation efficiency. All public buildings and irrigators of landscapes larger than three acres are candidates for this measure. The participants would receive a two-part audit. The first part would focus on indoor water use and would be similar to the commercial/industrial indoor audit, emphasizing the water used in sanitary fixtures likely to be present in city buildings. The second part would instruct landscape site managers to:

- Learn the targeted site's current irrigation efficiency,
- Be advised of available low-cost hardware improvements,
- Receive baseline irrigation schedules,
- Receive instructions about how to modify the schedules in according to weather changes, and
- Receive water savings information.

Pools and fountains would be excluded from this program if they are covered in another program. Follow-up audits would be provided once every three years. Site building and landscape managers would be responsible for implementing audit findings.

The COH has some experience with large turf audits, having audited three golf courses in the last two years: Sharpstown, Glenbrook and Hermann. Audits recommended a lower water application rate in all cases. The reduction compared to annual use 1988-1994 was 52 percent, 33 percent, and 87 percent respectively.[39] Sharpstown was able to reduce use 41 percent, which shows an 80 percent compliance rate with the recommended schedule. Results at the other two golf courses show a low compliance rate but the annual usage at the other two golf courses was about half the pre-audit rate at Sharpstown. Clearly there is a good potential for this sort of program, however compliance may be problematical.

### Marketing Strategies

The COH would offer this service to all green belts, common areas, schools, business parks, cemeteries, parks, and publicly owned landscapes on or adjacent to roadways involving three or more acres of landscaping. Most of these sites are included in the COH billing system as either lawn meter accounts or municipal/institutional accounts. Participants would first be screened to determine their savings potential under this service. The screening involves estimating the current water use per employee or per acre of landscaped area and an overall irrigation efficiency. A telephone interview would be used to determine if the existing system is neither too poorly designed or in too poor a condition to benefit from the audit. The participants would then receive an audit according to their need, addressing the lowest efficiencies first, and according to the program budget.

### Delivery

This program would have trained auditors and irrigation technicians provide a building audit and system maintenance check-up; a baseline irrigation schedule; periodic performance feedback; and follow-up field visits (at least every five years) at no cost to the customer.

The owners of sites that appear to have water savings potential would be offered an audit by mail and telephone. Buildings with more than ten bathrooms would be eligible for an indoor audit. For the outdoor audit, technicians would perform an initial site audit to evaluate each irrigation system's design, operating condition, and current overall efficiency. Sites having irrigation systems too poorly designed or maintained to benefit from the service would receive no further attention until the systems are upgraded. All others would be eligible for service. Selected sites would be examined to identify low-cost irrigation improvements such as aligning sprinkler heads, replacing broken heads, or trimming grass that disrupts spray patterns.

After the customer made these irrigation improvements, if required, the irrigation technicians would proceed with a detailed irrigation audit to determine precipitation rate, distribution uniformity, grass type, root depth, and soil type. Audits would be conducted according to methods described in the *Landscape Water Management Handbook* prepared for the California Department of Water Resources.[40] Acquired data would be used to develop a base irrigation schedule showing weekly watering times for every month. The schedule would be provided in a brief written report to the site manager for implementation. Follow-up checking would be done to assess implementation and satisfaction, and to adjust schedules as needed. A five-year duration is expected for this measure's water savings; thus, a follow-up audit would be conducted every five years.

### Participation Rates

It is assumed that the top 25 percent of accounts, based on winter water use would be offered an interior audit. Irrigation audits would be offered to the accounts in the top 25 percent of the category based on summer use. These criteria may produce different lists of accounts to be audited. It is assumed that 35 percent of all accounts will be audited.

A 50 percent participation rate for audits of interior use is assumed. This is based on 70 percent acceptance rate with 70 percent of the public buildings assumed to have significant water use warranting an audit. This means that 12.5 percent of the total

accounts will be audited, or about 600 municipal/institutional accounts. If the work is done over three years 200 audits will be done per year. This will be a full-time job for a COH auditor. To maintain the savings the audits will need to continue indefinitely.

An 80 percent participation rate is assumed for public accounts with irrigation systems serving more than 3 acres of turf. This rate is based on a 70 percent acceptance rate experienced for smaller commercial/industrial irrigators, and an apparent 95 percent acceptance rate of achieved by North Marin County Water District in California in its recent program for (mostly) public-sector customers.[22]

The target for this program is the large turf areas with separate lawn meter accounts and the large turf areas in the municipal/institutional account group. The total water use in this group is estimated to be 4.5 mgd. Assuming accounts representing 80% of the total will agree to an audit, the target water use is 3.6 mgd. This is represented by approximately 240 accounts, each using an average of 15,000 gpd. This amount of water could be applied to about 10 acres of turf at the rate of 1.5 feet per year. If the audits are done over a three year period the 80 audits per year could be done by one full-time auditor. After the first three years the follow-up could be handled by a half-time auditor.

### Costs

The customers would pay for implementing audit findings including minor irrigation systems repairs (replacing broken heads, repairing leaks, etc.), and incur the labor cost to reset irrigation controls periodically. Cost categories are given below.

- Administration: marketing and screening, hiring and training technicians;
- Audit work; and
- Follow up work: developing water schedules, training users, evaluating performance, preparing reports.

In the case of the indoor audit the building manager would be offered free low flow showerheads and toilet tank displacement devices and informed of the ULF toilet rebate program. The cost of the interior audit will be the labor cost of one full-time auditor, approximately $40,000 per year plus $20,000 per year for expenses.

The irrigation audits will also require the services of a full-time irrigation auditor for the first three years and then half-time thereafter. Due to the training required the cost will be higher than for the interior auditor. The annual cost will be $45,000 per year plus $20,000 per year for expenses.

The program set-up costs will be an additional $25,000.

### Water Savings

Water savings for the indoor audit portion of program will be less than the commercial/industrial audit program because the focus will be on sanitary fixtures and cooling towers only. For public facility conservation, a 5 percent indoor savings is has been used with estimating savings from California BMPs.[22] In this study a 10 percent indoor savings is used because plumbing fixture requirements did not start in Texas until 1992 whereas they started in 1978 in California so there are more high volume toilets installed in Texas. Also there is more cooling tower water use in Texas due to higher summer temperatures.

Based on an independent analysis of the North Marin County Water District audits, outdoor water savings for sites receiving irrigation audits was 14 percent.[33] The water savings from one COH run golf course that followed the schedule provided after a COH audit was about 41 percent.[39] The results at two other golf courses was much lower. A value of 15 percent of irrigation use was used in this study.

## PUBLIC BUILDING TOILET AND SHOWER REPLACEMENT

### Description

This program provides tangible evidence of the City's commitment to water conservation. Substantial savings can be realized by decreasing the volume of toilet flushes. Cash rebates would be offered to encourage replacement of all toilets, urinal valves, showers and aerators presently installed in public buildings that do not comply with the current plumbing fixture requirements. Complete replacement of flushometer-type toilets would be required over retrofit of the valve alone because the geometry of the bowl is critical to achieving a satisfactory flush with 1.6 gallons.[8] Cash rebates also could be offered to schools for replacement of conventional showerheads with low-volume showerheads. This program would apply to all municipal and institutional accounts.

### Marketing Strategies

The toilet replacement program would be directed at public building owners and managers, and at plumbing contractors and suppliers. The program would be announced through water bill stuffers where appropriate, internal city newsletters, and mailed to plumbing industry trade allies. The COH would need to conduct meetings with the public and facility managers to explain program specifics and to solicit participation in the program.

### Delivery

The COH would target all public buildings not already fully equipped with low-volume fixtures. Customers who purchase qualifying fixtures would complete a rebate application and return it to the COH with proof of purchase. Rebates would be paid following verification of replacements.

Showerhead rebates would have to be developed for each situation. These rebates would be based on avoided costs and capped at the installation costs. Showerhead rebates could range from $5-10 per unit.

### Participation Rates

The public toilet replacement participation rate is similar to or better than that achieved by residential rebate/replacement programs which convert approximately 3-5 percent per year of the total market over 5 years. Public customers are expected to convert at the rate of at least 3 percent per year if they pay for water and sewer service. A plumbing permit would be required to change out the toilets. This would tend to lower the participation rate because of the extra time involved.

### Costs

Unit costs for the COH would include the replacement rebate plus 30 percent for overhead (administration, marketing, and evaluation). The total cost of the rebate

program would therefore be based on $150 for toilets, $75 for urinal flush valves, and $7 for showerheads.

The number of fixtures in the public sector is not directly known. It can be estimated using employees per fixture (from the large commercial/industrial survey) and employment data from the census. The survey results showed that the number of employees per toilet at 18 sites averaged six employees per toilet. The number of employees per urinal averaged 22.[39] This can be used to estimate the number of fixtures qualifying for a rebate each year. Showerhead replacements will be taken as 25 percent of the toilets.

Customer costs would include equipment and labor assuming installation by a plumber, less the rebate. Complete replacement of the urinal valve is also assumed.

### Water Savings

Until recently there has not been definitive data on the water saved by replacing non-residential bathroom fixtures. Two new reports provide a basis for estimating water savings for replacement ULF toilets. The first, "Ultra Low Flush Toilet Programs" cited a water savings of 73.6 gpd per ULF toilet replaced at 250 commercial sites.[28] The second, "Public Facilities Toilet Retrofit," cited a water savings of 76.8 gpd per ULF toilet replaced at 70 public facilities.[29] Most of the latter sites had been using 3.5 gallons per flush toilets. Although employees at these sites probably only flush the toilet 2-3 times while at work, the large water savings should be due to walk-in public, guests, or students, such as occurs in restaurants, hotels, or schools respectively.

It is convenient to express water savings on a per employee basis because the number of employees in a city is known much more accurately than the number of nonresidential toilets. To use the above data in the fashion the number of employees per toilet must be known. The COH commercial/industrial water user survey provided data on employment and number of toilets per site. The results showed that the number of employees per toilet at 18 sites averaged six employees per toilet. The number of employees per urinal averaged 22 per urinal.[39]

Using these values replacement of ULF toilets saves 73.6 ÷ 6 or 12.3 gallons per employee per toilet. An allowance for replacement of urinals with ultra low-flush models is 0.4 gpd per employee.[26] The total water savings used in the study was 12.7 gallons per employee per day.

## PUBLIC FOUNTAIN/POOL WATER AUDIT AND REPAIR

### Description

This conservation audit targets all publicly owned fountains and pools. There are an estimated 60 public fountains and 260 public pools in the COH service area under the category of municipal and institutional account.[39] This includes the 24 fountains and 44 pools that are city-owned and operated. The qualifying public facility owners/managers would be offered a free fountain/pool audit and periodic follow-up to encourage implementation of audit findings. Incentives could be offered to speed up the repair process.

An interior audit would be conducted by COH staff. The auditor would perform an on-site interior inspection and produce a customized report that describes fixture and valve inspections, leak tests, retrofit possibilities, fountain/pool cleaning and backwashing operation and improvements, and recycling opportunities for each site. A leak test by a private contractor would be provided if warranted. The report would include a spreadsheet that compares the existing facility operations with conservation standards and potentials. The participant's actions and water use would be tracked over time. Standards would be based on previous experience and the performance of the latest technology.

The audit report would consider, when appropriate, the following measures:

- Changes in operation including cleaning and backwashing;
- Leak detection and repair
- Replacement of recirculation pump
- Install solenoid and automatic float (overflow) valves;
- Analyze whether recycling water and separating waste streams are feasible; and
- Determine placement of submeters.

**Marketing Strategies**

The COH would compile a list of public buildings with fountains or pools, targeting first those that have water use in the top 25 percent of all accounts in this category. After targeting existing high water-use customers, the COH would contact owners by telephone offering a free water audit to the owners. The program would also be promoted among maintenance companies and equipment manufacturers to further increase participation.

**Delivery**

COH staff would be trained, or consultants would be hired to conduct the audits. Appointments would be set with those owners accepting the audit. Since the audits would be site-specific, a pre-audit telephone survey would be performed to get general water use information about each site. The COH would conduct on-site audits to assess water conservation opportunities. Leak tests would be provided where needed.

The water conservation group would budget money to pay for top priority repairs of COH owned facilities. A rating system, based on cost-effectiveness would be developed to decide which repairs to do first. Other fountains and pools at schools, hospitals, churches and other non-city owned facilities would be provided the audit and the leak test but they would pay for repairs themselves.

Water use tracking and follow-up audits will be used to maintain water savings.

**Participation Rates**

Because the program is free, some of the facilities city-owned, and because the COH conservation group will pay for leak tests and repairs on city-owned facilities, the participation rate will be high. It is estimated that 80 percent of all fountains and pools will be covered. The program will be conducted over a five year period.

**Costs**

The costs per fountain/pool being audited would vary widely, depending on the complexity level of the audited site. The cost in staff time to arrange the audit, conduct

the audit, and administer a repair program on certain sites is estimated to take about four person-days per site. The total annual labor cost for implementing this program over a three year program is (#sites/3*four days*labor rate per day plus expenses). To deal with 256 (80 percent of the total) pool/fountain sites would involve 1024 person-days spread over three years. This would require two COH staff persons full time at a loaded labor cost of $100,000 per year. The cost of the leak detection by private contractor would be $750 per site and it is assumed that leaks would be checked for at all sites.[39] The leak detection cost for all sites would be $64,000 per year for three years.

The cost of repairs to city owned facilities (24 pools and 45 fountains) is estimated to be $500,000 spread over five years. This is based on the COH's experience in 1995 and estimates for repairing five pools.[41] Assuming the non-COH facilities are in better condition the per site cost of the repairs should be less than the $7,500 per site for COH facilities. Assuming the COH funds the entire repair program, a cost of $4,000 per site could be incurred. Total costs would be the $500,000 for the COH's facilities plus another $1,025,000 for the remaining non-COH sites for a total of $1,525,000, spread over five years.

**Water Savings**

Based on preliminary results the water savings potential for each COH fountain is estimated to be a 60 reduction. Assuming a 70 percent long-term success rate the actual water savings achieved at COH fountains is expected to be closer to 40 percent. Extending this to the remainder of the public fountains (an additional 29 fountains) the potential is likely lower because the other public accounts have been paying for water. The expected long-term savings non-COH fountains is 20 percent.

The savings from COH pools can only be roughly estimated at this time since the city program has just started. The potential appears to be less because the per site use for pools is less than for fountains. The potential for COH pools is estimated to be 30 percent, with a realistic target of achieving a 20 percent reduction. The target for non-COH pools, 15 percent.

The water use for COH facilities is 15 percent of the total Parks Department use for pools and 14 percent of the total for fountains. The Parks Department uses about 80 percent of the total General Fund billing category of water use. The savings in the General Fund billing category would be 40 percent of 12 percent of the total for pools plus 20 percent of 11 percent of the total for fountains. The total combined reduction is 7 percent, developed linearly over five years.

For the 29 non COH-fountains a pre-audit water use of 1,500 gallons per fountain per day (gpd) can be assumed together with a savings of 30 percent.

For the 173 non-COH pools a pre audit water use of 3,000 gpd can be assumed (a little less than half the COH pool water use rate per pool). Combined with a savings of 15 percent, the total savings can be determined.

The long-term savings depend on whether the pools and fountains remain in good repair, i.e. the various owners budget more for maintenance than they have in the past and the follow-up work is carried out. This is not expected to be a problem for the non-COH pools since they pay for water and should be more diligent after the water and sewer bill savings are realized for the first time. For COH facilities, unless the following measure is implemented (City departments pay for water), the water savings can not be assumed to be permanent and within ten years the water use will most likely return to pre-program

levels. Alternatively this program could be repeated every 5-10 years to sustain the savings.

## STANDARD FOR NEW FOUNTAINS/POOLS

### Description

This conservation audit targets all new publicly owned fountains and pools. There are an estimated 260 public fountains and 60 public pools in the COH service area. Existing fountains and pools would be audited in a related program. New fountains/pools would get a plan review with this program to make sure that the equipment is up to state-of-the-art in terms of water efficiency.

A plan review of new facilities would be conducted by COH staff and conveyed to the facility designer. The plan checker would look for the following features: low flow showerheads, ULF toilets, self closing faucets, dead man switches for hoses, and secured float valves at swimming pools, and recirculation pumps at pools and fountains. Other features would be compared with existing conservation standards and potentials. Standards would be based on previous experience and the performance of the latest technology.

The COH would develop operations manuals for ensuring proper operation of new equipment. Included would be sections on pool/fountain cleaning procedures, chemical water treatment, filter backwash frequency criteria, pool/fountain emptying and refilling criteria. Guidelines water use would be developed in terms of a water budget that would be provided to each facility manager. The manual would be loose leaf and a binder would be prepared and given to each new owner/operator. Training seminars for existing maintenance staff would be conducted periodically. The COH would set up a water use tracking system for all new accounts where pools and fountains are separately metered. Installing separate meters would be encouraged and required for large pools. Site visits to new installations would be made for suspected high water users and on-site advice offered.

### Marketing Strategies

The COH conservation group would explain the new policy to all affected departments, particularly the building department which issues permits for new installations. The COH Health Department would be consulted on the development of the manual and water budget to make sure that public health is maintained, even as water use is minimized. The respective COH departments would notify the conservation group when a new pool or fountain is being designed.

### Delivery

COH staff would be trained, or consultants would be hired to conduct the plan checks. Random site visits during construction would be made to verify that specified equipment is being installed.

The COH conservation group would develop the above referenced manual and conduct the training seminars.

The COH conservation group would develop a water use budgets and a tracking system to verify low water use. When water use at a monitored facility gets above the target a

trained staff person would visit the site to understand why the water use has increased and work with the manager to restore an efficient operation.

### Participation Rates

Because the program is free, some of the facilities city-owned, and all require a COH permit, the participation rate will be high. It is estimated that 90 percent of all new fountains and pools will be covered. The program will be conducted indefinitely.

### Costs

The costs for this program will be for the staff who are doing the plan checking. Based on an assumed 2-3 percent annual growth rate in new facilities about 6-10 new public pools or fountains will be built each year. The staff required would be one full-time person for the first year and then a one-quarter staff person to operate the program. The cost would be $75,000 for the first year for labor and materials decreasing to $20,000 each year thereafter

### Water Savings

Based on preliminary results the water savings per site are estimated to be 25 percent, on average, of all new sites, compared to existing pre-program water use levels.[39] It can be assumed that the city is adding eight facilities each year that will use 5,000 gallons per day without the program for a total new added use of 40,000 gpd per year. The water savings grow by 10,000 gpd each year.

## CITY OF HOUSTON IN-HOUSE PROGRAM

### Description

This program targets all City departments who are not now charged for water. Although most City accounts are metered, current City policy is to bill those departments that are a revenue-supported enterprise. Enterprise departments collect fees, charges or other non-tax revenues. All departments are currently billed for sewer service. However, departments that are not enterprise are not billed for water. Under this new program, a monthly "water statement" would be produced and distributed to each department. A goal of 10% to 20% reduction in water usage would also be imposed for each department. The goal would be determined by the Water Conservation Branch based on the department's water usage and work responsibilities.

The current policy of not charging for water has led to wasteful practices by those departments. The Parks department uses about 90 percent of water used by this group of departments. Each City department would be given a goal of a 20 percent water use reduction.

### Marketing Strategies

The COH facilities that are not presently metered would be metered. This includes city-owned pools, fountains, multi-service centers, esplanades, etc. These accounts and all existing and new accounts would be billed according to the current city rate schedule.

### Delivery

Conservation staff would make all departments aware of the new policy. They would also offer assistance through currently approved water saving programs which could include programs targeted at fixtures, pools, fountains, and large turf areas.

### Participation Rates

All COH departments would participate. Compliance of 100 percent is reasonably assured if this measure is adopted by the COH.

### Costs

Minor changes to the billing computer program would be required to start billing new accounts. The staff time to explain the policy and the available programs would be insignificant and covered in other programs.

### Water Savings

Studies have shown that when customers are metered and charged for water consumption, can drop 20 percent or more.[14] This program would support the other programs targeted at General Fund departments and make them work better and the savings long-lasting. The initial savings achieved by the audit and repair programs for pools, fountains, and large turf areas are expected to disappear over time without changing the way the departments are billed for water. If this measure is selected without the other programs, the departments may or may not undertake audits and repairs on their own to reduce water use. They may just ask for a higher budget to cover the new water bill. Operating independently, the reduction in use may be in the range of 5-10 percent in the General Fund billing category. Taken together with the other measures the savings are likely to be about an additional 5 percent and will have the effect of making the other program savings permanent.

## SYSTEM WATER AUDITS, LEAK DETECTION, AND REPAIR

### Description

Some system water losses, or unaccounted-for water (UAW), are authorized. Authorized losses include flushing hydrants by fire departments, or water use in unmetered government buildings. The remainder of UAW is caused by leaks. The purpose of this measure is to reduce leaks from older systems and from broken pipes, joints, or valves. Up to 40 percent of all UAW can be attributed to leaks. For example, if the UAW is greater than 10 percent of total production, then the leakage could be 4 percent, and the COH may find a leak-detection and repair program beneficial. Lower UAW levels usually indicate that leak-detection and repair would not be cost-effective.

For the COH service area, leak-detection and repair would be effective since the COH UAW varies between 7 and 26 percent monthly. The following annual averages have been achieved:

- FY 1991 - 19.5 percent
- FY 1992 - 18.3 percent
- FY 1993 - 16.8 percent
- FY 1994 - 17.3 percent
- FY 1995 - 14.3 percent

Although the average has been around 17 percent there is a definite downward trend and the difference between 1991 and 1995 is a decrease of 5 percent. According to the COH a realistic goal is 10 percent and a realistic time period to achieve this goal is ten years.[42] This goal allows twice as long to achieve the next five percent as the first five percent. The easy savings have probably been found and the COH now needs to move into leak detection and repair.

### Marketing Strategies

Assuming the UAW remains above 10 percent the COH would initiate it's leak detection and repair program. In addition, the COH would check customer bills for extreme changes that may indicate a leak on the customer's property. This step can be automated by programming the billing system to flag water bills with consumption greater than 25 percent of the previous year's consumption. The COH would encourage these customers to look for a leak.

### Delivery

Since 1989, each Quadrant within the COH has been conducting water distribution piping leak detection surveys and repairing leaks discovered during the surveys. In April 1995, the Water Prevention Maintenance Department was formed to provides technical support to each of the four Quadrants. The new department consists of 10 full time employees (water leak investigators) to help the Quadrants survey the entire COH water distribution system for leaks. The goal of the program is to begin inspection of the pipes in downtown Houston working outward to the outer limits of the City until all the piping has been inspected. The estimated time to inspect all water distribution pipes for leaks is four years. Reinspection of the pipes will begin upon the completion of the first overall survey and subsequent repairs. Currently the 10 employees are divided into five crews and together they are finding one leak per day. When a leak is located a crew with a leak corrector is called in to pinpoint the leak. The leak is then found and fixed by a repair crew.

Most of the work conducted by each Quadrant's leak detection and repair program is surveying the water distribution lines systematically, however, sometimes a water use customer calls the Department of Public Works and Engineering concerned that his/her water bill is unusually high. In this case, investigators assess the situation with the leak detection equipment to determine if in fact a leak is present on the property. If a leak is present, then it is the customer's responsibility to have the leak repaired. The only instance that the City would repair the leak is if City personnel caused the break in the pipe during the investigation.

### Participation Rates

The entire COH water service area would participate in the program.

### Costs

The leak detection function will involve 10 persons in 2-man crews with a pick-up truck. Assuming the crews continue to find one leak per day the repair cost can be estimated. Leak pinpointing will keep another 2-man crew busy full-time and repair will keep a 2-man repair crew busy full-time. These people are in addition to historical staffing levels.
The estimated cost components are:[42]

- Leak detection - $560,000 per year
- Pinpointing - $120,000 per year

- Leak repair - $100,000 per year
- Administration - $100,000 per year
- Total cost - $880,000 per year

### Water Savings

Average UAW in Houston is about 14 percent. In general, a total savings in production is possible if leakage is reduced. For this report, water savings is estimated to save 4 percent of production used in the retail sector by reducing the UAW to 10 percent over the next 10 years. The lifetime savings depends on whether the service is a one-time project, in which case the savings are not permanent because new leaks would appear; or whether the service is repeated periodically, in which case permanent savings would be assumed. In this study we assume that the surveys are done every 8-years over the planning period so the savings would stabilize at 4 percent.

## CONSERVATION PRICING

### Description

The existing COH rate structure was described in Section 2 of Tech Memo 1. It includes inclining blocks for both water and sewer pricing. Sewer pricing is based on total water use. This rate structure certainly encourages conservation. The purpose of this measure is to suggest some alternatives that could be considered to further increase the incentives to conserve water.

Under this measure the city would modify its existing water conservation rate structure directed at reducing consumption to avert or delay additions to capacity for delivery or treatment. Traditional objectives in rate structure design include that the rates be based on the costs to serve, that they provide adequate and stable revenues, that they be fair or equitable among customers classes and volume users, and that they be easy to implement and administer. Conservation rates provide a financial incentive to ratepayers to reduce water their water use, usually by applying a surcharge on peak months' usage or by charging a higher unit rate for water as more units are used. Conservation rates are often not based on historical costs to serve each customer group or rate block and therefore are held, by some ratepayers, to be unfair. It is, therefore, essential that conservation rates be developed through a public process that assures acceptance of the purpose and design of the rate structure. It is important to recognize that, for whatever conservation rate structure selected, greater leverage can be achieved from a combination of price with indoor and outdoor conservation programs than from price alone. Conservation pricing makes the most sense as part of a broad demand management program.

The following is a general discussion of alternative conservation rate structures that the COH may wish to consider. Tiered rates (inclining block rates) and seasonal rates are generally considered the basic conservation rate types. But there are other rate structures that are sometimes called conservation rate structures. For example, a single unit rate that replaces a declining block rate structure is often touted as a conservation rate structure. Another example is a marginal (or incremental) cost rate structure because the rate is tied to the cost of incremental water supplies which are affected by Demand Side Management measures. Four rate structure types are identified below that could be applicable for the COH.

**A single unit rate structure** charges the same unit rate for all volume used, usually for all customer classes, but sometimes with a different rate for each customer class. This rate

structure has gained in popularity over the traditional declining-block rate structure because of the intuitive appeal of all customers paying the same price for all water use, and the elimination of the perceived unfairness of large water users paying lower rates for high volume under the declining-block rate structures. The uniform volume rate structure is generally accompanied by a fixed monthly service charge, by meter size, that recovers customer costs unrelated to water volume. For the COH changing to this type would be a regressive move.

**Marginal cost or incremental costs** of new supplies or of the next increment of treatment facilities are sometimes used as the basis for seasonal or inclining block rates applied year-round. The rationale is to charge existing customers the unit cost of the next increment of supply so that their decision to use or not use their next increment of water is based on the cost of incremental supply. But if there were no account growth or increase in usage within the existing number of accounts, there would be no need for the next increment. Therefore, the existing customers of many utilities believe that incremental water supplies should be paid for, in connection or capacity charges, by future customers since they necessitate the requirement. Since marginal cost pricing is not based on current costs, excess revenues will accrue that must be applied to reductions in the service charge, to off-season rates, or to funds for financing incremental supply facilities. All of these alternative uses of excess revenues must be evaluated for this alternative in achieving fairness in rate structure design and revenue neutrality.

**A seasonal rate structure** is implemented for water consumed during a utility's peak-use season, either as a means of recovering the incremental cost of providing water during this period or as an inducement to conserve water because of inadequate or constrained supply. Seasonal rate structures can be constructed to apply either summer surcharges or a tiered rate structure. A summer surcharge can be applied to all summer volume or to summer volume in excess of winter volume. Most water economists prefer using a surcharge on summer use in excess of winter (indoor) use because the incremental cost of supply can be used as a basis for the rate blocks and the difference in rate blocks can be high enough to induce a consumption response without generating major excess revenues.

**Inclining block rates,** or tiered block rates, use two or more rate blocks with increasing unit rates as consumption increases from one block to the next. This structure can be applied during the summer only or during the entire year. Depending on the volume breakpoints of the blocks and the number of blocks, the upper blocks will rarely be applied in the off-season. Some utilities try to set each block rate at the cost of peaking or at the cost of each new increment of supply. If the rate blocks are mostly judgmental, the rate structure should be viewed simply as a conservation rate structure which does not require a strict cost-of-service justification. Determination of the number of blocks, price break points, and rate differentials between blocks requires careful analysis that addresses the patterns of use by blocks, the desired effect on consumption, and the impacts on total revenues. The COH presently has this type of rate structure. Changing the number of blocks or the break points between blocks could be considered to increase the incentives to conserve water.

### Marketing Strategies

Conservation rates, especially inclining block rates, are sometimes perceived by ratepayers as being unfair. Public hearings will be required to hear the ratepayers sentiments and to respond to them regarding the purpose of the rates and the design of the rate structure. Conservation rates should be presented to the public more as a subtle, but constant, reminder that water is a precious commodity that should not be wasted than as an unyielding deterrent to water use for traditionally acceptable applications. The public

should be reminded that they can minimize the effect of conservation rates by implementing the various conservation measures that the city endorses, whether or not they are chosen as participants in the programs that are restricted (for budget and practical implementation reasons) to a limited number of participants per year.

**Participation Rates**

It is anticipated that, in the interest of rate fairness or equity, all city customers would be included in the application conservation rates. The amount of rate impact for each customer class and within each customer class (by rate blocks) would depend on a water consumption by class and cost-of-service analysis.

**Costs**

A one-time system design/rate study/implementation cost of approximately $100,000 would be required to implement conservation rates for the water system. A separate wastewater rate study (approximately $50,000) should be undertaken since the rates for both systems are applied to total water consumed even though approximately 40 percent of residential peak summer use is for irrigation which does not enter the sanitary sewer system. The current rate structure has provisions for two rate blocks; it is assumed that no major reprogramming of the rate and billing system would be required to shift or add blocks and adjust the minimum charges. The above cost estimates include a provision for two public hearings to explain the purpose and basis for the conservation rates and allow for customer feedback.

**Water Savings**

Whatever conservation rate structure is selected, the rates must be set with an accurate prediction of the customers' response to price so that revenue requirements are met at the lower volumes that result. The demand for water is basically inelastic which means that a percentage increase in rates will evoke a proportionately smaller percentage decrease in the quantity of water used. The response is typically larger in summer (when more discretionary use takes place) than in winter, and the response is usually dependent on the magnitude of the increase and the level of rates. However, if there have been large increases in the recent past, the next rate increase, even if it is a large one, could evoke only a small response because there is little discretionary demand left to be eliminated. At some point water is an essential product irrespective of price.

It should be clear from the above discussion that one cannot generalize on the results of rate increases. The predicted response at the COH must result from an integrated analysis of all demand management measures with the conservation rate structure analysis.

The COH has changed its rate structure significantly over the last eight years. Water rates were increased both in the minimum rate blocks and in the volume rates applied to consumption in excess of the minimum. Because of changes (1991) in reporting for accounts, the simplest way to analyze the impact of rate changes over time is through typical bills for various volumes. To derive a total rate impact the water and wastewater bills should be combined since both systems apply rates to total water used.

## PUBLIC INFORMATION/EDUCATION

### Description

This measure is an extension of the COH existing public information/education efforts. It serves as the 'glue' to tie all the other measures together. It would not only address specific measures but also cultural/social aspects of establishing or enhancing a water conservation ethic among the COH customers; most importantly, it would convey to the public a understanding of why water conservation is important. Programs include school programs involving theatrical productions, poster contests, T-shirt design contests, presentations and tours with hands-on demonstrations; radio and television time, and printed educational material such as bill inserts. Public education would continue to be used to raise awareness of other conservation measures available to COH customers.

A full-time public information specialist and school education coordinator would likely devote most of their time to public education and to implementing a school program throughout the service area. Additional staff dedicated may be involved to help by educating the public through a speakers bureau, tours, producing bill inserts, creating displays at fairs and nurseries, giving presentations, and creating low water-use gardens.

### Marketing Strategies

A public information and school education program needs goals, staff, materials and a theme to be effective. Currently the COH has two persons devoted to these programs. This measure would expand on that effort to increase the market penetration of the existing programs. The program will need an increased annual budget to carry out the program. The following steps could be used to add new programs:

1. Develop a clean and persuasive statement of purpose.
2. Choose an appropriate theme.
3. Identify key target groups.
4. Select members for a water conservation committee.
5. Identify communication paths, resource materials, and volunteers.
6. Design and implement specific campaigns.
7. Ensure effective coordination and follow-through.

This measure targets all customers within the COH service areas. The coordinator would develop the program following the steps listed above. Once a purpose statement has been created, a water conservation theme would be decided upon. This could be based on the results of this study which will identify where most of the conservation benefits will come from. Examples of possible themes follows.

- Save Water
- Use Water Wisely
- Save Water, Save Money, Save Energy
- Save Water, It's Your Future
- Save Water Today for Tomorrow
- Water is Life, Don't Waste It

A program logo reflecting the theme should then be selected. The image could be realistic, stylized, or a friendly caricature; and it should be given a suitable name. Currently the COH uses Rusty Starr, an environmentally conscious frog, in school plays and at fairs and other media events. The program logo has become a familiar symbol and

can easily be used for printed matter. This theme can be retained or modified as needed in the future.

**Delivery**

**Public Education.** This program will likely be created in-house, as has been done in the past. Certain parts of the development could be contracted out, such as graphics and printing. The creative ideas for new program elements will most likely come from staff. A water conservation committee could be created to receive input from consumers affected by the program, to advise the water conservation coordinator about new programs, materials, and means of communicating with target groups; assist in ideas; and help develop and implement specific education programs. The committee could consist of an elected official as chairperson, representative of interested agencies and parties, and technical personnel.

To convey to the customers the importance of water conservation, the program may seek to explain why construction of water facilities may be necessary if water conservation is not practiced, how much these facilities would cost, and then compare these costs to what benefits can be received from conserving water. Public information would be used to promote the other selected conservation programs as well.

Currently the COH conducts tours of their water treatment plans. In 1995 approximately 80 tours were given.[43] The COH also uses a speakers bureau to target civic associations and community groups.

The various media forms including bill inserts, ads, and television and radio spots can be used to instill a conservation ethic in the community. In 1995 the COH did four conservation bill inserts to 400,000 residential accounts. The specific material compliments the other programs such as free audit programs so that the customers are aware of how to take advantage of existing conservation programs. For example, a spring bill insert could publicize the availability of irrigation audits to qualified customers (larger water users). The COH uses bill inserts to publicize the availability of free water audit kits for homeowners. In 1995 they gave away 35,000 kits.

Low water use landscaping is often promoted through demonstration gardens and brochures, developed through a public education program. The COH is starting a Xeriscape program that will include a demonstration garden at the conservation group's new office.

One area for possible expansion is to offer an employee education program for Houston area businesses. This could be done in conjunction with a commercial/industrial water audit program or independently. The education program would teach employees how to spot water waste and about simple, low cost methods to save water. This would complement and give water audits more staying power. The employee education program could be done with focused technical seminars and site visits with presentations, training videos, meetings, site surveys etc.

**School Education.** Long-term result to eliminate wasteful water-use habits are best achieved by education young people. Teaching children to respect the value of water will help them grow into responsible adults with a conservation ethic. The COH currently uses the "Major Rivers" developed by the Texas Water Development Board. This program offers comprehensive water education program for 4th graders. This program is offered to COH area schools at a cost of $35 for enough materials for a class of 25 students.

Water conservation presentations are given to schools. Last year 250 presentations were given reaching about 2,200 students per month.[43] Thus far 15,000 to 18,000 students have been reached. Pre and post-presentation surveys are done to gauge effectiveness.

In addition to the existing programs new school programs could be organized as follows.

1. Obtain approval for the new water education programs from the superintendent of schools.
2. Organize water utility efforts.
3. Coordinate teacher training.
4. Estimate the number of participants, including teachers, in the water education program.
5. Organize distribution of curriculum materials to teachers.
6. Monitor and follow the success of the program making adjustments as necessary to maximize student contact.

The school education coordinator will serve to administer and follow-through with the program. The coordinator would annually review any new program materials developed by other water utilities and consider introducing the materials into the program. The coordinator will also maintain an adequate supply of material for the program. For example the COH may decide to extend the program into high schools and modify the program used by the Metropolitan Water District of Southern California that focuses on debating the current statewide water issues that affect southern California.

**Participation Rates**

It is assumed that every customer will receive at least one message from the education program yearly--either hear a radio spot, see a poster in a store or on a bus or billboard, or catch a theatrical performance at the local shopping mall put on by school children. The program will especially target school-age children with presentations, poster contests, printed educational materials, and theatrical presentations. They, in turn, will inform their parents of the importance of water conservation in Houston.

**Costs**

Costs include design of marketing, printing and distributing public information materials. A cost of $0.50 per resident per year is estimated for the administration, marketing and educational programs.

**Water Savings**

Water savings from public education are difficult to determine because it supports other programs although estimates of two to five percent of residential use have been used.[5] For this report, water savings was estimated to be 1.5 percent of total consumption for all customers. Additional savings are contributed by the Water Wise and Energy Efficient program considered separately. This is considered to be achievable over the next five years by continuing existing programs and adding programs such as those mentioned above.

## WATER WISE AND ENERGY EFFICIENT PROGRAM

### Description

This measure is a portion of the COH's school education program described in the previous measure. It is limited to continuing the Water Wise and Energy Efficient program at the current level of effort.

### Marketing Strategies

The current strategy is to support the work of the Harris-Galveston Coastal Subsidence District who will continue to take the lead in involving Houston area schools in the program.

### Delivery

The COH, working with the Harris-Galveston Coastal Subsidence District, sponsors about 3,500 5th graders in the "Learning to be Water Wise and Energy Efficient" program.[41] The cost of the kit is about $30 each and requires a cooperative student-parent effort to install and report on the materials in the kit.

The kit includes a low flow showerhead, faucet aerators, public information materials and energy efficient products.

### Participation Rates

It is assumed that each student participating in the program would receive and install a kit.

### Costs

The program is funded at $100,000 per year. This budget is enough for 3,500 kits.

### Water Savings

Based on estimated water savings for showerheads, and faucet aerators combined with household size data in Section 3, a water savings of 23 gallons per day, per household participating, was derived.

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# APPENDIX D

## Water Plan Output for Recommended Plan

City of Houston Recommended Conservation Plan
SUMMARY REPORT FOR PLAN

| Water Savings<br><br>Final Recommended Plan COH | Net Savings to Utility (gal/day) |
|---|---|
| Total Lifecycle Water Savings | 1043745344 |
| Average Savings Per Year (over 50 years) | 20874907 |

| Final Recommended Plan COH<br><br>Perspective | Present Value of Total Costs (000 $) | Net Present Value (000 $) | Benefit / Cost Ratio | Average Lifecycle Unit Cost ($/000 gal) | Internal Rate of Return (%) |
|---|---|---|---|---|---|
| TOTAL RESOURCE COST TEST | 71069 | 190957 | 3.687 | 0.38 | 170.7 |
| UTILITY TEST | 71069 | 190957 | 3.687 | 0.38 | 170.7 |
| SOCIETAL TEST | 71069 | 190957 | 3.687 | 0.38 | 170.7 |

City of Houston Recommended Conservation Plan

SUMMARY REPORT FOR PROGRAMS IN PLAN

| Water Savings | Lifecycle Gross Savings to Customer (gal/day) | Lifecycle Net Savings to Utility (gal/day) | Average Gross Savings per Year (gal/day) | Average Net Savings per Year (gal/day) | No Yr |
|---|---|---|---|---|---|
| Final Recommended Plan COH | 212850336 | 1043745344 | 4257007 | 20874907 | 50 |
| Appliance Labeling | 34861288 | 34861288 | 711455 | 711455 | 49 |
| C/I Indoor Audits | 54793108 | 54793108 | 1165811 | 1165811 | 47 |
| C/I Cooling Tower Audits | 22999982 | 22999982 | 479166 | 479166 | 48 |
| COH In-House Program | 0 | 10100004 | 0 | 202000 | 50 |
| PF Indoor Audits | 17562022 | 17562022 | 358409 | 358409 | 49 |
| PF Pool/Fountain Audits-COH | 0 | 12999735 | 0 | 270828 | 48 |
| PF Pool/Fountain Standards | 12250112 | 12250112 | 250002 | 250002 | 49 |
| Unaccounted for Water Improv | 0 | 582402304 | 0 | 11648046 | 50 |
| PF Exterior Audits | 42299932 | 42299932 | 863264 | 863264 | 49 |
| Public Education Program | 0 | 225393024 | 0 | 4507860 | 50 |
| SFR Water Audits | 19904258 | 19904258 | 423495 | 423495 | 47 |
| Waterwise & Energy Efficient | 8179644 | 8179644 | 430508 | 430508 | 19 |

City of Houston Recommended Conservation Plan
ANALYSIS REPORT FOR PROGRAMS IN PLAN: UTILITY TEST

| Analysis Results<br>UTILITY TEST | Present Value of Total Costs (000 $) | Net Present Value (000 $) | Benefit / Cost Ratio | Average Lifecycle Unit Cost ($/000 gal) | Internal Rate of Return (%) |
|---|---|---|---|---|---|
| Final Recommended Plan COH | 71069 | 190957 | 3.687 | 0.38 | 170.7 |
| Appliance Labeling | 367 | 7608 | 21.711 | 0.07 | 67.5 |
| C/I Indoor Audits | 6221 | 7621 | 2.225 | 0.64 | 84.8 |
| C/I Cooling Tower Audits | 311 | 5501 | 18.674 | 0.08 | 272.5 |
| COH In-House Program | 50 | 2691 | 54.828 | 0.03 | ---- |
| PF Indoor Audits | 1542 | 3138 | 3.034 | 0.48 | 139.0 |
| PF Pool/Fountain Audits-COH | 525 | 2760 | 6.261 | 0.22 | 32.5 |
| PF Pool/Fountain Standards | 583 | 1936 | 4.321 | 0.32 | 19.0 |
| Unaccounted for Water Improv | 23321 | 123074 | 6.277 | 0.22 | 291.9 |
| PF Exterior Audits | 1004 | 9880 | 10.844 | 0.13 | ---- |
| Public Education Program | 31225 | 24405 | 1.782 | 0.79 | 79.1 |
| SFR Water Audits | 5040 | -12 | 0.998 | 1.43 | ---- |
| Waterwise & Energy Efficient | 879 | 2355 | 3.680 | 0.38 | 71.5 |

City of Houston Recommended Conservation Plan
DETAIL FOR PLAN: Final Recommended Plan COH
PERSPECTIVE: UTILITY TEST

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) |
|---|---|---|---|---|
| 1997 | 2253776 | 1735 | 1154 | -581 |
| 1998 | 4594504 | 2021 | 2354 | 334 |
| 1999 | 7115951 | 2164 | 3647 | 1484 |
| 2000 | 9981582 | 2696 | 5119 | 2424 |
| 2001 | 12880412 | 2719 | 6609 | 3890 |
| 2002 | 15071440 | 2779 | 7736 | 4957 |
| 2003 | 17013933 | 2792 | 8734 | 5942 |
| 2004 | 18821102 | 2617 | 9663 | 7046 |
| 2005 | 20287481 | 2631 | 10415 | 7784 |
| 2006 | 21760059 | 2644 | 11170 | 8526 |
| 2007 | 21795258 | 2558 | 11189 | 8631 |
| 2008 | 21830434 | 2572 | 11209 | 8637 |
| 2009 | 21880609 | 2586 | 11235 | 8649 |
| 2010 | 21915787 | 2600 | 11255 | 8654 |
| 2011 | 21950963 | 2617 | 11274 | 8657 |
| 2012 | 22001138 | 2634 | 11301 | 8666 |
| 2013 | 22045118 | 2651 | 11324 | 8673 |
| 2014 | 22097899 | 2669 | 11352 | 8683 |
| 2015 | 22129483 | 2687 | 11369 | 8682 |
| 2016 | 22154870 | 2705 | 11383 | 8678 |
| 2017 | 22255857 | 2723 | 11435 | 8712 |
| 2018 | 22350647 | 2741 | 11484 | 8742 |
| 2019 | 22454240 | 2760 | 11537 | 8777 |
| 2020 | 22536635 | 2779 | 11580 | 8800 |
| 2021 | 22612832 | 2790 | 11619 | 8829 |
| 2022 | 22667832 | 2800 | 11647 | 8847 |
| 2023 | 22707831 | 2811 | 11667 | 8857 |
| 2024 | 22762833 | 2821 | 11696 | 8874 |
| 2025 | 22802832 | 2832 | 11716 | 8884 |
| 2026 | 22857832 | 2843 | 11744 | 8902 |
| 2027 | 22897832 | 2854 | 11765 | 8911 |
| 2028 | 22952832 | 2865 | 11793 | 8928 |
| 2029 | 22992833 | 2876 | 11813 | 8938 |
| 2030 | 23047831 | 2887 | 11842 | 8955 |
| 2031 | 23087832 | 2899 | 11862 | 8963 |
| 2032 | 23142832 | 2912 | 11890 | 8978 |
| 2033 | 23197832 | 2925 | 11918 | 8994 |
| 2034 | 23252831 | 2938 | 11947 | 9009 |
| 2035 | 23307832 | 2951 | 11975 | 9024 |
| 2036 | 23377832 | 2964 | 12011 | 9047 |
| 2037 | 23432832 | 2977 | 12039 | 9061 |
| 2038 | 23487832 | 2991 | 12067 | 9076 |
| 2039 | 23542832 | 3004 | 12095 | 9091 |
| 2040 | 23597830 | 3018 | 12123 | 9105 |
| 2041 | 23652832 | 3047 | 12151 | 9104 |
| 2042 | 23707830 | 3077 | 12180 | 9103 |
| 2043 | 23777833 | 3107 | 12215 | 9109 |
| 2044 | 23832831 | 3138 | 12244 | 9106 |
| 2045 | 23902831 | 3169 | 12279 | 9110 |
| 2046 | 23957832 | 3201 | 12308 | 9107 |

City of Houston Recommended Conservation Plan
CALENDAR YEAR SAVINGS REPORT

| | GROSS WATER SAVINGS (gal/day) | | | NET WATER SAVINGS (gal/day) | | |
|---|---|---|---|---|---|---|
| Year | Indoor | Outdoor | Total | Indoor | Outdoor | Total |
| 1997 | 81776 | 0 | 81776 | 2061776 | 192000 | 2253776 |
| 1998 | 244504 | 190000 | 434504 | 4020505 | 574000 | 4594504 |
| 1999 | 513430 | 380000 | 893430 | 6103430 | 1012521 | 7115951 |
| 2000 | 1076310 | 614232 | 1690542 | 8486310 | 1495273 | 9981582 |
| 2001 | 1645388 | 848463 | 2493851 | 10902387 | 1978025 | 12880412 |
| 2002 | 2220663 | 1082695 | 3303357 | 12610662 | 2460777 | 15071440 |
| 2003 | 2727403 | 1136926 | 3864329 | 14250403 | 2763529 | 17013932 |
| 2004 | 3140341 | 1191158 | 4331499 | 15811339 | 3009761 | 18821102 |
| 2005 | 3271720 | 1201158 | 4472878 | 17075720 | 3211761 | 20287480 |
| 2006 | 3409297 | 1211158 | 4620455 | 18346296 | 3413761 | 21760058 |
| 2007 | 3389496 | 1221158 | 4610654 | 18371496 | 3423761 | 21795258 |
| 2008 | 3369672 | 1231158 | 4600830 | 18396670 | 3433761 | 21830434 |
| 2009 | 3349848 | 1241158 | 4591007 | 18436848 | 3443761 | 21880608 |
| 2010 | 3330025 | 1251158 | 4581183 | 18462024 | 3453761 | 21915786 |
| 2011 | 3310201 | 1261158 | 4571359 | 18487200 | 3463761 | 21950964 |
| 2012 | 3290378 | 1271158 | 4561536 | 18527376 | 3473761 | 22001138 |
| 2013 | 3264357 | 1281158 | 4545515 | 18561356 | 3483761 | 22045118 |
| 2014 | 3232138 | 1291158 | 4523296 | 18604138 | 3493761 | 22097898 |
| 2015 | 3193721 | 1301158 | 4494879 | 18625722 | 3503761 | 22129484 |
| 2016 | 3149108 | 1311158 | 4460266 | 18641108 | 3513761 | 22154870 |
| 2017 | 3180096 | 1321158 | 4501254 | 18732096 | 3523761 | 22255858 |
| 2018 | 3204886 | 1331158 | 4536044 | 18816886 | 3533761 | 22350648 |
| 2019 | 3223478 | 1341158 | 4564637 | 18910478 | 3543761 | 22454240 |
| 2020 | 3235874 | 1351158 | 4587031 | 18982872 | 3553761 | 22536636 |
| 2021 | 3242071 | 1361158 | 4603229 | 19049070 | 3563761 | 22612832 |
| 2022 | 3242071 | 1371158 | 4613229 | 19094070 | 3573761 | 22667832 |
| 2023 | 3242071 | 1381158 | 4623229 | 19124070 | 3583761 | 22707832 |
| 2024 | 3242071 | 1391158 | 4633229 | 19169070 | 3593761 | 22762832 |
| 2025 | 3242071 | 1401158 | 4643229 | 19199070 | 3603761 | 22802832 |
| 2026 | 3242071 | 1411158 | 4653229 | 19244070 | 3613761 | 22857832 |
| 2027 | 3242071 | 1421158 | 4663229 | 19274070 | 3623761 | 22897832 |
| 2028 | 3242071 | 1431158 | 4673229 | 19319070 | 3633761 | 22952832 |
| 2029 | 3242071 | 1441158 | 4683229 | 19349070 | 3643761 | 22992832 |
| 2030 | 3242071 | 1451158 | 4693229 | 19394070 | 3653761 | 23047832 |
| 2031 | 3242071 | 1461158 | 4703229 | 19424070 | 3663761 | 23087832 |
| 2032 | 3242071 | 1471158 | 4713229 | 19469070 | 3673761 | 23142832 |
| 2033 | 3242071 | 1481158 | 4723229 | 19514070 | 3683761 | 23197832 |
| 2034 | 3242071 | 1491158 | 4733229 | 19559070 | 3693761 | 23252830 |
| 2035 | 3242071 | 1501158 | 4743229 | 19604068 | 3703761 | 23307832 |
| 2036 | 3242071 | 1511158 | 4753229 | 19664070 | 3713761 | 23377832 |
| 2037 | 3242071 | 1521158 | 4763229 | 19709070 | 3723761 | 23432832 |
| 2038 | 3242071 | 1531158 | 4773229 | 19754070 | 3733761 | 23487832 |
| 2039 | 3242071 | 1541158 | 4783229 | 19799070 | 3743761 | 23542832 |
| 2040 | 3242071 | 1551158 | 4793229 | 19844070 | 3753761 | 23597830 |
| 2041 | 3242071 | 1561158 | 4803229 | 19889070 | 3763761 | 23652832 |
| 2042 | 3242071 | 1571158 | 4813229 | 19934070 | 3773761 | 23707830 |
| 2043 | 3242071 | 1581158 | 4823229 | 19994070 | 3783761 | 23777832 |
| 2044 | 3242071 | 1591158 | 4833229 | 20039070 | 3793761 | 23832832 |
| 2045 | 3242071 | 1601158 | 4843229 | 20099070 | 3803761 | 23902830 |
| 2046 | 3242071 | 1611158 | 4853229 | 20144070 | 3813761 | 23957832 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: Appliance Labeling
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 6198 | 26 | 3 | -22 | 420 |
| 1999 | 18593 | 21 | 10 | -11 | 840 |
| 2000 | 37185 | 14 | 20 | 6 | 1260 |
| 2001 | 61975 | 14 | 33 | 19 | 1680 |
| 2002 | 92963 | 14 | 49 | 36 | 2100 |
| 2003 | 130148 | 14 | 69 | 55 | 2520 |
| 2004 | 173531 | 14 | 92 | 78 | 2940 |
| 2005 | 223111 | 14 | 118 | 105 | 3360 |
| 2006 | 278888 | 14 | 148 | 134 | 3780 |
| 2007 | 340864 | 14 | 181 | 167 | 4200 |
| 2008 | 402839 | 14 | 214 | 200 | 4200 |
| 2009 | 464814 | 14 | 247 | 233 | 4200 |
| 2010 | 526789 | 14 | 279 | 266 | 4200 |
| 2011 | 588764 | 14 | 312 | 299 | 4200 |
| 2012 | 650740 | 14 | 345 | 331 | 4200 |
| 2013 | 706517 | 14 | 375 | 361 | 4200 |
| 2014 | 756097 | 14 | 401 | 387 | 4200 |
| 2015 | 799480 | 14 | 424 | 410 | 4200 |
| 2016 | 836665 | 14 | 444 | 430 | 4200 |
| 2017 | 867653 | 14 | 460 | 446 | 4200 |
| 2018 | 892443 | 14 | 473 | 460 | 4200 |
| 2019 | 911036 | 14 | 483 | 469 | 4200 |
| 2020 | 923431 | 14 | 490 | 476 | 4200 |
| 2021 | 929628 | 14 | 493 | 479 | 4200 |
| 2022 | 929628 | 14 | 493 | 479 | 4200 |
| 2023 | 929628 | 14 | 493 | 479 | 4200 |
| 2024 | 929628 | 14 | 493 | 479 | 4200 |
| 2025 | 929628 | 14 | 493 | 479 | 4200 |
| 2026 | 929628 | 14 | 493 | 479 | 4200 |
| 2027 | 929628 | 14 | 493 | 479 | 4200 |
| 2028 | 929628 | 14 | 493 | 479 | 4200 |
| 2029 | 929628 | 14 | 493 | 479 | 4200 |
| 2030 | 929628 | 14 | 493 | 479 | 4200 |
| 2031 | 929628 | 14 | 493 | 479 | 4200 |
| 2032 | 929628 | 14 | 493 | 479 | 4200 |
| 2033 | 929628 | 14 | 493 | 479 | 4200 |
| 2034 | 929628 | 14 | 493 | 479 | 4200 |
| 2035 | 929628 | 14 | 493 | 479 | 4200 |
| 2036 | 929628 | 14 | 493 | 479 | 4200 |
| 2037 | 929628 | 14 | 493 | 479 | 4200 |
| 2038 | 929628 | 14 | 493 | 479 | 4200 |
| 2039 | 929628 | 14 | 493 | 479 | 4200 |
| 2040 | 929628 | 14 | 493 | 479 | 4200 |
| 2041 | 929628 | 14 | 493 | 479 | 4200 |
| 2042 | 929628 | 14 | 493 | 479 | 4200 |
| 2043 | 929628 | 14 | 493 | 479 | 4200 |
| 2044 | 929628 | 14 | 493 | 479 | 4200 |
| 2045 | 929628 | 14 | 493 | 479 | 4200 |
| 2046 | 929628 | 14 | 493 | 479 | 4200 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: C/I Indoor Audits
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 243525 | 264 | 127 | -137 | 250 |
| 2001 | 487050 | 264 | 254 | -10 | 250 |
| 2002 | 730575 | 264 | 381 | 117 | 250 |
| 2003 | 974100 | 264 | 508 | 244 | 250 |
| 2004 | 1217625 | 264 | 635 | 371 | 250 |
| 2005 | 1217625 | 264 | 635 | 371 | 250 |
| 2006 | 1217625 | 264 | 635 | 371 | 250 |
| 2007 | 1217625 | 264 | 635 | 371 | 250 |
| 2008 | 1217625 | 264 | 635 | 371 | 250 |
| 2009 | 1217625 | 264 | 635 | 371 | 250 |
| 2010 | 1217625 | 264 | 635 | 371 | 250 |
| 2011 | 1217625 | 264 | 635 | 371 | 250 |
| 2012 | 1217625 | 264 | 635 | 371 | 250 |
| 2013 | 1217625 | 264 | 635 | 371 | 250 |
| 2014 | 1217625 | 264 | 635 | 371 | 250 |
| 2015 | 1217625 | 264 | 635 | 371 | 250 |
| 2016 | 1217625 | 264 | 635 | 371 | 250 |
| 2017 | 1217625 | 264 | 635 | 371 | 250 |
| 2018 | 1217625 | 264 | 635 | 371 | 250 |
| 2019 | 1217625 | 264 | 635 | 371 | 250 |
| 2020 | 1217625 | 264 | 635 | 371 | 250 |
| 2021 | 1217625 | 264 | 635 | 371 | 250 |
| 2022 | 1217625 | 264 | 635 | 371 | 250 |
| 2023 | 1217625 | 264 | 635 | 371 | 250 |
| 2024 | 1217625 | 264 | 635 | 371 | 250 |
| 2025 | 1217625 | 264 | 635 | 371 | 250 |
| 2026 | 1217625 | 264 | 635 | 371 | 250 |
| 2027 | 1217625 | 264 | 635 | 371 | 250 |
| 2028 | 1217625 | 264 | 635 | 371 | 250 |
| 2029 | 1217625 | 264 | 635 | 371 | 250 |
| 2030 | 1217625 | 264 | 635 | 371 | 250 |
| 2031 | 1217625 | 264 | 635 | 371 | 250 |
| 2032 | 1217625 | 264 | 635 | 371 | 250 |
| 2033 | 1217625 | 264 | 635 | 371 | 250 |
| 2034 | 1217625 | 264 | 635 | 371 | 250 |
| 2035 | 1217625 | 264 | 635 | 371 | 250 |
| 2036 | 1217625 | 264 | 635 | 371 | 250 |
| 2037 | 1217625 | 264 | 635 | 371 | 250 |
| 2038 | 1217625 | 264 | 635 | 371 | 250 |
| 2039 | 1217625 | 264 | 635 | 371 | 250 |
| 2040 | 1217625 | 264 | 635 | 371 | 250 |
| 2041 | 1217625 | 264 | 635 | 371 | 250 |
| 2042 | 1217625 | 264 | 635 | 371 | 250 |
| 2043 | 1217625 | 264 | 635 | 371 | 250 |
| 2044 | 1217625 | 264 | 635 | 371 | 250 |
| 2045 | 1217625 | 264 | 635 | 371 | 250 |
| 2046 | 1217625 | 264 | 635 | 371 | 250 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: C/I Cooling Tower Audits
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 100000 | 70 | 51 | -19 | 100 |
| 2000 | 200000 | 70 | 102 | 32 | 100 |
| 2001 | 300000 | 70 | 154 | 84 | 100 |
| 2002 | 400000 | 70 | 205 | 135 | 100 |
| 2003 | 500000 | 70 | 256 | 186 | 100 |
| 2004 | 500000 | 0 | 256 | 256 | 0 |
| 2005 | 500000 | 0 | 256 | 256 | 0 |
| 2006 | 500000 | 0 | 256 | 256 | 0 |
| 2007 | 500000 | 0 | 256 | 256 | 0 |
| 2008 | 500000 | 0 | 256 | 256 | 0 |
| 2009 | 500000 | 0 | 256 | 256 | 0 |
| 2010 | 500000 | 0 | 256 | 256 | 0 |
| 2011 | 500000 | 0 | 256 | 256 | 0 |
| 2012 | 500000 | 0 | 256 | 256 | 0 |
| 2013 | 500000 | 0 | 256 | 256 | 0 |
| 2014 | 500000 | 0 | 256 | 256 | 0 |
| 2015 | 500000 | 0 | 256 | 256 | 0 |
| 2016 | 500000 | 0 | 256 | 256 | 0 |
| 2017 | 500000 | 0 | 256 | 256 | 0 |
| 2018 | 500000 | 0 | 256 | 256 | 0 |
| 2019 | 500000 | 0 | 256 | 256 | 0 |
| 2020 | 500000 | 0 | 256 | 256 | 0 |
| 2021 | 500000 | 0 | 256 | 256 | 0 |
| 2022 | 500000 | 0 | 256 | 256 | 0 |
| 2023 | 500000 | 0 | 256 | 256 | 0 |
| 2024 | 500000 | 0 | 256 | 256 | 0 |
| 2025 | 500000 | 0 | 256 | 256 | 0 |
| 2026 | 500000 | 0 | 256 | 256 | 0 |
| 2027 | 500000 | 0 | 256 | 256 | 0 |
| 2028 | 500000 | 0 | 256 | 256 | 0 |
| 2029 | 500000 | 0 | 256 | 256 | 0 |
| 2030 | 500000 | 0 | 256 | 256 | 0 |
| 2031 | 500000 | 0 | 256 | 256 | 0 |
| 2032 | 500000 | 0 | 256 | 256 | 0 |
| 2033 | 500000 | 0 | 256 | 256 | 0 |
| 2034 | 500000 | 0 | 256 | 256 | 0 |
| 2035 | 500000 | 0 | 256 | 256 | 0 |
| 2036 | 500000 | 0 | 256 | 256 | 0 |
| 2037 | 500000 | 0 | 256 | 256 | 0 |
| 2038 | 500000 | 0 | 256 | 256 | 0 |
| 2039 | 500000 | 0 | 256 | 256 | 0 |
| 2040 | 500000 | 0 | 256 | 256 | 0 |
| 2041 | 500000 | 0 | 256 | 256 | 0 |
| 2042 | 500000 | 0 | 256 | 256 | 0 |
| 2043 | 500000 | 0 | 256 | 256 | 0 |
| 2044 | 500000 | 0 | 256 | 256 | 0 |
| 2045 | 500000 | 0 | 256 | 256 | 0 |
| 2046 | 500000 | 0 | 256 | 256 | 0 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: COH In-House Program
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 202000 | 50 | 103 | 53 | 1 |
| 1998 | 202000 | 0 | 103 | 103 | 1 |
| 1999 | 202000 | 0 | 103 | 103 | 1 |
| 2000 | 202000 | 0 | 103 | 103 | 1 |
| 2001 | 202000 | 0 | 103 | 103 | 1 |
| 2002 | 202000 | 0 | 103 | 103 | 1 |
| 2003 | 202000 | 0 | 103 | 103 | 1 |
| 2004 | 202000 | 0 | 103 | 103 | 1 |
| 2005 | 202000 | 0 | 103 | 103 | 1 |
| 2006 | 202000 | 0 | 103 | 103 | 1 |
| 2007 | 202000 | 0 | 103 | 103 | 1 |
| 2008 | 202000 | 0 | 103 | 103 | 1 |
| 2009 | 202000 | 0 | 103 | 103 | 1 |
| 2010 | 202000 | 0 | 103 | 103 | 1 |
| 2011 | 202000 | 0 | 103 | 103 | 1 |
| 2012 | 202000 | 0 | 103 | 103 | 1 |
| 2013 | 202000 | 0 | 103 | 103 | 1 |
| 2014 | 202000 | 0 | 103 | 103 | 1 |
| 2015 | 202000 | 0 | 103 | 103 | 1 |
| 2016 | 202000 | 0 | 103 | 103 | 1 |
| 2017 | 202000 | 0 | 103 | 103 | 1 |
| 2018 | 202000 | 0 | 103 | 103 | 1 |
| 2019 | 202000 | 0 | 103 | 103 | 1 |
| 2020 | 202000 | 0 | 103 | 103 | 1 |
| 2021 | 202000 | 0 | 103 | 103 | 1 |
| 2022 | 202000 | 0 | 103 | 103 | 1 |
| 2023 | 202000 | 0 | 103 | 103 | 1 |
| 2024 | 202000 | 0 | 103 | 103 | 1 |
| 2025 | 202000 | 0 | 103 | 103 | 1 |
| 2026 | 202000 | 0 | 103 | 103 | 1 |
| 2027 | 202000 | 0 | 103 | 103 | 1 |
| 2028 | 202000 | 0 | 103 | 103 | 1 |
| 2029 | 202000 | 0 | 103 | 103 | 1 |
| 2030 | 202000 | 0 | 103 | 103 | 1 |
| 2031 | 202000 | 0 | 103 | 103 | 1 |
| 2032 | 202000 | 0 | 103 | 103 | 1 |
| 2033 | 202000 | 0 | 103 | 103 | 1 |
| 2034 | 202000 | 0 | 103 | 103 | 1 |
| 2035 | 202000 | 0 | 103 | 103 | 1 |
| 2036 | 202000 | 0 | 103 | 103 | 1 |
| 2037 | 202000 | 0 | 103 | 103 | 1 |
| 2038 | 202000 | 0 | 103 | 103 | 1 |
| 2039 | 202000 | 0 | 103 | 103 | 1 |
| 2040 | 202000 | 0 | 103 | 103 | 1 |
| 2041 | 202000 | 0 | 103 | 103 | 1 |
| 2042 | 202000 | 0 | 103 | 103 | 1 |
| 2043 | 202000 | 0 | 103 | 103 | 1 |
| 2044 | 202000 | 0 | 103 | 103 | 1 |
| 2045 | 202000 | 0 | 103 | 103 | 1 |
| 2046 | 202000 | 0 | 103 | 103 | 1 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: PF Indoor Audits
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 74732 | 73 | 40 | -33 | 200 |
| 1999 | 149464 | 60 | 79 | 19 | 200 |
| 2000 | 224196 | 60 | 119 | 59 | 200 |
| 2001 | 298928 | 60 | 159 | 99 | 200 |
| 2002 | 373660 | 60 | 198 | 138 | 200 |
| 2003 | 373660 | 60 | 198 | 138 | 200 |
| 2004 | 373660 | 60 | 198 | 138 | 200 |
| 2005 | 373660 | 60 | 198 | 138 | 200 |
| 2006 | 373660 | 60 | 198 | 138 | 200 |
| 2007 | 373660 | 60 | 198 | 138 | 200 |
| 2008 | 373660 | 60 | 198 | 138 | 200 |
| 2009 | 373660 | 60 | 198 | 138 | 200 |
| 2010 | 373660 | 60 | 198 | 138 | 200 |
| 2011 | 373660 | 60 | 198 | 138 | 200 |
| 2012 | 373660 | 60 | 198 | 138 | 200 |
| 2013 | 373660 | 60 | 198 | 138 | 200 |
| 2014 | 373660 | 60 | 198 | 138 | 200 |
| 2015 | 373660 | 60 | 198 | 138 | 200 |
| 2016 | 373660 | 60 | 198 | 138 | 200 |
| 2017 | 373660 | 60 | 198 | 138 | 200 |
| 2018 | 373660 | 60 | 198 | 138 | 200 |
| 2019 | 373660 | 60 | 198 | 138 | 200 |
| 2020 | 373660 | 60 | 198 | 138 | 200 |
| 2021 | 373660 | 60 | 198 | 138 | 200 |
| 2022 | 373660 | 60 | 198 | 138 | 200 |
| 2023 | 373660 | 60 | 198 | 138 | 200 |
| 2024 | 373660 | 60 | 198 | 138 | 200 |
| 2025 | 373660 | 60 | 198 | 138 | 200 |
| 2026 | 373660 | 60 | 198 | 138 | 200 |
| 2027 | 373660 | 60 | 198 | 138 | 200 |
| 2028 | 373660 | 60 | 198 | 138 | 200 |
| 2029 | 373660 | 60 | 198 | 138 | 200 |
| 2030 | 373660 | 60 | 198 | 138 | 200 |
| 2031 | 373660 | 60 | 198 | 138 | 200 |
| 2032 | 373660 | 60 | 198 | 138 | 200 |
| 2033 | 373660 | 60 | 198 | 138 | 200 |
| 2034 | 373660 | 60 | 198 | 138 | 200 |
| 2035 | 373660 | 60 | 198 | 138 | 200 |
| 2036 | 373660 | 60 | 198 | 138 | 200 |
| 2037 | 373660 | 60 | 198 | 138 | 200 |
| 2038 | 373660 | 60 | 198 | 138 | 200 |
| 2039 | 373660 | 60 | 198 | 138 | 200 |
| 2040 | 373660 | 60 | 198 | 138 | 200 |
| 2041 | 373660 | 60 | 198 | 138 | 200 |
| 2042 | 373660 | 60 | 198 | 138 | 200 |
| 2043 | 373660 | 60 | 198 | 138 | 200 |
| 2044 | 373660 | 60 | 198 | 138 | 200 |
| 2045 | 373660 | 60 | 198 | 138 | 200 |
| 2046 | 373660 | 60 | 198 | 138 | 200 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: PF Pool/Fountain Audits-COH
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 56521 | 118 | 29 | -89 | 1 |
| 2000 | 113041 | 118 | 58 | -60 | 1 |
| 2001 | 169562 | 118 | 87 | -31 | 1 |
| 2002 | 226082 | 118 | 116 | -2 | 1 |
| 2003 | 282603 | 118 | 145 | 27 | 1 |
| 2004 | 282603 | 0 | 145 | 145 | 0 |
| 2005 | 282603 | 0 | 145 | 145 | 0 |
| 2006 | 282603 | 0 | 145 | 145 | 0 |
| 2007 | 282603 | 0 | 145 | 145 | 0 |
| 2008 | 282603 | 0 | 145 | 145 | 0 |
| 2009 | 282603 | 0 | 145 | 145 | 0 |
| 2010 | 282603 | 0 | 145 | 145 | 0 |
| 2011 | 282603 | 0 | 145 | 145 | 0 |
| 2012 | 282603 | 0 | 145 | 145 | 0 |
| 2013 | 282603 | 0 | 145 | 145 | 0 |
| 2014 | 282603 | 0 | 145 | 145 | 0 |
| 2015 | 282603 | 0 | 145 | 145 | 0 |
| 2016 | 282603 | 0 | 145 | 145 | 0 |
| 2017 | 282603 | 0 | 145 | 145 | 0 |
| 2018 | 282603 | 0 | 145 | 145 | 0 |
| 2019 | 282603 | 0 | 145 | 145 | 0 |
| 2020 | 282603 | 0 | 145 | 145 | 0 |
| 2021 | 282603 | 0 | 145 | 145 | 0 |
| 2022 | 282603 | 0 | 145 | 145 | 0 |
| 2023 | 282603 | 0 | 145 | 145 | 0 |
| 2024 | 282603 | 0 | 145 | 145 | 0 |
| 2025 | 282603 | 0 | 145 | 145 | 0 |
| 2026 | 282603 | 0 | 145 | 145 | 0 |
| 2027 | 282603 | 0 | 145 | 145 | 0 |
| 2028 | 282603 | 0 | 145 | 145 | 0 |
| 2029 | 282603 | 0 | 145 | 145 | 0 |
| 2030 | 282603 | 0 | 145 | 145 | 0 |
| 2031 | 282603 | 0 | 145 | 145 | 0 |
| 2032 | 282603 | 0 | 145 | 145 | 0 |
| 2033 | 282603 | 0 | 145 | 145 | 0 |
| 2034 | 282603 | 0 | 145 | 145 | 0 |
| 2035 | 282603 | 0 | 145 | 145 | 0 |
| 2036 | 282603 | 0 | 145 | 145 | 0 |
| 2037 | 282603 | 0 | 145 | 145 | 0 |
| 2038 | 282603 | 0 | 145 | 145 | 0 |
| 2039 | 282603 | 0 | 145 | 145 | 0 |
| 2040 | 282603 | 0 | 145 | 145 | 0 |
| 2041 | 282603 | 0 | 145 | 145 | 0 |
| 2042 | 282603 | 0 | 145 | 145 | 0 |
| 2043 | 282603 | 0 | 145 | 145 | 0 |
| 2044 | 282603 | 0 | 145 | 145 | 0 |
| 2045 | 282603 | 0 | 145 | 145 | 0 |
| 2046 | 282603 | 0 | 145 | 145 | 0 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: PF Pool/Fountain Standards
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 10000 | 95 | 5 | -90 | 8 |
| 1999 | 20000 | 20 | 10 | -10 | 8 |
| 2000 | 30000 | 20 | 15 | -5 | 8 |
| 2001 | 40000 | 20 | 20 | 0 | 8 |
| 2002 | 50000 | 20 | 26 | 6 | 8 |
| 2003 | 60000 | 20 | 31 | 11 | 8 |
| 2004 | 70000 | 20 | 36 | 16 | 8 |
| 2005 | 80000 | 20 | 41 | 21 | 8 |
| 2006 | 90000 | 20 | 46 | 26 | 8 |
| 2007 | 100000 | 20 | 51 | 31 | 8 |
| 2008 | 110000 | 20 | 56 | 36 | 8 |
| 2009 | 120000 | 20 | 61 | 41 | 8 |
| 2010 | 130000 | 20 | 67 | 47 | 8 |
| 2011 | 140000 | 20 | 72 | 52 | 8 |
| 2012 | 150000 | 20 | 77 | 57 | 8 |
| 2013 | 160000 | 20 | 82 | 62 | 8 |
| 2014 | 170000 | 20 | 87 | 67 | 8 |
| 2015 | 180000 | 20 | 92 | 72 | 8 |
| 2016 | 190000 | 20 | 97 | 77 | 8 |
| 2017 | 200000 | 20 | 102 | 82 | 8 |
| 2018 | 210000 | 20 | 108 | 88 | 8 |
| 2019 | 220000 | 20 | 113 | 93 | 8 |
| 2020 | 230000 | 20 | 118 | 98 | 8 |
| 2021 | 240000 | 20 | 123 | 103 | 8 |
| 2022 | 250000 | 20 | 128 | 108 | 8 |
| 2023 | 260000 | 20 | 133 | 113 | 8 |
| 2024 | 270000 | 20 | 138 | 118 | 8 |
| 2025 | 280000 | 20 | 143 | 123 | 8 |
| 2026 | 290000 | 20 | 149 | 129 | 8 |
| 2027 | 300000 | 20 | 154 | 134 | 8 |
| 2028 | 310000 | 20 | 159 | 139 | 8 |
| 2029 | 320000 | 20 | 164 | 144 | 8 |
| 2030 | 330000 | 20 | 169 | 149 | 8 |
| 2031 | 340000 | 20 | 174 | 154 | 8 |
| 2032 | 350000 | 20 | 179 | 159 | 8 |
| 2033 | 360000 | 20 | 184 | 164 | 8 |
| 2034 | 370000 | 20 | 189 | 169 | 8 |
| 2035 | 380000 | 20 | 195 | 175 | 8 |
| 2036 | 390000 | 20 | 200 | 180 | 8 |
| 2037 | 400000 | 20 | 205 | 185 | 8 |
| 2038 | 410000 | 20 | 210 | 190 | 8 |
| 2039 | 420000 | 20 | 215 | 195 | 8 |
| 2040 | 430000 | 20 | 220 | 200 | 8 |
| 2041 | 440000 | 20 | 225 | 205 | 8 |
| 2042 | 450000 | 20 | 230 | 210 | 8 |
| 2043 | 460000 | 20 | 236 | 216 | 8 |
| 2044 | 470000 | 20 | 241 | 221 | 8 |
| 2045 | 480000 | 20 | 246 | 226 | 8 |
| 2046 | 490000 | 20 | 251 | 231 | 8 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: Unaccounted for Water Improvements
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 1280000 | 880 | 655 | -225 | 1 |
| 1998 | 2560000 | 880 | 1311 | 431 | 1 |
| 1999 | 3840000 | 880 | 1966 | 1086 | 1 |
| 2000 | 5120000 | 880 | 2622 | 1742 | 1 |
| 2001 | 6400000 | 880 | 3277 | 2397 | 1 |
| 2002 | 7680000 | 880 | 3933 | 3053 | 1 |
| 2003 | 8960000 | 880 | 4588 | 3708 | 1 |
| 2004 | 10240000 | 880 | 5244 | 4364 | 1 |
| 2005 | 11520000 | 880 | 5899 | 5019 | 1 |
| 2006 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2007 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2008 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2009 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2010 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2011 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2012 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2013 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2014 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2015 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2016 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2017 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2018 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2019 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2020 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2021 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2022 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2023 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2024 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2025 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2026 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2027 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2028 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2029 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2030 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2031 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2032 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2033 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2034 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2035 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2036 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2037 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2038 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2039 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2040 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2041 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2042 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2043 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2044 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2045 | 12800000 | 880 | 6555 | 5675 | 1 |
| 2046 | 12800000 | 880 | 6555 | 5675 | 1 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: PF Exterior Audits
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 180000 | 83 | 92 | 10 | 80 |
| 1999 | 360000 | 70 | 184 | 114 | 80 |
| 2000 | 540000 | 70 | 277 | 207 | 80 |
| 2001 | 720000 | 35 | 369 | 334 | 80 |
| 2002 | 900000 | 35 | 461 | 426 | 80 |
| 2003 | 900000 | 35 | 461 | 426 | 80 |
| 2004 | 900000 | 35 | 461 | 426 | 80 |
| 2005 | 900000 | 35 | 461 | 426 | 80 |
| 2006 | 900000 | 35 | 461 | 426 | 80 |
| 2007 | 900000 | 35 | 461 | 426 | 80 |
| 2008 | 900000 | 35 | 461 | 426 | 80 |
| 2009 | 900000 | 35 | 461 | 426 | 80 |
| 2010 | 900000 | 35 | 461 | 426 | 80 |
| 2011 | 900000 | 35 | 461 | 426 | 80 |
| 2012 | 900000 | 35 | 461 | 426 | 80 |
| 2013 | 900000 | 35 | 461 | 426 | 80 |
| 2014 | 900000 | 35 | 461 | 426 | 80 |
| 2015 | 900000 | 35 | 461 | 426 | 80 |
| 2016 | 900000 | 35 | 461 | 426 | 80 |
| 2017 | 900000 | 35 | 461 | 426 | 80 |
| 2018 | 900000 | 35 | 461 | 426 | 80 |
| 2019 | 900000 | 35 | 461 | 426 | 80 |
| 2020 | 900000 | 35 | 461 | 426 | 80 |
| 2021 | 900000 | 35 | 461 | 426 | 80 |
| 2022 | 900000 | 35 | 461 | 426 | 80 |
| 2023 | 900000 | 35 | 461 | 426 | 80 |
| 2024 | 900000 | 35 | 461 | 426 | 80 |
| 2025 | 900000 | 35 | 461 | 426 | 80 |
| 2026 | 900000 | 35 | 461 | 426 | 80 |
| 2027 | 900000 | 35 | 461 | 426 | 80 |
| 2028 | 900000 | 35 | 461 | 426 | 80 |
| 2029 | 900000 | 35 | 461 | 426 | 80 |
| 2030 | 900000 | 35 | 461 | 426 | 80 |
| 2031 | 900000 | 35 | 461 | 426 | 80 |
| 2032 | 900000 | 35 | 461 | 426 | 80 |
| 2033 | 900000 | 35 | 461 | 426 | 80 |
| 2034 | 900000 | 35 | 461 | 426 | 80 |
| 2035 | 900000 | 35 | 461 | 426 | 80 |
| 2036 | 900000 | 35 | 461 | 426 | 80 |
| 2037 | 900000 | 35 | 461 | 426 | 80 |
| 2038 | 900000 | 35 | 461 | 426 | 80 |
| 2039 | 900000 | 35 | 461 | 426 | 80 |
| 2040 | 900000 | 35 | 461 | 426 | 80 |
| 2041 | 900000 | 35 | 461 | 426 | 80 |
| 2042 | 900000 | 35 | 461 | 426 | 80 |
| 2043 | 900000 | 35 | 461 | 426 | 80 |
| 2044 | 900000 | 35 | 461 | 426 | 80 |
| 2045 | 900000 | 35 | 461 | 426 | 80 |
| 2046 | 900000 | 35 | 461 | 426 | 80 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: Public Education Program
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 690000 | 705 | 353 | -352 | 1 |
| 1998 | 1398000 | 765 | 716 | -49 | 2 |
| 1999 | 2124000 | 825 | 1088 | 263 | 3 |
| 2000 | 2856000 | 885 | 1463 | 578 | 4 |
| 2001 | 3615000 | 945 | 1851 | 906 | 5 |
| 2002 | 3660000 | 1005 | 1874 | 869 | 5 |
| 2003 | 3705000 | 1018 | 1897 | 879 | 5 |
| 2004 | 3765000 | 1031 | 1928 | 897 | 5 |
| 2005 | 3810000 | 1045 | 1951 | 906 | 5 |
| 2006 | 3855000 | 1058 | 1974 | 916 | 5 |
| 2007 | 3900000 | 1072 | 1997 | 925 | 5 |
| 2008 | 3945000 | 1086 | 2020 | 934 | 5 |
| 2009 | 4005000 | 1100 | 2051 | 951 | 5 |
| 2010 | 4050000 | 1114 | 2074 | 960 | 5 |
| 2011 | 4095000 | 1131 | 2097 | 966 | 5 |
| 2012 | 4155000 | 1148 | 2128 | 980 | 5 |
| 2013 | 4215000 | 1165 | 2158 | 993 | 5 |
| 2014 | 4290000 | 1183 | 2197 | 1014 | 5 |
| 2015 | 4350000 | 1201 | 2228 | 1027 | 5 |
| 2016 | 4410000 | 1219 | 2258 | 1040 | 5 |
| 2017 | 4470000 | 1237 | 2289 | 1052 | 5 |
| 2018 | 4530000 | 1255 | 2320 | 1064 | 5 |
| 2019 | 4605000 | 1274 | 2358 | 1084 | 5 |
| 2020 | 4665000 | 1293 | 2389 | 1096 | 5 |
| 2021 | 4725000 | 1304 | 2420 | 1116 | 5 |
| 2022 | 4770000 | 1314 | 2443 | 1129 | 5 |
| 2023 | 4800000 | 1325 | 2458 | 1133 | 5 |
| 2024 | 4845000 | 1335 | 2481 | 1146 | 5 |
| 2025 | 4875000 | 1346 | 2496 | 1151 | 5 |
| 2026 | 4920000 | 1357 | 2520 | 1163 | 5 |
| 2027 | 4950000 | 1367 | 2535 | 1167 | 5 |
| 2028 | 4995000 | 1378 | 2558 | 1179 | 5 |
| 2029 | 5025000 | 1389 | 2573 | 1184 | 5 |
| 2030 | 5070000 | 1401 | 2596 | 1196 | 5 |
| 2031 | 5100000 | 1413 | 2612 | 1199 | 5 |
| 2032 | 5145000 | 1426 | 2635 | 1209 | 5 |
| 2033 | 5190000 | 1439 | 2658 | 1219 | 5 |
| 2034 | 5235000 | 1452 | 2681 | 1229 | 5 |
| 2035 | 5280000 | 1465 | 2704 | 1239 | 5 |
| 2036 | 5340000 | 1478 | 2735 | 1257 | 5 |
| 2037 | 5385000 | 1491 | 2758 | 1266 | 5 |
| 2038 | 5430000 | 1505 | 2781 | 1276 | 5 |
| 2039 | 5475000 | 1518 | 2804 | 1286 | 5 |
| 2040 | 5520000 | 1532 | 2827 | 1295 | 5 |
| 2041 | 5565000 | 1561 | 2850 | 1289 | 5 |
| 2042 | 5610000 | 1591 | 2873 | 1282 | 5 |
| 2043 | 5670000 | 1621 | 2904 | 1283 | 5 |
| 2044 | 5715000 | 1652 | 2927 | 1275 | 5 |
| 2045 | 5775000 | 1683 | 2957 | 1274 | 5 |
| 2046 | 5820000 | 1715 | 2980 | 1265 | 5 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: SFR Water Audits
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 88463 | 215 | 46 | -169 | 3461 |
| 2001 | 176926 | 214 | 92 | -121 | 3461 |
| 2002 | 265389 | 214 | 138 | -75 | 3461 |
| 2003 | 353853 | 214 | 184 | -29 | 3461 |
| 2004 | 442316 | 214 | 231 | 17 | 3461 |
| 2005 | 442316 | 214 | 231 | 17 | 3461 |
| 2006 | 442316 | 214 | 231 | 17 | 3461 |
| 2007 | 442316 | 214 | 231 | 17 | 3461 |
| 2008 | 442316 | 214 | 231 | 17 | 3461 |
| 2009 | 442316 | 214 | 231 | 17 | 3461 |
| 2010 | 442316 | 214 | 231 | 17 | 3461 |
| 2011 | 442316 | 214 | 231 | 17 | 3461 |
| 2012 | 442316 | 214 | 231 | 17 | 3461 |
| 2013 | 442316 | 214 | 231 | 17 | 3461 |
| 2014 | 442316 | 214 | 231 | 17 | 3461 |
| 2015 | 442316 | 214 | 231 | 17 | 3461 |
| 2016 | 442316 | 214 | 231 | 17 | 3461 |
| 2017 | 442316 | 214 | 231 | 17 | 3461 |
| 2018 | 442316 | 214 | 231 | 17 | 3461 |
| 2019 | 442316 | 214 | 231 | 17 | 3461 |
| 2020 | 442316 | 214 | 231 | 17 | 3461 |
| 2021 | 442316 | 214 | 231 | 17 | 3461 |
| 2022 | 442316 | 214 | 231 | 17 | 3461 |
| 2023 | 442316 | 214 | 231 | 17 | 3461 |
| 2024 | 442316 | 214 | 231 | 17 | 3461 |
| 2025 | 442316 | 214 | 231 | 17 | 3461 |
| 2026 | 442316 | 214 | 231 | 17 | 3461 |
| 2027 | 442316 | 214 | 231 | 17 | 3461 |
| 2028 | 442316 | 214 | 231 | 17 | 3461 |
| 2029 | 442316 | 214 | 231 | 17 | 3461 |
| 2030 | 442316 | 214 | 231 | 17 | 3461 |
| 2031 | 442316 | 214 | 231 | 17 | 3461 |
| 2032 | 442316 | 214 | 231 | 17 | 3461 |
| 2033 | 442316 | 214 | 231 | 17 | 3461 |
| 2034 | 442316 | 214 | 231 | 17 | 3461 |
| 2035 | 442316 | 214 | 231 | 17 | 3461 |
| 2036 | 442316 | 214 | 231 | 17 | 3461 |
| 2037 | 442316 | 214 | 231 | 17 | 3461 |
| 2038 | 442316 | 214 | 231 | 17 | 3461 |
| 2039 | 442316 | 214 | 231 | 17 | 3461 |
| 2040 | 442316 | 214 | 231 | 17 | 3461 |
| 2041 | 442316 | 214 | 231 | 17 | 3461 |
| 2042 | 442316 | 214 | 231 | 17 | 3461 |
| 2043 | 442316 | 214 | 231 | 17 | 3461 |
| 2044 | 442316 | 214 | 231 | 17 | 3461 |
| 2045 | 442316 | 214 | 231 | 17 | 3461 |
| 2046 | 442316 | 214 | 231 | 17 | 3461 |

City of Houston Recommended Conservation Plan
DETAIL FOR PROGRAM: Waterwise & Energy Efficient
PERSPECTIVE: UTILITY

| Year | Water Savings (gal/day) | Total Costs (000 $) | Total Benefits (000 $) | Net Benefits (000 $) | Packages Delivered (number) |
|---|---|---|---|---|---|
| 1997 | 81776 | 100 | 42 | -58 | 3571 |
| 1998 | 163575 | 100 | 84 | -16 | 3572 |
| 1999 | 245374 | 100 | 126 | 26 | 3572 |
| 2000 | 327172 | 100 | 168 | 68 | 3572 |
| 2001 | 408971 | 100 | 209 | 109 | 3572 |
| 2002 | 490770 | 100 | 251 | 151 | 3572 |
| 2003 | 572569 | 100 | 293 | 193 | 3572 |
| 2004 | 654367 | 100 | 335 | 235 | 3572 |
| 2005 | 736166 | 100 | 377 | 277 | 3572 |
| 2006 | 817965 | 100 | 419 | 319 | 3572 |
| 2007 | 736189 | 0 | 377 | 377 | 0 |
| 2008 | 654390 | 0 | 335 | 335 | 0 |
| 2009 | 572592 | 0 | 293 | 293 | 0 |
| 2010 | 490793 | 0 | 251 | 251 | 0 |
| 2011 | 408994 | 0 | 209 | 209 | 0 |
| 2012 | 327195 | 0 | 168 | 168 | 0 |
| 2013 | 245396 | 0 | 126 | 126 | 0 |
| 2014 | 163598 | 0 | 84 | 84 | 0 |
| 2015 | 81799 | 0 | 42 | 42 | 0 |
| 2016 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 0 | 0 | 0 | 0 | 0 |
| 2021 | 0 | 0 | 0 | 0 | 0 |
| 2022 | 0 | 0 | 0 | 0 | 0 |
| 2023 | 0 | 0 | 0 | 0 | 0 |
| 2024 | 0 | 0 | 0 | 0 | 0 |
| 2025 | 0 | 0 | 0 | 0 | 0 |
| 2026 | 0 | 0 | 0 | 0 | 0 |
| 2027 | 0 | 0 | 0 | 0 | 0 |
| 2028 | 0 | 0 | 0 | 0 | 0 |
| 2029 | 0 | 0 | 0 | 0 | 0 |
| 2030 | 0 | 0 | 0 | 0 | 0 |
| 2031 | 0 | 0 | 0 | 0 | 0 |
| 2032 | 0 | 0 | 0 | 0 | 0 |
| 2033 | 0 | 0 | 0 | 0 | 0 |
| 2034 | 0 | 0 | 0 | 0 | 0 |
| 2035 | 0 | 0 | 0 | 0 | 0 |
| 2036 | 0 | 0 | 0 | 0 | 0 |
| 2037 | 0 | 0 | 0 | 0 | 0 |
| 2038 | 0 | 0 | 0 | 0 | 0 |
| 2039 | 0 | 0 | 0 | 0 | 0 |
| 2040 | 0 | 0 | 0 | 0 | 0 |
| 2041 | 0 | 0 | 0 | 0 | 0 |
| 2042 | 0 | 0 | 0 | 0 | 0 |
| 2043 | 0 | 0 | 0 | 0 | 0 |
| 2044 | 0 | 0 | 0 | 0 | 0 |
| 2045 | 0 | 0 | 0 | 0 | 0 |
| 2046 | 0 | 0 | 0 | 0 | 0 |

# APPENDIX E

## Responses

TEXAS WATER DEVELOPMENT BOARD



October 14, 1996

Mr. Frederick A. Perrenot
City of Houston
P.O. Box 1562
Houston. Texas 77251-1562

Dear Mr. Perrenot:

Re: Review of the Draft Final Report Between City of Houston (City) and the Texas Water Development Board (Board), entitled "Reservoir Systems Operation Plan", Contract No. 94-483-037

Staff members of the Board have completed a review of the above referenced document under Board Contract No.94-483-037 with the City of Houston. The comments in Attachment 1 should be considered before the report is finalized.

The Board would like to proceed toward completion of this study as soon as possible.

The Board looks forward to receiving twelve copies of the Final Report following any revisions. Please contact Mr. Mike Personett, the Board's designated Contract Manager for this project, at (512) 463-8061, if you have any questions concerning the comments.

Sincerely,

Tommy Knowles
Deputy Executive Administrator
for Planning

cc: Mike Personett
v:\rpp\draft\94483037.ltr



P.O. Box 13231 • 1700 N. Congress Avenue • Austin, Texas 78711-3231
Telephone (512) 463-7847 • Telefax (512) 475-2053 • 1-800- RELAY TX (for the hearing impaired)
URL Address: http://www.twdb.state.tx.us • E-Mail Address: info@twdb.state.tx.us

Attachment 1

Three alternative plans were examined:

> Existing operations to maximize firm yield with reserve storage
> Operations to maximize firm yield without reserve storage
> Existing operations to maximize average yield with reserve storage

Board staff agrees with statement made on Page 13

> "This [initial] method of estimating the outflow . . . did not yield acceptable results. Because of the extremely large width of the Lake Houston Spillway, the application of the daily stage data with the elevation-discharge curve did not yield flows representative of the average daily spill. The calculated spills were approximately 60 percent greater than the average runoff per square mile computed by the upstream gages. . . .significant skew towards higher inflows during the last 20 years." This conclusion may be at least partially attributed to subsidence effects at stage gage locations.

There was difficulty evaluating model results presented in the report. Results presented on page 18 in Table 5.1 Summary of Model Results in Acre -Feet Alternative No. 2 Lake Houston Call Volume = 113,610 ac-ft did not agree with discussion on page 18 describing the Alternative No. 2 Lake Houston Call Volume = 28,820 ac-ft. Appendix C Evaluation of Alternatives using San Jacinto River Reservoir Operation Model appears to contain incomplete sets of results for Lake Conroe, creating further difficulty in verifying Table 5.1.

As a result of the previously mentioned problems, Board staff agrees with Section 6 recommendations (pages 20-21) that the model in its current form should be used only for general planning. Since the minimum pool volume was chosen arbitrarily, we agree that the analysis should be repeated after management goals for meeting emergency water supply, recreational, water quality needs are established. Once these goals are defined, simulations should be performed to maximize system yield (Lake Houston, Lake Conroe and other water supplies) while minimizing the remaining volume necessary to meet the established management goals. Finally, we agree that the planning analysis include provisions for meeting environmental flow requirements. Until target environmental flows for instream flows and freshwater inflows to bays and estuaries can be determined for the San Jacinto River and Galveston Bay, we suggest using the recently developed Consensus Water Plan environmental criteria to derive estimates to use the planning analysis.

The results presented in Table 5.1 are difficult to evaluate based on the data presented on Appendix C. In evaluating the spreadsheet presented in Appendix C, the maximum storage of Lake Conroe is 465,260 ac-ft, which contrast the technical data presented on page 2 of the report which stipulates that the Maximum Normal Water Level of Lake Conroe is at elevation 201.0 with a capacity of 430,260 ac-ft; where does the lake gain the other 35,000 ac-ft?.

The spreadsheet presented in Appendix C does not seem to consider possible spills from Lake Conroe as a gain for Lake Houston, and if so, what are the downstream spill values?.

In evaluating Appendix C alternative 1, the following is a sample of the calculations:

**Assuming that Lake Conroe starts at a capacity of 465,260 af, as shown on the table, adding the Jan-50 inflow of 40,294 af will give a storage of 506,184 af.**

**To the 506,184 af of storage add the precipitation of 7,802 af [4.34 in x (1ft/12 in) x 21,572 Acres] and subtract the evaporation of 1,726 af [0.96x (1ft/12 in) x 21,572 Acres]; the result will be 512,226 af.**

**To the 512,226 af of storage subtract 467 af of diversion, with a Downstream Call of 0 af; the result will be 511,793 af. If the EOM (end of month content) of Lake Conroe is 430,260 af where are the other 81,533 af [511,793 -430,260]?**

The previous calculation might indicate that the tables contain incomplete sets of results. Please be advised to review the calculations in the spreadsheet, because the water balance seems to be incomplete.

The model as presented should be used only for general planning; in order to develop a reservoir system operation plan, as proposed in Task 5, spills from both reservoirs and/or downstream water rights should be considered, in order to better estimate downstream flows from Lake Houston.

**ATTACHMENT**

**City of Houston**
**Reservoir Operations Plan**

**Montgomery Watson Response to TWDB Comments**

**Comment #1: Results from page 18 in Table 5.1 do not agree with discussion on page 19.**

There is not really a disagreement here, although it does appear that way. On page 19, the call volume is referenced as 28,820 ac-ft ***or higher.*** On table 5.1 we have listed the volume used in current practice, which is the same value used in the Alternative 2 print-out included in Appendix C. Both of these values are correct, in that they will both produce the full yield from the system. Many different model runs were performed of this, and the other Alternatives. Only one run of each Alternative was printed out. The Alternative 2 results in Table 5.1 indicate that the maximum yield of the watershed can be achieved without altering the current Lake Houston call criteria. This is the most important result from this Alternative, and so it was stressed in Table 5.1. The text and Table 5.1 will be revised to more clearly document this information.

**Comment #2: Appendix C appears to contain incomplete sets of results, creating difficulty in evaluating results.**

Appendix C is a complete print-out of the value of all model cells. It does not, however, present all of the model formulas. For this reason, one cannot simply add up certain cells and get the numbers shown in other cells, without knowing the formulas. This is why the column definitions were included in the appendix. An example of this is the formula in the "D.S. Calls" column. This formula is presented below:

D.S. Call = Minimum[If LH Storage less than Call Volume, Minimum{(0.333 x LC Storage), Maximum((Demands on LH + LH Evap - LH Gain - Luce Bayou + LH Dead Storage - LH Storage),0),0},LC Outlet Capacity]

This basically says that if the Lake Houston storage is below the Call Volume, release only as much Lake Conroe water as is necessary to satisfy that month's demands, given the other water supply inflows, and limited by the capacity of the outlet and one-third of the storage remaining in Lake Conroe.

In order to permit the reader to more easily check the math in Appendix C, the operation of the model will be more fully described, and the list of formulas presented at the start of Appendix C will be expanded.

**Comment #3: The results presented in Table 5.1 are difficult to evaluate based on the data in Appendix C.**

Appendix C is simply a print-out of the model, and many of the columns are not completely described in the headings. In particular, the columns showing storage volumes greater than the maximum normal water level of the reservoirs are intermediate calculations designed to reduce the effect of using a monthly timestep model. If the model put all of the inflow into the reservoir first (subject to the normal maximum water level), then took all of the demands out, the reservoir storage would be drawn down at the end of each month. This is not what happens in actual operation. To avoid this, the model allows the reservoir to temporarily "store" more water than the reservoir will actually hold. Then this water is released to satisfy that month's demands. The reservoirs are then limited to their normal maximum water levels at the end of each month's calculations. The model descriptions and the text of the report will be improved to alleviate the misunderstanding. This, and the revised list of formulas (described above) should clarify the matter.

**Comment #4: The spreadsheet presented in Appendix C does not seem to consider spills from Lake Conroe.**

The model does consider spills from Lake Conroe. They are included in the column entitled "Total Outflow", and added to the "Lk Houston GAIN" to get "Total Inflow Lk Houston". This is more completely described in the revised column descriptions and in the response below.

**Comment #5: Details of the Lake Conroe water balance calculation.**

The water balance calculations have been thoroughly reviewed and checked, and we have not found any problems. The model accounts for all of the water in the basin, including reservoir spills. The downstream flows from Lake Houston are also correctly estimated, given the availability of streamgage data.

Several items in the Lake Conroe water balance have been misunderstood. Lake Conroe starts at a capacity of 430,260 acre-ft, not 465,260 (see "EOM Storage" column). The inflow produces a temporary "Maximum Storage" which is limited to 465,260. To this 465,260 acre-ft is added 7,802 acre-ft of precipitation, but only 1,208 acre-ft of evaporation is deducted, (An evaporation pan coefficient of 0.7 has been applied to the evaporation data listed.) This results in a storage that is again limited to a temporary "Intermediate Storage" maximum of 440,260 acre-ft. The column entitled "EOM Storage" includes another water balance. The "Diversions" and "D.S. Calls" are deducted from the "Intermediate Storage", and the result is limited to the normal maximum storage of 430,260 acre-ft. The "Total Outflow" column is where the water balance is completed. This column totals the difference between last month's and this month's "EOM Storage", plus "Inflow C4'", plus "Precip" times "Area" (divided by 12), minus 70% of "Evap." times "Area" (again divided by 12), minus "Diversions".

The column descriptions and headings will be modified to eliminate the source of confusion. With this additional information (which will be provided in the Final Report), Board staff should be able to verify the water balance, and the operation of the model.

With reference to the accuracy of the model analysis, the reason that the draft report recommended that the model only be used for general planning purposes, was not due to the accuracy of the model itself. The model is accurate and complete. The problem has to do with the inaccuracy of the Lake Houston inflow data. This is the reason the lack confidence in the model results. This will be more fully explained in the final report.

# TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

*Protecting Texas by Reducing and Preventing Pollution*

December 19, 1996

Mr. Jimmie Schindewolf, Director
Department of Public Works and Engineering
City of Houston
1801 Main Street
Houston, Texas 77002

Dear Mr. Schindewolf:

I recently had the opportunity to study a copy of the City of Houston's Water Conservation Plan developed in partnership with the Texas Water Development Board and Montgomery Watson and Associates. In Houston and throughout Texas, water quality and quantity issues remain closely linked with air, land, public health and policy concerns.

Protection of environmental resources shared by Texans requires the proactive, positive and cooperative efforts of public officials and communities. This plan represents impressive foresight and I look forward to reviewing the results that are inevitable from implementing a plan of this nature.

The Texas Natural Resource Conservation Commission's CLEAN CITIES 2000 program is an appropriate place for you to receive recognition for implementing your Water Conservation Plan. Therefore, we were extremely pleased to learn that Houston is in the process of developing its application for the program.

CLEAN CITIES 2000 encourages local governments to develop comprehensive environmental programs to meet the goal of reducing waste in Texas by 50 percent. CLEAN CITIES 2000 encourages municipalities, civic groups, schools, businesses and industries to work together to achieve their goals. Currently, 67 cities ranging in population from 51 in the town of Quintana to 1.3 million in the City of Dallas are participating in the CLEAN CITIES 2000 program. As members of the program, they are achieving real and measurable results. In 1995, 57 member cities diverted 336,000 tons of waste from Texas landfills, saving an estimated $10 million in disposal costs.

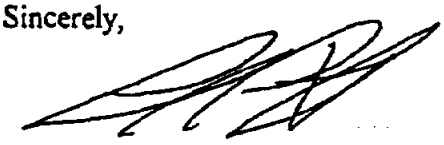
Municipalities with populations under 50,000 are only required to commit to developing solid waste initiatives. Larger cities are also required to complete a second phase of the program, focusing on water, air and other pollution prevention projects. Fortunately, the City of Houston already has many of these programs in place.

For example, many member communities have committed to implementing programs for community and backyard composting, community and workplace recycling, recycling market development, used oil and used tire collections and local public education as part of the initial phase of the program. As part of the secondary phase of the program, projects have included household hazardous waste collections, city-wide volunteer water quality monitoring programs, well-head protection programs, appointment of a citizens' advisory committee, various water quality and non point source pollution projects, and air quality projects to promote education and emission reductions.

As you move forward with your CLEAN CITIES 2000 Plan of Action and application, as well as a Water Conservation Plan, we look forward to learning of your progress.

If you should have any questions about CLEAN CITIES 2000 or any of the TNRCC's water conservation programs, please do not hesitate to call me at (512) 239-3166. I look forward to continuing to work with the City of Houston on the implementation of programs and improving the environment of the state, and providing better services to our citizens.

Sincerely,



Andrew C. Neblett, Director
Office of Pollution Prevention and Recycling

AN/jo

# TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

*Protecting Texas by Reducing and Preventing Pollution*

January 17, 1997

Mr. Mike Personnet
Texas Water Development Board
P.O. Box 13231
Austin, TX 78711-3231

**RE: City of Houston draft water conservation plan evaluation**

Dear Mike:

Per your request, I have reviewed the draft water conservation plan ("plan") developed for the City of Houston ("City") by Montgomery Watson. The evaluation process is consistent with the technical review practices that are utilized when staff reviews a plan in the Water Rights Permitting process. The focus of the review is based on the following three steps:

(1) Determine whether the plan addresses all the minimum requirements of a water conservation plan as established by the Texas Natural Resource Conservation Commission (TNRCC) in TAC, Title 30, Chapter 288;

(2) Determine whether reasonable conservation goals have been set; and

(3) Determine whether the strategies proposed can achieve the stated goals.

If these criteria are met, then sufficient evidence has been provided to conclude that by implementing the plan the City will avoid waste and achieve water conservation. This process assist staff in determining if goals were established to solve water resource problems and based on a system audit, and therefore not arbitrarily established. In addition, identification of specific water use problems and water use characteristics allow for the designation of specified goals.

The water conservation plan provides information in response to the minimum requirements addressed in §288.5, except a reservoir systems operations plan. The plan provides evidence that Montgomery Watson obtained and analyzed current and historical service area data on climate, population, housing stock, economic activities and current conservation practices. In addition, they disaggregated total water use (i.e., total production and/or delivery) into water use sectors and disaggregated water use in each sector into specific purposes of use (i.e., significant end uses).

The water conservation plan developed by Montgomery Watson clearly defines the overall purpose of the conservation plan. The City required the development of a plan for the following reasons: (1) Projected population and water demand indicate that the City will need an additional water supply by the year 2030, (2) Flooding and other serious problems caused by subsidence due to groundwater pumpage (some areas of the city that have dropped as much as ten feet), and (3) An increase in customers and resulting water demand, due to continued annexation, have intensified the problems related to the conversion to surface water. Based on the water resource problems identified it was found that a water conservation plan that focused on programs or measures that best targeted reducing summer peak-day demand water use would be most effective.

Montgomery Watson compiled a list of potential demand management measures that would appropriately address the water use problems of the service area. This process yielded nearly 200 potential conservation measures. Further, they adopted a screening process that attempted to screen out measures that had a very low potential for achieving water conservation. From this analysis of water conservation measures, devices, and programs, Montgomery Watson provided the City with three plans which allow for a range of water conservation effects.

It is the finding of staff that Montgomery Watson has provided evidence that they did not take a single objective, single purpose, single facility water resource project approach to solving water resource problems. The draft plans for the City of Houston meet the minimum requirements for water conservation as required in §288.5 TAC. They also evaluate the potential for the additional water conservation strategies addressed in §288.5. The plans go beyond the requirements by providing a cost-benefit analysis, therefore identifying the overall benefit by adopting the recommended conservation measures. Reasonable conservation goals have been set and the strategies proposed can achieve the stated goals.

Sincerely,

Stacy Dakea-Rhone

Technical Specialist

TEXAS
PARKS AND WILDLIFE DEPARTMENT
4200 Smith School Road • Austin, Texas 78744 • 512-389-4800

ANDREW SANSOM
Executive Director

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January 17, 1997

Alicia Ramirez
Texas Water Development Board
P.O. Box 13231
1700 N. Congress Avenue
Austin, Texas 78711-3231

RE: Review of the Draft Final Report Submitted by the City of Houston, TWDB Contract Number 94-483-037

Dear Ms. Ramirez:

I have reviewed the above referenced document entitled "City of Houston - Final Draft Water Conservation Plan " prepared by the firm Montgomery Watson.

The Draft Conservation Plan appears to be the product of thorough and detailed analysis. However, the conservation plan is clearly lacking measures targeted to conserve outdoor water use. According to the report, combined single-family and multifamily categories have by far the highest total use, amounting to approximately 63 percent of retail water sales. Furthermore, water demands increase in the summer due primarily to landscape irrigation. Overall, 16 percent of the billed water use occurs outdoors, up to 250 gpd/account in the peak summer months. The report goes on to say that the single-family category has the highest contribution to peak demand, 18 percent annually of all water used for exterior purposes. The variation is more extreme in monthly water use; The daily basis variation would certainly be even more extreme, but this data by customer class is not available. It is these peak demands that determine the sizing of capital facilities. Conservation can reduce the peak demands, capital facilities can be either smaller or deferred in time. The expense of proposed water capital improvement projects can be deferred or avoided by reducing summer peak-day water use. "Prime targets to reduce peak-day use are the *exterior uses* by single families and public agencies." [emphasis added]

The report lays out very convincing and logical support for reducing exterior water use through such measures as providing information for planning water-efficient landscaping, using native plants that do not require supplemental watering, and irrigating only in the morning and evening, to reduce amount of water lost to evaporation.

Using native plants also provides additional benefits in the form of wildlife habitat and reduces the need for synthetic fertilizers and pesticides. According to Table 6.3 Projected Water Savings, combined water savings of nearly 15 million gallons per day by the year 2050 are projected for the Water Efficient Landscape and Low Water Use Landscape Ordinance Programs.

Why then are measures that would reduce outdoor water use not part of the Recommended Conservation Plan? Table 7-1 rates single family and multifamily Landscape Incentives and the Landscape Ordinance as "unacceptable due to non quantifiable impacts to community", thereby removing them from the analysis. No supporting text is given other than that "landscape codes, ... tend to be unpopular." Also eliminated from the Recommended Plan was the Commercial

Landscape Ordinance program. This action also needs further explanation, since it had a benefit/cost ratio of 20.48 and had a lower first five year total cost than 3 of 4 Commercial Measures that were included.

A water conservation plan that does not include at least the minimal basic common sense measures to reduce outdoor water use is not satisfactory. The Department recommends that the draft plan be revised to include those measures as well as more progressive measures such as the Landscape Incentive Program and the Commercial Landscape Ordinance Program.

Sincerely,

Cindy Loeffler

Cindy Loeffler, P.E.
Water Resources Team Leader,
Resource Protection Division

CLL:cll

# CITY OF HOUSTON

Post Office Box 1562 Houston, Texas 77251-1562

Bob Lanier, Mayor

CITY COUNCIL MEMBERS: Helen Huey Michael J. Yarbrough Martha J. Wong Jew Don Boney, Jr. Rob Todd Ray F. Driscoll John Kelley Felix Fraga John E. Castillo Gracie Guzman Saenz Joe Roach Orlando Sanchez Chris Bell Judson W. Robinson III CITY CONTROLLER: Lloyd E. Kelley

**Chief of Staff**
**Office of the Mayor**

**JIMMIE SCHINDEWOLF, P.E.**

**Director of Public Works & Engineering**


March 17, 1997

Mr. Mike Personett
Texas Water Development Board
P.O. Box 13231
1700 N. Congress Avenue
Austin, TX 78711-3231

**RE: Texas Parks and Wildlife Department's Comments Regarding the Draft Final Report Submitted by the City of Houston, TWDB Contract Number 94-481-037**

Dear Mr. Personett:

In response to the letter from Ms. Cindy Loeffler, P.E., to the Board (forwarded to us by your office) regarding the above referenced report, we would like to make the following comments:

Ms. Loeffler's review of the statistics included in the report and her support for "reducing exterior water use through such measures as providing information for planning water-efficient landscaping, using native plants that do not require supplemental watering . . . ", etc., are well taken. However, her assertion that "the plan is clearly lacking measures targeted to conserve outdoor water use" fails to take into consideration the current in-house conservation program described in the report and several new programs which are recommended by the study.

First, the "in-house program" currently includes irrigation audits of all City owned large turf areas, including golf courses, esplanades, parks, etc. In addition, we are in the process of adopting new procedures for controlling water waste at more than 1,000 City esplanades. These procedures include requiring new irrigation systems to be equipped with programmable controllers and moisture probes, limiting the plants allowed to low water use and indigenous plants, limiting spray heads to within 3 feet of curbs or other paved areas, prohibiting above ground sprinkler heads in esplanades with a width of less than 12 feet, etc.

Also, the conservation plan includes several programs which are targeted to reduce exterior water use by single- and mulit-family customers and public agencies. The report describes the residential water audit program, "The . . . program would offer an indoor and outdoor water audit to existing single-family and multifamily residential customers in the top 25% of water users. . . The auditors would focus most on outdoor water use." The public facility water audit program would also involve offering exterior audits and water saving information to landscape site managers at all public facilities including schools, libraries, state, local, and federal government buildings, etc.

In preparing our conservation plan, we felt that attempting to impose landscape ordinances on Houstonians without first laying the ground work through an education program which emphasizes the need for changing irrigation and landscape practices would be difficult to

state. Therefore, our citizens often do not see the need to limit their outdoor watering practices. For this reason we recommended an increase in the budget for the conservation education program to allow that kind of education to take place.

And finally, the City is committed to continuously monitoring and evaluating its overall water conservation effort in relation to its water supply and water and wastewater facility capacity needs. As the need for major capital investments draws near, the City will consider expanding current programs and/or implementing additional water conservation measures. More aggressive water conservation measures may be implemented throughout the utility service area or targeted to specific sub-areas in order to delay planned capital improvements. Proper timing of future investments in water conservation is essential to maximizing the benefits of such programs to the utility and its rate payers.

Hopefully, the Parks and Wildlife Department will find these measures acceptable and we can finalize the report and go forward with the recommended plan. If you, your staff, or Ms. Loeffler have any questions, please feel free to contact me at (713) 880-2444 X372.

Sincerely,

Pat Truesdale

Pat Truesdale, MPA
Water Conservation Manager
Department of Public Works and Engineering
City of Houston

cc: Jimmie Schindewolf, P.E.
Frederick A. Perrenot, P.E.
Ronald E. Hudson, P.E.
Charles F. Settle, P.E.
Alicia Ramirez
Cindy Loeffler, P.E.
Chuck Profilet, P.E.

TEXAS WATER DEVELOPMENT BOARD



February 13, 1997

Mr. Frederick A. Perrenot
City of Houston
P.O. Box 1562
Houston, Texas 77251-1562

Re: Response to Comments Regarding Regional Water Supply Planning Contract Between the Texas Water Development Board (Board) and the City of Houston, TWDB Contract No. 94-483-037

Dear Mr. Perrenot:

Staff members of the Texas Water Development Board have completed a review of the consultant's reponse to our comments and have determined the response to be satisfactory.

Board staff looks forward to the completion of this project and delivery of one (1) unbound camera-ready original and nine (9) bound double-sided copies of the final report.

If you have any questions about completion of this planning project, please contact me at (512) 463-8061.

Sincerely,

Mike Personett
Division Director, Local and Regional Assistance

cc: Mike Personett, TWDB
Ron Hudson, City of Houston
Chuck Settle, City of Houston
Pat Truesdale, City of Houston

# Houston Audubon Society

*440 Wilchester, Houston, Texas 77079, (713) 932-1639, 461-2911 (fax)*


April 1, 1997

Ms. Pat Truesdale
City of Houston, Public Works & Engineering
Water Conservation Branch
Post Office Box 1562
Houston TX 77251-1562

Dear Ms. Truesdale,

Unfortunately, I am unable to attend the April 3 public meeting on the draft Water Conservation Planning Study. Please accept my comments on behalf of Houston Audubon Society, while I am in Florida at the Gulf Restoration Network meetings!

Houston is to be congratulated for moving forward with this important step, which has far-reaching implications for Texas river basins, bays, and ultimately the Gulf of Mexico. There are three areas which I would like to see strengthened:

1) **Landscape education:** The city should be more active in educating the public about the beneficial aspects of xeriscaping and using natives. You have excellent information in print, but it needs to be more actively demonstrated - in public gardens such as those at City Hall, the Zoo, Multi-Service Centers. Elyse Lanier could help so much be sacrificing part of her rose gardens and leading the demonstrations!

2) **Penalties for wasteful practices:** I often see, in my neighborhood, the practice of deliberately watering the street to insure that every inch of that insidious Augustine grass gets watered. Automatic sprinkler systems are big offenders. I watch helplessly as perfectly good drinking water flows straight into the storm drain. A schedule of fines should be set in place and actually enforced until people get the message and use the equipment properly.

3) **Water is too cheap:** As with gasoline, there is less incentive to conserve until it hits out pocketbooks harder. Raise the price of water, and use the income to aggressively repair our infrastructure in the areas where it is still prone to bursting water mains.

Your plan is technically excellent, and I applaud your efforts. My suggestions are designed to teach the conservation ethic to all citizens.

Sincerely,

Page S Williams

(Ms.) Page S. Williams, Vice President for Environmental Affairs

Houston Apartment Association

April 28, 1997

Ms. Pat Truesdale
Water Conservation
City of Houston
P O Box 1562
Houston, Texas 77251-1562

Dear Ms. Truesdale:

**Re: Recommended Water Conservation Plan - Toilet Rebates**

I am writing on behalf of the Houston Apartment Association, a non-profit trade association representing the owners and managers of over 320,000 apartment units in the Houston area.

While we commend the hard work by consultant Montgomery Watson and the city on this plan, we feel that the failure to include rebates for water saving toilets should be reconsidered. "Early retirement" of old toilets yields a benefit/cost ratio that is much more favorable to the city than any of the water conservation programs that were ultimately chosen. According to the Montgomery Watson study, a toilet replacement rebate program would be popular with the community, and would save city ratepayers a great deal of money over the next nine years.

Please consider adding toilet rebates to the Water Conservation Plan.

Thank you for your hard work on this important issue.

Sincerely,

Andy Teas
Director of Government Affairs

10815 Fallstone Road • Houston, Texas 77099 • (713) 933-2224 • FAX: (713) 933-8412

**WRITTEN COMMENTS RECEIVED FROM CITIZENS AT PUBLIC MEETINGS**

As an employee of a large property management corporation (Hines), I feel that it would be extremely advantageous for us to maintain contact and work together on these future plans discussed on 6/13/96 and so we may plan with you.

John M. Humphrey

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Emphasis needs to be placed on water reuse of treated water from wastewater plants. Ex: 69th street treatment plant treats water outfalls into Buffaol Bayou which is a waste of all the process it undergoes.

Sujeeth Draksharam

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If we are so "water rich", why has the City of Houston spent 30 years promoting the Wallisville Dam. For its water rights. It's time to drop that project.

Marg Hanselman

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I have observed many City buildings that have leaking faucets and toilets. Last year I measured one faucet leaking 6 gallons of water in 7 hours. I know that is a lot of loss from just one faucet. I think City buildings should be inspected first and even metered where possible.

Sgt. Les Bashaw
Houston Police Dept.

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I am interested in landscape/irrigation ordinance.

Dan Pope

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- Give rebates to nurseries that feature Xeriscape™ plants (maybe with a COH poster)
- Since we have plenty of water and already pipe it around, couldn't we put some in Sheldon Reservoir until TXDOT corrects its mistakes?

Page Williams

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Are the wholesale/industrial customers going to receive incentives to participate?

Thomas P. Reel