INSTALLATION PROCEDURES / INSTRUCTIONS

Data Entry Scripts
Nhcrwa_queries_scripts.zip

This document describes the contents of the file nhcrwa_queries_scripts.zip. This zip file accompanies the nhcrwa_queries application described in the application documentation. This document will outline how to install the various dialogs and scripts if the master ArcView file, nhcrwa_queries.apr, should become corrupted or a particular module should stop functioning correctly.

Installation of Dialogs and Scripts

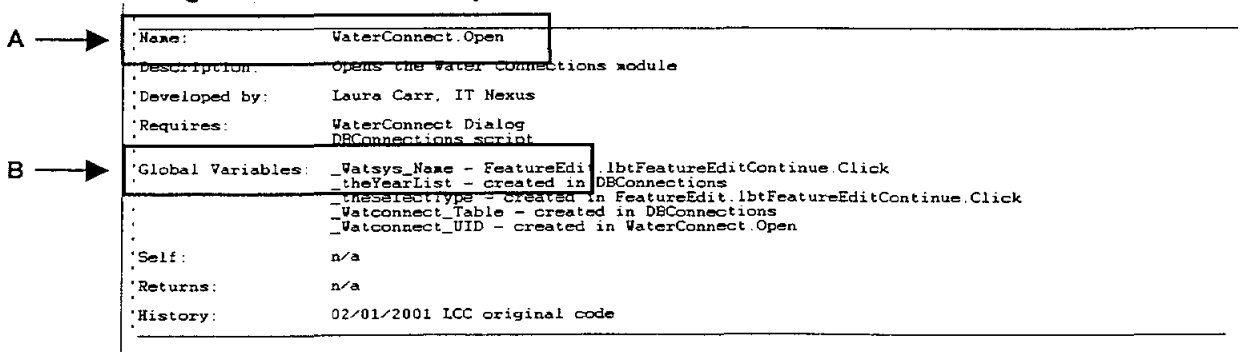
Listed in the zip file are quite a few script files. To load these files:

1. Open up a new ArcView project
2. Open up a new Script Editor
3. Select the Load Text File button.
4. Go to Script – Properties and rename the script to the correct name (See "A" in graphic below)
5. You should now be able to run the script.

Listed below are the instructions on how to load the Print application or the print.ded file in the zip file.

1. Open up a new ArcView project.
2. Go to File – Extensions – and be sure the Dialog Designer is loaded.
3. Open up a new Dialog Designer Editor window.
4. Load an existing dialog.
5. Navigate to where the dialogs are stored and select the print.ded file
6. The window will list all of the scripts associated with this dialog. They are also stored with the dialog in the .ded file. Do not uncheck any of the scripts.
7. Select OK and you will notice in the project window under dialogs and scripts you now have the dialog window you loaded and the associated scripts that run the dialog.

You should now be able to run the dialog, but be careful that you have any associated scripts or dialogs that must also be loaded into the project. In each script the name is outlined in the beginning documentation (see "A" below) and what other scripts or dialogs are required to run this script (see "B" below). If errors occur in reloading, a good check would be to use these two sections and make sure the loaded scripts or dialogs are named correctly.



Contents of Zip File

Print.ded

Contains the print application dialog and associated scripts.

Print.Open
Print.lbtPrint.Click
Print.lbtPrintCancel.Click
Print.lbtPrintPreview.Click

1. **Print_script.ave**
   Script attaches to the print button in the View Window and starts the print application.

2. **Template.def**
   System file that holds the templates for the print application

3. **Age_of_wells.ave**
   Age of wells query script

4. **District_servicearea_features.ave**
   District/Service area features script

5. **Qa_qc_ccn.ave**
   Runs with Qa_qc_start.ave to link the CCN coverage to the ACCESS database.

6. **Qa_qc_mud.ave**
   Runs with Qa_qc_start.ave to link the MUD coverage to the ACCESS database.

7. **Qa_qc_start.ave**
   Begins the QA/QC link applications that link the coverages to the appropriate tables in the ACCESS database.

8. **Qa_qc_sysint.ave**
   Runs with Qa_qc_start.ave to link the SYSINT coverage to the ACCESS database.

9. **Qa_qc_tank.ave**
   Runs with Qa_qc_start.ave to link the TANK coverage to the ACCESS database.

10. **Qa_qc_well.ave**
    Runs with Qa_qc_start.ave to link the WELL coverage to the ACCESS database.

11. **Qa_qc_wwtp.ave**
    Runs with Qa_qc_start.ave to link the WWTP coverage to the ACCESS database.

12. **Systeminterconnects.ave**
    System interconnect query script

13. **Tank_capacity.ave**
    Tank capacity query script

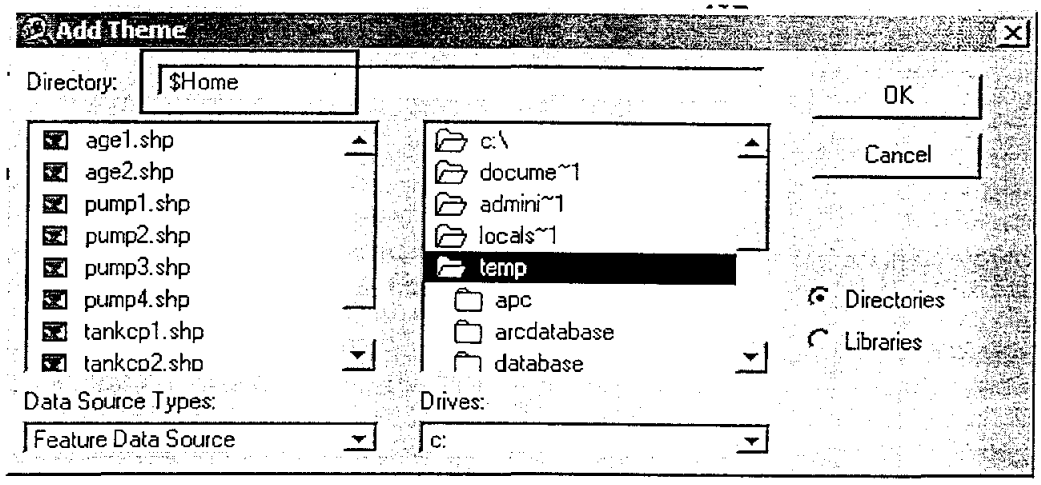
14. **Well_pumpage.ave**
    Well pumpage query script

15. **Wells_that_serve_district.ave**
    Well query script

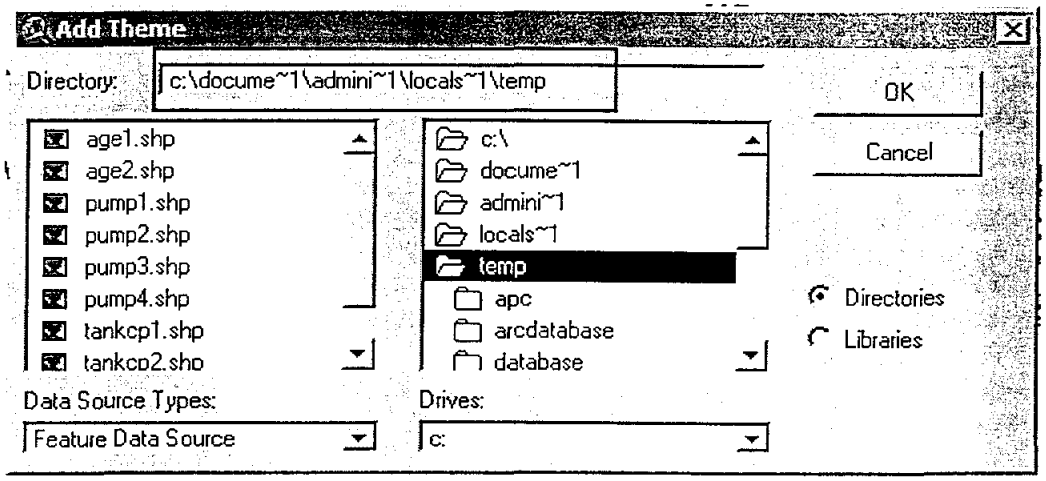
Installation of the Template.def file

This section of the instructions are very important if the print application is to be run correctly. This file contains the templates that the application draws upon to create the map layouts. It is a simple procedure, but must be followed very closely.

1. Find the %HOME% directory for ArcView.
   a. A simple way to find this directory is to go to the View window in ArcView.
   b. Select the ADD THEME button.
   c. In the ADD THEME window, type in $HOME, see below, and press enter



   d. After hitting enter, the file name of your %HOME% directory will appear in the directory line. Write this file name down.



   e. Remove from the zip file nhcrwa_queries_scripts.zip the template.def file and place in the %HOME% directory. Now the print application can draw from the correct template list.

Connecting to the ACCESS database from ArcView

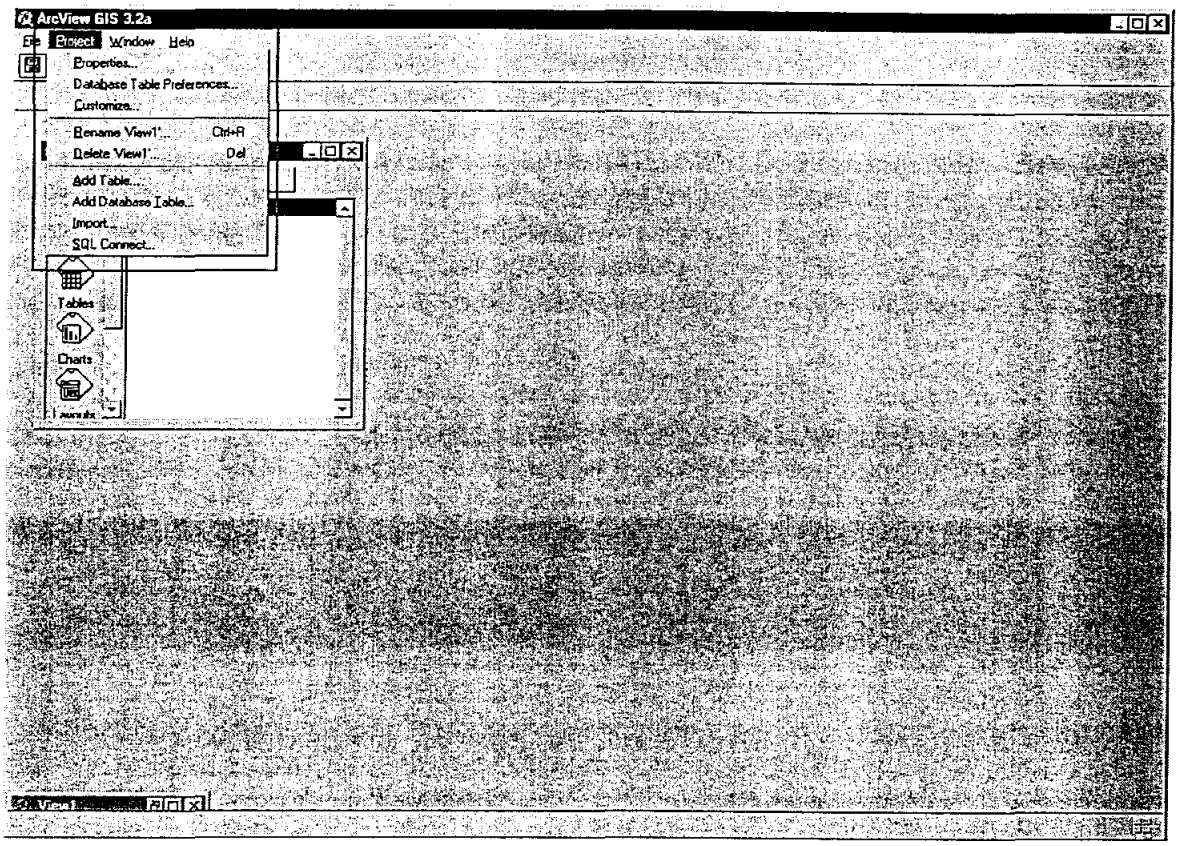
Before beginning insure that your are aware of the following:

- The ODBC Connection must be set-up before the following procedures are preformed.
- The type of connection discussed is the SQL Connect provided within ArcView. This documentation must be followed for each ACCESS table.
- The Relational Database Management System is discussed in Section III of the project manual and each table is outlined in Appendix D. The tables must be joined to the related tables using their unique identification number (XXX_UID).

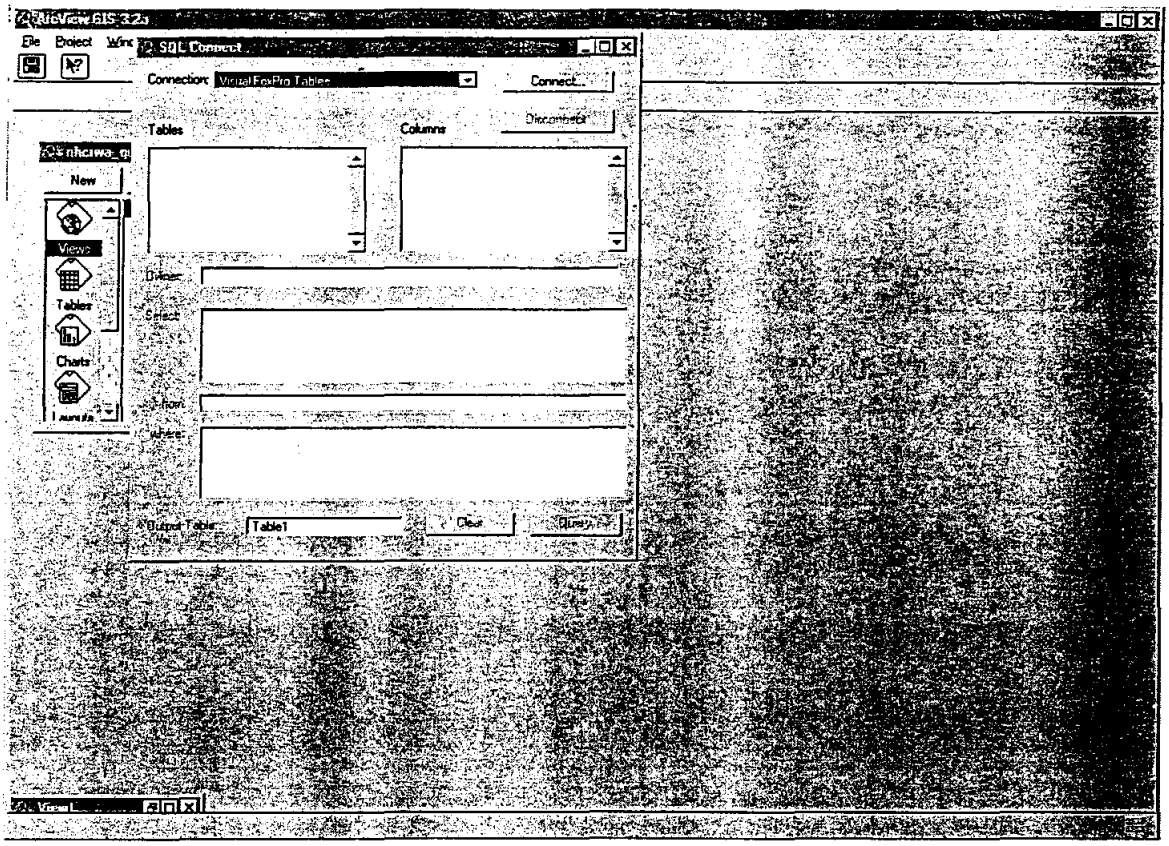
Instructions:

1. Start ArcView and open the nhcrwa_queries.apr provide by The CLR Team.
2. Minimize View1 (see "A" below).

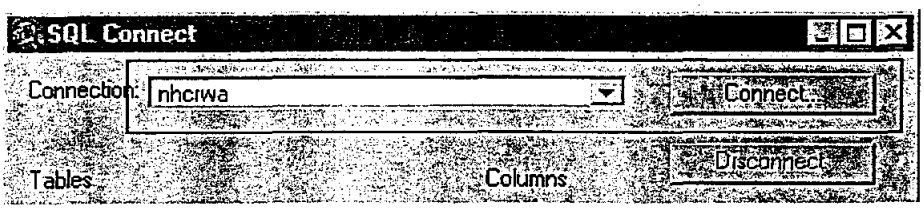
3. After minimizing View1 the select "Project" from the pull-down menu and select SQL Connect...



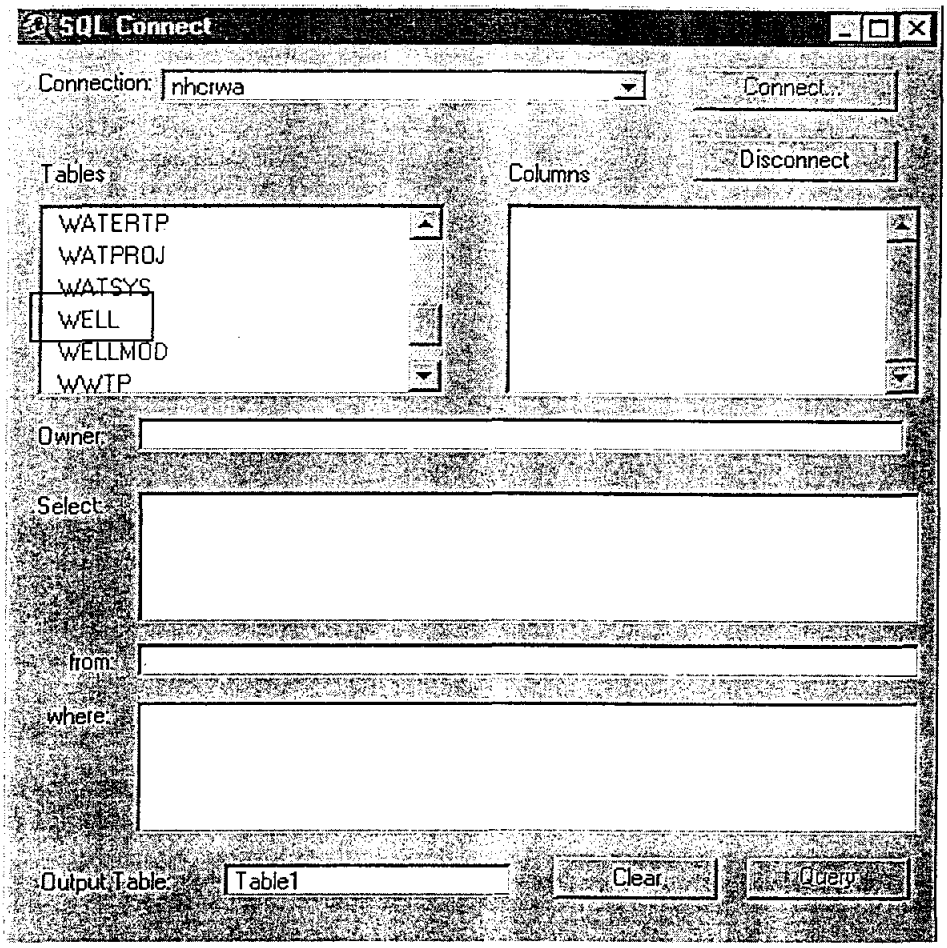
After selecting "SQL Connect...", the below dialog screen appears.



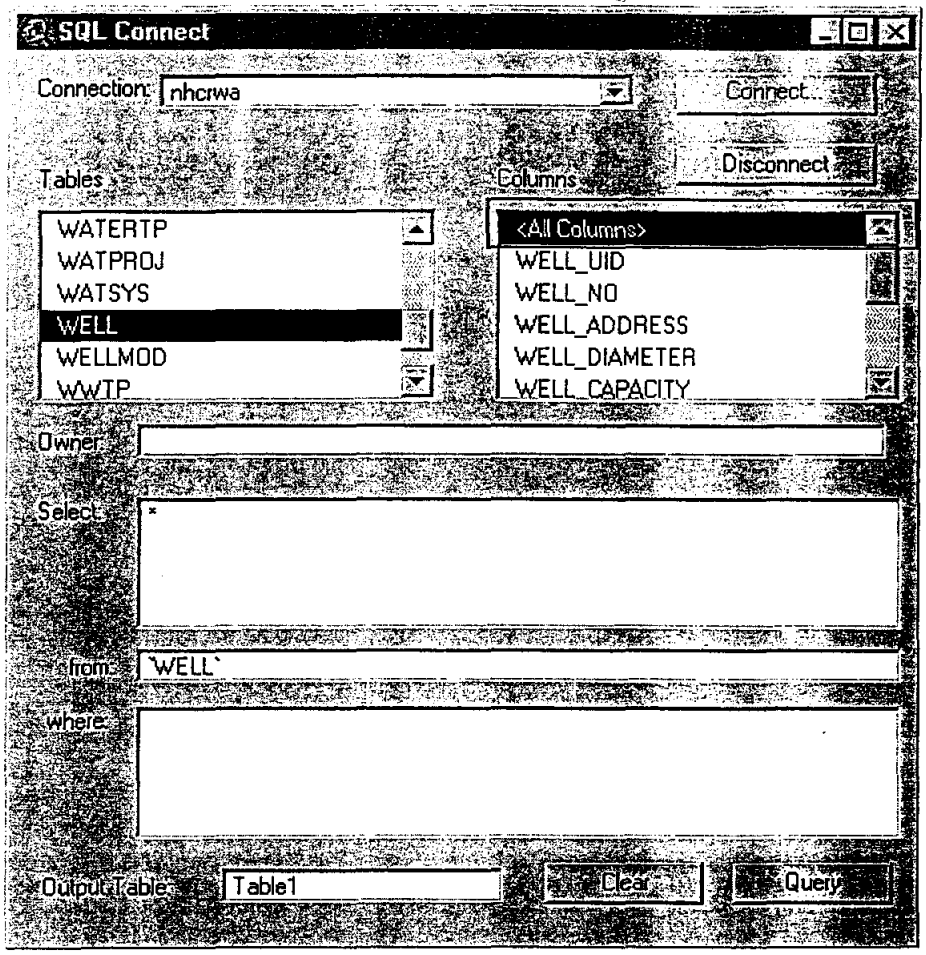
4. In the Connection box, select nhcrwa and press the "Connect..." button. This task connects to the ACCESS database.



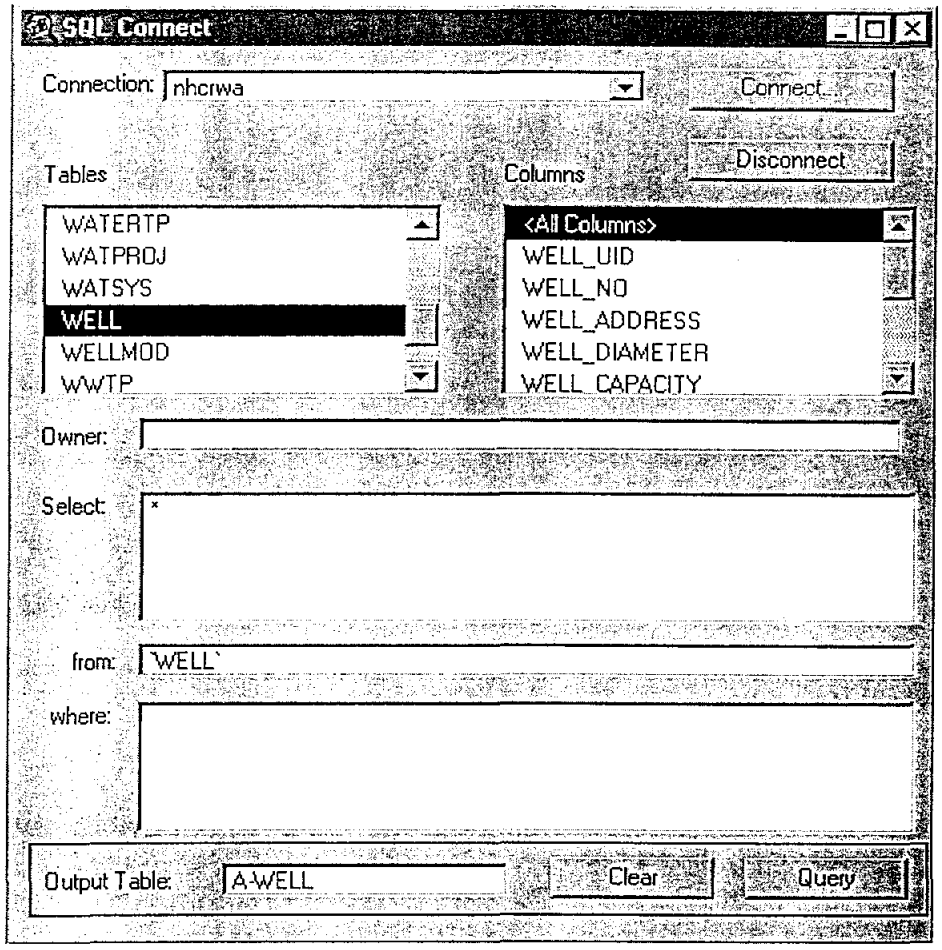
5. Scroll down the list of Tables until desired table is presented in the window. Double-click the desired table, for example the "WELL" table.



6. The fields from the "WELL" table will be viewable in the columns window. To retrieve all fields in the "WELL" table double-click "<All Columns>".



7. To name the Output Table, type over the "Table1" using all caps "A- the [ACCESS table name], for example: A-WELL. Select the "Query" button after naming the Output Table.



This will connect the "WELL" table in ACCESS to ArcView. The new table will reside in the ArcView project window under the Tables icon. The join table button is required to link the attributes of wells in ArcView to the A-WELL table. The join command is discussed in ArcView's Help pull down.

Data Standards

At the beginning of the data entry process, it became evident that no naming standards had been developed to this point on the various data sets received. A naming convention was created to promote consistency within the data entry process. The following abbreviations were used during data entry from the questionnaire:

Ave.	Avenue
Blvd.	Boulevard
Ct.	Court
Dr.	Drive
Frwy.	Freeway
Hwy.	Highway
Ln.	Lane
St.	Street
P.E.	Professional Engineer
P.C.	Professional Corporation
L.L.P.	Limited Liability Partnership
Assoc.	Associated or Associates
OP	Operator
EN	Engineer
AT	Attorney
BP	Board President
CO	Current Owner
H.O.A.	Home Owners Association
MIL	Million
EM	Emergency
NO	Normally Open
CCN	Certificate of Convenience and Necessary
MUD	Municipal Utility District
PUD	Public Utility District
SUD	Special Utility District
UD	Utility District
ID	Improvement District
FWSD	Fresh Water Supply District
WCID	Water Control and Improvement District
WSC	Water Supply Corporation
GS	Ground Storage Tank, this abbreviation was presented in the map layout in the questionnaire.
GST	Ground Storage Tank, this abbreviation was presented in the questionnaire as the name or Id of the Ground Storage Tank.
GRD	Ground Storage Tank, this was presented in the ACCESS database.
ES	Elevated Storage Tank, this abbreviation was presented in the map layout in the questionnaire.
EST	Elevated Storage Tank, this abbreviation was presented in the questionnaire as the name or Id of the Elevated Storage Tank
ELV	Elevated Storage Tank, this was presented in the ACCESS database.
SI	System Interconnect, this abbreviation was presented in the map layout in the questionnaire.

IC	System Interconnect, this abbreviation was presented in the map layout in the questionnaire.
WL	Water Well
WW	Wastewater Treatment Plant, this abbreviation was presented in the map layout in the questionnaire.
STP	Wastewater Treatment Plant, this abbreviation was presented in the map layout in the questionnaire.
WWTP	Wastewater Treatment Plant, this abbreviation was presented in the questionnaire as the name or Id and the ACCESS database of the Wastewater Treatment Plant.
WTP	Water Treatment Plant, this abbreviation is found in the database design.
NHCRWA	North Harris County Regional Water Authority
HGCSD	Houston Galveston Costal Subsidence District
GRP	Groundwater Reduction Plan

In addition, the naming system employed a numbering system for those items that had only a generic name or no name at all, such as ground storage tanks. In this case, an abbreviated standard –# was used, where # represents a unique number. Thus, for the ground storage tanks, each tank in a district has a unique name, e.g. GST-1, GST-2, and GST-3, etc.

NORTH HARRIS COUNTY
REGIONAL WATER
AUTHORITY

WATER CONSERVATION PLAN

MAY 2002

2001-483-366
FINAL REPORT
2 OF 3

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TABLE OF CONTENTS

PREFACE

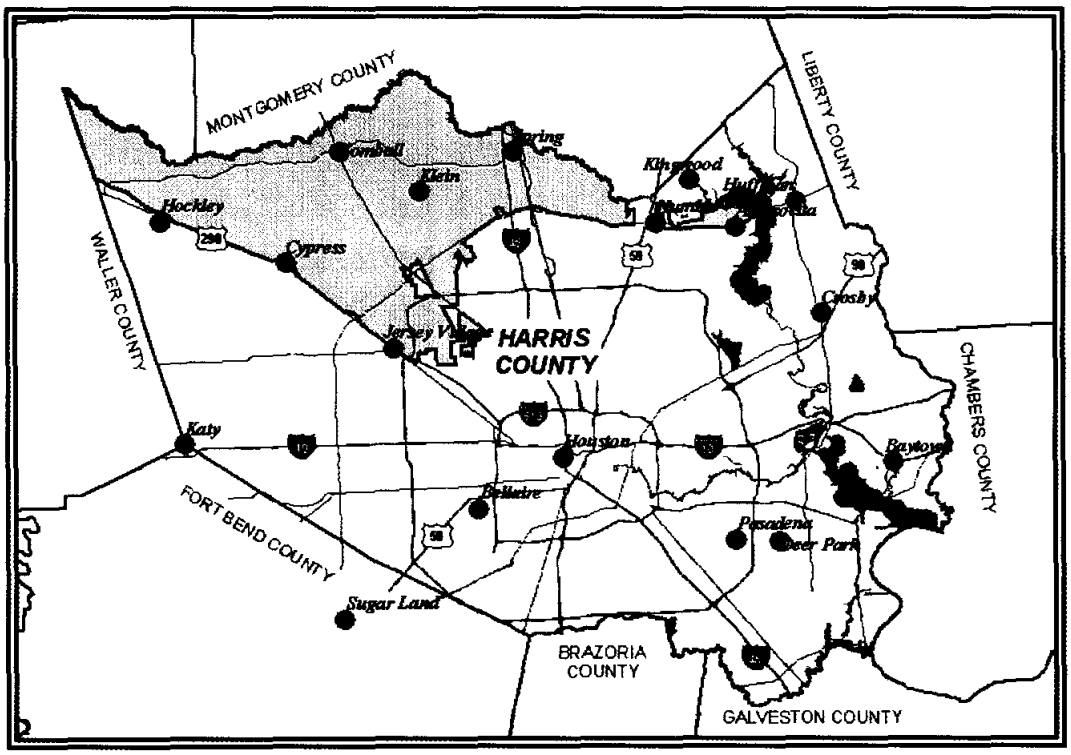
The enclosed Water Conservation Plan (WCP) describes tentative conservation methods, not a fully implemented plan. The North Harris County Regional Water Authority does not currently own and operate a potable water system but anticipates having the first phase operational by first or second quarter of 2009. The WCP offers conservation concepts for the future potable water system. The North Harris County Regional Water Authority Board of Directors will consider for approval and implementation a final WCP closer to the time the potable water system is operational.

1.0 INTRODUCTION

A. Service Area Description

The service area of the North Harris County Regional Water Authority (Authority) is located entirely in northern Harris County. The Authority is generally bounded on the west by SH 290, Spring Creek to the north, Houston to the east and portions of FM 1960 on the south. The southernmost part of the area extends inside Beltway 8 and the easternmost area is located between US 59 and Lake Houston just past US 59. **Figure 1** shows the boundary of the Authority's service area that is approximately 335 square miles with approximately 368,000 residents.

FIGURE 1: SERVICE AREA BOUNDARY



The Authority was created in order to develop a mechanism for coming into regulatory compliance with the requirements of the Harris-Galveston Coastal Subsidence District's

(HGCSD) 1999 Regulatory Plan (Plan). The Plan requires a reduction in groundwater withdrawals to no more than 20% of total water demand by the year 2030. This includes interim reductions in groundwater withdrawals to no more than 30% of total water demand by the year 2010 and no more than 70% of total water demand by the year 2020. The main objective for creation of the Plan is to reduce or stop subsidence due to excessive withdrawals of groundwater by the well owners. A component of reducing water use, whether it is groundwater or surface water, is water conservation.

The first planning milestone for the Authority requires the preparation and submittal of a Groundwater Reduction Plan (GRP) report that describes the mechanisms identified for meeting HGCSD's groundwater reduction mandates. The Authority will attain the phased groundwater reduction as a wholesale public water supplier (wholesale supplier) providing wholesale water to retail public water suppliers (retail suppliers). One component of a GRP is the preparation of a Water Conservation Plan (WCP). The Texas Water Development Board (TWDB) requires a WCP be prepared for those projects receiving TWDB grants from the Regional Facilities Planning Grant Program. This WCP will satisfy both of these requirements.

B. TWDB Regional Water Supply Facilities Program

The Authority received grant authorization from TWDB *Regional Water Supply Facilities Planning Program* (Regional Facility Planning Grant) in August 2000 under TWDB Contract No. 2001-483-366. The Regional Facility Planning Grant program is for studies and analyses to evaluate alternatives that meet regional water supply facility needs, estimate the costs associated with implementing feasible regional water supply facility alternatives, and identify institutional arrangements to provide regional water supply services for proposed planning areas in Texas. The Authority's commitment to its constituents is to provide adequate and reliable potable water to its customers at the lowest possible cost. Funding assistance from the Texas Water Development Board will offset a portion of the planning costs required to develop the GRP.

The Authority's Regional Facility Planning Grant has three major tasks that include the WCP. In accordance with 31 Texas Administrative Code Chapter 357, development of a Water Conservation Plan (WCP) must be included as a specific task in the scope of work for proposed planning areas in Texas without a previously approved WCP by TWDB or TNRCC. The Authority submits this report to TWDB in compliance with this regulation and the Authority's contract.

C. Population Projections

The Authority will provide wholesale water for municipal use to 160 independent water districts, municipal utility districts, permitted well owners located in Northwest Harris County and the cities of Tomball and Jersey Village. The report entitled *Update of Population and Water Demand Forecasts for the Harris-Galveston Coastal Subsidence District* (Update Report) was prepared by Turner Collie & Braden in March 1996 for the HGCSD and projected population and water demand at the census-tract level. The Update Report gave projections by census tract for Harris and Galveston Counties for every five years from 1990 to 2030. These population and water demand projections were used to develop the WCP. Table No. 1 shows the projected census population and HGCSD annual average water demand for 2000.

TABLE NO. 1

YEAR 2000 POPULATION AND AVERAGE WATER DEMAND

Consumer	Year 2000 Projected Service Area Population	**Year 2000 Average Day Water Demand (mgd)**
North Harris County Regional Water Authority	367,722	71.27

Population projection development included the actual census population and HGCSD annual average water demand for 1990. The population projection was based on actual 1990 census block group data based on delineated geographical boundaries. The census block group and population data was obtained from the USGS Census Bureau 1990 Census Tracts for Harris County, Texas. Each census block group with the corresponding projected population for years

2000, 2010, 2020 and 2030, and the total population within the boundary of the Authority is shown in Appendix A.

D. Water Demand Projections

The calculation of water demand was performed at the geographic level of a census block group. Each category of water demand was calculated separately. Agricultural demand was computed by multiplying the unit factor of irrigation times the acreage of irrigated cropland. Industrial usage was determined by prorating the total usage at each physical location of the industrial facility times the projected increase overall by county.

Municipal demand was calculated by the sum of single family demand plus multi-family demand plus commercial demand. Multi-family unit usage factors were determined to be 254 gallons per unit. Unit factors of 450.8 gallons per single family connection and 115 gallons per multi-family occupant were applied. Total demand was then a function of multiplying the projected population times the respective unit factor. The division between single and multi-family population growth was assumed to exhibit the same ratio as exhibited in 1990. Commercial demand was calculated as the projected employment times the unit factor for water consumption per employee, adopted as 27 gallons per day.

The issue most important to the Subsidence District is the geographic distribution of water production based on water demand. A part of the issue concerns the geographic distribution of water demand and where water will be produced to meet this demand. The use of GIS became an integral part of the geographic distribution of water demand. Aggregation of water demand was accomplished by using GIS software to intersect a 2½ x 2½-mile grid with census block groups. The GIS was used to overlay the geographic delineation of the regulatory areas over the census block groups. Each census block group in Harris and Galveston counties was assigned to an area in this manner. A mathematical relationship between area and density of demand was then used to calculate the final water demand in each grid cell. Appendix B shows the projected annual average water demand for 2010, 2020, and 2030.

E. Wastewater Demand Projections

Wastewater demand data is not provided because the Authority will solely be a wholesale regional water supplier and will only be responsible for maintaining and supplying potable water to its customers. It is not anticipated at this time that the Authority will ever be a wastewater treatment provider, therefore, the determination of projected wastewater demand is not included as part of this WCP.

2.0 CONSERVATION GOALS

The goal of the Authority is the assurance of an adequate and safe potable water supply for its customers in years to come. The goals of a WCP are to reduce water consumption, limit unaccounted for water, and protect both existing and future water supplies. The result of a successful WCP will be reduced peak-day demands, thereby potentially reducing, or downsizing distribution and treatment facilities, resulting in economic benefits to the Authority and it's customers. Reduced peak day demand could also delay the construction of facilities.

The Authority is expected to complete construction of a wholesale regional water supply system in 2009. One year later in 2010, approximately 30 percent of the water demand in the Authority will be converted to surface water and will be distributed to designated participants. Participants will be required to execute a contract with the Authority.

The most direct effects a wholesale water provider can make to water conservation are to reduce unaccounted for water and protect water supplies. Unaccounted for water is the difference between the quantity of water that is withdrawn from a supply source and the amount that is actually delivered to the customer. If the supply is raw water, the "supply source" is defined as the forebay or raw water storage reservoir ahead of a water treatment plant. If the supply is potable water, the "supply source" is defined as the take point for the potable water. The goal of the Authority will be to limit unaccounted for water to less than 10 percent of reported water usage.

Both surface water supplies and groundwater supplies must be protected. This includes preventing pollution of water supplies and assuring the availability of water supplies for future needs. Supply source contamination and issues related to public health and safety will be monitored through all applicable testing procedures as defined by American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), American Water Works Association (AWWA), and any additional Local, State or Federal Agencies that are applicable.

The goals of the WCP are:

- Reduce water consumption by its retail suppliers. Reduction of water consumption by retail suppliers will begin as soon as a contractual agreement with the retail suppliers is entered into. These will be in place by 2010.
- Limit unaccounted for water to no more than 10 percent of the reported water usage. Limiting unaccounted for water will begin at such time as the Authority constructs its water supply infrastructure. Based on the timetable for conversion to surface water, it is anticipated that the infrastructure will be in place by 2010.
- Prevent pollution of surface water and groundwater supplies. This has already begun and will be an ongoing effort.
- Sustain water supplies for future users. This has already begun and will be an ongoing effort.

3.0 CONSERVATION STRATEGIES

The WCP is a strategy, or combination of strategies, for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water.

The conservation strategies used to attain the goals mentioned in Section Two can be divided into three (3) categories: operational, administrative and educational.

A. Operational Strategies

The following operational strategies are considered for implementation:

- Effective use of groundwater and surface water.
- Efficient utilization of existing water supplies through universal metering.
- Water Audits and Leak Detection.
- Reservoir Systems Operation Plan.
- Methods to Monitor the Effectiveness and Efficiency.
- Wastewater Reclamation

1. Effective Use of Groundwater and Surface Water

The major water source for surface water has not been determined at this time, however municipal users will continue to provide groundwater from existing wells to supplement the use of surface water.

Surface water is a renewable resource; groundwater is not as easily renewable. The use of surface water will extend the availability of groundwater for future use. In addition, the future availability of groundwater may supplement surface water in times of drought or other emergencies. The supply lines constructed by the Authority will have sufficient pressure to

distribute wholesale water to the participants; fill retail suppliers ground storage tanks; and deliver peak hour and/or peak day volumes, whereby the retail suppliers will be required to meet the distribution pressure and system requirements outlined by the TNRCC.

The total cost to the Authority will be affected by the supplemental use of ground water in areas where it may be cost prohibitive to build surface water lines. Providing surface water to those areas located remotely from the surface water lines will be costly. Some of the NHCRWA customers on the outer reaches will not be provided treated surface water, while other customers will be delayed until a time that it is feasible to construct surface water transmission lines to these customers. The Authority's ability to delay construction of these lines will not affect the overall goals of the WCP.

2. Efficient Utilization of Existing Water Supplies through Universal Metering

Water meters at point of delivery of wholesale supply to the Authority and at the Authority's delivery point to its customers will serve as a means for leak detection, thus providing a cost benefit savings to the Authority by lowering unaccounted water use. The Authority will be responsible for its meters that lead up to the point of connection at the retail supplier's main point of distribution.

Because the Authority's customers will use their existing water distribution facilities, a program for the testing and calibration of retail water meters will be required. Retail suppliers will be required to provide documentation demonstrating that existing water meters on its water mains and at its water treatment plants have been tested and calibrated prior to connection to the wholesale supplier's distribution system. This will serve as a means of documenting unaccounted water use in the retail distribution systems.

3. Water Audits and Leak Detection

Water audits and leak detection in water systems are effective ways to achieve water conservation and offer a cost savings to both the retail supplier and the Authority. Successful leak detection programs benefit everyone because they prevent unnecessary costs and lost revenue. Periodic testing and calibration of the Authority's meters will reduce the chance of

lost revenues and prevent leaks, which also benefits the Authority. The Authority will implement a method for record management and testing of its water meters. **Table No. 2** shows an estimated daily loss of revenue due to water leaks based on total projected water demand for years 2010, 2020 and 2030.

TABLE NO. 2

PROJECTED AVERAGE DAILY WATER LOSSES

Description	2010	2020	2030
[1]Total Daily Demand (mgd):	76.9	87.3	99.9
[2]Estimated Water Loss (mgd):	7.7	8.7	10.0
[3]Estimated Revenue Loss (dollars):	$1,922	$2,183	$2,498
[4]Total Estimated Daily Revenue Losses After Leak Detection and Repair (dollars):	**$961**	**$1,091**	**$1,249**

Source: AWWA Leak Detection Committee.1999, pp 5-33. *Water Audits and Leak Detection.* Manual of Water Supply Practices. (M36). American Water Works Association: Denver, CO. Notes: [1] Total projected daily demands based on Table No. 1 shown in Section 1 – Introduction. [2] Assumes 10% unaccountable due to leaks, system losses, system flushing, etc., [3] Based on estimated $0.25 / 1000 gallons fee imposed by wholesale water provider, [4] Estimated 50% recoverable leakage due to leak detection system and repairs.

Table No. 3 shows an estimated annual loss of revenue due to water leaks based on total projected water demand for years 2010, 2020 and 2030. Similar assumptions and methodology were used to determine annual revenue losses as those used to create **Table No. 2.**

TABLE NO. 3

PROJECTED AVERAGE ANNUAL WATER LOSSES

Description	2010	2020	2030
Total Yearly Demand (mgd):	28,056.5	31,864.8	36,476.1
Estimated Water Loss (mgd):	2,805.7	3,186.5	3,647.6
Estimated Revenue Loss (dollars):	$701,413	$796,619	$911,902
Total Estimated Annual Revenue Losses After Leak Detection and Repair (dollars):	**$350,706**	**$398,309**	**$455,951**

Source: AWWA Leak Detection Committee.1999, pp. 5-33. *Water Audits and Leak Detection.* Manual of Water Supply Practices. (M36). American Water Works Association: Denver, CO.

The Authority will require each retail supplier who enters into contract for purchasing water to submit a water conservation plan that includes a water audit and leak detection program approved by the Authority. Each retail supplier will provide forms for conducting a comprehensive, system wide audit of its internal distribution system. These forms, sometimes referred to as "water audit worksheets," should consist of the following:

- ✓ Frequency of Audit.
- ✓ Means to measure the required water supply.
- ✓ Means to measure authorized metered use.
- ✓ Means to measure authorized unmetered use.
- ✓ Calculation of water losses.
- ✓ Analysis of water audit results.

The submittal of a leak detection program, or a "leak detection worksheet," by the retail supplier should include the following:

- ✓ Description of the area surveyed for leaks.
- ✓ List of procedures and equipment used during the leak detection process.
- ✓ Leak detection costs, budget and repair schedule.
- ✓ Means to track daily surveys or log books.
- ✓ Means to monitor repair history of service lines.
- ✓ Leak detection summary.

The water audit will quantify the water losses and the leak detection program will determine if the losses are due to leaks or unauthorized uses. Leaks will be located and repaired and unauthorized uses will be located and shut down.

4. Reservoir Systems Operation Plan

The Authority will address the requirements and consider the need for a reservoir systems operation plan, if necessary, once the primary source for water has been determined.

5. Methods to Monitor the Effectiveness and Efficiency of the WCP.

The Authority will develop a plan for monitoring the effectiveness and efficiency of the WCP. This plan will include contractual requirements of the retail supplier to establish a method to monitor their individual conservation plans.

B. Administrative Strategies

The Authority could implement several administrative strategies to encourage water conservation by its customers to lower overall demand for water. These strategies include:

- Water Rate Structure.
- Water Rates and Related Charges.
- Prepare and implement a Drought Contingency Plan.
- Water Conservation Plan.
- Implementation and Enforcement.

1. Water Rate Structure

Wholesale rates will be designed to recover the costs of providing service based on usage, pattern of usage, and level of service to retail suppliers. The wholesale rate structures that are typically used to promote conservation are uniform volume, seasonal, increasing block, and demand rates.

The Authority will evaluate the different types of rate structures and select the one which best suits its need for revenue and the promotion of water conservation. Currently, the four rate structures mentioned above are being considered by the Authority.

For uniform volume rates, the basis for recovering costs is the same for all retail suppliers and is incurred by the wholesale supplier through an average price for water. Uniform rates tend to facilitate the basic principles of water conservation because customer bills vary directly with the level of water usage. The actual efficiency of the uniform rate depends on the circumstances of the wholesale supplier.

Seasonal demand rates allow the Authority the ability to recover costs associated with high demands imposed by the retail customer during a few months of the year. In cases where seasonal increases are weather related, applying seasonal rates to large wholesale customers may affect the Authority's financial stability or require it to establish a rate stabilization fund. Setting seasonal rates is more complex than setting a uniform volume rate for the wholesale customer class.

The increasing block rate structure usually conserves more water than the uniform rate structure because it tends to be conservation-oriented. Increasing block rates would allow the Authority the ability to send consistent price signals to retail suppliers without over earning or under earning revenues. At its optimum, no customer within a given class, using similar amounts of water, should be rewarded more or less than another customer for saving a gallon of water. The increasing block rate structure will provide the Authority the flexibility to deal with difficult situations such as increased growth in water demand, decreased existing water supplies, and regional requirements to improve water efficiency and decrease subsidence due to groundwater withdrawals.

The demand rate structure is less common to the water industry than in the electric industry. This rate structure allocates, or reserves, a portion of water production facilities for a given customer or customer class. The capacity allocated or reserved is the peak-daily or peak-hourly demand allowed for the customer class. For this reserved capacity, the retail customer pays a fixed charge per month to cover demand or extra capacity-related costs. Commodity or base-related charges are then recovered through a uniform charge per unit of volume. While demand rates can effectively reduce the peak usage, they may not be as effective as seasonal rates at reducing total annual usage. The economic impacts should be carefully considered as

well. If peak demand is a major determinant of system capacity and the need for system expansion, a demand charge is appropriate. If system expansion is driven more by the total annual use, a demand charge is less appropriate.

2. Water Rates and Related Charges

Properly designed rates will recover the cost, as nearly as is practicable, of providing service to the retail supplier. Water rates will consider operation and maintenance costs related to only the Authority's wholesale distribution system. The retail suppliers will be required to provide and maintain their own distribution facilities. Depending on specific circumstances, the cost analysis may determine that some of the costs for smaller distribution mains will not be allocated to the retail suppliers.

As with any rate structure, the effect of a change to uniform rates varies depending on the magnitude of the change and the means of implementation. A transition from block rates can be accomplished by gradually reducing the number of rate blocks and the differentials among them. A phased approach can reduce the rate shock, particularly for large-volume customers.

Source: AWWA Leak Detection Committee.1999, pp. 1-6, 43-77. *Water Rate Structures and Pricing.* Manual of Water Supply Practices. (M34). American Water Works Association: Denver, CO.

3. Drought Contingency Plan

A Drought Contingency Plan (DCP) is a strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other supply emergencies. A DCP is useful to sustain water supplies for the highest priority uses during times of shortage and to preserve the water for human sustenance. Drought conditions are usually the result of extended periods of below average rainfall but could result from equipment failure. The Authority will develop a DCP to provide an orderly procedure for the limitation of water to its retail suppliers in accordance with §288.22 at a later date.

4. Water Conservation Plan

The Authority will require its retail suppliers to have approved WCP's prior to connection to the wholesale supply distribution system. Before executing a water supply contract, each retail supplier will be required to develop and implement a WCP or applicable water conservation measures in accordance with §288.2. The retail supplier's WCP will provide a means to control the rate structure and pricing of the retail water supply.

5. Means of Implementation and Enforcement

The Authority will require all retail suppliers to comply with the Authority's WCP by contractual agreement. The means of enforcement will be considered by the Authority when a final WCP is adopted.

C. Educational Strategies

Educational strategies provide an overall savings benefit to the retail supplier and its customers, thereby lowering the overall demand for water. Although consumer education programs exist, the Authority will not require its customers to enforce or maintain a customer education program; however, several strategies are described below.

- Water Conservation Devices.
- Consumer Education Programs.
- Prepare and implement a Drought Contingency Plan.

1. Water Conservation Devices

Retail suppliers could provide information of water conservation strategies, including the adoption of low flow devices in the home. These low flow devices could include showerheads, lavatory faucets, kitchen faucets, toilet dams, outdoor watering timers, etc. Large water users, such as apartments, schools, office buildings, and City facilities could be fitted, or retrofitted, with these devices as well. A reduction could be realized at apartment complexes where most tenants are not aware of water use because they are not directly metered like homeowners. **Table No. 4** lists several types of water conservation devices and estimated unit water savings based on selected water conservation programs or devices.

TABLE NO. 4

ESTIMATED UNIT WATER SAVINGS BASED ON SELECTED WATER CONSERVATION DEVICES

Appliance/Fixture	Typical Flow Rates	Water Savings
Standard toilet	5.5 gal/flush	---
Low-flush toilet	3.5 gal/flush	2 gal/flush
Ultra-low-flush toilet	1.6 gal/flush	3.9 gal/flush
Toilet dam	---	1 gal/flush
Toilet tank bag	---	0.7 gal/flush
Toilet tank replacement bottles (2)	---	0.5 gal/flush
Standard showerhead	3.4 gal/minute	---
Low-flow showerhead	1.9 gal/minute	1.5 gal/minute
Standard washing machine	55 gal/load	---
Water-efficient washing machine	42 gal/load	13 gal/load
Standard dishwasher	14 gal/load	---
Water-efficient dishwasher	8.5 gal/load	5.5 gal/load

Source: Dziegielewski, Benedykt, Eva M. Opitz, Jack C. Keifer, and Duane D. Baumann. 1993, p. 74. *Evaluating Urban Water Conservation Programs: A Procedures Manual.* Planning and Management Consultants, Ltd.: Carbondale, IL.

The retail supplier should educate its customers of the benefits of water conservation practices. More emphasis should be placed on lawn watering schedules that incorporate the effective use of water timers and ideal watering times during the daytime in summer months. Commercial water sprinklers in esplanades are highly visible sources of improper watering techniques that commonly yield complaints from citizens. The use of water-wise, landscaping, effective irrigation systems, proper mowing and proper fertilizer techniques can also lower the water consumption and waste. **Table No. 5** shows potential water savings for selected water conservation practices on an annual basis.

TABLE NO. 5

POTENTIAL WATER SAVINGS FOR SELECTED CONSERVATION PRACTICES

Measure Description	Estimated Water Savings[1]		
	gpcd[2]	gphd[3]	Percent
Single-family retrofit (pre-1980 homes)			
Toilet retrofit	1.3	4	1% of annual use
Low-flow showerhead	7.2	22	4% of annual use
Multi-family retrofit (pre-1980 homes)			
Toilet retrofit	1.3	3	1% of annual use
Low-flow showerhead	7.2	17	6% of annual use
Home water audits (pre-1980 single-family homes)			
Toilet retrofit	1.3	4	1% of annual use
Low-flow showerhead	7.2	22	5% of annual use
Leak repair	0.5	2	< 1% of annual use
Outdoor use	---	---	5-10% of outdoor use
Home water audits (post-1980 single-family homes)			
Low-flow showerhead	2.9	9	2% of annual use
Leak repair	0.5	2	< 1% of annual use
Outdoor use	---	---	5-10% of outdoor use
Large landscape water audits	---	---	10-20% of irrigation use in affected sectors
Landscape requirements for new commercial, industrial, multifamily complexes	---	---	10-20% of irrigation use in affected sectors
Distribution system water audits and leak detection	---	---	< 10% of total production

Source: Dziegielewski, Benedykt, Eva M. Opitz, Jack C. Keifer, and Duane D. Baumann. 1993, p. 77. *Evaluating Urban Water Conservation Programs: A Procedures Manual.* Planning and Management Consultants, Ltd.: Carbondale, IL. Notes: [1] Estimated savings based on practices in California, but not substantiated with empirical data, [2] gpcd = gallons per capita per day, [3] gphd = gallons per household per day.

2. Consumer Education Programs

Programs designed to educate water consumers could include any one or combinations of the following: doorhanger notifications, rebates, subsidies, telephone solicitation, internet sites, direct written contact, mass-media contacts including radio and/or television spots, mailed flyers, water bill inserts, billboards and invitational workshops. Most water conservation programs rely on the customer to install a device or modify a behavior based on education information, products, or assistance provided by the utility. Costs to residential customers must be considered if a water retailer is to make recommendations to its customers. Any customers who feel that the program will cost them too much will not participate. **Table No. 6** shows energy savings associated with residential water conservation.

TABLE NO. 6

POTENTIAL ENERGY SAVINGS ASSOCIATED WITH RESIDENTIAL WATER CONSERVATION PRACTICES

Device	Water saved Gal/day/person	Annual Energy Saved per Person		Value of Energy Saved per Person $/year	
		Gas Water Heaters Therm/year	Electric Water Heaters KWh/year	Gas	Electric
Low-flow shower-heads, 2.75 gpm	7.2	11.6	275	$8.30	$33.0
Water-saving dishwashers	1.0	3.0	71	$2.20	$8.50
Water-saving clothes washer	1.7	5.1	121	$3.70	$14.50
Total	9.9	19.7	467	$14.20	$56.00

Source: Dziegielewski, Benedykt, Eva M. Opitz, Jack C. Keifer, and Duane D. Baumann. 1993, p. 104. *Evaluating Urban Water Conservation Programs: A Procedures Manual.* Planning and Management Consultants, Ltd.: Carbondale, IL.

3. Prepare and Implement a Drought Contingency Plan

The Authority will develop a program to assist customers in the development of drought contingency plans and conservation pollution prevention abatement plans. The extent of this assistance will be determined when the Authority enters a contractual agreement with its customers. These contracts should be in place by 2010.

D. Wastewater Reclamation

Treated wastewater effluent for reuse is an effective means by which conservation can be achieved at a minimum cost to the Authority. An expressed interest from various users of groundwater could justify the cost to supply reclaimed water. A separate water reclamation study identified these various users by conducting a survey of potential reclaimed water users located within the boundaries of the Authority. School grounds and athletic fields were considered as potential reuse candidates, but rejected due to the small amount of irrigation water needed by these facilities. Its was determined that the cost to provide reclaimed water to these facilities greatly outweighed the benefit of groundwater pumpage reduction.

The water reclamation study reported that thirteen potential reuse projects were evaluated as part of this study, including twelve golf courses and one park facility. Evaluations include preliminary distribution system layouts; determination of reclaimed water demand and availability and detailed cost estimates for each project. Several of the projects were evaluated as joint facilities serving two or more users based on the proximity of single reclaimed water production facilities to multiple potential users. In addition, the Reliant Energy power plant on SH 249 is considering operating up to 70 percent of its present demand using reclaimed water as an alternative supply for its industrial use. This is an effective means of substituting recycled water for treated potable water. The Authority is pursuing the use of reclaimed water by the power plant.

A regional reclaimed water plan could provide economic and regulatory benefits to all participants and to the Authority as a whole by reducing the demand for potable water for

irrigation applications. The golf courses and park / recreation facilities considered as potential reclaimed water users represent a potential reduction of groundwater pumpage of 1.13 billion gallons per year, which is 4.5% of the Authority's current groundwater demand of 25 billion gallons per year.

Implementation of a regional reclaimed water system, to be planned, constructed and maintained by the Authority, is a viable solution to providing a low cost, readily available irrigation resource that is beneficial to the environment as well as to the constituents of the Authority by reducing overall groundwater pumpage requirements.

PROJECTED POPULATION

Census Tract	Population Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0244.01:1	2,754	2,754	3,051	3,051	3,300	3,300	3,574	3,574
0244.01:2	1,516	1,516	1,753	1,753	1,952	1,952	2,171	2,171
0244.01:3	1,397	1,397	1,444	1,444	1,482	1,482	1,525	1,525
0244.01:4	1,969	1,969	3,111	3,111	4,068	4,068	5,123	5,123
0244.12:1	681	681	789	789	880	880	976	976
0244.12:2	80	80	131	131	174	174	220	220
0244.22:1	1,643	1,643	1,919	1,919	2,149	2,149	2,393	2,393
0244.22:2	1,785	1,785	2,217	2,217	2,578	2,578	2,962	2,962
0244.22:3	2,917	2,917	2,979	2,979	3,030	3,030	3,084	3,084
0244.22:4	3,980	1,274	5,384	1,723	6,555	2,098	7,802	2,497
0248.00:1	1,324	583	2,101	924	2,765	1,216	3,538	1,557
0248.00:2	1,514	560	3,039	1,124	4,344	1,607	5,863	2,169
0248.00:3	2,926	2,926	3,034	3,034	3,126	3,126	3,234	3,234
0248.00:4	3,800	3,420	4,313	3,882	4,752	4,277	5,263	4,737
0248.00:5	2,673	1,363	3,357	1,712	3,942	2,011	4,624	2,358
0248.00:6	1,968	1,968	2,010	2,010	2,046	2,046	2,088	2,088
0530.01:1	2,467	2,467	2,935	2,935	3,459	3,459	5,992	5,992
0530.03:3	3,079	800	3,406	886	3,620	941	3,745	974
0530.03:4	2,453	883	3,635	1,309	4,405	1,586	4,857	1,748
0530.03:5	4,979	3,187	5,936	3,799	6,560	4,198	6,926	4,433
0530.03:6	2,313	1,735	2,596	1,947	2,781	2,085	2,889	2,167
0536.11:1	1,561	1,561	1,676	1,676	1,790	1,790	1,905	1,905
0536.11:2	1,493	1,493	1,494	1,494	1,496	1,496	1,497	1,497
0536.11:3	1,305	1,305	1,314	1,314	1,324	1,324	1,333	1,333
0536.11:4	1,596	1,596	1,644	1,644	1,692	1,692	1,740	1,740
0536.11:5	1,128	1,128	1,128	1,128	1,128	1,128	1,128	1,128
0536.21:1	2,988	2,988	3,113	3,113	3,139	3,139	3,164	3,164
0536.21:2	1,286	746	1,685	977	1,765	1,024	1,845	1,070
0536.21:3	2,398	1,631	2,440	1,659	2,448	1,665	2,456	1,670
0536.21:4	3,025	3,025	3,744	3,744	3,889	3,889	4,034	4,034
0536.21:5	2,341	2,341	2,672	2,672	2,739	2,739	2,806	2,806
0537.01:1	1,467	1,467	1,839	1,839	2,157	2,157	2,569	2,569
0537.01:2	1,857	1,857	2,166	2,166	2,429	2,429	2,771	2,771
0537.01:3	2,166	2,166	2,319	2,319	2,449	2,449	2,619	2,619
0537.01:4	3,915	3,915	5,360	5,360	6,589	6,589	8,186	8,186
0537.12:1	492	462	721	678	916	861	1,145	1,076

PROJECTED POPULATION (cont.)

Census Tract	Population Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0537.12:2	1,901	1,969	1,521	2,040	2,099	1,632	2,159	2,221
0537.12:3	1,312	1,377	1,312	1,446	1,503	1,446	1,560	1,621
0538.11:1	2,086	2,227	2,086	2,383	2,508	2,383	2,640	2,790
0538.11:2	2,582	3,006	1,730	3,475	3,851	2,328	4,249	4,700
0538.12:1	2,125	2,125	1,849	2,125	2,125	1,849	2,125	2,125
0538.12:2	1,338	1,367	1,338	1,398	1,423	1,398	1,448	1,474
0538.12:3	1,458	1,458	1,458	1,458	1,458	1,458	1,458	1,458
0538.12:4	1,368	1,368	1,368	1,368	1,368	1,368	1,368	1,368
0538.12:5	1,757	1,757	1,757	1,757	1,758	1,757	1,758	1,758
0538.12:6	2,968	4,196	2,434	5,480	6,527	4,494	7,580	8,653
0538.12:7	2,366	2,521	2,366	2,683	2,815	2,683	2,948	3,083
0538.21:1	954	1,045	954	1,142	1,220	1,142	1,299	1,385
0538.21:2	1,303	1,381	1,303	1,466	1,533	1,466	1,602	1,676
0538.21:3	1,846	2,116	1,846	2,406	2,637	2,406	2,874	3,127
0538.21:4	2,096	2,346	2,096	2,613	2,826	2,613	3,045	3,279
0538.31:1	1,434	1,435	1,434	1,437	1,438	1,437	1,438	1,438
0538.31:2	2,265	2,748	2,265	3,249	3,638	3,249	3,889	3,960
0538.31:3	1,425	1,425	1,425	1,425	1,425	1,425	1,425	1,425
0538.31:4	1,441	1,441	1,441	1,441	1,441	1,441	1,441	1,441
0538.31:5	1,442	1,817	1,442	2,206	2,507	2,206	2,701	2,757
0539.00:4	2,316	2,790	2,153	3,284	3,691	3,054	4,174	5,130
0540.01:3	6,016	6,885	6,016	7,786	8,530	7,786	9,306	10,146
0540.12:2	2,436	2,442	682	2,448	2,452	685	2,457	2,465
0540.12:3	1,213	1,399	1,213	1,591	1,738	1,591	1,903	2,174
0540.12:4	5,391	6,039	5,121	6,707	7,220	6,372	7,793	8,739
0540.12:5	1,895	2,101	891	2,314	2,477	1,088	2,660	2,961
0540.22:3	2,625	2,920	2,337	3,221	3,429	2,866	3,673	4,168
0540.22:5	1,716	1,814	429	1,915	1,984	479	2,066	2,231
0541.10:1	1,101	1,167	507	1,253	1,331	576	1,424	1,560
0541.10:2	1,697	1,911	1,069	2,186	2,440	1,377	2,738	3,176
0541.10:3	1,050	1,418	1,050	1,892	2,329	1,892	2,842	3,596
0541.20:1	3,204	3,391	2,564	3,593	3,763	2,874	3,939	4,133
0541.20:3	1,505	1,746	1,505	2,007	2,227	2,007	2,454	2,705
0541.20:4	3,501	3,763	3,501	4,046	4,284	4,046	4,530	4,802
0541.20:5	2,763	2,875	2,763	2,995	3,097	2,995	3,202	3,318
0541.20:6	5,124	5,608	5,124	6,131	6,571	6,131	7,027	7,530

PROJECTED POPULATION (cont.)

Census Tract	Population Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0541.20:7	5,154	5,254	5,154	5,362	5,452	5,362	5,546	5,650
0541.20:8	7,439	9,031	7,439	10,749	12,196	10,749	13,695	15,349
0541.30:1	1,022	1,037	1,022	1,052	1,068	1,052	1,083	1,098
0541.30:2	2,019	2,035	1,878	2,052	2,068	1,908	2,085	2,101
0541.30:3	1,977	2,007	1,839	2,037	2,066	1,894	2,096	2,126
0545.01:1	1,614	1,645	1,614	1,683	1,719	1,683	1,759	1,810
0545.01:2	634	829	634	1,072	1,299	1,072	1,552	1,874
0545.01:3	3,370	4,102	3,370	5,013	5,863	5,013	6,811	8,015
0545.12:1	1,999	2,020	1,999	2,044	2,064	2,044	2,085	2,108
0545.12:2	1,683	1,935	1,683	2,222	2,453	2,222	2,706	2,986
0545.12:3	1,656	2,143	1,656	2,696	3,141	2,696	3,630	4,170
0545.22:1	1,713	2,038	1,713	2,393	2,666	2,393	2,952	3,147
0545.22:2	3,178	3,560	3,178	3,978	4,299	3,978	4,634	4,864
0545.22:3	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
0545.22:4	3,109	3,575	3,109	4,084	4,476	4,084	4,884	5,165
0545.32:1	2,528	3,105	1,997	3,716	4,187	2,936	4,665	4,838
0545.32:2	3,555	4,447	3,555	5,394	6,122	5,394	6,863	7,131
0545.32:3	2,599	2,629	2,599	2,660	2,684	2,660	2,708	2,717
0545.32:4	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737
0545.32:5	1,696	1,696	1,696	1,696	1,696	1,696	1,696	1,696
0545.32:6	1,331	1,374	1,331	1,419	1,454	1,419	1,489	1,502
0548.98:9	582	587	518	589	567	524	545	525
0549.00:1	1,878	1,891	1,878	1,904	1,903	1,904	1,902	1,901
0549.00:2	708	817	680	927	912	890	904	902
0550.00:9	2,417	2,565	2,417	2,715	2,749	2,715	2,788	2,832
0551.01:1	2,104	2,296	2,104	2,520	2,707	2,520	2,915	3,150
0551.01:2	2,558	2,636	2,558	2,727	2,802	2,727	2,887	2,982
0551.01:3	892	1,002	892	1,130	1,237	1,130	1,356	1,490
0551.01:4	3,534	4,582	3,534	5,797	6,813	5,797	7,944	9,222
0551.12:1	1,864	1,889	1,864	1,915	1,941	1,915	1,966	1,992
0551.12:2	2,379	2,380	2,379	2,380	2,381	2,380	2,381	2,382
0551.12:3	1,582	1,605	1,582	1,628	1,652	1,628	1,675	1,698
0551.12:4	2,232	2,232	2,232	2,232	2,232	2,232	2,233	2,233
0551.12:5	2,087	2,087	2,087	2,087	2,087	2,087	2,087	2,087
0551.12:6	1,600	1,694	1,600	1,788	1,881	1,788	1,975	2,069
0551.22:1	3,133	3,646	3,133	4,195	4,622	4,195	5,059	5,506

PROJECTED POPULATION (cont.)

Census Tract	Population Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0551.22:2	761	887	761	1,022	1,127	1,022	1,234	1,344
0551.22:3	2,955	3,098	2,955	3,251	3,371	3,251	3,493	3,618
0551.22:4	2,765	2,895	2,765	3,035	3,143	3,035	3,254	3,368
0551.22:5	1,025	1,324	451	1,642	1,890	723	2,144	2,404
0552.00:1	2,350	2,712	2,350	3,156	3,556	3,156	3,999	4,562
0552.00:2	1,916	2,257	1,916	2,677	3,054	2,677	3,473	4,005
0552.00:3	1,604	1,784	1,604	2,006	2,205	2,006	2,425	2,706
0553.00:1	1,291	1,299	1,291	1,308	1,313	1,308	1,319	1,325
0553.00:2	2,118	2,244	2,118	2,379	2,465	2,379	2,557	2,655
0553.00:3	937	1,152	937	1,382	1,529	1,382	1,685	1,852
0553.00:4	1,911	2,194	1,911	2,496	2,689	2,496	2,895	3,114
0553.00:5	1,368	1,492	1,368	1,625	1,710	1,625	1,800	1,897
0554.00:1	1,276	1,512	1,276	1,814	2,109	1,814	2,439	2,872
0555.01:1	1,426	1,580	1,426	1,768	1,937	1,768	2,128	2,358
0555.01:2	815	1,054	815	1,345	1,608	1,345	1,902	2,260
0555.12:1	1,564	1,861	1,564	2,200	2,475	2,200	2,777	3,116
0555.12:2	2,411	2,672	2,411	2,970	3,213	2,970	3,478	3,776
0555.22:1	1,557	1,805	1,557	2,003	2,029	2,003	2,055	2,082
0555.22:2	2,244	2,653	2,244	2,980	3,024	2,980	3,068	3,111
0555.22:3	2,388	2,468	2,388	2,531	2,540	2,531	2,548	2,557
0555.22:4	3,423	3,987	3,423	4,438	4,498	4,438	4,559	4,619
0555.22:5	3,383	3,974	3,383	4,446	4,509	4,446	4,572	4,635
0555.22:6	3,071	3,430	3,071	3,717	3,755	3,717	3,793	3,831
0555.32:1	1,450	1,572	1,450	1,710	1,819	1,710	1,936	2,067
0555.32:2	1,159	1,487	1,159	1,856	2,148	1,856	2,461	2,811
0555.32:3	2,188	2,348	2,188	2,527	2,669	2,527	2,820	2,991
0555.32:4	1,880	2,160	1,880	2,474	2,722	2,474	2,988	3,287
0556.01:1	2,002	2,060	2,002	2,128	2,188	2,128	2,255	2,335
0556.01:2	1,793	1,978	1,793	2,199	2,393	2,199	2,609	2,864
0556.01:3	2,021	2,338	2,021	2,716	3,047	2,716	3,417	3,854
0556.01:4	1,675	2,357	1,675	3,170	3,882	3,170	4,677	5,616
0556.12:1	1,684	1,696	1,684	1,710	1,720	1,710	1,732	1,734
0556.12:2	1,237	1,242	1,237	1,246	1,250	1,246	1,255	1,255
0556.12:3	2,233	2,233	2,233	2,233	2,233	2,233	2,233	2,233
0556.12:4	2,710	3,570	2,710	4,543	5,319	4,543	6,171	6,330
0556.12:5	1,995	2,511	1,995	3,095	3,561	3,095	4,072	4,167

PROJECTED POPULATION (cont.)

Census Tract	Population Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0556.22:1	2,504	2,773	2,504	3,066	3,291	3,066	3,526	3,689
0556.22:2	3,227	3,481	3,227	3,758	3,971	3,758	4,193	4,347
0556.22:3	1,261	1,550	1,261	1,866	2,108	1,866	2,360	2,536
0556.22:4	2,923	3,380	2,923	3,878	4,260	3,878	4,658	4,936
0557.00:1	896	939	896	986	1,014	986	1,044	1,076
0557.00:2	1,777	1,987	1,777	2,210	2,347	2,210	2,491	2,646
0558.01:1	2,431	2,953	2,431	3,565	4,082	3,565	4,660	5,322
0558.01:2	5,622	6,036	5,622	6,521	6,931	6,521	7,390	7,915
0558.01:3	2,787	3,224	2,787	3,736	4,170	3,736	4,654	5,209
0558.01:4	3,118	3,981	3,118	4,991	5,847	4,991	6,802	7,896
0558.12:1	1,325	1,938	1,325	2,632	3,189	2,632	3,799	4,473
0558.12:2	2,188	2,403	2,188	2,647	2,843	2,647	3,057	3,293
0558.12:3	1,995	2,102	1,995	2,223	2,320	2,223	2,427	2,544
0558.12:4	2,203	2,353	2,203	2,523	2,659	2,523	2,808	2,974
0558.12:5	1,590	1,793	1,590	2,024	2,209	2,024	2,411	2,635
0558.22:1	2,713	2,751	2,713	2,766	2,780	2,766	2,794	2,809
0558.22:2	3,350	3,433	3,350	3,464	3,495	3,464	3,526	3,557
0558.22:3	2,678	2,847	2,678	2,911	2,975	2,911	3,038	3,102
0559.01:1	1,223	1,763	1,223	2,377	2,871	2,377	3,415	4,015
0559.01:2	523	700	523	900	1,062	900	1,239	1,436
0559.01:3	1,021	1,294	1,021	1,604	1,853	1,604	2,127	2,430
0559.01:4	1,154	1,329	1,154	1,528	1,688	1,528	1,864	2,058
0559.01:5	2,940	3,177	2,940	3,446	3,663	3,446	3,901	4,164
0559.01:6	3,177	3,221	3,177	3,271	3,311	3,271	3,355	3,403
0559.02:1	4,967	5,417	4,967	5,935	6,349	5,935	6,800	7,321
0559.02:2	5,375	6,055	5,375	6,837	7,463	6,837	8,145	8,933
0559.02:3	2,714	3,063	2,714	3,465	3,786	3,465	4,136	4,540
0559.02:4	3,225	3,230	3,225	3,236	3,240	3,236	3,245	3,250
0559.02:5	3,877	4,454	3,877	5,119	5,650	5,119	6,229	6,897
0559.02:6	6,356	8,614	6,356	11,212	13,289	11,212	15,555	18,171
0559.02:7	3,732	3,942	3,732	4,185	4,379	4,185	4,591	4,835
0559.02:8	1,177	1,269	1,177	1,374	1,458	1,374	1,549	1,655
Totals	**391,519**	**367,722**	**485,532**	**455,085**	**563,479**	**527,769**	**657,03**	**615,197**

Source: *Update of Population and Water Demand Forecasts for the Harris-Galveston Coastal Subsidence District (Update Report),* Turner Collie & Braden, Inc., March 1996.

PROJECTED WATER DEMAND

Census Tract	Water Demand Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0244.01:1	0.47	0.48	0.47	0.50	0.51	0.50	0.53	0.54
0244.01:2	0.25	0.26	0.25	0.28	0.29	0.28	0.30	0.32
0244.01:3	0.24	0.25	0.24	0.25	0.25	0.25	0.25	0.26
0244.01:4	0.27	0.35	0.27	0.43	0.49	0.43	0.56	0.63
0244.12:1	0.14	0.15	0.14	0.17	0.17	0.17	0.18	0.19
0244.12:2	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05
0244.22:1	0.28	0.29	0.28	0.31	0.33	0.31	0.35	0.36
0244.22:2	0.29	0.31	0.29	0.35	0.37	0.35	0.40	0.42
0244.22:3	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.53
0244.22:4	0.76	0.97	0.24	1.10	1.22	0.35	1.34	1.46
0248.00:1	0.23	0.28	0.10	0.34	0.39	0.15	0.44	0.49
0248.00:2	0.16	0.25	0.06	0.35	0.43	0.13	0.51	0.60
0248.00:3	0.52	0.53	0.52	0.54	0.54	0.54	0.55	0.56
0248.00:4	0.67	0.70	0.60	0.74	0.77	0.67	0.80	0.84
0248.00:5	0.48	0.53	0.24	0.58	0.62	0.29	0.66	0.71
0248.00:6	0.35	0.35	0.35	0.36	0.36	0.36	0.36	0.36
0530.01:1	0.43	0.47	0.43	0.50	0.52	0.50	0.57	0.72
0530.03:3	0.20	0.22	0.05	0.24	0.25	0.06	0.26	0.27
0530.03:4	0.25	0.32	0.09	0.38	0.43	0.14	0.47	0.51
0530.03:5	0.82	0.89	0.53	0.96	1.00	0.61	1.04	1.08
0530.03:6	0.41	0.43	0.31	0.44	0.46	0.33	0.47	0.48
0536.11:1	0.23	0.24	0.23	0.24	0.25	0.24	0.26	0.27
0536.11:2	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
0536.11:3	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
0536.11:4	0.26	0.27	0.26	0.27	0.27	0.27	0.27	0.28
0536.11:5	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
0536.21:1	0.53	0.55	0.53	0.55	0.55	0.55	0.55	0.55
0536.21:2	0.24	0.28	0.14	0.29	0.30	0.17	0.31	0.31
0536.21:3	0.44	0.45	0.30	0.45	0.45	0.30	0.45	0.45
0536.21:4	0.56	0.65	0.56	0.67	0.69	0.67	0.70	0.71
0536.21:5	0.43	0.47	0.43	0.48	0.49	0.48	0.49	0.50
0537.01:1	0.27	0.30	0.27	0.33	0.35	0.33	0.37	0.40
0537.01:2	0.34	0.36	0.34	0.39	0.41	0.39	0.43	0.45
0537.01:3	0.39	0.41	0.39	0.42	0.43	0.42	0.44	0.45
0537.01:4	0.65	0.75	0.65	0.86	0.94	0.86	1.03	1.13
0537.12:1	0.10	0.11	0.09	0.12	0.14	0.12	0.15	0.16

PROJECTED WATER DEMAND (cont.)

Census Tract	Water Demand Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0537.12:2	0.35	0.36	0.28	0.37	0.38	0.30	0.39	0.40
0537.12:3	0.29	0.30	0.29	0.31	0.32	0.31	0.32	0.33
0538.11:1	0.36	0.38	0.36	0.40	0.42	0.40	0.44	0.46
0538.11:2	0.41	0.46	0.27	0.53	0.57	0.35	0.63	0.69
0538.12:1	0.40	0.40	0.35	0.40	0.40	0.35	0.40	0.40
0538.12:2	0.26	0.27	0.26	0.27	0.27	0.27	0.28	0.28
0538.12:3	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0538.12:4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
0538.12:5	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
0538.12:6	0.44	0.61	0.36	0.78	0.92	0.64	1.07	1.21
0538.12:7	0.44	0.46	0.44	0.49	0.51	0.49	0.53	0.55
0538.21:1	0.20	0.21	0.20	0.22	0.23	0.22	0.24	0.26
0538.21:2	0.26	0.27	0.26	0.28	0.29	0.28	0.30	0.31
0538.21:3	0.34	0.38	0.34	0.42	0.45	0.42	0.49	0.52
0538.21:4	0.39	0.42	0.39	0.46	0.49	0.46	0.52	0.55
0538.31:1	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0538.31:2	0.36	0.43	0.36	0.49	0.55	0.49	0.58	0.59
0538.31:3	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0538.31:4	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0538.31:5	0.24	0.30	0.24	0.36	0.41	0.36	0.43	0.44
0539.00:4	0.34	0.41	0.32	0.47	0.53	0.44	0.59	0.72
0540.01:3	0.97	1.10	0.97	1.23	1.34	1.23	1.46	1.63
0540.12:2	0.11	0.11	0.03	0.11	0.11	0.03	0.11	0.11
0540.12:3	0.20	0.22	0.20	0.25	0.27	0.25	0.30	0.34
0540.12:4	0.89	0.98	0.84	1.07	1.15	1.02	1.23	1.37
0540.12:5	0.32	0.35	0.15	0.38	0.41	0.18	0.43	0.48
0540.22:3	0.44	0.49	0.39	0.53	0.58	0.47	0.63	0.69
0540.22:5	0.18	0.19	0.05	0.20	0.22	0.05	0.23	0.25
0541.10:1	0.20	0.21	0.09	0.22	0.24	0.10	0.25	0.27
0541.10:2	0.31	0.34	0.19	0.38	0.42	0.24	0.47	0.53
0541.10:3	0.17	0.22	0.17	0.29	0.35	0.29	0.43	0.54
0541.20:1	0.57	0.60	0.45	0.63	0.65	0.50	0.68	0.71
0541.20:3	0.33	0.36	0.33	0.40	0.43	0.40	0.47	0.51
0541.20:4	0.64	0.68	0.64	0.72	0.75	0.72	0.79	0.83
0541.20:5	0.61	0.65	0.61	0.57	0.59	0.57	0.61	0.63
0541.20:6	0.87	0.94	0.87	1.02	1.08	1.02	1.15	1.23

PROJECTED WATER DEMAND (cont.)

Census Tract	Water Demand Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0541.20:7	0.92	0.93	0.92	0.95	0.96	0.95	0.98	0.99
0541.20:8	1.19	1.43	1.19	1.67	1.89	1.67	2.11	2.36
0541.30:1	0.23	0.23	0.23	0.24	0.24	0.24	0.24	0.24
0541.30:2	0.46	0.46	0.43	0.47	0.47	0.43	0.47	0.47
0541.30:3	0.59	0.59	0.55	0.60	0.60	0.56	0.61	0.61
0545.01:1	0.29	0.29	0.29	0.30	0.31	0.30	0.31	0.32
0545.01:2	0.15	0.18	0.15	0.22	0.25	0.22	0.29	0.33
0545.01:3	0.62	0.73	0.62	0.87	1.00	0.87	1.13	1.31
0545.12:1	0.36	0.36	0.36	0.36	0.37	0.36	0.37	0.37
0545.12:2	0.28	0.32	0.28	0.36	0.40	0.36	0.43	0.47
0545.12:3	0.26	0.33	0.26	0.41	0.47	0.41	0.54	0.62
0545.22:1	0.27	0.31	0.27	0.35	0.38	0.35	0.42	0.44
0545.22:2	0.53	0.59	0.53	0.64	0.69	0.64	0.73	0.76
0545.22:3	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
0545.22:4	0.50	0.57	0.50	0.64	0.70	0.64	0.75	0.79
0545.32:1	0.46	0.54	0.36	0.62	0.69	0.49	0.76	0.78
0545.32:2	0.61	0.73	0.61	0.85	0.95	0.85	1.05	1.08
0545.32:3	0.49	0.50	0.49	0.50	0.51	0.50	0.51	0.51
0545.32:4	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
0545.32:5	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
0545.32:6	0.30	0.30	0.30	0.31	0.31	0.31	0.32	0.32
0548.98:9	0.11	0.11	0.10	0.11	0.11	0.10	0.11	0.11
0549.00:1	0.37	0.38	0.37	0.38	0.38	0.38	0.38	0.38
0549.00:2	0.13	0.15	0.13	0.16	0.16	0.16	0.16	0.16
0550.00:9	0.42	0.45	0.42	0.47	0.47	0.47	0.48	0.48
0551.01:1	0.39	0.41	0.39	0.44	0.47	0.44	0.50	0.53
0551.01:2	0.49	0.50	0.49	0.51	0.52	0.51	0.53	0.55
0551.01:3	0.17	0.19	0.17	0.21	0.22	0.21	0.24	0.26
0551.01:4	0.70	0.85	0.70	1.02	1.17	1.02	1.33	1.51
0551.12:1	0.43	0.43	0.43	0.44	0.44	0.44	0.45	0.45
0551.12:2	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
0551.12:3	0.34	0.34	0.34	0.34	0.35	0.34	0.35	0.36
0551.12:4	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0551.12:5	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0551.12:6	0.25	0.27	0.25	0.28	0.30	0.28	0.31	0.33
0551.22:1	0.51	0.58	0.51	0.66	0.72	0.66	0.78	0.85

PROJECTED WATER DEMAND (cont.)

Census Tract	Water Demand Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0551.22:2	0.13	0.15	0.13	0.17	0.18	0.17	0.20	0.21
0551.22:3	0.51	0.53	0.51	0.55	0.57	0.55	0.58	0.60
0551.22:4	0.48	0.49	0.48	0.51	0.53	0.51	0.54	0.56
0551.22:5	0.14	0.18	0.06	0.21	0.24	0.09	0.27	0.30
0552.00:1	0.39	0.44	0.39	0.50	0.55	0.50	0.61	0.69
0552.00:2	0.31	0.35	0.31	0.41	0.46	0.41	0.51	0.58
0552.00:3	0.27	0.29	0.27	0.32	0.35	0.32	0.38	0.42
0553.00:1	0.18	0.18	0.18	0.19	0.19	0.19	0.19	0.19
0553.00:2	0.25	0.26	0.25	0.35	0.36	0.35	0.37	0.39
0553.00:3	0.10	0.11	0.10	0.20	0.22	0.20	0.25	0.27
0553.00:4	0.22	0.23	0.22	0.36	0.39	0.36	0.42	0.45
0553.00:5	0.17	0.18	0.17	0.24	0.25	0.24	0.26	0.28
0554.00:1	0.21	0.25	0.21	0.29	0.33	0.29	0.38	0.44
0555.01:1	0.25	0.28	0.25	0.31	0.35	0.31	0.39	0.44
0555.01:2	0.13	0.17	0.13	0.22	0.27	0.22	0.33	0.40
0555.12:1	0.26	0.30	0.26	0.35	0.38	0.35	0.43	0.47
0555.12:2	0.42	0.45	0.42	0.50	0.53	0.50	0.57	0.61
0555.22:1	0.27	0.31	0.27	0.34	0.34	0.34	0.34	0.35
0555.22:2	0.38	0.44	0.38	0.49	0.49	0.49	0.50	0.51
0555.22:3	0.44	0.46	0.44	0.46	0.47	0.46	0.47	0.47
0555.22:4	0.58	0.66	0.58	0.72	0.73	0.72	0.74	0.75
0555.22:5	0.56	0.65	0.56	0.72	0.72	0.72	0.73	0.74
0555.22:6	0.54	0.59	0.54	0.63	0.64	0.63	0.65	0.65
0555.32:1	0.28	0.30	0.28	0.32	0.33	0.32	0.35	0.37
0555.32:2	0.23	0.28	0.23	0.34	0.38	0.34	0.43	0.48
0555.32:3	0.42	0.44	0.42	0.47	0.49	0.47	0.52	0.54
0555.32:4	0.36	0.40	0.36	0.45	0.49	0.45	0.53	0.57
0556.01:1	0.38	0.39	0.38	0.40	0.41	0.40	0.42	0.43
0556.01:2	0.36	0.38	0.36	0.42	0.45	0.42	0.48	0.52
0556.01:3	0.40	0.45	0.40	0.50	0.55	0.50	0.60	0.67
0556.01:4	0.36	0.46	0.36	0.58	0.68	0.58	0.80	0.94
0556.12:1	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
0556.12:2	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23
0556.12:3	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
0556.12:4	0.41	0.54	0.41	0.67	0.78	0.67	0.90	0.93
0556.12:5	0.32	0.40	0.32	0.48	0.55	0.48	0.62	0.63

PROJECTED WATER DEMAND (cont.)

Census Tract	Water Demand Projections							
	2000	2000 Adjusted	2010	2010 Adjusted	2020	2020 Adjusted	2030	2030 Adjusted
0556.22:1	0.42	0.46	0.42	0.49	0.52	0.49	0.56	0.58
0556.22:2	0.57	0.61	0.57	0.65	0.68	0.65	0.71	0.74
0556.22:3	0.20	0.25	0.20	0.29	0.33	0.29	0.36	0.39
0556.22:4	0.48	0.54	0.48	0.61	0.66	0.61	0.72	0.75
0557.00:1	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19
0557.00:2	0.33	0.36	0.33	0.39	0.41	0.39	0.43	0.45
0558.01:1	0.39	0.46	0.39	0.54	0.61	0.54	0.69	0.78
0558.01:2	0.98	1.04	0.98	1.11	1.16	1.11	1.23	1.30
0558.01:3	0.48	0.54	0.48	0.61	0.67	0.61	0.74	0.82
0558.01:4	0.50	0.63	0.50	0.77	0.89	0.77	1.02	1.18
0558.12:1	0.19	0.27	0.19	0.36	0.44	0.36	0.52	0.61
0558.12:2	0.39	0.42	0.39	0.46	0.48	0.46	0.51	0.55
0558.12:3	0.36	0.38	0.36	0.40	0.41	0.40	0.43	0.44
0558.12:4	0.39	0.41	0.39	0.44	0.46	0.44	0.48	0.50
0558.12:5	0.28	0.31	0.28	0.34	0.37	0.34	0.40	0.43
0558.22:1	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.49
0558.22:2	0.57	0.59	0.57	0.59	0.60	0.59	0.60	0.60
0558.22:3	0.42	0.44	0.42	0.45	0.46	0.45	0.47	0.48
0559.01:1	0.23	0.32	0.23	0.41	0.49	0.41	0.57	0.66
0559.01:2	0.09	0.11	0.09	0.14	0.17	0.14	0.20	0.23
0559.01:3	0.16	0.20	0.16	0.25	0.29	0.25	0.33	0.38
0559.01:4	0.19	0.22	0.19	0.25	0.27	0.25	0.30	0.33
0559.01:5	0.54	0.57	0.54	0.61	0.65	0.61	0.69	0.73
0559.01:6	0.58	0.59	0.58	0.60	0.60	0.60	0.61	0.62
0559.02:1	0.84	0.90	0.84	0.98	1.04	0.98	1.10	1.18
0559.02:2	0.88	0.98	0.88	1.09	1.18	1.09	1.28	1.39
0559.02:3	0.44	0.49	0.44	0.55	0.59	0.55	0.64	0.70
0559.02:4	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0559.02:5	0.64	0.73	0.64	0.82	0.90	0.82	0.98	1.08
0559.02:6	0.94	1.26	0.94	1.63	1.93	1.63	2.25	2.62
0559.02:7	0.65	0.68	0.65	0.72	0.75	0.72	0.78	0.81
0559.02:8	0.21	0.22	0.21	0.23	0.25	0.23	0.26	0.27
Totals	**67.74**	**64.29**	**81.29**	**76.87**	**92.48**	**87.30**	**105.99**	**99.93**

Source: *Update of Population and Water Demand Forecasts for the Harris-Galveston Coastal Subsidence District (Update Report),* Turner Collie & Braden, Inc., March 1996.

2001-483-366
FINAL REPORT
3 of 3

MUD INTERCONNECTION REPORT

Task C. Evaluate MUD Interconnections to Provide Short Term Demand (District 3)

PREPARED FOR

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY

ARCADIS WSBC

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MUD INTERCONNECTION REPORT

Task C. Evaluate MUD Interconnections to Provide Short Term Demand (District 3)

Engineer: Dennis Seeman, P.E. #41932
Date: August 29, 2001

Dennis W. Seeman, P.E.
Project Director

Prepared for:
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Date:
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1. Purpose

The purpose of this study was to assess the existing well capacity, quality, and short-term anticipated needs of the water supply entities in the North Harris County Regional Water Authority (NHCRWA) – District 3. There are a total of five voting districts in the NHCRWA and the study was expanded to cover all five voting districts. District 3 includes the City of Jersey Village and approximately 34 Municipal Utility Districts (MUD's). Area representatives (primarily from District 3) reported potential capacity needs and/or quality degradation that may require action prior to the first Harris Galveston Coastal Subsidence District (HGCSD) milestone in year 2010. The first milestone requires 30% conversion to alternative water sources. This report evaluates the need and feasibility of providing interconnections between existing MUD's to satisfy short-term water demands.

2. Well Pumpage Data

The population data is based on the "Application for Regional Facility Planning Grant" report. Part II Planning Information, Item 26. and 29. of the report shows that the population for the area was estimated to be 392,000 in the year 2000. The growth factor from 1990 to 2000, based on information obtained from the HGCSD March 1996 Update of Population and Water Demand Forecasts, is 1.022. Using this growth factor and the 1990 Census TIGER files from HGCSD, the population of the area increased from 367,220 in 1997 to 375,300 in 1998 and 383,560 in 1999.

Well pumpage data were developed based on HGCSD well data for 1997, 1998, and 1999. Well pumpage for 1997 was 16.62 billion gallons (bg). It was 20.31 bg for 1998 and 21.50 bg for 1999. Reference Table 1 "Well Pumpage Data" for tables of water pumpage by voting district and MUD.

Dividing the quantity of water pumped by the population and 365 days per year yields the estimated per capita usage of 124 gallons/capita/day (g/c/d) in 1997, 148 g/c/d in 1998, and 154 g/c/d in 1999. Since 1998 and 1999 were considered drought years, it can be seen that water usage increased approximately 20% and 24% during 1998 and 1999 respectively. The pumpage data collected prior to the year 2000 was collected by a different source (HGCSD) and used for a different purpose when compared to the data collected in the year 2000. Data collected in the year 2000 was used to generate pumping fees for NHCRWA and was more comprehensive and therefore is not statistically accurate when compared to the less detailed previous years. Year 2000 estimated population of 392,000 and a pumpage figure of 24.84 bg provides a per

capita usage of 184 g/c/d which represents a 48% increase over the base year of 1997. Since a relatively normal amount of rainfall occurred in 2000, the large increase in per capita usage is attributed to the different methods of data collection prior to 2000.

Table 2 "Well Summary Sheet", prepared from NHCRWA pumpage fee data, shows the estimated population and pumpage per voting district. This summary sheet shows a total of 1,570 wells located within the NHCRWA boundaries. Of this total, approximately 1/3 of the wells were not pumped. Over 84% of the wells (1,320) pumped less than 10 million gallons per year each for a total of just 3.86% of the water pumped authority-wide. Data for the year 1999 was used to calculate per capita usage by individual voting district. These data indicate that the amount pumped in 1999 was 23.26 bg with a population of 345,585. Data for the year 1999 was used to compare water usage by NHCRWA voting district. Based on the voting district population shown in the census tracts, and the year 1999 well pumpage data collected by NHCRWA; District 1 used an average of 220 g/c/d, District 2 used an average of 260 g/c/d, District 3 used an average of 176 g/c/d, District 4 used an average of 144 g/c/d, and District 5 used an average of 126 g/c/d. In the year 2000, 12 MUD's elected to leave the NHCRWA. These 12 MUD's were located in Voting Districts 3 and 5. Population estimates for 1999 were reduced to reflect these excluded MUD's and therefore the actual numbers vary slightly from those in previous years. This last set of data would tend to reflect the lower population and the more agrarian nature of Voting Districts 1 and 2. Irrigation use and a lower population would tend to increase the total amount of water used per capita. The population is denser in Voting District 3 and would seem to better represent average water usage per capita. Voting Districts 4 and 5 have the lowest per capita water use and contain some of the older MUD's. It is possible that these districts contain a greater number of small wells that were not tracked in this study (less than 5 million gallons per year). These wells consist of some single family residential wells, some small industrial private wells, and all agricultural wells.

3. Telephone Survey

A preliminary telephone survey was performed in Voting District 3 to identify well owners and as a means to develop a mailing database for a NHCRWA area wide questionnaire designed to determine interest/needs by individual MUD's in a "MUD Interconnection Program". Selected MUD's in Voting District 3 were asked about their well status and their need for a MUD interconnection program in order to judge possible interest from MUD's throughout the NHCRWA. The initial telephone survey was based on the HGCSD records and sought to update basic information such as the

number and size of wells, the general location of the wells in District 3, the district president/operator/engineer, and their mailing address. The results of the telephone survey are shown in Table 3.

A follow-up mail-out questionnaire was prepared in order to gage MUD interest in a "MUD Interconnection Program" in all five voting districts. In addition, the questionnaire was to be used to determine areas that need additional water and areas that have surplus water available. The telephone survey data was supplemented and used to mail the questionnaire to individual MUD's via registered mail. As can be seen on the attached sample Questionnaire (Figure 1), districts with no interest in the program were not required to return the questionnaire and the "return-receipt-requested" status was necessary to ensure that no response meant "no interest" instead of "not received".

Table 4 contains the results of this survey. Of the 126 questionnaires sent, only 16 MUD's responded. Only one of the responses (Prestonwood Forest Utility District in District 2) indicated a need for additional water. One additional MUD (Westador MUD in District 4) indicated that they had additional water that they would consider selling. This district qualified their statement, however, by indicating that they would not sign a firm yield contract and would only sell water if they did not need it. Responses from all the other districts were not returned which indicated no interest on their part in the "MUD Interconnection Program". This lack of interest was confirmed in several "town hall" and public meetings. The general feeling of the individual MUD's was that districts in need of additional water had already solved the problem by reworking their existing wells, drilling additional wells, or entering a contract to purchase water from adjacent districts.

The use of wastewater effluent to provide a secondary source of irrigation water or industrial water was also considered to reduce the demands on the individual districts' potable water systems. A preliminary survey was performed to determine possible users and quantities. A rules search was also performed to determine the requirements under which the gray water could be used. One potential project is being evaluated to use effluent from nearby wastewater treatment plants as power plant cooling water, however no projects were identified that could economically be constructed and that would reduce potable water needs within individual MUD's.

4. Preliminary Inventory of District 3 Needs

The results of the telephone survey and the questionnaire showed effectively no interest in a "MUD Interconnection Program" on the part of the MUD's. Since the Maximum Contaminant Levels (MCL) on several contaminants were under review at the time of this study, we investigated the effects that a reduction in allowable MCL's may have on the need for, and desire of, the MUD's to participate in a "MUD Interconnection Program". We contacted the Texas Natural Resource Conservation Commission (TNRCC) and obtained the reporting data for public water systems within the NHCRWA boundaries. This data is based on individual water systems and not a well-by-well analysis. It is possible that a water system with a second source of water such as a second well or an interconnect to another district may have a well that does not comply with an MCL and yet the system does comply because of the ability to blend water with another source in order to reduce the system's level of the contaminant below the MCL.

The TNRCC regulations for public drinking water are divided into three categories that consist of MCL's for inorganic compounds, MCL's for organic compounds, and compliance requirements for secondary standards. The TNRCC database for contaminants was searched for systems that have had excursions with the existing MCL's. These systems are shown graphically in Figure 2 as exceeding 100% of the current MCL for individual contaminants. In the inorganic contaminant category, the current MCL for arsenic and thallium were exceeded by two water systems for each contaminant. The two systems that exceed the current MCL for arsenic are located close together on the east end of Voting District 1 while the two systems that exceed the current MCL for thallium are located close together in the west/central portion of Voting District 4. None of the water systems inside the NHCRWA have reported excursions of the MCL for the organic contaminants. In the secondary standards category, the current MCL for aluminum, iron, and manganese were exceeded by four, eighteen, and six water systems respectively for each contaminant. Two of the four systems that exceed the current MCL for aluminum are located close together in the west/central portion of Voting District 4 while the remaining two water systems are located on the north and south boundary of Voting District 3. The eighteen water systems that exceed the MCL for iron are scattered fairly uniformly across the central portion of the NHCRWA. This area includes the east end of Voting District 1 and all of Voting Districts 2, 3, and 4. One of the six systems that exceed the current MCL for manganese is located near the north boundary of Voting District 2 while the remaining water systems are located on or near the south boundary of Voting District 4.

At the time of the study, the EPA was considering reducing several of the MCL's and adding additional contaminants such as radon to the list of MCL's. Charts were developed for the existing contaminants to show systems that would have trouble meeting proposed contaminate levels of 90% and 50% of those presently in force. In addition, a plot is provided for a proposed arsenic MCL of 4.5 ppb in lieu of the current level of 50 ppb. Since there is currently no radon MCL, water systems do not test specifically for this contaminant. Gross alpha, which is tested, was used as an indicator for the proposed radon MCL. As shown in Figure 2, a much greater number of water systems would have had problems with stricter MCL's. The urgency for a "MUD Interconnection Program" from this point of view was reduced when the proposed MCL reductions were delayed indefinitely.

5. Total Estimated Available "Supply Versus Demand"

Prior to the telephone survey, questionnaires, and analyses; a number of the MUD's reportedly stated a need for a "MUD Interconnection Program" because of failing supplies or water quality problems. During the investigations above, it was determined that approximately 99% all of the water systems (MUD's) in the NHCRWA have either sufficient supplies to meet their short-term needs or they have already contracted with adjacent MUD's and provided system interconnects to meet short term emergency needs. It appears that the systems that originally reported a need for a "MUD Interconnection Program" misunderstood the emergency nature of this proposed program for the long-term solution to the area's water needs.

6. Identify "Have" and "Need" Areas

Only one MUD (Prestonwood Forest Utility District in District 2) expressed interest in purchasing additional water through a MUD Interconnection Program. This MUD also indicated on the questionnaire that they are currently investigating drilling an additional well to solve their water shortage problem. Only one MUD (Westador MUD in District 4) indicated that they had additional water that they would consider selling during low demand periods within their district.

7. Possible City of Houston Short Term Supply

Meetings were held with the City of Houston to determine if water will be available short-term from their accelerated water line program. This program consists of advancing the original schedule for a large diameter transmission main along the North Loop (IH 610). The City has stated that water will be available from this program until

areas in the northwest portion of the City develop and require the water (5 to 10 years). The Prestonwood Forest Utility District is too far north of this project to make the purchase of water from this source economically feasible. For this reason it appears that this district will have to drill an additional well to meet their short-term needs.

8. Meetings and Coordination with Authority, Districts, Cities, and Others

A series of Town Hall meetings were held with various NHCRWA member MUD representatives in attendance. In these meetings, the NHCRWA updated members on the course of various analyses and obtained input from the MUD districts. The meetings indicated that the member districts generally felt there was no need for a "MUD Interconnection Program" administered by the NHCRWA. The reasons most often quoted were that member districts have already upgraded their systems to meet TNRCC quality requirements and have added interconnects with adjacent districts or have drilled new wells to meet water supply requirements for the short-term. All member districts were much more concerned with long-term solutions and their cost effectiveness.

9. Conclusions and Findings

In summary, the results of the telephone survey, the questionnaire, the TNRCC Maximum Contaminate Level analysis, and the Town Hall meetings showed that member MUD's have essentially no interest in a NHCRWA sponsored program of this type. For this reason, the MUD Interconnection Task was ordered halted by the NHCRWA Board after these preliminary analyses and meetings.

Table 1

Well Pumpage Data

TABLE 1: WELL PUMPAGE DATA SUMMARY

Voting District	1997	1998	1999
1	3,743,799,773	4,582,902,067	5,092,089,696
2	4,009,291,140	4,974,429,580	5,626,516,600
3	3,040,596,167	3,725,066,607	3,656,895,066
4	3,179,800,000	3,865,863,000	3,989,535,759
5	2,642,027,569	3,160,271,755	3,136,515,238
Total	**16,615,514,649**	**20,308,533,008**	**21,501,552,360**

Voting District 1

VD_NO_	WELL	OWNER	USE*	1997	1998	1999
1	5946	AQUASOURCE UTILITY, INC.	P	714,150	7,436,400	14,969,000
1	5947	AQUASOURCE UTILITY, INC.	P	714,150	7,436,400	14,969,000
1	6909	AQUASOURCE UTILITY, INC.	P	0	2,660,150	5,725,000
1	3593	AQUASOURCE UTILITY, INC.	P	5,889,500	8,120,000	7,154,000
1	3669	AQUASOURCE UTILITY, INC.	P	3,869,000	4,921,500	5,581,500
1	3544	AQUASOURCE UTILITY, INC.	P	5,889,500	8,120,000	7,154,000
1	5816	AQUASOURCE UTILITY, INC.	P	767,100	2,660,150	5,725,000
1	5736	AQUASOURCE UTILITY, INC.	P	3,869,000	4,921,500	5,581,500
1	1923	AQUASOURCE, INC.	P	1,968,000	2,572,000	2,350,500
1	3418	COMPAQ COMPUTER CORP.	I	26,977,000	26,726,000	37,337,000
1	2907	CY-FOREST SERVICE ASSOCIATION	P	3,722,025	4,980,500	4,820,733
1	3195	CY-FOREST SERVICE ASSOCIATION	P	3,722,025	4,980,500	4,820,733
1	2908	CY-FOREST SERVICE ASSOCIATION	P	3,722,025	4,980,500	4,820,733
1	3769	CY-FOREST SERVICE ASSOCIATION	P	3,722,025	4,980,500	4,820,733
1	1607	CYPRESS CREEK U.D.	P	64,326,667	72,209,667	73,474,444
1	3824	CYPRESS CREEK U.D.	P	64,326,667	72,209,667	73,474,444
1	1606	CYPRESS CREEK U.D.	P	64,326,667	72,209,667	73,474,444
1	3566	CYPRESS HILL M.U.D. 1	P	17,945,000	29,787,500	44,892,500
1	4644	EMERALD FOREST U.D.	P	105,865,500	121,527,500	124,480,000
1	3428	EMERALD FOREST U.D.	P	105,865,500	121,527,500	124,480,000
1	2952	ENCHANTED VALLEY WATER SUPPLY	P	19,868,000	21,557,000	22,359,000
1	5496	FAULKEY GULLY M.U.D.	P	91,607,667	137,114,000	154,933,000
1	4338	FAULKEY GULLY M.U.D.	P	91,607,667	137,114,000	154,933,000
1	2901	FAULKEY GULLY M.U.D.	P	91,607,667	137,114,000	154,933,000
1	2536	GRANT ROAD P.U.D.	P	52,402,000	63,091,000	66,784,000
1	3368	GRANTWOOD CIVIC CLUB	P	5,923,000	7,111,333	6,346,667
1	2949	GRANTWOOD CIVIC CLUB	P	5,923,000	7,111,333	6,346,667
1	5524	HARRIS CO. F.W.S.D. 61	P	115,139,250	110,030,400	104,708,200
1	1514	HARRIS CO. F.W.S.D. 61	P	115,139,250	110,030,400	104,708,200
1	1513	HARRIS CO. F.W.S.D. 61	P	115,139,250	110,030,400	104,708,200
1	3676	HARRIS CO. F.W.S.D. 61	P	115,139,250	110,030,400	104,708,200
1	3735	HARRIS CO. M.U.D. # 69	P	160,922,000	168,244,000	167,582,000
1	3430	HARRIS CO. M.U.D. #18	P	115,698,000	128,286,500	132,883,000
1	3941	HARRIS CO. M.U.D. #230	P	21,039,000	22,445,000	47,905,000

Voting District 1 - Cont.

1	4526	HARRIS CO. M.U.D. 18	P	115,698,000	128,286,500	132,885,000
1	4412	HARRIS CO. M.U.D. 222	P	84,746,000	113,663,000	156,146,000
1	4059	HARRIS CO. M.U.D. 286	P	64,318,000	80,476,500	104,734,000
1	4297	HARRIS CO. M.U.D. 286	P	64,318,000	80,476,500	104,734,000
1	4162	HARRIS CO. M.U.D. 358	P	123,555,000	156,261,000	171,620,000
1	4340	HARRIS CO. M.U.D. 358	P	123,555,000	156,261,000	171,620,000
1	4657	HARRIS CO. M.U.D. 360/PILGRIM	P	116,411,000	200,648,000	276,334,000
1	5963	HARRIS CO. M.U.D. 365	P	0	5,420,000	63,077,000
1	1662	HARRIS CO. W.C.&I.D. 113	P	30,953,000	36,587,000	36,712,000
1	3512	HMW SPECIAL UTILITY DISTRICT	P	21,081,500	22,205,500	26,149,500
1	5231	HMW SPECIAL UTILITY DISTRICT	P	7,669,000	11,046,000	12,159,333
1	4556	HMW SPECIAL UTILITY DISTRICT	P	7,669,000	11,046,000	12,159,333
1	3508	HMW SPECIAL UTILITY DISTRICT	P	21,081,500	22,205,500	26,149,500
1	3960	HMW SPECIAL UTILITY DISTRICT	P	5,738,500	6,130,500	7,378,000
1	4557	HMW SPECIAL UTILITY DISTRICT	P	7,669,000	11,046,000	12,159,333
1	4102	HMW SPECIAL UTILITY DISTRICT	P	5,738,500	6,130,500	7,378,000
1	2689	LAKE FOREST U.D.	P	172,669,500	186,028,000	190,879,000
1	4287	LAKE FOREST U.D.	P	172,669,500	186,028,000	190,879,000
1	5883	LAKES OF FAIRFIELD H.O.A., THE	O	2,724,000	31,191,200	30,154,700
1	5878	LAKES OF FAIRFIELD H.O.A., THE	O	9,796,000	11,447,000	59,986,000
1	5358	LAKEWOOD GROVE ASSOC., LTD.	O	5,163,600	4,513,300	4,693,000
1	5675	MALCOMSON ROAD U.D.	P	80,711,500	140,831,700	159,640,100
1	1616	MALCOMSON ROAD U.D.	P	80,711,500	140,831,700	159,640,100
1	4010	MILLS ROAD M.U.D.	P	82,022,500	94,615,500	96,516,000
1	2973	MILLS ROAD M.U.D.	P	82,022,500	94,615,500	96,516,000
1	5948	MUSTANG DEVELOPMENT	P	1,400,000	2,692,000	4,426,600
1	4746	NATIONAL GOLF PROPERTIES, INC.	O	66,286,440	68,505,000	118,869,000
1	3164	NORTHWEST FREEWAY M.U.D.	P	42,242,500	42,578,000	41,733,500
1	3165	NORTHWEST FREEWAY M.U.D.	P	42,242,500	42,578,000	41,733,500
1	2609	NW HARRIS CO. M.U.D. 5	P	115,029,000	160,210,000	92,435,000
1	4151	NW HARRIS CO. M.U.D. 9	P	96,233,000	101,665,500	105,004,000
1	3399	NW HARRIS CO. M.U.D. 9	P	96,233,000	101,665,500	105,004,000
1	3234	NW HARRIS CO. M.U.D. 10	P	30,007,500	39,565,500	38,957,500
1	3634	NW HARRIS CO. M.U.D. 10	P	30,007,500	39,565,500	38,957,500
1	7903	R CREEK LP	O		0	

Voting District 1 - Cont.

1	2177	TALL PINES UTILITY	I	3,349,000	4,468,500	4,710,000
1	5616	TIMBERLAKE I.D.	P	48,996,667	77,732,500	82,381,000
1	3383	TIMBERLAKE I.D.	P	48,996,667	77,732,500	82,381,000
1	3238	TOWER OAK BEND WATER SUPPLY	P	15,743,000	18,292,000	19,746,000
1	1730	TRUNKLINE GAS COMPANY	I	7,412,900	2,989,300	18,333,800
1	4373	WAYNEWOOD PLACE CIVIC CLUB, INC.	P	4,174,000	6,403,500	7,151,000
		TOTAL VOTING DISTRICT NO. 1		**3,743,799,773**	**4,582,902,067**	**5,092,089,696**
* P = Public; I = Industrial; O = Other						

Voting District 2

VD_NO	WELL	OWNER	USE*	1997	1998	1999
2	3350	ALBURY MANOR UTILITY CO.	P	6,625,000	9,819,000	10,386,000
2	7818	AQUASOURCE DEVELOPMENT COMPANY	P	0	0	
2	3641	AQUASOURCE UTILITY, INC.	P	7,391,000	8,093,000	8,765,000
2	3670	AQUASOURCE, INC.	P	4,219,000	4,280,000	4,390,000
2	4099	BAMMEL U.D.	P	116,230,000	150,800,000	153,854,000
2	3668	BERRY HILL	P	4,473,000	5,516,000	6,021,000
2	1593	CHAMPIONS GOLF CLUB, INC.	O	18,702,300	29,480,900	37,639,400
2	1594	CHAMPIONS GOLF CLUB, INC.	O	18,702,300	29,480,900	37,639,400
2	5116	CHAMPIONS LAKESIDE CLUB	O	14,000,000	5,614,800	8,116,000
2	3529	CHARTERWOOD M.U.D.	P	65,223,500	80,618,000	79,840,000
2	2424	CHARTERWOOD M.U.D.	P	65,223,500	80,618,000	79,840,000
2	5135	CY-CHAMP P.U.D.	P	107,371,500	131,709,500	145,885,000
2	1630	CY-CHAMP P.U.D.	P	107,371,500	131,709,500	145,885,000
2	4086	CYPRESS FOREST P.U.D.	P	185,026,000	232,377,000	240,246,500
2	3161	CYPRESS FOREST P.U.D.	P	185,026,000	232,377,000	240,246,500
2	2333	GLEANNLOCH FARMS COMMUNITY ASSO.	P	330,236	0	32,470,000
2	7598	GLEANNLOCH GOLF CLUB, L.P.	O	0	0	27,125,000
2	1528	HARRIS CO. F.W.S.D. 52	P	133,673,000	162,759,000	167,127,000
2	1529	HARRIS CO. F.W.S.D. 52	P	133,673,000	162,759,000	167,127,000
2	3751	HARRIS CO. M.U.D. #191	P	57,861,000	72,272,000	65,820,000
2	4540	HARRIS CO. M.U.D. #368	P	35,607,100	44,065,000	22,799,000
2	5897	HARRIS CO. M.U.D. 1	P	42,964,500	56,564,000	63,082,500
2	2175	HARRIS CO. M.U.D. 1	P	42,964,500	56,564,000	63,082,500
2	1779	HARRIS CO. M.U.D. 24	P	178,739,500	211,112,000	209,807,500
2	3750	HARRIS CO. M.U.D. 24	P	178,739,500	211,112,000	209,807,500
2	6164	HARRIS CO. M.U.D. 280	P	0	4,221,180	27,041,000
2	5828	HARRIS CO. M.U.D. 367	P	0	13,350,000	74,965,000
2	7381	HARRIS CO. M.U.D. 368	P	0	0	22,799,000
2	1534	HARRIS CO. W.C.&I.D. 114	P	112,032,667	140,757,000	136,891,667
2	4316	HARRIS CO. W.C.&I.D. 114	P	112,032,667	140,757,000	136,891,667
2	2094	HARRIS CO. W.C.&I.D. 116	P	114,351,500	138,891,000	145,956,500
2	4091	HARRIS CO. W.C.&I.D. 119	P	94,528,000	111,202,000	116,386,000
2	2183	HARRIS CO. W.C.&I.D. 119	P	94,528,000	111,202,000	116,386,000
2	3409	HARRIS CO. W.C.I.D. 114	P	112,032,667	140,757,000	136,891,667

Voting District 2 - Cont.

2	4508	HEATHERLOCH M.U.D.	P	90,306,500	94,799,000	117,525,500
2	1867	HEATHERLOCH M.U.D.	P	90,306,500	94,799,000	117,525,500
2	3089	HOE WATER SUPPLY CORPORATION	P	12,262,147	13,390,300	12,588,000
2	3356	HOMETOWN UTILITIES LP	P	33,339,800	50,112,500	25,232,400
2	7655	HOMETOWN UTILITIES LP	P	0	0	25,232,400
2	6741	INLINE DEVELOPMENT CORP.	P	0	0	3,751,500
2	1727	KLEINWOOD M.U.D.	P	68,788,000	79,829,500	99,041,500
2	4413	KLEINWOOD M.U.D.	P	68,788,000	79,829,500	99,041,500
2	4489	LAKES OF CYPRESS HILL HOMEOWNERS	O	8,136,000	21,713,700	39,546,000
2	3956	LOUETTA NORTH P.U.D.	P	108,412,000	146,925,000	161,657,000
2	4243	NORTHAMPTON M.U.D.	P	103,675,000	139,610,000	155,626,667
2	1553	NORTHAMPTON M.U.D.	P	103,675,000	139,610,000	155,626,667
2	1554	NORTHAMPTON M.U.D.	P	105,171,667	139,610,000	155,626,667
2	7441	NW HARRIS CO. M.U.D. 5	P	0	0	92,435,000
2	3269	NW HARRIS CO. M.U.D. 15	P	64,019,000	85,557,000	88,216,000
2	3424	NW HARRIS CO. M.U.D. 19	P	8,230,000	20,639,000	21,542,000
2	6848	POWDER MILL ESTATES, INC.	P	0	11,249,500	14,669,000
2	5406	POWDER MILL ESTATES, INC.	P	12,667,000	11,249,500	14,669,000
2	3293	PRESTONWOOD FOREST U.D.	P	86,886,000	103,167,500	110,107,500
2	1544	PRESTONWOOD FOREST U.D.	P	86,886,000	103,167,500	110,107,500
2	4283	SCOTT, L. W., JR.	P	1,543,645	4,567,600	3,394,250
2	4282	SCOTT, L. W., JR.	P	1,543,645	4,567,600	3,394,250
2	1664	SPRING CREEK FOREST P.U.D.	P	56,402,000	77,646,500	81,250,500
2	3355	TOMBALL COUNTRY CLUB	O	9,624,000	13,456,000	19,608,000
2	3388	TOMBALL COUNTRY CLUB	P	1,000,000	1,000,000	1,000,000
2	6927	TOMBALL, CITY OF	P	0	136,385,000	145,688,500
2	4131	TOMBALL, CITY OF	P	159,028,333	136,385,000	145,688,500
2	4023	TOMBALL, CITY OF	P	159,028,333	136,385,000	145,688,500
2	1934	TOMBALL, CITY OF	P	159,028,333	136,385,000	145,688,500
2	3839	TREELINE GOLF CLUB, INC.	O	27,099,800	38,046,600	39,978,000
2	8156	WILLOW CREEK GOLF CLUB, INC.				0
2	3681	WILLOW CREEK GOLF CLUB, INC.	O	33,802,000	45,500,000	48,300,000
		TOTAL VOTING DISTRICT NO. 2		**4,009,291,140**	**4,974,429,580**	**5,626,516,600**
* P = Public; I = Industrial; O = Other						

Voting District 3

VD NO	WELL	OWNER	USE*	1997	1998	1999
3	6922	AQUASOURCE UTILITY, INC.	O		12,262,000	67,764,000
3	3386	AQUASOURCE, INC.				
3	3335	BAMMEL OAKS 2	P	3,162,500	3,949,500	3,265,000
3	3334	BAMMEL OAKS 2	P	3,162,500	3,949,500	3,265,000
3	3608	C & P UTILITIES, INC.	P	23,222,000	26,650,000	27,723,000
3	2856	CEMEX USA	I	4,098,750	7,387,250	7,935,100
3	2857	CEMEX USA	I	4,098,750	7,387,250	7,935,100
3	1854	FOUNTAINHEAD M.U.D.	P	116,899,500	126,223,500	132,590,193
3	3478	HARRIS CO. M.U.D. 16	P	160,554,000	184,769,000	155,826,000
3	3412	HARRIS CO. M.U.D. 168	P	173,623,500	224,817,000	215,123,000
3	3332	HARRIS CO. M.U.D. 168	P	173,623,500	224,817,000	215,123,000
3	3461	HARRIS CO. M.U.D. 170	P	57,204,000	63,035,000	76,883,000
3	3867	HARRIS CO. M.U.D. 202	P	42,653,000	79,937,000	30,179,000
3	1759	HARRIS CO. M.U.D. 25	P	67,493,000	123,774,000	116,843,000
3	3333	HARRIS CO. W.C.I.D. #109	P	148,268,000	178,830,333	174,451,667
3	1379	HARRIS CO. W.C.I.D. 109	P	148,268,000	178,830,333	174,451,667
3	1378	HARRIS CO. W.C.I.D. 109	P	148,268,000	178,830,333	174,451,667
3	7374	JERSEY LAKE HOMEOWNERS ASSOC.	P			6,993,050
3	7781	JERSEY VILLAGE, CITY OF	P			
3	4147	JERSEY VILLAGE, CITY OF	P	155,752,500	183,799,500	171,873,000
3	3320	JERSEY VILLAGE, CITY OF	P	155,752,500	183,799,500	171,873,000
3	3872	JERSEY VILLAGE, CITY OF - Annexed HARR	P	52,863,000	92,491,000	
3	1361	JERSEY VILLAGE, CITY OF - JERSEY MEADO	O	14,139,633	15,553,233	15,765,633
3	1359	JERSEY VILLAGE, CITY OF - JERSEY MEADO	O	14,139,633	15,553,233	15,765,633
3	3448	NW HARRIS CO. M.U.D. 21	P	99,678,000	104,937,000	73,055,333
3	4178	NW HARRIS CO. M.U.D. 21	P	99,678,000	104,937,000	73,055,333
3	3797	NW HARRIS CO. M.U.D. 24	P	18,245,000	21,721,500	23,542,000
3	3771	NW HARRIS CO. M.U.D. 24	P	18,245,000	21,721,500	23,542,000
3	3944	NW HARRIS CO. M.U.D. 29	P	68,556,000	66,197,000	119,196,000
3	2731	NW HARRIS CO. M.U.D. 6	P			
3	3804	REID ROAD M.U.D. 1	P	125,921,500	131,749,000	131,868,000
3	2445	REID ROAD M.U.D. 1	P	125,921,500	131,749,000	131,868,000
3	3805	REID ROAD M.U.D. 2	P	100,012,000	126,547,000	128,419,000
3	4567	SAM HOUSTON RACE PARK	O	22,158,900	35,002,000	38,265,200

Voting District 3 - Cont.

3	3075	SMITH, B.G.	P	262,550	2,747,000	2,886,500
3	3076	SMITH, B.G	P	262,550	2,747,000	2,886,500
3	3390	W. HARRIS CO. M.U.D. 9	P	213,016,000	254,946,000	235,833,000
3	3391	W. HARRIS CO. M.U.D. 10	P	110,311,000	126,207,500	156,649,500
3	5850	W. HARRIS CO. M.U.D. 10	P	110,311,000	126,207,500	156,649,500
3	4579	W. HARRIS CO. M.U.D. 11	P	129,509,000	202,443,000	118,428,500
3	7609	W. HARRIS CO. M.U.D. 11	P			118,428,500
3	4560	W. HARRIS CO. M.U.D. 21	P	31,053,000	29,677,000	35,702,000
3	3296	WHITE OAK BEND M.U.D.	P	86,648,000	97,694,000	98,815,000
3	5369	WILLOW BRIDGE HOMEOWNERS ASSOC.	O	1,308,500	2,013,240	1,720,990
3	6838	WOODWIND LAKES HOMEOWNERS, ASSOC	O	0	2,634,500	4,586,400
3	5335	WOODWIND LAKES HOMEOWNERS, ASSOC	O	6,125,200	8,271,700	7,657,050
3	4778	WOODWIND LAKES HOMEOWNERS, ASSOC	O	6,125,200	8,271,700	7,657,050
		TOTAL VOTING DISTRICT NO. 3		**3,040,596,167**	**3,725,066,607**	**3,656,895,066**
* P = Public; I = Industrial; O = Other						

Voting District 4

VD_NO	WELL	OWNER	USE*	1997	1998	1999
4	1725	AQUASOURCE UTILITY INC.	P	21,511,250	26,008,500	
4	1724	AQUASOURCE UTILITY INC.	P	21,511,250	26,008,500	36,618,333
4	3921	AQUASOURCE UTILITY, INC.	P	21,511,250	26,008,500	36,618,333
4	1916	BAMMEL FOREST UTILITY COMPANY	P	25,242,500	37,138,500	36,732,500
4	4098	BAMMEL FOREST UTILITY COMPANY	P	25,242,500	37,138,500	36,732,500
4	7080	BILMA P.U.D.	P		94,165,000	112,233,000
4	3229	BILMA P.U.D.	P	160,357,000	94,165,000	112,233,000
4	4713	BRIDGESTONE M.U.D.	P	85,060,000	102,493,000	96,490,667
4	2680	BRIDGESTONE M.U.D.	P	85,060,000	102,493,000	96,490,667
4	3352	BRIDGESTONE M.U.D.	P	85,060,000	102,493,000	96,490,667
4	3691	C & P UTILITIES, INC.	P	16,550,000	18,800,000	15,847,500
4	5654	CNP UTILITY DISTRICT	P	91,600,250	98,812,000	101,613,000
4	1658	CNP UTILITY DISTRICT	P	91,600,250	98,812,000	101,613,000
4	2634	CNP UTILITY DISTRICT	P	91,600,250	98,812,000	101,613,000
4	3564	CNP UTILITY DISTRICT - Outside WRA				
4	4353	CYPRESS-KLEIN U.D.	P	101,490,000	129,273,000	137,119,500
4	7252	CYPRESS-KLEIN U.D.	P			
4	4916	DOVE MEADOWS M.U.D.	P	64,815,000	66,010,000	77,827,500
4	3777	DOWDELL P.U.D.	P	34,440,000	39,566,500	38,302,000
4	1868	DOWDELL P.U.D.	P	34,440,000	39,566,500	38,302,000
4	2065	ENCANTO REAL U.D.	P	35,033,000	38,299,000	40,358,000
4	7675	FRONTIER MATERIALS	I			870,226
4	2970	HARRIS CO. M.U.D. #104	P	74,643,000	98,580,000	127,992,000
4	3726	HARRIS CO. M.U.D. 233	P	34,167,000	37,486,000	53,095,000
4	4069	HARRIS CO. M.U.D. 275	P	24,534,000	27,192,000	38,733,000
4	2546	HARRIS CO. M.U.D. 44	P	137,782,000	134,175,000	192,658,000
4	7622	HARRIS CO. M.U.D. 44	P			
4	1538	HARRIS CO. W.C.&I.D. 91	P	36,797,000	85,189,500	88,302,500
4	1537	HARRIS CO. W.C.&I.D. 91	P	36,797,000	85,189,500	88,302,500
4	1617	HARRIS CO. W.C.I.D. # 110	P	103,931,500	116,691,000	144,226,500
4	1673	HARRIS CO. W.C.I.D. # 132	P	115,823,167	134,861,000	131,466,667
4	1870	HARRIS CO. W.C.I.D. #132	P	115,823,167	134,861,000	131,466,667
4	3648	HARRIS CO. W.C.I.D. #132	P	115,823,167	134,861,000	131,466,667
4	2903	HARRIS CO. W.C.I.D.# 110	P	103,931,500	116,691,000	144,226,500