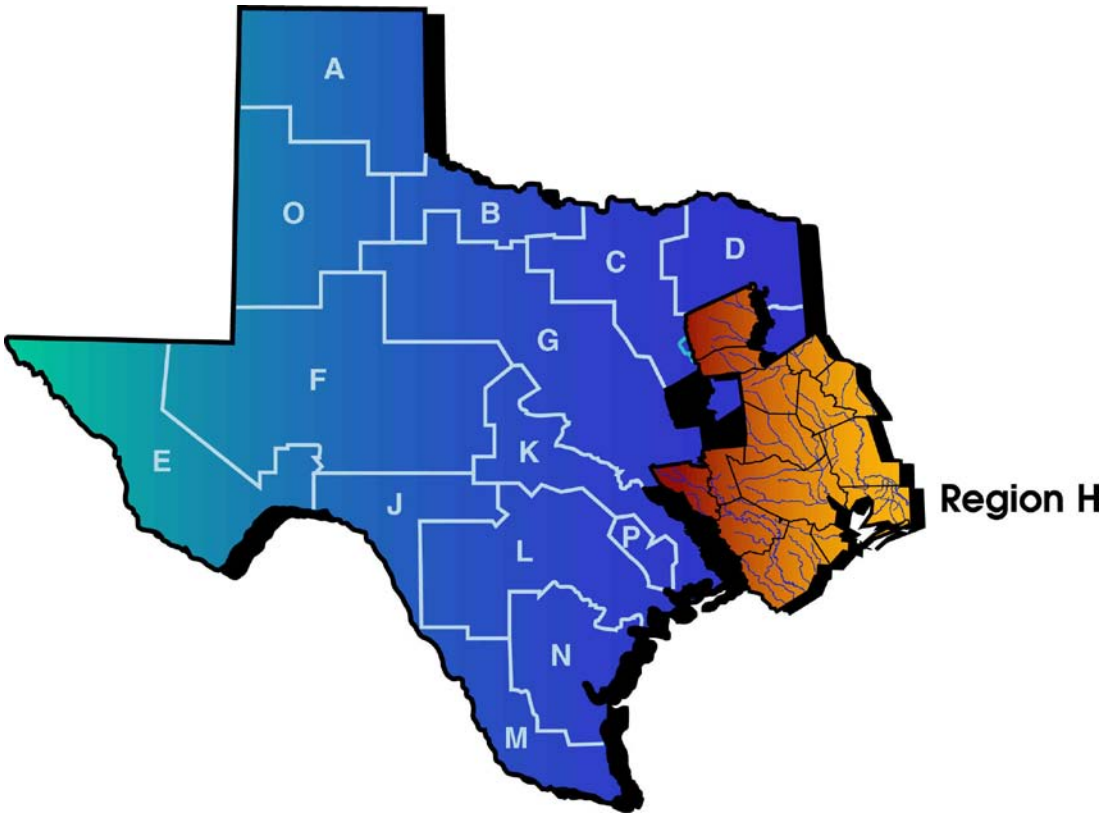
REGION H
WATER PLANNING GROUP



EXECUTIVE SUMMARY
OF THE REGIONAL WATER PLAN

prepared by

Brown & Root / Turner Collie & Braden

Joint Venture

Ekistics Corporation
LBG-Guyton Associates

January 2001

Executive Summary

Table of Contents

List of Tables

List of Figures

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

Introduction

Under legislation passed in 1997, the State of Texas designated 16 regions to plan for future water supply. The Texas Water Development Board appointed a water planning group in each region to carry out that mission. The members of the Region H Water Planning Group (RHWPG) and the interests they represent are shown in Table ES-1. Region H encompasses all or part of fifteen counties in southeast Texas and includes the entire San Jacinto River basin as well as the lower reaches of the Brazos and Trinity River basins. A Location Map showing the regional boundaries is included in Figure ES-1 and a listing of counties in the Region is included in Table ES-2. Regional Water Planning is conducted under the oversight of the Texas Water Development Board. A listing of state points of contact is included in Table ES-3.

The RHWPG is charged with comparing the water needs and supplies in the region to determine if supplies are adequate through the 50-year planning period. If shortages are identified, the RHWPG must develop water management strategies to overcome the shortages. Management strategies to meet projected water shortages were divided into near-term (2030 and before) and long-term (post-2030). The water supply assessment and identification of recommended management strategies comprise the Region H Regional Water Plan. Information on Region H and Senate Bill 1 planning statewide can be found at the TWDB website, www.twdb.state.tx.us/.

Region H is an economic powerhouse crucial to the Texas and national economies. Adequate water supplies are essential to continued economic health and to the region's future growth. Two thirds of all U.S. petrochemical production and almost a third of the nation's petroleum industries are located in Region H. The area provides some of the state's most popular vacation spots that generate hundreds of millions of dollars in annual tourism revenues. The Port of Houston is the second busiest port in the nation. In 1995, the Houston area employed 1.75 million people or 22 percent of the state's total employment. Region H is generally characterized by urbanizing land uses and broad-based economic development. In areas outside of the urban core, agriculture dominates economic activities. Key contributors to each of six primary economic sectors are:

- Services--Medical (Texas Medical Center in Houston, University of Texas Medical Branch in Galveston), tourism, banking, construction and engineering.
- Manufacturing--Petroleum exploration, production and refining, petrochemicals, biotechnology, chemicals, computers and technology, and pulp and paper.
- Transportation--Port of Houston, rail and highway systems, Intracoastal Waterway, airlines, airports and air cargo facilities.
- Government--Federal, state and local including the Texas Department of Corrections, the Johnson Space Center, numerous law enforcement agencies, universities, colleges and school districts.
- Agriculture--Rice, soybeans, grain sorghum, peanuts, vegetables, hay, cattle, horses, swine, timber and pulp wood.
- Fishing--Commercial (oysters, shrimp, finfish) and recreational.

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Any large-scale water supply or conveyance projects will require the close cooperation of political entities in the affected areas. While municipal and county governments are most visible in Region H, there are numerous other governmental and regulatory agencies with jurisdiction over aspects of water supply development in the region. These include, but are not limited to:

- Fort Bend Subsidence District
- Harris-Galveston Coastal Subsidence District
- Texas Water Development Board (TWDB)
- Texas Natural Resource Conservation Commission (TNRCC)
- Texas Department of Parks and Wildlife (TPWD).
- Brazos River Authority
- San Jacinto River Authority
- Trinity River Authority
- Gulf Coast Water Authority
- Houston-Galveston Area Council of Governments
- Brazos Valley Council of Governments
- Deep East Texas Council of Governments
- Eleven soil and water conservation districts
- Numerous Utility Districts and Water Supply Corporations

Of particular note are the two subsidence districts since it is their regulations that compel many municipalities to seek new surface water sources to replace their current groundwater supplies. Finally, formation of public/private partnerships aligning the interests of the public with those of the manufacturing, agricultural, power generating and mining sectors will be essential in developing the water needed to support the population and economy of Region H.

For public review and comment, copies of the initially prepared Region H Draft Regional Water Plan are available at the County Clerks' offices in each of the 15 Region H counties and are available in one public library in each of the 15 counties. The Plan is comprised of separate memoranda and reports covering the following planning tasks:

- Task 1 Memorandum: Description of Region
- Task 2 Report: Presentation of Population and Water Demands
- Task 3 Report: Analysis of Current Water Supplies
- Task 4 Report: Identify Water Surpluses and Shortages and Resulting Potential Impacts
- Task 5 Report: Identification, Evaluation and Selection of Water Management Strategies
- Task 6 Report: Additional Recommendations
- Task 7 Report: Public Involvement

For an in-depth discussion of any of the topics addressed in this Executive Summary, the reader is referred to the complete set of reports located in any of the 30 repositories noted below. The full list of addresses of the 30 report holders is shown in Table ES-2.

Population Projections

Population in Region H is projected to grow from 4.8 million in 2000 to 9.7 million in 2050. The doubling of population over the fifty-year planning period represents an annual growth rate of slightly more than one percent. Population projections by county are shown in Table ES-4.

Population projections for the region are based on the "Most Likely Growth Scenario" from the "consensus" projections developed for the 1997 State Water Plan by the Texas Water Development Board (TWDB) with input from the Texas Parks and Wildlife Department, the Texas Natural Resources Conservation Commission (TNRCC) and a number of interested organizations. Using methods approved by the TWDB, the RHWPG reviewed the 1997 state projections and adjusted estimates when recent local information documented that near-term projections were outdated. Four public meetings and several workshops were held in the region to present the proposed projections for comment.

Revised projections were adopted by the RHWPG in June 1999, and subsequently submitted to the TWDB for approval at its October 1999 meeting. The approved projections are compiled in a report titled "Task 2 Report: Population and Water Demand Projections." Population data are presented for each of the fifteen counties in the region and for cities of more than 500 persons. The population projections serve as the basis for calculating municipal water demands.

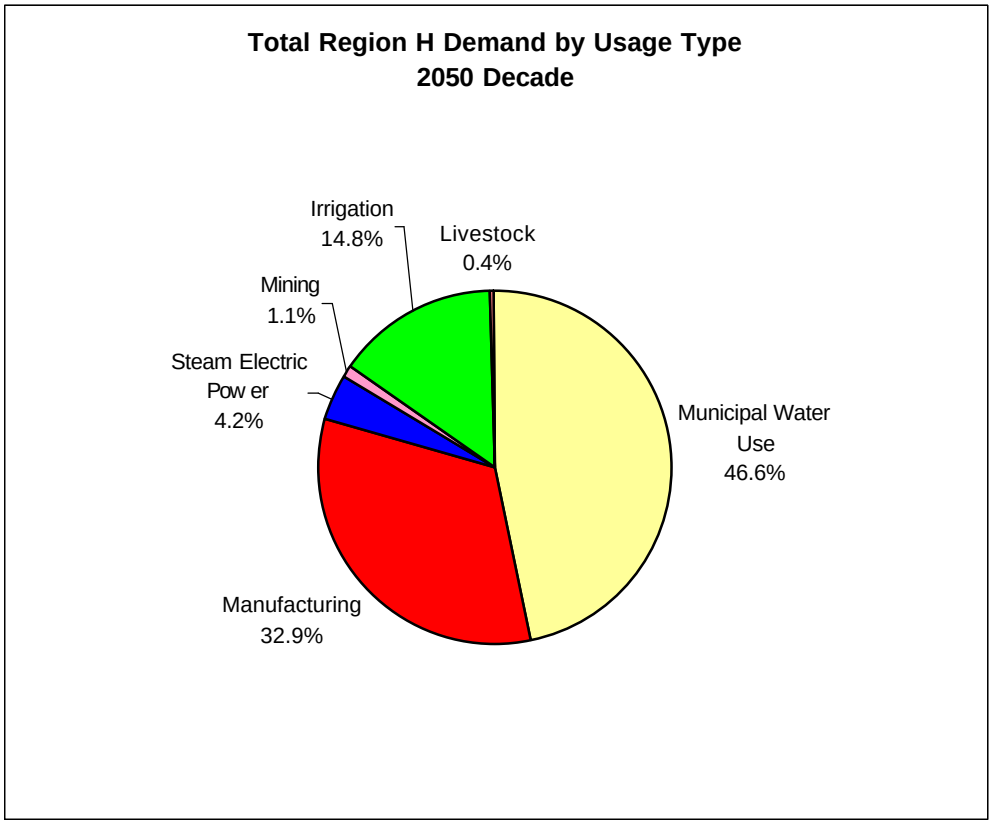
Water Demand Projections

Region H water demands are projected to increase from approximately 2.25 million acre-feet per year in year 2000 to over 3.18 million acre-feet per year by year 2050. In addition to municipal demand, water consumption for manufacturing, steam electric power generation and mining will increase throughout the planning period. Water demands for livestock production are projected to remain constant within Region H. Irrigation water demands are expected to decrease in Brazoria County and remain constant in the other counties in Region H, resulting in an overall reduction in irrigation water demands through the planning period. Table ES-5 presents the forecasts for water demands in Region H, summarized by county and totaled for Region H. Figure ES-2 shows that municipal water demands are projected to account for over 46 percent of the total regional water demands. Manufacturing demands are estimated to account for over 33 percent of the regional water demands. The projected water demands for municipal and manufacturing uses result from an application of water conservation practices. Within the region, conservation demand reductions vary by water user group, but range up to approximately 25 percent of demand. This expected level of conservation is projected to occur based on per capita demand reductions. Region H has the largest projection of manufacturing water use of any of the sixteen planning regions within the state. Harris County is projected to account for over 48 percent of the total regional water demand.

In addition to the above usage categories, the RHWPG considered the environmental water needs of streams and freshwater inflows into the Galveston Bay system. The Galveston Bay Freshwater Inflows Group (GBFIG) has been working to develop management strategies to

ensure freshwater inflows for Galveston Bay. Texas Parks and Wildlife Department has recommended 5.2 million acre-feet per year as the freshwater inflow needed to achieve maximum productivity of the bay. GBFIG has recommended a schedule of target flows shown in Table ES-6, which includes meeting the maximum productivity target in at least 50% of future years. The RHWPG has endorsed GBFIG's recommendation, and supports further efforts to develop strategies for meeting the freshwater needs of both humans and the bay.

Figure ES-2: Water Demand Allocation



Water Supplies

The total amount of water supply currently available to Region H from existing water sources is 3,687,500 acre-feet per year (ac-ft/yr). Of that amount, about two-thirds is surface water. By the years 2030 and 2050, the available supply will be 3,460,000 ac-ft/yr. The reduction in supply between 2000 and 2030 reflects a decrease in availability of groundwater as restrictions on use of groundwater are instituted to combat subsidence in a large part of the region. Groundwater supply is based on the projected sustainable yield of each aquifer, which limits extraction to the annual rate of recharge. The predominant sources of surface water supply are derived from three reservoirs: Lakes Conroe and Houston within the San Jacinto river basin and Lake Livingston within the lower Trinity River basin.

The RHWPG has defined surface water supplies as dependable supplies that should be available in a "drought of record." For most of Region H, that means a drought comparable to the drought from the early to mid-1950s. Some activities, such as livestock watering and mining, use surface waters that are not available during drought. These undependable supplies are considered "local sources" and are not calculated in available supplies for Region H.

A detailed analysis of Region H supplies is found in the full Task 3 Report, "Analysis of Current Water Supplies." A summary of available water supply by source is provided in Table ES-7.

Water Demand versus Supplies

Water supplies were compared to water demands to determine if any areas in the region are expected to experience water shortages during the planning period. Despite adequate overall water supplies for Region H in the year 2050, the RHWPG has identified communities that will experience water shortages during the planning period without action to increase their supplies. Most of these communities will be able to meet their demands simply by extending or increasing existing water supply contracts.

Of the total 215 Water User Groups (WUGs) in Region H, 122 of them, primarily those reliant on wells in areas with abundant groundwater, will experience no shortages during the planning period. All of the counties within the region north of Montgomery County are projected to have sufficient long-term water supplies. A detailed comparison of available supplies versus demands revealed 93 other WUGs that will develop water supply shortages by 2050. These areas of need all exist within the southern portion of the region. Future water supply planning therefore focused on the southern and western portions of Region H. Of the Major Water Providers (MWPs)--Brazos River Authority, City of Houston, San Jacinto River Authority, Gulf Coast Water Authority, and Trinity River Authority--all but the TRA will face projected supply shortages by 2050. Both the identification of shortages and surpluses and the socioeconomic impact of not meeting projected water demands are addressed in detail in the full Task 4 Report, "Identify Water Surpluses and Shortages and Resulting Potential Impacts."

Socioeconomic Impact of Not Addressing Shortages

Water supply is critical to public health, and failure to provide water would severely constrain economic and population growth in Region H. The TWDB has calculated the potential impacts of not meeting projected water demands. Their calculations are based on the following assumptions:

- A drought of record occurs during each decade modeled
- No changes in the structural economic relationships within the regional economy
- No technological advances occur
- No change in human behavior occurs

These are clearly severe and unrealistic assumptions, but they do allow creation of a worst-case scenario. In addition, the TWDB looked at impacts with and without extension of existing water supply contracts. The RHWPG is of the opinion that the impacts should be presented assuming current supply contracts are extended through the planning period. Figure ES-3 shows that, even with extension of current supply contracts, significant negative impacts on employment, population and income would occur if water needs are not met.

Water Management Strategies

The RHWPG considered a variety of strategies for meeting the projected shortages and solicited input from the public before adopting a management plan. A detailed analysis process was developed to define potential water management strategies. The process addressed the specific shortages of the 93 WUGs discussed above and then developed associated specific strategies assuming the MWPs would be the vehicle to solve WUG shortages. The process generally consisted of the following:

1. Contract Extension - For all WUGs currently served by a MWP, first extend the existing contracts throughout the planning period for the current contracted amount of water.

2. Contract Extension and Increase - If the current contracted amount of water is insufficient for a Municipal WUG now served by a MWP, then increase the contracted supply from the MWP to meet future water needs of those Municipal WUGs. This could not be applied to collective WUGs, such as manufacturing.

Steps 1 and 2 solved the supply needs for 42 of the 93 WUGs with shortages. The remainder of the WUGs with shortages required additional actions:

3. MWP Association - For the Municipal WUGs not now served by a MWP, for the Municipal County-Other WUGs and for the Non-Municipal WUGs with shortages, associate each of these WUGs with a MWP.

4. Allocation of Uncommitted Supplies - Determine the total supply required to meet shortages of the WUGs defined in Steps 1 through 3 for each MWP. Allocate uncommitted supplies of each MWP to these WUGs until the existing MWP supplies are fully allocated.

5. Define Strategies - Determine the remaining water supplies needed to satisfy the water shortages remaining for each MWP. Define potential water management strategies for each MWP based on its identified water shortages.

Management strategies that involved adjoining regions were coordinated with the appropriate water planning group. This allowed the consideration of larger projects.

The water management strategies selected to meet the MWPs' shortages are as follows:

- **Municipal Conservation**--The concervation strategy is applied at the WUG level and decreases WUG demands on the associated MWP, allowing the MWP to allocate its supplies elsewhere. Projected water savings total 30,383 ac-ft/yr in year 2030 and 30,563 ac-ft/yr in year 2050.
- **Irrigation Conservation**--Also applied at the WUG level, this strategy allows allocation of MWP supplies to other users. Projected water savings are 24,312 ac-ft/yr in Brazoria County, 14,259 ac-ft/yr in Fort Bend County, and 5,010 ac-ft/yr in Waller County.
- **Contractual Transfer**--This strategy involves the transfer of 28,500 ac-ft/yr of manufacturing water rights to irrigation water rights within the boundaries of the Brazos River Authority service area.
- **Allen's Creek Reservoir**--This proposed reservoir creates 99,650 ac-ft/yr of supplies for the City of Houston and for the Brazos River Authority.
- **Little River Reservoir**--This proposed reservoir creates 101,000 ac-ft/yr for the Brazos River Authority (of which 30,000 ac-ft/yr are consumed outside Region H) and 28,000 ac-ft/yr for the Gulf Coast Water Authority.
- **Bedias Reservoir**--This proposed reservoir creates 90,700 ac-ft/yr for the San Jacinto River Authority and the Trinity River Authority.
- **Wastewater Reclamation**--This strategy proposes that 90,700 ac-ft/yr of Houston's municipal wastewater be treated and reused by industries along the Houston Ship Channel.
- **Luce Bayou**--This conveyance project enables the City of Houston to transfer water it owns in the Trinity basin to Lake Houston to meet projected growth in north and northwest Harris County.
- **Houston/Trinity River Authority Contract**--Under this strategy, the City of Houston will purchase up to 200,000 ac-ft/yr of uncommitted supplies from the Trinity River Authority.
- **Brazos River Authority Voluntary Redistribution**--The Brazos River Authority is in the process of re-purchasing unused supplies from current customers in the upper Brazos basin and will then be able to sell up to 75,000 ac-ft/yr of this water to customers in Region H.
- **Bedias Reservoir to San Jacinto River Authority Transfer**--In conjunction with the Bedias Reservoir construction, this strategy is the conveyance system to facilitate the interbasin transfer of 75,000 ac-ft/yr to the San Jacinto River Authority service area.
- **Houston to Gulf Coast Water Authority Transfer**--To meet 2050 demands of the Gulf Coast Water Authority, this strategy calls for the sale of 23,000 ac-ft/yr of Houston's raw water supplies. Included is a pumping station and pipeline to convey the water to the GCWA's Texas City reservoir.
- **San Jacinto River Authority/Chambers-Liberty Counties Navigation District Contract**--Under this strategy, the San Jacinto River Authority will purchase 30,000 ac-ft/yr of uncommitted supplies from the Chambers-Liberty Counties Navigation District.

A summary of the selected strategies, their yields and their costs is shown in Table ES-8. Table ES-9 shows the combination of strategies required for each MWP to meet its projected water shortages. Table ES-10 details the approach used for each WUG. An in-depth discussion of the recommended plan is contained in the Task 5 Report, “Identification, Evaluation and Selection of Water Management Strategies.”

Proposed Unique Stream Segments

The Texas Water Code offers the opportunity to identify river and stream segments of unique ecological value. The selection criteria established within the Texas Water Code are as follows:

- Biological Function
- Hydrologic Function
- Riparian Conservation Area
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value
- Threatened or Endangered Species/Unique Natural Communities

After consideration of the above factors, the following six streams were designated as Streams of Unique Ecological Value in Region H:

Stream Segments (Not in priority order)	County
Armand Bayou	Harris
Bastrop Bayou	Brazoria
Big Creek	Fort Bend
Big Creek	San Jacinto
Cedar Lake Creek	Brazoria
Menard Creek	Liberty, Hardin*, Polk

*Hardin County portion is in Region I.

The entire stream segment length was designated for Armand Bayou and Menard Creek (segment within Region H). For the remaining four streams, only those portions adjacent to or within riparian conservation areas were designated as unique streams.

Unique Reservoir Sites

The Texas Water Code offers an opportunity to designate sites of unique value for use as surface water supply reservoirs. Through use of a decision-based water management strategy analysis and selection process, the RHWPG selected three surface water reservoir projects for inclusion within the Regional Water Plan. The RHWPG has decided to designate the site locations of each of these projects as unique sites.

The three sites are:

Name	County	General Location
Allen's Creek	Austin	1 Mile N. of the City of Wallis
Bedias	Madison (Principally)	Bedias Creek, 3.5 Miles W. of State Hwy 75
Little River	Milam	Main Stem of Little River, Immediately Upstream of its Confluence with the Brazos River

Regulatory, Administrative and Legislative Recommendations

Section 357.7(a)(9) of the Texas Water Development Board regional water planning guidelines requires that a regional water plan include recommendations for regulatory, administrative, and legislative changes. These recommendations are addressed to each governmental agency that has the appropriate jurisdiction over each subject. It is generally assumed that regulatory recommendations are directed towards the Texas Natural Resources Conservation Commission (TNRCC), that administrative recommendations are directed towards the Texas Water Development Board (TWDB), and that legislative recommendations are directed towards the State of Texas Legislature.

The Region H Water Planning Group has currently adopted the following regulatory, administrative, and legislative recommendations:

- **Regulatory and Administrative Recommendations**

– Review the population estimates immediately following determination of the 2000 census and make revisions to WUG population estimates as necessary.
– Allow more flexibility in the allocation of multiple water management strategies to defined water shortages.
– Base water planning on renewal of current water supply contracts when they expire.
– Modify the notification procedures for amendments to a regional water plan to limit notification requirements.
– Direct the TNRCC to utilize more realistic assumptions in the development of the surface water Water Availability Models that will serve as the basis of future regional water planning efforts.
– Maintain the current definition of each of the sixteen regional water-planning areas.

- **Legislative Recommendations**

– Revise Chapter 297.73 of the Texas Water Code to exempt from cancellation certain water rights that have not been used in whole or in part for 10 years.
– Adopt regulations to exempt from cancellation any water rights of project sponsors, whose water rights have been developed as a result of project sponsor financing of a water supply project.
– Remove barriers to interbasin transfers of water.
– Maintain the current rule of capture basis of groundwater law within Texas in all areas not subject to defined groundwater conservation districts.
– Support development of Groundwater Conservation Districts to protect current groundwater users.
– Develop a structure and funding method to support ongoing activities of the RWPG following development of the regional water management plan.
– Establish funding for continuing the Bays and Estuaries programs of state resource agencies and for additional monitoring and research to develop strategies to meet freshwater inflow needs.

- Establish financing mechanisms for development of new water supply projects identified within the adopted regional water plans.
- Clarify the definition of and intent of designating unique stream segments and unique reservoirs.
- Continue and expand funding of the State of Texas Groundwater Availability Modeling effort.
- Establish funding for agricultural research into the area of use of efficient irrigation practices.
- Establish a research and development program for desalination with appropriate financial incentives for desalination project implementation.
- Address and improve water conservation activities in the state.

Table ES-1: Member Information for the Region H Water Planning Group

Executive Committee	
Office	**Officer**
Chair	Jim Adams, P.E. San Jacinto River Authority P.O. Box 329 Conroe, TX 77305-0329 Phone: (936) 588-1111 Fax: (936) 588-3043
Vice-Chair	Judge Mark Evans
Secretary	Ron Neighbors
At-Large	Michael Sullivan
At-Large	C. Harold Wallace
Offices	
Office	**Entity**
Administrative	Harris-Galveston Coastal Subsidence District
Political Subdivision	San Jacinto River Authority P.O. Box 329 Conroe, TX 77305-0329

Note:
Administrative Office manages records.
Political Subdivision is the entity eligible to apply for State grant funds.

Table ES-1 (continued)

Voting Membership			
Interest	**Name Dates Served**	**Entity**	**County (Location of Interest)**
Public	Roosevelt Alexander March 1998 - Present	Retired	Waller
Counties	Judge Mark Evans March 1998-Present	Trinity County	Trinity
	Commissioner Jack Harris March 1998 - Present	Brazoria County Commissioners Court	Brazoria
	Gary Stobb, P.E. June 2000 - Present	Harris County	Harris
	Judge Robert Eckels March 1998 - June 2000	Harris County	Harris
Municipalities	Larry Taylor December 2000 - Present	City of Friendswood	Galveston
	Tom Manison March 1998 - Sept. 2000	City of Friendswood	Galveston
	Gary Oradat, P.E. November 1999 - Present	City of Houston	Harris, Ft Bend & Montgomery
	Fred A. Perrenot, P.E. April 1998 - Nov. 1999	City of Houston	Harris, Ft Bend & Montgomery
Industries	James Murray March 1998 - Present	Exxon-Mobil	Harris
	Carolyn Johnson March 1998 - Present	Dow Chemical	Brazoria
Agricultural	Robert Bruner March 1998 - Present	Rancher	Walker
	David Jenkins July 1998 - Present	Rice Farmer	Chambers
Environmental	John Bartos March 1998 - Present	Galveston Bay Foundation	Harris

Table ES-1 (continued)

Voting Membership (Continued)			
Interest	**Name Dates Served**	**Entity**	**County (Location of Interest)**
Small Businesses	Steve Tyler March 1998 - Present	Steve Tyler Creative Services	Trinity
	Mary Alice Gonzalez March 1998 - Present	Stewart Title - Fort Bend Div.	Fort Bend
	Michael Sullivan March 1998 - Present	Sea-Master Marine Coatings, Inc.	Harris
Electric Generating Utilities	Kerry Whelan April 1999 - Present	Reliant Energy	Harris
	Cynthia Schmidt March 1998 - April 1999	Houston Lighting & Power	Harris
River Authorities	Jim Adams, P.E. March 1998 - Present	San Jacinto River Authority	Montgomery (service in central part of Region H)
	Tom Ray March 1998 - Present	Brazos River Authority	McLennan (service in west and southwest part of Region H)
	Danny F. Vance March 1998 - Present	Trinity River Authority	Tarrant (service in east and southeast part of Region H)
Water Districts	J.C. Searcy, Jr. March 1998 - Present	Spirit of North Harris County Coalition	Harris
	Marvin Marcell July 1998 - Present	Fort Bend Subsidence District	Fort Bend
	Ron Neighbors March 1998 - Present	Harris-Galveston Coastal Subsidence District	Harris and Galveston
Water Utilities	James Morrison March 1998 - Present	Walker County WSC	Walker
	William Teer March 1998 - Present	Retired	Leon
	C. Harold Wallace March 1998 - Present	West Harris County Surface WSC	Harris

Table ES-1 (continued)

Non-Voting Members	
Name **Dates Served**	**Entity**
David Alders July 1998 - Present	East Texas RWPG (I)
Sterling Cornelius January 1999 - Dec. 2000	Texas Association of Nurserymen
Rick Gangluff July 1998 - Present	Lower Colorado RWPG (K)
Lacy Fryer April 1999 - Present	Texas Department of Agriculture
Tommy Hebert July 1998 - Present	Representative for extra-regional holder of 1,000+ acre-feet of water rights.
Larry Jacobs July 1998 - Present	Montgomery County Soil and Water Conservation District
Tony Jones July 1998 - Present	Brazos G RWPG
Phil Kaiser December 2000 - Present	Just Trees
Gordon Myers July 1998 - Present	Gulf Coast Water Authority
Ernest Rebuck March 1998 - Present	Texas Water Development Board
Danny Vance July 1998 - Present	Region C RWPG (also a voting member)
Woody Woodrow July 1998 - Present	Texas Parks and Wildlife Department

Table ES-2: Public Repositories of the Region H Regional Water Plan

AUSTIN COUNTY
County Clerk
County Courthouse
1 East Main
Bellville, TX 77418

AUSTIN COUNTY
Gordon Library
917 Circle Drive
Sealy, TX 77474

BRAZORIA COUNTY
County Clerk
County Courthouse
111 East Locust
Angleton, TX 77511

BRAZORIA COUNTY
Angleton Public Library
401 East Cedar
Angleton, TX 77515

CHAMBERS COUNTY
County Clerk
County Courthouse
Anahuac, TX 77514

CHAMBERS COUNTY
Chambers County Library
– Main Branch
202 Cummings
Anahuac, TX 77514

FORT BEND COUNTY
County Clerk
301 Jackson
Richmond, TX 77469

FORT BEND COUNTY
George Memorial Library
1001 Golfview
Richmond, TX 77469

GALVESTON COUNTY
County Clerk
County Courthouse
722 Moody
Galveston, TX 77550

GALVESTON COUNTY
Rosenberg Library
2310 Sealy
Galveston, TX 77550

HARRIS COUNTY
County Clerk
Harris County Administration Building
1001 Preston Avenue
Houston, TX 77002

HARRIS COUNTY
Houston Public Library
1st Floor, Bibliographic Information Center
500 McKinney
Houston, TX 77002

LEON COUNTY
County Clerk
Leon County Courthouse
Centerville, TX 75833

LEON COUNTY
Leon County Library
129 East Main
Centerville, TX 75833

Table ES-2 (continued)

LIBERTY COUNTY County Clerk County Courthouse 1923 Sam Houston Liberty, TX 77575	**LIBERTY COUNTY** Sam Houston Regional Library And Research Center FM1011 Liberty, TX 77575
MADISON COUNTY County Clerk 101 West Main, Room 102 Madisonville, TX 77864	**MADISON COUNTY** Madison County Library 605 South May Madisonville, TX 77864
MONTGOMERY COUNTY County Clerk County Courthouse 301 N. Thompson Conroe, TX 77301	**MONTGOMERY COUNTY** Montgomery County Central Library 104 Interstate 45 North Conroe, TX 77301
POLK COUNTY County Clerk County Courthouse, 1st Floor 101 West Church Livingston, TX 77351	**POLK COUNTY** Murphy Memorial Library 601 West Church Livingston, TX 77351
SAN JACINTO COUNTY County Clerk County Courthouse #1 Highway 150 Coldspring, TX 77331	**SAN JACINTO COUNTY** Coldspring Library 220 South Bonham Coldspring, TX 77331
TRINITY COUNTY County Clerk County Courthouse 1st and Main Groveton, TX 75845	**TRINITY COUNTY** Blanche K. Werner Library Highway 19 Trinity, TX 75862
WALKER COUNTY County Clerk County Courthouse 1100 University Avenue Huntsville, TX 77340	**WALKER COUNTY** Huntsville Public Library 1216 – 14th Street Huntsville, TX 77340
WALLER COUNTY County Clerk County Courthouse 836 Austin Street Hempstead, TX 77445	**WALLER COUNTY** Waller County Library - Brookshire/Pattison 3815 Sixth Street Brookshire, TX 77423

Table ES-3: State Agencies with Oversight of Water Planning

Texas Water Development Board

William Mullican
Director, Water Resource Planning
PO Box 13231, 1700 N. Congress Ave., Austin, TX 78711-3231
(512) 936-0813

Ernest Rebuck, P.E.
Assistant Director, Water Resources Planning
PO Box 13231, 1700 N. Congress Ave., Austin, TX 78711-3231
(512) 936-2317

Texas Natural Resource Conservation Commission (plan review)

Jeffrey Saitas
Executive Director
12500 Park 35 Circle, Austin, TX 78753
(512) 239-3900

Texas Parks and Wildlife Department (plan review)

Andrew Sansom
Executive Director
4200 Smith School Road, Austin, TX 78744-3291
(512) 389-4800

Table ES-4: Region H Water Planning Group Population Projections

County	1990	2000	2010	2020	2030	2040	2050
Austin	19,832	23,571	26,639	30,362	34,161	38,200	42,980
Brazoria	191,707	241,233	279,519	322,819	378,774	424,518	489,838
Chambers	20,088	27,943	35,180	44,395	50,154	54,561	57,719
Fort Bend	225,421	372,666	505,935	683,080	914,290	1,147,629	1,399,774
Galveston	217,399	259,656	300,009	349,260	399,936	434,319	456,631
Harris	2,818,199	3,303,757	3,809,510	4,434,344	4,796,682	5,249,691	5,543,482
Leon	12,665	14,879	16,737	18,664	20,423	22,308	24,108
Liberty	52,726	69,124	77,625	104,156	141,589	153,963	167,415
Madison	10,931	12,673	13,048	13,203	13,049	12,612	11,914
Montgomery	182,201	295,403	439,173	602,374	818,084	989,264	1,162,046
Polk (part)	22,369	33,196	37,057	41,706	46,952	51,040	54,731
San Jacinto	16,372	21,806	27,018	32,118	36,637	41,012	45,872
Trinity (part)	7,666	10,673	11,174	11,550	11,949	12,504	13,304
Walker	50,917	62,592	71,217	78,895	89,676	96,974	101,675
Waller	23,389	30,912	42,606	63,870	94,028	109,453	128,788
Region H	3,871,882	4,780,084	5,692,447	6,830,796	7,846,384	8,838,048	9,700,277

Table ES-5: Water Demand Forecasts for Region

(Water use in acre-feet per year)						
Austin County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	3549	3754	4039	4401	4793	5379
Manufacturing	120	147	176	207	249	296
S.E. Power Cooling	0	0	0	0	0	0
Mining	97	74	53	35	28	27
Irrigation	12291	12291	12291	12291	12291	12291
Livestock	1993	1993	1993	1993	1993	1993
Total Water Use	18050	18259	18552	18927	19354	19986
Brazoria County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	34698	37647	41145	46751	51167	58556
Manufacturing	228424	257569	274057	288204	316451	344404
S.E. Power Cooling	0	0	0	0	0	0
Mining	1511	1305	1169	1114	1043	1063
Irrigation	131207	118758	108276	104256	101833	101833
Livestock	1066	1066	1066	1066	1066	1066
Total Water Use	396906	416345	425713	441391	471560	506922
Chambers County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	3937	4509	5262	5762	6124	6420
Manufacturing	4675	5052	5229	5383	5792	6207
S.E. Power Cooling	1100	1100	1100	1100	1500	5000
Mining	13233	9379	8155	7707	7388	7344
Irrigation	128452	128452	128452	128452	128452	128452
Livestock	768	768	768	768	768	768
Total Water Use	152165	149260	148966	149172	150024	154191
Fort Bend County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	69084	88351	113748	149905	185273	225200
Manufacturing	21139	23616	25556	27401	30592	33639
S.E. Power Cooling	70000	70000	70000	70000	70000	70000
Mining	258	250	235	219	220	228
Irrigation	62045	62045	62045	62045	62045	62045
Livestock	1134	1134	1134	1134	1134	1134
Total Water Use	223660	245396	272718	310704	349264	392246
Galveston County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	42675	46149	50632	56247	60130	63522
Manufacturing	64614	70905	75743	80269	88858	97460
S.E. Power Cooling	1500	1500	1500	1500	1500	1500
Mining	84	63	55	44	42	44
Irrigation	10334	10334	10334	10334	10334	10334
Livestock	182	182	182	182	182	182
Total Water Use	119389	129133	138446	148576	161046	173042

Table ES-5 (continued)

Harris County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	656756	720323	800122	848390	884519	925140
Manufacturing	386430	419816	446155	468909	515487	561743
S.E. Power Cooling	16500	17500	20000	22500	22500	22500
Mining	702	574	392	316	255	240
Irrigation	17995	17995	17995	17995	17995	17995
Livestock	1147	1147	1147	1147	1147	1147
Total Water Use	1079530	1177355	1285811	1359257	1441903	1528765
Leon County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	2320	2447	2573	2746	2921	3129
Manufacturing	178	191	192	193	194	195
S.E. Power Cooling	0	0	0	0	0	0
Mining	1459	1045	508	384	327	335
Irrigation	0	0	0	0	0	0
Livestock	2105	2105	2105	2105	2105	2105
Total Water Use	6062	5788	5378	5428	5547	5764
Liberty County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	9605	10145	12587	16376	17279	18580
Manufacturing	486	551	615	681	753	826
S.E. Power Cooling	0	0	0	0	0	0
Mining	15430	16852	19021	21193	23389	25827
Irrigation	109905	109905	109905	109905	109905	109905
Livestock	432	432	432	432	432	432
Total Water Use	135858	137885	142560	148587	151758	155570
Madison County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	2773	2720	2629	2541	2393	2262
Manufacturing	78	82	85	87	94	99
S.E. Power Cooling	0	0	0	0	0	0
Mining	42	36	33	28	27	28
Irrigation	50	50	50	50	50	50
Livestock	1379	1379	1379	1379	1379	1379
Total Water Use	4322	4267	4176	4085	3943	3818
Montgomery County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	45944	61942	73824	92270	110886	131839
Manufacturing	1670	1935	2128	2317	2604	2897
S.E. Power Cooling	6000	6000	6000	6000	6000	6000
Mining	196	98	53	30	19	15
Irrigation	20	20	20	20	20	20
Livestock	420	420	420	420	420	420
Total Water Use	54250	70415	82445	101057	119949	141191

Table ES-5 (continued)

Polk County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	4684	4890	5174	5639	5936	6288
Manufacturing	0	0	0	0	0	0
S.E. Power Cooling	0	0	0	0	0	0
Mining	26	26	27	27	28	29
Irrigation	0	0	0	0	0	0
Livestock	136	136	136	136	136	136
Total Water Use	4846	5052	5337	5802	6100	6453
San Jacinto County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	2586	2926	3234	3547	3855	4244
Manufacturing	24	27	31	34	38	41
S.E. Power Cooling	0	0	0	0	0	0
Mining	76	52	30	10	2	0
Irrigation	0	0	0	0	0	0
Livestock	170	170	170	170	170	170
Total Water Use	2856	3175	3465	3761	4065	4455
Trinity County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	1683	1664	1624	1634	1652	1737
Manufacturing	3	4	4	5	5	6
S.E. Power Cooling	0	0	0	0	0	0
Mining	10	10	10	10	10	10
Irrigation	4	4	4	4	4	4
Livestock	303	303	303	303	303	303
Total Water Use	2003	1985	1945	1956	1974	2060
Walker County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	10521	11095	11569	12627	13285	13576
Manufacturing	228	245	260	276	290	306
S.E. Power Cooling	0	10000	15000	15000	20000	30000
Mining	15	16	18	19	21	23
Irrigation	345	345	345	345	345	345
Livestock	565	565	565	565	565	565
Total Water Use	11674	22266	27757	28832	34506	44815
Waller County	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Municipal Water Use	6394	7958	10930	15103	17129	19767
Manufacturing	44	49	56	62	68	75
S.E. Power Cooling	0	0	0	0	0	0
Mining	687	351	192	106	53	30
Irrigation	28405	28405	28405	28405	28405	28405
Livestock	1238	1238	1238	1238	1238	1238
Total Water Use	36768	38001	40821	44914	46893	49515

Table ES-5 (continued)

Total Region H	2000	2010	2020	2030	2040	2050
Municipal Water Use	897209	1006520	1139092	1263939	1367342	1485639
Manufacturing	708113	780189	830287	874028	961475	1048194
S.E. Power Cooling	95100	106100	113600	116100	121500	135000
Mining	33826	30131	29951	31242	32852	35243
Irrigation	501053	488604	478122	474102	471679	471679
Livestock	13038	13038	13038	13038	13038	13038
Total Water Use	**2248339**	**2424582**	**2604090**	**2772449**	**2967886**	**3188793**

Table ES-6: Environmental Water Needs for Galveston Bay

The frequency of annual Galveston Bay system freshwater inflows recommended by the Galveston Bay Freshwater Inflows Group.

Inflow Scenario	Quantity Needed (acre-feet/year)	Historical Frequency	Target Minimum Frequency
Max H	5.2 million	66%	50%
Min Q	4.2 million	70%	60%
Min Q-Sal	2.5 million	82%	75%
Min Historic	1.8 million	98%	90%

Note: The health and productivity of Galveston Bay must consider the quantity, quality, seasonality (monthly inflows), and location of inflows. It is anticipated that the inflow needs projections will continue to be refined over time. The use of improved data focused on the fisheries production solely from the Galveston Bay system is one example of an anticipated means of refinement.

Scenario Descriptions:

Max H: Modeled inflows recommended for maximum bay and estuary fisheries harvest by Texas Parks & Wildlife Department.

Min Q: Minimum modeled inflow recommended to maintain the bay and estuary fisheries harvest.

Min Q-Sal: Estimated minimum acceptable inflow recommended to maintain the salinity needed for bay and estuary fisheries viability.

Min Historic: Minimum annual inflow calculated for Galveston Bay over the period of record (1941-1990).

Table ES-7: Summary of Water Supplies Available to Region H For Years 2000, 2030, and 2050

Supply Source	Supply Available (1,000 Acre-Feet per year) 2000	2030	2050
Groundwater			
Gulf Coast Aquifer	816.2	588.3	588.3
Carrizo-Wilcox Aquifer	168.5	168.5	168.5
Queen City & Sparta Aquifer	25.3	25.3	25.3
Brazos River Alluvium	41.3	41.3	41.3
Subtotal Groundwater	**1,051.3**	**823.4**	**823.4**
Surface Water			
Trinity River Basin	1,567.5	1,567.5	1,567.5
San Jacinto River Basin	330.6	330.7	330.7
Brazos River Basin	642.6	642.7	642.8
Coastal Basins	89.3	89.2	89.5
Lower Neches Basin	6.2	6.4	6.4
Subtotal Surface Water	**2,636.2**	**2,636.5**	**2,636.9**
Total Water Supplies	**3,687.5**	**3,459.9**	**3,460.3**

Table ES-8: Region H Selected Management Strategies

Management Strategy	Yield (ac-ft/yr)	Strategy Cost ($)
Municipal Conservation	30,563	$3,667,600
Irrigation Conservation		
Brazoria County	24,312	$1,876,000
Fort Bend County	14,259	$1,085,000
Waller County	5,010	$391,000
Contractual Transfers	28,500	None
Reservoirs		
Allens Creek	99,650	$157,300,000
Little River	129,000	$361,000,000
Bedias	90,700	$132,000,000
Wastewater Reclamation	90,700	$175,498,000
Luce Bayou	None	$84,000,000
Houston/TRA Contract	200,000	Unknown
BRA Voluntary Redistribution	75,000	None
Bedias/SJRA Transfer	None	$62,340,000
Houston/GCWA Transfer	23,000	$63,270,000
SJRA/CLCND Contract	30,000	$8,250,000

Table ES-9: Management Strategies for Major Water Providers

Major Water Provider Management Strategy	2000 af/y	2010 af/y	2020 af/y	2030 af/y	2040 af/y	2050 af/y
Brazos River Authority						
Balance Without Strategies *	-48,573	-89,544	-107,392	-135,860	-173,649	-216,704
Voluntary Redistribution	50,000	50,000	50,000	75000	75000	75000
GCWA	-18,000	-18,000	-18,000	-33,000	-33,000	-33,000
Brazosport Water Authority ***	0	0	0	0	0	-1,200
Municipal Conservation	0	762	3008	4101	4302	5207
Irrigation Conservation	0	29,332	43,581	43,581	43,581	43,581
Needville's shortage ***			-123	-282	-462	-711
Allens Creek Reservoir	0	0	29,900	29,900	29,900	29,900
Little River Reservoir **	0	0	0	0	71,000	71,000
Contractual Transfer - MFR to IRR	28,500	28,500	28,500	28,500	28,500	28,500
Balance	11,927	1,050	29,474	11,940	45,172	1,573
City of Houston						
Balance Without Strategies *	515,639	394,117	174,907	88,414	9,728	-76,380
Municipal Conservation	98	7,763	17,055	16,783	13,652	13,366
Allens Creek Reservoir	0	0	69,750	69,750	69,750	69,750
Luce Bayou	0	0	0	0	0	0
Wastewater Reclamation	0	90,700	90,700	90,700	90,700	90,700
Houston / GCWA Transfer	0	0	0	0	0	-23,000
Houston / TRA Contract	0	200,000	200,000	200,000	200,000	200,000
Balance	515,737	692,580	552,412	465,647	383,830	274,436
Gulf Coast Water Authority						
Balance Without Strategies *	-11,393	-11,919	-18,767	-34,631	-59,087	-85,440
Municipal Conservation	92	840	1,676	2,676	2,858	3,682
Little River Reservoir	0	0	0	0	28,000	28,000
New BRA Contract	18,000	18,000	18,000	33,000	33,000	33,000
Houston / GCWA Transfer	0	0	0	0	0	23,000
Balance	6,699	6,921	909	1,045	4,771	2,242
San Jacinto River Authority						
Balance Without Strategies *	56,495	34,876	5,045	-19,222	-47,003	-74,602
Municipal Conservation	0	2,632	5,080	6,175	6,586	7,707
SJRA / CLCND Contract	30,000	30,000	30,000	30,000	30,000	30,000
Bedias Reservoir / Interbasin Transfer	0	0	0	75,000	75,000	75,000
Balance	86,495	67,509	40,125	91,953	64,583	38,105
Trinity River Authority						
Balance Without Strategies *	278,220	273,421	271,891	260,925	259,129	255,392
Municipal Conservation	0	0	0	579	451	531
Bedias Reservoir	0	0	0	15,700	15,700	15,700
Houston / TRA Contract	0	-200,000	-200,000	-200,000	-200,000	-200,000
Balance	278,220	73,421	71,891	77,204	75,280	71,623

* Starting balance reflects extensions of current contracts
** Little River Reservoir total yield is 129,000 afy. 30,000 afy will go to BRA in Region G, 71,000 afy will go to BRA in Region H, and 28,000 afy will go to the GCWA
*** Entities previously designated for self-supply

Table ES-10: Recommended Water Management Strategies by City and Category*

WUG Name	County #	Basin#	Strategy Description	Source Name	Capital Cost **	Supply 2030	Supply 2050
ALVIN	20	11	Municipal conservation, new contracts	BRA/COE System	$6,390,000	0	1,201
ANGLETON	20	11	Renew and increase existing contract with BWA	Brazos ROR, BRA/COE System	$20,353,000	1,622	4,683
BRAZORIA	20	12, 13	Renew and increase existing contract with BWA	Brazos ROR		127	515
CLUTE	20	11	Renew and increase existing contract with BWA	Brazos ROR	$6,618,000	643	1957
FREEPORT	20	11, 12, 13	Renew and increase existing contract with BWA	Brazos ROR	$8,694,000	723	3,036
LAKE JACKSON	20	11, 12	Renew and increase existing contract with BWA	Brazos ROR	$872,000	1,145	4,200
OYSTER CREEK	20	11	Renew and increase existing contract with BWA	Brazos ROR		46	168
PEARLAND (P)	20	11	Renew existing contract (split between Brazoria & Harris Co)	Brazos ROR	$2,320,000	5,599	5,599
RICHWOOD	20	11	Renew and increase existing contract with BWA	Brazos ROR	$4,333,000	266	664
BRAZORIA COUNTY-OTHER	20	11, 12, 13	Municipal conservation, Renew and increase current contracts, Little River Reservoir	Brazos ROR, BRA/COE System, Little River Reservoir		1,996	6,876
MANUFACTURING	20	11, 12, 13	Renew and increase existing contracts, new reservoirs	Brazos ROR, BRA/COE System, Allens Creek Reservoir, Little River Reservoir	$157.3 MM (ACR) $361 MM (LRR)	67,240	114,058
MINING	20	11, 12, 13	New contracts	BRA/COE System		213	1,012
IRRIGATION	20	11, 12, 13	Renew and increase existing contracts, irrigation conservation, Contractual transfer of manufacturing supply for irrigation	Brazos ROR, BRA/COE System, Chocolate Bayou	$203,000	40,393	39,750
ANAHUAC	36	7, 8	Extend existing contract	Lake Anahuac	$882,000	1,049	1,049
BAYTOWN (P)	36	9	Renew and increase existing contract	Lake Livingston		729	831
CHAMBERS COUNTY-OTHER	36	7, 8, 9	Municipal conservation, renew existing contracts	Lake Anahuac		663	669
MANUFACTURING	36	9	Extend existing contracts	Lake Livingston		7,796	7,796
FULSHEAR	79	11, 12	Municipal conservation, New contracts	BRA/COE System	$4,394,000	59	180
KATY (P)	79	10	Municipal conservation, New contracts	BRA/COE System		225	543
MEADOWS	79	10	Municipal conservation, New contract with Houston	Lake Livingston	$1,181,000	693	1,582

Table ES-10 (continued)

WUG Name	County #	Basin#	Strategy Description	Source Name	Capital Cost	Supply 2030	Supply 2050
MISSION BEND (P)	79	11	Municipal conservation, New contract with Houston	Lake Livingston		553	914
MISSOURI CITY (P)	79	10, 11	Renew and increase existing contracts	Brazos ROR, BRA/COE System	$8,386,000	8,805	19,001
NEEDVILLE	79	12, 13	Municipal conservation, Supply realized through irrigation conservation			282	711
RICHMOND	79	12	Municipal conservation, New contracts, Allens Creek Reservoir, Little River Reservoir	BRA/COE System, Allens Creek Reservoir, Little River Reservoir	$15,232,000	1,757	4,224
ROSENBERG	79	12	Municipal conservation, New contracts, Allens Creek Reservoir, Little River Reservoir	BRA/COE System, Allens Creek Reservoir, Little River Reservoir	$14,705,000	1,872	4,995
STAFFORD (P)	79	10, 11	Extend existing contract through 2050 -for both Fort Bend and Harris Co	Brazos ROR		10,903	10,903
SUGAR LAND	79	11, 12	Renew existing contracts	Brazos ROR	$4,071,000	22,441	22,441
TOWN WEST (CDP)	79	11	Municipal conservation, New contract with Houston	Lake Livingston	$917,000	205	478
FORT BEND COUNTY-OTHER	79	10, 11, 12	Municipal conservation, renew existing contracts, Little River Reservoir, Allens Creek Reservoir	Brazos ROR, BRA/COE System, Little River Reservoir, Allens Creek Reservoir		45893	77,648
MANUFACTURING	79	10, 11, 12	New contracts, Little River Reservoir, Allens Creek Reservoir, Supply realized through irrigation conservation	BRA/COE System, Little River Reservoir, Allens Creek Reservoir		21,373	26,238
STEAM ELECTRIC POWER	79	12	Extend existing contract through 2050	BRA/COE System		0	83,000
IRRIGATION	79	10, 12	Irrigation conservation		$269,000	14,259	14,259
BAYOU VISTA	84	11	Bayou Vista will switch from SE plant to GCWA in 2001 and will need to increase the GCWA contract	BRA/COE System	$912,000	222	332
DICKINSON	84	11	Increase existing contract	BRA/COE System	$1,962,000	2,643	3,315
FRIENDSWOOD (P)	84	11	Increase existing contract for both Galveston & Harris Co	Lake Livingston		3,815	3,815
GALVESTON	84	11	Little River Reservoir contract with GCWA	Little River Reservoir	$34,682,000	0	1,391
HITCHCOCK	84	11	Hitchcock will switch from SE plant to GCWA in 2001 and will need to increase the GCWA contract	BRA/COE System	$5,326,000	332	471

Table ES-10 (continued)

WUG Name	County #	Basin#	Strategy Description	Source Name	Capital Cost	Supply 2030	Supply 2050
LA MARQUE	84	11	Increase existing contract	BRA/COE System	$1,173,000	120	275
SANTA FE	84	11	Santa Fe will switch from SE plant to GCWA in 2001 and will need to increase the GCWA contract	BRA/COE System	$8,828,000	1,457	1,700
GALVESTON COUNTY-OTHER	84	7, 11	Municipal conservation, New contracts	BRA/COE System		1,531	283
MANUFACTURING	84	11	Renew and increase existing contracts, Little River Reservoir, transfer from Houston	BRA/COE System, Little River Reservoir, Houston/CWA system		10,243	27,434
ALDINE (CDP)	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$1,274,000	1,503	1,475
BARRETT	101	9, 10	Municipal conservation, New contract with SJRA	San Jacinto ROR	$3,199,000	626	662
BAYTOWN (P)	101	9,10	Renew and increase existing contracts	Lake Livingston	$4,083,000	14,318	16,661
BELLAIRE	101	10	Municipal conservation, Wastewater reuse, New contract with Houston	Lake Livingston	$7,187,000	3,567	3,632
BUNKER HILL VILLAGE	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$1,194,000	1,016	1,075
CHANNELVIEW (CDP)	101	10	Renew and increase existing contract	Lake Livingston	$1,734,000	3,770	3,711
CROSBY	101	9, 10	Renew existing contract	San Jacinto ROR	$1,437,000	1,050	1,050
DEER PARK	101	10, 11	Renew and increase existing contracts	Lake Livingston	$982,000	6,295	6,933
EL LAGO	101	11	Increase existing contract	Lake Livingston	$933,000	239	295
FRIENDSWOOD (P)	101	11	Renew and increase existing contract for both Galveston Co & Harris Co	Lake Livingston	$4,584,000	5,049	5,049
GALENA PARK	101	10	Renew and increase existing contracts	Lake Livingston		1,512	1,521
HEDWIG VILLAGE	101	10	Renew and increase existing contracts	Lake Livingston		977	1,124
HIGHLANDS	101	9, 10	Renew and increase existing contracts	Lake Livingston	$1,271,000	1,277	1,343
HUMBLE	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$3,288,000	5,490	6,456
HUNTERS CREEK VIL.	101	10	Renew and increase existing contracts	Lake Livingston		1,631	1,750
JACINTO CITY	101	10	Renew and increase existing contracts	Lake Livingston	$876,000	1,549	1,655
JERSEY VILLAGE	101	10	Municipal conservation, New Contract with Houston	Lake Livingston	$1,445,000	1,465	1,685
KATY	101	10	Municipal conservation, New contracts, Allens Creek Reservoir	BRA/COE System, Allens Creek Reservoir	$25,396,000	2,181	2,692

Table ES-10 (continued)

WUG Name	County #	Basin#	Strategy Description	Source Name	Capital Cost	Supply 2030	Supply 2050
LA PORTE	101	11	Renew existing contract	Lake Livingston	$856,000	7,391	7,391
MCNAIR	101	9	Renew and increase existing contracts	Lake Livingston	$859,000	263	263
MISSION BEND (P)	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$1,685,000	1,666	1,749
MISSOURI CITY (P)	101	10	Renew existing contract	Brazos ROR		8,399	8,399
NASSAU BAY	101	11	Renew existing contract	Lake Livingston		728	728
PASADENA	101	10, 11	Contract increases due to facility expansion. Renew contract through 2050	Lake Livingston	$5,578,000	21,672	21,672
PEARLAND (P)	101	11	Renew existing contract (split between Brazoria & Harris Co)	Brazos ROR		5,599	5,599
PINEY POINT VILLAGE	101	10	Renew and increase existing contracts	Lake Livingston		1,569	1,769
SEABROOK	101	11	Renew and increase existing contracts	Lake Livingston		1,727	1,879
SHELDON	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$6,373,000	353	408
SOUTH HOUSTON	101	10	Contract increases due to facility expansion. Renew contract through 2050	Lake Livingston		1,399	1,399
SOUTHSIDE PLACE	101	10	Renew and increase existing contracts	Lake Livingston		452	499
SPRING (CDP)	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$21,565,000	5,416	5,899
SPRING VALLEY	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$976,000	538	571
STAFFORD (P)	101	10	Renew existing contract for both Fort Bend and Harris Co	Brazos ROR		545	545
TOMBALL	101	10	Municipal conservation, New contract with Houston	Lake Livingston	$19,491,000	2,203	2,669
WEST UNIVERSITY PL.	101	10	Renew and increase existing contracts	Lake Livingston		2,209	2,246
HARRIS COUNTY-OTHER	101	9, 10, 11	Municipal conservation, Renew and increase existing contracts, Bedias Reservoir	Lake Livingston, Brazos ROR, San Jacinto ROR, Bedias Reservoir		192,278	209,959
MANUFACTURING	101	9, 10, 11	Renew and increase existing contracts, Wastewater reclamation, Bedias Reservoir	Lake Livingston, Trinity ROR, San Jacinto ROR, Bedias Reservoir	$120.4 MM	525,267	612,261
STEAM ELECTRIC POWER	101	10, 11	Renew existing contracts, new contracts	Lake Livingston		44,870	44,870
MINING	101	10, 11	Renew existing contracts, new contracts	Lake Livingston		639	639
LIBERTY COUNTY-OTHER	146	6, 7, 8, 9, 10	Municipal conservation, New contracts with TRA	Lake Livingston		2,081	4,229
MINING	146	8, 9	New Contract with TRA	Lake Livingston		3,113	6,952

Table ES-10 (continued)

WUG Name	County #	Basin#	Strategy Description	Source Name	Capital Cost	Supply 2030	Supply 2050
CONROE	170	10	Municipal conservation, New contracts with SJRA, Bedias Reservoir	Lake Conroe, Bedias Reservoir	$48,101,000	10,632	21,940
OAK RIDGE NORTH	170	10	Municipal conservation, New contracts with SJRA	Lake Conroe	$1,680,000	371	504
PANORAMA VILLAGE	170	10	Municipal conservation, New contracts with SJRA	Lake Conroe	$6,883,000	421	993
SHENANDOAH	170	10	Municipal conservation, New contracts with SJRA	Lake Conroe	$1,486,000	0	386
THE WOODLANDS	170	10	Renew and increase existing contracts	Lake Conroe	$30,805,000	3,514	2,846
WILLIS	170	10	Municipal conservation, New well fields	Gulf Coast Aquifer	$10,905,000	202	597
MONTGOMERY COUNTY-OTHER	170	10	Municipal conservation, New contracts with SJRA, Bedias Reservoir	Lake Conroe, Bedias Reservoir	$176.1 MM	24,999	53,346
MANUFACTURING	170	10	New contracts with SJRA	Lake Conroe		647	1,227
MINING	170	10	New contracts with SJRA	Lake Conroe		30	15
LIVINGSTON	187	8	Renew existing contracts	Lake Livingston		5,601	5,601
POLK COUNTY-OTHER	187	8	Renew existing contract	Lake Livingston		672	672
SAN JACINTO COUNTY-OTHER	204	8	Renew existing contract	Lake Livingston		1,118	1,114
HUNTSVILLE	236	8, 10	Renew existing contract	Lake Livingston	$940,000	9,209	9,209
WALKER COUNTY-OTHER	236	8, 10	Renew existing contracts	Lake Livingston		1,993	1,993
BROOKSHIRE	237	12	Municipal conservation, New contracts	BRA/COE System	$14,545,000	493	1,047
HEMPSTEAD	237	12	Municipal conservation, Allens Creek Reservoir, Little River Reservoir	Allens Creek Reservoir, Little River Reservoir	$7,041,000	82	381
KATY (P)	237	10	Municipal conservation, New contract	BRA/COE System		454	642
PRAIRIE VIEW	237	12	Municipal conservation, Allens Creek Reservoir, Little River Reservoir	Allens Creek Reservoir, Little River Reservoir	$10,754,000	290	1,181
WALLER COUNTY-OTHER	237	10	Municipal conservation, New Contracts, Allens Creek Reservoir, Little River Reservoir	BRA/COE System, Allens Creek Reservoir, Little River Reservoir		4,735	5,595
IRRIGATION	237	10	Irrigation conservation, New contracts, Little River Reservoir	BRA/COE System, Little River Reservoir		5,010	5,640

Table ES-10 (continued)

County Legend		Basin Legend
8 - Austin	157 - Madison	7 - Trinity-Neches Coastal Basin
20 - Brazoria	170 - Montgomery	8 - Trinity River Basin
36 - Chambers	187 - Polk	9 - Trinity-San Jacinto Coastal Basin
79 - Fort Bend	204 - San Jacinto	10 - San Jacinto River Basin
84 - Galveston	228 - Trinity	11 - San Jacinto-Brazos Coastal Basin
101 - Harris	236 - Walker	12 - Brazos River Basin
145 - Leon	237 - Waller	13 - Brazos-Colorado Coastal Basin
146 - Liberty		

(CDP) is an unincorporated, census-defined place
(P) is a partial municipality, split between counties

* This table is extracted from the Task 5 report, TWDB Table 12

** Capital Costs for municipalities reflect new or additional conveyance, storage and treatment facilities. Capital costs for major water supply strategies appear as follows:

Allens Creek Reservoir - Brazoria County Manufacturing
Bedias Reservoir and SJRA Transfer Pipeline- Montgomery County-Other
Little River Reservoir - Brazoria County Manufacturing
Wastewater Reuse - Harris County Manufacturing
Houston to GCWA Transfer - Galveston Manufacturing

Figure ES-1: Location Map

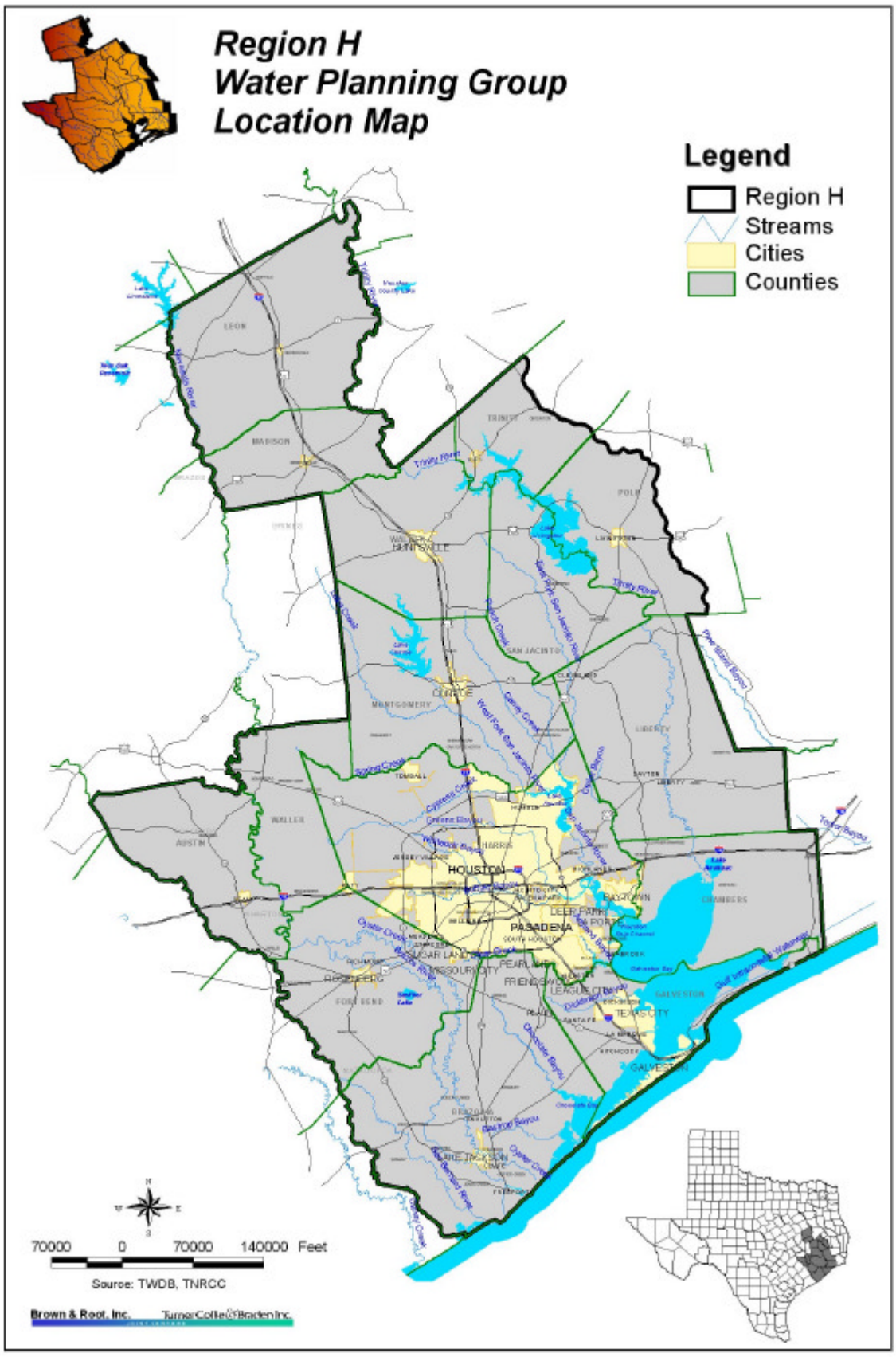


FIGURE ES-3. SUMMARY OF SOCIO-ECONOMIC IMPACTS OF NOT MEETING WATER NEEDS, REGION H, 2000 - 2050

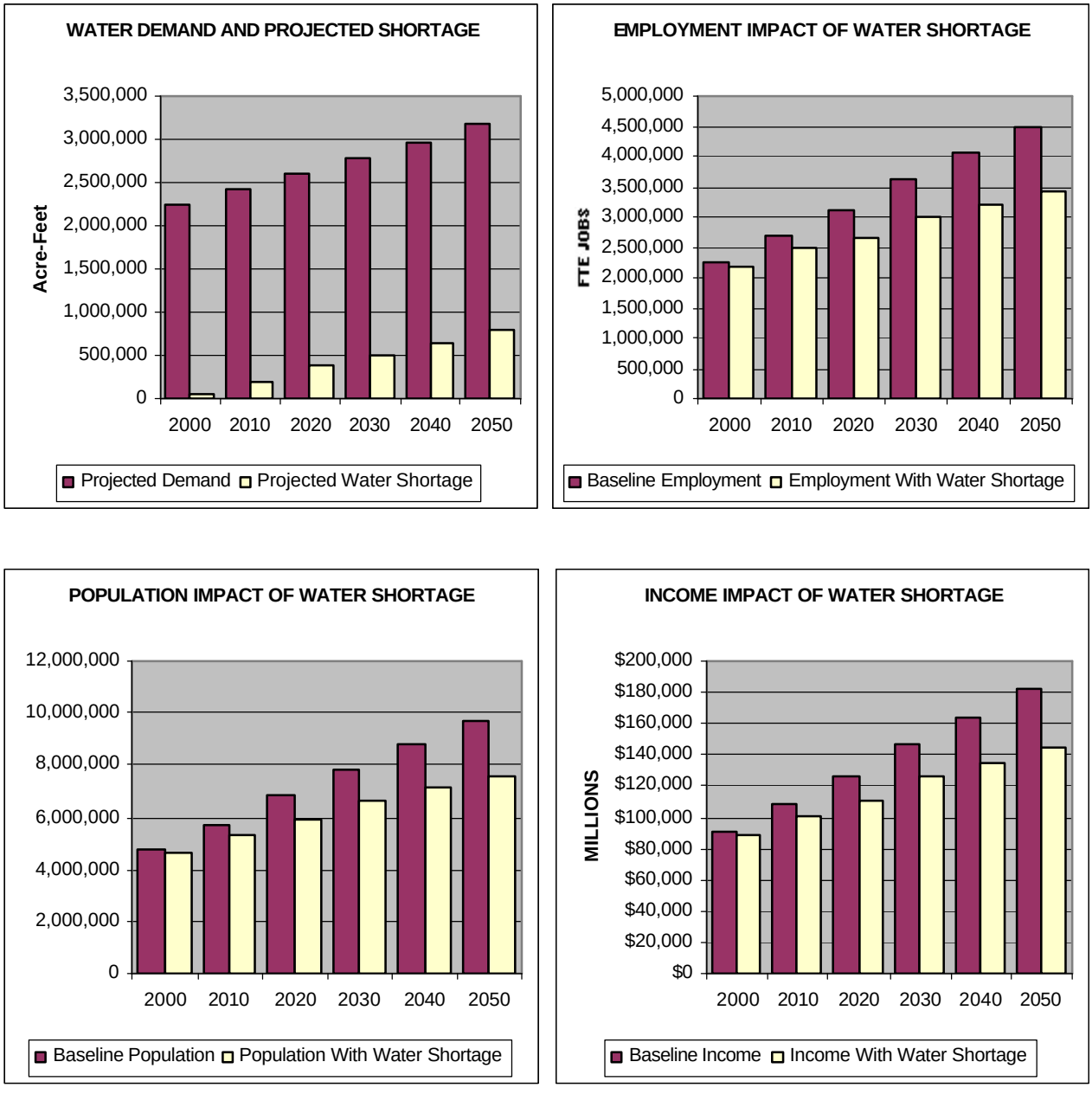


Table of Contents

Figures

Tables

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

1. Region H Water Management Plan: Description of Region

1.1. Regional Water Planning in Texas

The 1997 State legislature, through Senate Bill 1, determined that the Texas State Water Plan for the 2000 - 2050 time frame, would be developed through a regional water planning approach. To accomplish this task the Texas Water Development Board (TWDB) divided the state into 16 regional water planning areas and appointed representational Regional Water Planning Groups (RWPG) to guide the development of each region's plan. The TWDB will combine these 16 regional plans to form the next State Water Plan.

1.2. Description of Region H

Region H, located along the upper Texas coast, consists of all or part of 15 counties; Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity, Walker and Waller. The eastern portions of Trinity and Polk counties are included in the Region I planning area. The Region spans three river and four coastal basins in southeast Texas. Region H encompasses the San Jacinto River basin, the lower portions of the Trinity and Brazos River Basins, and includes part or all of the Brazos-Colorado, the San Jacinto-Brazos, the Trinity-San Jacinto and the Neches-Trinity coastal basins. This area includes the Galveston and Trinity Bay estuaries, the urbanized, rapidly growing Houston-Galveston Metropolitan Area encompassing Brazoria-Harris-Galveston-Ft. Bend and Montgomery counties, the coastal port communities of Galveston and Freeport, and agricultural areas in Austin, Chambers, Leon, Liberty, Madison, Polk, San Jacinto, Trinity, Walker and Waller counties. Figure 1 is a map of the Region H area. The Region H Water Planning Group (RHWPG) is a 25-member committee representing the diverse interests of the Region. Table 1 lists the RHWPG membership.

Figure 1: Region H Water Planning Area

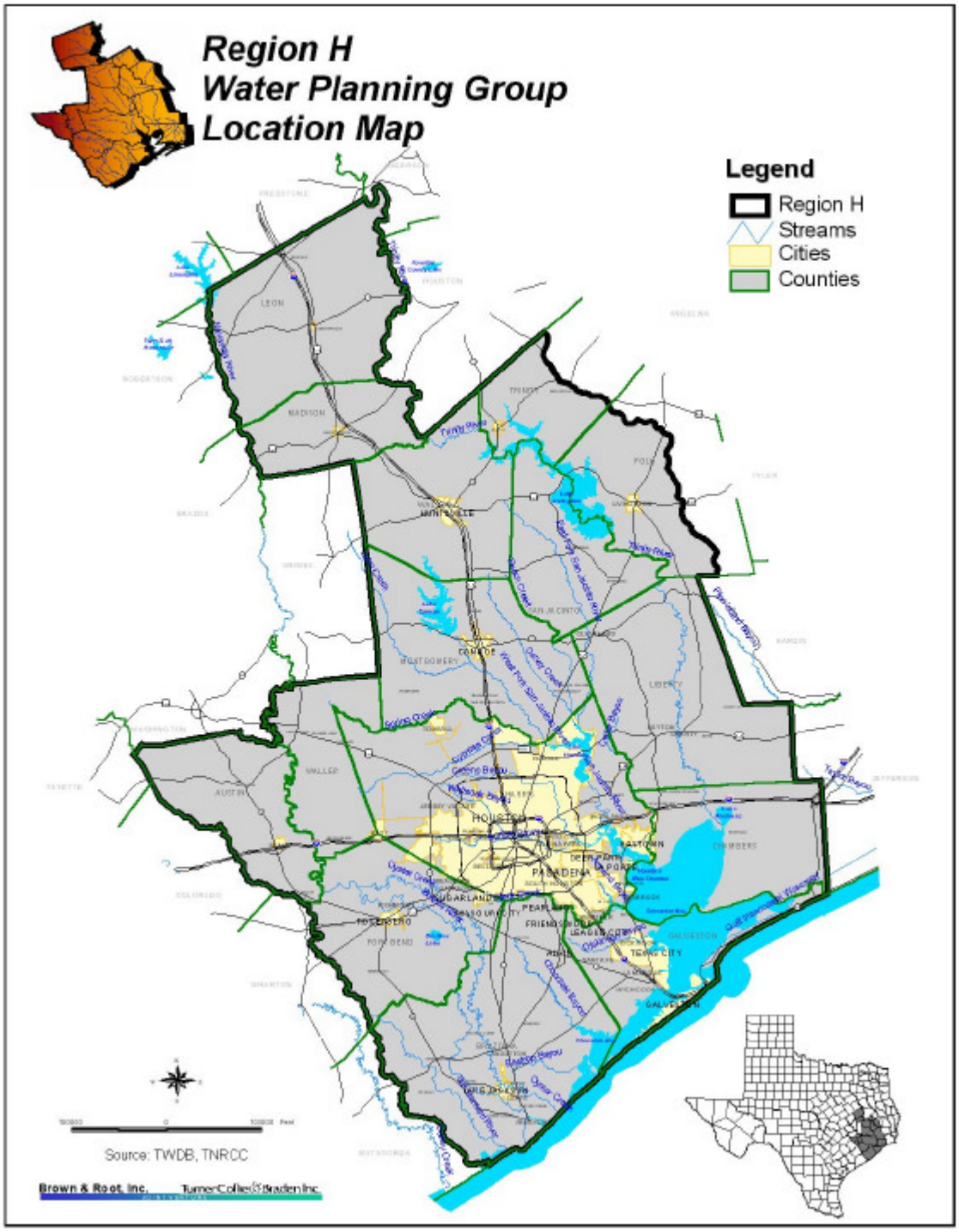


Table 1: Member Information for the Region H Water Planning Group

Executive Committee	
Office	**Officer**
Chair	Jim Adams, P.E. San Jacinto River Authority P.O. Box 329 Conroe, TX 77305-0329 Phone: (936) 588-1111 Fax: (936) 588-3043
Vice-Chair	Judge Mark Evans
Secretary	Ron Neighbors
At-Large	Michael Sullivan
At-Large	C. Harold Wallace
Offices	
Office	**Entity**
Administrative	Harris-Galveston Coastal Subsidence District
Political Subdivision	San Jacinto River Authority P.O. Box 329 Conroe, TX 77305-0329
Note: Administrative Office manages records. Political Subdivision is the entity eligible to apply for State grant funds.	

Table 1 (continued)

Voting Membership			
Interest	**Name** **Dates Served**	**Entity**	**County (Location of Interest)**
Public	Roosevelt Alexander March 1998 - Present	Retired	Waller
Counties	Judge Mark Evans March 1998-Present	Trinity County	Trinity
	Commissioner Jack Harris March 1998 - Present	Brazoria County Commissioners Court	Brazoria
	Gary Stobb, P.E. June 2000 - Present	Harris County	Harris
	Judge Robert Eckels March 1998 - June 2000	Harris County	Harris
Municipalities	Larry Taylor December 2000 - Present	City of Friendswood	Galveston
	Tom Manison March 1998 - Sept. 2000	City of Friendswood	Galveston
	Gary Oradat, P.E. November 1999 - Present	City of Houston	Harris, Ft Bend & Montgomery
	Fred A. Perrenot, P.E. April 1998 - Nov. 1999	City of Houston	Harris, Ft Bend & Montgomery
Industries	James Murray March 1998 - Present	Exxon-Mobil	Harris
	Carolyn Johnson March 1998 - Present	Dow Chemical	Brazoria

Table 1 (continued)

Voting Membership (Continued)			
Interest	**Name** **Dates Served**	**Entity**	**County (Location of Interest)**
Agricultural	Robert Bruner March 1998 - Present	Rancher	Walker
	David Jenkins July 1998 - Present	Rice Farmer	Chambers
Environmental	John Bartos March 1998 - Present	Galveston Bay Foundation	Harris
Small Businesses	Steve Tyler March 1998 - Present	Steve Tyler Creative Services	Trinity
	Mary Alice Gonzalez March 1998 - Present	Stewart Title - Fort Bend Div.	Fort Bend
	Michael Sullivan March 1998 - Present	Sea-Master Marine Coatings, Inc.	Harris
Electric Generating Utilities	Kerry Whelan April 1999 - Present	Reliant Energy	Harris
	Cynthia Schmidt March 1998 - April 1999	Houston Lighting & Power	Harris
River Authorities	Jim Adams, P.E. March 1998 - Present	San Jacinto River Authority	Montgomery (service in central part of Region H)
	Tom Ray March 1998 - Present	Brazos River Authority	McLennan (service in west and southwest part of Region H)
	Danny F. Vance March 1998 - Present	Trinity River Authority	Tarrant (service in east and southeast part of Region H)

Table 1 (Continued)

Voting Membership (Continued)			
Interest	**Name Dates Served**	**Entity**	**County (Location of Interest)**
Water Districts	J.C. Searcy, Jr. March 1998 - Present	Spirit of North Harris County Coalition	Harris
	Marvin Marcell July 1998 - Present	Fort Bend Subsidence District	Fort Bend
	Ron Neighbors March 1998 - Present	Harris-Galveston Coastal Subsidence District	Harris and Galveston
Water Utilities	James Morrison March 1998 - Present	Walker County WSC	Walker
	William Teer March 1998 - Present	Retired	Leon
	C. Harold Wallace March 1998 - Present	West Harris County Surface WSC	Harris

Table 1 (continued)

Non-Voting Members	
Name **Dates Served**	**Entity**
David Alders July 1998 - Present	East Texas RWPG (I)
Sterling Cornelius January 1999 - Dec. 2000	Texas Association of Nurserymen
Rick Gangluff July 1998 - Present	Lower Colorado RWPG (K)
Lacy Fryer April 1999 - Present	Texas Department of Agriculture
Tommy Hebert July 1998 - Present	Representative for extra-regional holder of 1,000+ acre-feet of water rights.
Larry Jacobs July 1998 - Present	Montgomery County Soil and Water Conservation District
Tony Jones July 1998 - Present	Brazos G RWPG
Phil Kaiser December 2000 - Present	Just Trees
Gordon Myers July 1998 - Present	Gulf Coast Water Authority
Ernest Rebuck March 1998 - Present	Texas Water Development Board
Danny Vance July 1998 - Present	Region C RWPG (also a voting member)
Woody Woodrow July 1998 - Present	Texas Parks and Wildlife Department

Governmental Authorities in Region H

While municipal and county governments are the primary governmental entities there are three regional councils of government represented in the region. The Houston-Galveston Area Council of Governments represents ten counties in the central and eastern part of the planning area, Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Walker and Waller Counties. The Brazos Valley Council of Governments includes Leon and Madison counties, the two northwestern counties of the region. The Deep East Texas Council of Governments represents Trinity, Polk and San Jacinto counties located in the northeastern part of Region H.

In addition to these regional councils there are several other entities with regulatory or management authority of importance to long range water planning for the region. The State exercises certain responsibilities over water planning, supply and quality through the Texas Water Development Board (TWDB), the Texas Natural Resource Conservation Commission (TNRCC), and Texas Department of Parks and Wildlife (TPWD). Points of contact for these state agencies are listed in Table 2. Three river authorities manage surface water supply in the region's three river basins: the Brazos River Authority, the San Jacinto River Authority and the Trinity River Authority. There are eleven soil and water conservation districts within Region H. Two groundwater management districts in Region H, the Fort Bend Subsidence District and the Harris-Galveston Coastal Subsidence District, have the authority to regulate groundwater withdrawals.

During the planning period, two new regional water planning entities were formed: the North Harris County Regional Water Authority and the Mid-Brazoria County Regional Water Planning Group. Also during the planning period, Austin, Leon and Madison Counties took the initial steps towards establishing groundwater conservation districts.

Table 2: State Agencies with Oversight of Water Planning

Texas Water Development Board

William Mullican,
Director, Water Resource Planning
PO Box 13231, 1700 N. Congress Ave., Austin, TX 78711-3231
(512) 936-0813

Ernest Rebuck, P.E.
Assistant Director, Water Resources Planning
PO Box 13231, 1700 N. Congress Ave., Austin, TX 78711-3231
(512) 936-2317

Texas Natural Resource Conservation Commission

Jeffrey Saitas
Executive Director
12500 Park 35 Circle, Austin, TX 78753
(512) 239-3900

Texas Parks and Wildlife Department

Andrew Sansom
Executive Director
4200 Smith School Road, Austin, TX 78744-3291
(512) 389-4800

General Economic Conditions

Two thirds of all U.S. petrochemical production and almost a third of the nation's petroleum industries are located in Region H. The area provides some of the states most popular vacation spots that, in 1994, generated approximately $390 million dollars. That year the Port of Houston handled 184.9 million tons, to make it the second busiest port in the nation. In 1995 the Houston area employed 1.75 million people or 22 percent of the state's total employment. Region H is generally characterized by urbanizing land uses and broad-based economic development. In areas outside of the urban core agriculture dominates economic activities. The region supports six primary economic sectors: services, manufacturing, transportation, government, agriculture and fishing.

The service sector employs the greatest number of people in Region H. Medical specialties are concentrated at the Texas Medical Center in Houston and the University of Texas Medical Branch in Galveston. Tourism is also a major industry for both Galveston and Houston.

The region's manufacturing industry is based on the historically important energy industries. Petroleum refining and chemical production are the largest two industries in the region. Technology and biotechnology firms have contributed to the diversification of the region's economic base. Petro-chemical, chemical and pulp and paper industries are major employers outside of the urban core of the region.

The transportation industry includes the Port of Houston and the Houston Ship Channel, the second largest port in the nation. A well-developed highway system and rail connections support this activity. The Gulf Intracoastal Waterway connects the ports of Freeport, Galveston, Houston and Texas City.

Government sector jobs are disbursed throughout the region, with the Texas Department of Corrections a major employer at prisons located in the region. The Johnson Space Center has program management responsibility for the International Space Station, ensuring continued economic importance into the next decade. There are numerous colleges in the region, and local school districts continue to grow and expand with population increases.

The agricultural industry, while providing limited numbers of jobs, contributes significantly to the region's economy. Major agricultural crops in the region include rice, soybeans, vegetables and hay. Cattle are the principal livestock, followed by horses and hogs.

Fishing, both commercial and sport, within Galveston Bay is a major contributor to the local economic base. One third of the state's commercial fishing income and one half of the state's expenditures for recreation fishing come from Galveston Bay. Oysters, shrimp and finfish are important commercial species in the bay.

1.3. Population and Water Demand in Region H

Based on the TWDB estimates the total 1996 estimated population for Region H is approximately 4,328,800. Approximately 69% (2,995,500) of this population resides in 98 cities and towns with populations of over 500 persons, 16 of these cities have populations in excess of 25,000.

Table 3 lists the cities with over 25,000 persons and their 1996 estimated population and associated retail water demand. The balance of the population resides in smaller communities or the unincorporated portions of the 15 counties of the region.

Table 3: Cities with Populations Over 25,000

City	1996 Population Estimate	1996 Reported Municipal Use (acre-feet/year)
Baytown	69,010	10,200
Conroe	39,837	6,124
Deer Park	30,055	4,077
Friendswood	30,583	4,012
Galveston	63,857	15,165
Houston	1,709,476	355,064
Huntsville	34,594	4,683
La Porte	31,284	3,739
Lake Jackson	24,829	3,564
League City	41,331	5,032
Missouri City	50,719	8,276
Pasadena	130,168	18,930
Pearland	25,291	3,836
Rosenberg	26,741	3,070
Sugar Land	44,009	6,516
Texas City	41,475	6,979

Source: Texas Water Development Board

The 1996 estimated total county populations and water use are listed in Table 4. Detailed information on local, county and regional population estimates and projections for the 50-year planning period are included in the Task 2 Report of this plan. In 1996 municipal uses accounted for 41 percent of the region's total reported water use. In addition to municipal water use, 1996 estimates of other water use types were prepared by the TWDB for use in the planning process.

Table 4: Estimated County Population and Municipal Water Demand

County	1996 Population Estimate	1996 Reported Municipal Use (acre-feet/year)
Austin	22,222	3,384
Brazoria	217,318	31,487
Chambers	24,165	3,735
Fort Bend	272,245	46,075
Galveston	239,292	40,614
Harris	3,087,153	586,993
Leon	13,446	1,794
Liberty	62,843	8,942
Madison	12,139	2,270
Montgomery	236,192	38,430
Polk*	27,921	4,254
San Jacinto	18,076	2,297
Trinity*	8,293	1,059
Walker	55,879	10,657
Waller	26,573	4,697
Region H Total	4,323,757	786,688

* Includes portion of the county in the Region H area
Source: Texas Water Development Board

Manufacturing uses accounted for 34 percent and irrigation uses represented 19 percent of the region's total 1996 reported use. Figure 2 illustrates the distribution of 1996 water demand by use type. Total water demand for each county are listed in Table 5.

Figure 2: Percentage of 1996 Total Water Demand by Use

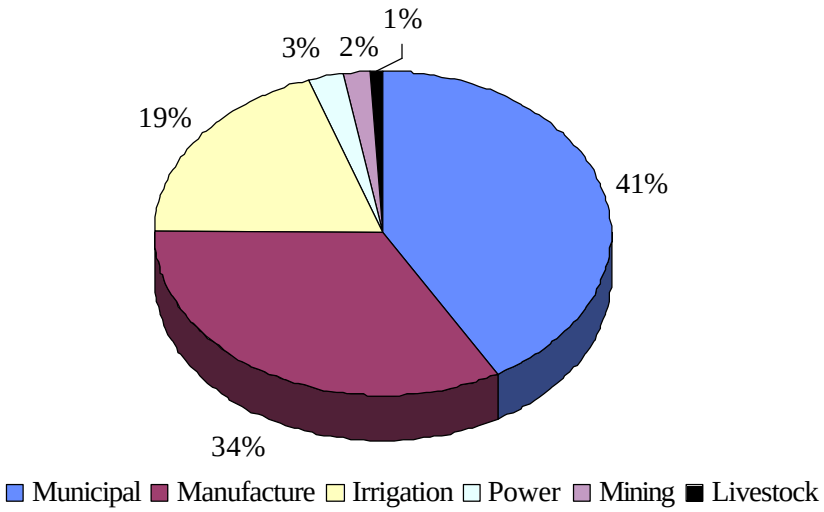


Table 5: Reported 1996 Non-municipal Water Use

County	Manu	Irrigation	Mining	Power	Livestock	Total
Austin	172	9,627	58	0	1,925	11,782
Brazoria	202,846	76,285	1,494	0	1,836	282,461
Chambers	5,393	122,752	19,490	767	448	148,850
Fort Bend	14,108	48,609	205	31,527	807	95,256
Galveston	50,705	10,342	521	1,287	198	63,053
Harris	362,849	15,300	2,470	13,223	923	394,765
Leon	290	0	2,789	0	1,768	4,847
Liberty	267	61,503	8,748	0	467	70,985
Madison	194	19	23	0	1,777	2,013
Montgomery	1,375	0	341	4,986	397	7,099
Polk*	4	0	24	0	220	248
San Jacinto	26	1	36	0	295	358
Trinity*	0	0	8	0	225	233
Walker	258	11	12	0	624	905
Waller	74	23,396	1,031	0	1,787	26,288
Region H Totals	638,561	367,845	37,250	51,790	13,697	1,109,143

* Includes the portion of the county in Region H.
Source: Texas Water Development Board

Major Demand Centers

Major demand centers are locations or water uses that require a significant portion of the region's water supply. As would be expected major urban areas with large populations and major industrial development are typically major demand centers. In Region H major demand centers are defined for municipal, manufacturing and irrigation uses as having a reported 1996 use, by use type, exceeding 25,000 acre-feet for counties and 10,000 acre-feet for cities.

Harris County has the greatest overall water demand in the region, as was shown in Tables 2 and 3. The next highest demands are Brazoria, Chambers, Fort Bend and Galveston counties. Harris County and the City of Houston dominate municipal water use in Region H. The City of Houston used 355,064 acre-feet or 45 percent of the total regional municipal use. As shown in Table 6, Brazoria, Fort Bend, Galveston and Montgomery Counties are major demand centers with 1996 reported use in excess of 25,000 acre-feet. In addition to the City of Houston, municipalities identified as major demand centers (reported municipal demands in excess of 10,000 acre-feet in 1996) include the cities of Pasadena, Galveston and Baytown, although their combined demands are less than one-tenth that of the City of Houston.

Table 6: Major Municipal Demand Centers

County/City	1996 Municipal Use (acre-feet)
City of Houston	355,064
Harris County (excluding Houston)	238,669
Fort Bend	46,075
Galveston	40,614
Montgomery	38,430
Brazoria	31,487
City of Pasadena	18,930
City of Galveston	15,165
City of Baytown	10,200

Source: Texas Water Development Board

The largest manufacturing demand center is Harris County, which used 362,849 acre-feet of water in 1996 (57 percent of the regional total). Two other major demand centers are identified; Brazoria County, with reported 1996 manufacturing use of 202,846 acre-feet, and Galveston County with a reported 1996 manufacturing use of almost 51,000 acre-feet. The principal water using industries in the region are Petroleum Refining, Chemical Products and Pulp and Paper Mills. The three largest manufacturing demand centers are shown in Table 7.

Table 7: Major Manufacturing Demand Centers

County	1996 Manufacturing Use (acre-feet)
Brazoria	202,846
Galveston	50,705
Harris	362,849

Source: Texas Water Development Board

The four largest irrigation demand centers are Chambers, Brazoria, Liberty and Fort Bend counties. Table 8 defines each county's reported 1996 irrigation use. The major irrigated crops in the region are rice, soybeans, vegetables and cotton.

Livestock and mining water use represent smaller demands in the Region H area. Mining water demands in Region H are associated primarily with oil and gas production.

Table 8: Major Irrigation Demand Centers

County	1996 Irrigation Use (acre-feet)
Chambers	122,752
Brazoria	76,285
Liberty	61,503
Fort Bend	48,609

Source: Texas Water Development Board

1.4. Region H Water Supply Sources and Providers

Groundwater, surface water captured in reservoirs and run-of-river sources comprise the available water supply within a river basin. Reused and recycled water and saline sources are additional supply sources utilized in Region H.

Groundwater Sources

Four aquifers supply groundwater within the Region H area. The aquifer that furnishes the most groundwater within the area is the Gulf Coast aquifer. This aquifer is composed of the Evangeline, Chicot and Jasper formations and extends from near the shoreline to approximately 100 to 120 miles inland, to Walker and Trinity counties. The other major aquifer in the study area is the Carrizo-Wilcox, which begins 115 to 125 miles inland and extends beyond the northern boundary of the region. There are also three minor aquifers in this part of the state; the Sparta and Queen City aquifers occur in Leon County, the southern part of Madison County and northern parts of Walker and Trinity Counties. In Leon and Madison Counties, they lie above the Carrizo-Wilcox Aquifer. The Brazos River alluvium occurs along the main stem of the Brazos as it passes through the region, except in Brazoria County. Figure 3 and Figure 4 illustrate these groundwater sources. Groundwater use is regulated in Harris and Galveston counties due to the potential for aquifer over-drafting, and regulations are pending for Fort Bend County. The groundwater resources of Montgomery County are being developed relatively rapidly due to urbanization and future pumpage could reach the aquifers sustainable yield. Gulf Coast Aquifer supplies within the remaining Region H counties appear to be limited. Groundwater withdrawals in 1996 accounted for approximately 34 percent of the total regional water supply.

Surface Water Sources

Surface water sources in Region H are reservoir storage and run-of-river supply for the three rivers in the area, the Trinity, the San Jacinto and the Brazos. There are no major springs located within Region H. The following discussion of each basin's surface water supply is based upon information in the Trans-Texas Water Program *SE Area Phase I*

Figure 3: Region H Major Groundwater Sources

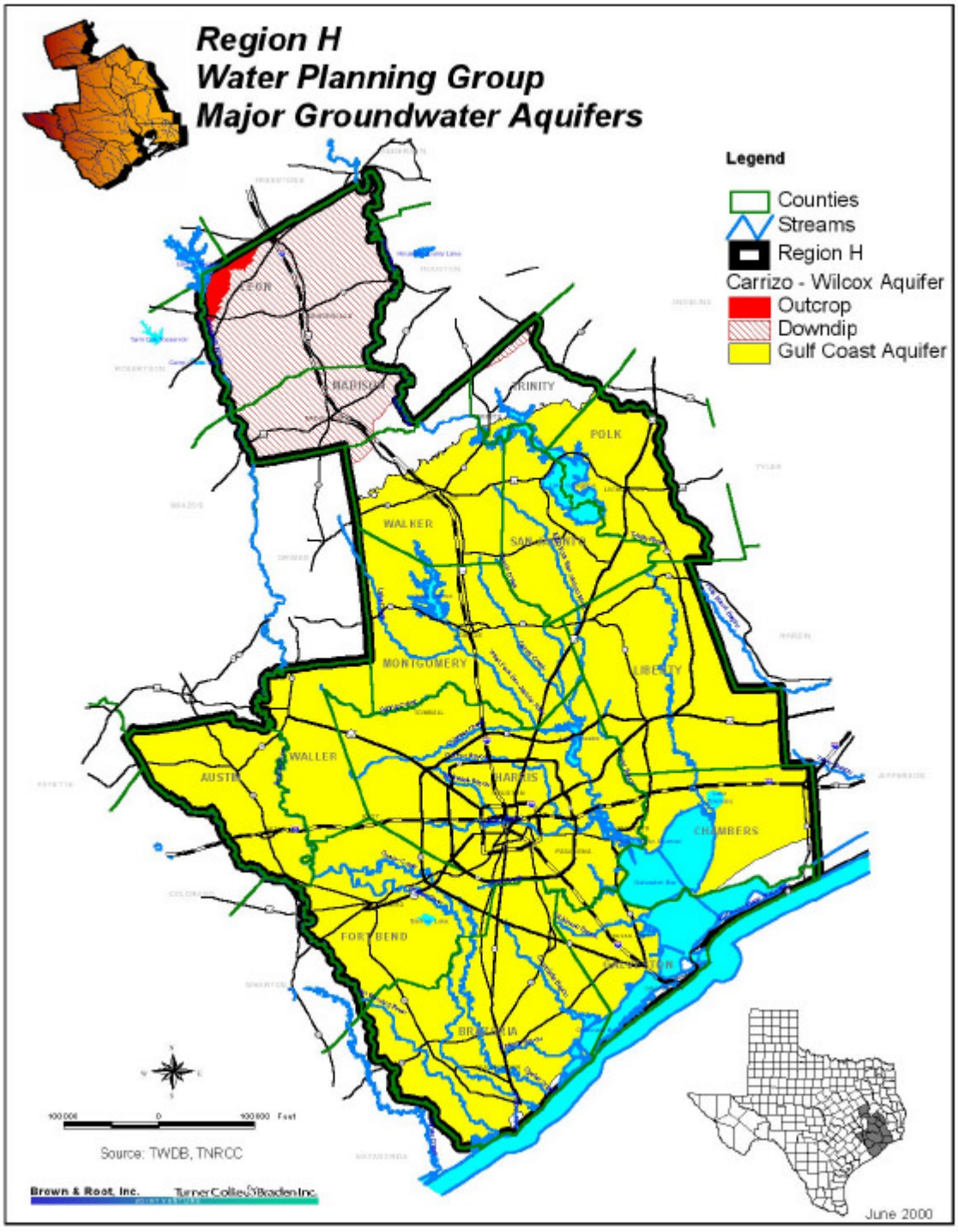


Figure 4: Region H Minor Groundwater Sources

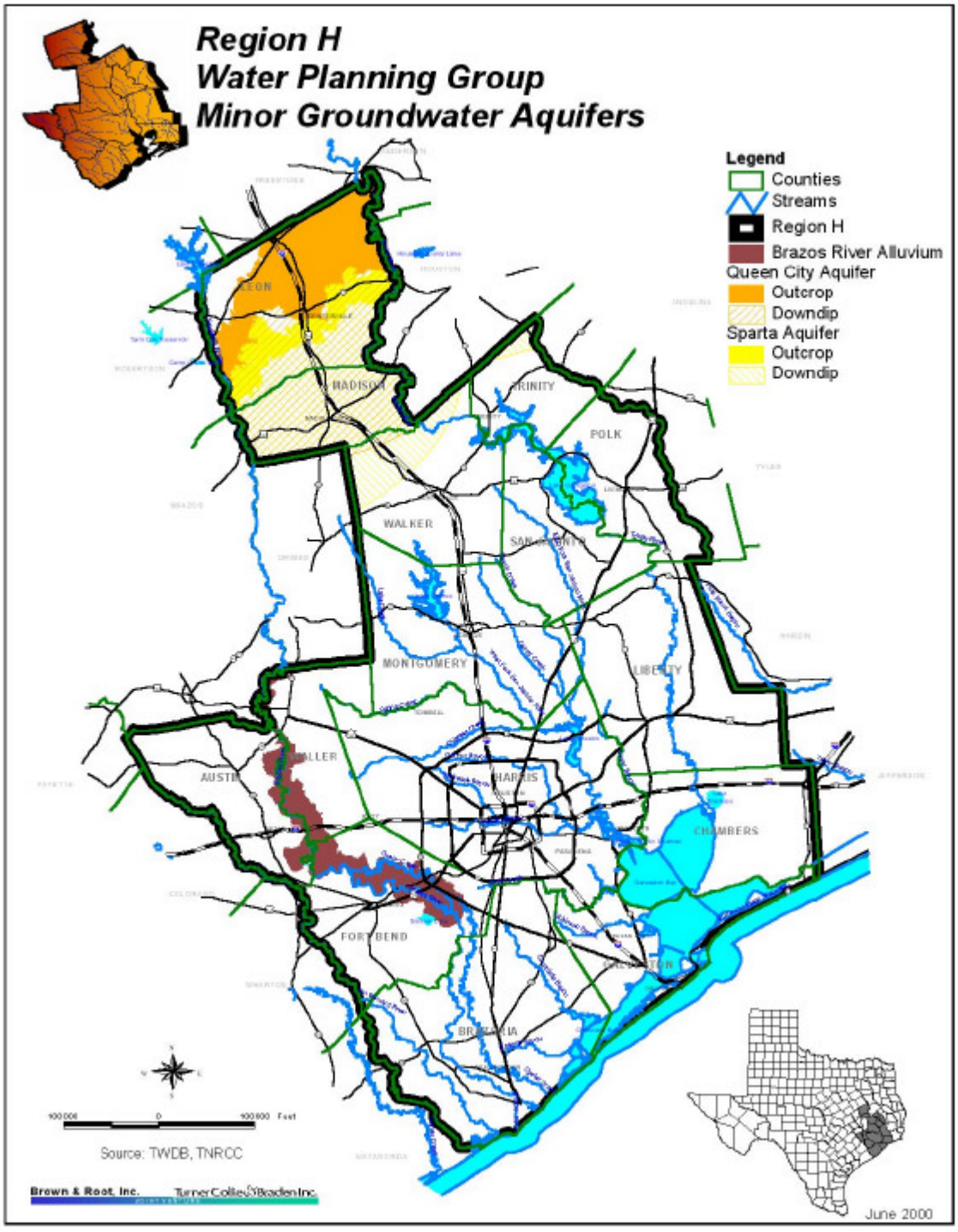
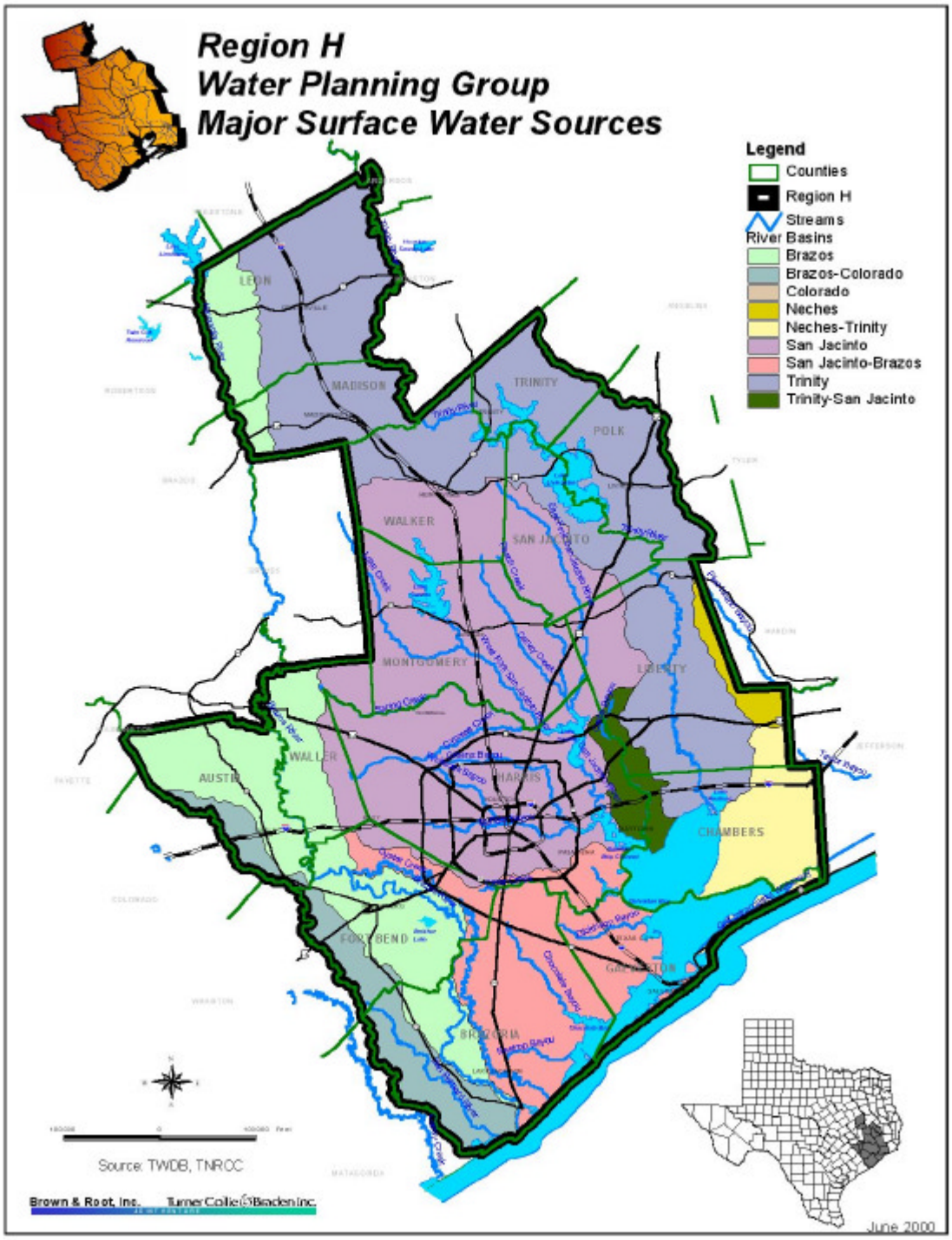


Figure 5: Region H Surface Water Sources



Report (1994) and *Planning Information Update* (1996), and *Water for Texas* (1997). Figure 5 illustrates the region's surface water sources. A selected bibliography of related references is included at Appendix A.

Trinity River Basin

The Trinity River basin contains two water projects, Lake Livingston and the Wallisville salt water barrier. The City of Houston and the Trinity River Authority (TRA) sponsored Lake Livingston's construction. It is operated by the TRA to meet the service demands of the City of Houston and other local users in the Trinity Basin and in the Neches-Trinity Coastal Basin. The U.S. Army Corps of Engineers recently completed the Wallisville Saltwater Barrier. These two projects are operated as a system, Livingston primarily to store water and Wallisville to control the migration of salt water from Trinity Bay. Lake Livingston and Wallisville computed yields are 1,255,500 acre-feet/year and 89,700 acre-feet/year respectively. The sum of these permitted yields is the combined yield of the system (1,345,200 acre-feet per year). Additional run-of-the-river water supplies downstream of Lake Livingston total 180,320 acre-feet per year. These supplies are associated with the water rights agreements established at the time of Lake Livingston permitting.

San Jacinto River Basin

The San Jacinto River Basin has two major public water supply reservoirs, Lake Houston and Lake Conroe. Lake Houston, with a permitted yield of 151,400 acre-feet/year, is owned and operated by the City of Houston for use in its service area. The City of Houston, and San Jacinto River Authority (SJRA) jointly own Lake Conroe with the City holding two-thirds of the permitted rights (66,667 acre-feet/year) and SJRA holding one-third (33,333 acre-feet/year). SJRA manages Lake Conroe providing supply to the City of Houston and other local users. The SJRA has additional run-of-the-river water rights of 55,000 acre-feet per year. Lewis Creek Reservoir has a permitted yield of 6,300 acre-feet per year and provides supply for hydroelectric power generation.

Brazos River Basin

The Brazos River Authority (BRA) manages the water supply resources from 13 reservoirs within this basin. Several of these reservoirs are operated by BRA as a System Operation where commitments made to downstream demands can be met from any upstream reservoir storage available in the system. The U.S. Army COE owns 9 of these reservoirs and BRA owns four reservoirs within the basin. In addition to the BRA water supply reservoirs, there are several other reservoirs in the basin. While none of these reservoirs are located within the Region H area, supply from the "system" is committed in Region H.

The total Brazos Basin supply is estimated at over 1,200,000 acre-feet per year and the estimated yield from BRA's reservoirs is over 600,000 acre-feet per year. Over 450,000 acre-feet per year is committed under contracts to various entities upstream of Region H with approximately 137,300 acre-feet per year used in the Region H area. Lower-Brazos River Basin run-of-river permits in excess of 454,600 acre-feet per year have been granted. Previous studies suggest that only 211,000 acre-feet per year of run-of-river supplies may be 100 percent reliable.

San Jacinto - Brazos Coastal Basin

There are several significant water users within the San Jacinto-Brazos Coastal Basin supported by the run-of-river water supplies from the Brazos Basin. These users include the Chocolate Bayou Water Company (80,000 acre-feet per year), Dow Chemical (280,000 acre-feet per year), and the Richmond Irrigation/Houston Lighting & Power (40,000 acre-feet per year). Each of these entities diverts surface water from the Brazos River and enhances the reliability of their supplies through off-channel surface reservoirs.

Use by Source

TWDB reports that Region H used 1,859,831 acre-feet of water in 1996. Of that, 653,227 acre-feet (35.1%) came from groundwater wells, and 1,242,604 acre-feet (64.9%) came from rivers and other surface sources. Industrial water users (principally chemical industry users) in the region used an additional 1,069,171 acre-feet of saline

(sea) water and the petroleum industry reported the reuse of a total of 3,164 acre-feet of treated effluent. Table 7 lists the estimated year 2050 dependable yields available from existing and under construction reservoirs in the various basins of Region H. Table 8 summarizes these data and Figure 6 illustrates the groundwater - surface water usage for each water use type

Table 9: Projected 2050 Surface Reservoir Yields Available for Use in Region H[1]

Basin/Reservoir/Run-of-River	Projected 2050 Yield (acre-feet/year)
Trinity Basin	
Lake Livingston/Wallisville	1,345,200
Run-of-River	180,320
San Jacinto River Basin	
Lake Houston	151,400
Lake Conroe	99,950
Other Reservoirs	6,300
Run-of-River	55,000
Brazos River Basin	
Brazos River Authority System[2]	137,300
Run-of-River	211,000 - 454,600
Total Existing Surface Reservoir Yield Available in the Region H Area	2,186,470 - 2,430,070

[1] Adapted from Trans-Texas Water Program Southeast Area *Phase I Report,* Table 3.3, 1994, *Planning Information Update*, Table 9, 1996, and *Water for Texas*, 1997.

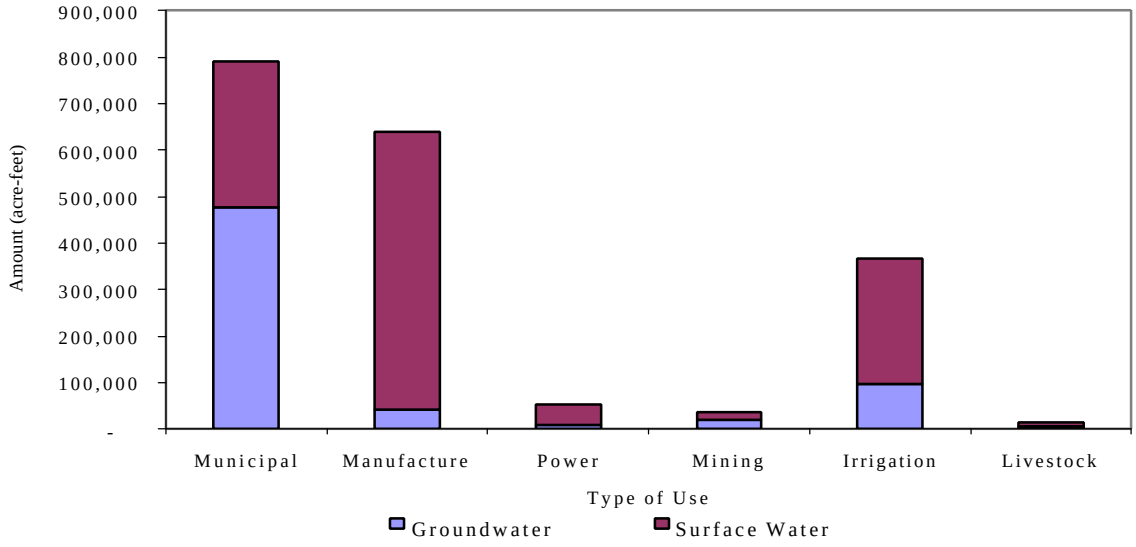
[2] Based upon long-term contract amounts.

Table 10: 1996 County Water Use by Source

County	Ground Water (acre-feet)	Surface Water (acre-feet)	Total Use (acre-feet)
Austin	13,500	1,666	15,166
Brazoria	34,623	279,325	313,948
Chambers	10,812	141,773	152,585
Fort Bend	89,802	54,529	141,331
Galveston	3,670	99,997	103,667
Harris	386,433	595,325	981,758
Leon	4,207	2,434	6,641
Liberty	25,354	54,573	79,927
Madison	4,060	223	4,283
Montgomery	41,683	3,846	45,529
Polk	2,801	1,701	4,502
San Jacinto	2,299	356	2,655
Trinity	611	681	1,292
Walker	7,175	4,387	11,562
Waller	29,197	1,788	30,985
Totals	653,227	1,242,604	1,895,831

Source: TWDB Annual Survey of Ground and Surface Water Use

Figure 6: Water Use by Source



Major Water Providers

A major water provider is an entity that delivers and sells a significant amount of raw or treated water for municipal and/or manufacturing use on a wholesale and/or retail basis.[3] Generally major providers serve as a primary water source for a significant portion of the region's municipal or industrial water users and are those entities likely to develop future major water supply projects. As in the rest of the state, Region H has relatively few entities that hold the rights to significant amounts of water, particularly surface water, and provide retail or wholesale water supplies to a significant number of area users.

Five entities in Region H own over 100,000 acre-feet per year of municipal and/or industrial water rights. Their total holdings represent approximately 62 percent of the region's municipal and industrial water rights. The Chocolate Bayou Water Company and the Chambers-Liberty Counties Navigation District each has rights to over 100,000 acre-feet per year, but their supplies are primarily for irrigation. Additionally, portions of these supplies are not 100 percent reliable. These entities are listed in Table 11 along with other substantial water rights holders.

Table 11: Major Region H Municipal and Industrial Water Rights

Provider	Permitted Amount (acre-feet/year)
City of Houston	1,258,829
Gulf Coast Water Authority	236,932
Trinity River Authority *	403,200
Chocolate Bayou Water Co.	212,500
San Jacinto River Authority	146,421
Brazos River Authority *	137,300
Brazosport Water Authority	45,000
Chamber-Liberty County Navigation Dist.	103,146

* Portion available within Region H only

Source: TNRCC Master Water Rights

[3] TWDB Guidelines on the Definition of Major Water Providers. 1999.

A total of 2,319 public water suppliers deliver water to communities and businesses in Region H. A review of these suppliers indicates that 70 percent serve fewer than 500 customers. Of the 735 municipal providers serving 500 or more customers in 1996, 5 municipal water providers reported the use of 51 percent of the total municipal supply with the City of Houston being the largest public water system provider, the largest rights holder in the region and the largest retail provider. Table 12 lists public water systems with over 10,000 connections or wholesalers that sold over 10,000 acre-feet of water in 1996. Note that many of these entities either hold significant rights or purchase their water supplies from one or more of the major rights holders identified in Table 9. One other group of water rights holders should be noted, industrial entities that hold large manufacturing use water rights to provide for plant operations. These entities, listed in Table 13, generally do not act as providers to other industrial customers.

Table 12: Other Large Wholesale and Retail Providers

System Name	Retail Connections	Retail Population	Annual Use (acre-feet/year)
City of Houston -Public Works	527,424	1,608,000	319,387
City of Pasadena	32,753	114,000	22,937
Houston - Greenspoint	24,009	76,323	10,418
Clear Lake City Water Auth.	23,138	69,414	8,838
City of Galveston	20,423	31,149	16,217
City of Baytown	18,000	70,000	10,686
City of Houston - UD #5	15,315	45,951	7,150
City of Conroe	13,205	32,000	7,449
City of Texas City	12,800	38,400	6,804
City of Huntsville	12,350	34,592	5,653
City of League City	12,000	36,000	4,234
City of Sugarland - annexed area	10,603	29,370	6,463
City of Friendswood	10,025	30,075	2,885
Soda Water Supply Corp.	471	1413	25,577
Pine Shadows Water System	160	480	12,336
Baytown Area Water Auth.	8	25	11,200
Gulf Coast Water Auth.-Webster	2	N/A	19,983
Gulf Coast Water Auth -Tx City	1	95000	18,709

Table 13: Large Industrial Water Rights Holders

Industrial Water Rights Holder	Fresh Water Permits (acre-feet/year)
Dow Chemical Company	280,000
Reliant Energy / HL&P	166,238
Occidental Chemical Corporation	140,000
Phillips Petroleum Company	39,880

1.5. Water Quality and Natural Resources

Water Quality

TNRCC published *The State of Texas Water Quality Inventory* in 1996 addressing water quality in light of recent Federal Clean Water Act amendments. Also that year, participating water authorities compiled and published their *Regional Water Quality Assessments* as part of the Texas Clean Rivers Program. These reports established the condition of each river and stream segment and identified those segments with water quality concerns for a number of parameters. In Region H, the Brazos, San Jacinto and Trinity River Authorities participate in the Texas Clean Rivers Program and have each published reports on the water quality conditions within their respective basins.

Groundwater within the region is generally of good quality, with total dissolved solids below 1,000 mg/l. Iron is a concern in some portions of the Carrizo-Wilcox Aquifer, and calcium, magnesium and sulfate cause high total hardness in portions of the Brazos River Alluvium. Surface water throughout Region H is treated for municipal use using conventional measures. Contact recreation use is limited in the Lower Trinity River due to fecal coliform bacteria levels. Growth in the San Jacinto River Basin has increased nutrient loading and fecal coliform levels in many streams, particularly Buffalo Bayou. Likewise, nutrients, dissolved minerals and elevated fecal coliform levels have been identified in the Lower Brazos River. Also of concern in the Lower Brazos River are seasonal low flows, which allow the tidal salt-wedge to reach municipal and industrial freshwater intakes in Freeport.

Topography

Region H is located in the Gulf Coastal Plains of Texas. It is primarily made up of two vegetational areas, the Gulf Prairies and Marshes and the Piney Woods.

The Gulf Prairies make up the majority of the region. They hold marsh and saltwater grasses in tidal areas, and bluestems and tall grasses inland. Oaks, elms and other hardwoods grow in limited amounts. The natural grasses make the region ideal for cattle grazing, and the fertile soils support rice, cotton, wheat and hay farming as well. Wildlife in the area includes alligator, river otter, Attwater's prairie chicken, eastern brown pelican, Eskimo curlew, piping plover and whooping crane. Counties in the Gulf Prairie include Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris and Waller.

The Piney Woods encompass the northeastern portion of Region H, consisting of pine forests interspersed with native and improved grasslands. Longleaf, shortleaf and loblolly pine are the dominant native species harvested, but slash pine and various hardwood species are cultivated as well. Timber production and cattle are the principal agricultural products in that portion of the region. Wildlife in the area includes bobcat, ringtail, river otter, red-cockaded woodpecker and bald eagle. Counties in the Piney Woods include Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity and Walker.

Public Lands

The Region contains 325,394 acres of state and national forests, supporting hiking, camping, picnicking and horseback riding. It also contains 107,138 acres of coastal wildlife refuges for migratory waterfowl, as well as native waterfowl and plant species. It contains a portion of the Big Thicket National Preserve, designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as part of the International Biosphere Reserve. Finally, the region holds 12,170 acres of Texas Wildlife Management Areas, preserved for bird watching in coastal areas and seasonal hunting inland. The area names and locations are presented in Table 14, and a location map is provided at Figure 7.

Table 14: Public Lands

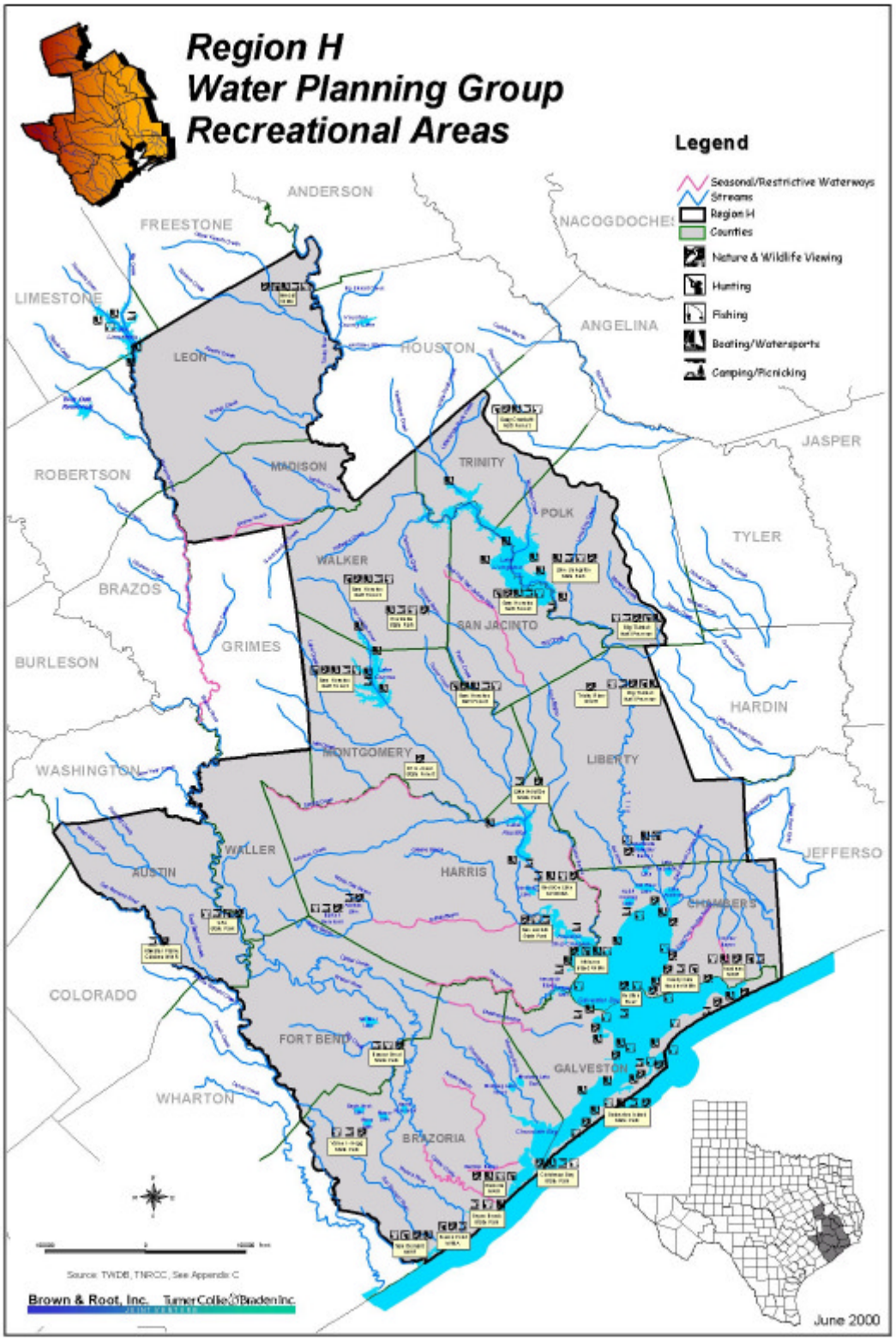
Resource Area	Acreage	County
State and National Forests		
W. Goodrich Jones State Forest	1,725	Montgomery
Davey Crockett National Forest	162,012	Total
	67,329	Trinity
Sam Houston National Forest	161,657	Total
	47,777	Montgomery
	60,247	San Jacinto
	53,633	Walker
Big Thicket National Preserve	86,000	Total
National Wildlife Refuges		
Anahuac NWR	30,000	Chambers
Brazoria NWR	42,338	Brazoria
San Bernard NWR	28,000	Brazoria
Trinity River NWR	6,800	Liberty
Texas Wildlife Management Areas		
Candy Cain Abshier WMA	207	Chambers
Atkinson Island WMA	151	Harris
Keechi Creek	1,500	Leon
Peach Point	10,312	Brazoria

Source: Texas Almanac, Texas Parks & Wildlife Department

Navigation

Navigation within Region H rivers is generally limited to the lower reaches of the main stems of the Brazos, San Jacinto, and Trinity Rivers including the Houston Ship Channel and Turning Basin. In addition the Gulf Coast Intracoastal Waterway, an inland canal system that connects ports in the Gulf of Mexico, traverses the Region H coastline through the ports of Galveston and Freeport. There is significant use of rivers, streams and reservoirs throughout the region by recreational boaters and fishermen. There are no navigation water permits in the Region H area.

Figure 7: Public Lands within Region H



1.6. Existing Water Planning

Existing Regional and Local Water Management Plans

The Region H area was part of The Trans-Texas Water Program (TTWP): Southeast Area, a comprehensive water resource planning program created to evaluate a full range of water management strategies for a 32 county area of East Texas. This area encompassed all of Region H, plus the lower Sabine River Basin and portions of the middle Brazos River Basin. *The Phase II Report* (1998) identified a regional long-term shortage by the year 2035. To meet that need, the following management techniques were studied further: water conservation, wastewater reclamation, use of existing reservoir surplus supply, coordinated reservoir system operation, interbasin transfers and contractual transfers.

Technical studies of these management techniques were completed in Phase II of the TTWP. The *Phase II Report* (1998) determined that the Southeast Area could develop adequate supplies to meet expected regional demands, and export water to Central Texas (Regional Planning Regions L and N). Various management strategies would need to be implemented to accommodate growth in the different geographic areas across the fifty-year planning period. Water conservation, wastewater reclamation and coordinated systems operations strategies would extend the period of adequate supply, allowing additional time to plan and develop new water sources. The Allen's Creek Reservoir in the Brazos River Basin, with a yield of approximately 70,000 acre-feet per year, was reported as a potentially feasible project. Contractual transfers were identified that would align surface water rights with the owner's service areas, shortening conveyance systems. Finally, sustained interbasin transfers from the Toledo Bend Reservoir in the Sabine River Basin to the Trinity and San Jacinto River Basins were also reported as feasible strategies to meet the growing needs of the region and areas of central Texas.

Other previously completed regional water supply plans include the City of Houston Master Plan, Brazos River Authority Long-Range Resource Plan, the San Jacinto River Authority Water Resources Development Plan, and the Trinity River Basin Master Plan.

Within Region H, the BRA plan also recommends development of the Allen's Creek Reservoir. The SJRA plan recommended development of two reservoirs, Lake Creek and Spring Creek. These projects were tabled when the SJRA purchased part of the Devers Canal Systems water rights, which allowed the transfer of approximately 50,000 acre-feet per year from the Trinity River Basin. The TRA recommends development of thirteen potential reservoirs, six of which are located in Region H. The largest, Bedias Creek, could potentially provide 109,000 acre-feet per year, and is located to allow use in the Trinity, San Jacinto or Brazos River Basins.

The Harris-Galveston Coastal and Fort Bend Subsidence Districts developed Groundwater Management Plans to address subsidence through reduced groundwater extraction within their respective regulatory areas. The Harris-Galveston Coastal Subsidence District also adopted a revised regulatory plan in 1999.

Additional plans are noted in the Region H Bibliography, included as Appendix A.

Current Preparations for Drought

The 1997 State Legislature mandated water conservation and drought contingency planning for all holders of municipal, industrial and non-irrigation water rights of 1,000 acre-feet or more and irrigation rights holders of 10,000 or more acre-feet. Previously, all water rights permit applications required a water conservation and drought contingency plan but existing rights holders were not required to prepare or implement plans. New regulations also distinguish between water conservation and drought contingency plans and extend the requirement to prepare and implement drought contingency plans to all holders of water rights as noted above and to public water systems with over 3,300 connections. In the Region H area there are 97 wholesale water providers, 44 public water systems and 42 irrigators who must submit water conservation and drought contingency plans by September 1, 1999. Smaller providers (fewer than 3,300 connections) must submit plans to the TNRCC by September 1, 2000. As of October 1, 2000, forty water conservation plans and 464 drought contingency plans had been submitted from Region H. These plans are further discussed in the Task 5 report.

Recommendations included within the 1997 State Water Plan

In the 1997 State Water Plan, *Water for Texas*, the State noted specific conditions and recommended specific opportunities in the Region H area. These included:

- The conversion to surface water required by subsidence regulatory plans will require the construction of additional surface water conveyances and treatment facilities.
- The development of Allens Creek Reservoir for near-term supply within the Brazos River Basin to meet the needs of Fort Bend and Brazoria Counties.
- The reallocation of hydropower storage in Lake Whitney as water supply storage to provide almost 125,000 acre-feet of supply for Regions G and H.
- The importation of additional surface water supply from the Sabine and Trinity River Basins to meet demands in the San Jacinto basin.
- The development of wastewater reuse projects to expand existing supplies in the San Jacinto basin.

1.7. Issues for Region H

At the beginning of the Region H planning process a series of public meetings explored issues of concern to the citizens, businesses and governmental entities in the region. Surveys distributed at these meetings and through Region H WPG members questioned respondents about their perspective on water resources issues; local and regional water supply, or a particular concern about water, such as agriculture, recreation, or the environment. Twenty survey responses were received. Comments from the meetings and the survey results indicate several general areas of concern: technical issues relating to water supply and water quality, procedural issues, and specific use issues. These are discussed briefly below. A copy of the survey is included in Appendix B.

Technical Issues

- *Subsidence, the conversion from ground to surface water and conjunctive use of ground- and surface water in the counties affected by subsidence*. The Harris-Galveston Coastal and the Fort Bend Subsidence Districts have established goals of reducing groundwater use. Some conversion to surface water sources will be necessary and this will require the development of alternative supply sources for communities currently dependent upon groundwater as well as water conveyance and treatment systems.

- *Interbasin transfer of surface water from one basin to another*. Equity issues associated with these transfers, return flows, the environmental impacts of transfers and the coordination within the region and between Region H and other regions are issues of concern among respondents.

- *Multiple uses of water supply reservoirs*. The reservoirs in Region H were designed to provide water supply. They also serve as recreation sites for much of the region providing opportunities for boating, fishing and other water based uses. Conflicts may occur between these uses and operating the reservoir for water supply, especially during low flow conditions where the lowering of the reservoir pool can impact recreational uses.

- *The water quality of drinking water sources (both ground and surface water) and of streams is an area of concern throughout the region*. Several river and stream segments have been identified as having water quality problems. There is public concern over the effects of the quality of return flows from upstream users to water sources.

- *The increased reuse of wastewater in the upstream area of the region's basins.* There is concern that increased reuse of wastewater in the upper Trinity basin will decrease return flows to the streams that supply downstream reservoirs and other uses.

- *Irrigation water demand projections may be inadequate for continued rice production*. Existing TWDB projections assume constant acreage of most crops, and

a decline in rice farming. Adequate water supply cannot be allocated for agricultural demands without better projections.

Procedural Issues

- *The representation of rural counties east of the Trinity River and smaller interests in the planning process*. The TWDB selected the members of an Initial Coordinating Body for Region H, and that Initial Coordinating Body formed the Region H Water Planning Group. The Region H WPG has the authority to add members, as it believes appropriate. Several rural counties and some user groups believe their interests are under-represented on the RWPG and may be overshadowed by those of the metropolitan area.

- *The selection of water management alternatives*. The planning process defined by the state includes a public process for evaluation and selection of the water management alternatives to be incorporated in the final plan. These alternatives specify the way each community/entity with a defined water shortage will secure the needed water supply. There are questions about the method by which these alternatives will be developed, evaluated and selected.

- *Impacts of regional water planning*. There is concern about the effect regional water planning will have on local actions and local water management decisions.

Environmental Issues

- *Freshwater inflows into Galveston Bay.* The Galveston Bay Estuary is a significant natural resource for the Region, providing both fishing and recreational incomes. With the increased demand for surface water supply there are concerns about protecting the quantity, quality and timing of inflows to Galveston Bay.

- *Instream flows for rivers and streams*. Adequate quantities of instream flows are necessary for the environmental health of the river systems and adjacent lands. There are concerns that increased demand for surface water will reduce instream flows in rivers and streams, impacting aquatic ecosystems and related habitat.

Appendix A

APPENDIX A

Regional Water Planning for Region H
Selected Bibliography by Topic

Section **Page**

1. Water Planning Reports

Trans-Texas Water Program Reports

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Appendix B

SURVEY OF WATER SUPPLY INTERESTS AND CONCERNS

REGION H REGIONAL WATER PLANNING AREA

Public Meetings - March 1999

PURPOSE: The purpose of this survey is to provide information for use in planning water supplies for Region H as designated by the Texas Water Development Board under Senate Bill 1 passed by the Legislature in 1997.

Region H consists of all or part of 15 counties: Leon, Madison, Walker, Trinity, Polk, San Jacinto, Liberty, Chambers, Montgomery, Harris, Waller, Austin, Fort Bend, Brazoria and Galveston. The 24-member Regional Water Planning Group representing different interests in the area will develop the regional water plan.

INSTRUCTIONS: Please complete the information below based on the perspective of your interest in water resources. Your interest may be the water supply in your community or area within the region in which you live, or you may belong to a group that has a particular concern about water, such as agriculture or an environmental organization.

If you prefer to complete the survey after the meeting, please return the survey to: Glenda Callaway, Ekistics Corporation, 2727 Kirby Drive, Suite 523, Houston, Texas 77098 by March 31, 1999. This address is printed on the last page of the survey. Just fold and staple the survey, and provide the first class postage.

If you have any questions or need additional information, please contact Glenda at 713-520-9031or Mr. Jim Adams, Chair Region H Water Planning Group, at SJRA, 409-588-1111.

OPTIONAL INFORMATION:

1. Name _____

2. Address _____

   _____

3. Telephone/Fax/E-mail _____

WATER INTEREST INFORMATION:

4. County of Residence _____

5. Community (location within county) or Group of Interest: _____

   _____

6. Please circle your primary interest group (circle only one):

Municipal (urban)	Municipal (rural)	Small Business	Water Utility
Water District	County	Agriculture	Industry
Recreational	Environmental	General Public	

   Other (please specify) _____

7. What kinds of water supply problems has your community or interest group experienced in the last five years? (Please check all items that are appropriate.)

   _____ Problems with or Inadequate Surface Water Supply

   _____ Problems with or Inadequate Groundwater Supply

   _____ Poor Quality of Surface Water Supply

   _____ Poor Quality of Groundwater Supply

_____ Problems with Drinking Water Treatment

_____ Problems with Drinking Water Distribution

_____ Other (please specify) _____

_____

_____

8. What type of constraints limit your community or group's ability to solve its water supply problems? (Please check all items that are appropriate.)

_____ Funds for Facility Construction

_____ Funds for Operation and Maintenance

_____ Lack of Citizen Support

_____ State Regulations

_____ Federal Regulations

_____ Need for Technical Assistance

_____ Other (please specify) _____

_____

_____

9. What problems or threats to the water supply for your community/group do you expect to have in the next <u>five to twenty years</u>?

_____ Problems with or Inadequate Surface Water Supply

_____ Problems with or Inadequate Groundwater Supply

_____ Poor Quality of Surface Water Supply

_____ Poor Quality of Groundwater Supply

_____ Problems with Drinking Water Treatment

_____ Problems with Drinking Water Distribution

_____ Inadequate Water Supply to Maintain Stream Flows or Inflows to Bays

_____ Other (please specify) _____

_____

10. Does your community or group have the following:

	Yes	No	Don't Know
Water Conservation Plan	☐	☐	☐
Drought Management Plan	☐	☐	☐
Long-term Water Supply Plan	☐	☐	☐

11. To meet your water supply needs over the next twenty years, which of the following options should be considered to meet your community's or group's needs?

	Yes	No	Don't Know
New Dams and Lakes	☐	☐	☐
New Water Wells	☐	☐	☐
Municipal and Industrial Water Conservation	☐	☐	☐
Agricultural Water Conservation	☐	☐	☐
Reuse of Treated Wastewater	☐	☐	☐
Recharge of Aquifers	☐	☐	☐
Transfer of Water from Another Area to Your Area	☐	☐	☐
Brush Control	☐	☐	☐

Conjunctive Surface Water and Groundwater Use	☐	☐	☐
Purchase Water Rights	☐	☐	☐
Surface Water Exchanges	☐	☐	☐
Desalination	☐	☐	☐

Other options that should be considered: _____

_____

12. To meet your long-term water supply needs from 20-50 years in the future, which of the following options should be considered to meet your community's or group's needs?

	Yes	No	Don't Know
New Dams and Lakes	☐	☐	☐
New Water Wells	☐	☐	☐
Municipal and Industrial Water Conservation	☐	☐	☐
Agricultural Water Conservation	☐	☐	☐
Reuse of Treated Wastewater	☐	☐	☐
Recharge of Aquifers	☐	☐	☐
Transfer of Water from Another Area to Your Area	☐	☐	☐
Brush Control	☐	☐	☐
Conjunctive Surface Water and Groundwater Use	☐	☐	☐
Purchase Water Rights	☐	☐	☐
Surface Water Exchanges	☐	☐	☐
Desalination	☐	☐	☐

Other options that should be considered: _____

_____

13. What factors should be considered in developing a regional water plan that will meet the long-term water supply needs of your community or group?

_____

_____

_____

_____

14. Please make any additional comments you wish.

_____

_____

_____

_____

15. Please indicate the method you prefer for receiving updates on the Region H Regional Water Planning Group's activities.

_____ Letter

_____ Email

_____ Newspaper

_____ Newsletter

_____ Public Meetings

_____ Other (please specify) _____

16. What time of day would you prefer public meetings to be held?

_____ 10:00 a.m. _____ 7:00 p.m.

_____ 2:00 p.m. _____ Other (please specify) _____

17. If your interest group has a newsletter and would like updates provided to it, please give us the name of the organization and a contact address or telephone number.

_____

_____

18. Do you wish to be placed on a list for future mailings from the Region H Regional Water Planning Group? If so, please note below and complete the address information in Questions 1 - 3.

Yes No

☐ ☐

Thank you for completing this survey.

Region H Survey, Spring 1999

Responses to Open-Ended Questions

7. Water supply problems in last five years -- other:

#2 Red water.

#3 Declining static water levels in wells.

#6 Many houses have shallow wells that run dry during summers and the quality is poor.

#8 Had to rework #1 well; drill new #2 well; over .05 ML Arsenic in #2 well, still investigating.

#10 Summers of drought test our limits; not looking to drill second well.

#11 Distribution to all needed areas.

#14 Distance between rural communities (some cases it's miles).

#17 Leaks.

#20 Concern over freshwater inflows to Galveston Bay.

8. Constraints limiting resolution -- other:

#3 Need for an authority to begin development of a surface water infrastructure for north and west Harris County.

#4 Okay for now, but we must convert to surface water.

#13 Lack of public awareness; apathy.

#14 Time involved as process is proceeding.

9. Water supply problems in next 5-20 years -- other:

#3 Must begin conversion to surface water.

#8 Inadequate surface water supply to meet HGCSD conversion requirements. Need entity to represent all MUDs to contract for water and build infrastructure. Lindsay's bill should solve.

#13 Silting of Trinity River and Lake Livingston.

#15 Concerns about freshwater inflows to Galveston Bay and having enough instream flows to our rivers so that they remain alive.

11. Consider as options for next 20 years -- other:

#4 Teach people landscaping that uses much less water.

#10 Co-op of MUDs in west and northwest Houston to supply water and/or transmission system.

#20 Comment: reuse of treated wastewater should be considered, but it is not a solution.

12. Consider as options for 20-50 years -- other:

#4 Teach people landscaping that uses much less water.

#10 A/A.

13. Factors to consider in developing regional water plan:

#1 Adequate water supplies while not degrading the status of the groundwater aquifers.

#2 Equity for all interests given the available supply.

#3 New lake/dam in Montgomery County; Allen's Creek project.

#7 Plan for providing more conservation, less groundwater, more interbasin transfers -- higher cost.

#8 RWPG H appears to be covering the bases in accordance with SB-1 based on meetings I have attended.

#9 The emphasis I would place on planning is achieving a balance between people/industrial/agricultural needs, and the needs of the environment and ecosystems so that the Trinity and other rivers and Galveston and Trinity Bays, fisheries, marshes, wetlands and other habitats and ecosystems are preserved and enhanced.

#10 Setting up a transmission network of pipelines to supply water at a set price (one) for all within the Region H system. City of Houston should not control this system!!

#11 Adequate source, storage and replacement.

#13 Population growth, residence and industrial use and agricultural use, environmental concerns have been playing a big part, but Health should be High priority.

#18 It has got to be economically feasible. It has got to allow for resident representation. This is too important an issue to remove it from voter input.

#13 Balance between human and ecological needs--conservation, wise use, population growth.

14. Additional comments:

#3 Area should work to create hard surface water sources in the north and west part of Harris - Montgomery - Waller, etc.

#4 We need to be educating the public--newspapers, etc. These are real problems and some will require voting for bonds. People must be told and told again -- we don't accept bad news easily.

#9 If more costly measures (such as desalination technology) are required to achieve the balance referred to in #13 above, perhaps an exploratory group of environmental, eco-tourist industry and other interested groups/agencies could raise the funds to purchase an economic study (such as was discussed by Ted Eubanks at the GBF Annual Meeting on 2-26-99) to determine the value of Galveston Bay-Trinity Bay and how to preserve and nurture these resources (specifically including fresh water supply requirements). If the dollar value is found to be substantial, political support for developing and implementing the technological means of safeguarding/insuring fresh water supplies could be garnered, such as in the form of tax incentives to water utility suppliers and industrial and agricultural users who assist in developing and using the technology.

#10 Costs should be distributed evenly by number of end users and after system is built, each additional end user should be charged tap fees and a principal sum of money to the pipeline system.

#11 Keep water coming.

#18 Any public-private sector partnership deal is likely to remove all control from the voters and put too much emphasis on making a profit and not enough emphasis on finding a solution which provides water at a reasonable cost.

15. Methods -- other:

#8 Public meetings -- to have opportunity to ask questions.

#18 Fax

17. Groups/newsletters suggested:

Cypress Creek United Civic Association, Lisa Eggebrecht, Editor, 11402 Gatesden, Tomball TX 77375; 281-370-3709/Fax 281-370-3833/ brian@hummingbird-designs.com.

Galveston Bay Estuary Program Website, c/o Marie Nelson, 281-332-9937, mnelson@tnrcc.state.tx.us.

Spirit of North Harris County Coalition *Update Bulletins* c/o Al Rendl, 17535 Ponderosa Pines, Houston, TX 77090.

TABLE OF CONTENTS

SECTION IV AGRICULTURAL IRRIGATION WATER DEMAND

LIST OF FIGURES

LIST OF TABLES

APPENDICES

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

SECTION I - INTRODUCTION

A. Scope of Work

The overall project scope consists of preparing a regional water supply plan for the Region H Water Planning Group, representing 15 counties as shown in *Figure 2.1*. Region H is one of 16 state water supply planning regions defined by the Texas Water Development Board (TWDB). The regional water plans prepared by each Regional Water Planning Group (RWPG) will be combined into a comprehensive state water plan. The planning effort is part of a new consensus-based planning effort to include local concerns in the statewide planning effort.

This report summarizes the procedures and results of Task 2 of the project scope. The report presents updated population and water demand data for the region and outlines the guidelines and methodology used for the update. Also, to provide consistency and facilitate the compilation of the different regional plans, TWDB required the assimilation of this data into standardized table formats. These tables are identified below; and a discussion of the methodology for the tables is included in the *Appendices.*

- *Table 1*, Population by City and Rural County
- *Table 2*, Water Demand by City and Category
- *Table 2A*, Environmental Water Needs for Galveston Bay
- *Table 3*, Water Demand by Major Provider of Municipal and Manufacturing Water
- *Table 3A*, Water Demand by Major Provider of Municipal and Manufacturing Water, Assuming Extension of Existing Contracts in Region H

B. Background[1]

The increased demand for water, combined with recent droughts, has increased awareness of water supply availability issues in Texas. According to the 1997 State Water Plan estimates, Texas population is projected to double, increasing from about 19 million (current population) to more than 36 million people by the year 2050. Statewide water use is anticipated to increase by about 11 percent by 2050. A projected decline in water used for agriculture needs offsets a considerable increase in water needs of municipal and manufacturing uses. Urban water use in Texas is projected to grow by about 52 percent in the next 50 years, despite anticipated savings from water conservation measures.

Water resource planning and management in Texas is a shared responsibility of local utilities, regional special purpose districts, and state agencies. Local and regional water development authorities and municipalities have had primary responsibility for financing and constructing

[1] Some of the information used for describing the background came from *Water for Texas*, published and distributed by the TWDB, August 1997, and referred to as the 1997 State Water Plan.

new water resource projects. The state's primary role has been providing guidance, regulatory insight, and limited financial assistance.

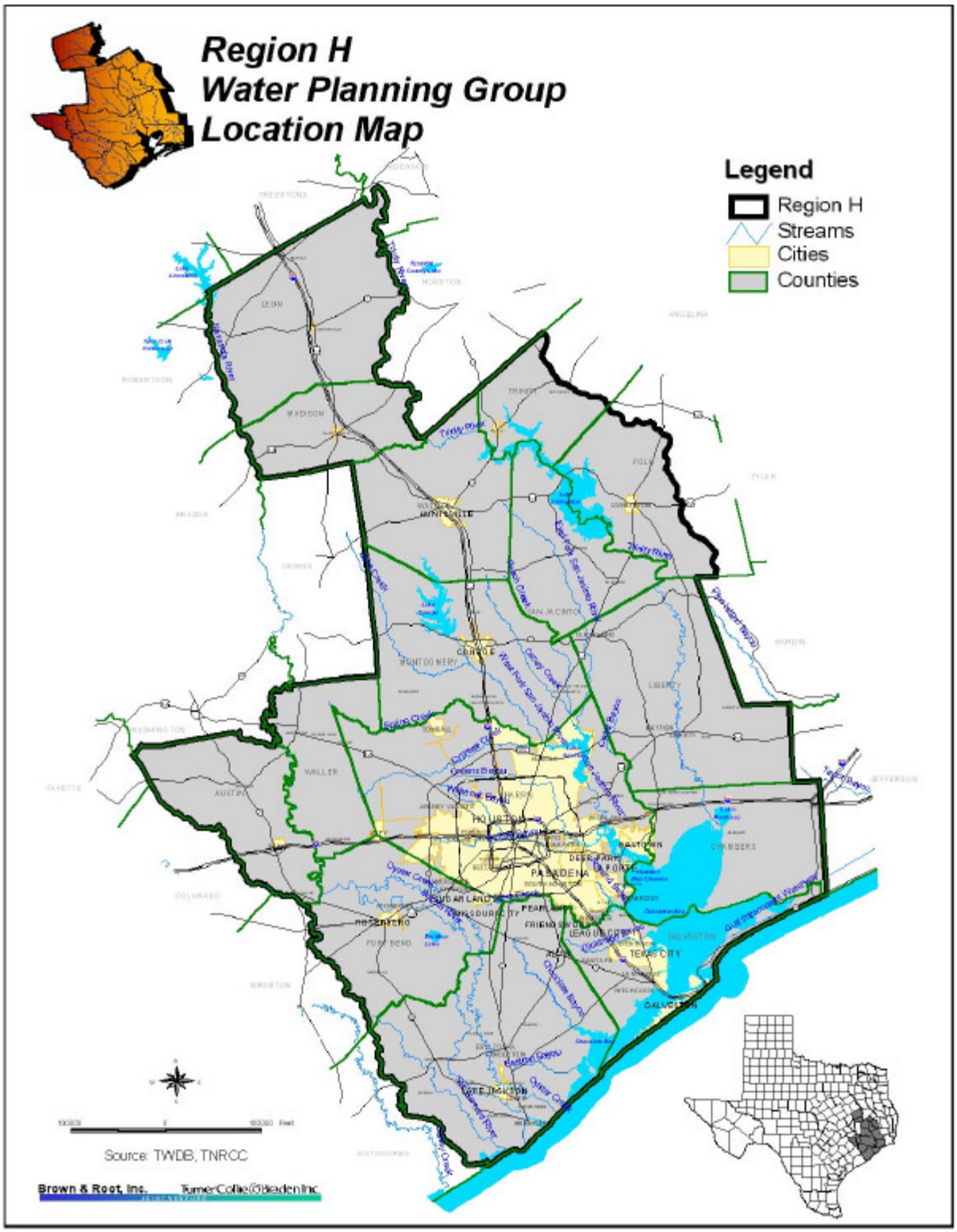
Senate Bill 1 (SB 1), 75th Texas Legislature, established a new approach to preparation of the state water plan consisting of local consensus on regional plans first. The Region H Water Planning Group is responsible for completing a consensus-based regional water supply management plan for submittal to the TWDB by January 5, 2001. The Region H Water Planning Group contracted with the Brown and Root/Turner Collie & Braden Joint Venture (Team) to develop technical data needed to prepare a regional water plan.

C. Description of the Region[2]

Region H, located along the southeastern Texas coast, consists of all or part of 15 counties, including Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity, Walker, and Waller. The eastern portions of Trinity and Polk counties are included in the Region I planning area. Region H encompasses the San Jacinto River basin, the lower portions of the Trinity and Brazos river basins, and includes part or all of the Brazos-Colorado, San Jacinto-Brazos, Trinity-San Jacinto, and Neches-Trinity coastal basins. This area includes the Galveston and Trinity Bay estuaries; the urbanized, rapidly growing Houston-Galveston Metropolitan Area, encompassing Brazoria, Harris, Galveston, Fort Bend, and Montgomery counties; the coastal port communities of Galveston and Freeport; and agricultural areas in Austin, Chambers, Leon, Liberty, Madison, Polk, San Jacinto, Trinity, Walker, and Waller counties. *Figure 2.1* is a map of the Region H area.

[2] *Region H Water Management Plan: Description of Region*, submitted by Team.

Figure 2.1


Region H
Water Planning Group
Location Map
Legend
Region H
Streams
Cities
Counties
Source: TWDB, TNRCC
Brown & Root, Inc.
Turner Collie & Braden Inc.

SECTION II - GUIDELINES AND METHODOLOGY

A. General

A key task in the preparation of the water supply plan for Region H is to determine current and future water demands within the region. Projections of future water demand are to be compared with estimates of currently available water supply to identify future water shortages. SB 1 and associated rules of the TWDB require that population and water demand projections from the current state water plan be used as the default for regional water planning unless there are substantiated reasons to revise those projections. The terms "default estimates" or TWDB projections are used throughout this report to refer to the 1997 State Water Plan consensus-based estimates developed by the TWDB in conjunction with the Texas Natural Resources Conservation Commission (TNRCC) and Texas Parks and Wildlife Department (TPWD). This section discusses the guidelines and methodology used to evaluate these projections and to select projections for use in the regional water plan for Region H.

TWDB rules require that the analysis of current and future water demands be performed for each water user group (WUGs) within Region H. Within the municipal category, each city with a population of 500 or more is considered a WUG, and all smaller communities and rural areas, aggregated at the county level, are considered a WUG and are referred to as "County-Other" for each county. For each county, manufacturing, irrigation, steam-electric power generation, mining, and livestock water use categories are each considered WUGs.

In addition, TWDB rules require the determination of demands associated with each of the Major Water Providers designated by the RWPG. Region H defines major providers of municipal and manufacturing water as entities selling and delivering significant amounts of water for municipal and/or manufacturing use or providing water supply to a significant portion of the region's population and/or industry and likely to be involved in the development of major water supply projects in the region. For Region H, the Major Water Providers are the Brazos River Authority, City of Houston, Gulf Coast Water Authority, San Jacinto River Authority, and Trinity River Authority.

The regional water planning process includes developing a regional consensus of population and water demand estimates. Public involvement is a key element in this process. The Region H Water Planning Group held public meetings, local government workshops, and special interests meetings with environmental, agricultural, and manufacturing groups.

Public meetings were held at four locations in Region H. Since Region H is a large region, the locations were selected to provide the most convenient access to the meetings for members of the interested public. Sites selected were San Jacinto College-South (Houston and south), Bear Creek Park (Houston and west), White Memorial Park (east), and Walker County Courthouse (north). Meeting notices were placed in 12 newspapers in the region; press releases were sent to 42 papers, as well as radio and television stations. Region H Planning Group members also assisted by advising interested groups of the meetings.

Throughout this section, language excerpted directly from the TWDB published guidelines for changes to the 1997 Consensus Water Plan Projections appears in italics. The applicable TWDB criteria used to support and develop revisions to the TWDB numbers are designated in bold, italic type.

B. TWDB Guidelines for Revisions to Population and Water Demand Projections

The TWDB established criteria and data requirements to be used in evaluating and developing revisions to the state consensus-based population and water demand projections. The criteria applied in developing revisions to the 1997 State Water Plan projections for Region H are displayed in bold, italic type below and are described in detail.

1. Population Projections

Combined with estimates of per capita water use and water conservation assumptions, population is the principal determinant for projected future municipal water demand. As such, emphasis has been placed on evaluating the state's default population projections and on developing revisions in accordance with the following criteria.

> ***Criteria:*** *One or more of the following criteria must be verified by the Regional Water Planning Group and the Executive Administrator of the TWDB for consideration of revising the consensus-based population projections.*
>
> ***a) The current population estimate of a county or city is greater than or equal to the year 2000 population projection for that respective county or city which was used in the preparation of the 1997 State Water Plan.***
>
> ***b) The population growth rate for a county or city over the latest period of record, beginning in year 1990, is greater than the 1997 State Water Plan projected growth rate for that county or city over the period 1990 to year 2000.***
>
> *c) If the Regional Water Planning Group disagrees with the long-term population projections (2000-2050) for a county or city that was used in preparation of the 1997 State Water Plan, historical growth rates will be used for comparison purposes and possible verification of changes to the population projections. Historical growth rates for cities must be calculated for the last 30 years of reported population data and the last 40 years of reported population data for counties. Specifically, historical growth rates will be calculated for each 10-year period over the 30- and 40-year periods.*
>
> ***d) Identification of areas that have been recently annexed by a city within the regional water planning area***

e) Other criteria that the Regional Water Planning Group believes are important for consideration of revisions to the State Water Plan population projections

Data Requirements: *The Regional Water Planning Group must provide the following data associated with the identified criteria to the Executive Administrator of the Water Development Board for justifying any revisions to the consensus-based population projections that were used in the preparation of the 1997 State Water Plan.*

1) Population estimates for counties and cities developed and published by the State Data Center will be used for verifying criteria (a) and (b).

2) If an entity disagrees with the State Data Center's most current population estimate for that entity, the Regional Water Planning Group must provide one or more of the following data sets along with the analysis and documentation used in estimating the entity's current population.

a) School enrollment information

b) Building permits information

c) Active residential water service information

d) Appraisal district information

e) Other information or current population estimates that the Regional Water Planning Group believes are appropriate and important

3) Census counts for cities and counties published by the U.S. Bureau of the Census will be used for verifying historical long-term population growth rates for cities and counties.

4) The population of an area that has been annexed by a city

5) Other data that the Regional Water Planning Group believes are important to justify any changes to the consensus-based population projections used in preparation of the State Water Plan

2. Municipal Water Use

As indicated above, per capita water use rates and assumptions regarding water conservation are additional variables in municipal water demand projections.

Accordingly, the following criteria were applied in the evaluation of the state's municipal water demand projections and in the development of revisions to those projections.

> ***Criteria:*** *One or more of the following criteria must be verified by the Regional Water Planning Group and the Executive Administrator of the Texas Water Development Board for consideration of revising the consensus-based municipal water use projections that were used in the preparation of the 1997 State Water Plan:*
>
> ***a) Any changes to the population projections for an entity will require revisions to the municipal water use projections***
>
> *b) Errors identified in the reporting of annual municipal water use for an entity*
>
> *c) Differences identified between the Board's calculated per capita water use for a city and the per capita water use calculated by the respective city*
>
> *d) The consensus-based municipal water use projections include both the expected case and advanced case conservation savings for any specific municipality. Any requests for changing the conservation savings scenarios (expected or advanced) must be accompanied with complete documentation justifying the request*
>
> *e) Trends indicating that per capita water use for a city or a rural area of a county has increased over the latest period of record, beginning in 1980*
>
> *f) Other criteria that the Regional Water Planning Group believes are important for consideration of revisions to the State Water Plan municipal water use projections*

3. Other User Groups

The TWDB water demand projections were used for other categories of water users (e.g., manufacturing, irrigation, steam-electric power generation, mining, and livestock), except for those cases where more current or better data were provided. Revisions to the projections for these WUGs are described in *Section 3* of this report.

C. Methodology

This section describes the methodology used to develop projections for population and for water demand for each municipal, manufacturing, irrigation, steam-electric power generation, mining, and livestock WUG in Region H.

1. Population Projection Methodology

The following procedure was used to develop population projections for each city and County-Other:

a). **Identify the baseline projection:** The baseline population projection for SB1 regional water planning is the TWDB's "most likely" scenario for each county, each city of 500 population and greater, and cities of less than 500 population and rural areas (county-other). These projections are presented by decade from 1990 (actual reported from census) to 2050. These TWDB default projections are to be used unless revisions are justified per TWDB guidelines.

b). **Evaluate recent population growth trends:** As indicated in *Section A*, TWDB guidelines allow for adjustments of population projections if there is evidence that growth trends during the 1990s have been greater than originally projected by the TWDB. Using the 1990 census and a January 1998 population estimate provided by the State Data Center, the growth rate for this period was calculated and extrapolated to the year 2000. This extrapolated year 2000 population estimate was then used as the starting point for the development of a Team-SDC revised population projection through 2050, using the growth rates in TWDB's projections for each decade. For those cities and county-other areas where the modified year 2000 population estimate is greater than the TWDB year 2000 projection, the effect of the modification is to adjust the population projection upward for the planning period.

c). **Develop Subsidence District estimates:** Population and water demand estimates were developed in March 1996 by Turner Collie & Braden for the Harris-Galveston Coastal Subsidence District. The report, titled *Update of Population and Water Demand Forecasts*, 8 of the Region H counties and addressed was submitted to the TWDB for review of the projection methodology.

d). **Compare to the best available information:** In cases where better, more current information is available, that information is presented as the revised projection. Other information applied on a case-by-case basis are described by WUG in *Section III*.

e). **Select a proposed population projection:** For each city and county-other proposed population projections were determined after the TWDB, the Team-SDC revised, the Subsidence District estimates, and other available projections were compared. The higher of the projections was selected as the proposed projection, except in cases where better information was available. The revised population projections proposed and ultimately adopted by the TWDB are presented by county in *Appendix A* and in Table 1 of *Appendix B* in the TWDB standardized format.

2. Municipal Water Demand Projection Methodology

a) Per Capita Water Use:

The second key variable in the TWDB's municipal water demand projections is per capita use, expressed as gallons of water used per person per day. TWDB estimates of per capita water use are derived from data provided by water suppliers annually, and are simply the total annual reported municipal water use divided by total estimated population, and then divided by 365 (days in a year). The starting point in TWDB's default projections is a per capita use estimate for a year with below-normal rainfall when water use is typically high. These per capita use values were taken from data from the 1982-1991 period.

TWDB guidelines for revisions to municipal water demand projections provide that adjustments in per capita use rates can be proposed if more recent data indicate that per capita use has increased. The guidelines also provide for the modification of TWDB conservation assumptions where justified. Given these guidelines (presented in *Section B2,* above), the following procedure was used to develop per capita water use rates.

i. **Identify TWDB projected per capita use rate:** Estimated per capita water use for the year 2000 under a "below-normal rainfall" and "no conservation" scenario was identified.

ii. **Identify reported 1996 per capita water use rate:** Using data provided by the TWDB, per capita water use for 1996 was calculated. This value was selected as a more recent measure of per capita use under below-normal rainfall conditions, as drought conditions affected the entire region for much of 1996. These values were comparable to the TWDB rate projections; therefore, the TWDB per capita use rate was used to calculate demands.

iii. **Apply TWDB water conservation assumptions:** TWDB's baseline or default projections of municipal water demand include a set of water conservation assumptions described as the most likely scenario. This includes the effects of state and federal plumbing fixture efficiency standards, reductions in seasonal water use (e.g., landscape irrigation), and savings in other uses (e.g., public education). These assumptions are applied in the TWDB projections in such a manner as to result in each city having a unique projection of water savings. In some of the cities and counties, an advanced conservation scenario was used by TWDB in response to anticipated shortages. This combination of expected and advanced conservation was used in Harris County.

b) Municipal Water Demand:

The municipal water demand projections are the product of the proposed population projections and the proposed per capita usage projections described above. These projections were adopted by the TWDB, and are presented for each municipal WUG by county and by decade in *Appendix A*; for all WUG, including non-municipal categories, they are presented by county, basin, and decade, in *Table 2* of *Appendix B* in the TWDB standardized format.

3. Manufacturing Water Demand Projection Methodology

For SB 1 regional water planning purposes, manufacturing water use is considered to be the cumulative water demand by county for all industries within specified standard industrial classifications (SICs) determined by the TWDB. The manufacturing water use projections that were developed by the TWDB and used in the 1997 State Water Plan were accepted for use by Region H Water Planning Group with no changes. These data were presented to representatives of the chemical manufacturing industry in a meeting on May 20, 1999.

4. Irrigation Water Demand Projection Methodology

The Region H Water Planning Group did not adopt the irrigation water use projections that were developed by the TWDB and used in the 1997 State Water Plan. The TWDB projections were determined with assistance from Texas A&M, and assume expected case water conservation practices and no reduction in federal farm program subsidies. They were based on projected future rice prices for 1996 through 2000 that have not followed the projected trends. Texas A&M is currently reviewing its previous estimates based on revised economic estimates and estimates of projected improvements in disease resistance and rice yield. Some of this information is presented in *Section IV*. Revisions to the TWDB projections were adopted for all counties as a result of the submission of better, more current projection information. These revisions are described in *Section III* and *Section IV*.

5. Steam-Electric Water Demand Projection Methodology

The steam-electric water use projections that were developed by the TWDB and used in the 1997 State Water Plan were accepted for use by Region H Water Planning Group with one exception: the Walker County steam-electric power demand was eliminated based upon current information regarding power plant development.

6. Mining Water Demand Projection Methodology

The TWDB mining water use projections that were used in the 1997 State Water Plan were developed based on projected future production levels by mineral category and expected water use rates. These production projections were derived from state and national historic rates, and were constrained by accessible mineral reserves in each region. The 1997 State Water Plan mining water demand projections were accepted for use by Region H Water Planning Group with no changes.

7. Livestock Water Demand Projection Methodology

The livestock water use projections developed by the TWDB and used in the 1997 State Water Plan were accepted for use by Region H Water Planning Group with no changes.

8. Demand of Major Providers of Municipal and Manufacturing Water

Designated major providers in the Region H area include Brazos River Authority, City of Houston, Gulf Coast Water Authority, San Jacinto River Authority and Trinity River Authority. Major providers are obligated to provide 1,306,547 acre-feet

of supply to meet the current (year 2000) requirements of long term contracts or retail commitments. TWDB guidance required consideration of active contracts only, which reduces major provider obligations to 786,620 acre-feet in year 2050. Region H major providers assume the continuation of municipal contracts across the 50-year planning period, at least to the level of existing obligations. Two tables were developed to reflect these two assumptions. *Table 3* in *Appendix B* provides the projected water demands by Major Providers of municipal and manufacturing water in the TWDB standardized format. *Table 3A* and *Appendix B* provides the projected water demands by Major Providers with the assumption that existing contracts will be continued at their current amount through 2050.

SECTION III - POPULATION AND WATER DEMAND PROJECTIONS

This section discusses the projections for population and for municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for each of the fifteen counties in Region H. These projections were developed using the general methodology described in *Section II*, with any exceptions described by WUG for each county. *Figure 2.2*, at the end of this section, presents a summary of Region H's total revised water demand projections by water user category.

After the revised population and water demand projections were approved by the RWPG and adopted by the TWDB, the projections were incorporated into standardized tabular formats required by the TWDB. These tables and a description of the methodology used to create them are included in *Appendix B* and present the projections for each WUG by county and river basin, for each decade. *Tables 1, 2,* and *3* are part of the Task 2 deliverables required by TWDB. *Tables 2A* and *3A* were prepared at the request of the Region H RWPG.

Table 1 presents Population by City and Rural County; *Table 2* presents Water Demand by City and Category; *Table 2A* presents the Environmental Needs for Galveston Bay; *Table 3* presents water Demand by Major Provider of Municipal and Manufacturing Water; *Table 3A* contains the same basic data as *Table 3*, with the exception that all existing contracts were assumed to be extended at the current amounts for all the decades 2000-2050.

A. Regional Summary of Projections by Category

Population:

The revised population projections indicate that Region H's population will grow from 4,780,084 in 2000 to 9,700,277 in the year 2050. These projections represent an increase relative to the state default population projections by 11.06 percent, or 1,073,248 persons in the year 2050. *Appendix A* presents the revised projections by county and decade, as well as a comparison to the TWDB projections. *Table 1* in *Appendix B* presents these projections in the TWDB standardized format by county, river basin, and decade.

Municipal Water Demand:

Revised municipal water demand projections for Region H show an increase in projected demand from 897,209 acre-feet in the year 2000 to 1,485,639 acre-feet per year in the year 2050. These projections exceed the default TWDB projections by 5.37 percent in 2000 and by 8.11 percent in the year 2050. The revised projections by county for each municipal WUG are provided in *Appendix A* and in *Table 2*, *Appendix B*, in the TWDB standardized format, by county and by river basin. *Figure 2.3*, shown at the end of this section, presents the comparison of the TWDB default demand to the revised projections.

Manufacturing Water Demand:

The proposed manufacturing water demands for Region H are the TWDB default projections that are included in the 1997 State Water Plan. The proposed manufacturing water demand for Region H is projected to increase from 708,113 to 1,048,194 acre-feet per year from 2000 to 2050. The revised projections are provided in *Appendix A* and in *Table 2, Appendix B,* in the TWDB standardized format.

Irrigation Water Demand:

The TWDB default estimate for rice irrigation projects a sharp decline in irrigation water demand. This was based on a 1996 study prepared by Texas A&M. Texas A&M has prepared a revised rice irrigation projection based on the latest conditions that exist in the region. Projections for rice irrigation were also developed by the Team, as part of a consensus effort of local rice growers, agricultural businesses, Texas A&M University Agriculture Specialists, and local County Extension Agents; these projections are contained in *Appendix C*. This projection shows a slight decrease in irrigation water demand over current usage. *Figure 2.4*, shown at the end of this section, presents a comparison of the TWDB default demands to the Region H proposed revision. *Section IV* has been included to explain the methodology used to project agricultural water demands. Total irrigation water demand for the region is projected to decrease from 501,053 to 471,679 acre-feet per year between 2000 and 2050. The TWDB estimates were 461,625 acre-feet per year in 2000 and 350,213 acre-feet per year in 2050. The proposed change results in a 34.68 percent increase over the TWDB projections for the year 2050. The revised projections are provided in *Appendix A* and in *Table 2, Appendix B,* in the standardized TWDB format.

Steam-Electric Water Demand:

The steam-electric water demands for Region H were initially proposed to be the TWDB default projections. Those projections were adopted by Region H and the TWDB. However, during the public meeting process, it was determined that the steam-electric power facility within Walker County has actually occurred within Region G in Grimes County. Therefore, the steam-electric water demand for Walker county was eliminated.

As a result the proposed steam-electric water demand for Region H is 95,100 acre-feet per year in 2000 and 105,000 acre-feet per year in 2050. The revised projections are provided in *Appendix A* and in *Table 2, Appendix B,* in the standardized TWDB format.

Mining Water Demand:

The proposed mining water demands for Region H are the TWDB default projections that are included in the 1997 State Water Plan.

The proposed mining water demand by decade for Region H is 33,826 acre-feet per year in the year 2000 and 35,243 acre-feet per year in 2050. The revised projections are provided in *Appendix A* and in *Table 2, Appendix B*, in the standardized TWDB format.

Livestock Water Demand:

The proposed livestock water demands for Region H are the TWDB default projections that are included in the 1997 State Water Plan.

The proposed livestock water demand by decade for Region H is 13,038 acre-feet per year in the year 2000 and 13,038 acre-feet per year in 2050. The revised projections are provided in *Appendix A* and in *Table 2, Appendix B*, in the standardized TWDB format.

Demand of Major Water Providers

Designated major providers in the Region H area include Brazos River Authority, City of Houston, Gulf Coast Water Authority, San Jacinto River Authority and Trinity River Authority. Major providers maintain current customer contracts for 1,939,769 acre-feet of supply. TWDB guidance required consideration of active contracts only, which reduces major provider obligations to 788,670 acre-feet in year 2050. Region H major providers assume the continuation of municipal contracts across the 50-year planning period, at least to the level of existing obligations. Two tables were developed to reflect these two assumptions. *Table 3* in *Appendix B* provides the projected water demands by Major Providers of municipal and manufacturing water in the TWDB standardized format. *Table 3A* in *Appendix B* provides the projected water demands by Major Providers with the assumption that existing contracts will be continued at their current size through 2050.

B. Projections for Austin County

1. Population

   The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Austin County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Austin County. Municipal and irrigation demands deviate from the TWDB water demand projections. The irrigation demands used are the ones projected by the Region H Water Planning Group Team, as adopted by the TWDB (explained in detail in *Section IV*).

C. Projections for Brazoria County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Brazoria County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Brazoria County. Municipal and irrigation demands deviate from the TWDB water demand projections. The irrigation demands differ only for 2040 and 2050 and represent the projections made by the Region H Water Planning Group Team.

D. Projections for Chambers County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Chambers County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for Chambers County. Municipal and irrigation demands deviate from the TWDB water demand projections. The irrigation demands used are the ones projected by the Region H Water Planning Group Team, as adopted by the TWDB (explained in detail in *Section IV*).

E. Projections for Fort Bend County

1. Population

The population projection for the county total is based on the 1996 Subsidence District estimate. The Subsidence District population projections do not present estimates for individual cities; therefore, the Team-SDC estimates were used to develop population projections for the cities in Fort Bend County. Additional county growth identified in the Subsidence District Projections, but not accounted for in the Team-SDC numbers, was placed in County-Other. First Colony was removed as a separate entity since Sugar Land annexed it.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Fort Bend County. Municipal and irrigation demands deviate from the TWDB water demand projections. The irrigation demands used are the ones projected by the Region H Water Planning Group Team, as adopted by the TWDB (explained in detail in *Section IV*).

F. Projections for Galveston County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Galveston County. The population in Clear Lake Shores was capped at 2500 from 2030 until 2050 because of geographic location and lack of room for expansion.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for Galveston County. Municipal demands deviate from the TWDB water demand projections. The irrigation demands used are the ones projected by the Region H Water Planning Group Team, as adopted by the TWDB (explained in detail in *Section IV*).

G. Projections for Harris County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Harris County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Harris County. Municipal demands deviate from the TWDB water demand projections. The irrigation values used are the ones projected by the Region H Water Planning Group, as adopted by the TWDB (explained in detail in *Section IV*).

H. Projections for Leon County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and County-Other areas in Leon County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for Leon County. Municipal demands deviate from the TWDB water demand projections.

I. Projections for Liberty County

1. Population

The population projection for the county total is based on the 1996 Subsidence District estimate. The Subsidence District population projections do not present estimates for individual cities; therefore, the Texas State Data Center estimates were used to develop population projections for the cities in Liberty County. Additional county growth identified in the Subsidence District Projections, but not accounted for in the Texas State Data Center numbers, was placed in County-Other. The maximum value between the Subsidence District projected population and the population projected using the methodology described in *Section II,* was chosen as the revised population number.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Liberty County. Municipal and irrigation demands deviate from the TWDB water demand projections. The irrigation demands used are the ones projected by the Region H Water Planning Group Team, as adopted by the TWDB (explained in detail in *Section IV*).

J. Projections for Madison County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Madison County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for Madison County. Municipal demands deviate from the TWDB water demand projections.

K. Projections for Montgomery County

1. Population

The population projection for the county total is based on the 1996 Subsidence District estimate. The Subsidence District population projections do not present estimates for individual cities; therefore, the Team-SDC estimates were used to develop population projections for the cities in Montgomery County. Additional county growth identified in the Subsidence District Projections, but not accounted for in the Team-SDC numbers, was placed in county-other. The year 2000 population projection for The Woodlands reported by Interfaith Ministries replaced the TWDB population projection for year 2000. The new value increases the TWDB value by 32.39 percent. This value was projected at the TWDB growth rate for 2010. From year 2020, The Woodlands population was capped at 119,300.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for

Montgomery County. Municipal demands deviate from the TWDB water demand projections.

L. Projections for Polk County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Polk County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for the portion of Polk County within Region H. Municipal demands deviate from the TWDB water demand projections.

M. Projections for San Jacinto County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in San Jacinto County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for San Jacinto County. Municipal demands deviate from the TWDB water demand projections.

N. Projections for Trinity County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Trinity County. For the county-other population, an adjustment was made after a review of TNRCC records. Total population of the identified public water systems in the TNRCC database is nearly 18,000, with a split of 80 percent in Region H and 20 percent in Region I. This split is different than the one indicated by the TWDB projection for the year 2000, which shows 55 percent for Region H and 45 percent for Region I. As a result, the TNRCC percentages were used instead of the TWDB projected values, for the Trinity county-other population. This application will increase the population in year

2000 from 4,902 to 6,886, and will be projected to year 2050 based on the TWDB projected growth rates.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for the portion of Trinity County within Region H. Municipal demands deviate from the TWDB water demand projections.

O. Projections for Walker County

1. Population

The population projection methodology described in *Section II* was used to develop initial population projections for the cities and county-other areas in Walker County.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demand for Walker County. Municipal demands deviate from the TWDB water demand projections. During the public meetings the steam-electric power demand was eliminated based upon current information regarding power plant development. Therefore, the steam-electric demand for Walker County is zero.

P. Projections for Waller County

1. Population

The population projection for the county total is based on the 1996 Subsidence District estimate. The Subsidence District population projections do not present estimates for individual cities; therefore, the Texas State Data Center estimates were used to develop population projections for the cities in Waller County. Additional county growth identified in the Subsidence District projections, but not accounted for in the Texas State Data Center numbers, was placed in "county-other." The maximum value between the Subsidence District projected population and the population projected using the methodology described in *Section II*, was chosen as the revised population number.

2. Water Demand

Appendix A presents the projections for population, municipal, manufacturing, irrigation, mining, livestock, and steam-electric water demands for Waller

County. Municipal and irrigation demands deviate from the TWDB water demand projections. The irrigation demands used are the ones projected by the Region H Water Planning Group Team, as adopted by the TWDB (explained in detail in *Section IV*).

Table 2.1 is a reference table that summarizes which methodology was used for each water demand category in each county within Region H.

Table 2.1 - Summary of Methodology Used for Revised Projections

	Category	*Team-SDC Methodology*	*TWDB Default*	*Other*	*Notes*
Austin	Municipal	X			
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the Region H Water Planning Group (RHWPG) on 6/2/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Brazoria	Municipal	X			
	Livestock		X		
	Irrigation			X	Irrigation demand based on TWDB projections through 2030 and flat after that point. Demands after 2030 developed using the method described in *Section IV* and adopted by the RHWPG on 6/2/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Chambers	Municipal	X			
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the RHWPG on 6/2/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		

Table 2.1 - Summary of Methodology Used for Revised Projections (Continued)

	Category	*Team-SDC Methodology*	*TWDB Default*	*Other*	*Notes*
Fort Bend	Municipal	X		X	Used Subsidence District Projections and removed First Colony.
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the RHWPG on 6/2/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Galveston	Municipal	X		X	Clear Lake Shores capped at 2,500 in 2030.
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the RHWPG on 8/24/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Harris	Municipal	X			
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the RHWPG on 8/24/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		

Table 2.1 - Summary of Methodology Used for Revised Projections (Continued)

	Category	*Team-SDC Methodology*	*TWDB Default*	*Other*	*Notes*
Leon	Municipal	X			
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Liberty	Municipal	X		X	Maximum of Subsidence District projections and the Team-SDC methodology was used.
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the RHWPG on 6/2/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Madison	Municipal	X			
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		

Table 2.1 - Summary of Methodology Used for Revised Projections (Continued)

	Category	*Team-SDC Methodology*	*TWDB Default*	*Other*	*Notes*
Montgomery	Municipal	X		X	Maximum of Team-SDC and Subsidence District projections and cap on The Woodlands.
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Polk	Municipal	X			
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
San Jacinto	Municipal	X			
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		

Table 2.1 - Summary of Methodology Used for Revised Projections (Continued)

	Category	*Team-SDC Methodology*	*TWDB Default*	*Other*	*Notes*
Trinity	Municipal	X		X	Used TNRCC percent split for county-other population projections.
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Walker	Municipal	X			
	Livestock		X		
	Irrigation		X		
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		
Waller	Municipal	X		X	Maximum of Subsidence District projections and Team-SDC methodology was used.
	Livestock		X		
	Irrigation			X	Irrigation demand based on revised projections developed using the method described in *Section IV* and adopted by the RHWPG on 6/2/99.
	Manufacturing		X		
	Mining		X		
	Steam-Electric		X		

SECTION IV - AGRICULTURAL IRRIGATION WATER DEMAND

A. Basis for Revision

The basis for requesting a revision to the agricultural irrigation water demands is described in detail herein.

Criteria: *One or more of the following criteria must be verified by the Regional Water Planning Group and the Executive Administrator of the Texas Water Development Board for consideration of revising the State Water Plan irrigation water demand projections:*

a. *Based on the production period of record (last 20 years), regional irrigated acreage for crops grown in the region has increased at a faster rate or declined at a slower rate than the State Water Plan projected regional irrigated crop acreage for the period 1990 to the year 2000.*

b. *Based on the production period of record (last 20 years), regional irrigation water use has increased at a faster rate or declined at a slower rate than the consensus-based projected regional irrigation water use for the period 1990 to the year 2000.*

c. *Differences identified between the Board's annual irrigation water use estimates for a region or county and estimates provided by the Regional Water Planning Group*

d. ***Other criteria that the Regional Water Planning Group believes are important for consideration of revisions to the State Water Plan projections***

Data Requirements*: The Regional Water Planning Group must provide the Executive Administrator of the Texas Water Development Board the following data associated with the identified criteria for justifying any revisions to the consensus-based State Water Plan irrigation water demand projections.*

1. ***Historical irrigated acreage data for major crops grown in a region as published by the Texas Agricultural Statistics Service, the Texas Agricultural Extension Service, or the Farm Service Agency (USDA) certified acreage***

2. ***Historical annual estimated quantities of water used for irrigation purposes in a region or a county***

3. ***Historical irrigation application rates per acre for crops grown in a region***

4. Other data that the Regional Water Planning Group believes are important to justify revisions to the State Water Plan projections

B. Supporting Data

The Region H Water Planning Group expressed concern about the decline in irrigation predicted by the Texas Water Development Board since the inception of the water planning process. A review of the TWDB usage data showed that the majority of irrigation practiced is for rice irrigation, and that the decline in total irrigation is largely in the rice area. A series of tables of acreages were developed, representing certified acreage for the various crops for the area from the Texas Agricultural Statistics Service (TASS) and from the Farm Services Agency (FSA). The irrigation projections are contained in *Appendix C. Table C-1* shows the rice acreage for the past eight years for the rice-producing counties in Texas. This table, developed using data from interviews with FSA directors in the rice-producing counties, and agrees with TWDB data through 1996. *Table C-2* is from TWDB records and shows rice production through 1996.

With the acreages shown, the participants then developed estimated quantities of water that are used in irrigation of the crops shown. For rice, the area has both surface water and groundwater irrigation, with surface water irrigation predominant. Acreages that are used for these calculations are the highest acreage from the 1996, 1997, and 1998 records for each county. It should be noted that total rice acreage for the Region H counties increased each year from 1996 to 1998, as shown in *Table C-12*. The acreage determined in this fashion was then multiplied by the 1996 usage factor per acre determined from *Table C-2*. This represents the use of below-normal rainfall demand conditions. This factor includes demands from both the main crop and the rattoon, or second, crop. *Table C-11* shows the regional totals.

C. Regional Concerns

The first concern is the TWDB Year 2000 irrigation projection for Region H. This projection shows approximately 461,625 acre-feet of irrigation use. The 1990 recorded irrigation use is shown as 498,513 acre-feet. The calculated rate of decline from those numbers is approximately 7 percent for the 10-year period overall. The year 2000 demand estimated from the consensus numbers presented in the tables above for irrigation is 471,261 acre-feet, which is based on acreages and usages noted above. This estimate includes estimates of rice, corn, and soybean irrigation based on estimated percentages of total acres planted.

The second concern is the TWDB projection of a long-term decline in irrigation demands throughout the 50-year planning horizon. This decline was projected based on information developed by Texas A&M University through the Agricultural and Food Policy Center (AFPC), and information from the Food and Agricultural Products Research Institute (FAPRI).

The projected declines were based on a number of factors that pertained to the profitability of rice production in the Texas Gulf Coast area. Costs of production in this area were relatively high. The cost of surface water was expected to increase throughout the planning period as

competition for scarce resources intensified. In addition, the AFPC December 1995 baseline report, published in February 1996, predicted certain impacts of the modifications contained in the 1996 Farm Bill. These impacts were that landowners who leased land to tenant farmers would be able to collect support payments for rice without growing rice or taking any of the normal risks associated with farming. It was assumed that many of these landowners would opt for the payments and would not farm. This report predicted loss in real equity for Texas farms, as rice prices were predicted to be low, and the high costs of production in this area would continue. It should be noted, however, that, even under this scenario, the moderate-sized Texas farm was projected to experience a small increase (under 10 percent) in real earned equity. It should also be reemphasized that the total acreage for the Region H rice counties increased in both 1997 and 1998, as shown in *Table C-12*.

A review of the prices projected for rice for 1996, 1997, and 1998 versus the prices paid to farmers in the Gulf Coast area is shown in *Table 2.2* below:

TABLE 2.2 COMPARISONS OF ACTUAL AND PROJECTED PRICES FOR RICE

Year	*AFPC Projection $/cwt.*	*Actual Price on Farm $/cwt.*	*Percent Difference*
1996	$7.29	$10.58	45
1997	$7.23	$10.82	50
1998	$7.30	$9.69	33

Prices paid to farmers are shown as reported by local farmers, and represent an average for the year.

As a result of the higher-than-anticipated prices and experience following the implementation of the 1996 Farm Bill, a January 1997 baseline update of the FAPRI study was done to look at the Representative Farms Economic Outlook. This study, entitled *AFPC Working Paper 97-1, Appendix D,* again ranked the farms in the various states. In this study, the moderate Texas rice farm was predicted to experience a real equity gain of 53 percent over the 1996 to 2002 planning horizon. The following statement is excerpted from the report. "Average cash expenses as a percent of receipts range from 74 percent on the moderate Texas Farm (TXR2118) to 91 percent for the moderate Missouri operation (MOR1900)." This statement indicates that the Texas operations are not at a disadvantage, in comparison to rice farms in California, Arkansas, Louisiana, and Missouri. The analysis also states that all of the rice farms would see a net decrease in real equity if net cash farm income as a percent of receipts were to decline by as much as 10 percent. A review of the FAPRI 1999 Briefing Book shows that rice prices are expected to dip slightly during the next three years, but will remain within 90 percent of the 1998 price for all but one year of the next five years. Beginning in 2003, prices are expected to be above $9.00 per cwt. through the remainder of the study period to 2009.

In addition to the improved economic picture presented by the information above, members of Texas Agricultural Extension Service at Texas A&M University have provided further information on the long-term viability of the rice industry in Texas. Their information is incomplete, but major points that were made at a meeting on April 1, 1999, at Bear Creek

Park in Houston further reinforced the economic viability of the rice industry. To summarize, Texas A&M University extension personnel believe that there are significant advances in rice varieties and disease resistance that will significantly reduce costs of production. Of particular note is the projected development of disease-resistant plant varieties that can be planted on the same ground every second year instead of every third year, as is currently practiced. This development alone could result in an increase of 50 percent in total acres in production. At the same time, there is a growing segment of the population in Texas that is of either Asian or Hispanic ethnicity. Both of these ethnic groups are rice users, and the long-term prediction is for the per capita consumption of rice in Texas to increase as these population groups increase. The FAPRI 1999 Briefing Book similarly shows exports decreasing as a greater proportion of U.S.-grown rice is consumed domestically. Projected harvested area for the entire U.S. increases slightly, returns to just below the 1999 level by 2005, and declines after that.

As a result of the predicted increase in production and the increasing demand for rice in Texas, Texas A&M University presented a table recommending that water be set aside for irrigation of rice acreage at levels well above the approximately 350,000 acre feet projected for 2050.

In view of the uncertainty in yield increases and improved disease resistance predicted by Texas A&M University, the Region H Water Planning Group is requesting only that demands for rice irrigation and other row crops be held steady throughout the planning period. *Table C-13* shows the comparisons between the year 2000 TWDB and year 2000 Team irrigation water demands. The revised composite water demand was developed using the higher of the Team or TWDB estimates. The stated intent of the Region H Water Planning Group is to hold irrigation levels steady throughout the planning period, so only those counties where the Team estimate was higher were adopted. In other counties where TWDB default demand estimates were used, irrigation demands were allowed to decrease at the TWDB decrease rate until they equaled the Team demand projection. The demand projections were held constant at the Team projection beyond that point. The only county where this applies is Brazoria County. The TWDB demands were higher for Harris and Galveston Counties also, but the lower Team demands were used by agreement with TWDB and Region H Water Planning Group. These demands were then held constant throughout the planning period.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Exhibits

Appendices

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

REGION H TASK 3 - ANALYSIS OF CURRENT WATER SUPPLIES

Introduction

The available water supply within Region H includes both groundwater and surface water. Groundwater is provided from two major aquifers—the Gulf Coast and the Carrizo-Wilcox; three minor aquifers—the Sparta, Queen City, and Brazos River alluvium. Primary surface water sources are reservoir storage and run-of-river (ROR) supply from the three rivers in the area—the Trinity, the San Jacinto, and the Brazos.

Much of the regional water demand is supplied by surface water. Of the total 1996 water demand, almost 66 percent, or 1,247,360 acre-feet, was supplied by surface water. Surface water supplies are obtained from the Lake Livingston-Wallisville Salt Water Barrier System on the Trinity River; Lakes Conroe and Houston on the San Jacinto River; the Brazos River Authority/Corps of Engineers (BRA/COE) System; run-of-river flows from the Trinity, Brazos, and San Jacinto rivers; the corresponding coastal basins; and some smaller tributaries and reservoirs. Ground water supplies accounted for the remaining 34 percent of the total 1996 water demand predominately supplied by the Gulf Coast aquifer.

As a part of Task 3, the Texas Water Development Board (TWDB) requires the presentation of *Tables 4, 5*, and *6* in accordance with *Exhibit B, "Data and Format Guidelines for SB1 Regional Water Plan – Technical Reports." Table 4, "Current Water Supply Sources,"* indicates the amount of water supply that could be obtained during drought of record conditions from each unique supply source currently available to serve the region. *Table 5*, *"Current Water Supplies Available to Region H by City and Category,"* evaluates the current water supplies available to the region for cities and categories of water users for each county/basin, or portion of a county/basin, in the regional water planning area. In most cases, this is represented by existing contracts or rights. *Table 6*, *"Current Water Supplies Available to the RWPG by Major Water Provider of Municipal and Manufacturing Water,"* tabulates the current water supplies available to the major providers of municipal and manufacturing water for each county/basin, or portion of a county/basin, in the regional water planning area. The RWPG designated five major water providers (MWPs) within the region—Brazos River Authority (BRA), City of Houston (COH), Gulf Coast Water Authority (GCWA), San Jacinto River Authority (SJRA), and Trinity River Authority (TRA). An additional table, *Table 5A*, was compiled as requested by the RWPG. *Table 5A* is identical to *Table 5* except in *Table 5A*, it is assumed that existing water supply contracts included in *Table 5* will be renewed at the current contract amounts and extended through the planning period. The tables and the detailed methodology associated with compiling the tables are included in *Appendix A*.

Some of the information contained within this Task 3 report was based on information published in the *Task 1 – Description of the Region*. For a complete and detailed list of sources, see *Appendix A – References* in the Task 1 report.

Task 3.1 Identification of Groundwater Sources[1]

Groundwater Aquifers

As presented in the Task 1 report, groundwater resources in Region H consist of two major aquifers and three minor aquifers. The two major aquifers are the Gulf Coast aquifer and the Carrizo-Wilcox aquifer with the Gulf Coast aquifer furnishing by far the most groundwater within the region. There are also three minor aquifers present: the Sparta, Queen City and Brazos River alluvium aquifers.

The Carrizo-Wilcox aquifer is the main aquifer in the northern part of Region H in Leon County and the north part of Madison County. The aquifer is composed of, in ascending order, the Wilcox Group and the Carrizo Formation. Because they are hydraulically connected, they are considered one aquifer. The Wilcox Group is composed of alternating beds of sand, sandy clay, and clay with locally interbedded gravel, silt, clay, and lignite. The Carrizo Formation is a uniform, well sorted sand that contains a few very thin beds of clay with the aquifer dipping downward to the southeast at about 70 to 100 feet per mile. The Carrizo-Wilcox aquifer supplies groundwater for domestic, municipal, manufacturing, and agricultural uses in Leon and Madison counties. *Exhibit 1, Major Groundwater Aquifers*, provides a map showing the location of the aquifer.

The Gulf Coast aquifer consists of four general water-producing units. The shallowest is the Chicot aquifer followed by the Evangeline aquifer, the Jasper aquifer and the Catahoula Formation. The Chicot and Evangeline aquifers are the more prolific water producing units in the Gulf Coast aquifer followed by the Jasper aquifer and the Catahoula Formation. The aquifer extends from the Gulf Coast to approximately 100 to 120 miles inland, in Walker and Trinity counties. The units are composed of alternating beds of sand, silt, and clay, and at deeper depths shale can occur at and below the base of the Evangeline aquifer. Formation beds vary in thickness, composition; areal extent and individual beds normally cannot be traced over extended distances. Total aquifer sand thickness varies and can be as great as several hundred feet. The Gulf Coast aquifer supplies ground water for domestic, municipal, manufacturing, and agricultural uses in Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Polk, San Jacinto, Trinity, Walker, and Waller counties.

The Queen City Formation is a minor aquifer that occurs in central and southeast Leon County and in Madison County. The Queen City Formation is composed of sand and loosely cemented sandstone with interbedded shale layers occurring throughout. The Queen City Formation ranges in thickness from 250 feet to 400 feet with approximately 60 to 70 percent of the total thickness being sand according to Texas Water Commission Bulletin 6513, "Availability and Quality of Ground Water in Leon County, Texas, 1965" (Bulletin 6513). Groundwater is provided by the Queen City Formation for domestic, municipal, industrial and agricultural uses in Leon and Madison counties.

The Sparta Formation is another minor aquifer that occurs in southeast Leon county, all of Madison County, northwest Walker County, and northeast Trinity County. The Sparta Formation consists of sand and interbedded clay, with the lower portion of the aquifer containing massive unconsolidated sands with a few layers of shale. The Sparta Formation ranges in thickness from 200 to 300 feet in Leon County (Bulletin 6513) and Madison County. Groundwater from the aquifer is provided for

[1] The information in this section of the Task 3 report was provided by LBG-Guyton Associates.

domestic, municipal, and agricultural uses in Leon County and for domestic, municipal, manufacturing, and agricultural uses in Madison County.

The Brazos River alluvium is the third minor aquifer in the region. The Brazos River alluvium occurs in the floodplain and terrace deposits of the Brazos River in Austin, Fort Bend and Waller Counties as shown on *Exhibit 2, Minor Groundwater Aquifers*. The Quaternary alluvial sediments consist of clay, silt, sand, and gravel according to Texas Water Development Board Report 345 "Aquifers of Texas," (1995) with the more permeable sand and gravel in the lower part of the aquifer. The saturated thickness of the sediment is as much as 85 feet with a width of the alluvium that ranges from less than 1 mile to approximately 7 miles according to Report 345. The Brazos River alluvium supplies groundwater for domestic and agricultural purposes in Fort Bend and Waller counties. In Austin County, it supplies groundwater for domestic, manufacturing and agricultural uses.

Recharge to the two major and three minor aquifers is principally from the infiltration of precipitation and stream flow on the outcrops, see *Exhibit 3, Aquifer Outcrop Areas*. Part of the water infiltrates to the zone of saturation and then moves downdip through the aquifers, while large amounts of precipitation on the outcrops are rejected recharge and become runoff. Average annual precipitation in Region H ranges from about 40 inches per year in the northern section to about 50 to 54 inches in the southeastern section.

Groundwater Use Overview

According to the Texas Water Development Board (TWDB) Region H pumped approximately 653,279 acre-feet of groundwater in 1996. Groundwater in the region is used for domestic, municipal, manufacturing, steam-electric power cooling and agricultural purposes. The majority of the water is used for municipal purposes. Municipal usage accounts for approximately 73 percent or 475,910 acre-feet of the water pumped. Municipal pumpage consists of water used for cities and communities, parks, campgrounds and water districts. Agricultural usage accounts for approximately 16 percent or 103,279 acre-feet of the groundwater pumped. Major agricultural crops include rice, soybean, corn, cotton and hay. Cattle are the principle livestock raised in the region. Finally, industrial usage represents approximately 11 percent or 74,090 acre-feet of the groundwater – water pumped for manufacturing, mining, steam electric power and other industrial needs. A majority of the overall groundwater usage is in the southern section of the region where more of the population, industrial and agricultural demands exist and where the aquifer is capable of providing large quantities of water for the various uses.

Aquifer Conditions

Groundwater conditions within the region have been favorable and should continue to be favorable for the pumping of substantial quantities of good quality water to help satisfy the multiple water needs. The principal aquifers that will provide the water include the Carrizo-Wilcox in Leon and Madison counties and the Gulf Coast aquifer system in the central and southern sections of the region. Smaller amounts of water can be provided by the Queen City, Sparta, and Brazos River alluvium aquifers with the minor aquifers being particularly important in areas that do not require large quantities of water but desire an adequate supply of water.

Carrizo-Wilcox Aquifer

The Carrizo-Wilcox aquifer was deposited in a manner that resulted in a combined aquifer with a thickness of about 2,000 feet in the very northern section of the region. The Carrizo Sand, the principal water-producing unit of the Carrizo-Wilcox aquifer, is about 100 to 200 feet thick. According to TWDB estimates in the 1997 Texas State Water Plan, the overall availability of water from the Carrizo-Wilcox aquifer in Leon and Madison counties is about 165,900 acre-feet per year. In 1996 only about 3,350 acre-feet of groundwater was pumped from the aquifer in the two counties based on data from the TWDB. Conditions are favorable in the region's northern two counties to develop additional supplies from the Carrizo-Wilcox aquifer. The development should be done in a manner that will properly manage the aquifer and monitor its response to the stress of additional groundwater pumping. Water from the aquifer contains less than 1,000 mg/l of total dissolved solids, but water from the Carrizo Sand can contain elevated levels of iron that require sequestering or treatment for removal for water used for most municipal and industrial purposes.

Gulf Coast Aquifer

The Gulf Coast aquifer was deposited in a manner that resulted in a substantial thickness of sand that contains fresh (good quality) water. The lower unit of the aquifer, Catahoula Sandstone, is screened by wells for the City of Huntsville to the north, and to the south in Galveston County, the Chicot unit is screened in wells used by the City of Galveston. The aquifer is capable of yielding larger quantities of water in the central and southern section of Region H and has been utilized over the past 100 years to provide part of the water supply. The Gulf Coast aquifer has sand thicknesses ranging from about 200 to 500 feet in the central and southern sections of the region with the sand thickness containing fresh water decreasing within about 30 to 40 miles of the Gulf Coast.

The pumpage of large quantities of water in the southern part of the region has caused the aquifer potentiometric head to decline from 50 to about 450 feet in parts of the area. Subsidence of significant proportions has occurred in parts of Harris and Galveston Counties resulting in the gradual reduction and shift in areal extent of groundwater pumping to the west over the past 25 years. Subsidence is discussed in the next section of this report.

Digital groundwater flow models have been developed over the past 25 years for the Chicot and Evangeline aquifers in the southern part of Region H to help assess the groundwater resources. The most recent digital model was developed by the US Geological Survey with a report regarding the model currently in review.

Queen City and Sparta Aquifers

The Queen City and Sparta aquifers occur in the northern part of the region and are capable of providing some water in Leon, Madison, Trinity, and Walker counties. Estimated overall availability from the aquifers is about 25,800 acre-feet per year based on groundwater supply data from the TWDB 1997 Texas State Water Plan. Water availability estimates from the Queen City and Sparta aquifers are about 12,500, 11,100, 245 and 2,035 acre-feet per year in Leon, Madison, Trinity and Walker Counties, respectively. The two aquifers are composed of sands that can provide small to moderate quantities of water to wells. The water transmitting capabilities of the aquifers is limited but adequate for meeting smaller demands (pumping rates of 50 to 500 gpm). The aquifers contain water with less than 1,000 mg/l of total dissolved solids to depths that range from about 800 to 1,000 feet. Pumping from the two aquifers in Leon, Madison, Trinity, and Walker counties in 1996 was about 3,950 acre-feet based on data from the TWDB.

Brazos River Alluvium

The Brazos River alluvium is a shallow aquifer that is about one mile to seven miles wide in a corridor along the Brazos River in Waller, Austin, and Fort Bend counties. The aquifer normally is not greater than about 100 feet deep with wells mostly constructed to provide water for irrigation of row crops and hay. The aquifer may contain water with total dissolved solids that approach 1,000 mg/l with the water having high total hardness due to the amounts of calcium, magnesium and sulfate it contains. Based on estimates from the TWDB in the 1997 Texas State Water Plan, the overall availability of water from the Brazos River alluvium in Austin, Waller and Fort Bend counties is about 41,500 acre-feet per year with pumpage in 1996 estimated at 12,321 acre-feet per year by the TWDB. The aquifer should continue to be able to provide water for use along the Brazos River.

Subsidence Effects

Subsidence has occurred principally in Harris, Galveston, Brazoria, Fort Bend and Chambers counties as the result of the withdrawal of large quantities of groundwater from the Chicot and Evangeline aquifers. Studies and reports prepared by the US Geological Survey and the Harris-Galveston Coastal Subsidence District (HGCSD) show that about 9 plus feet of subsidence occurred in a small part of the Houston Ship Channel area with lesser amounts away from the channel area. In the City of Katy, total subsidence through 1995 is estimated to be about 1.5 feet. In the City of Rosenberg in Fort Bend County, estimated subsidence also is about 1.5 feet through 1995. The HGCSD has developed regulatory plans that have been updated through the years. Groundwater pumping in Harris and Galveston counties has decreased over the past 23 years as additional surface water was utilized and less groundwater was pumped.

A regulatory plan adopted by the HGCSD in 1999 prescribes general areal pumpage limits for the next three decades until 2030. The regulatory plan pumping requirements were used in estimating the availability of groundwater within the Harris and Galveston counties area with the estimate of groundwater availability in 2010 being 363,000 acre-feet per year and decreasing to 211,904 acre-feet per year by 2030. The HGCSD regulatory plan essentially segments Harris and Galveston counties into geographic regions and mandates reduction of groundwater supplies per a scheduled reduction timeline. Water users located within the southeast portion of Harris County and all of Galveston County must currently receive no more than 10 percent of their total water supply from groundwater. This limit will exist throughout the Region H planning period. The remainder of Harris County is segmented within two other regulatory regions. Water users within Regulatory Area 2, which comprises the central portion of the county, must receive no more than 20 percent of their water supply from groundwater as of year 2000. Groundwater users within the remainder of Harris County, within HGCSD Regulatory Area 3, can receive only 70 percent of their water supplies from groundwater by year 2010, 30 percent of their water as groundwater by year 2020, and only 20 percent of their water supply from groundwater by year 2030. These regulatory limitations affect all of the WUGs (except irrigation for agricultural purposes and livestock uses) within Harris and Galveston counties by year 2010, causing a continuing decrease in the availability of groundwater in these two counties over time.

The Fort Bend Subsidence District is scheduled to enact a groundwater regulatory plan within the next few years to further discharge its duties. The plan also probably will include pumping limits as needed to control subsidence within the District.

Groundwater Availability in Fort Bend and Montgomery Counties

Groundwater pumpage in Fort Bend County has been increasing over the past ten years from about 69,000 acre-feet per year in 1990 to about 74,500 and 85,000 acre-feet per year in 1996 and 1998, respectively, based on data provided by the Fort Bend Subsidence District. Groundwater availability for the county was estimated by the TWDB at about 55,581 acre-feet per year from the Gulf Coast aquifer. Region H investigated the availability of groundwater in the county and performed simulations using the groundwater flow model developed for the Chicot and Evangeline aquifers by the HGCSD. The data from the model show that groundwater pumping could be increased from its present level up to about 91,500 acre-feet per year with a small resulting water-level decline of 20 feet occurring in a limited part of the county. Over the past 10 years static water levels within the county in observation wells have been stable or showed a slight water-level recovery in east, south, and west Fort Bend County. In the northern section of Fort Bend County there has been about 25 feet of water-level decline over the past 10 years in some Evangeline aquifer screened wells (refer to *Figures 1* through *4*). Based on the results of the model runs and well water-level data, groundwater availability from the Gulf Coast aquifer in Fort Bend County is estimated at 91,548 acre-feet per year. Groundwater availability in Fort Bend County may be adjusted in the future as the Fort Bend Subsidence District develops its regulatory management plan.

The Gulf Coast aquifer provides groundwater to Montgomery County with the Jasper aquifer the principal source for about three-quarters of the county and the Chicot and Evangeline aquifers providing water in the southeast and very southern portion of the county. The TWDB estimated groundwater availability from the Gulf Coast aquifer at about 39,997 acre-feet per year. Pumpage within the county was about 41,683 and 40,925 acre-feet per year in 1996 and 1997, respectively, based on data from the TWDB. Pumpage is concentrated in the central and southern portions of the county along the Interstate Highway 45 corridor, around Lake Conroe, and in the southeastern portion of the county north of the City of Humble.

The outcrop of the upper Jasper aquifer encompasses about 520 square miles in the northern portion of Montgomery County extending into Grimes and Walker counties. If recharge to the aquifer is two inches per year, there would be a minimum of about 55,000 acre-feet per year of recharge. Recharge also occurs on the outcrop of the Evangeline and Chicot aquifers within Montgomery County. The estimated availability of groundwater within Montgomery County for the Gulf Coast aquifer is about 55,000 acre-feet per year. Past pumpage and subsequent aquifer response to pumpage show that the development of additional groundwater will cause additional potentiometric head decline in wells. Groundwater pumpage should be spread throughout the county to take advantage of developing water in areas where aquifer conditions are favorable but where the demand has not developed for the water, which is principally in the western and eastern portions of the county away from the Interstate Highway 45 corridor area.

Public Supply Groundwater Usage

Region H relied on groundwater to provide approximately 60 percent or 475,910 acre-feet of the municipal water supply in 1996. Austin, Leon, Liberty, Madison and Montgomery counties relied on groundwater to supply essentially 100 percent of the domestic and municipal demand. *Figure 5* gives the amount of groundwater pumped for municipal purposes for each county in the region. Within the region, Harris County accounted for the most municipal groundwater usage in 1996 with 328,791 acre-feet. The next highest demands are Fort Bend County with 46,007 acre-feet,

Montgomery County with 38,430 acre-feet and Brazoria County with 22,901 acre-feet. Municipal users represent cities and communities, parks, campgrounds and any water districts.

Cities with populations of 1,000 or greater and county-other users that rely on groundwater for at least part of their overall supply are identified in *Table 5* with a source code of 01 based on the source of their water supply. The amount of groundwater projected to be available to the users can vary through the planning period depending on the demand for water by a user and whether surface water is needed or available in future years to satisfy part of the demand.

Existing and Planned Groundwater Systems

Groundwater systems provide water to most of the cities, towns, and county-other users within the region. Wells that provide water to the cities over 1,000 population and county-wells will require refurbishing and replacing as they reach the end of their useful life. Storage facilities will require maintenance and periodic refurbishing. Additional wells and storage facilities will be needed for certain cities or county-other users identified in the following paragraphs. The estimated needs for additional facilities for the cities and county-other users were developed based on a review of data provided by the TWDB, TNRCC, and the cities and county-other users.

Liberty County

The City of Cleveland has three wells with an estimated combined capacity of about 1,100 gallons per minute (gpm). With a demand of 1,915 acre-feet per year or 1,197 gpm by 2030, it is estimated that the City should construct an additional well by 2030 with a capacity of at least 300 gpm to supplement its current well capacity and possibly add about 0.5 million gallons of ground storage.

The City of Liberty has three wells with an estimated combined capacity of about 1,100 to 1,400 gpm. With estimated demand of 2,105 acre-feet per year by 2010 or an average of 1,315 gpm, the City should have adequate well capacity through 2010. Demand is projected to reach 2,694 acre-feet per year by 2050 or an average of about 1,684 gpm. After 2010, it is estimated that the City should drill an additional well with a capacity of at least 400 gpm to provide additional water to the City system.

Walker County

Walker County has a number of rural water supply corporations and Texas Department of Criminal Justice facilities that have water demands classified as county-other. Based on review of information provided in data from the TWDB, the estimated pumping capacity of these facilities is about 4,300 acre-feet per year or about 2,687 gpm. Estimated water demand in 2000 for this user group is about 5,309 acre-feet per year with demand projected to increase to 5,977 acre-feet per year by 2050. The approximately 668 acre-feet per year of increase in demand, if met with groundwater, will require wells and probably ground storage facilities be constructed in the county. Data show that wells drilled for water supply corporations normally provide about 80 to 150 gpm with the average about 115 gpm. With 668 acre-feet per year of additional demand equaling about 418 gpm, it would require four additional wells at about 105 gpm each. It also is estimated that about 0.5 million gallons of ground storage capacity could be required for the additional supply facilities of about 418 gpm. Construction of wells and ground storage should occur gradually through the decades as the demand for water increases in various areas of the county.

Waller County

The Town of Brookshire has an estimated water demand of 762 acre-feet in 2000, 1,013 in 2010 and 2,060 acre-feet by 2050. Available data show that two small, older wells drilled in the 1950s and one newer well are in use as of 1996 with an estimated capacity of about 1,100 acre-feet per year or about 688 gpm. It is estimated that after 2010, the Town of Brookshire could need to drill an additional water well to provide about 960 acre-feet per year or 600 gpm. Sands are available for screening in the Evangeline aquifer to construct a well with a pumping rate of 600 gpm.

The City of Hempstead had three operational wells as of 1996 with an estimated capacity of about 1,200 gpm. One of the wells was drilled in 1956. It is estimated that by about 2030 the City could require one additional well to provide water to the system with the demand for water being 851 acre-feet per year in 1996 and projected to increase to 1,405 acre-feet per year by 2050. The well should provide a minimum of a few hundred gallons per minute.

The Town of Prairie View and Prairie View A&M University had an estimated combined usage of 1,323 acre-feet in 1990. Demand for water in that area is projected to increase to 3,092 acre-feet per year by 2050. The combined present pumping capacity of the wells is about 2,470 acre-feet per year, thus it is estimated by about 2030 that the area could need additional pumping rate capacity of about 620 acre-feet per year or about 390 gpm. An additional 0.5 million gallons of ground storage also could be needed for the water system as the user demand for water on the system increases.

Industrial Groundwater Usage

In 1996, Region H relied on groundwater to provide approximately 11 percent of the water used for industrial purposes, which accounted for approximately 74,090 acre-feet of the groundwater used in Region H. Industrial consumption represents water that is used for manufacturing, mining and steam electric power. *Figure 6* shows the amount of groundwater used for industrial purposes for each county in the region. Within the region Harris County accounted for the most industrial groundwater usage in 1996 with 38,541 acre-feet. The next highest users were Liberty with 9,015 acre-feet, Fort Bend with 8,901 acre-feet, and Chambers with 8,178 acre-feet.

Agricultural Groundwater Usage

In 1996, Region H relied on groundwater to provide approximately 27 percent of the water used for agricultural purposes. This equaled approximately 16 percent or 103,279 acre-feet of the total groundwater used in the region. Agricultural usage represents water that is used for livestock purposes and irrigation of crops. The main agricultural crops in the region include rice, cotton, and soybeans in the south and corn, cotton, and hay in the north. Cattle are the principle livestock raised. *Figure 7* shows the amount of groundwater used for agricultural purposes for each county in the region. Within the region, Fort Bend County accounted for the most agricultural groundwater usage in 1996 with 34,709 acre-feet. The next highest user is Waller County with 23,532 acre-feet followed by Harris County with 16,038 acre-feet.

Groundwater Drought Susceptibility

The aquifers within Region H generally have low transmissivity rates, and are less susceptible to drought because the static water levels do not fluctuate drastically during a severe drought. In general, Region H water suppliers have established drought triggers for their groundwater systems as

a function of system capacity (pumps, storage, etc.) as opposed to other regions where static aquifer groundwater levels are used as drought triggers.

Groundwater Availability Summary

Groundwater has been an important water resource within Region H for the past 100 years. The major Carrizo-Wilcox and Gulf Coast aquifers and minor Sparta, Queen City, and Brazos River alluvium aquifers should continue providing an important water resource to the region to be used in combination with surface water to help satisfy the regional water demand. Water of good quality continues to be available from the aquifers and should continue in the future with prudent management of the resource. Subsidence issues were taken into consideration when estimating future groundwater availability within Harris and Galveston counties. The groundwater availability data given in *Table 4, "Current Water Sources,"* and *Table 5, "Current Water Supplies Available to Region H by City and Category,"* as a part of the overall water resources, provide quantitative numbers of the amount of the resource estimated to be available in Region H.

Task 3.2 Identification of Surface Water Sources

As stated in the Task 1 report, surface water sources in Region H consist of reservoir storage and run-of-river supply for the three rivers in the area, the Trinity, the San Jacinto and the Brazos. The supply information presented in Task 1 is based on the Trans-Texas Water Program *Phase I Report* (1994), *Planning Information Update* (1996), and *Water for Texas* (1997). Since the publication of these documents, additional data gathering and evaluations were performed by the engineering consulting team to more completely investigate the supplies of Region H, rendering new insight and information regarding those supplies. This information was used to arrive at the current supplies that will be considered for the remainder of the planning effort. Major refinements of the Task 1 data include determination of the amount of water available from the lower Brazos run-of-river supply and the addition of reliable coastal basin and tributary supplies. A map showing major surface water sources that serve Region H is included as *Exhibit 4*. A map showing the approximate service areas for the current regional water providers is included on *Exhibit 5*.

Available Surface Water

Table 1 below summarizes the surface water supply sources currently available to Region H based on the information gathered to compile *Table 4, "Current Water Sources."*

The total supply available from each source currently being used to serve Region H is included in *Table 4*, *"Current Water Sources,"* in *Appendix A*. In general, *Table 4* indicates the maximum amount of water supply that could be obtained during drought of record (DOR) conditions from each unique supply source. The information in *Table 4* was compiled from existing contracts and water rights in Region H, existing water availability modeling results for various supply sources, review of previous reports and contact with actual providers and contracting entities. A detailed explanation of the information in *Table 4* and how it was obtained can be found in *Appendix A-Table 4 Methodology*. Not all of the sources listed in *Table 4* are actually available to Region H. With regard to this issue, the TWDB Executive Administrator issued this guidance:

> *If multiple RWPGs plan on utilizing water from the same reservoir to meet future demands, it is imperative that the firm yield reported for the reservoir in question be*

consistent across all planning decades for all affected regions in Table 4. RWPGs shall report existing reservoirs physically located within their region in Table 4, as well as reservoirs located in a different region if those supplies are available to the region.

Table 1: Current Surface Water Supply Sources Available for Use in Region H

Basin/Reservoir/Run-of-River	Current Year 2000 Available Yield (acre-feet/year)
Trinity Basin	
Lake Livingston/Wallisville	1,321,279
Run-of-River and Big Ditch	185,320
Other Tributaries, Local Supplies and Reservoirs	60,859
San Jacinto River Basin	
Lake Houston	168,000
Lake Conroe	99,950
Lewis Creek	6,300
Run-of-River and Local Supplies	56,352
Brazos River Basin	
BRA/COE System[2]	137,293
Run-of-River and Local Supplies	505,364
Coastal Basins	89,307
Sam Rayburn Reservoir and Neches Basin Supplies	6,202
Total Existing Surface Water Supply Available to Serve Region H	**2,636,226**

Thus, *Table 4* lists the entire firm yields of each of the upper Brazos River reservoirs jointly owned by BRA and COE, even though only a small portion of those sources is available to Region H, via long term contractual commitments. By the same rationale, *Table 4* considers that the surface water supplies of the Trinity River Authority are common between regions, and therefore, these Trinity River supplies have been shown in *Table 4*.

Surface Water Drought Susceptibility

Within this report, the surface water reservoir and run-of-river supplies represent firm yield and reliable quantities, respectively. The five Major Water Providers in Region H maintain Drought Contingency Plans prepared under provision of the Texas Administrative Code, Section 30, Chapter 288 for their respective shares of these supplies. These drought plans are summarized in Appendix D. While each major provider utilizes unique criteria to define drought stages, their drought contingency plans use a common methodology. A first stage trigger is used to initiate customer notification systems and voluntary use reductions. A second stage trigger is used to initiate mandatory use reductions. Finally, a third stage trigger is used to initiate additional use reductions and/or the suspension of service to some customers. The drought triggers established by the Major Water Providers are included in Appendix D.

[2] This amount is based on current contracts within Region H. The total yield of the BRA/COE system is 736,016 ac-feet/yr.

Surface Water Conveyance Systems

Region H contains a number of raw surface water conveyance systems (pipelines, canals, and pump stations). The conveyance systems mainly lie in the coastal river basins in the southern counties of Region H. The main canal systems belong to the City of Houston, Coastal Water Authority (CWA), the Gulf Coast Water Authority (GCWA), the Trinity River Authority (TRA), the Lower Neches Valley Authority (LNVA), the Chocolate Bayou Water Company, the San Jacinto River Authority (SJRA), the Chambers-Liberty Counties Navigation Districts, and Dow Chemical. The information in this section was gathered from each of the entities listed above and the Trans-Texas Water Program Phase I Report for the Southeast Area. These systems are shown on *Exhibit 6*.

The CWA project consists of a main conveyance canal system and a pipeline distribution system. The conveyance system includes the Trinity River pump station, the Main Canal, the Lynchburg Reservoir, the Cedar Point Lateral, the Lake Houston pump station, and the West Canal. The Trinity River pump station near Liberty has an existing capacity of 723 mgd and an ultimate design capacity of 1,300 mgd. The main canal runs westerly from the Trinity River pump station about 22 miles to the Lynchburg Reservoir (north of the Houston Ship Channel). The total capacity of the canal is approximately 1,300 mgd from the Trinity River Pump Station to the Cedar Point Lateral. Downstream of the Cedar Point Lateral, the canal has a capacity of 1,100 mgd. The Lynchburg Reservoir has an impoundment capacity of 4,600 acre-feet. The Cedar Point Lateral, with a design capacity of 230 mgd, is located about 8 miles southwest of the Trinity River pump station and diverts water from the main canal southward. The Lake Houston pump station diverts water from Lake Houston into the CWA west canal, which travels southwesterly until it terminates at the City of Houston East Water Purification Plant. The CWA distribution system consists of pressure pipelines that start at the Lynchburg Reservoir with the Lynchburg pump station and extend southwest about 10 miles to the Bayport Industrial complex and eastward along State Highway 225 conveying raw water to industrial users.

The GCWA system consists of three main canals that deliver water from the Brazos River to Fort Bend, Brazoria, and Galveston Counties: the American Canal, the Briscoe Canal, and the Galveston Canal System. The American Canal runs parallel to State Highway 6 southeasterly from the Brazos River lift station (the Shannon Plant, which is 12 miles north of Rosenberg) to Alvin, Texas. The Briscoe Canal runs southeasterly from the Brazos River pump station (the Briscoe Plant, which is 6 miles west of Arcola) to Alvin and then to an industrial complex in southern Brazoria County. The American Canal is connected to the Briscoe Canal by a lateral called “Lateral 10” just west of Manvel. The Galveston Canal System extends from the old Briscoe system southeast of Alvin to the GCWA reservoir (4 miles east of Dickinson). The Galveston Canal System connects to the American Canal 6 miles east of Alvin. GCWA has three pump stations, the Shannon Plant with a total capacity of 347 mgd, the Briscoe Plant with a total capacity of 302.4 mgd, and the American Canal’s second lift station located at Sugar Land with a total capacity of 225 mgd.

The Dayton Canal is a small system that serves Liberty County. The canal, which is off the Trinity River, extends about 20 miles west of the river and has an estimated capacity of 90 mgd.

The Devers canal system currently delivers irrigation water easterly from the Trinity River to customers in Liberty and Chambers Counties. The main canal system is 81 miles with 125 miles of laterals. Due to the flat grade of the main canal the flow can be reversed to flow westerly. The system contains two pump stations. The first one on the Devers main canal at the Trinity River has a

total name plate capacity of 295 mgd, and the second pump station (near State Highway 563) has a total capacity of 274 mgd.

The Lower Neches Valley Authority System diverts water from the Neches River and Pine Island Bayou and delivers it to customers in Jefferson County and farmers in Chambers and Liberty Counties. The LNVA canal consists of two main canals, the Neches Main and the BI Main. After the junction of the two main canals, the Neches Main travels southwesterly until the Nolte Canal branches off traveling westward into Liberty County. At this point the Neches Main turns and extends southward into Chambers County. The Nolte Canal and the end of the Neches Main are the only sections of the LNVA canal system that extend into Region H. The capacity of the Nolte Canal upstream of the check structure is 130 mgd, and 36 mgd downstream from the check.

The Chocolate Bayou Water Company has a distribution system that can be divided into two sections. The Juliff section, also known as the old South Texas Water system, which transports water from the Juliff pump station on the Brazos River near the Fort Bend-Brazoria County boundary, and the Chocolate Bayou Canal section, which transports water from Chocolate Bayou near Liverpool. The Juliff section has two main canals (the North Canal and the Main Canal) and the Angleton Lateral. This section provides irrigation water to rice farmers and some industrial water to Brazoria County. The Chocolate Bayou Canal section has its main pump station on Chocolate Bayou, but there are additional pump stations on Mustang Bayou and Halls Bayou as well. This section also provides irrigation and industrial water to Brazoria County.

The San Jacinto River Authority provides raw surface water from a point at the Lake Houston dam through its canal system and SJRA's Highlands Reservoir to a point just north of the Houston Ship Channel, providing service to the industrial customers in eastern Harris County.

The Chambers-Liberty Counties Navigation District canal system diverts water from the Trinity River just south of Anahuac Lake. The canal travels easterly and branches to the north and south along the length of the main canal to serve the City of Anahuac and irrigators in Chambers County.

The Dow Chemical canal in Brazoria County diverts water from Oyster Creek near Lake Jackson. From there the canal travels parallel to the Brazos River into the Dow complex just north of Freeport. Exiting the Dow complex, a drainage canal transports water to the Gulf.

Previously Studied Potential Reservoir Sites

Part of the Task 3 analysis includes the identification of reservoir sites of unique value, based on the definition given in the Texas Water Code §16.053(e)(5). In this portion of the analysis, previously studied proposed reservoir sites planned to serve Region H were identified and presented to the RWPG. Using information provided in existing studies and reports, a summary table was prepared listing expected yields, total and unit costs, and a brief discussion of potential issues of concern regarding each proposed reservoir. This information is included in *Appendix B*. The RWPG reviewed the information in *Appendix B* and elected to identify any reservoirs of unique value during the evaluation of water supply management strategies to be performed in Task 5.

Legal and Regulatory Constraints

A number of legal (institutional) and regulatory factors affect water planning, development, and usage within the Region H area. The most notables of these factors are surface water rights,

groundwater conservation districts, interbasin transfer rules, wastewater return flow impacts, environmental flows, and the newly created North Harris County Regional Water Authority.

All of the water that is included in the analysis of surface water supplies for Region H is water that is obtained under a water right issued through the Texas Natural Resources Conservation Commission (TNRCC), or a predecessor agency of the TNRCC. The major water providers have a substantial portion of the rights available to the region, and these major providers contract to supply water obtained under those rights to various water user groups.

Two groundwater conservation districts exist within the Region H area. These districts are the Harris-Galveston Coastal Subsidence District and the Fort Bend Subsidence District. Each district enacts and enforces groundwater regulations within their respective counties. The specific rules regulating the use of groundwater use was described in the previous section titled "Subsidence Effects." The HGCSD has adopted rules that will limit the availability of groundwater within Harris and Galveston counties. It is anticipated that the Fort Bend Subsidence District will likewise adopt rules that limit future groundwater withdrawals.

The Brown-Lewis bill (formally Senate Bill 1) included restrictions on the interbasin transfer of water. These rules mandate that water supplies obtained by a receiving basin become junior to all other rights in existence within the originating basin of the transfer. This rule applies to all future permits associated with interbasin transfer. As illustrated within this report, a significant quantity of water currently supplied within Region H occurs via interbasin transfer. Some of the water delivered by all of the major water providers occurs through some type of interbasin transfer. The most significant of these are the City of Houston and SJRA transfers of Trinity River water into the San Jacinto watershed and the BRA and GCWA transfers of Brazos River water into the San Jacinto-Brazos Coastal basin. It is anticipated that new interbasin transfers will be needed to support growth within and throughout Region H, particularly to the San Jacinto and San Jacinto-Brazos basins where the largest amounts of population growth are occurring. Current limitations on interbasin transfers will affect the development of future water resource management strategies.

The use of wastewater reuse and reclamation is a water management strategy that is growing in usage within the Texas water industry. Wastewater reuse is the reuse of wastewater prior to its discharge into a receiving stream of the state. These reused quantities can be used for irrigation, manufacturing, mining, and steam electric power and limited municipal purposes (landscaping, etc.) Wastewater reclamation, however, can affect the reliability of existing surface water rights. In particular, within Region H, one of the greatest potential areas of reuse is within Harris and Montgomery counties upstream of Lake Houston. Significant reuse of these flows will, however, affect the water rights of the SJRA and City of Houston associated with their San Jacinto River water rights. While reuse should be investigated as a viable water management strategy, particular analysis must be performed to minimize the impact of existing surface water rights.

Currently, while water rights for environmental uses can be adopted, it is not the norm within Texas water law to do so. Environmental water releases are routinely enacted, as a result of a mitigative measure associated with development of a water supply project. Adoption of a water right for an environmental beneficial use has not occurred. Several reasons for this situation include the lack of definition in terms of supporting data on environmental needs of rivers, streams and bays. Also, the cost associated with development or procurement of environmental rights has not historically occurred. As discussed herein, environmental water uses are benefiting Region H economically.

Additionally, a number of agencies and interest groups (GBFIG and others) have been trying for many years to resolve the historical issues associated with the lack of development of environmental water rights. A new provision under the Texas Water Code establishes the Texas Water Trust within the Texas Water Bank. Existing water rights can be placed in the Texas Water Trust to be dedicated to environmental needs, including instream flows, water quality, fish and wildlife habitat, or bay and estuary inflows. While no water rights from Region H have yet been placed in the Texas Water Trust, it can be anticipated that it will figure in further efforts to address both the technical and institutional issues associated with environmental water rights within Region H.

During January 2000, a new water management agency, the North Harris County Regional Water Authority (NHCRWA) was created. This entity has the power to develop and supply water within a large geographic region of north Harris County. To date, the NHCRWA has been in the process of adopting administrative functions associated with its creation and has recently begun the process of assessing future water supply strategies for its jurisdictional region. To date, the Region H planning process has not specifically segmented out the NHCRWA region and defined specific management strategies for this entity. Upon completion of the analysis of appropriate water supply methods for the NHCRWA, the Region H water plan should be revised to incorporate the NHCRWA as a WUG, develop the associated data, and assign the determined water management strategies. The NHCRWA should become a part of future water management plans for Region H.

Environmental Uses and Requirements

The Region H RWPG agreed to include information on freshwater inflow needs provided by the Galveston Bay Freshwater Inflows Group (GBFIG), an ad-hoc group of regional water supply agencies, state and federal water agencies, environmentalists, business and recreational interests. The GBFIG recommended and the Region H RWPG formally adopted a set of freshwater inflow needs for Galveston Bay. These needs are summarized in *Table 2A* as contained in the Task 2 report and as reproduced below.

Unique River and Stream Segments

The RHWPG has received information compiled by Texas Parks & Wildlife addressing unique river and stream segments. The segments recommended by the RHWPG as unique are listed in the Task 6 Report.

Navigational Uses

As the governing bodies of the nation's waterways, the US Coast Guard and the Army Corps of Engineers were contacted in an effort to define water requirements and navigational parameters. The US Coast Guard referred to the Texas Natural Resources Code that states if a water body maintains an average width of 30 feet, then it is navigable.

No information has been found that defines minimum water quantity volumes for any particular waterway nor requirements for reservoir releases to maintain minimum flows within a waterway. A search of the TNRCC water rights database indicated that there are no navigation water rights in Region H.

Table 2A: Environmental Water Needs for Galveston Bay

Inflow Scenario	Quantity Needed (acre-feet/year)	Historical Frequency	Target Minimum Frequency
Max H	5.2 million	66%	50%
Min Q	4.2 million	70%	60%
Min Q-Sal	2.5 million	82%	75%
Min Historic	1.8 million	98%	90%

Note: The health and productivity of Galveston Bay must consider the quantity, quality, seasonality (monthly inflows), and location of inflows. It is anticipated that the inflow needs projections will continue to be refined over time. The use of improved data focused on the fisheries production solely from the Galveston Bay system is one example of an anticipated means of refinement.

Scenario Descriptions:

Max H: Modeled inflows recommended for maximum bay and estuary fisheries harvest by Texas Parks & Wildlife Department.

Min Q: Minimum modeled inflow recommended to maintain the bay and estuary fisheries harvest.

Min Q-Sal: Estimated minimum acceptable inflow recommended to maintain the salinity needed for bay and estuary fisheries viability.

Min Historic: Minimum annual inflow calculated for Galveston Bay over the period of record (1941-1990).

The 13th Edition (1996) of the *State of Texas Water Quality Inventory Report* put together by the Texas Natural Resource Conservation Commission divides the Texas rivers basins into various segments. Each segment is described and classified, the designated water uses are identified, and the water quality is determined. This report was used to identify all of the river segments located in Region H along with their associated uses.

The Texas Parks and Wildlife Department conducted an *Analysis of Texas Waterways: A Report on the Physical Characteristics on Rivers, Streams, and Bayous in Texas*. This report identifies the seasonal and restrictive waterways: "those sections of rivers, streams, and bayous… which have been found to contain an insufficient flow of water for recreational use under normal conditions, or for various reasons could not be classified as a major waterway, and would be restricted to seasonal usage" (Analysis of Texas Waterways, TPWD). Using this information the seasonal and restrictive waterways of Region H are shown on *Exhibit* 7.

Recreational Uses

Water-based recreational uses in Region H include activities that are directly dependent upon the region's rivers, streams and reservoirs, such as swimming, boating, fishing and paddle sports, as well as those enhanced by proximity to water sources such as wildlife viewing, camping and hunting, and eco-tourism. There are also economic activities associated with water-based recreation such as marinas, tourist accommodation and services, and other recreation-based businesses. Generally, communities developed adjacent to or near recreational lakes contribute an increased tax base, from which economic benefits can accrue. Positive local tax base impacts in rural communities of Region H have been and can be significant, therefore, reservoir development in these areas has been viewed as an economic benefit for these regions. Recreation water needs and requirements have two distinct components – physical and economic.

The physical component addresses the amount (volume) of water needed to perform various recreational activities. This is strictly a function of the geometry of whatever body of water is being considered and the type of activity that is being investigated.

In order to provide for this need, some stakeholders in water-related recreational activities apply for diversion permits from the TNRCC that allow them to divert water into man-made lakes and ponds dedicated to recreational purposes. A search of the TNRCC water rights database returned 125 records for recreation water rights with stated total diversion of about 10,303 acre-feet per year. Six of these rights account for 7,652 acre-feet per year in authorized diversions. The entity associated with, the location of, and the diversion amount of each of these six is shown in *Table 2*.

Table 2: Major Recreational Water Rights in Region H

Owner	Stream	Diversion (af/yr)
Brazos River Club	Brazos River	3,000
Properties of the Southwest	Log Gully	1,164
US Fish and Wildlife	Big Slough	1,080
C E Zwahr ET AL	Austin Bayou	1,003
George W Maxwell	Cow Island	805
The Woodlands Corporation	Bear Branch	600

The majority of the region's fresh water recreation occurs, not on dedicated recreational lakes, but on water supply reservoirs. The region's water reservoirs provide a broad range of recreational opportunities but were created for a water supply purpose to meet the region's consumptive water demands. While recreation is permitted on most of the region's water supply reservoirs, there are no dedicated recreational water rights protecting volumes for recreational purposes on these reservoirs. There are three water supply reservoirs in Region H that provide a significant portion of the freshwater-related recreational activities that take place in the region. They are Lake Livingston, Lake Conroe, and Lake Houston; with Lake Livingston having the largest capacity and Lake Houston having the smallest capacity.

The economic importance of water-based recreational businesses is illustrated within recent studies that indicate that water-related recreational activities account for a significant portion of the Texas

economy. In 1996, Texas ranked second in the United States in angler expenditures at roughly $2.9 billion, providing more than 80,000 jobs. In the same year, there were an estimated 2.6 million anglers in Texas, with 2.1 million classified as primarily freshwater anglers. Furthermore, one study estimates that in 1997, Texas ranked fifth in the United States in boat ownership with about $302 million in retail boat sales. Texas Parks and Wildlife Department reported in February of 2000 that 617,864 boats are registered in the state, 98 percent of which are used as pleasure craft. Counties in Region H account for nearly one-quarter of these (134,289) and 99 percent of these are registered as pleasure craft. In Texas, the 1991 retail sales for migratory bird hunting was $262,600,000, and the 1991 retail sales for migratory waterfowl hunting was $48,900,000. The 1991 retail sales for non-consumptive bird use was $155,300,000; The 1991 non-consumptive waterfowl use in Texas was $103,600,000. Such statistics demonstrate an economic-driven recreational need for water in Texas.

While there is a direct relationship between water needs and these industries, there are no statistical data available to calculate or quantify that relationship. Although, anecdotal information suggest negative impacts on communities when reservoirs levels decrease, there is no data available to indicate specific reservoir levels required to support boating and fishing activities or how much water is necessary to maintain habitat that supports resident and migratory wildlife. Wildlife viewing had the most quantitative data, yet this data was only available for small pockets of Region H. For instance, High Island is a major birding area, but there is no information that quantifies the number of birds and people that come to the area as a result of the amount of water in the area.

In an effort to better define this aspect of the recreational needs, all state parks and forests, national parks and forests, wildlife refuges, and wildlife management facilities in Region H were identified. Every facility was researched to determine if it provided facilities for camping and picnicking, nature and wildlife viewing, hunting, fishing, and boating and other water sports. Sources include various websites and publications from the Texas Parks and Wildlife Department, National Park Service, USDA Forest Service, US Fish and Wildlife Service, National Wildlife Refuge System, Galveston Bay National Estuary Program, US Army Corps of Engineers, US Historical Society, Great Outdoor Recreation Pages, Recreation.Gov, *1998-1999 Texas Almanac*, various Texas road atlases, and various county and river authority websites. All of this information was compiled into the following three tables contained in *Appendix C*.

1. "Region H-River Segments, Bay and Estuaries" – Lists all of the river basins, river segments, bays and estuaries in the region, and the recreational opportunities associated with each.

2. "Recreation" – Lists all of the national parks, preserves, wildlife refuges, state parks, wildlife management areas, and forests, and the recreational opportunities associated with each.

3. "Region H-River Segments, Bay and Estuaries-Special Features" – Lists all of the lakes and reservoir segments in the region and the recreational opportunities associated with each.

These tables contain data that was available from the entities listed in the scope and other resources found, but they are not complete and lack data for some of the waterways and public recreational areas. *Appendix C* contains a detailed bibliography of all of the sources used for this section. From the table containing the public recreational sites and data obtained from the *Galveston Bay*

Recreational User's Handbook, an exhibit was prepared to illustrate the location and each associated recreational activity for Region H (see *Exhibit* 7). This exhibit also shows the seasonal and restricted waterways. Additional information was acquired from the Houston Canoe Club on areas within the region of importance to paddle sports.

Recreational water needs are currently met through the use of water supply reservoirs, rivers and streams, and Galveston Bay. Economic activities are associated with water-based recreation, hunting, wildlife viewing and eco-tourism, and reflect an additional element in evaluating recreational water needs.

Task 3.3 Total Water Supply

The total amount of water supply currently available to Region H from existing available water sources is 3,687,495 acre-feet per year. Of that, approximately 71 percent is surface water. By the years 2030 and 2050, the available supply is expected to be 3,459,862 acre-feet per year and 3,460,265 acre-feet per year, respectively. *Table 3* below summarizes these current and projected water supplies.

Table 3:

Summary of Water Supply Available for Region H for Study Years 2000, 2030, and 2050

Supply Source	Supply Available (af/yr)		
	Year 2000	Year 2030	Year 2050
Groundwater			
• Gulf Coast Aquifer	816,180	588,266	588,255
• Carrizo-Wilcox Aquifer	168,487	168,479	168,479
• Queen City & Sparta Aquifer	25,320	25,314	25,325
• Brazos River Alluvium	41,282	41,282	41,282
Subtotal GW	1,051,269	823,341	823,341
Surface Water			
• Trinity River Basin	1,567,458	1,567,458	1,567,458
• San Jacinto River Basin	330,602	330,703	330,682
• Brazos River Basin	642,657	642,734	642,843
• Coastal Basins	89,307	89,204	89,465
• Lower Neches Basin	6,202	6,422	6,476
Subtotal SW	2,636,226	2,636,521	2,636,924
Total	**3,687,495**	**3,459,862**	**3,460,265**

This water supply is distributed to each Water User Group (WUG), i.e. each city, each county-other and each non-municipal water use category. This distribution is shown in *Table 5, "Current Water Supplies available to the RWPG by City and Category,"* contained in *Appendix* A.

In *Table 5*, the ground and surface water supply sources available to Region H are assigned to the various WUGs in the region based on contracts and water rights, limitations of conveyance facilities and in some cases, current usage patterns. In general, a thorough search was performed to determine how each WUG obtained its water supply. This required identification of third-party contracts as well as water providers in addition to the major water providers (MWPs). A detailed description of the methodology and information used to compile *Table 5* is contained in *Appendix A*.

About 61 percent of the year 2000 total available Region H supply is allocated to the region through one of the MWPs. The following *Table 7* shows the distribution of the available supply among the providers for study years 2000, 2030 and 2050.

Table 7:

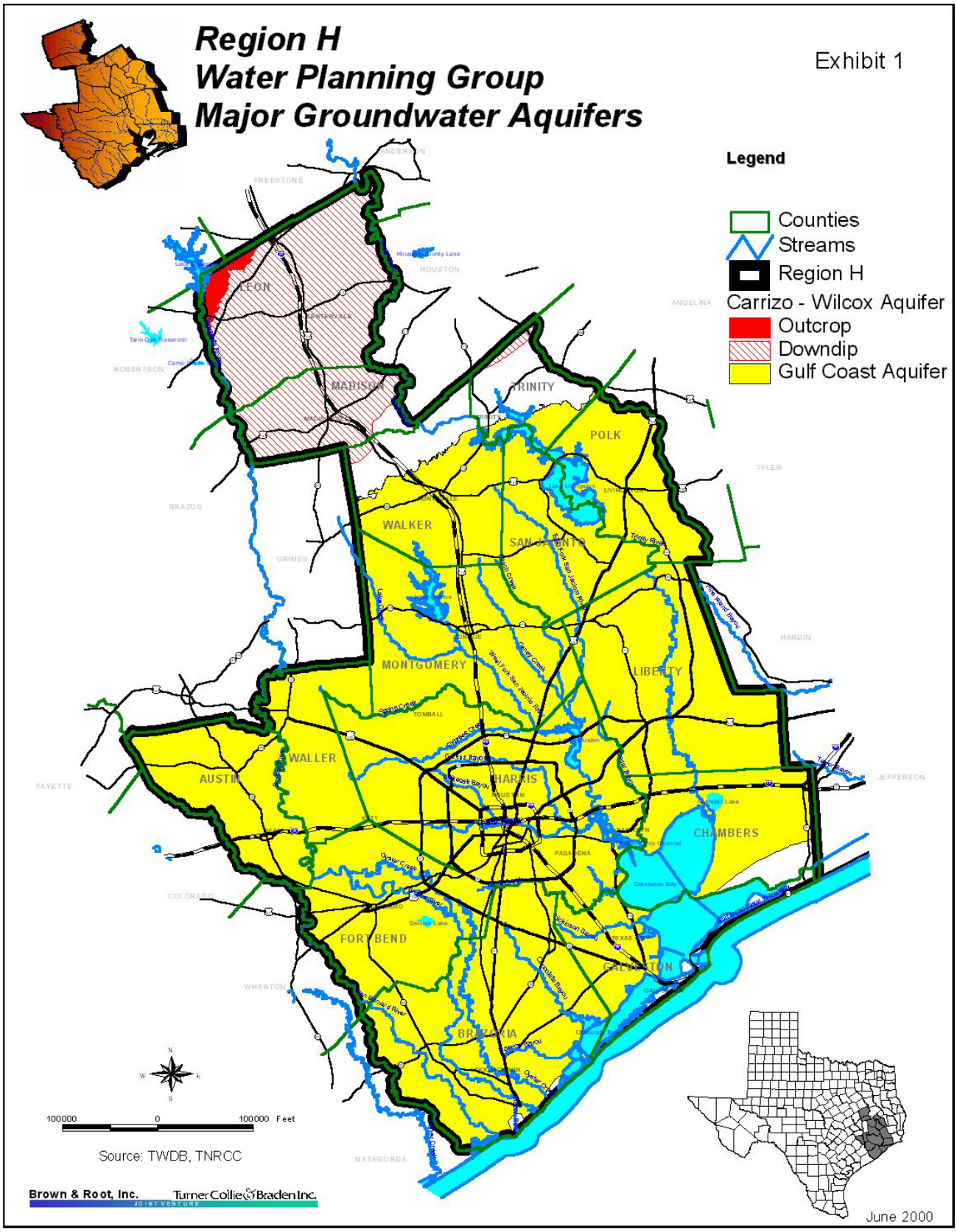
Available Supply by Major Provider within Region H for the Study Years 2000, 2030, and 2050

Provider	Supply (af/yr)		
	Year 2000	Year 2030	Year 2050
BRA	104,625	104,625	104,625
City of Houston			
• Groundwater	145,479	100,643	99,345
• Surface Water	1,258,829	1,258,829	1,258,829
GCWA	210,850	210,850	210,850
SJRA			
• Groundwater	12,181	18,001	18,001
• Surface Water	143,921	143,921	143,921
TRA	380,479	380,479	380,479
Other Sources/Providers			
• Groundwater	893,609	704,697	705,995
• Surface Water	537,522	537,817	538,220
Total	**3,687,495**	**3,459,862**	**3,460,265**

The current and projected available supplies are allocated to each of the five MWPs by source in *Table 6, "Current Water Supplies available to RWPG by Major Provider of Municipal and Manufacturing Water,"* contained in *Appendix* A.

As in *Table 5*, the information used to compile *Table 6* included contracts, water rights, limitations of conveyance facilities, and current usage patterns. As with *Table 5*, the procedure consisted of a thorough iterative evaluation. A description of the methodology and information used to compile *Table 6* is contained in *Appendix A*.

The information on supply described in this Task 3 report was summarized and used in presentations made to the public in four separate public meetings held throughout the region in February 2000. Few public comments were received on the supply data and those comments did not result in any substantive revisions to the data or assumptions used as the basis for the determination of total supply available to Region H.


Region H
Water Planning Group
Major Groundwater Aquifers
Exhibit 1
Legend
Counties
Streams
Region H
Carrizo - Wilcox Aquifer
Outcrop
Downdip
Gulf Coast Aquifer
LEON
MADISON
TRINITY
POLK
WALKER
SAN JACINTO
MONTGOMERY
LIBERTY
WALLER
AUSTIN
HARRIS
CHAMBERS
FORT BEND
GALVESTON
BRAZORIA
FREESTONE
HOUSTON
ANGELINA
ROBERTSON
BRAZOS
GRIMES
TYLER
HARDIN
JEFFERSON
FAYETTE
COLORADO
WHARTON
MATAGORDA
100000 0 100000 Feet
Source: TWDB, TNRCC
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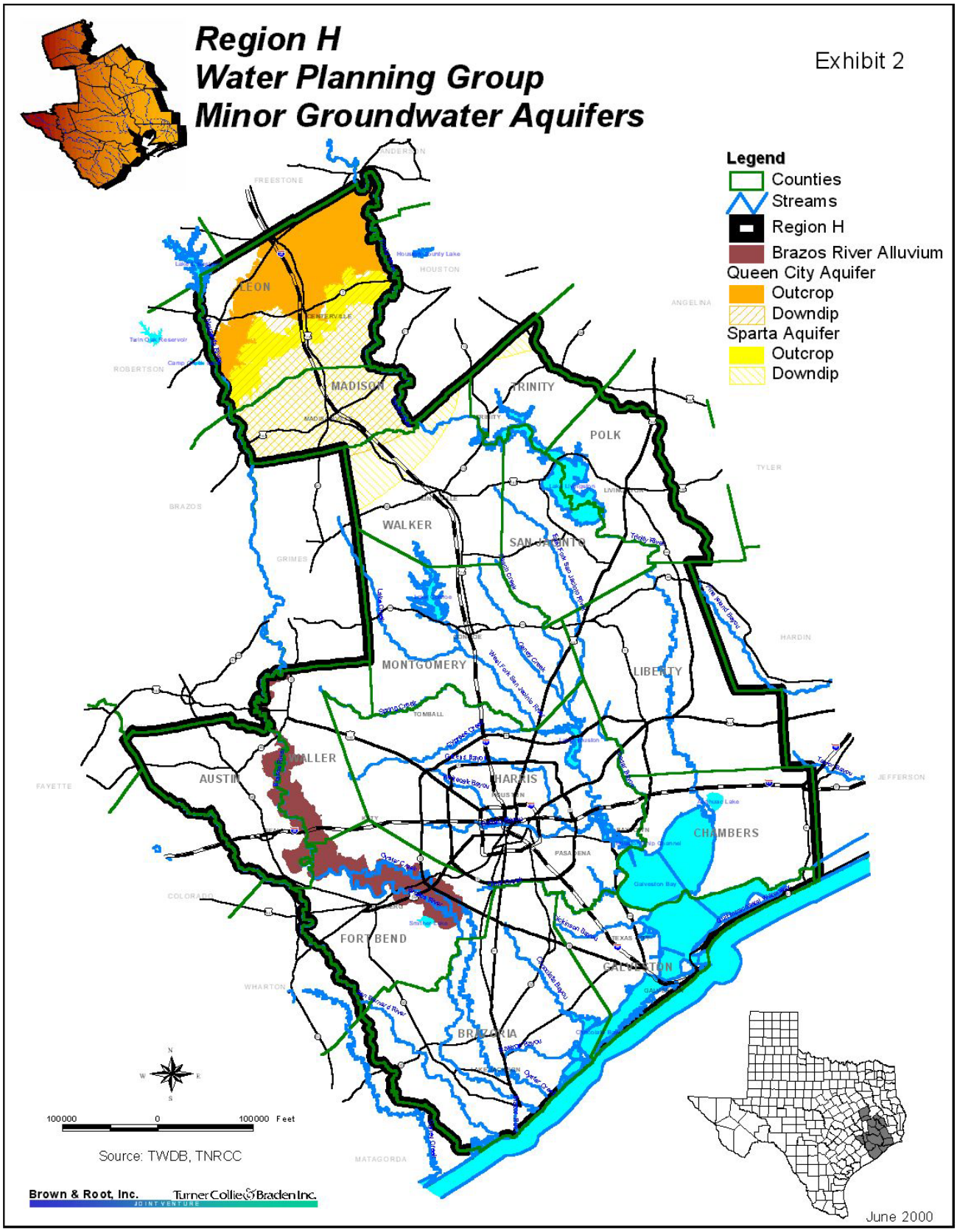
June 2000


Region H
Water Planning Group
Minor Groundwater Aquifers
Exhibit 2
Legend
Counties
Streams
Region H
Brazos River Alluvium
Queen City Aquifer
Outcrop
Downdip
Sparta Aquifer
Outcrop
Downdip
LEON
MADISON
TRINITY
POLK
WALKER
SAN JACINTO
MONTGOMERY
LIBERTY
AUSTIN
WALLER
HARRIS
CHAMBERS
FORT BEND
GALVESTON
BRAZORIA
FREESTONE
HOUSTON
ANGELINA
ROBERTSON
BRAZOS
GRIMES
TYLER
HARDIN
FAYETTE
JEFFERSON
COLORADO
WHARTON
MATAGORDA
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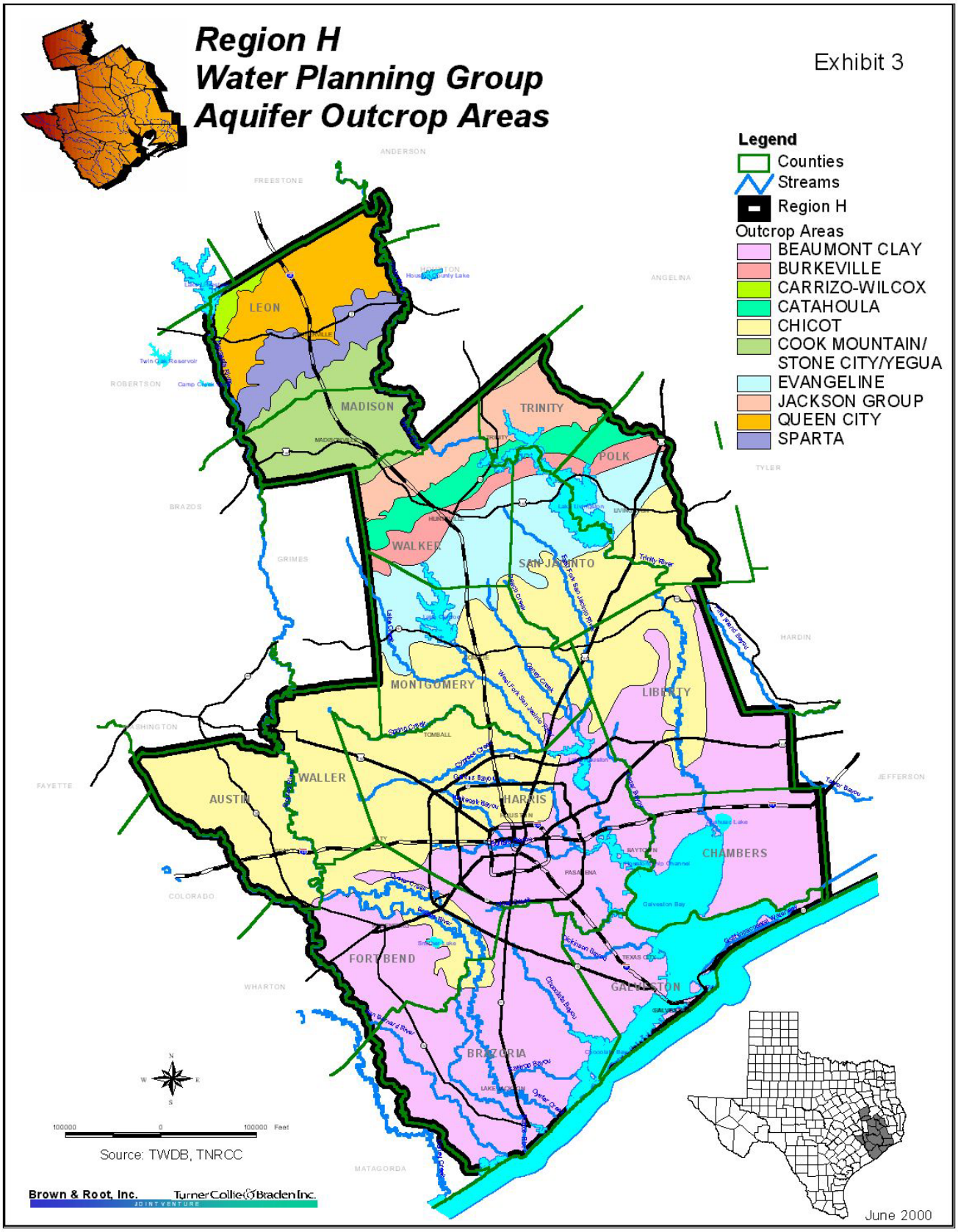
Source: TWDB, TNRCC
Brown & Root, Inc.
Turner Collie & Braden Inc.
JOINT VENTURE
June 2000


Region H
Water Planning Group
Aquifer Outcrop Areas
Exhibit 3
Legend
Counties
Streams
Region H
Outcrop Areas
BEAUMONT CLAY
BURKEVILLE
CARRIZO-WILCOX
CATAHOULA
CHICOT
COOK MOUNTAIN/
STONE CITY/YEGUA
EVANGELINE
JACKSON GROUP
QUEEN CITY
SPARTA
LEON
MADISON
TRINITY
POLK
WALKER
SAN JACINTO
MONTGOMERY
LIBERTY
WALLER
AUSTIN
HARRIS
CHAMBERS
FORT BEND
GALVESTON
BRAZORIA
ANDERSON
FREESTONE
ANGELINA
ROBERTSON
BRAZOS
GRIMES
HARDIN
WASHINGTON
FAYETTE
JEFFERSON
COLORADO
WHARTON
MATAGORDA
TYLER
Source: TWDB, TNRCC
Brown & Root, Inc.
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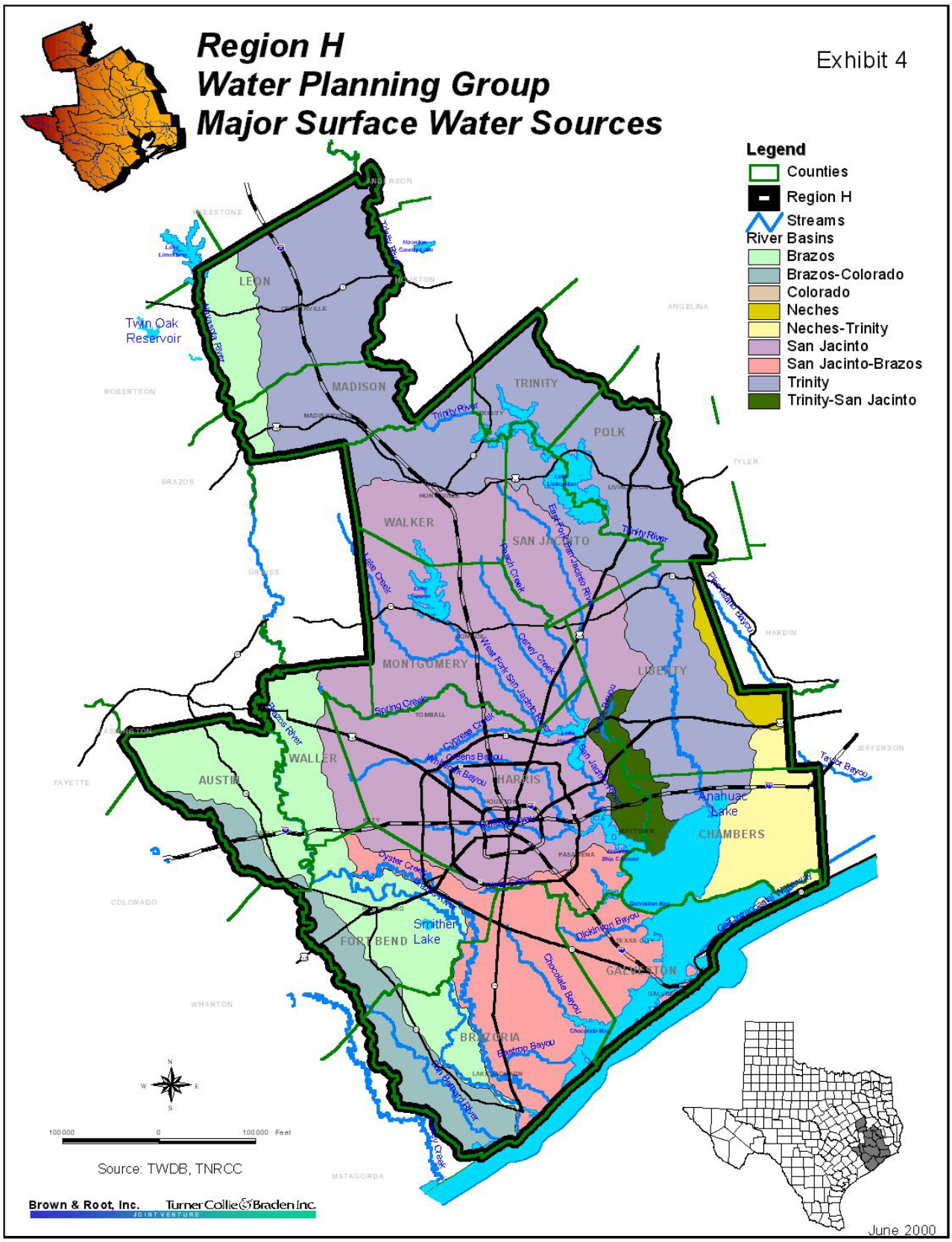
Region H
Water Planning Group
Major Surface Water Sources
Exhibit 4
Legend
Counties
Region H
Streams
River Basins
Brazos
Brazos-Colorado
Colorado
Neches
Neches-Trinity
San Jacinto
San Jacinto-Brazos
Trinity
Trinity-San Jacinto
Twin Oak Reservoir
Anahuac Lake
Smither Lake
LEON
MADISON
TRINITY
POLK
WALKER
SAN JACINTO
MONTGOMERY
LIBERTY
WALLER
AUSTIN
HARRIS
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
ANDERSON
HOUSTON
ANGELINA
ROBERTSON
BRAZOS
TYLER
GRIMES
HARDIN
WASHINGTON
JEFFERSON
FAYETTE
COLORADO
WHARTON
MATAGORDA
Trinity River
Navasota River
Lake Creek
Peach Creek
East Fork San Jacinto River
West Fork San Jacinto River
Caney Creek
Spring Creek
Cypress Creek
Brays Bayou
Greens Bayou
Sims Bayou
Taylor Bayou
Oyster Creek
Dickinson Bayou
Chocolate Bayou
Bastrop Bayou
Clear Creek
Pleasant Bayou
Brazos River
100000 0 100000 Feet
Source: TWDB, TNRCC
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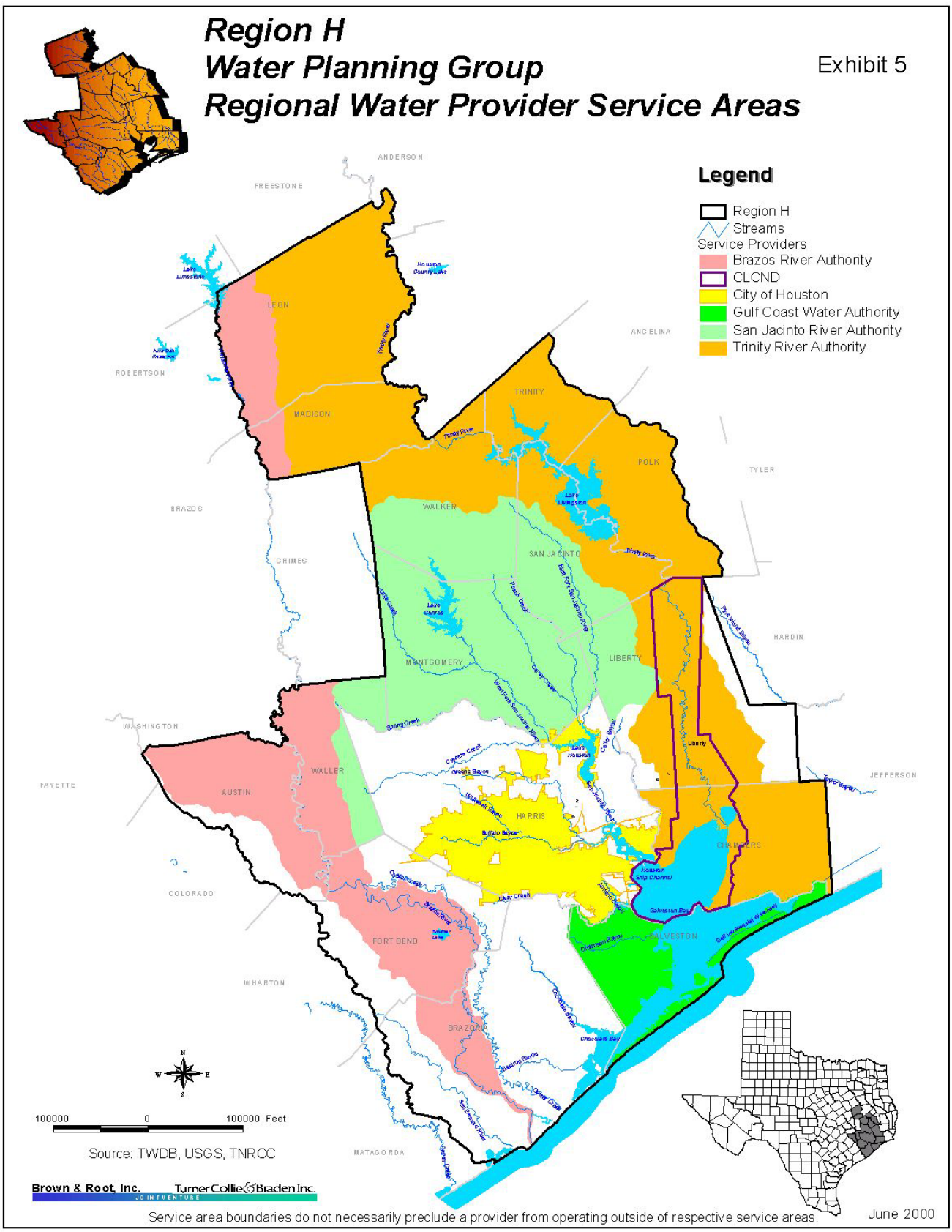
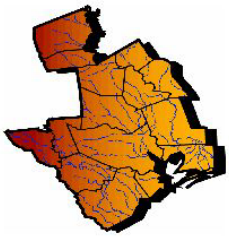
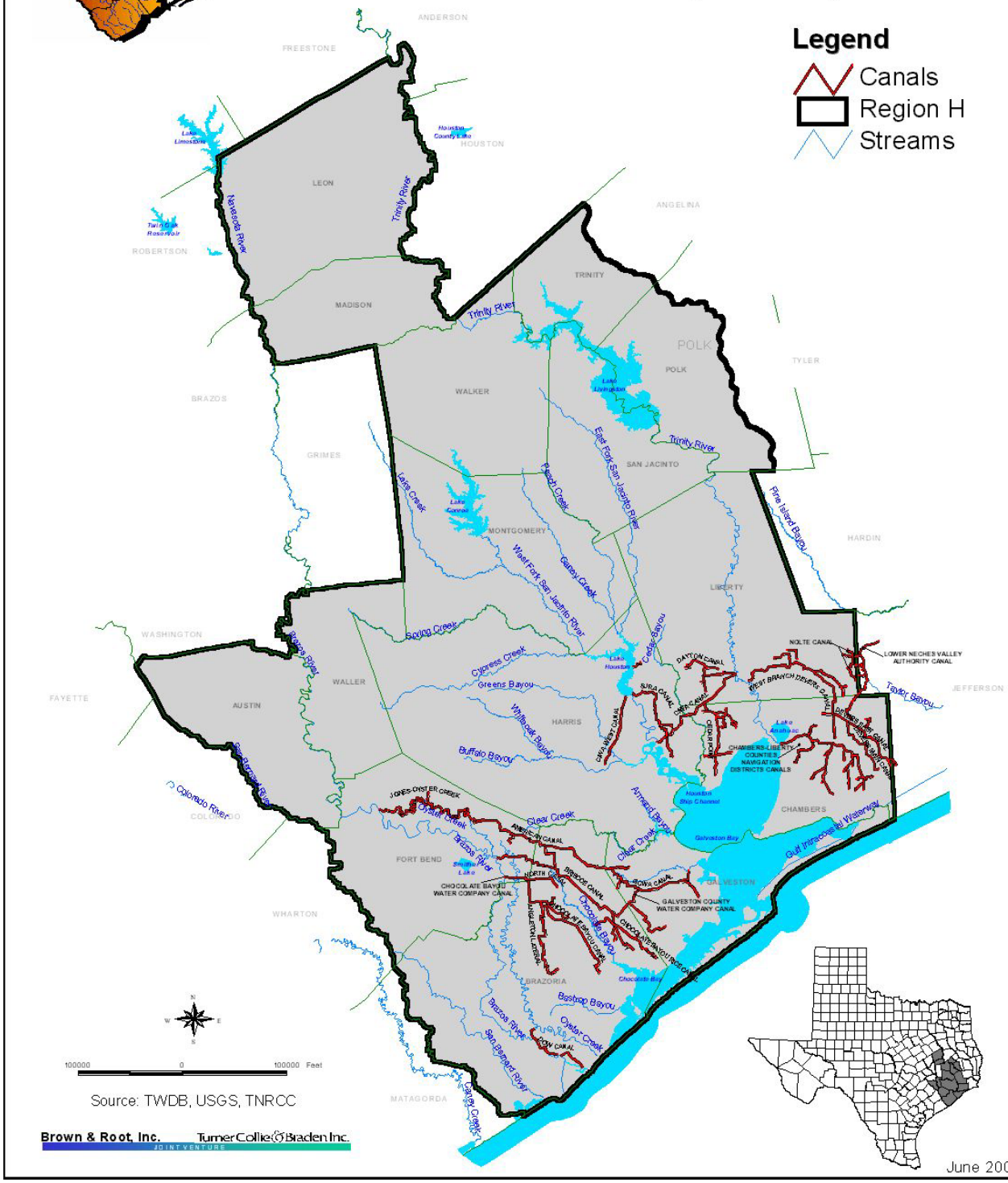
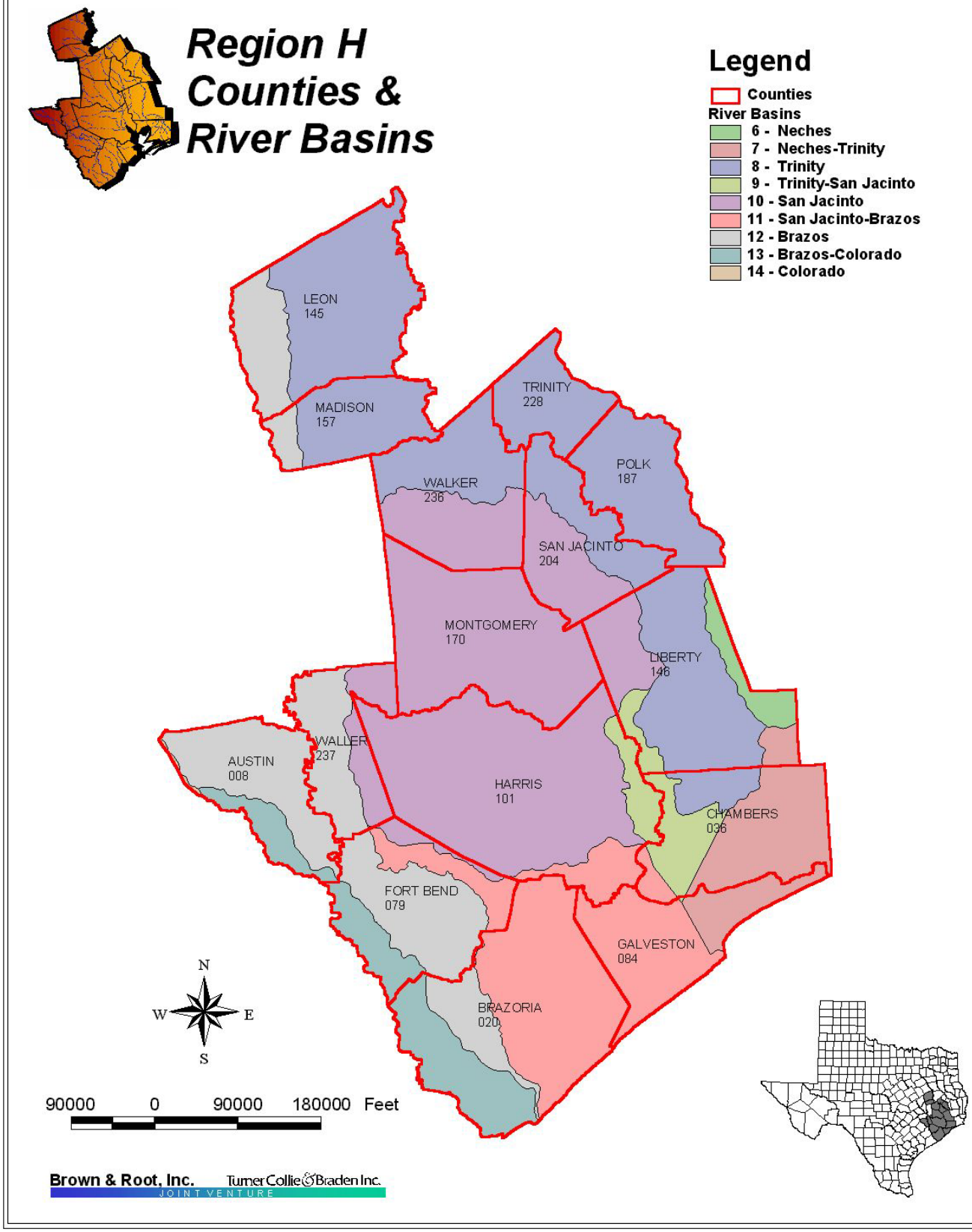

Region H
Water Planning Group
Regional Water Provider Service Areas
Exhibit 5
Legend
Region H
Streams
Service Providers
Brazos River Authority
CLCND
City of Houston
Gulf Coast Water Authority
San Jacinto River Authority
Trinity River Authority
ANDERSON
FREESTONE
LEON
ANGELINA
ROBERTSON
MADISON
TRINITY
POLK
TYLER
BRAZOS
WALKER
SAN JACINTO
GRIMES
MONTGOMERY
LIBERTY
HARDIN
WASHINGTON
WALLER
FAYETTE
AUSTIN
HARRIS
JEFFERSON
CHAMBERS
COLORADO
FORT BEND
GALVESTON
WHARTON
BRAZORIA
MATAGORDA
100000 0 100000 Feet
Source: TWDB, USGS, TNRCC
Brown & Root, Inc.
Turner Collie & Braden Inc.
JOINT VENTURE
Service area boundaries do not necessarily preclude a provider from operating outside of respective service areas.
June 2000



Region H
Water Planning Group
Raw Surface Water Conveyance Systems

Exhibit 6




Region H
Counties &
River Basins
Legend
Counties
River Basins
6 - Neches
7 - Neches-Trinity
8 - Trinity
9 - Trinity-San Jacinto
10 - San Jacinto
11 - San Jacinto-Brazos
12 - Brazos
13 - Brazos-Colorado
14 - Colorado
LEON
145
MADISON
157
TRINITY
228
POLK
187
WALKER
236
SAN JACINTO
204
MONTGOMERY
170
LIBERTY
146
WALLER
237
AUSTIN
008
HARRIS
101
CHAMBERS
036
FORT BEND
079
GALVESTON
084
BRAZORIA
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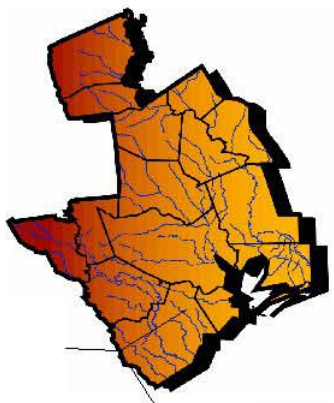
Region H Water Planning Group Recreational Areas

Exhibit 7



Legend

- Seasonal/Restrictive Waterways
- Streams
- Region H
- Counties
- Nature & Wildlife Viewing
- Hunting
- Fishing
- Boating/Watersports
- Camping/Picnicking

ANDERSON
FREESTONE
NACOGDOCHES
LIMESTONE
LEON
ANGELINA
HOUSTON
ROBERTSON
MADISON
TRINITY
POLK
TYLER
JASPE
WALKER
BRAZOS
SAN JACINTO
GRIMES
BURLESON
HARDIN
MONTGOMERY
LIBERTY
WASHINGTON
WALLER
JEFFERSON
AUSTIN
HARRIS
CHAMBERS
COLORADO
FORT BEND
GALVESTON
WHARTON
BRAZORIA
ORDA

Upper Keechi Creek, Big Creek, Navasota River, Browns Creek, Keechi WMA, Big Elkhart Creek, Houston County Lake, Hurricane Bayou, Trinity River, Steele Creek, Keechi Creek, Cochino Bayou, Piney Creek, Neches River, Davy Crockett Nat'l Forest, Tenthogale Creek, White Rock Creek, Little White Rock Creek, Bedias Creek, Lattison Creek, Cedar Creek, Robinson Creek, Long King Creek, Nelsons Creek, Harmons Creek, Lake Livingston, Lake Livingston State Park, Sam Houston Nat'l Forest, Huntsville State Park, Wickson Creek, South Bedias Creek, Winters Bayou, East Fork San Jacinto River, San Jacinto River, Menard Creek, Hickory Creek, Turkey Creek, Kimball Creek, Sandy Creek, Big Thicket Nat'l Preserve, Gibbons Creek, Lake Creek, Lake Conroe, Peach Creek, Cypress Creek, Trinity River NWR, Little Pine Island Bayou, Pine Island Bayou, Mill Creek, W G Jones State Forest, New Year Creek, Spring Creek, Lake Houston State Park, Lake Houston, Trinity River, Old River, Cypress Creek, Greens Bayou, White Oak Bayou, Addicks Barker Reservoir, Buffalo Bayou, Sheldon Lake SP/WMA, Sheldon Lake, Barbers Cut-off Canal, East Fork Double Bayou, Oyster Bayou, San Bernard River, East Bernard Creek, SFA State Park, Attwater Prairie Chicken NWR, Oyster Creek, Brazos River, Clear Creek, San Jacinto State Park, Houston Ship Channel, Atkinson Island WMA, Anahuac NWR, Candy Cain Abshier WMA, Redfish Reef, Galveston Bay, Dickinson Bayou, Armands Bayou, Chocolate Bayou, Mustang Bayou, Austin Bayou, Galveston Island State Park, Christmas Bay State Park, Brazoria NWR, Bryan Beach State Park, Peach Point WMA, San Bernard NWR, Varner - Hogg State Park, Brazos Bend State Park, Eagle Nest Lake, Moon Lake, Manor Lake, Mustang Lake East, Mustang Lake West, Harris Reservoir, Jones Lake, Salt Bayou, Big Creek, Caney Creek

100000 0 100000 Feet

Source: TWDB, TNRCC, See Appendix C

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JOINT VENTURE

June 2000

TABLE OF CONTENTS

TASK 4 REPORT

LIST OF TABLES

LIST OF TABLES
(Continued)

Page

LIST OF FIGURES

Page

APPENDIX A – TABLES

APPENDIX A – TABLES (Continued)

APPENDIX B – TECHNICAL APPENDICES FOR TABLE 9 AND 10

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

Introduction

The following report chronicles the results of the Region H water planning analysis of water shortages and surpluses. This effort is principally based on a comparison of available reliable water supplies versus projected water demands.

Task 4.1 Compare Water Demand and Water Supply Data

As a part of Task 4, the Texas Water Development Board (TWDB) requires the presentation of *Tables 7* and *8*, located in *Appendix A*. *Table 7* is a comparison of the supplies in *Table 5* (Task 3 Report) as allocated to a specific Water User Group (WUG), versus the established demands of those WUGs represented in *Table 2* (Task 2 Report). *Table 8* is the difference between *Table 6* (Task 3 Report), supply available to major water providers, and *Table 3* (Task 2 Report), the demand on the major water providers. Surpluses and shortages for Region H are shown in *Tables 7* and *8*.

Task 4.2 and 4.3 Identify and Present Surpluses and Shortages in Region H

Table 7, "Comparison of Water Demands with Current Water Supplies in Region H by City and Category"

The attached *Table 7* is a comparison of *Table 5*, Current Water Supplies Available to Region H by City and Category, with the projected demands established by Region H and included in *Table 2*, Water Demand by City and Category. It reflects the water balance for water user groups (WUGs) in Region H. The attached *Table 7A* compares the supplies available to WUGs in Region H as cited in *Table 5A* (which represents supplies available assuming existing contracts are extended through 2050) with the established demands of those WUGs represented in *Table 2*. *Table 7* satisfies the format and methodology required by TWDB in Technical Memorandum No. 3. *Table 7A* meets the requirements of the Region H Water Planning Group (RWPG) for its evaluation of water management strategies because it reflects anticipated contract renewals and extensions by current regional water providers and is therefore a more representative estimate of the Region H shortages.

Demands

The demands represented in *Table 2* increase from 2,248,339 acre-feet per year in the year 2000 to 3,158,793 acre-feet per year in the year 2050. Demand is approximately 44 percent municipal, 32 percent manufacturing, 19 percent agricultural (18 percent irrigation and 1 percent livestock demand), 4 percent steam electric power demand, and 1 percent mining demand.

Supplies

Two estimates of current water supply available to WUGs in Region H were prepared as represented by *Tables 5* and *5A*.

Table 5 meets the TWDB guidelines and includes all current, reliable water supply supported by water rights, permits and/or long-term contracts. In 2000, the total volume of groundwater and surface water through rights/permits/contracts available to WUGs in the region is 3,075,132

acre-feet/year. In 2050, the total amount is reduced to 2,568,257 acre-feet/year as contracts expire across the study period.

Table 5A follows TWDB guidelines (includes all current, reliable water supplies supported by water rights, permits and/or long-term contracts) but extends existing water supply contracts at their current levels throughout the study period. In 2000, the total volume of groundwater and surface water through rights/permits/contracts available to WUGs in the region is 3,075,132 acre-feet/year. In 2050 the total amount is 2,893,273 acre-feet/year. This decrease in water availability is principally a result of groundwater reductions due to implementation of the Harris-Galveston Coastal Subsidence District (HGCSD.)

This supplemental table reflects the Region H RWPG assumption that all existing long-term contracts will be extended through 2050. The Region H RWPG believes it represents a better estimate of shortage in the region and will be used as an additional tool to evaluate potential water management strategies in the Region H area.

Needs for Additional Supplies

Tables 7 and *7A* identify the needs for additional supply and the surpluses for each WUG by county and basin as specified in TWDB Technical Memorandum 3.

Table 7 indicates that Region H has shortages in 11 counties in one or more time periods between 2000 and 2050. These include Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Polk, San Jacinto, Walker and Waller Counties. Shortages are projected for a total of 70 cities/CDPs, 11 counties in the municipal county-other category, 6 counties in the manufacturing category, 4 counties in the mining category, 3 counties in the irrigation category and 2 in the steam-electric power category. It was assumed without verification of reliability that livestock WUGs would be supplied by local sources. The total quantity of the projected water shortages within Region H (from Table 7) is approximately 1,005,052 acre-feet per year in year 2030 and 1,375,459 acre-feet per year in 2050. The single county with the largest projected shortage is Harris County with over 50 percent of the total regional shortages. The San Jacinto river basin contains approximately 50 percent of the total water shortages for the region.

Table 7A, which assumes the extension of existing water supply contracts, indicates that Region H has shortages in the following 8 counties in at least one of the 2000-2050 decade years: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller. Shortages are projected for 62 cities/CDPs, 8 counties with municipal county-other shortages, 5 counties with manufacturing shortages, 4 counties with mining shortages, 3 counties with irrigation shortages, and 1 county with steam-electric power shortages. It was assumed without verification of reliability that livestock WUGs would be supplied by local sources. The total quantity of the projected shortages within the region from Table 7A is approximately 497,970 acre-feet per year in year 2030 and 790,059 acre-feet per year in 2050. Again, Harris County and the San Jacinto basin are the areas with the largest shortages within the region.

In an effort to better identify the entities with shortages in Region H two summary tables were constructed from *Table 7* and *7A*. These shortage summary tables contain only the entities in

Region H that have a projected shortage in at least one of the years. These tables are located in *Appendix A* immediately following *Table 7* and *7A*.

Shortages are delineated by basin, and therefore some of the WUGs may show a shortage in one basin and have a surplus in another basin. Management strategies will be used to determine whether the surpluses in one basin can be used to meet the shortages in another for these WUGs.

There are WUGs in *Table 7* with surplus supplies. These surpluses will be considered as they may apply to the management strategies addressed in Task 5.

Table 8, "Comparison of Water Demands with Current Water Supplies by Major Providers of Municipal and Manufacturing Water"

The attached *Table 8* is a comparison of *Table 6*, Current Water Supplies Available to Region H by Major Provider of Municipal and Manufacturing Water, with the projected demands established by Region H and included in *Table 3*, Water Demand by Major Provider of Municipal and Manufacturing Water. It reflects the water balance for major water providers (MWPs) in Region H. The attached *Table 8A* compares the supplies available to MWPs in Region H, as cited in *Table 6*, with the established demands of those MWPs represented in *Table 3A*, assuming existing contracts are extended through 2050. *Table 8* satisfies the format and methodology required by TWDB in Technical Memorandum No. 4. *Table 8A* meets the requirements of the Region H Water Planning Group for its evaluation of water management strategies because it reflects anticipated contract renewals and extensions by current regional water providers and is therefore a more representative estimate of the Region H shortages.

Demands

The demands on the MWPs in Region H were prepared as represented by *Tables 3* and *3A*.

Table 3 meets the TWDB guidelines and includes all current, reliable water supply supported by water rights, permits and/or long-term contracts. The Region H demands represented in *Table 3* decrease from 1,440,468 acre-feet per year in the year 2000 to 918,027 acre-feet per year in the year 2050.

Table 3A follows TWDB guidelines (includes all current, reliable water supplies supported by water rights, permits and/or long-term contracts) but extends existing water supply contracts at their current levels throughout the study period. In 2000 the total demand for groundwater and surface water through rights/permits/contracts with MWPs in Region H is 1,440,468 acre-feet/year. In 2050 the total amount is 1,665,140 acre-feet/year. This supplemental table reflects the Region H WPG assumption that all existing long-term contracts will be extended through 2050. The Region H WPG believes it represents a better estimate of shortage in the region and will be used as an additional tool to evaluate potential water management strategies in the Region H area.

Supplies

The MWP supplies in the region range from 2,256,364 acre-feet per year in 2000 to 2,183,382 acre-feet per year in the year 2050. Of this amount, in the year 2000 approximately 7 percent is groundwater and 93 percent is surface water. In the year 2050 approximately 5 percent is groundwater and 95 percent is surface water.

Needs for Additional Supplies

Tables 8 and *8A* identify the needs for additional supply for each MWP as specified in TWDB Technical Memorandum 4.

Table 8 indicates that the Gulf Coast Water Authority will have a shortage in the year 2000, but all of the other MWPs have adequate supplies to meet their demands. All of the other MWPs are projected to have uncommitted water supplies throughout the planning period.

Table 8A, which assumes the extension of existing water supply contracts, indicates that the Gulf Coast Water Authority will have shortages in every decade, but all of the other MWPs will have adequate supplies to meet their demands.

The projected uncommitted water supply surpluses of the major water providers will be considered as they may apply to the management strategies addressed in Task 5.

Task 4.4 Sub-Regional Supply and Demand

A water allocation method was used to compare water supply versus demand. The counties in the regional planning area were first reviewed to determine the amount of reliance on groundwater in each area. After demands were determined, and the amounts of groundwater available to each county were determined, then the available supplies of groundwater were allocated. Quantities of groundwater were distributed equally throughout each county when groundwater was available. Supply and demand were balanced in this manner so that when systems ran out of water, the shortages were shared somewhat equally for the mid-sized systems and larger. In this way, it was assumed that growth in groundwater short areas occurred on surface water and that the management strategies for those counties were weighted heavily toward finding additional supplies. Growth for existing WUGs was supplied using a combination of existing groundwater capacity and new surface water sources.

Rural

For the rural areas, specific attention was paid to the distribution of groundwater throughout each county. For most of the counties and for all of the rural areas, the distribution of groundwater was sufficiently uniform to allow water providers to increase well capacities as needed and to be able to secure enough additional groundwater to meet their increased demands.

Metropolitan

The largest shortages in Region H are in the county-other portion of the counties with a large urban population. There is a high level of growth expected in the vicinity of existing metropolitan areas, but there is little specific information about the eventual disposition of that growth. Some growth areas may be annexed and served by adjacent municipalities. Some

growth may occur within the jurisdiction of newly formed suppliers, like the North Harris County Regional Water Authority. As a result, there is no way to determine with certainty what available supply may be assigned to this growth; it could be a variety of suppliers. In order to maintain flexibility and accommodate local conditions and constraints, the RWPG did not designate any metropolitan sub-regions to be evaluated. It is expected that as specific information is developed regarding the supply for some of these metropolitan areas, the Regional Planning Group will consider amendments to the plan that clarify the specific distribution of the available supply.

Task 4.5 and 4.6 Impacts of the Surpluses and Shortages Presented to the RWPG

Socioeconomic Impacts

Section 357.7(4) of the rules for implementing Senate Bill 1 require that the social and economic impact of not meeting regional water supply needs be evaluated by the Regional Water Planning Groups. The Texas Water Development Board is required to provide technical assistance, upon request, to complete the evaluations. The Board offered its staff to conduct the required analysis of the impacts of the identified needs for each region, using a common methodological approach for all regions, which will facilitate compiling the regional plans into a State Water Plan. The Region H RWPG submitted a request to TWDB for assistance (see *Appendix B*), and TWDB completed the analysis of the social and economic impacts of not meeting water needs as identified in Region H *Table 7*.

TWDB has stated that the purpose of this element of Senate Bill 1 planning is to give each region an estimate of the potential costs of not acting to meet anticipated needs in each water user group, or conversely, the potential benefit to be gained from devising a strategy to meet a water need. Collectively, adding up all the impacts gives the region a view of the ultimate magnitude of the impacts caused by not meeting every one of the entire list of needs. These summations are a ***very worst-case scenario*** for the region, since the likelihood of not meeting the entire list of needs is virtually nonexistent.

The TWDB analysis assumes the following conditions for each decade modeled:

- Shortages occur in a drought equivalent to the drought-of-record (1950-1956)
- No change in the structural relationship within the regional economy occurs
- No change in technology occurs during this period
- No change in human behavior occurs during this period.

Obviously, the assumption of a prolonged drought during which no water management strategies are devised and applied is unrealistic. Nevertheless, the analysis is useful in illustrating the overall value of applying (or failing to apply) management strategies to meet potential water shortages.

At the request of the Region H RWPG, TWDB replicated its analysis based on Table 7 water needs with an analysis of Table 7A which reflects water needs after extending current water supply contracts through 2050. Region H considers the extension of current water supply contracts a logical first step in any set of water management strategies. Table 7A water needs thus provide a more realistic assessment of water shortages in Region H.

The TWDB used data that connect water use with the economy and the population of the region, to evaluate each negative value in *Table 7 and 7A* for an individual water user group. A negative value in *Table 7 or 7A* indicates an unmet water need. The TWDB staff constructed a regional input-output model to determine socioeconomic impact. The detailed results of the analysis are found in *Tables 9, 9A, 10* and *10A*, included in *Appendix A*. Additional information on the analysis of impacts, including notes on interpreting the results, is provided in *Appendix B*. A more detailed description of the methodology currently is being prepared by TWDB.

The data in *Tables 9.00* through *9.50 (and Tables 9A.00 through 9A.50)* show the impacts on the socioeconomic variables for each water user group by decade, from 2000 (*Tables 9.00 and 9A.00*) through 2050 (*Tables 9.50 and 9A.50*). *Tables 10.00* through *10.50 (and Tables 10A.00 through 10A.50)* correspond to the same decades as for *Table(s) 9*, but provide additional detail on the impact in each river basin where a shortage for a particular water user group occurs in two or more basins. These tables can be used to assess any remaining unmet needs after the management strategies to meet water shortages are determined by the RWPG. The impacts of each unmet, or partially met, need can be added together to determine the remaining economic development costs of not meeting the needs.

Each water user group with a need was evaluated in terms of direct and indirect economic and social impact *on the region* resulting from the shortage. Economic variables chosen by TWDB for this analysis include:

- gross economic output (sales and business gross income),
- employment (number of jobs) and
- personal income (wages, salaries and proprietors net receipts).

Social variables of the analysis are:

- population and
- school enrollments.

Declining populations indicate a depreciation of social services in most, but not every case, while decreasing school enrollment indicates loss of younger cohorts of the population and the possibility of strain on tax bases, when combined with economic losses.

Impacts of Unmet Water Needs for Region H

Under extreme supply limitations (drought-of-record) and with no management strategies in place *(Table 7),* Region H water shortages are projected to be approximately 59,000 acre-feet in 2000, rising to one million acre-feet in 2030 and to 1.38 million acre-feet by 2050. The unmet water needs of the region amount to about 19% of the forecasted demand by 2020, rising to 41% of demand in 2040, and to 43% of demand in 2050. This means that by 2050 the region would be able to supply only 57% of the projected needs unless supply development *or other water management strategies* are implemented. (See *Table 4-1* and *Figure 4-1*.)

To provide some perspective on this estimate of shortage, there are a number of WUGS for whom adequate supplies exist that will not be under contract absent action on their part. Simply extending the current supply contracts of these water user groups' increases the percentage of

regional water needs that can be met to 91% in 2030 and 87% in 2050. Conversely, additional management strategies will need to be defined to fill 9% of the 2030 water demand and 13% of the 2050 water demand.

Economic Growth Limitations

This analysis was performed for both Table 7 and Table 7A water needs to meet both TWDB and Region H RWPG requirements. As a result, companion tables and figures summarizing Tables 9 and 9A and Tables 10 and 10A are provided below. The text description relates to Tables 9 and 10, which do not include the extension of current water supply contracts.

Impact on economic development is measured as the difference between expected future growth (the baseline projection), unrestricted by water shortage, and expected growth, restricted by unmet water needs.

> ***Employment*** – Left entirely unmet, the level of water shortage in 2010 results in 249,000 fewer jobs than would be expected in unrestricted development (without unmet water needs) in 2010. The gap between unrestricted and restricted job growth increases to 1.27 million in 2030,and to 1.84 million jobs that the restricted economy could support in 2050.
>
> ***Population*** – The forecasted population growth of the region would be economically restricted by curtailed potential job creation. This in turn causes both an out-migration of some current population and an expected curtailment of future population growth. Compared to the baseline growth in population, the region could expect 496,000 fewer people in 2010, 2.55 million fewer in 2030 and 3.69 million fewer in 2050. The expected 2050 population under the severe shortage conditions (drought-of-record with no management strategies applied) would be 38% lower than projected in the "most likely" growth forecast for the region.
>
> ***Income*** – The potential loss of economic development in the region amounts to about 8% less income to people in 2010, with the gap growing to 32% less than expected in 2030. By 2050 the region would have 37% less income than is currently projected assuming no restrictions because of unmet water needs.

TABLE 4-1. RELATIONSHIP OF WATER NEEDS AND IMPACTS TO PROJECTIONS WITHOUT CONSTRAINTS, REGION H, 2000 – 2050

WATER

Decade	Projected Demand	Projected Water Shortage	Percent Shortage
	(acre-feet)		
2000	2,248,339	59,028	2.6%
2010	2,424,582	210,357	8.7%
2020	2,604,090	488,085	18.7%
2030	2,772,451	1,005,054	36.3%
2040	2,967,886	1,213,716	40.9%
2050	3,188,793	1,375,458	43.1%

EMPLOYMENT

Decade	Baseline Employment	Employment With Water Shortage	Percent Loss
	(Full Time Equivalent jobs)		
2000	2,249,094	2,185,365	2.8%
2010	2,680,947	2,431,716	9.3%
2020	3,107,046	2,474,846	20.3%
2030	3,633,673	2,364,158	34.9%
2040	4,043,189	2,511,028	37.9%
2050	4,495,943	2,657,962	40.9%

POPULATION

Decade	Baseline Population	Population With Water Shortage	Percent Loss
2000	4,780,084	4,653,284	2.7%
2010	5,692,447	5,196,449	8.7%
2020	6,830,796	5,568,089	18.5%
2030	7,846,384	5,298,503	32.5%
2040	8,838,048	5,763,535	34.8%
2050	9,700,277	6,011,908	38.0%

INCOME

Decade	Baseline Income	Income With Water Shortage	Percent Loss
	(millions, 1999 $)		
2000	91,142	88,604	2.8%
2010	108,643	99,660	8.3%
2020	125,910	103,329	17.9%
2030	147,251	99,705	32.3%
2040	163,846	106,537	35.0%
2050	182,194	114,007	37.4%

TABLE 4-1A. RELATIONSHIP OF WATER NEEDS AND IMPACTS TO PROJECTIONS WITHOUT CONSTRAINTS, REGION H, 2000 - 2050

(Supplemental Analysis of Needs Identified in Table 7A)

WATER

Decade	Projected Demand	Projected Water Shortage	Percent Shortage
	(acre-feet)		
2000	2,248,339	59,028	2.6%
2010	2,424,582	193,932	8.0%
2020	2,604,090	377,557	14.5%
2030	2,772,451	497,972	18.0%
2040	2,967,886	647,960	21.8%
2050	3,188,793	790,058	24.8%

EMPLOYMENT

Decade	Baseline Employment	Employment With Water Shortage	Percent Loss
	(Full Time Equivalent jobs)		
2000	2,249,094	2,185,365	2.8%
2010	2,680,947	2,475,414	7.7%
2020	3,107,046	2,654,562	14.6%
2030	3,633,673	3,013,981	17.1%
2040	4,043,189	3,208,221	20.7%
2050	4,495,943	3,431,918	23.7%

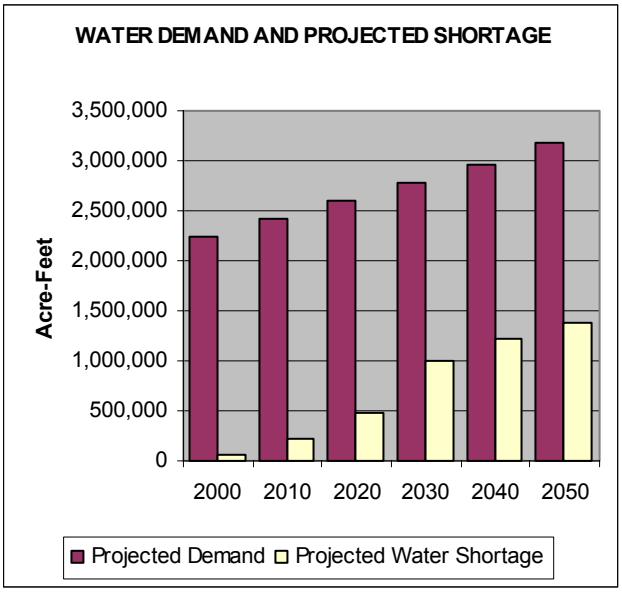
POPULATION

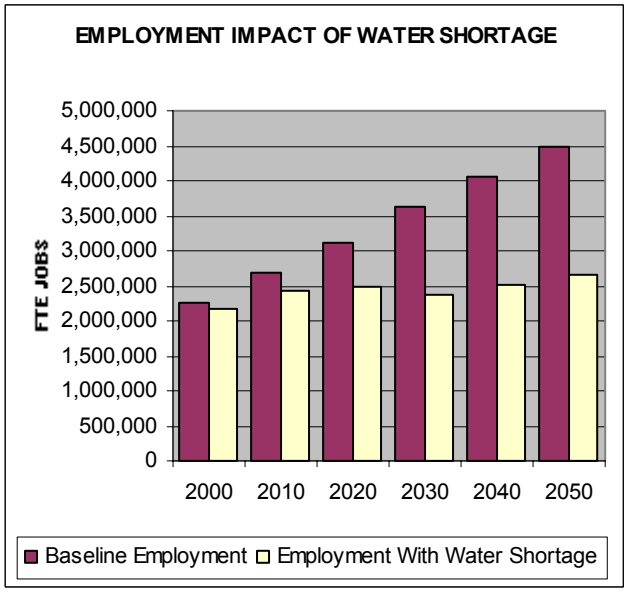
Decade	Baseline Population	Population With Water Shortage	Percent Loss
2000	4,780,084	4,653,284	2.7%
2010	5,692,447	5,283,415	7.2%
2020	6,830,796	5,927,451	13.2%
2030	7,846,384	6,602,075	15.9%
2040	8,838,048	7,162,010	19.0%
2050	9,700,277	7,563,394	22.0%

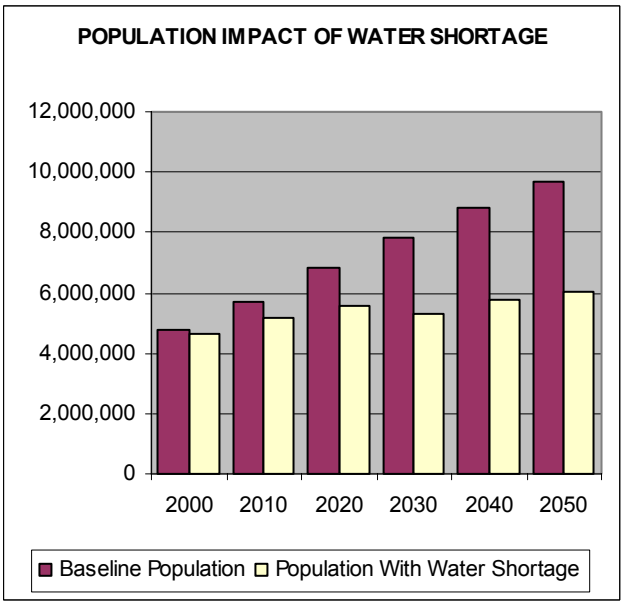
INCOME

Decade	Baseline Income	Income With Water Shortage	Percent Loss
	(millions, 1999 $)		
2000	91,142	88,604	2.8%
2010	108,643	101,097	6.9%
2020	125,910	110,133	12.5%
2030	147,251	125,650	14.7%
2040	163,846	134,365	18.0%
2050	182,194	144,347	20.8%

FIGURE 4-1. SUMMARY OF SOCIO-ECONOMIC IMPACTS OF NOT MEETING WATER NEEDS, REGION H, 2000 – 2050







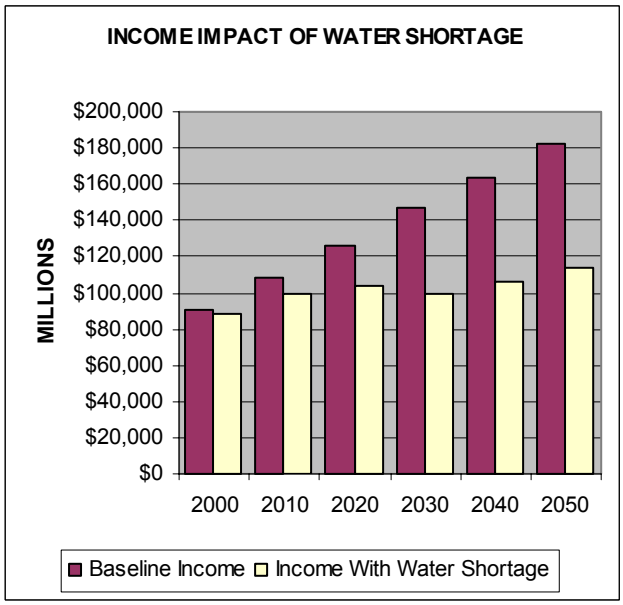
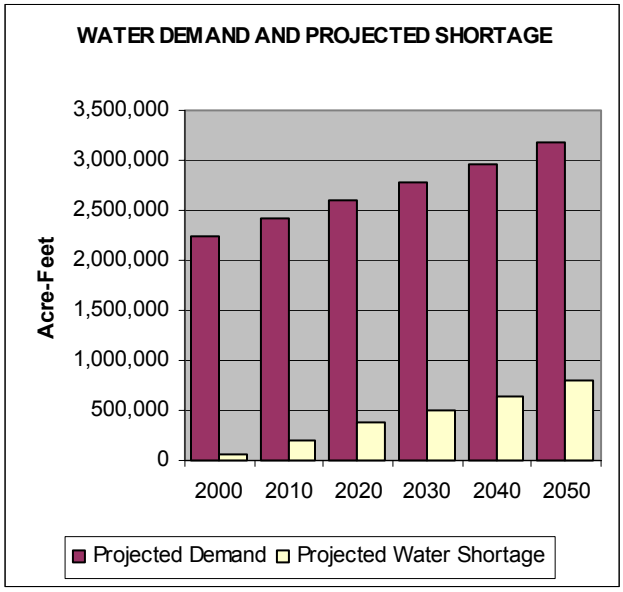
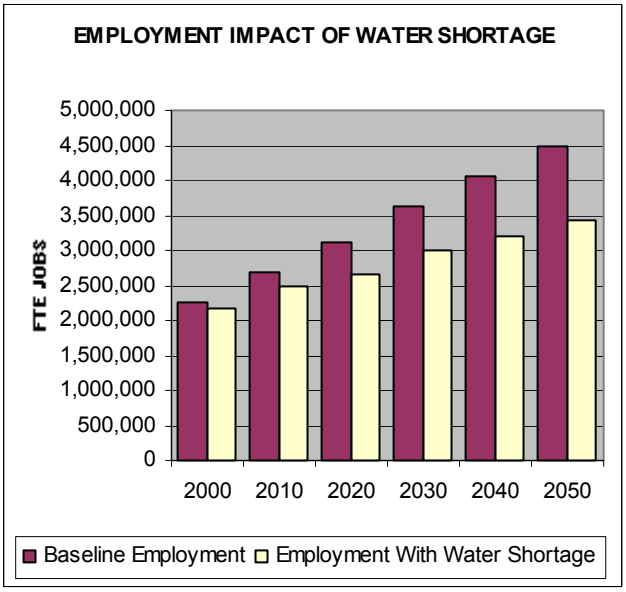
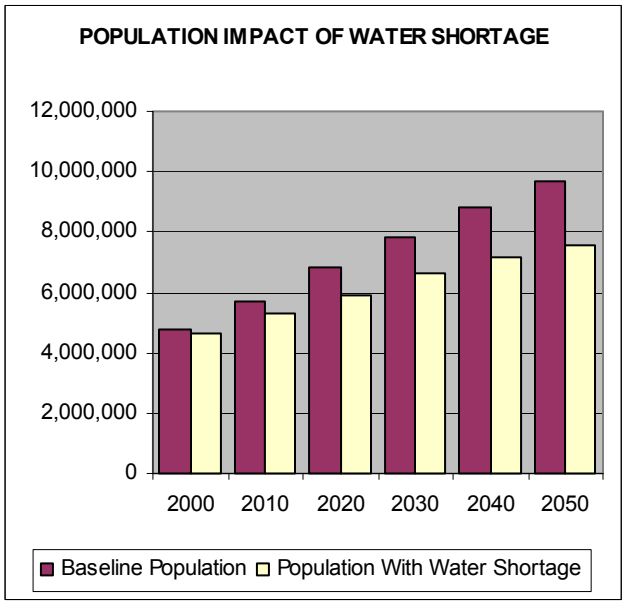


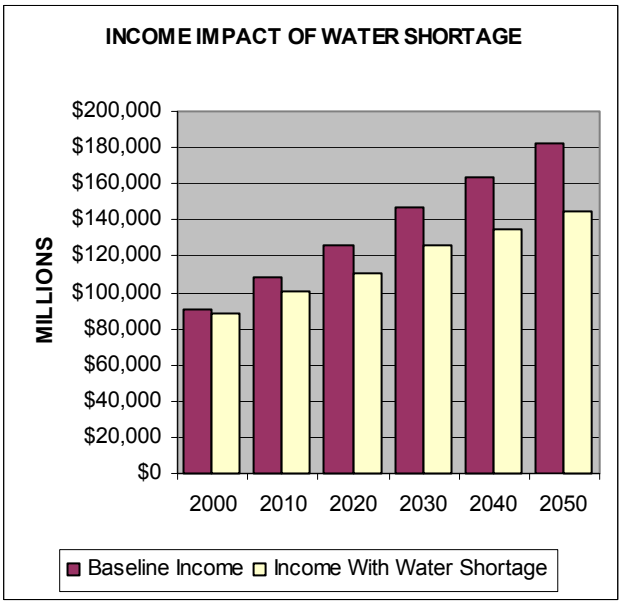
FIGURE 4-1A. SUMMARY OF SOCIO-ECONOMIC IMPACTS OF NOT MEETING WATER NEEDS, REGION H, 2000 - 2050

(Supplemental Analysis of Needs Identified in Table 7A)









Water User Groups with Shortages

The economic and social impact of an unmet water need varies greatly depending on the type of Water User Group for which the shortage is anticipated. On a per acre-foot basis, the largest impacts will generally result from shortages in manufacturing and municipal uses, while shortages for irrigation will typically result in the smallest impact. *Table 4-2* presents the impacts of unmet water needs summarized for each of the six types of Water User Groups.

The vast majority of the economic and social impacts of unmet water needs in Region H result from municipal and manufacturing water shortages. In 2010, municipalities are projected to have unmet needs of 99,000 acre-feet, 47% of the total unmet needs. The economic impacts of this shortage (169,000 jobs, $14.7 billion in output, and $5.4 billion of income) represent approximately 60% of the total impacts. By 2050, projected unmet municipal needs total 565,000 acre-feet (41% of the total) resulting in 1.13 million jobs not created, and reductions of $96.3 billion in potential output and $36.4 billion in potential income.

The impact of not meeting manufacturing needs increases over time. In 2010, manufacturing has projected unmet needs of 59,000 acre-feet, 28% of the total unmet needs. The economic impacts of this shortage include the loss of 80,000 projected jobs (32% of the total employment impact) and $13.3 billion in output (47.5% of the total output impact). In 2050, projected unmet manufacturing needs are 687,000 acre-feet (50% of the total) resulting in 685,000 jobs not created and reduction of $113.8 billion in output (53% of the total output impact).

Shortages are also projected for steam electric generation, mining, and irrigation. The impacts of these needs represent less than 2% of the total impact in any year.

Table 4-2. Summary of Impacts by Decade and Category, Region H, 2000-2050

Category	Decade	Value of Need (acre-feet)	Impact of Need on Employment	Impact of Need on Gross Business Output in 1999 US Dollars (Millions)	Impact of Need on Population	Impact of Need on School Enrollment	Impact of Need on Income in 1999 US Dollars (Millions)	Number of WUGs with Needs
Municipal	2000	-10,258	24,494	2,042.50	48,717	11,771	791.9	17
Manufacturing	2000	-16,277	38,933	6,468.90	77,478	18,689	1,739.90	3
Steam Elec.	2000	0	0	0	0	0	0	0
Mining	2000	-498	106	20.8	219	59	5.1	3
Irrigation	2000	-31,994	195	6.9	386	95	1.9	3
Livestock	2000	0	0	0	0	0	0	0
TOTAL		-59,028	63,729	8,539.00	126,800	30,614	2,538.80	
Municipal	2010	-98,974	168,593	14,678.80	335,522	82,519	5,388.80	72
Manufacturing	2010	-58,891	80,135	13,314.60	159,471	39,250	3,581.20	9
Steam Elec.	2010	-380	109	22.6	217	52	6.2	1
Mining	2010	-371	79	15.5	159	44	3.8	4
Irrigation	2010	-51,740	316	11.1	629	153	3.1	2
Livestock	2010	0	0	0	0	0	0	0
TOTAL		-210,357	249,232	28,042.60	495,998	122,018	8,983.00	
Municipal	2020	-274,414	442,638	38,857.10	883,604	217,130	14,116.60	96
Manufacturing	2020	-171,010	189,133	31,425.10	378,266	92,675	8,452.30	9
Steam Elec.	2020	-380	109	22.6	217	55	6.2	1
Mining	2020	-292	62	12.2	115	38	3	5
Irrigation	2020	-41,989	256	9	505	134	2.5	4
Livestock	2020	0	0	0	0	0	0	0
TOTAL		-488,085	632,200	70,326.00	1,262,707	310,032	22,580.50	
Municipal	2030	-407,407	730,537	63,136.20	1,467,031	363,768	23,397.00	116
Manufacturing	2030	-529,711	532,077	88,406.10	1,066,968	263,534	23,778.30	11
Steam Elec.	2030	-20,380	5,848	1,214.70	11,756	2,926	331	2
Mining	2030	-3,672	785	153.2	1,585	400	37.3	6
Irrigation	2030	-43,883	268	9.4	541	138	2.7	4
Livestock	2030	0	0	0	0	0	0	0
TOTAL		-1,005,054	1,269,515	152,919.60	2,547,881	630,766	47,546.30	
Municipal	2040	-487,998	902,307	77,649.00	1,811,315	443,439	28,931.40	118
Manufacturing	2040	-608,799	608,766	101,148.30	1,220,865	298,486	27,205.50	11
Steam Elec.	2040	-68,980	19,794	4,111.40	39,783	9,756	1,120.40	3
Mining	2040	-4,820	1,031	201.1	2,034	487	49	6
Irrigation	2040	-43,118	263	9.2	516	122	2.6	5
Livestock	2040	0	0	0	0	0	0	0
TOTAL		-1,213,716	1,532,161	183,119.00	3,074,513	752,290	57,308.80	
Municipal	2050	-564,941	1,131,381	96,336.10	2,272,193	563,710	36,378.30	119
Manufacturing	2050	-687,296	684,768	113,776.10	1,372,320	338,323	30,601.90	11
Steam Elec.	2050	-68,980	19,794	4,111.40	39,785	9,896	1,120.40	3
Mining	2050	-8,219	1,757	342.9	3,515	860	83.5	7
Irrigation	2050	-46,022	281	9.9	556	137	2.8	6
Livestock	2050	0	0	0	0	0	0	0
TOTAL		-1,375,458	1,837,981	214,576.50	3,688,369	912,926	68,186.90	

Table 4-2A. Summary of Impacts by Decade and Category, Region H, 2000-2050

(Supplemental Analysis of Needs Identified in Table 7A)

Category	Decade	Value of Need (acre-feet)	Impact of Need on Employment	Impact of Need on Gross Business Output in 1999 US Dollars (Millions)	Impact of Need on Population	Impact of Need on School Enrollment	Impact of Need on Income in 1999 US Dollars (Millions)	Number of WUGs with Needs
Municipal	2000	-10,258	24,494	2,042.51	48,717	11,771	791.8525883	17
Manufacturing	2000	-16,277	38,933	6,468.90	77,478	18,689	1,739.92	3
Steam Elec.	2000	0	0	0	0	0	0	0
Mining	2000	-498	106.477901	20.77904372	219	59	5.06004509	3
Irrigation	2000	-31,994	195.3474643	6.858355675	386	95	1.936390833	3
Livestock	2000	0	0	0	0	0	0	0
TOTAL		-59,028	63,729	8,539.05	126,800	30,614	2,538.76	
Municipal	2010	-84,056	126,436	11,223.18	251,625	61,895	4,019.96	61
Manufacturing	2010	-57,385	78,593	13,058.43	156,402	38,504	3,512.28	8
Steam Elec.	2010	-380	109.0436329	22.64902725	217	52	6.171944058	1
Mining	2010	-371	79.32389816	15.47997032	159	44	3.769631985	4
Irrigation	2010	-51,740	315.9107495	11.0911513	629	153	3.13148001	2
Livestock	2010	0	0	0	0	0	0	0
TOTAL		-193,932	205,533	24,330.82	409,032	100,648	7,545.31	
Municipal	2020	-244,311	341,165	30,666.28	680,728	167,381	10,809.15	79
Manufacturing	2020	-90,585	110,890	18,424.75	221,780	54,336	4,955.64	8
Steam Elec.	2020	-380	109.0436329	22.64902725	217	55	6.171944058	1
Mining	2020	-292	62.4328255	12.18369632	115	38	2.966934069	5
Irrigation	2020	-41,989	256.3742415	9.000914039	505	134	2.541321602	4
Livestock	2020	0	0	0	0	0	0	0
TOTAL		-377,557	452,483	49,134.87	903,345	221,944	15,776.47	
Municipal	2030	-326,116	469,756	42,000.21	942,921	233,463	14,905.62	90
Manufacturing	2030	-129,857	148,876	24,736.24	299,243	74,441	6,653.21	10
Steam Elec.	2030	-380	109	22.65	221	56	6.171944058	1
Mining	2030	-3,360	718.4051154	140.1959577	1,454	366	34.14006326	5
Irrigation	2030	-38,258	233.5939408	8.201131944	470	120	2.315510812	4
Livestock	2030	0	0	0	0	0	0	0
TOTAL		-497,972	619,693	66,907.49	1,244,309	308,446	21,601.46	
Municipal	2040	-396,991	608,377	53,839.92	1,220,633	299,223	19,359.25	92
Manufacturing	2040	-208,526	225,276	37,430.19	452,803	110,556	10,067.46	10
Steam Elec.	2040	-380	109	22.65	217	52	6.17	1
Mining	2040	-4,569	977	190.6414674	1,937	465	46.42438959	5
Irrigation	2040	-37,493	228.9230939	8.037145532	448	106	2.269210824	5
Livestock	2040	0	0	0	0	0	0	0
TOTAL		-647,960	834,968	91,491.44	1,676,038	410,402	29,481.58	
Municipal	2050	-454,730	761,001	66,431.97	1,527,826	378,668	24,306.82	94
Manufacturing	2050	-286,568	300,962	50,005.64	604,930	150,482	13,449.83	10
Steam Elec.	2050	-380	109	22.65	219	53	6.17	1
Mining	2050	-7,983	1,707	333.0905744	3,422	835	81.11313244	6
Irrigation	2050	-40,397	246.6539952	8.659650813	486	120	2.444969209	6
Livestock	2050	0	0	0	0	0	0	0
TOTAL		-790,058	1,064,025	116,802.02	2,136,883	530,158	37,846.38	

Task 4.7 Potential impacts of water shortages on selected economic activities in Region H

Economic Impacts of Water Shortages on Recreational Interests

Recreational Activities Sensitive to Water Supply

One of the distinguishing characteristics of Region H is the abundance of recreational opportunities that enrich the quality of life of its residents. (See Task 3 Report for a discussion of recreational water uses.) Recreation also contributes to attracting tourists and tourist dollars to the region. Some of these recreational activities are associated with water, both freshwater and salt water, and may be sensitive to water supply. The relation to water supply translates through impacts on reservoir levels, instream flows, bay and estuary inflows, water quality, habitat and aesthetics. *Table 4-3* lists recreational activities in Region H and the ways in which those activities are sensitive to water supply.

Table 4-3. Recreational Activities Associated with Water in Region H

Activity	Major Sensitivity to Supply
Boating (Canoe/kayak, sailboats, personal watercraft, power boats)	Reservoir level Instream flow Aesthetics
Swimming	Water quality Reservoir level
Fishing	Reservoir level Instream flow Bay & Estuary inflows Water quality Habitat
Hunting	Habitat
Parks (Camping, hiking, biking, horseback riding)	Aesthetics Habitat
Nature Tourism	Reservoir level Instream flow Bay & Estuary inflows Habitat Aesthetics
Golfing	Course upkeep Aesthetics

Although the major reservoirs in Region H were built and are maintained for municipal and industrial water supply, their existence has spurred the development of recreation related economic activity around their perimeters. In addition, this recreation-oriented development expands the tax base of local jurisdictions located near the reservoirs. Other water bodies similarly provide economic opportunities in recreation support activities.

These activities impact the economy of the region through many paths, some of which are captured under the heading of "commercial activities" in the municipal water user group (WUG) in the preceding socioeconomic analysis of water shortages. Examples of these would be the sale of boating equipment, pier use fees collected by a convenience store or hotel receipts. Others impacts are not accounted for among the WUGs.

Economic Importance of Water Related Recreational Activities to Local and Regional Economies

Nationally, a number of studies discuss the contribution of water-related recreational activities, but few studies quantify the importance of those activities to the regional economy. In 1996, Texas ranked second in the U.S. in angler expenditures at $2.9 billion, providing more than 80,000 jobs. In 1997, Texas ranked fifth in the U.S. in boat ownership with about $302 million in retail boat sales. To provide some estimate of how Region H shares in this economic activity Texas Parks and Wildlife Department reported 617,864 boat registrations for February 2000, 98% of which are used as pleasure craft. Counties in Region H account for 134,289 boats, with 99% used as pleasure craft. If that ratio is indicative of water-related recreational activity in Texas, then about one-fourth of water-related recreational activity in the State occurs in Region H.

Within Region H, a 1995 study by Texas A&M University prepared for the TWDB estimated the positive economic impact of recreational activities in the Trinity-San Jacinto estuary. Using survey and other expenditure data, impacts were estimated as shown in *Table 4-4*.

Table 4-4. Economic Impacts of Recreation Activities, Trinity-San Jacinto Estuary

Economic Impact Variable	Regional Impact	State Impact
Direct Impact ($mil)	421.92	421.92
Output ($mil)	757.69	812.40
Personal Income ($mil)	324.50	331.65
Value-Added ($mil)	491.15	510.94
Employment (jobs)	15,287	16,483

(Source: Table III.6, Tanyeri-Abur, Jones and Jiang, March 1998)

The study noted that it was not possible to develop standard multipliers for recreational activities because these activities are spread across several economic sectors. However, it concluded that "each dollar of tourist and recreationist expenditures resulted in about $1.79 in total output, $0.77 in personal income and $1.16 of value-added in the Trinity San Jacinto estuary regional economy," with "an employment multiplier of about 36 jobs per million dollars of tourist and recreationist expenditures" (Tanyeri-Abur et al, 1998).

A complete picture of the importance of water related recreational activities on the regional economy is not available from current data. The data that are available indicate that water-related recreation is very important to the regional economy and to the state economy.

Recommendations on methods to recognize recreational needs in water resource management planning

These recreational activities (excluding golfing) usually are not traditional "users" of water supply, and so do not show up in an analysis of "shortages" or "unmet needs," particularly when the analysis is restricted to drought-of-record conditions. The Region H Task 3 Report noted six holders of recreational diversion water rights, totaling 7,652 acre-feet per year.

Although some water-related recreational activities, such as boating, appear to benefit most from high reservoir and instream flow levels, many associated with environmental quality or habitat, such as fishing, require varying levels and flows. While water suppliers are accustomed to dealing with seasonal or daily use patterns for their customers, they are less well equipped in their operations to consider seasonal or cyclical environmental water needs or needs of third parties. Based on RWPG discussions and data analysis, the following recommendations are offered for consideration for future water planning.

1. Perform studies of recreational activities that are important to Region H that would define the quantity, timing and location of water supplies necessary to support each activity.

2. Extend regional water planning to consider water needed to support recreational activities (maintain reservoir levels, instream flows, bay and estuary inflows). This task requires analysis of water needs during non-drought conditions.

3. Assist localities to perform economic studies to determine the contribution of water-related recreation to local economies focusing on locational and industry specific socioeconomic impact studies.

Economic impacts on agricultural and nursery industries

Areas where agricultural water supplies are inadequate or under pressure

Region H is projected to have inadequate irrigation water available throughout the 50-year planning period; however, this shortage will result from unmet needs in just three of the region's counties. Under drought-of-record water supply conditions, irrigated agriculture in Brazoria and Waller Counties would be projected to experience water shortages in year 2000 and throughout the planning period. (See *Table 4-5*) Fort Bend County is projected to experience water shortages in the agricultural sector around 2040. This shortage will gradually worsen through the year 2050. The greatest impact under worst case conditions is projected to occur circa 2010 with most of the deficit occurring in Brazoria County. After 2010, the deficit decreases as projected demands decrease in Brazoria County. The deficit then slowly increases through 2050. At all times, Brazoria County accounts for over 85% of the projected agricultural water shortages in Region H. From these figures, it is evident that the impacts resulting from a shortfall of water for agricultural uses in Region H will be confined primarily to Brazoria County.

The impacts of this shortfall are projected to include approximately 186 fewer agriculture jobs in 2000 than are projected to occur if irrigation water needs are met. (See *Table 4-6*). To provide some context, various reports indicate that Brazoria County had 1,097 agricultural jobs in 1997. Agricultural employment will be between 235 to 300 jobs lower than the baseline forecast between 2010 and 2050 if irrigation water needs in Brazoria are not met, with the greatest impact occurring in 2010. These projected water shortages are the result of drought-of-record supply conditions. No management of the water resource is assumed. There is an inherent assumption in the regional planning process that various industries would not employ pro-active short-term water strategies if drought conditions occurred. For these reasons, it is not likely that the projected shortages will be as severe as projected or will occur as soon as indicated. The remaining counties are projected to have sufficient water to meet agricultural demands throughout the planning period.

Table 4-5. Water Deficit for Irrigation Water User Group

in Acre-feet/Year						
County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***
Brazoria	-30,479	-49,106	-38,872	-40,133	-38,440	-39,750
Fort Bend	0	0	0	0	-101	-632
Waller	-1,515	-2,634	-3,117	-3,750	-4,577	-5,640
Total	-31,994	-51,740	-41,989	-43,883	-43,118	-46,022

Source: *Table 7*

The impact on Brazoria County as a result of foregone agricultural jobs is projected to range from 368 persons in 2000 to almost 600 persons in 2010. Concomitant with these decreased expectations of population growth will be smaller projected school enrollment during this period, ranging in impact from a low of 90 fewer students in the year 2000 to a high of 144 fewer students in 2010.

These impacts to population, employment and income are small when compared to the population, employment and income levels in Brazoria County as a whole, but are severe when compared to those levels in the agricultural sector. The number of jobs projected to be foregone under the worst case scenario in the agricultural sector represents only 0.06% of all jobs in Brazoria County, but between 10 and 30 % of the number of agricultural jobs in 1997. The reduced farm income represents less than 0.1% of the total Brazoria County 1997 payroll, but approximately 31% of the 1997 farm payroll. Additionally, impacts to agricultural workers tend to be more severe since jobs in the agricultural sector often pay lower than jobs in many other sectors. As stated earlier, the likelihood of the above scenario is small. The assumption of year of record drought conditions coupled with no water management planning creates a worse case scenario that is not likely to be realized. Therefore the impacts described above are used only to represent the worst possible case and to provide a basis for evaluating the effect of management strategies.

Table 4-6. Impact of Irrigation Water Shortages on Baseline Forecast Employment, Business Output, Population, School Enrollment and Income.

Decade and County	Value of Need (acre-feet)	Impact of Need on Employ-ment	Impact of Need on Gross Business Output in 1999 US Dollars (Millions)	Impact of Need on Population	Impact of Need on School Enrollment	Impact of Need on Income in 1999 US Dollars (Millions)
Year 2000						
Brazoria County	-30,479	186	6.5	368	90	1.8
Waller County	-1,515	9	0.3	18	5	0.1
Region H	-31,994	195	6.9	386	95	1.9
Year 2010						
Brazoria County	-49,106	300	10.5	597	144	3.0
Waller County	-2,634	16	0.6	32	9	0.2
Region H	-51,740	316	11.1	629	153	3.1
Year 2020						
Brazoria County	-38,872	237	8.3	469	122	2.4
Waller County	-3,117	19	0.7	36	12	0.2
Region H	-41,989	256	9.0	505	134	2.5
Year 2030						
Brazoria County	-40,133	245	8.6	496	126	2.4
Waller County	-3,750	23	0.8	45	12	0.2
Region H	-43,883	268	9.4	541	138	2.7
Year 2040						
Brazoria County	-38,440	235	8.2	464	111	2.3
Fort Bend County	-101	1	0.0	2	0	0.0
Waller County	-4,577	28	1.0	50	11	0.3
Region H	-43,118	263	9.2	516	122	2.6
Year 2050						
Brazoria County	-39,750	243	8.5	485	118	2.4
Fort Bend County	-632	4	0.1	8	2	0.0
Waller County	-5,640	34	1.2	63	17	0.3
Region H	-46,022	281	9.9	556	137	2.8

Source: *Tables 9.00-9.50*

Recommendations on policy or institutional changes that can mitigate impacts on agricultural and nursery industries

In 1990, irrigation use accounted for approximately 500,000 acre-feet or over 25% of the water used in Region H. This amount is projected to decline by 2050 to just over 14% of the water used, although the amount of water used for irrigation is projected to decline by only approximately 29,000 acre-feet. During this period, water used for irrigation in Brazoria County is projected to decline from just over 131,000 acre feet to just under 102,000 acre feet or from just over 33% of water used to just over 20%. Supply in Region H and irrigation supply in Brazoria County is projected to decrease from 3,686,684 acre-feet to 3,459,035 acre-feet and from 91,671 acre-feet to 63,414 acre-feet, respectively.

Balance between water supply and demand can be achieved by reducing demand, increasing supply or both; therefore recommendations to alleviate water shortages include measures to increase supply while reducing demand or reallocating water among existing users. Additionally, the water supply forecasts used for this study assumed that persons or organizations holding water contracts within the Region would not automatically renew these contracts upon expiration. This assumption is likely not correct. Potential methods of meeting projected shortages could include, but are not limited to:

- Extension of current contracts;
- Construction of new water development projects (including interbasin transfers);
- Requiring conservation in other User Groups to free more water for agriculture;
- Development of crop strains that require less water;
- Cultivation of new crops that require less water;
- Requiring conservation measures in agriculture

The use of more efficient irrigation systems and practices, including government assistance to agriculture to develop more efficient irrigation systems, should be considered. Potential measures and the implementation costs (Stansel, 2000) for these methods include:

- Land leveling to eliminate highs and lows in a cut to maintain more uniform water levels- estimated costs range from $100 to $150 per acre.
- Multiple inlets in a field to enhance control of water levels in fields - cost is approximately $2/acre/year
- Reduced levee spacing to reduce the depth of water to flood the entire field within the levee - estimated cost is $0.50/acre/year
- Replacement of field laterals (ditches) with irrigation pipelines to prevent water loss through evaporation, transpiration, and seepage - cost is approximately $10/foot.

Economic impacts on manufacturing

Region H is projected to have inadequate water for manufacturing throughout the 50 year planning period. This shortage will result from unmet needs in six of the 15 constituent counties. Manufacturing in Fort Bend County would already be experiencing water shortages under drought conditions and is projected to experience shortages throughout the planning period (see *Table 4-7*). Brazoria, Galveston, Harris, and Montgomery Counties are projected to experience water shortages under drought conditions starting circa 2010. Chambers County will experience shortages by 2030. These shortages will gradually worsen through the year 2050. A notable increase in the shortfall for Harris County is projected from 2020 to 2030 when the shortage of water available for manufacturing almost quadruples from just over 110,000 acre-feet to just over 430,000 acre-feet. The shortfall in manufacturing water increases with each decade from a total of 16,277 acre-feet in Fort Bend County to a total shortage of over 650,000 acre-feet by 2050 in the six counties with deficits. The projected water shortages are forecast with drought-of-record supply conditions. No management of the water resource is assumed. Again, for these reasons it is not likely that the projected shortages will be as severe as projected and may not occur as soon as indicated. The remaining counties are projected to have sufficient water to meet manufacturing demands throughout the planning period.

Table 4-7. Water Deficit for Manufacturing Water User Group

in Acre-feet/Year						
County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***
Brazoria	-	-16,853	-30,454	-60,521	-84,042	-107,339
Chambers	-	-	-	-2,361	-2,780	-3,228
Fort Bend	-16,277	-18,185	-19,934	-21,373	-23,862	-26,238
Galveston	-	-879	-5,717	-10,243	-18,832	-27,434
Harris	-	-22,709	-114,447	-434,566	-478,349	-521,830
Montgomery	-	-265	-458	-647	-934	-1,227
Region H Deficit County Total	-16,277	-58,891	-171,010	-529,711	-608,799	-687,296

The greatest impact under worst case conditions is projected to occur in Harris County in terms of the reduction in manufacturing jobs below the baseline forecasts. In terms of proportion of impacts to job growth, Brazoria, Fort Bend, and Montgomery Counties might experience impacts that are at least as severe as those in Harris County.

The impacts of this shortfall are projected to include approximately 680,000 fewer manufacturing jobs in 2050 than would occur if there were not unmet manufacturing water needs. Most of these jobs would have been located in Harris County (see *Table 4-8*). These figures indicate substantial economic impacts resulting from reduced job growth in Region H along with a potential reduction in tax revenue and income levels in the region. The effects of these water shortages on the impacted counties as a result of foregone manufacturing jobs are

projected populations below the baseline forecasts ranging from over 77,000 persons in 2000 to almost 1,400,000 persons in 2050. Concomitant with these decreased expectations of population growth will be smaller projected school enrollment during this period ranging in impact from just over 18,000 fewer students in the year 2000 to over 338,000 fewer students in 2050.

The reduction from the baseline population forecasts in the impacted counties would mean lower tax revenues, lower total wages, lower business output and fewer housing starts. The effects of manufacturing water shortages would be felt throughout the Region H economy, not only in other economic sectors, but in other geographic areas throughout the region, as well.

With the exception of Chambers County, these impacts to population, employment, and income occur in Region H's most populous counties. The projected impacts are substantial when compared to the population, employment, and income levels in each of the counties and in the Region as a whole. The severity of these impacts are magnified when compared to the manufacturing sector, which accounts for approximately 17.4% of the 1997 total employment in the impacted counties. By 2050, the foregone jobs comprise 41% of the number of the total jobs in 1997 in the impacted area, but exceed the number of manufacturing jobs present in 1997 in these counties. The foregone income from manufacturing increases from $1.7 billion dollars in 2000 to over $30 billion in 2050.

Table 4-8. Impact of Manufacturing Water Shortages on Baseline Forecast Employment, Business Output, Population, School Enrollment and Income for Counties with Manufacturing Water Deficits.

Decade and County	Value of Need (acre-feet)	Impact of Need on Employment	Impact of Need on Gross Business Output in 1999 US Dollars (Millions)	Impact of Need on Population	Impact of Need on School Enrollment	Impact of Need on Income in 1999 US Dollars (Millions)
Year 2000						
Fort Bend County	-16,277	38,933	6,468.9	77,478	18,689	1,739.9
Region H Impact Area	-16,277	38,933	6,468.9	77,478	18,689	1,739.9
Year 2010						
Brazoria County	-16,853	13,118	2,179.7	26,107	6,428	586.3
Fort Bend County	-18,185	43,497	7,227.2	86,560	21,314	1,943.9
Galveston County	-879	936	155.6	1,863	449	41.8
Harris County	-22,709	21,933	3,644.2	43,647	10,747	980.2
Montgomery County	-265	650	108.0	1,294	312	29.0
Region H Impact Area	-58,891	80,134	13,314.7	159,471	39,250	3,581.2
Year 2020						
Brazoria County	-30,454	23,706	3,938.7	47,410	11,615	1,059.4
Fort Bend County	-19,934	47,681	7,922.3	95,362	23,364	2,130.8
Galveston County	-5,717	6,088	1,011.6	12,176	2,983	272.1
Harris County	-114,447	110,536	18,365.8	221,072	54,163	4,939.8
Montgomery County	-458	1,123	186.6	2,246	550	50.2
Region H Impact Area	-171,010	189,134	31,425	378,266	92,675	8,452.3
Year 2030						
Brazoria County	-60,521	47,110	7,827.4	94,689	23,555	2,105.3
Chambers County	-2,361	1,635	271.6	3,286	818	73.1
Fort Bend County	-21,373	51,123	8,494.2	102,757	25,562	2,284.6
Galveston County	-10,243	10,908	1,812.4	21,925	5,454	487.5
Harris County	-434,566	419,715	69,736.8	841,121	207,351	18,756.9
Montgomery County	-647	1,587	263.7	3,190	794	70.9
Region H Impact Area	-529,711	532,078	88,406.1	1,066,968	263,534	23,778.3
Year 2040						
Brazoria County	-84,042	65,419	10,869.5	131,490	32,105	2,923.5
Chambers County	-2,780	1,925	319.8	3,869	963	86.0
Fort Bend County	-23,862	57,076	9,483.4	114,722	28,065	2,550.7
Galveston County	-18,832	20,054	3,332.0	40,309	9,826	896.2
Harris County	-478,349	462,002	76,762.9	925,870	226,381	20,646.6
Montgomery County	-934	2,291	380.6	4,605	1,146	102.4
Region H Impact Area	-608,799	608,767	101,148.2	1,220,865	298,486	27,205.4

Year 2050						
Brazoria County	-107,339	83,553	13,882.6	167,942	41,777	3,733.9
Chambers County	-3,228	2,235	371.4	4,492	1,118	99.9
Fort Bend County	-26,238	62,759	10,427.7	126,146	31,380	2,804.7
Galveston County	-27,434	29,214	4,854.0	58,720	14,607	1,305.6
Harris County	-521,830	503,997	83,740.5	1,008,972	247,936	22,523.4
Montgomery County	-1,227	3,009	500.0	6,048	1,505	134.5
Region H Impact Area	-687,296	684,767	113,776.2	1,372,320	338,323	30,602

Source: TWDB *Tables 9.00-9.50*

Other impacts include added expense to manufacturers as they implement measures to meet their water needs. A concern of industry is a lack of water supply reliability (Wade, et al., 1991). This concern has the potential to impact manufacturing growth by causing planned plant expansions to occur outside the impacted region, existing plants to relocate to other areas with reliable water supplies and discouraging new industry from moving into areas with potential water shortages. Wade, et al., 1991 found that industry will implement water conservation projects with costs many times higher than avoided costs to ensure a reliable water supply. As stated earlier, the likelihood of the above scenario is small. The assumption of year of record drought conditions coupled with no water management planning and no renewal of expiring water contracts creates a worse case scenario that is not likely to be realized. Therefore the impacts described above are used only to represent the worst possible case and not the most likely scenario.

Table 4-9. Economic Indicators for Counties with Unmet Manufacturing Water Needs

County	1997 Population	1997 Total Employment	1997 Mfg. Employment	1997 Total Payroll ($1,000)	1997 Mfg. Payroll ($1,000)
Brazoria	191,707	56,732	14,626	$1,657,034	$708,598
Chambers	20,088	5,360	1,536	$184,714	$86,085
Fort Bend	225,421	66,938	12,991	$2,020,264	$537,937
Galveston	217,399	64,513	7,816	$1,586,526	$380,666
Harris	2,818,199	1,511,905	179,830	$51,235,596	$8,199,957
Montgomery	182,201	66,939	7,674	$1,673,405	$269,550
Others	216,765	46,517	7,442	$960,455	$217,349
Region Total	3,871,780	1,818,904	231,915	$59,317,994	$10,400,142

Recommendations on policy or institutional changes that can mitigate impacts on manufacturing

In 1990, manufacturing use accounted for approximately 635,000 acre-feet or over 33% of the water used in Region H. While the amount of water required for manufacturing use is projected to increase to over 1,000,000 acre feet, the percentage of the water demand required for manufacturing within the region is projected to remain relatively constant.

Balance between water supply and demand can be achieved by reducing demand, increasing supply or both; therefore recommendations to alleviate water shortages include measures to increase supply while reducing demand or reallocating water among existing users. Additionally, the water supply forecasts used for this study assumed that persons or organizations holding water contracts within the region would not automatically renew these contracts upon expiration. This assumption is likely not correct. Potential methods of meeting projected shortages could include, but are not limited to:

- Extension of current contracts;
- Construction of new water development projects (including interbasin transfers);
- Requiring conservation in other User Groups to free more water for manufacturing and transfer of water rights from other User Groups to manufacturers;
- Development and implementation of manufacturing processes that require less water;
- Influx of industries that require less water.

Additionally, more efficient use of water by industry will likely be implemented to increase reliability in the water supply and to offset rising water costs (Wade, et. al., 1991). These methods include:

- Replace once through cooling systems with recirculation
- Treatment and reuse of process water

Economic Impacts on Commercial Fishing and Associated Industries

Most of the commercial fisheries in Region H are associated with the Trinity-San Jacinto Estuary (commonly called the Galveston Bay system). The balance of freshwater from rivers (52-54% from the Trinity River; 26-28% from the San Jacinto River) and saltwater from the Gulf of Mexico makes possible an extremely high level of fisheries productivity for Galveston Bay. Galveston Bay has been named an "estuary of national significance" in part because of this productivity. The Bay is the source of approximately 1/3 of Texas' shrimp harvest, 2/3 of the state's oyster harvest and 1/3 of the state's recreational finfish harvest. Seafood harvest by coastal fishermen average more than 100 million lbs/year and virtually all of the coastal fishery species (mollusks, crustaceans, and vertebrate fishes) are estuarine-dependent during at least some important part of their life cycle. (Powell, 1999)

Total impacts on the state's economy from commercial fishing, sport fishing, and other recreational activities has been estimated at about $3.5 billion/year (1994 dollars). The value of that portion associated with Galveston Bay and the Trinity-San Jacinto Estuary is about $1.6 billion/year. (Powell, 1999) These are naturally renewable resources that are free for the harvest or use and don't have to be subsidized, just protected. Without freshwater flows from the rivers to balance saltwater from the Gulf, this productivity is likely to be impaired.

Water Shortage Related Impacts on Commercial Fishing and Associated Industries

Commercial fishing is impacted by the supply of water through instream flows, and bay and estuary inflows. Water supply quantities also affect water quality (including salinity levels) and habitat to support the fisheries. In general, water rights to provide for water needs related to commercial fishing do not exist. Water needs of fish and wildlife are generally accounted for under the public trust function of the State.

Aquaculture, or fish farming, is a special case. In Texas, aquaculture is classified as a manufacturing industry. It is not thought to be a large component of the manufacturing sector, but data to separate aquaculture from other manufacturing are not available to Region H at this time.

Fish and seafood processing facilities associated with commercial fishing would be impacted by water shortages just as any traditional manufacturing water user would. While these facilities individually may consume substantial quantities of water, they do not represent a large portion of total regional manufacturing.

Impacts on Region H of Water Shortages Related to Commercial Fishing

The average value (direct impact) of output from commercial fishing of finfish, shellfish and shrimp in the Trinity-San Jacinto Estuary for the period 1993-1995 is $61.8 million per year. The total regional impact of commercial fishing in the Trinity-San Jacinto Estuary in 1995 was estimated to be $92.1 million, with an employment impact of 1,688 jobs. There is also a direct regional impact of about $42 million from landing of shrimp and fish caught in other waters but landed (sold or processed) in the counties surrounding Galveston Bay. Because of differences in the sources of the data used to develop these estimates of output, they do not appear to be additive. (Tanyeri-Abur et al., 1998)

If water shortages in Region H result in severely curtailing the inflow of freshwater into the Galveston Bay estuary, productivity of the fishery will be impacted through increasing salinities, reduced sediment and nutrients and changed water circulation patterns. Although the exact magnitude of the impact cannot be calculated at this time, the oyster fishery, because oysters are stationary and dependent on salinity levels for protection from predators, will likely be the most severely impacted. If prolonged, increasing salinities will result in loss of some marsh that serves as habitat for juvenile species of fish and shrimp. Bay and gulf fishers and shrimpers would face increased costs in searching for a reduced amount of catch. Seafood processors would likely see reduced amounts of catch offered, but catch from other Gulf areas may be brought in to bay area processors. Reduced harvest would also ultimately impact the distribution system (truckers/rail) and wholesale or retail grocers and restaurants.

Recommendations of Policy or Institutional Changes that can Mitigate Impacts of Water Shortages on Commercial Fishing and Associated Industries

The following recommendations are offered to address water supply concerns for the commercial fishing and its related industries.

1. Support the efforts of Galveston Bay Freshwater Inflows Group efforts to continue studies and develop management strategies for freshwater inflows to the Galveston Bay system that address quantity, quality, timing, and location of inflows while meeting other human water needs.

2. Support the continued efforts of state resource agencies (Texas Water Development Board, Texas Parks and Wildlife Department, Texas Natural Resource Conservation Commission, General Land Office and Texas Department of Health) to monitor stream and bay conditions to provide data to support sound scientific studies of instream and inflow needs.

3. The State of Texas should define regional water planning to consider water needed to support instream flows and bays and estuaries. Looking only at drought-of-record conditions focuses attention toward stored water rather than stream flows.

Socioeconomic Impacts Associated with Ground to Surface Water Conversion and Conjunctive Use Issues

Historically, readily available groundwater in Region H has supported a high level of development. Extensive use of the aquifers in various regions have resulted in subsidence and related impacts including faulting, flooding, and decreased groundwater quality. Subsidence districts have been formed to manage groundwater resources and encourage conversion from groundwater to surface water. These conversion practices have produced:

1. A realization that the cost of water will increase as growth continues within Region H

2. A growing recognition that regionalization of water supplies may serve to produce the least cost water to the end-use customer.

3. Equity issues associated with the development and implementation of future regional water supplies.

Based on these conditions, the most populous areas of Region H are anticipated to incur increased water costs throughout a broader subregional area. If this happens, virtually all of the WUGs within this subregion will incur similar costs for finished treated water. The region will have to work together to minimize the socioeconomic impacts resulting from these anticipated higher water costs.

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TABLE OF CONTENTS

TABLES

EXHIBITS

Following Page

APPENDICES

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

5.1. INTRODUCTION

This Task 5 report describes the analysis required within 31 TAC 357.7 (a) (5-7) regarding identification, evaluation and selection of appropriate water management strategies for the Region H water planning area. Management strategies have been defined for each of the previously identified future water shortages within Region H as required by the regional water planning process. Included within this report are:

- Review of the projected water shortages.
- Description of the potentially available water management strategies.
- Definition of the recommended management strategies.
- Allocation of selected strategies to specific Water User Groups (WUGs).
- The Region H Water Management Plan.

In addition to the above, this report contains a description of socioeconomic, environmental and institutional management aspects of the recommended plan. See the Exhibit 1, Location Map, for a general map description of the Regional H area.

5.2 WATER SHORTAGES REVIEW

Water User Groups

The Task 4 Report for Region H described the methodology and resulting definition of projected water shortages for WUGs within the region. In summary, the Task 4 Report stated that Region H contains approximately 229 WUGs (excludes subdividing of WUGs by river basin and county boundaries.) The following summary illustrates the result of the comparison of water supply versus projected demand for the Region H WUGs:

a. Total WUGs	229
b. WUGs with sufficient supply (surpluses)	136
c. WUGs with insufficient supply (shortages)	93

The following distribution exists across WUG categories for those 93 WUGs with projected water shortages:

a. Municipal WUGs served by a Regional Provider	43
b. Municipal WUGs not served by a Regional Provider	29
c. Municipal County-Other WUGs	8
d. Non-Municipal WUGs	13

In the above summary, note that the municipal category is defined within two subcategories; those municipal WUGs currently served by a regional water provider versus those WUGs not currently served by a regional water provider. Within Region H, a significant number of municipal WUGs currently receive surface water by contract from some type of regional water provider. It is assumed that the water supply relationship of these water providers and water customers will continue into the future.

Conversely, a significant number of municipal WUG communities have historically obtained their water supply from available groundwater. Analysis performed on groundwater availability (described within the Region H Task 3 Report) suggests that groundwater will cease being available in the quantities needed to many communities currently dependent on groundwater within the next 50-year period. This is particularly true of Fort Bend, Montgomery, and Brazoria counties which are projected to experience significant growth. These WUGs will need to acquire surface water supplies in the future. The category of the municipal WUGs not currently served by a regional water provider indicates that these communities will need to form a relationship with a water provider.

The regional planning process requires development of two types of water management strategies: near-term and long-term. Near-term regional planning is defined as water analysis through the year 2030, while long-term planning focuses on the 2040 and 2050 periods. Water shortages have been defined for these two time periods. Table 5-1 shows the projected water shortages by WUG category within the region.

Table 5-1- Water Shortages by WUG Category

Year	2030 (acre-feet per year)	2050 (acre-feet per year)
WUGs Served by Regional Provider	31,758	56,739
WUGs Not Served by Regional Provider	45,083	71,793
Municipal County-Other	250,981	329,471
Non-Municipal	171,706	335,180
Total	**499,438**	**793,183**

The Region H Task 3 Report concluded that there is more available water supplies than there is projected water shortages throughout the region. While this is true, as shown above, there are 72 specific municipal communities with projected water shortages. Further, there are WUGs within the region with total water shortages of approximately 500,000 acre-feet per year by year 2030 and these shortages increase to approximately 800,000 acre-feet per year by the end of the long-term planning period.

Major Water Providers

Of the available regional water providers within Region H, five of them have been designated as Major Water Providers (MWPs):

- Brazos River Authority
- City of Houston
- Gulf Coast Water Authority
- San Jacinto Water Authority
- Trinity River Authority

Major Water Providers are those entities that will be viewed as developing and implementing future water management strategies that will satisfy the projected water shortages. Table 8A which is contained within the Region H Task 4 Report, illustrates the quantity of available water supplies that these MWPs are projected to maintain based on satisfying their current water customer contracts. Table 5-2 provides data excerpted from Table 8A.

Table 5-2- Major Water Provider Available Supplies

Year	2030* (acre-feet per year)	2050* (acre-feet per year)
Brazos River Authority	0	0
City of Houston	341,143	271,609
Gulf Coast Water Authority	(7,363)	(7,363)
San Jacinto Water Authority	53,177	53,845
Trinity River Authority	265,585	265,488
Total	**652,452**	**583,579**

* Values reflect remaining balance after meeting contract obligations. All contracts extended through 2050.

The purpose of reviewing this data is to relate the potential current availability of supply to the previously illustrated water shortages. As shown, the Brazos River Authority (BRA) has no currently available water supplies within Region H. The Gulf Coast Water Authority (GCWA) shows immediate water supply needs which continue throughout the planning period. These two MWPs are noteworthy in that they both serve the Brazos River basin. This situation would suggest that the focus of future management strategies within the region may need to occur within the western portion of Region H and particularly within the Brazos River basin. Conversely, the Trinity River Authority (TRA) has a significant availability of water supply throughout the planning period suggesting that uncommitted supplies are available within the eastern portion of the region.

A cursory comparison of this data suggests that currently uncommitted supplies within the eastern portion of Region H may need to be conveyed to the western portions of the region to satisfy projected water shortages. One focus of the Region H water management plan may then be to consider conveyance means to transfer water across the region to the areas of need.

5.3 POTENTIAL WATER MANAGEMENT STRATEGIES

A detailed analysis process was developed to define potential water management strategies. The process was based on addressing the specific shortages of the 93 WUGs per the four WUG categories discussed above and then developing associated specific strategies assuming the MWPs would be the vehicle to solve WUG shortages. The process generally consisted of the following steps in the order shown:

1. Contract Extension - For the all WUGs served by a MWP, first use a strategy of "contract extension" throughout the planning period for the current contracted amount.

2. Contract Expansion - For the Municipal WUG category served by a MWP, then use a second strategy of "contract increase" to meet future water needs of Municipal WUGs currently associated with a specific provider.

3. MWP Association - For the Municipal WUGs, not served by a MWP, the Municipal County-Other and Non-Municipal WUGs with shortages- First associate a MWP to each of these WUGs.

4. Allocation of Uncommitted Supplies - Determine the total required shortage of the WUGs defined in Step 3 as it relates to each specific MWP. Then allocate current uncommitted supplies of each MWP to these WUGs with shortages until the existing MWP supplies are fully allocated.

5. Define Strategies - Determine the remaining required water supplies needed to satisfy the water shortages associated with each MWP. Define potential water management strategies for each specific MWP based on the identified water shortages.

A description of each of the above steps is provided below.

Step 1- Contract Extension

Tables 3 and 5 included in the Region H Task 2 Report were used to identify contract extensions required for continued provision of water at the existing contract volume for all Municipal and Non-Municipal WUGs with shortages. This strategy was applied to every WUG with a contract that expires during the planning period. Table 5-3 below shows those WUGs for which shortages are fully addressed through these contract extensions.

Table 5-3- WUG Shortages Met Through Contract Extension

Water User Group	2030 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)	Recommended Water Management Strategy
WUGs with Shortages Met by Extending Existing Contracts at Current Levels			
ANAHUAC	793	954	Extend existing contract of 1,049 af/y through 2050
CROSBY	634	707	Extend existing contract of 1,050af/y through 2050
HUNTSVILLE	4,411	5,373	Extend existing contract of 9,209 af/y through 2050
LA PORTE	2,363	3,325	Year 2000 shortage met with facility expansion scheduled in 2001. Scheduled step increase of 6.6 mgd through 2050.
LIVINGSTON	1,920	2,179	Extend existing contract of 5,601 af/y through 2050
MISSOURI CITY –Harris	1,298	1,664	Extend existing contract of 16,797 af/y with GCWA through 2050 - split by county (1/2 Harris - 1/2 Fort Bend)
NASSAU BAY	214	493	Scheduled step increase of 0.65 mgd
PASADENA	6,207	7,700	Year 2000 shortage met with facility expansion scheduled in 2001. Scheduled step increase of 19.35 mgd
PEARLAND	2,951	6,048	Extend existing contract of 11,198 af/y through 2050
SOUTH HOUSTON	769	1,037	Year 2000 shortage met with facility expansion scheduled in 2001. Contract increase of 1.25 mgd through 2050.
STAFFORD	1,810	3,809	Extend existing contract of 11,449 af/y through 2050
SUGAR LAND	9,310	18,947	Extend existing contract through 2050
POLK COUNTY-OTHER	299	657	Extend existing contract of 672 af/y through 2050
SAN JACINTO COUNTY-OTHER	252	930	Extend existing contract of 1,118 af/y through 2050
WALKER COUNTY-OTHER	1,712	1,677	Extend existing contract of 1,993 af/y through 2050
CHAMBERS MANUFACTURING	-	757	Extend existing contract of 7,796 af/y through 2050
FORT BEND STEAM ELECTRIC POWER	-	48,600	Extend existing contract of 83,000 af/y through 2050

Table 5-3 shows the near-term and long-term quantities of water shortages met through simple contract extension. A total of fifteen Municipal and two Non-Municipal WUG shortages can be solved through contract extension at the current contract quantity. This strategy addresses a total year 2050 WUG shortage of 104,857 acre-feet per year. It is important to recognize that this strategy is not limited to the MWPs. Contract extensions are used for all of the regional water providers within the region with current water contracts.

Step 2- Contract Increases

Similar to Step 1, the previous Regional Planning Tables 3 and 5 were used to identify those Municipal WUGs with projected shortages that would be met if their existing contracts were increased in quantity. Table 5-4 lists the Municipal WUGs that can be addressed in this fashion. This could not be applied to collective WUGs, such as County-Other or Manufacturing.

Table 5-4 – Municipal Shortages Met Through Contract Increases

Water User Group	2030 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)	Recommended Water Management Strategy	
WUGs Currently Served by Regional Water Providers				
Angleton	1,622	2,868	Extend and Increase existing contract by	2,868 ac-ft/yr
Bayou Vista	222	332	Extend and Increase existing contract by	332 ac-ft/yr
Baytown	3,157	5,552	Extend and Increase existing contract by	5,552 ac-ft/yr
Brazoria	127	179	Extend and Increase existing contract by	179 ac-ft/yr
Channelview (CDP)	1,974	1,915	Extend and Increase existing contract by	2,203ac-ft/yr
Clute	643	837	Extend and Increase existing contract by	837 ac-ft/yr
Deer Park	2,339	2,977	Extend and Increase existing contract by	2,977ac-ft/yr
Dickinson	2,643	3,315	Extend and Increase existing contract by	3,315 ac-ft/yr
El Lago	239	295	Extend and Increase existing contract by	295ac-ft/yr
Freeport	723	1,131	Extend and Increase existing contract by	1,131ac-ft/yr
Friendswood	2,987	7,185	Contract step increase of 1.5 mgd, but still need to increase by	7,185ac-ft/yr
Galena Park	559	568	Extend and Increase existing contract by	568ac-ft/yr
Galveston	-	1,391	Contract step increases by 4 mgd	
Hedwig Village	934	1,081	Extend and Increase existing contract by	1,081ac-ft/yr
Highlands	446	512	Extend and Increase existing contract by	512 ac-ft/yr
Hitchcock	332	471	Extend and Increase existing contract by	471 ac-ft/yr
Hunters Creek Village	1,557	1,676	Extend and Increase existing contract by	1,676 ac-ft/yr
Jacinto City	429	535	Extend and Increase existing contract by	535ac-ft/yr
La Marque	120	275	Extend and Increase existing contract by	275 ac-ft/yr
Lake Jackson	1,145	1,960	Extend and Increase existing contract by	1,960 ac-ft/yr
Mcnair	62	61	Extend and Increase existing contract by	62 ac-ft/yr
Missouri City -Fort Bend	271	10,468	Extend and Increase existing contract by	1,0468 ac-ft/yr
Oyster Creek	46	62	Extend and Increase existing contract by	62 ac-ft/yr
Piney Point Village	1,499	1,699	Extend and Increase existing contract by	1,699ac-ft/yr
Richwood	266	401	Extend and Increase existing contract by	401 ac-ft/yr
Santa Fe	1,457	1,700	Extend and Increase existing contract by	1,700 ac-ft/yr
Seabrook	1,727	1,879	Extend and Increase existing contract by	1,879ac-ft/yr
Southside Place	144	191	Extend and Increase existing contract by	191ac-ft/yr
The Woodlands	3,514	2,846	Extend and Increase existing contract by	4,048ac-ft/yr
West University Place	574	611	Extend and Increase existing contract by	611ac-ft/yr

A total of thirty Municipal WUGs can have all of their projected water shortages satisfied through increasing the supply provided by their current contracts. A significant number of these WUGs receive their water supply from the City of Houston which will be able to meet the Municipal WUG shortages throughout the planning period. Contract increases address a total of 56,739 acre-feet per year of shortages in the year 2050.

Step 3- MWP Association for Remaining WUGs

The remaining WUGs with shortages are entities that have historically obtained water supplies exclusively from groundwater but for which the projections indicate that future groundwater supplies will not be available. For each of these WUGs, an "association" was made with one or more of the MWPs.

The association process for the Municipal WUGs Not Served by a Regional Provider, Municipal County-Other, and Non-Municipal WUGs consisted of first identifying the geographic location of the current service areas for each of the MWPs. Within the region, the MWPs maintain both a jurisdictional service area and an actual customer service area. The actual customer service area consists of areas which have developed due to convenience of service and other reasons. One example is that the GCWA was established to serve only customers within Galveston County (its jurisdictional service area). The GCWA, however, has an extensive canal system that conveys flow from the Brazos River through Brazoria County to Galveston County. The existence and location of the canal system has resulted in the provision of service to Brazoria County customers in close proximity to the GCWA canals. See the exhibit titled "Raw Surface Water Conveyance Systems" for a location of canal systems within the region. Table 5-5 indicates the location of the MWP service areas while Table 5-6 shows the association of the remaining Municipal WUGs with shortages to the Region H MWPs.

Table 5-5- Major Water Provider Service Areas

County	BRA	GCWA	City of Houston	SJRA	TRA
Brazoria	*	x			
Chambers					*
Fort Bend	*	x	x		
Galveston		*	x		
Harris			x	x	
Liberty				*	*
Montgomery				*	
Waller	*				

Table 5- - Jurisdictional Service Area
x Actual Current Service Area

Table 5-6- Municipal WUGs Associated with MWPs

Water User Group	2030 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)	Recommended Water Management Strategy
WUGs Not Currently Served by Regional Water Provider			
Aldine (CDP)	1,503	1,463	Associate with Houston
Alvin	-	1,201	Associate with GCWA
Barrett	626	662	Associate with SJRA
Bellaire	3,567	3,632	Associate with Houston
Brookshire	493	1,047	Associate with BRA
Bunker Hill Village	1,016	1,075	Interconnect with City of Houston
Conroe	10,632	21,398	Associate with SJRA
Fulshear	59	180	Associate with BRA
Hempstead	82	381	Associate with BRA
Humble	5,490	6,456	Interconnect with City of Houston
Jersey Village	1,465	1,685	Associate with Houston
Katy	2,860	3,877	Associate with BRA
Meadows	693	1,582	Associate with Houston
Mission Bend (CDP)	2,219	2,663	Associate with Houston
Oak Ridge North	371	504	Associate with SJRA
Panorama Village	421	993	Associate with SJRA
Prairie View	290	1,136	Associate with BRA
Richmond	1,757	4,224	Associate with BRA
Rosenberg	1,872	4,995	Associate with BRA
Sheldon	353	408	Associate with Houston
Shenandoah	-	386	Associate with SJRA
Spring (CDP)	5,416	5,899	Associate with Houston
Spring Valley	538	571	Associate with Houston
Tomball	2,203	2,669	Associate with Houston
Town West (CDP)	205	478	Associate with Houston

Table 5-6 also shows the year 2030 and 2050 shortages that can be met by the MWPs based on the established association. The total quantity of year 2050 water shortages addressed within this category of WUGs is 71,793 acre-feet per year.

A similar process was followed to create an association for the MWPs to the Municipal County-Other and the Non-Municipal WUG categories. The Municipal County-Other WUGs were defined by county and watershed basin to create as accurate an association as possible. Table 5-7 shows the projected water shortages by decade for each of the Municipal and Municipal County-Other WUGs that have been associated with each of the five MWPs. Municipal County-Other shortages reflect the remaining shortage after all current contracts are extended through 2050.

Table 5-7- Municipal and Municipal County-Other WUG Needs from MWPs

Water User Group	2000 Shortage (ac-ft/yr)	2010 Shortage (ac-ft/yr)	2020 Shortage (ac-ft/yr)	2030 Shortage (ac-ft/yr)	2040 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)
Brazos River Authority Service Area						
Brookshire	0	0	-217	-493	-742	-1,047
Fulshear - Basin 11	0	0	-26	-54	-122	-162
Fulshear - Basin 12	0	0	-3	-5	-14	-18
Hempstead	0	0	0	-82	-210	-381
Katy – Fort Bend County	0	0	-98	-225	-359	-543
Katy – Harris County	0	-571	-1,644	-2,181	-2,316	-2,692
Katy – Waller County	0	-102	-308	-454	-534	-642
Prarie View	0	0	0	-290	-674	-1,136
Richmond	0	0	-712	-1,757	-2,819	-4,224
Rosenberg	0	0	-752	-1,872	-3,248	-4,995
Brazoria County Other Basin 12	0	0	-13	-96	-250	-469
Brazoria County Other Basin 13	0	0	-71	-392	-947	-1,576
Fort Bend County Other Basin 12	0	-1,355	-6,620	-13,995	-19,844	-25,416
Fort Bend County Other Basin 13	0	0	0	-1,877	-3,999	-6,033
Waller County Other Basin 10	0	0	-540	-1,307	-1,411	-1,576
Waller County Other Basin 12	0	0	-1,461	-3,381	-3,565	-3,887
Total	**0**	**-2,028**	**-12,465**	**-28,460**	**-41,054**	**-54,797**
City of Houston Service Area						
Aldine (CDP)	0	-600	-1,348	-1,503	-1,467	-1,463
Bellaire	-3,072	-3,265	-3,494	-3,567	-3,489	-3,632
Bunker Hill Village	0	-982	-1,018	-1,016	-998	-1,075
Humble	0	-1,571	-4,486	-5,490	-5,789	-6,456
Jersey Village	0	-439	-1,266	-1,465	-1,495	-1,685
Meadows	0	-157	-364	-693	-1,064	-1,582
Mission Bend (CDP) - Fort Bend Co	0	-312	-372	-553	-730	-914
Mission Bend (CDP) - Harris Co	0	-650	-1,608	-1,666	-1,668	-1,749
Sheldon	0	-306	-335	-353	-367	-408
Spring (CDP)	0	-1,961	-4,596	-5,416	-5,559	-5,899
Spring Valley	0	-176	-483	-538	-536	-571
Tomball	0	-603	-1,702	-2,203	-2,326	-2,669
Town West (CDP)	0	-103	-140	-205	-321	-478
Harris County Other Basin 10 (90%)	0	-31,740	-115,528	-132,845	-146,093	-141,442
Harris County Other Basin 11	0	-6,905	-23,876	-27,314	-29,898	-29,099
Total	**-3,072**	**-49,770**	**-160,617**	**-184,827**	**-201,800**	**-199,122**
Gulf Coast Water Authority Service Area						
Alvin	0	0	0	0	-541	-1,201
Brazoria County Other Basin 11	0	0	-134	-988	-2,493	-4,259
Fort Bend County Other Basin 10	0	-46	-229	-487	-695	-893
Fort Bend County Other Basin 11	0	-3,849	-9,386	-18,626	-27,260	-35,600
Galveston County Other Basin 7	-132	-149	-229	-311	-285	-76
Galveston County Other Basin 11	-387	-453	-794	-1,220	-1,088	-207
Total	**-519**	**-4,497**	**-10,772**	**-21,632**	**-32,362**	**-42,236**

Table 5-7- Municipal and Municipal County-Other WUG Needs from MWPs (Cont'd)

Water User Group	2000 Shortage (ac-ft/yr)	2010 Shortage (ac-ft/yr)	2020 Shortage (ac-ft/yr)	2030 Shortage (ac-ft/yr)	2040 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)
San Jacinto River Authority Service Area						
Barrett - Basin 9	0	-2	-6	-6	-6	-7
Barrett - Basin 10	0	-218	-581	-620	-615	-655
Conroe	0	-1,610	-6,183	-10,632	-15,388	-21,398
Oak Ridge North	0	0	-164	-371	-432	-504
Panorama Village	0	0	-185	-421	-680	-993
Shenandoah	0	0	0	0	-178	-386
Harris County Other Basin 9	0	-1,380	-4,772	-5,462	-5,988	-5,819
Harris County Other Basin 10 (10%)	0	-3,527	-12,836	-14,761	-16,233	-15,716
Liberty County Other Basin 10	0	0	0	-534	-779	-1,087
Montgomery County Other Basin 10	0	-4,346	-10,714	-24,600	-38,325	-52,585
Total	**0**	**-11,082**	**-35,441**	**-57,407**	**-78,623**	**-99,150**
Trinity River Authority Service Area						
Chambers County Other Basin 8	0	0	0	0	0	-7
Liberty County Other Basin 6	0	0	0	-70	-105	-150
Liberty County Other Basin 7	0	0	0	-10	-11	-13
Liberty County Other Basin 8	0	0	0	-1,425	-2,072	-2,889
Liberty County Other Basin 9	0	0	0	-42	-62	-86
Total	**0**	**0**	**0**	**-1,547**	**-2,250**	**-3,145**

Table 5-8 shows the association of Non-Municipal WUGs for each of the MWPs. Non-Municipal WUGs were defined by each specific Non-Municipal category of manufacturing, mining, irrigation, and steam electric power.

Table 5-8 Suggested Major Providers for Non-Municipal WUGs

WUGs	Regional Provider
Brazoria Manufacturing	BRA,GCWA,CBWC*
Brazoria Mining	BRA
Brazoria Irrigation	BRA,CBWC*
Fort Bend Manufacturing	BRA
Fort Bend Irrigation	BRA
Galveston Manufacturing	GCWA
Harris Manufacturing	Houston, SJRA
Harris Power	Houston
Harris Mining	Houston
Liberty Mining	TRA
Montgomery Manufacturing	SJRA
Montgomery Mining	SJRA
Waller Irrigation	BRA
	* Chocolate Bayou Water Company

Table 5-9 shows the resultant Non-Municipal WUG shortages associated with each MWP. The values in this table reflect the remaining shortages after current contracts are extended through 2050.

Table 5-9 Non-Municipal WUG Needs from MWPs

Water User Group	2000 Shortage af/y	2010 Shortage af/y	2020 Shortage af/y	2030 Shortage af/y	2040 Shortage af/y	2050 Shortage af/y
Brazos River Authority Service Area						
Brazoria Manufacturing	0	-16,853	-30,454	-44,521	-68,042	-91,332
Brazoria Mining	-302	-266	-234	-213	-213	-1,012
Brazoria Irrigation	-30,479	-49,106	-38,872	-34,508	-32,815	-34,125
Fort Bend Manufacturing	-16,277	-18,185	-19,934	-21,373	-23,862	-26,238
Fort Bend Irrigation	0	0	0	0	-101	-632
Waller Irrigation	-1,515	-2,634	-3,117	-3,750	-4,577	-5,640
Total	**-48,573**	**-87,044**	**-92,611**	**-104,365**	**-129,610**	**-158,979**
City of Houston Service Area						
Harris Manufacturing	0	-18,625	-32,142	-48,890	-85,317	-121,746
Harris Power	0	-380	-380	-380	-380	-380
Harris Mining	0	-7	-5	-4	-4	-4
Total	**0**	**-19,012**	**-32,527**	**-49,274**	**-85,701**	**-122,130**
Gulf Coast Water Authority Service Area						
Galveston Manufacturing	0	0	0	-3,625	-12,214	-20,816
Total	**0**	**0**	**0**	**-3,625**	**-12,214**	**-20,816**
San Jacinto River Authority Service Area						
Harris Manufacturing	0	-3,457	-7,597	-10,801	-18,157	-25,209
Montgomery Manufacturing	0	-265	-458	-647	-934	-1,227
Montgomery Mining	-196	-98	-53	-30	-19	-15
Total	**-196**	**-3,820**	**-8,108**	**-11,478**	**-19,110**	**-26,451**
Trinity River Authority Service Area						
Liberty Mining	0	0	0	-3,113	-4,333	-6,952
Total	**0**	**0**	**0**	**-3,113**	**-4,333**	**-6,952**

Step 4- Allocation of Existing Uncommitted Supplies of MWPs

This step entailed defining the total quantity of WUG water shortages associated with each of the MWPs. Then based on the above associations, existing uncommitted supplies of the MWPs were determined. Table 5-10 is a summary of the total WUG shortages that have been associated to each MWP. Included within this table are the needed shortages associated with the contract extensions defined in Step 2 of this process. The shortages are shown by decade to illustrate both the near-term and long-term water shortages by MWP.

Table 5-10 Water User Group Needs from Major Water Providers

Water User Group	2000 Shortage (ac-ft/yr)	2010 Shortage (ac-ft/yr)	2020 Shortage (ac-ft/yr)	2030 Shortage (ac-ft/yr)	2040 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)
Brazos River Authority Service Area						
Municipal Contract Increases	0	0	0	0	0	0
Municipal WUGs	0	-2,028	-12,465	-28,460	-41,054	-54,797
Non-Municipal WUGs	-48,573	-87,044	-92,611	-104,365	-129,610	-158,979
Total	**-48,573**	**-89,072**	**-105,076**	**-132,825**	**-170,664**	**-213,776**
City of Houston Service Area						
Municipal Contract Increases	-5,637	-11,280	-15,119	-18,627	-20,965	-26,737
Municipal WUGs	-3,072	-49,770	-160,617	-184,827	-201,800	-199,122
Non-Municipal WUGs	0	-19,012	-32,527	-49,274	-85,701	-122,130
Total	**-8,709**	**-80,062**	**-208,262**	**-252,728**	**-308,467**	**-347,989**
Gulf Coast Water Authority Service Area						
Municipal Contract Increases	-180	-2,823	-3,613	-5,045	-10,134	-17,952
Municipal WUGs	-519	-4,497	-10,772	-21,632	-32,362	-42,236
Non-Municipal WUGs	0	0	0	-3,625	-12,214	-20,816
Total	**-699**	**-7,320**	**-14,385**	**-30,302**	**-54,710**	**-81,004**
San Jacinto River Authority Service Area						
Municipal Contract Increases	0	-3,456	-4,048	-3,514	-2,980	-2,846
Municipal WUGs	0	-11,082	-35,441	-57,407	-78,623	-99,150
Non-Municipal WUGs	-196	-3,820	-8,108	-11,478	-19,110	-26,451
Total	**-196**	**-18,359**	**-47,597**	**-72,399**	**-100,714**	**-128,447**
Trinity River Authority Service Area						
Municipal Contract Increases	0	0	0	0	0	0
Municipal WUGs	0	0	0	-1,547	-2,250	-3,145
Non-Municipal WUGs	0	0	0	-3,113	-4,333	-6,952
Total	**0**	**0**	**0**	**-4,660**	**-6,583**	**-10,097**

Table 5-11 compares the uncommitted supply by MWP (taken from Regional Planning Table 8A-Task 4 Report) to the WUG shortages defined within Table 5-10. Table 8A represents total MWP supply less current contract demands (all contracts extended through 2050.) The resultant balance in Table 5-11 represents that quantity of uncommitted supply available to the MWP or the quantity of additional supply needed to address the projected WUG shortages. If it is a

shortage, it is the remaining quantity that must be provided through the use of new water management strategies.

Table 5-11- Projected Major Water Provider Availability

Major Water Provider	2000 (ac-ft/yr)	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)
Brazos River Authority						
Uncommitted Supply	0	0	0	0	0	0
Water User Group Needs	48,573	89,072	105,076	132,825	170,664	213,776
Balance	**-48,573**	**-89,072**	**-105,076**	**-132,825**	**-170,664**	**-213,776**
City of Houston						
Uncommitted Supply	524,348	474,179	383,169	341,143	318,195	271,609
Water User Group Needs	8,709	80,062	208,262	252,728	308,467	347,989
Balance	**515,639**	**394,117**	**174,907**	**88,414**	**9,728**	**-76,380**
Gulf Coast Water Authority						
Uncommitted Supply	-10,694	-7,363	-7,363	-7,363	-7,363	-7,363
Water User Group Needs	699	7,320	14,385	30,302	54,710	81,004
Balance	**-11,393**	**-14,683**	**-21,748**	**-37,665**	**-62,073**	**-88,367**
San Jacinto River Authority						
Uncommitted Supply	56,691	53,235	52,643	53,177	53,711	53,845
Water User Group Needs	196	18,359	47,597	72,399	100,714	128,447
Balance	**56,495**	**34,876**	**5,045**	**-19,222**	**-47,003**	**-74,602**
Trinity River Authority						
Uncommitted Supply	278,220	273,421	271,891	265,585	265,712	265,488
Water User Group Needs	0	0	0	4,660	6,583	10,097
Balance	**278,220**	**273,421**	**271,891**	**260,925**	**259,129**	**255,392**

As shown in Table 5-11, the TRA is projected to have a significant quantity of uncommitted water supply through the planning period. Both GCWA and BRA are projected to have immediate and significant near-term water shortages prior to year 2030. The City of Houston has sufficient supplies until approximately year 2050 and the SJRA is projected to need additional supplies by approximately year 2030.

Step 5- Potential Water Management Strategy Definition

A series of potential water management strategies were defined based on the above determination of need illustrated within Table 5-11. Strategies were configured to address the specific types and nature of identified shortages. For instance, no strategies were effectively defined for the TRA due to the extent of the available uncommitted supplies. A number of potential strategies were defined for the Brazos River basin due to the needs of the BRA and GCWA. The following potential management strategies were identified:

1. Municipal Water Conservation
2. Irrigation Conservation
3. Contractual Transfer
4. New Surface Water Reservoirs
5. Wastewater Reclamation
6. Desalination
7. San Jacinto River Authority/City of Houston Water Transfer
8. Luce Bayou Conveyance
9. City of Houston/Trinity River Authority Contract Agreement
10. Sabine Basin to Region H Interbasin Transfer
11. Lake Bedias to Lake Conroe Transfer
12. Houston To Gulf Coast Water Authority Transfer
13. San Jacinto River Authority/Chambers-Liberty Counties Navigation District Contract

A detailed technical memorandum for each of these management strategies is provided within Appendix A. Not all of the strategies are based on creation of additional water. Several strategies consist of water transfer facilities only (for instance, Luce Bayou or Bedias Transfer) Other strategies only involve the contractual exchange of water supplies between various water suppliers (for instance, SJRA/City of Houston water transfers). These strategies recognize the need to transfer supply from areas of excess to the specific areas of need.

A total of 19 different surface water reservoir projects were reviewed. Ten of these projects were evaluated in detail due to their increased potential for development. A summary listing of the potential reservoir projects is provided in Table 5-12.

No groundwater development strategies were investigated since there is a complete utilization of the sustainable safe yield of all of the aquifers within the counties of highest water demand need. The only counties with available groundwater within Region H are distant from the areas of water need. It is generally not considered prudent to transfer groundwater between counties due to the potential adverse impact on growth within the local communities and due to the political ramifications of such a strategy. If specific groundwater transfer projects were determined to be cost effective, there would still be a significant degree of uncertainty and therefore risk associated with the long-term viability of such a project.

Assessment of each of the potential management strategies conducted as a part of this study included an evaluation of cost, environmental, socioeconomic and other types of impacts. Discussion of necessary implementation activities associated with various strategies is also

included in this report. In order to assess the strategies on a comparable cost basis, a detailed set of unit costs was developed and applied to each alternative. A description of the costing methodology is contained within Appendix B.

Table 5-12 Potential Reservoir Sites

Reservoir Name	River Basin	County(s)	Project Yield	Project Cost	Unit Water Cost ($/ac-ft)
Allens Creek	Brazos	Austin	99,650	$157,300,000	$121
Little River	Brazos	Milam	129,000	$361,065,000	$197
Millican-Panther	Brazos	Brazos Grimes Robertson Leon	235,200	$1,237,300,000	$366
Millican-Bundic Crossing	Brazos	Brazos Grimes Robertson Leon	73,800	$552,370,000	$541
Cleveland	San Jacinto	San Jacinto	65,900	$199,000,000	$231
Lake Creek	San Jacinto		67,200	$339,500,000	$387
Humble	San Jacinto	Montgomery	Not Developed	Not Developed	NA
Spring Creek	San Jacinto	Harris Montgomery	7,500	$21,255,000	$217
Bedias	Trinity	Madison Walker Grimes	90,700	$132,000,000	$112
Caney	Trinity	Trinity	15,700	Not Developed	NA
Harmons	Trinity	Walker	10,100	Not Developed	NA
Hurricane Bayou	Trinity	Houston	17,900	Not Developed	NA
Long King	Trinity	Polk	20,200	Not Developed	NA
Lower Keechi	Trinity	Leon	25,800	Not Developed	NA
Mustang	Trinity	Houston	15,700	Not Developed	NA
Nelson	Trinity	Walker	17,900	Not Developed	NA
Tehuacana	Trinity	Freestone	61,100	$169,000,000	$212
Tennessee Colony	Trinity	Anderson Freestone	405,800	$2,061,000,000	$389
Upper Keechi	Trinity	Freestone	15,700	Not Developed	NA

Table 5-13 provides a summary comparison of the water management strategies analyzed for Region H. A detailed comparison is provided in Table 5A-1 at the end of Appendix A. The RHWPG discussed each potential water management strategy at the time it was presented, weighing the economic, social and environmental costs and benefits. Special attention was paid to the impacts of interbasin transfers, which figured prominently due to the surplus of supply in the Trinity basin and projected shortages in the San Jacinto and Brazos basins. The issues were again discussed during the final management selection process. Regional water planning Table 11, which associates the potential management strategies in Table 5-13 to the WUGs, is contained within Appendix C.

Table 5-13- Comparison of Alternative Management Strategies

Management Strategy	Yield (ac-ft/yr)	Strategy Cost ($)	Unit Cost ($/ac-ft)	Starting Decade	Basin
Municipal Conservation	30,563	$3,667,600	$120	2000	All
Irrigation Conservation					
Brazoria County	24,312	$1,876,000	$70	2000	Brazos, Brazos-Colo.
Fort Bend County	14,259	$1,085,000	$59	2040	Brazos, Brazos-Colo.
Waller County	5,010	$391,000	$78	2000	San Jacinto
Contractual Transfers	28,500	None	None	2000	San Jacinto-Brazos
Reservoirs					
Allens Creek	99,650	$157,300,000	$121	2000	Brazos
Little River	129,000	$361,065,000	$197	2000	Brazos
Millican – Panther	235,200	$1,237,300,000	$366	2000	Brazos
Millican – Bundic Crossing	73,800	$552,370,000	$541	2000	Brazos
Cleveland	65,900	$199,000,000	$231	2030	San Jacinto
Lake Creek	67,200	$339,500,000	$387	2030	San Jacinto
Spring Creek	7,500	$21,255,000	$217	2030	San Jacinto
Bedias	90,700	$132,000,000	$112	2030	Trinity
Tehaucana	61,100	$169,000,000	$212	>2050	Trinity
Tennessee Colony	405,800	$2,061,000,000	$389	>2050	Trinity
Wastewater Reclamation	90,700	$175,498,000	$299	2030	San Jacinto-Brazos
Desalination	44,600	$151,177,000	$500	2030	San Jacinto-Brazos
SJRA/Houston Transfer	67,029	Unknown	Unknown	2030	San Jacinto
Luce Bayou	None	$84,000,000	$24	2020	Trinity to San Jacinto
SJRA/ Lake Livingston	None	$133,800,000	$204	2030	Trinity to San Jacinto
Houston/TRA Contract	200,000	Unknown	Unknown	2050	Trinity to San Jacinto
Bedias / SJRA Transfer	None	$62,340,000	$79	2030	Trinity to San Jacinto
Houston/GCWA Transfer	23,000	$63,270,000	$230	2050	Trinity to San Jacinto-Brazos
Sabine/Region H Transfer					
Sabine to Trinity Transfer	453,000	$311,004,000	$56	2030	Sabine, Neches, Trinity
Trinity to Brazos Transfer	377,000	$498,940,000	$127	2010	Trinity, San Jacinto, Brazos
Voluntary Redistribution	75,000	None	None	2000	Brazos
SJRA / CLCND Contract	30,000	$8,250,000	$275	2000	Trinity to San Jacinto

- **SELECTED WATER MANAGEMENT STRATEGIES**

Decision Process

All of the information developed within Section 3 of this report was provided to the Region H Water Planning Group for their review and comment. Each of the analysis steps was presented to the RHWPG and discussed during a series of RHWPG meetings. At the conclusion of the information development stage, the RHWPG conducted an open meeting to discuss the merits of each strategy and select recommended strategies for inclusion in the Region H plan. This meeting began with a review of the projected water shortages for both the WUGs and the MWPs. Emphasis on the location, quantity and timing of need of projected shortages was reviewed. The RHWPG subsequently conducted a three-step selection process as follows.

Step 1 consisted of consideration of the use of conservation-based demand-management strategies. These strategies apply directly to the WUGs as opposed to the MWPs and will result in a decrease of the projected remaining water shortages.

The RHWPG selected four types of conservation strategies including:

- Municipal Conservation (for WUGs with shortages only)
- Irrigation Conservation within Brazoria County
- Irrigation Conservation within Fort Bend County
- Irrigation Conservation within Waller County

The municipal conservation strategy applies to 30 Municipal WUGs and 8 Municipal County-Other WUGs. The irrigation conservation strategy applies to three counties. This strategy within Fort Bend County also assists in the resolution of the Municipal WUG shortage for the City of Needville. This strategy consists of the City of Needville assisting in the reduction of irrigation water usage in exchange for the ability of Needville to continue to pump groundwater. This is significant in that groundwater is limited within Fort Bend County. All of the other potential strategies available to the City of Needville would cost significantly more than the cost of irrigation conservation.

Step 2 consisted of consideration of specific management strategies for each of the MWPs. The water shortage quantity needed by each water provider was defined and that quantity of supply, at a minimum, was met by selected management strategies. The RHWPG selected the following strategies:

Strategies	MWP Sponsor
• Contractual Transfer	None
• Allens Creek Reservoir	BRA, City of Houston
• Little River Reservoir	BRA, GCWA
• Bedias Reservoir	SJRA, TRA
• Wastewater Reclamation	City of Houston
• Luce Bayou	City of Houston
• City of Houston/TRA Contract Agreement	City of Houston, TRA
• BRA Voluntary Redistribution	BRA
• SJRA / CLCND Contract Agreement	SJRA

The BRA Voluntary Redistribution was introduced by the BRA, which is in the process of obtaining water currently committed under contract to BRA customers but which is not needed in the long-term by those customers. The BRA has the ability to enter into new contracts with their current customers for a smaller contract quantity and then sell this "freed-up" water to new customers. The BRA reports that approximately 75,000 acre-feet per year can be made available.

The SJRA Contract Agreement with the Chambers-Liberty Counties Navigation District was executed in December 2000. A conveyance method has yet to be determined for this supply.

Step 3 consisted of consideration of long-term strategies that would not be needed until significantly beyond the 2050 timeframe. These strategies might be those that have some technical and economic merit but would not be likely to be pursued in the short-term by any particular MWP. Three management strategies were selected by the RHWPG as long-term strategies:

- Desalination
- Sabine to Region H Interbasin Transfer
- Millican - Bundic Crossing Reservoir

The RHWPG believed that the cost of desalination may decrease in the future as technology improves and that this strategy might merit consideration at that time, especially for certain isolated WUGs. The Sabine to Region H transfer was included due to its potential to provide a significant quantity of supply. The RHWPG discussed issues associated with that strategy including the current interbasin transfer limitations within the Texas Water Code, potential freshwater inflow impacts within the Sabine Lake estuary, and political opposition within East Texas as reasons why this strategy would not be pursued in the short-term. Millican-Bundic Crossing Reservoir was included as the next most economical means of increasing supply in the Lower Brazos River basin.

Regional Water Planning Table 12, which defines each of the water management strategies for each WUG, is shown in Appendix C. The major strategies outlined above are shown in Table 12. Additional strategies are shown which allocate supplies from each MWP to each WUG or from each MWP to a 2nd tier water supplier (Brazosport Water Authority or Baytown Area Water Authority) and then to a WUG. An analysis was performed to determine the cost of expanding the water supply facilities of each WUG with a projected shortage. This methodology is outlined in Appendix C, and the current facility expansion plans reviewed for this analysis are in Appendix D. The costs defined within Tables 11 and 12 represent these WUG facility costs. Facility expansion and maintenance costs for WUGs without projected shortages are not addressed.

Major Water Providers

Each of the Region H MWPs will be involved in development of new surface water reservoirs and in making more efficient usage of existing water supplies. Regional water planning Table 13, which defines the water management strategies associated with each MWP, is shown in Appendix C. Table 13 shows the allocation of supply for each management strategy. This table also shows the allocation of supply from a strategy when multiple MWPs serve as strategy sponsors. Table 5-14 (below) summarizes the proposed management strategies under each MWP, and relates them to the WUG shortages allocated to the MWPs. The BRA will include these strategies in the annual planning process for the BRA Long-Range Plan.

The selected water supply management strategies can potentially make available to the region an additional 485,000 acre-feet per year. Further, the City of Houston/TRA Contract Agreement strategy will utilize 200,000 acre-feet of existing supply. Importantly, the defined strategies either locate supply in closer proximity to areas of need or include development of transfer facilities (specifically Luce Bayou and the Bedias Transfer) that can convey supplies to areas of need. Based on the recommended strategies, in total, the Region H MWPs will have adequate supplies to meet projected water needs beyond the year 2050.

Water User Groups

Strategies were also developed that include demand-management practices. The selected conservation strategies reduced projected water demands by approximately 74,000 acre-feet per year. Additionally, the Contractual Transfer strategy reduces needs by approximately 28,500 acre-feet per year without the expenditure of additional capital investment. Each of the conservation strategies and the Contractual Transfer strategy would be implemented by specific WUGs and not developed by a MWP.

Summary tables were prepared for each WUG, listing projected population, supply, demand and supply from management strategies (if needed), by decade. These tables are in Appendix E.

Table 5-14 Management Strategies for Major Water Providers

Major Water Provider Management Strategy	2000 af/y	2010 af/y	2020 af/y	2030 af/y	2040 af/y	2050 af/y
Brazos River Authority						
Balance Without Strategies *	-48,573	-89,072	-105,076	-132,825	-170,664	-213,776
Voluntary Redistribution	50,000	50,000	50,000	75,000	75,000	75,000
GCWA	-18,000	-18,000	-21,000	-35,000	-35,000	-35,000
Brazosport Water Authority ***	0	0	0	0	0	-1,200
Municipal Conservation	0	762	3008	4101	4302	5207
Irrigation Conservation	0	29,332	43,581	43,581	43,581	43,581
Needville's shortage ***			-123	-282	-462	-711
Allens Creek Reservoir	0	0	29,900	29,900	29,900	29,900
Little River Reservoir **	0	0	0	0	71,000	71,000
Contractual Transfer - MFR to IRR	28,500	28,500	28,500	28,500	28,500	28,500
Balance	11,927	1,522	28,790	12,975	46,157	2,501
City of Houston						
Balance Without Strategies *	515,639	394,117	174,907	88,414	9,728	-76,380
Municipal Conservation	98	7,763	17,055	16,783	13,652	13,366
Allens Creek Reservoir	0	0	69,750	69,750	69,750	69,750
Luce Bayou	0	0	0	0	0	0
Wastewater Reclamation	0	90,700	90,700	90,700	90,700	90,700
Houston / GCWA Transfer	0	0	0	0	0	-23,000
Houston / TRA Contract	0	200,000	200,000	200,000	200,000	200,000
Balance	515,737	692,580	552,412	465,647	383,830	274,436
Gulf Coast Water Authority						
Balance Without Strategies *	-11,393	-14,683	-21,748	-37,665	-62,073	-88,367
Municipal Conservation	92	840	1,676	2,676	2,858	3,682
Little River Reservoir	0	0	0	0	28,000	28,000
New BRA Contract	18,000	18,000	21,000	35,000	35,000	35,000
Houston / GCWA Transfer	0	0	0	0	0	23,000
Balance	6,699	4,157	926	11	3,785	1,316
San Jacinto River Authority						
Balance Without Strategies *	56,495	34,876	5,045	-19,222	-47,003	-74,602
Municipal Conservation	0	2,632	5,080	6,175	6,586	7,707
SJRA CLCND Contract	30,000	30,000	30,000	30,000	30,000	30,000
Bedias Reservoir / Interbasin Transfer	0	0	0	75,000	75,000	75,000
Balance	86,495	67,509	40,125	91,953	64,583	38,105
Trinity River Authority						
Balance Without Strategies *	278,220	273,421	271,891	260,925	259,129	255,392
Municipal Conservation	0	0	0	579	451	531
Bedias Reservoir	0	0	0	15,700	15,700	15,700
Houston / TRA Contract	0	-200,000	-200,000	-200,000	-200,000	-200,000
Balance	278,220	73,421	71,891	77,204	75,280	71,623

* Starting balance reflects extensions of current contracts

** Little River Reservoir total yield is 129,000 afy. 30,000 afy will go to BRA in Region G, 71,000 afy will go to BRA in Region H, and 28,000 afy will go to the GCWA

*** Entities previously designated for self-supply

5.5. PROPOSED REGION H WATER MANAGEMENT PLAN

Table 5-15 summarizes the final recommended Region H Water Management Plan as developed through the RHWPG selection process. The Task 4 Report, based on a severe set of assumptions, paints a pessimistic picture of Region H's future if action is not taken to address projected water shortages. In contrast, this section outlines the regional impacts if the Region H Water Plan is implemented.

Table 5-15 Region H Selected Management Strategies

Management Strategy	Yield (ac-ft/yr)	Strategy Cost ($)
Municipal Conservation	30,563	$3,667,600
Irrigation Conservation		
Brazoria County	24,312	$1,876,000
Fort Bend County	14,259	$1,085,000
Waller County	5,010	$391,000
Contractual Transfers	28,500	None
Reservoirs		
Allens Creek	99,650	$157,300,000
Little River	129,000	$361,065,000
Bedias	90,700	$132,000,000
Wastewater Reclamation	90,700	$175,498,000
Luce Bayou	None	$84,000,000
Houston/TRA Contract	200,000	Unknown
BRA Voluntary Redistribution	75,000	None
Bedias/SJRA Transfer	None	$62,340,000
Houston/GCWA Transfer	23,000	$63,270,000
SJRA / CLCND Contract	30,000	$8,250,000

Implementation Methods

Several of the selected management strategies will be developed jointly by multiple MWPs. These projects include each of the reservoir projects:

Allens Creek Reservoir	BRA and City of Houston
Little River Reservoir	BRA and GCWA
Bedias Reservoir	SJRA and TRA

The location of each of these reservoir sites is shown on the exhibit titled, "Recommended Reservoir Sites". As these projects move forward in the development process, the regional benefits of each project can be supported by each of the joint project sponsors. Each of the MWPs has the legal, management and financial capability to develop the proposed reservoir projects.

Successful implementation of the conservation strategies requires that a specific WUG support and guide adoption of the conservation practices. Development of these strategies should begin with definition of the appropriate institutional entity that can enact the conservation measures.

In general, the remainder of the management strategies requires monitoring of local municipal and customer needs to determine when development of specific projects should begin. Reservoir projects require approximately 10 to 20 years to develop. Detailed planning and permitting should be begun many years in advance of the actual time of water supply need. Identification of customers associated with each project will assist the MWP project sponsors assessment of the appropriate time to initiate each project. To a lesser extent, the same is true of each of the other strategies. Market forces based on the localized supply needs of the MWP customer base will determine the appropriate time to initiate each project.

The Region H Water Management Plan ensures that there is adequate water supply available for all water user groups in the Region. It does not identify the facility expansion requirements for water user groups without projected shortages, nor does it address the facility requirements of aggregate WUGs such as Manufacturing and Municipal County-Other. Water supply projects required at the WUG level for water treatment, storage or conveyance, which do not involve the development of or connection to water sources not included in the plan, are consistent with this regional water plan. Planned facility projects identified to the RHWPG are listed in Appendix D. Similarly, this plan addresses water demands and supplies at the WUG level, while water rights, permits and contracts can be held by companies or individuals. Surface water uses that will not have a significant impact on the region's water supply, even though not specifically recommended, are consistent with this regional water plan.

Social, Environmental, and Economic Impacts

Social Impact

Water supply development under the proposed Region H Water Plan will enable continued population increases in the region. With population growth comes urban and suburban residential development, increases in school enrollments, commercial expansions, more demands for governmental social services and a host of other changes, both beneficial and otherwise, that accompany an expanded population in the region. Governmental agencies will be challenged to provide the infrastructure and services required to maintain an acceptable quality of life within the region while keeping taxes and fees at reasonable levels.

Many of the actions proposed under the Region H Water Plan involve increased intra-regional dependencies due to new water provider/consumer relationships. These relationships will help efficiently allocate regional water supplies and provide supply redundancy. However, there is also the potential for political and legal tensions arising from these interrelationships if groups or individuals perceive that their interests are compromised.

Conservation, primarily by municipal and irrigation users, plays a small, but significant role in the Region H Water Plan. While irrigation conservation costs are low, use of irrigation conservation measures may push some marginal farms out of production, even if the cost of irrigation conservation improvements are borne primarily by the industries or municipalities benefiting from the supplies which otherwise would have met irrigation demands. To promote municipal water conservation, consumers will see higher unit water costs as consumption increases. Urban residents will be required to adjust to low-flow plumbing fixtures and will be encouraged to landscape their homes using grasses and shrubs requiring little water.

Reservoir development as envisioned in the plan will have significant social consequences. Reservoirs provide substantial recreational opportunities for residents within and outside the region and promote local development and population growth. Social costs of reservoir construction include displacement of homes and businesses within the reservoir footprint and possible displacement of low-income area residents as the value of lakefront property escalates.

Environmental Impact

Construction of the physical facilities required by the Water Plan, particularly the planned reservoirs, will have significant environmental impact. Even under the best circumstances, reservoirs will inundate wooded bottomlands, wetlands, prime farmland or other ecologically significant areas. Real estate and recreational development of the lakeshore areas brings congestion to previously rural area, noise and some unavoidable air and water pollution. On the other hand, virtually all residents of the region will welcome the new camping, fishing, picnicking and boating opportunities. Construction of facilities other than reservoirs (i.e., pipelines, storage tanks, pumping stations, and water treatment plants) will have local, and generally temporary, effects on air and water quality.

Freshwater inflow impacts within the rivers of the region and within Galveston Bay have been identified as an issue through the course of this planning effort. Detailed analysis of the potential environmental water quantity issues associated with each strategy should be studied in detail prior to implementation of that strategy.

Mandated groundwater withdrawal reductions in Harris and Galveston Counties are accounted for in the plan. Less groundwater pumpage will result in less land subsidence and will reduce potential flood damages. The development of additional surface water supplies will serve to assist in the successful achievement of the Harris-Galveston Coastal Subsidence District (Subsidence District) Regulatory Plan.

Several strategies involve the interbasin transfer of water. The physical, chemical and biological consequences of large-scale mixing of, for example, Trinity River water with San Jacinto River

water in Lake Houston are somewhat undefined. A detailed study of the ecological effects of these proposed transfers will be necessary to determine the extent of any negative impacts and of any required environmental mitigation.

Economic Impact

As the Task 4 Report noted, economic growth in the region will be severely constrained without adequate water supplies. Conversely, the proposed Region H plan will allow the projected population and economic growth and its concomitant development. This growth will fuel residential, commercial and infrastructure construction and will result in higher school enrollments. Local and state governments will realize higher property tax revenues as land is developed for new homes, stores and industries. As population grows, sales tax receipts will increase.

A major component of the Region H plan is the shift of many consumers from groundwater to surface water supplies. The costs of source development, conveyance and treatment are generally greater with surface water than with groundwater. Consumers converting to surface water will see higher bills, in some instances significantly higher. In Harris and Galveston counties, conversion to surface water from current groundwater supplies is mandated by Subsidence District regulations. Although consumers will pay more for water, the reduction in the rate of land subsidence will decrease potential property damages from flooding.

Reservoir construction enhances property values in the vicinity, promotes recreational development and creates employment. Offsetting some of these economic gains are losses of timber, wildlife, cropland and mineral resources (such as oil, gas or lignite) resulting from inundation.

Plan Costs

Tables 11, 12, and 13 include capital and/or annual costs for various management strategies. These costs were estimated in accordance with the criteria outlined by the TWDB's Exhibit B, "Data and Format Guidelines for SB1 Regional Water Plan—Technical Reports." Complete details of the methodology for estimating costs is included in Appendix B, "Cost Estimating Procedures."

Capital costs are based on historical costs of similar facilities, adjusted in scale and updated as required to the second quarter of 1999 using recognized cost indices. TWDB-recommended factors (30% for pipeline projects, 35% for all other projects) have been used for the engineering cost estimates. Land and easement costs were estimated on a case-by-case basis, as were environmental, archeological and mitigation costs. Interest during construction was calculated using TWDB guidelines. Construction durations were assigned based on the size and complexity of an individual project and ranged from one year (e.g., a short pipeline) to three years (e.g., a large reservoir).

The annual cost component of debt service, O&M costs and energy were estimated in accordance with TWDB criteria. The cost of water varies greatly depending on the specific

provider, the provider's source and whether an end user receives raw or treated water. Published rates were used when available. Many providers have sliding raw water cost schedules; in these cases, the highest published rate was generally used. Table 5-16 shows the prices of water, raw and treated, being furnished by major and minor suppliers.

Table 5-16 Costs of Purchased Water

Provider	Raw Water Rate	Treated Water Rate
BRA	$26/af	-
TRA	$95/af	-
SJRA	$75/af	-
GCWA	$27/af (canal) $53/af (pipeline)	$225/af
COH	$130/af	$368/af
BWA	-	$515/af
BAWA	-	Use COH rate
MVWA	-	-
Galena Park	-	-
Pasadena	-	-
Clear Lake	-	-
Seabrook	-	-
CBWC	Use GCWA canal rate	-
Fort Bend WCID	-	Use GCWA rate
Galveston WCID	-	-
Crosby MUD	Use SJRA rate	-
Freeport	-	Use BWA rate
CLCND	$35/af	-

BAWA—Baytown Area Water Authority
BRA—Brazos River Authority
BWA—Brazosport Water Authority
CBWC—Chocolate Bayou Water Company
CLCND—Chambers-Liberty Counties Navigation District
COH—City of Houston
GCWA—Gulf Coast Water Authority
MVWA—Memorial Villages Water Authority
SJRA—San Jacinto River Authority
TRA—Trinity River Authority

The tabulated costs above represent the current costs of existing water supplies. These prices were applied in Table 11 as the annual water cost for contracts from existing supplies. Where new raw water or treated water sources are needed, the costs of new facilities were generated and annualized using the methodology in Appendix B. These costs were then converted to a price per acre-foot and used as the unit cost of water in Table 11 for WUGs receiving water from new

sources. It is understood that the costs shown in Table 5-16 represent system costs for these providers, and the development of new water sources will increase the average system cost, but for Table 11 the rates for existing and new water sources were kept separate to facilitate comparison of alternatives.

The capital costs of treatment plants, conveyance pipelines, storage tanks and pumping stations are assigned to the WUG receiving the water. If a strategy provides water to multiple WUGs via common facilities, the capital costs are prorated among the WUGs. Capital expenditures for new reservoirs accrue only to the MWPs as shown in Table 13; the cost to the WUGs is reflected in the price of water from the MWP. Many WUGs meet their future shortages simply by extending existing supply contracts. Contract extensions were assigned no capital cost. However, if a WUG requires additional conveyance or treatment facilities to use the full quantity of its contracted supply (or any increase in its contracted amount), then an appropriate capital cost was estimated and included in Table 11. No capital cost was assigned to supplies generated by municipal conservation because no concentrated construction expense is involved. On the other hand, irrigation conservation has identifiable capital expenditures, notably canal lining and field re-leveling costs, and these have been entered as appropriate in Table 11. Per TWDB guidance, no attempt has been made to estimate the costs of improvements that the WUGs must make to their internal distribution systems.

Cost Impact on Each Water User Category

This section addresses the cost impact of the recommended Region H Water Plan on the six user categories:

- Municipal
- Manufacturing
- Irrigation
- Mining
- Steam-Electric Power
- Livestock

Generally, the lowest cost water comes from sources already developed and in close proximity to the point of use, including those supplies “created” by conservation. Somewhat higher in cost are those supply strategies that transfer water owned by a user or provider within a basin (or between basins in some cases) to where the demand exists. Some strategies will require the purchase of water outside the basin of need and construction of facilities for conveying the water to the consumers. This approach adds significantly to the cost of water supply since sellers of water may demand the price of “replacement” sources of water. Finally, new sources of water—reservoirs, wastewater reclamation, desalination, etc.—cost the most.

Municipal users, including those in the “County—Other” groups, will see a variety of effects from the proposed plan. Many WUGs currently on groundwater are in areas with sufficient groundwater supplies. These WUGs will remain on groundwater throughout the planning period and can expect little cost impact on their customers. Users whose supply will shift partially or wholly to surface water can expect significant water rate increases over time. This will primarily affect residents in Waller, Montgomery, Harris, Fort Bend, Brazoria and Galveston counties.

Only manufacturers in Brazoria, Fort Bend, Galveston and Harris counties have projected supply shortages within the planning period. As the MWPs from whom these manufacturers obtain their water develop new and more costly sources of water, the costs of the new sources will be "blended" into the MWPs' cost bases. All consumers served by a particular MWP will share the incremental costs. The cost of water for industrial customers, as well as all other categories of customers served by the MWP, will increase over time as new sources are brought on line.

The wastewater reclamation strategy deserves specific discussion. Under this strategy, reclaimed Houston domestic wastewater will be further treated and delivered to industrial users along the Houston Ship Channel. The reclaimed water will be of higher quality than current supplies and will reduce the industries' costs of process water treatment in many cases. Ship Channel industries should be willing to pay a somewhat higher price for reclaimed water because of this advantage. However, the primary benefit of this strategy will accrue to the City since Houston avoids the cost of developing a new water source. Therefore, the bulk of this strategy's cost should be borne by the broad Houston customer base.

Irrigation shortfalls occur only in Brazoria, Fort Bend and Waller counties. Irrigation conservation will cover these shortfalls and more. Since reductions in irrigation demand allow meeting the needs of other categories of users (e.g., meeting of the City of Needville's shortage), the capital costs of irrigation conservation should be borne by those who benefit. Consequently, the cost to irrigators for conservation implementation should be minimal. As with the manufacturing category, irrigators will face gradual water cost increases as their suppliers develop new and more costly sources of water. As the MWP "blends" the increased cost into its overall system rates, water price increases should be gradual and predictable for irrigators.

Mining, steam-electric power and livestock categories have relatively small (if any) shortfalls predicted. These users will be affected, as the other user categories, by gradual and predictable water cost increases as the MWPs bring new, and more costly, sources of water on line.

TASK 6 REPORT

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF EXHIBITS

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

INTRODUCTION

Chapters 31 TAC 357.7 (a)(9), 31 TAC 357.8 and 31 TAC 357.9 of the Texas Water Code specifies that each regional water planning group throughout Texas shall make recommendations that are necessary to effect and/or implement the adopted regional water plan. This report presents the Additional Recommendations of the Region H Water Planning Area. This area includes all or part of fifteen counties including Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity, Walker and Waller.

The Region H Water Planning Group (RHWPG) has drafted a set of Additional Recommendations in accordance with the above provisions. This report outlines these recommendations in three areas of interest:

- Unique Stream Segments
- Unique Reservoir Sites
- Regulatory, Administrative and Legislative Recommendations

The RHWPG believes that stewardship of the environment can be coupled with water supply development. Successful planning and implementation of these three subject areas will serve to enhance the quality of life and sustain the local economy throughout the Region H water planning area.

6.1 UNIQUE STREAM SEGMENTS

The Texas Water Code offers the opportunity to identify river and stream segments of unique ecological value within a planning region. The criteria established within the Texas Water Code are as follows:

31 TAC § 357.8 Ecologically Unique River and Stream Segments

(a) Regional water planning groups may include in adopted regional water plans recommendations for all or parts of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by supporting literature and data. The recommendation package shall address each of the criteria for designation of river and stream segments of ecological value found in subsection (b) of this section. The regional water planning group shall forward the recommendation package to the Texas Parks and Wildlife Department and allow the Texas Parks and Wildlife Department 30 days for its written evaluation of the recommendation. The adopted regional water plan shall include, if available, Texas Parks and Wildlife Department's written evaluation of each river and stream segment recommended as a river or stream segment of unique ecological value.

(b) A regional water planning group may recommend a river or stream segment as being of unique ecological value based upon the following criteria:

*(1) **biological function**--stream segments which display significant overall habitat value including both quantity and quality considering the degree of biodiversity, age, and uniqueness observed and including terrestrial, wetland, aquatic, or estuarine habitats;*

*(2) **hydrologic function**--stream segments which are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization, or groundwater recharge and discharge;*

*(3) **riparian conservation areas**--stream segments which are fringed by significant areas in public ownership including state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations for conservation purposes, or stream segments which are fringed by other areas managed for conservation purposes under a governmentally approved conservation plan;*

*(4) **high water quality/exceptional aquatic life/high aesthetic value**--stream segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses dependent on or associated with high water quality; or*

(5) ***threatened or endangered species/unique communities****--sites along streams where water development projects would have significant detrimental effects on state or federally listed threatened and endangered species, and sites along streams significant due to the presence of unique, exemplary, or unusually extensive natural communities.*

Texas Parks and Wildlife Department (TPWD) provided the Region H Water Planning Group with the document "Ecologically Significant River and Stream Segments of Region H Regional Water Planning Area" (Norris and Linam, October 1999) that detailed information on streams in the region that meet the Senate Bill One criteria. Two hundred fifty-nine (259) streams were identified that exist within Region H. TPWD selected twenty-seven (27) for inclusion as "ecologically significant" streams. This analysis served as the basis for further consideration of which streams might be of "unique ecological value." The RHWPG then used the additional following described methodology to make a final selection.

Methodology:

(1) Screened initial selection of 27 streams presented by Texas Parks and Wildlife Department (TPWD, October 1999; see Table 1) using a decision rule of selecting those streams with seven or more criteria factors cited by the TPWD.
(2) Compared screened streams with previously studied reservoir sites and published or potential water conveyance plans and eliminated streams that might conflict with potential water development projects.
(3) Compared screened streams with TNRCC water rights and wastewater discharge information and eliminated streams that might raise water quality permitting issues.
(4) Compared screened streams with Houston Canoe Club ranking of streams in region and other recreational use information from the Region H Task 3 Report.
(5) Compared screened streams with riparian conservation areas and prior ecological designations and added four streams that had not met the initial numeric selection criterion: Armand Bayou (a State Coastal Preserve); lower portion of Big Creek, Fort Bend County (Brazos Bend State Park); Big Creek, San Jacinto County (Sam Houston National Forest); and Menard Creek (a Corridor Unit of the Big Thicket National Preserve).

Table 6-1. TPWD Recommended River or Stream Segments and Criteria Satisfied[1]

River or Stream Segment	Biological Function	Hydrologic Function	Riparian Cons. Area	High Water Quality / Aesthetic Value	Endangered / Threatened Species
Armand Bayou	x	xx	xx	x	
Austin Bayou	x	x	xx		xxx
Bastrop Bayou	x	x	xx		xxx
Big Creek (Fort Bend)	x	x	xx	xx	
Big Creek (San Jacinto)	x		xxx	x	x
Brazos River	x	xxx	xxx		xx
Caney Creek	x	xx	xx		
Carpenters Bayou	x	xx	x		
Cedar Lake Creek	x	xx	xx		xxxx
Clear Creek	x	xx		x	
East Fork San Jacinto	x	xx	xx	xxx	
East Sandy Creek	x	x	x		
Halls Bayou	x	x			x
Harmon Creek	x	xx	x	x	
Jones Creek	x	x	xx		
Lake Creek	x	xx		xxx	x
Luce Bayou	x	xx			
Menard Creek	x	xx	x		x
Mill Creek	x	xx		xx	x
Nelson Creek	x	x		xx	
Old River	x	xx	x	x	
San Bernard River	x	xx			xx
Upper Trinity River		x			x
Lower Trinity River	x	xxx	xxx		xx
Upper Keechi Creek	x	x	x		
Wheelock Creek		x		x	
Winters Bayou	x	xx	x	x	

Note: More than one "x" in a criteria column indicates that the river or stream segment satisfies that particular criteria in more than one way. For example, Armand Bayou is a State Coastal Preserve and is also a part of the Great Texas Coastal Birding Trail.

[1] TPWD Report, Norris and Linam, October 1999.

After consideration of the above factors, six streams are recommended for designation as Streams of Unique Ecological Value in Region H. These are illustrated on the attached exhibit entitled "Recommended Unique Stream Segments."

Recommended Unique Stream Segments (Not in priority order)	County
Armand Bayou	Harris
Bastrop Bayou	Brazoria
Big Creek	Fort Bend
Big Creek	San Jacinto
Cedar Lake Creek	Brazoria
Menard Creek	Liberty, Hardin*, Polk

*Hardin County portion is in Region I.

The entire stream segment length is recommended for unique designation status for two of the streams; Armand Bayou and Menard Creek (segments within Region H.) For the remaining four streams only those portions adjacent to or within the riparian conservation areas are proposed for designation as unique streams.

The following are descriptions of each of these special watercourses.

Armand Bayou[2]

Armand Bayou is a coastal tributary of Clear Lake, a secondary bay in the Galveston Bay System, in southern Harris County. The bayou is often shallow and has a mean width of 40 feet that supports varying flow over a muddy substrate. This scenic natural bayou and associated riparian forest offer habitat for alligators, waterfowl, and other wildlife such as raccoons, bobcats, and river otters. Noteworthy bird species known to inhabit the area include; pileated woodpeckers, red shouldered hawks, barred owls, ospreys, and migratory songbirds. Several hundred acres of restored coastal prairie offer habitat for grassland species such as the sedge wren and Le Conte's sparrow. The associated marshes that border the riparian forest provide valuable habitat to commercially and recreationally important species such as white shrimp, blue crabs, and red drum. In addition, the bayou also provides valuable recreational opportunities to local residents within an urban context. The ecologically significant segment is from the confluence with Clear Lake in Harris County upstream to Genoa-Red Bluff Road in Harris County.

(1) Biological Function- significant riparian zone and associated marshes display significant overall habitat value.
(2) Hydrologic Function- performs valuable hydrologic function relating to flood attenuation for the Pasadena and Clear Lake areas.

[2] TPWD Report, Norris and Linam, October 1999

(3) Riparian Conservation Area- fringed by the Armand Bayou Coastal Preserve and is a part of the Great Texas Coastal Birding Trail.
(4) High Water Quality/Exceptional Aquatic Life/High Aesthetic Value- high aesthetic value for outdoor recreation within an urban context.
(5) Threatened or Endangered Species/Unique Communities- none identified.

Bastrop Bayou[3]

Bastrop Bayou is a scenic coastal waterway fringed by extensive freshwater wetland habitat. The bayou rises in the central part of Brazoria County and flows deeply in a southeasterly direction for 13 miles where it empties into Austin Bayou and ultimately Bastrop Bay. Like Austin Bayou, Bastrop Bayou provides valuable habitat for endangered or threatened shorebirds as well as waterfowl, grassland species, and birds of prey. These include geese, sandhill cranes, sedge wrens, grasshopper sparrows, white-tailed kites, and white-tailed hawks. In addition to numerous bird watching opportunities, the bayou also provides outdoor opportunities in the form of water related activities to local residents. The ecologically significant segment is that portion adjacent to the Brazoria National Wildlife Refuge within Brazoria County. This segment is within TNRCC stream segment 1105.

(1) Biological Function- extensive freshwater wetland habitat that displays significant overall habitat value.
(2) Hydrologic Function- extensive freshwater wetlands perform valuable hydrologic function relating to water quality.
(3) Riparian Conservation Area- fringed by the Brazoria National Wildlife Refuge and is part of the Great Texas Coastal Birding Trail.
(4) High Water Quality/Exceptional Aquatic Life/High Aesthetic Value- insufficient data to evaluate criteria.
(5) Threatened or Endangered Species/Unique Communities- designated as an internationally significant shorebird site by the Western Hemisphere Shorebird Reserve Network, provides habitat for the wood stork, reddish egret, and white-faced ibis.

Big Creek (Fort Bend)[4]

Big Creek begins south of Rosenberg and flows southeasterly 25 miles into the Brazos River in Fort Bend County. The creek is an old Brazos River channel with associated sloughs, bayous, oxbow lakes, and coastal prairies that are bordered by bottomland hardwood forest. This habitat provides an excellent opportunity for bird watching, as over 270 species of birds have been sighted in this area. Birds commonly seen here include purple gallinules, least bitterns, prothonotary warblers, barred owls, white-ibis', herons, and egrets among others. Other wildlife that inhabits the area

[3] TPWD Report, Norris and Linam, October 1999
[4] TPWD Report, Norris and Linam, October 1999

includes alligators, bobcats, raccoons, feral hogs, and gray foxes. The ecologically significant segment is that portion of the stream within the Brazos Bend State Park.

(1) Biological Function- no significant biological function identified.
(2) Hydrologic Function- bottomland hardwood forest and associated wetlands perform valuable hydrologic function relating to water quality.
(3) Riparian Conservation Area- fringed by Brazos Bend State Park and is part of the Great Texas Coastal Birding Trail.
(4) High Water Quality/Exceptional Aquatic Life/High Aesthetic Value- designated as an Ecoregion Reference Stream by the TPWD River Studies Program for high dissolved oxygen and diversity of benthic macroinvertebrates.
(5) Threatened or Endangered Species/Unique Communities- none identified.

Big Creek (San Jacinto)[5]

Big Creek rises near Cold Springs in Central San Jacinto County and flows southeasterly into Northern Liberty County where it joins the Trinity River. The creek is narrow with a sandy bottom, follows a run, riffle, pool sequence, and contains abundant woody debris. This provides habitat for a diverse community of fish and macroinvertebrates including the southern brook lamprey, blacktail shiner, blacktail redhorse, blackstripe topminnow, numerous perch species, and several species of sunfish. The creek meanders through pristine forestland in the Sam Houston National Forest and provides significant opportunities for bird watching and outdoor recreation. Bird species often found include Louisiana waterthrushes and worm-eating warblers, as well as the endangered red-cockaded woodpecker that the National Forest Service developed an interpretive site around. An interpretive trail through the Big Creek Scenic Area and the Lone Star Hiking Trail provide access to the creek and provide an opportunity to see mammals such as bobcats, squirrels, and beavers. The ecologically significant segment is that portion of the stream that exists within the Sam Houston National Forest within San Jacinto County.

(1) Biological Function- displays significant overall habitat value considering the high degree of biodiversity.
(2) Hydrologic Function- no information available.
(3) Riparian Conservation Area- fringed by the Sam Houston National Forest and the Big Creek Scenic Area and is part of the Great Texas Coastal Birding Trail.
(4) High Water Quality/Exceptional Aquatic Life/High Aesthetic Value- exceptional aesthetic value.
(5) Threatened or Endangered Species/Unique Communities- red-cockaded woodpecker group nearby.

Cedar Lake Creek[6]

[5] TPWD Report, Norris and Linam, October 1999
[6] TPWD Report, Norris and Linam, October 1999

Cedar Lake Creek begins in northwest Brazoria County and flows southeasterly 28 miles into Cedar Lake and ultimately to the Gulf of Mexico. The creek is bordered by bottomland hardwood forest in the northern portion and by interspersed native prairies, farmland, and coastal marshes in the south. It is one of the few remaining unchannelized bayous in the region. Approximately 3,500 acres of forested land along three miles of creek are in the process of being acquired as a Wildlife Management Area. The creek itself and the adjacent San Bernard National Wildlife Refuge provide habitat to numerous bird species including the scissor-tailed flycatcher and numerous shorebirds. The ecologically significant segments are those portions of the stream adjacent to the proposed Wildlife Management Area and the San Bernard Wildlife Refuge within Brazoria County.

(1) Biological Function- undredged bayou with extensive forest and wetlands that display significant overall habitat value.
(2) Hydrologic Function- bottomland forest and wetlands perform valuable hydrologic functions relating to flood attenuation and water quality.
(3) Riparian Conservation Area- fringed by San Bernard National Wildlife Refuge and is part of the Great Texas Coastal Birding Trail.
(4) High Water Quality/Exceptional Aquatic Life/High Aesthetic Value- insufficient data to evaluate criteria.
(5) Threatened or Endangered Species/Unique Communities- significant due to presence of reddish egret, wood stork, brown pelican, and white-faced ibis.

Menard Creek[7]

Menard Creek begins east of Livingston in central Polk County and flows southeasterly to the Polk County line, where it turns northwesterly and flows through Liberty County into the Trinity River. The creek channel is narrow and shallow with a sandy bottom and follows a sinuous path through banks lined with pine and hardwood forest. The ecologically significant segment is from the confluence with the Trinity River near the Polk/Liberty County line upstream to its headwaters located east of Livingston in the central part of Polk County. The portion that runs through Hardin County is not included in the segment as it is out of Region H.

(1) Biological Function- bottomland hardwood forest that displays significant overall habitat value.
(2) Hydrologic Function- performs valuable hydrologic functions relating to water quality and groundwater recharge of the Chicot Aquifer.
(3) Riparian Conservation Area- fringed by the Big Thicket National Preserve.
(4) High Water Quality/Exceptional Aquatic Life/High Aesthetic Value- insufficient data to evaluate criteria.
(5) Threatened or Endangered Species/Unique Communities- high diversity of freshwater mussels, many of which are rare.

[7] TPWD Report, Norris and Linam, October 1999

6.2 UNIQUE RESERVOIR SITES

The Texas Water Code offers an opportunity to designate sites of unique value for use as surface water supply reservoirs within a planning region. The following criteria are outlined within the Texas Water Code.

> ***31 TAC § 357.9 Unique Sites for Reservoir Construction***
>
> *A regional water-planning group may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and expected beneficiaries of the water supply to be developed at the site. The following criteria shall be used to determine if a site is unique for reservoir construction:*
>
> 1. *Site-specific reservoir development is recommended as a specific water management strategy or in an alternative long-term scenario in an adopted regional water plan; or*
> 2. *The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics, or other pertinent factors make the site uniquely suited for:*
>   A. *Reservoir development to provide water supply for the current planning period; or*
>   B. *Where it might reasonably be needed to meet needs beyond the 50-year planning period.*

Through use of a decision-based water management strategy analysis and selection process, the Region H Water Planning Group selected three surface water reservoir projects for inclusion within the final plan. Each of these projects is therefore a specific water management strategy. Water supply from each project is needed to meet water needs within the current 50-year planning period. The RHWPG has decided to designate the site locations of each of these projects as unique sites. Therefore, after consideration of all of the above factors, three reservoir sites are recommended for designation as Sites of Unique Value in Region H. These are illustrated on the attached exhibit entitled "Recommended Reservoir Sites."

The three sites include:

ALLENS CREEK RESERVOIR

This site is located in Austin County, 1 mile north of the City of Wallis, on Allens Creek, a tributary to the Brazos River. This site exists within the Brazos River Basin and is in Region H. Approximately 7,000 acres would be inundated. This project is configured as a scalping reservoir that would divert stormwater flows (periods of high water) from the Brazos River and impound these flows in the reservoir to create storage yield. The maximum dam height is 53 feet. The conservation storage quantity is approximately

145,500 acre-feet at an elevation of 121.0 feet msl. The projected firm yield of this project is 99,650 acre-feet per year. The total project cost is estimated as $157,300,000. The Brazos River Authority and City of Houston will jointly develop this reservoir project for their water users within the lower Brazos and San Jacinto river basins.

The project location is shown on Exhibit 3, Allens Creek Reservoir.

BEDIAS RESERVOIR

This site is at the junction of Grimes, Madison and Walker Counties, located principally within Madison County about 3.5 miles west of Highway 75. The site includes Bedias and Caney Creeks. This site exists within the Trinity River Basin and is in Regions G and H. The upstream drainage area is approximately 395 square miles. The dam is proposed with a maximum height of 45 feet and a normal pool elevation of 230.0 feet msl. The reservoir would have conservation storage of 181,000 acre-feet and would inundate approximately 13,000 acres. The approximate firm yield of Bedias Reservoir is 90,700 acre-feet per year. The estimated project cost is $132,000,000. This project is currently included in the TRA Trinity River Basin Master Plan. As planned, the Trinity River Authority and the San Jacinto River Authority would jointly develop this project for their water users within the lower Trinity and San Jacinto river basins, respectively.

The Project location is shown on Exhibit 4, Bedias Reservoir

LITTLE RIVER RESERVOIR

This site is located on the main stem of the Little River just upstream from its confluence with the Brazos River. It is near the City of Cameron in Milam County, and is located within the Brazos River basin within Region G. The site would have a surface area of 35,000 acres and a storage volume of about 930,000 acre-feet. The approximately 7,500 square mile upstream drainage area is uncontrolled which produces a significant yield. The fully developed site would have a firm yield of about 129,000 acre-feet per year. The approximate project cost is $361,000,000. The Brazos River Authority and the Gulf Coast Water Authority propose this project for joint development for their water customers within the Brazos and the San Jacinto-Brazos river basins. Brazos River Authority customers would exist within both Regions G and H, making this project truly regional in scope.

The project location is shown on Exhibit 5, Little River Reservoir.

6.3 REGULATORY, ADMINISTRATIVE AND LEGISLATIVE RECOMMENDATIONS

INTRODUCTION

Section 357.7(a)(9) of the Texas Water Development Board regional water planning guidelines requires that a regional water plan include recommendations for regulatory, administrative, and legislative changes:

> *"357.7(a) Regional water plan development shall include the following…*
> *(9) regulatory, administrative, or legislative recommendations that the regional water planning group believes are needed and desirable to: facilitate the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of the state and regional water planning area. The regional water planning group may develop information as to the potential impact once proposed changes in law are enacted."*

These recommendations are addressed to each governmental agency that has the appropriate jurisdiction over each subject. It is generally assumed that regulatory recommendations are directed towards the Texas Natural Resources Conservation Commission (TNRCC), that administrative recommendations are directed towards the Texas Water Development Board (TWDB), and that legislative recommendations are directed towards the State of Texas Legislature (Legislature.)

SUMMARY OF RECOMMENDATIONS

The Region H Water Planning Group has currently adopted the following regulatory, administrative, and legislative recommendations:

- Regulatory and Administrative Recommendations
  - Review the population estimates immediately following determination of the 2000 census and make revisions to WUG population and demand estimates as necessary.
  - Allow more flexibility in the allocation of multiple water management strategies to meet defined water shortages.
  - Base the water planning on renewal of current water supply contracts when they expire.
  - Modify the notification procedures for amendments to regional water plans to limit notification requirements.
  - Direct the TNRCC to utilize more realistic assumptions in the development of the surface water Water Availability Models that will serve as the basis of future regional water planning efforts.
  - Maintain the current definition of each of the sixteen regional water-planning areas.

- Legislative Recommendations
  - Revise Chapter 297.73 of the Texas Water Code to exempt from cancellation those water rights that have not been used in whole or in part for 10 years.
  - Adopt regulations to exempt from cancellation any water rights of project sponsors, whose water rights were developed as a result of financing a water supply project.
  - Remove barriers to interbasin transfers of water.
  - Maintain the current rule of capture basis of groundwater law within Texas in all areas not subject to defined groundwater conservation districts.
  - Support development of Groundwater Conservation Districts to protect current groundwater users.
  - Develop a structure and funding method to support ongoing activities of the RWPG following development of the regional water management plan.
  - Establish funding for continuing the Bays and Estuaries programs of state resource agencies and for additional monitoring and research to develop strategies to meet freshwater inflow needs.
  - Establish financing mechanisms for development of new water supply projects identified within the adopted regional water plans.
  - Clarify the definition and intent of the unique stream segments and unique reservoirs.
  - Continue and expand funding of the State of Texas Groundwater Availability Modeling effort.
  - Establish funding for agricultural research into the area of efficient irrigation practices.
  - Establish a research and development program for desalination with appropriate financial incentives for desalination project implementation.
  - Address and improve water conservation activities in the state.

REGULATORY AND AMINISTRATIVE RECOMMENDATIONS

Revise Population Projections

A number of Municipal WUGs within Region H strongly disagree with the current set of population and water demand projections. Various Municipal WUGs have transmitted evidence that their specific communities have year 2000 populations significantly higher or lower than the projections used in the current regional planning effort. An opportunity exists to rectify this situation with completion of the year 2000 Census. Accurate, consistent information should exist for each Region H Municipal WUG as a result of the Census.

The Region H Water Planning Group recommends that the TWDB immediately revise the existing population and water demand projections upon official acceptance of the Census information. These revised population and water demand projections should then be transmitted to the regional planning groups for amendment, if necessary, of the current regional water plan.

Water Management Strategy Flexibility

Section 357.7(a)(8) of the TWDB Regional Water Planning guidelines requires "specific recommendations of water management strategies to meet near term needs…" The TWDB interpretation of these requirements suggests a direct relationship between a defined water shortage with one specific water management strategy. We are concerned that this requirement decreases the local control and flexibility that have been an important part of successful efforts to meet water needs in Region H and throughout the state. Changing circumstances can alter the preferred alternative for new water supplies very quickly. We are also concerned that limiting the options of water suppliers may make negotiations to obtain needed land or water (through contract, for instance) more difficult and drive up the cost of new water supplies.

The Region H Water Planning Group recommends that the TWDB and the TNRCC interpret existing legislation to give the maximum possible flexibility to water suppliers. Legislative and regulatory changes should be made to remove this requirement for specificity from the regional water planning guidelines and allow plans to present multiple sources of supply where appropriate.

Contract Expiration Policy

TWDB has interpreted its current regulations to require regional water planning groups to assume that contract water will not be made available after the expiration date of the current contracts. In reality, buyers and sellers of water virtually always renew their contract commitments. The existing TWDB policy therefore appears to create a worst case scenario in regard to the long-term availability of water for WUGs with contracts. Subsequently, this assumption causes an unrealistically enormous estimate of

socioeconomic impacts. These impacts occur as a result of projected water shortages, which are based on the assumption that expiring contracts will not be renewed. For some municipalities, these expiring contracts represent the majority of their supply, and the projected impacts (loss of population, loss of industry, etc.) are severe. The magnitude of the socioeconomic impacts in Region H might cause a public official or the public in general to be unduly alarmed, when in fact sufficient water supplies are in existence to address near-term water needs.

The Region H Water Planning Group recommends that the TWDB change its policy to allow water planning groups to assume that current contracts will be extended beyond the current expiration date unless specific information suggests otherwise.

Notification Procedures for Regional Plan Amendments

The same notification requirements associated with adoption of a regional water plan should not be used upon amendment of a specific component of the plan. The RHWPG anticipates a number of plan amendments prior to review of the entire plan in approximately five years. These plan amendments will only affect certain aspects of the plan and certain communities and water suppliers. The current notification requirements for the entire plan are expensive.

The Region H Water Planning Group recommends adoption of a revised set of notification procedures for regional water plan amendments.

WAM Analysis Assumptions

The current TNRCC Water Availability Modeling (WAM) effort will produce a wealth of information that may assist in the development of future regional water plans. The current TNRCC rules regarding construction of the WAMs are based on a need for water rights permitting (strict prior appropriation doctrine) whereas the regional water planning efforts need WAMs based on a water supply planning basis. This distinction can create very different results.

The Region H Water Planning Group recommends adoption of WAMs predicated on planning based water models that represent current operations of regional water suppliers.

Regional Water Planning Area Definition

There may be a tendency to revise the current water planning regional boundaries. Planning region revision could potentially require large-scale re-analysis of the current plans. Additionally, it is anticipated that modifications to the plans would become more difficult to assess with an added burden of revising the existing regional definitions.

The Region H Water Planning Group recommends maintenance of the current boundary definitions of the sixteen regional water planning areas.

LEGISLATIVE RECOMMENDATIONS

Permit Exemption from Cancellation for Nonuse

Existing Texas Water Law provides for the potential cancellation of a water right due to 10 years of nonuse of the permitted water supplies. Water rights associated with relatively large water supply projects may be developed many years in advance of the actual need. These projects and their associated water rights are a result of prudent planning and a financial commitment to develop such a project. Cancellation of water rights associated with such a project defeats the purpose of performing long-term planning and project development.

The Region H Water Planning Group supports modification of current Texas Water Law to exempt from cancellation certain water rights that have not been utilized for 10 years or more.

Permit Exemption of Water Rights of Project Sponsor

Existing Texas Water Law is indiscriminate in regards to potential cancellation proceedings. The sponsors of water supply projects that secure water rights resulting with development of water supplies developed by that project sponsor should be exempt from any potential cancellation proceedings. Water supply project sponsors invest a significant amount of time, energy and capital in the development of water supply projects. These investments should not be subject to forfeiture due to nonuse of the developed water supplies.

The Region H Water Planning Group supports adoption of new legislation to exempt from cancellation those water rights secured by the project sponsor of a water supply project.

Interbasin Transfers

Senate Bill One states that water rights developed as a result of an interbasin transfer become junior to other water rights granted before the interbasin transfer permit. The effect of this change is to make obtaining a permit for interbasin transfer significantly more problematic than it was under prior law and thus discourages the use of interbasin transfers for water supply. This is undesirable for several reasons:

- Current supplies greatly exceed projected demands in some basins, and the supplies already developed in those basins can only be used via interbasin transfers (Trinity basin within Region H.)

- Interbasin transfers have been used extensively in Texas and are an important part of the state's current water supply. For example, three of the five Region H Major

Water Providers (City of Houston, Trinity River Authority and San Jacinto River Authority) maintain current permits for interbasin transfers collectively of over 1,000,000 acre-feet per year. Virtually all future water demands within the San Jacinto basin (Harris County in particular) of Region H must rely on interbasin transfers.

- Emerging regional water supply plans for major metropolitan areas in Texas (Dallas-Fort Worth and San Antonio) rely on interbasin transfers as a key component of their plans. It is difficult to envision developing a water supply for these areas without significant new interbasin transfers.

The Region H Water Planning Group recommends that the legislature revise the current law on interbasin transfers and remove the unnecessary and counterproductive barriers to such transfers that now exist.

Rule of Capture

Groundwater is a vital resource within Region H. This is especially true within the rural counties of the region that are predominantly dependent on groundwater. Current groundwater law based on the Rule-of-Capture has facilitated orderly development of groundwater systems throughout the State of Texas and, barring the intrusion of private interests, could continue to serve the water usage interests throughout the state. It appears that the Rule-of-Capture could continue per the status quo to serve the groundwater interests within the region.

The Region H Water Planning Group supports continued usage of the Rule-of-Capture as the basis of groundwater law throughout the State of Texas except as modified through creation of certified groundwater conservation districts.

Groundwater Conservation Districts

Region H communities, particularly those within the rural areas of the region, are dependent on groundwater supplies. Groundwater is a very valuable resource to this region. Region H contains counties, specifically Austin, Leon and Madison where some municipalities, water supply corporations and property owners believe groundwater conservation districts (GCD) are needed to retain long-term groundwater supplies within their respective counties. Region H also has several counties, including Brazoria, Waller and Montgomery, where groundwater supplies will, in theory, reach their maximum sustainable yield due solely to projected in-county water usage rates. A GCD is a potential vehicle for these counties to manage and protect groundwater supplies from over-development within each respective county. The potential of losing these supplies to outside interests before the county of origin can maximize the use of these supplies would create a burden on local water users.

The Region H Water Planning Group supports creation of GCDs, as necessary, by local subarea water interests. The RHWPG supports development of truly regional GCDs as

opposed to single county districts to recognize the regional expansiveness of underground aquifers and to provide the greatest degree of regional water supply protections.

Ongoing RWPG Activities

It is apparent that the RWPGs will have to meet periodically to address changed conditions related to the adopted regional water management plans. Ongoing activities will include, but not be limited to:

- Consideration of additions and modifications to the adopted plans
- Serving as communications liaisons with the water user communities within each region
- Assisting in the reconciliation of inter-regional water issues

It will be necessary to consider additional funding to support maintenance of the RWPGs. Also, the administrative provisions of Senate Bill One and the subsequent policies that have been enacted should be reviewed to determine if the appropriate organizational structure exists to accomplish the work of the RWPGs. Additional funding should be developed to support technical studies necessary to support the needs of the RWPGs.

The Region H RWPG recommends that the TWDB request additional funding and adoption of the appropriate administrative procedures from the legislature to facilitate ongoing activities of the RWPGs.

Texas Bays and Estuaries Program Funding

The RHWPG has adopted specific language associated with establishment of freshwater inflows to maintain the health and productivity of the bay. Galveston Bay is an important economic and recreational resource for our region. Current levels of funding within the State of Texas Bay & Estuary program are insufficient to continue the needed monitoring, study and development of management strategies for the bay.

The Region H Water Planning Group recommends establishment of additional funding to pursue necessary future efforts of the Galveston Bay & Estuary program.

Water Supply Project Financing Mechanism

The Region H Regional Water Plan includes development of several surface water reservoirs and other supply projects. The capital cost to develop these projects is significantly higher than the historic cost of water supply projects. The projected costs are such as to dissuade local communities from making a financial commitment to support future projects. These financing issues will delay the implementation of needed projects.

To address this situation, the Region H Water Planning Group supports establishment of financing methods by the State of Texas to capitalize a fund to support development of water supply projects recommended within adopted regional water management plans.

Unique Stream Segments and Reservoirs

While the RHWPG adopted both unique stream segment and reservoirs, there appears to be some confusion on the definition and legislative intent of the designations for each of these elements. It is clear that conflicts may be created for stream segments that might be used for both water supply conveyance and recreational purposes. To assist in the adoption of future unique stream segments and/or unique reservoir sites the RHWPG requests additional legislative clarification.

The Region H Water Planning Group supports clarification and definition of the legislative intent of the unique stream segments and of the unique reservoir sites.

Groundwater Availability Modeling Funding

Many areas of Region H are totally dependent on groundwater to support the long-term viability of these areas. The current Groundwater Availability Modeling effort is supported since it is the most comprehensive groundwater assessment and analysis effort of the previous 20 years. The current GAMs effort, however, is omitting minor aquifers and other groundwater considerations that are vital for certain local communities.

The Region H Water Planning Group supports continued funding for the GAMs effort, and recommends comprehensive analysis of all groundwater resources within the state.

Agricultural and Irrigation Conservation Funding

The Region H water management plan includes a number of irrigation conservation based water management strategies. It is apparent that adoption of irrigation conservation practices may benefit the irrigation and agricultural industry in addition to local communities that may take advantage of water supply savings resulting from irrigation conservation. Additionally, the RHWPG supports further research and development of water-efficient and drought-resistant crop and species.

The Region H Water Planning Group supports funding of research and development studies associated with the efficient usage of irrigation technologies and practices.

Desalination

The RHWPG considered desalination of brackish groundwater as a potential water source, but did not include it in the final plan because this strategy was more costly than other strategies. However, the RHWPG recognizes that the cost of desalination technology is decreasing, and that this strategy may merit consideration in future plans. It would be helpful and appropriate for the state to establish a program promoting

desalination research and development. Such a program might offer financial assistance or incentives for project implementation.

The Region H Water Planning Group recommends that a research and development program for desalination be established in Texas, and that it include financial assistance and/or incentives for desalination project implementation.

Water Conservation

The RHWPG strongly supports water conservation at all levels, and has incorporated it in the regional water plan as a management strategy. However, realizing advanced conservation savings in municipal county-other areas may be difficult, as these practices require some management, funding and oversight. While the RHWPG does not advocate a one-size-fits-all conservation program for the State of Texas, they recommend that the legislature address water conservation and provide some guidance and ability for county and local governments to implement these programs.

The Region H Water Planning Group supports water conservation and recommends that the legislature address and improve water conservation activities in the state.

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TASK 7 REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

7.1 Public Involvement in Developing the Region H Water Plan

The Region H approach to public involvement has been to secure early participation of interested parties so that concerns could be addressed as the plan is being developed. From its initial deliberations, the Region H Water Planning Group (RHWPG) has made a commitment to an open planning process and has actively solicited public input and involvement in developing the elements of the regional water plan. This has occurred while realizing that long-term planning, even for a topic so vital to public well-being as water supplies, does not often capture the attention of the public or the news media in a major media market. The existence of a drought in Texas for the past several years has been the most visible attraction for public attention. Nevertheless, the RHWPG has shouldered the responsibility of reaching out to communicate with the general public and especially with those segments of the population who will be most affected by the results of the regional water plan. This has been accomplished by pursuing several avenues to gain public involvement.

Regional Water Planning Group as Stakeholder Representatives

The first line of public involvement occurs through the membership of the Region H Water Planning Group. Each of the members of the RHWPG represent an interest category, such as river authority, agriculture, small businesses, general public, etc. Most of these members have organizational linkages to the community. These linkages, such as professional organizations or citizens groups, are the first avenue for taking information to the public and for receiving input to the RHWPG.

The RHWPG has met monthly on the first Wednesday of each month so that interested parties can plan to attend and follow the proceedings. Through the summer of 2000, the RHWPG has been meeting twice a month, on the first and third Wednesdays, to deliberate on potential water management strategies as well as other topics. The RHWPG maintains minutes of its meetings and places them on the Texas Water Development Board Internet website.

Joint meetings of the Region H Water Planning Group and members of neighboring planning groups aid in coordinating the work that is underway and identifying any concerns or issues that need to be addressed. A joint meeting of Regions H and I (East Texas) was hosted by Region I in September 1999. A second meeting with Region I was hosted by Region H in April 2000. Both of these meetings followed a format of brief presentations on behalf of each RWPG, and then ample time for discussion. A third joint meeting was held August 16, 2000. This meeting was hosted by Region H and included representatives from two neighboring regions: Region I and Region G.

Public Meetings during Plan Development

In addition to the July 1998 public hearing initiating the planning effort, the Region H Water Planning Group committed in its scope of work to hold a series of public meetings/hearings at four points in the planning process. All but one of these meetings was held in the evening at four locations for each series. An afternoon meeting is planned for September 2000. Meeting

formats encouraged discussion of the issues. Summaries of the meetings and lists of attendees were prepared and distributed to the RHWPG and others; they are included as an appendix to this report.

In March 1999, meetings were held in South Houston, Huntsville, West Houston, and White's Memorial Park in Chambers County. This series of meetings was held as soon as practical as an opportunity to advertise the planning effort to the public and to solicit public concerns or issues that needed to be dealt with when developing the water plan. A questionnaire was developed and distributed at this series of meetings.

In May 1999, meetings were held in South Houston, West Houston, Huntsville, and Wallisville Heritage Park in Chambers County. The purpose of this series of meetings was to present the population and water demand projections to be used in planning for Region H and to receive comments and requests for corrections or changes to the projections from attendees.

In February-March 2000, meetings were held in Huntsville, Alvin, the Greenway Plaza area of Houston, and at Wallisville Heritage Park in Chambers County. The topics of this series were available water supplies and areas with potential water shortages. Potential management strategies were introduced; environmental water needs also were discussed.

Public meetings are planned for September 2000 in Huntsville, Alvin, East Houston, and White's Memorial Park in Chambers County. This series will serve as the public hearing on the draft Regional Water Plan.

Targeted Meetings during Plan Development

Through the efforts of RHWPG members and others, meetings were held with groups who were identified as likely to be interested in the regional water plan. The agricultural community, industry, and environmental groups were targeted for meetings with presentations about regional water planning, particularly water use projections and environmental water needs. Regular interaction with and updates to the Galveston Bay Freshwater Inflow Group provided a forum for communication with the environmental, commercial and recreational fisher groups. A workshop for local governments was organized and held in May 1999 to discuss in detail the population and water demand projections on which the regional water plan is based.

Public Notices and Press Releases

Media coverage was sought in conjunction with each series of public meetings. Paid meeting notices were placed in twelve newspaper providing service to all fifteen of the counties in Region H. Press releases were sent to nine outlets in television and radio and forty outlets in the print media. Press releases also were sent to organizations that might distribute the information through their newsletters.

Region H Update

A newsletter was developed to provide summary coverage of the development of the plan. In January 2000, about 550 units were mailed to a mailing list comprised of interested individuals, organizations, and local governments. The January Update dealt with SB-1 water planning in general and projected population and water demands for the region. A second Update was prepared in June 2000. Nearly 800 units were mailed out. The issue covered available water supplies and potential designation of streams of unique ecological value. A third issue of the Update was prepared in September to provide a brief summary of water shortages and water management strategies and to publicize the public hearing on the draft plan.

Texas Water Development Board Internet Site

The Region H Water Planning Group has taken advantage of the Internet site provided by TWDB on its home page (www.twdb.state.tx.us). Upcoming meetings, minutes of previous meetings, and contact information are posted. A copy of the Draft Region H Water Plan was posted on the TWDB site as well.

7.2 Summary of Public Meetings, March 1999

During March 1999, public meetings were held in the evening at four locations in Region H. Since Region H is a large region, the locations were selected to provide as convenient as possible access to the meetings for members of the interested public. Sites selected were: San Jacinto College-South (Houston and south); Bear Creek Park (Houston and west); White Memorial Park (east) and Walker County Courthouse (north). Paid meeting notices were placed in 12 newspapers in the region; press releases were sent to 42 papers, as well as radio and television stations. Region H Planning Group members also assisted by advising interested groups of the meetings.

The purpose of the meetings was to provide an update on Region H water planning and to get from attendees any of their interests or concerns about water supply in the region so issues can be dealt with up front rather than after the technical work is done.

Each of the meetings followed a similar format:

- Ms. Callaway opened the meeting and covered any necessary logistical information for that site, mentioned the questionnaires, and gave the format anticipated;
- Introductions were made;
- Mr. Taylor gave a slide presentation orienting attendees to the Senate Bill 1 planning process, Region H, and the water planning tasks;
- Questions were taken on Mr. Taylor's presentation;
- Comments were heard from those registering to speak;
- General discussion was pursued as time or interest of attendees allowed.

Comments received at those meetings are summarized below. Transcripts of the meetings are available upon request to the San Jacinto River Authority, the City of Houston, or Ekistics Corporation. Presentation slides are at Appendix A.

On the 8th of March, a total of 17 people attended the meeting at **San Jacinto College-South**. Of those, 6 were not Planning Group or consulting team members. One person made formal comments. He presented two issue areas of concern: the need for ***conservation and wise use of water***; and the need for ***freshwater inflows for the Galveston Bay Estuary*** in order to preserve its ecological health and productivity.

On the 9th of March, 22 people attended the meeting held at the Texas Agricultural Extension Service facility at **Bear Creek Park**. Twelve of those were members of the interested public. Initially, only one person registered to speak, but after her comments, two others asked to speak. Issues raised were: the needs for ***instream flows and freshwater inflows for Galveston Bay*** and for those needs to be taken into account up front rather than after the fact; the need to ***consider environmental water needs while planning for residential and other uses to avoid unintended consequences*** (citing lessons to be learned from the Everglades); the need to **find a balance that maximizes ground water use relative to surface water use to achieve the lowest cost and leave as much surface water as possible for other uses**.

On the 11th of March, 39 people attended the meeting held at **White Memorial Park** near Anahuac in Chambers County, including a number of elected officials. There was also a lively discussion and question and answer period. Issues raised during discussion were: (1) Once the plan is developed and water management strategies identified, then projects to develop water and to seek funding with the TWDB have to be consistent with those strategies identified in the plan. This also applies to TNRCC permitting for water diversions and amendments to water rights permits. (2) Chambers and Liberty Counties are concerned about a perceived underrepresentation of their interests relative to the northern and more populous parts of the region. When vacancies on the Planning Group occur, they would like to have residents considered for appointment.

Four persons registered to make formal comments. In addition, written comments were submitted on behalf of a fifth person. Comments and issues raised were: The oyster industry in Galveston Bay is dependent on ***freshwater inflows to the bay***, and recommends that the Region H Planning Group adopt the Texas Parks and Wildlife Department's recommended 5.2 million acre-feet of water per year as the target amount of needed inflows. Inflows should be of the same or similar quality and arrive on the same schedule as water that has historically come into the bay. ***Dams interfere with transport of sediment and nutrients*** which alters the quality of inflows.

Planning Group should recognize that Galveston Bay is not only a major oyster farming area, but a massive recreational area used by the population of the entire state. ***Dynamics of freshwater inflows*** need drawdowns in the rivers and their floodplains so vegetation can grow, then floods flush these nutrients out into the bay. Just having water flow down a normal river bed is not going to keep the bay healthy and the food chain going.

Projections of population and water demand are massive data sets, and the public needs time to understand and review them for errors. There is concern that Chambers and Liberty Counties have sufficient water supply, but ***if future demands are not documented the water will be used to meet shortages elsewhere***.

Planning Group should consider that ***Devers Canal***, owned and run by farmers (about 27,500 or 30,000 in 2007), ***has applied to TNRCC for additional water rights***. ***Farmers will need additional water, but can't project farming to 50 years.*** Concerned that water will move from east to west because ***representation on Planning Group is from the west***.

Attendees confirmed that White Memorial Park is a good meeting location for the eastern part of Region H.

On the 18th of March, 35 people attended the meeting held at **Walker County Courthouse** in Huntsville, including a number of elected officials. Walker County Judge Wagamon welcomed participants. No one registered to make formal comments; however, there were questions that suggested issues for consideration. (Please note that questions were being posed from the floor with attendant difficulty in recording.) These were:

(1) A concern that **contaminated surface water might contaminate ground water.**

(2) Questions about **reservoir reclamation** and about rights and practices with regard to reservoir-front property owners specifically relating to Lake Livingston. Answered by manager of Lake Livingston.

(3) Question about the portion of **water in Lake Livingston owned by the City of Houston that is now being used**. Responded to by Lake Livingston manager: 55% being used now of 70% owned by City of Houston.

(4) Question about **historical lake drawdown**. Answer: Lake Livingston level declined 5-3/4 feet in 1988.

(5) Question about **drawdown if Houston takes 100% of their water** during a drought. Answer: with a drought as in the '50s, Lake Livingston would be a channel. Lake Conroe would be the same way. Without a 7-year drought, that's not going to happen. Both Livingston and Conroe are water supply reservoirs, rather than flood control or recreational facilities.

(6) Question of whether planning effort will **address recreation uses** as well as drinking water. Response: Water supply is the main focus, but RWPG member Steve Tyler is interested in the issue of recreational water use and has already asked that it be included in the study. The socioeconomic effect on recreation of not meeting water demand will definitely be illustrated.

(7) Question about **population projections cited by Ernie Rebuck** at an earlier meeting. Response by Rebuck: Texas population expected to double by 2050.

(8) Question about using **return flows to recharge an aquifer**. Taylor pointed out the importance of return flows from the Dallas region to Lake Livingston. Seifert added that the part of agricultural return flows containing chemicals that might seep into the ground are filtered out before they reach an aquifer used for water supply and probably are not a problem. In the case of artificial recharge, water is treated to drinking water standards before it is pumped back into an aquifer.

(9) Question about **recent publicity about drought**. Answer: There is a real drought situation from the Edwards Aquifer west. A speaker from the audience noted that testimony before a legislative committee had stated that soil moisture conditions west of the Edwards were drier than last year.

(10) Follow-up question about **reservoir reclamation** to increase capacity and possibility of selling dredged soil for fill or farming. Answer: Reservoir reclamation is not currently in the scope of planning work because experience has indicated that dredging sediment out of a reservoir is not cost effective. The chemical makeup of dredged materials might be useful for some purposes if the cost of removing and hauling them were not so high. Hydrologic studies of Lake Conroe indicate that siltation has claimed only 13,000 acre-feet of storage. Lake Livingston has lost only 4-1/2 percent volume over 30 years, less than had originally be projected. Some areas near creeks in the upper part of the lake have had more siltation.

(11) Question about **12 reservoirs proposed in Trinity River Master Plan.** Answer: The 1997 State Water Plan included only 8 proposed reservoirs statewide. In Region H, only Allen' s Creek on the Brazos River was in the Plan. A comment was made that Bedias Creek might still be viable, but that Tennessee Colony is not. A comment was made that more reservoir projects should be built. Adams recounted the cost of water for Lake Conroe in 1970 ($300 per acre-foot) and the proposed Lake Creek Reservoir in 1990 ($4500 per acre-foot) indicated why reservoirs are not being built. There were several comments about added costs and delays because of environmental concerns.
(12) Question about whether it would be better to have a few deep reservoirs rather than several shallow reservoirs because of **evaporation**. Response: The topography here makes deep reservoirs difficult. The average depth of Lake Livingston is 22 feet. Adams contributed that the evaporation out of Lake Conroe was 70-100 million gallons a day in the summer, and could go up to 180 million gallons per day.
(13) Comment from Southeast WSC illustrating **costs and delays** on expansion project stemming from concerns about **endangered species**: fruited sand verbena, Navasota lady's tresses, and the Houston toad. Project has been delayed 5 years and costs at $3.5 million are more than double initial investment of WSC. Response: Some mitigation demands are extortion, but need to give some credit to environmental folks. The State has never allocated water for instream needs or for bay and estuary needs. There is a very productive bay at the bottom of the San Jacinto and Trinity Rivers that needs to be protected given all the population growth expected in the next 50 years. We need to take care of our streams. Texas Parks and Wildlife is doing a good job of that. This study will take those needs into account.
(13) Follow-up comment on **reservoirs**: This planning effort has divided the State into 16 regions to look at water needs taking into account the environment, agriculture, industry. There is specific language directing the project to look at reservoir sites. If new reservoirs are needed, the sites can be set aside so that will be available.
(14) Comment: First you need to do **conservation**. Then you look for new sources.

Callaway stated that SB1 water planning is to take all these factors into account up front so at the end we don't have projects that face obstacles that will cost more time and money and not have the water we need. Attendees supported continued use of the Walker County Courthouse for future meetings.

Table 7-1: Attendance at Public Meetings, March 1999

8 March 1999, San Jacinto College-South, Houston

Interested Public
Ruth Anderson, Houston
Steven Anderson, GBEP, Webster (Speaker)
Carole Baker, Subsidence District, Friendswood
Jace Houston, Subsidence District, Friendswood
Charles Johnson, Dow, Freeport
Tom Michel, Subsidence District, Friendswood

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
John Bartos, GBF, Houston
Jack Harris, Brazoria County, Pearland

Region H Water Planning Group Members (continued)
Carolyn Johnson, Dow-TCC, Freeport
James Murray, Exxon, Baytown
Ron Neighbors, Subsidence District, Friendswood
Fred Perrenot, City of Houston, Houston
Lance Robinson, TPWD-Coastal Fisheries, Seabrook (alternate)

Consulting Team
Glenda Callaway, Ekistics Corporation, Houston
Mark Lowry, Turner Collie & Braden, Houston
Jeff Taylor, Brown & Root, Houston

9 March 1999, Bear Creek Park, Houston (west)

Interested Public
Bobby Adams, Turner, Collie & Braden, Houston
Wayne Ahrens, Spencer Road PUD, Houston
Dan Freeland, H2O Consulting, Houston
Chris Hoffman, H2O Consulting, Houston
Ryan Johansen, Johnson, Radcliffe & Petrov, Houston
Gordon Landwormeyer, Spirit of North Harris County, Houston
Alan Rendl, Spirit of North Harris County, Houston (Speaker)
Pamela Rocchi, Harris County Pct. Four, Spring
Linda Shead, Galveston Bay Foundation, Webster (Speaker)
Andy Sturbenz, Brown & Root, Houston
Ray Zobel, Cypress Creek United Civic Assn., Tomball (Speaker)
Karen Zurawski, This Week, Houston

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Roosevelt Alexander, Brookshire
Robin Green, City of Houston, Houston (alternate)
David Jenkins, Stowell
Jack C. Searcy Jr., Spirit of North Harris County, Houston

Consulting Team
Glenda Callaway, Ekistics Corporation, Houston
Becky Olive, Turner Collie & Braden, Houston
John Nelson, LBG-Guyton Associates
John Seifert, LBG-Guyton Associates
Jeff Taylor, Brown & Root, Houston

Table 7-1: Attendance at Public Meetings, March 1999 (continued)

11 March 1999, White Memorial Park, Anahuac

Interested Public
Bobby Blake, Liberty County & City of Liberty, Liberty
John Cheesman, Anahuac (Speaker)
C. B. Cone, Trinity Bay Conservation District, Winnie
Norman Dykes, City of Liberty, Liberty
Bobby Edwards, Stowell
W. S. Edwards, rancher/farmer, Stowell
Judy Edmonds, Chambers Co. Commissioner Pct. 2, Anahuac
Sue Hawthorne, Anahuac Progress, Anahuac
Mark Huddleston, Chambers Co. Commissioner Pct. 1, Winnie (Speaker)
Buddy Irby, Chambers Co. Commissioner Pct. 3, Mont Belvieu
Guy C. Jackson III, Coastal Oyster Leaseholders Assn., Anahuac (Speaker)
Guy Robert Jackson, Anahuac Chamber of Commerce, Anahuac
John W. Jenkins, TRA/farmer, Hankamer
Jim Kirkham, farmer, Anahuac
Lloyd Kirkham, Liberty County Judge, Liberty
Mike Kubik, Chambers County, Anahuac
Maurice Locke, TRA, Liberty
Ben H. Nelson, Smith Point (Written comments)
Jerry Sparks, Winnie Area Chamber of Commerce, Winnie

Interested Public (continued)
Cynthia Stevenson, GBF, Houston
Don Stevenson, Houston
Michael Van Dyke, City of Liberty, Liberty
Bill Wallace, Chambers Co. Commissioner Pct. 4, Baytown
Jean Wallace, Chambers County, Baytown
Kay Willcox, Anahuac
Pudge Willcox, CLCND, Anahuac (Speaker)
Laura Yarbrough, USDA-NRCS, Anahuac
Billy Yarbrough, farmer, Liberty

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
John Bartos, GBF, Houston
James Murray, Exxon, Baytown
David Jenkins, Stowell
Michael S. Sullivan, Houston
Ernest Rebuck, TWDB, Austin

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
John Nelson, LBG-Guyton Associates
Jeff Taylor, Brown & Root
Ann Wood, Brown & Root

Table 7-1: Attendance at Public Meetings, March 1999 (continued)

18 March 1999, Walker County Courthouse, Huntsville

Interested Public
Herschel Brannen, Trinity Farm Bureau, Trinity
Lee Brooks, First National Bank, Trinity
Pauline Coburn, RSWC, Huntsville
Jeff Coburn, Huntsville
Debra Daugette, City of Huntsville, Huntsville
Charles Elliott, Trinity
Tom Ferguson, Camp Olympia, Trinity
H. O. Halloais, Midway
Scott Heini, Trinity
Thomas A. Leeper, Huntsville
Phillip Morrison, Trinity
Richard Nira, The Huntsville Item, Huntsville
Johnny Poteet, City of Huntsville, Huntsville
Jim R. Sims, Trinity River Authority, Huntsville
Neal Smith, Trinity City Council, Trinity
Wayne Sorge, KSAM radio, Huntsville
Michael Straughan, The Huntsville Item, Huntsville
Charles S. Wagamon, Walker County Judge, Huntsville
Billy Jack Walker, Trinity City Council, Trinity
Julian Weslord, Trinity
Eugene West, Lake Livingston Tourism Council, Trinity
Frederick M. Weiwzieke, Riverside
Steve Widner, City of Huntsville, Huntsville
Boyd Wilder, City of Huntsville, Huntsville

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Robert Bruner, Huntsville
Mark Evans, Trinity County Judge, Groveton
Jeff Henson, TPWD, Bryan (alternate)
Ernest Rebuck, TWDB, Austin
William Teer, Southeast WSC, Centerville
Steve Tyler, Trinity

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Jeff Taylor, Brown & Root

7.3 Summary of Public Meetings, May 1999

During the week of 10 May 1999, Region H hosted four public meetings on successive evenings. Since Region H is a large region, four locations were selected to provide as convenient as possible access to the meetings for members of the interested public. San Jacinto College-South (Houston and south); Bear Creek Park (Houston and west); and Walker County Courthouse (north) were repeated as meeting sites. White Memorial Park, which had been used as the meeting site for the eastern part of the Region in the first round, was reserved for school related activities in May and was not available. Wallisville Heritage Park allowed us to meet there.

The purpose of the meetings was to present the population and water demand projections to be used in planning for Region H and to receive comments and requests for corrections or changes to the projections from attendees. The meetings also served as an opportunity to provide an update on Region H water planning and to elicit any concerns attendees have about planning for water supply in the region. Meetings were relaxed, with questions and discussion encouraged.

Each of the meetings followed a roughly similar format:

- Ms. Callaway opened the meeting and introductions were made;
- Mr. Lowry gave a slide presentation on Region H population and water demands;
- Questions were taken during and after Mr. Lowry's presentation;
- Comments were heard from those registering to speak;
- General discussion was pursued as time or interest of attendees allowed.

Comments received at those meetings are summarized below. Transcripts of the meetings are available upon request to the San Jacinto River Authority, the City of Houston, or Ekistics Corporation. Presentation slides are at Appendix B.

On the 10th of May, a day with severe thunderstorms and localized floods a total of 12 people attended the meeting at the Texas Agricultural Extension Service facility at **Bear Creek Park** (which is located in a flood control reservoir). Of those, 3 were not Planning Group or consulting team members. One person made formal comments. She expressed concern that environmental water demands were not present in the data set and pointed out the need for ***environmental flows for wildlife, forests, marshes and the bays.*** She pointed out the ***value of ecotourism to the economy*** (and later submitted a newly completed guide to the Great Texas Coastal Birding Trail for the Upper Coast and reports discussing the economic value of birding). She applauded the attention being given to ***rice irrigation demand***, and pointed out the use of some rice fields as wildlife habitat. She also discussed the need for ***more water conservation*** and encouraged local government to take an active approach and pass ordinances to prevent waste of water.

Responding to a question, Lowry pointed out that water demand with "expected conservation" is based on a law passed in 1991 mandating low flow plumbing fixtures and current requirements for water conservation plans. "**Advanced conservation**" will require additional efforts, and will be looked at as a management strategy in Region H water planning. In response to another question, Taylor pointed out that "**conservation pricing**" (higher prices for water) could also be

a viable advanced conservation measure. Taylor also pointed out that environmental water needs will be taken into account in the analysis of available water supply.

On the 11th of May, 23 people attended the meeting held at the **Walker County Courthouse** in Huntsville; 12 of those were members of the interested public. No one formally registered to speak; however, questions and discussion were forthcoming.

One question was whether the Texas State Data Center based its estimates on studies within each county. Lowry responded that the ***Data Center methodology*** involved sampling, but that information from all the counties was used.

In response to a question about water for cattle, Lowry said that there is a slight increase in ***water for livestock*** over time, but it is a very small percentage of the total water demand.

The mayor of Huntsville voiced a concern about ***how the numbers would be used, how they would affect the city***, and wanted to know if ***water would be allocated*** according to these numbers. Lowry responded that the Texas Water Development Board (TWDB), in making loan and funding decisions, and the Texas National Resource Conservation Commission (TNRCC), in making permitting decisions, would look to the Regional Plan to determine if the requested action was consistent. He pointed out that an applicant could always provide data to justify a change from the Regional Plan. It was further pointed out that the Plan would be reviewed and updated every five years. It was also stated that the TWDB would be using the sum of the regional plans' projections to determine the water supply facility needs for the State. Everyone agreed that projections for larger aggregated areas (such as the State or the Region) would likely be more accurate than those for the smaller areas (such as small cities). On follow up, Lowry responded that Region H would not be using its plan to allocate existing water; it is focussing on how to meet any identified water shortages.

A question was raised about an ***application by Dallas and Fort Worth to reuse their wastewater***, reducing the flow downstream. Lowry responded that there is considerable debate over proposals to reuse wastewater that has been returned to a stream, most of which is treated to a high, though not potable, quality. Rebuck pointed out that the 1997 Water Plan estimated that by 2030 about 10% of the water use in the Trinity Basin would be recycled water. Lowry added that even when water is reused, a portion is generally discharged back into a stream. The TNRCC will look at downstream impacts before they act on reuse applications.

A follow up to earlier questions was a concern about ***how the Regional Plan would affect applications for funding*** of things such as expanding a water plant if the Regional Plan didn't indicate a need, but the water plant owner had the water demand. Lowry reiterated that evidence of actual growth would be compelling. He said that a conflicting long term projection might be more difficult to support. Rebuck added that the Plan will be updated at five year intervals and that a process for amending at any time has been provided. Callaway added that the SB-1 planning process and the RWPGs continue beyond the initial planning phase. Lowry concluded that the current projections are a base from which to start and illustrate the type of data that will be needed if someone wants to change the projections.

On the 12th of May, 25 people attended the meeting held at **Wallisville Heritage Park** in Chambers County; 18 of those were interested public. There was a lively discussion centering on the need to incorporate information on ***freshwater inflows*** from the Trinity and San Jacinto Rivers and the ***value of the estuary, including the value of Gulf of Mexico*** catch and recreational use that is dependent on the estuary, into the plan. It was recommended that ***National Marine Fisheries Service data*** be sought. Lowry assured attendees that data is being sought from all quarters.

It was clarified that the comment period closing on 21 May applied only to the population and water demands that are the subject of this meeting. It was noted that a ***one-page schedule of steps in the Region H planning process*** would be helpful.

A question was raised as to how ***environmental water needs*** could be raised to equal priority with agricultural, municipal and industrial needs since that water demand category doesn't exist. Lowry said that this plan will look at the socioeconomic impact of not meeting needs such as environmental needs.

In response to questions he said this planning process will not be making ***water allocations***, nor is it regulatory. The planning process will try to determine how much water is needed, how much is available, and if there are shortages, how they can be overcome.

There was discussion of need for a ***socioeconomic study of the Galveston Bay/Trinity Bay ecosystem***. Callaway said several studies related to value of the bay system had been done, but not a comprehensive study of the value of the bay, and that would not be done as part of Region H planning, which will be using available data.

There was a comment that you could look at water supply and subtract from that supply for uses such as estuaries to arrive at an ***"available" supply*** and then match that to the water needs such as agricultural, municipal and industrial to determine if there is a deficit and then look at alternatives. This is the process that is being followed.

There was a comment that ***population growth*** could eventually lead to a situation where no more growth could be achieved without tapping into water needed for estuarine maintenance. The opinion was voiced that the human population would always win. Another attendee pointed out that without the ***SB-1 planning process and these meetings***, the only people who would have access to the projections would be the "guys in the planning department," rather than rural people or the oyster industry. It was asked if the ***assumption*** was that there would be absolutely ***no population control or population growth planning*** of any kind. Lowry responded that he was not aware of any specific controls for limiting population. The TWDB projections do consider available land area for development or for redevelopment at higher population densities as a limiting factor. Lowry offered the opinion that putting the projections and economic impact numbers on the table will result in better decisions.

It was pointed out that ***changes in technology*** can result in huge changes in the projections. The example of decline in industrial water use following EPA mandated changes in treatment of cooling water was given.

There was a question about the impact of the Wallisville Saltwater Barrier on releases from Lake Livingston; would it cut off all flow. Lowry said there would be a determination made of the ***freshwater inflow needs***, which may or may not be as high as the amount of water needed to keep the saltwater back; there would be some flow.
A comment was made that ***back room deals*** would be in control. Another comment was made about the Galveston Bay Freshwater Inflows Group working on the problem of how much, when and where freshwater inflows are needed. Putting that information out in the open makes it more difficult to do the back room deals. Another commentor pointed out that attending these meetings was important: to say that the bay's needs are important. Callaway responded that transcripts of the meetings are being made and summaries distributed to let the Regional Water Planning Group and others know what attendees think is important.

The issue of ***water reuse in the upper basin*** and its potential impact on the downstream area was raised. Lowry pointed out that TNRCC would be looking at downstream impacts when considering applications for reuse.

There was a comment opposing ***transbasin diversions***. Rebuck commented with respect to the Sabine River and Toledo Bend Reservoir, which was a state participation project. The State put in half the money; payback of that money was based on two things: hydroelectric power and water supply. Well there is no water supply, because the wilderness people had enough political force to stop that part. The contract was rewritten to be based strictly on hydroelectric power.

There was a question about the percentage reduction in demand that is allowed for in the "***expected conservation***" case. The comment was made that nationally about 10% reduction could be achieved by things such as low flow plumbing fixtures; that should be an expected amount. The suggestion was made to take a closer look at what could be done to achieve aggressive or advanced conservation savings. Lowry said that would be looked at in the management strategies. A discussion of lawns and watering followed. A comment was made that 10% conservation savings on municipal use wouldn't have a significant impact on water needed for estuarine maintenance. Lowry responded that depended on the size of the population. The opinion was expressed that not wasting resources is a mind set our nation needs. Lowry agreed that 10% conservation off peak day use could make a significant difference in the amount of plant needed.

A question was raised about whether it is assumed that all the municipal water in ***Liberty County*** is provided by ***groundwater*** through 2050. Lowry responded that groundwater supply is being assessed. If groundwater is sufficient and of reasonable quality, then it would be assumed that Liberty County would stay on groundwater. If groundwater is not sufficient, then we'll be looking at management strategies. It might be possible for a larger city to increase its use of surface water so that Liberty County can continue to use groundwater.

Specific comments on the population projections and water demands were: (1) Anahuac is two square miles with a lot of public land in it. It is surrounded by the Trinity Bay Conservation District, which performs the same services--water and sewer. Anahuac will not get any bigger geographically, and probably won't see much population growth. (2) Why does Galveston County Other grow until 2050 and then drop off to 18,000 people? (3) Clear Lake Shores in Galveston County is basically an island, but is expected to almost triple in population; that doesn't seem realistic.

One formal comment was made on behalf of the Galveston Bay Estuary Program: supporting the ***maintenance of freshwater inflows*** to preserve habitat, and a request to consider the ***quality of waters returned to the Bay***.

There was a question about the ***definition of "mining"*** for Region H. Lowry responded that mining is an activity that involves the development of mineral resources and may require the use of water for extraction purposes or for washing of whatever mineral it is. It could be coal, sulfur, limestone, gravel. In response to a question about the amount of water allocated to mining, Lowry said that in some cases water had to be pumped out of the aquifer to allow the mining to take place. In that case, return flow to a stream was probably near 100%, but it was a withdrawal from the aquifer.

Sullivan said that one indicator that the Planning Group cares what those in the eastern part of the region think is the fact that one of the four meetings being held in the entire Region is being held in Chambers County. He suggested that people in the eastern part of the region may have more political support than they realize, and requested that they continue to participate in the planning process.

On the 13th of May, 13 people attended the meeting at ***San Jacinto College-South***. Of the eight members of the interested public, six were first time attendees. Responding to a question, Lowry said that ***growth*** in Fort Bend County might be expected to ***"taper off"*** eventually as population density increases and available desirable land is developed. Using the example of a utility district, Lowry said they typically experience rapid growth for 10-12 years, and then much slower growth as they approach full build out. He pointed out that cities have the ability to annex, so this tapering off of growth is less easy to see in the projections than it is for counties. The comment was made that as growth in the more populated areas slows down, it will move out to the less populated areas such as Madison County. Taylor added that this phenomenon is captured in the analysis of in- and out-migration for each county.

A question was raised about projections for the City of Pearland. (It was noted that city projections are allocated to each of the counties in which they are located.)

Responding to a question about ***manufacturing water demand***, Lowry said that most large manufacturing is handled separately from the projection of population. Small commercial or manufacturing operations that receive their water from a municipal facility may be reflected in higher per capita water usage for those areas. Lowry noted that Butch Bloodworth of the TWDB

would be speaking about industrial demand at a meeting next week hosted by the Chemical Manufacturers Association.

Asked about the cause of ***higher water usage under the "below normal rainfall condition,"*** Lowry responded that it was primarily landscape irrigation. Although he did not have on hand an exact percentage difference in use, Lowry said it is not a large amount, but that the increased use occurs when a system is already taxed. Taylor pointed out that a "drought" condition is a worse case than "below normal", and that drought is used to determine safe yield of surface water reservoirs.

A comment was made that ***water from rice fields*** if usually pretty clean and ***could be reused***. It was noted that agriculture is experiencing the same kind of movement to the outlying counties as is growth.

There was discussion of the ***schedule*** for submitting population and water demand projections to TWDB for approval.

On question about the ***authority of the TWDB***, Callaway responded that their primary responsibilities are statewide planning and financing for water related projects. In answer to a follow up question, Taylor said that TNRCC permits water use.

The comment was made that TNRCC would eventually by default ***control population and development*** in the state, giving the analogy of sewer permits determining where growth could occur in a city. California was cited as an example of growth being water limited. Taylor said that was an elected official policy discussion. In his opinion the mind set in California is different from that in Texas. In Texas, he sees the likelihood that when total water demands are determined -- including environmental or recreational flows -- Texas will do something to obtain that amount of water. In California, public policy decisions made over the last 20 or 30 years have left them without enough water to meet demands for the next 15 years.

A comment was made that huge ***technological advances*** have occurred in seawater ***desalinization***. As a result, desalinization is much more economical. Citing a Tampa contract recently bid, the cost of water from desalinization had dropped from $6.00 per thousand gallons three or four years ago to $2.00 per thousand gallons today. There was agreement that such technological changes would change all the equations. Given that, it was stated that interbasin transfers would not occur. Lowry pointed out that transportation was a big part of delivered cost, so desalinization would probably not supply Dalhart. Another speaker said that it might be as easy to desalinate in Freeport and pump it to Houston as to move water from Toledo Bend to Houston.

Lowry commented that water could then be moved from ***Toledo Bend*** to somewhere closer to them. Taylor said East Texas is realizing that it has a renewable resource that they could receive some compensation for if they let the process work. They're going to see that communities like Houston, Dallas and Fort Worth are going to go other places and get the water they need.

Another speaker commented that there is still a mind set in East Texas that they've got the water, so eventually people will come to them rather than to Houston.

There was a comment from a representative of a committee in Brazoria County that is looking at long range problems noting that water supply was one-half of their water problem but the other side was peak discharge (or ***flooding***). He suggested that managing flood flows might provide additional local water supply. He added that the drainage district commissioners were not involved in or knowledgeable about Region H planning. Lowry pointed out that the charge to the RWPG was to develop a plan for supply of water rather than removal of water. Commissioner Harris noted that Brazoria County was about to begin developing a county-wide drainage plan to address some of those concerns.

Table 7-2: Attendance at Public Meetings, May 1999

10 May 1999, Bear Creek Park, Houston (west)

Interested Public
Pamela Rocchi, Harris County Pct. Four, Spring
Page Williams, Sierra Club
Ray Zobel, Cypress Creek United Civic Assn., Tomball

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Roosevelt Alexander, Brookshire

Region H Water Planning Group Members (continued)
John Bartos, Galveston Bay Foundation, environmental
Ron Hudson, City of Houston, Houston

Consulting Team
Glenda Callaway, Ekistics Corporation
Becky Olive, Turner Collie & Braden
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Jeff Taylor, Brown & Root

11 May 1999, Walker County Courthouse, Huntsville

Interested Public
Debra Daugette, City of Huntsville, Huntsville
Charles Elliott, Trinity
Don Farris, Madison County Commissioner, Midway
Leigh-Anne Gideon, Huntsville Item, Huntsville
Bill Green, Mayor, City of Huntsville
Mack Hurd, Westwood Shores MUD, Trinity
Mike McClurg, Trinity Chamber of Commerce, Trinity
Mrs. Mike McClurg, Trinity
Tim Paulsel, Walker County Commissioner, New Waverly
Jim R. Sims, Trinity River Authority, Huntsville
Mrs. Teer, Centerville
Frederick M. Weiwzieke, Riverside

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Robert Bruner, Huntsville
Mark Evans, Trinity County Judge, Groveton
Jeff Henson, TPWD, Bryan (alternate)
Ernest Rebuck, TWDB, Austin
William Teer, Southeast WSC, Centerville
Steve Tyler, Trinity

Consulting Team
Glenda Callaway, Ekistics Corporation, Houston
Mark Lowry, Turner Collie & Braden, Houston
John Seifert, LBG-Guyton Associates
Ann Wood, Brown & Root, Houston

Table 7-2: Attendance at Public Meetings, May 1999 (continued)

12 May 1999, Wallisville Heritage Park, Wallisville

Interested Public
Steven M. Anderson, Galveston Bay Estuary Program, Webster
H. M. Carleton, Wallisville
M. T. Carleton, Wallisville
Sue Hawthorne, Anahuac Progress, Anahuac
Guy C. Jackson III, Coastal Oyster Leaseholders Assn., Anahuac
Tom Michel, Subsidence District, Friendswood
Harris Miller, Trinity Bay Conservation District, Anahuac
Ben H. Nelson, Smith Point
Joe Nelson, Smith Point
Sammy M. Ray, Texas A&M-Galveston
Linda Shead, Galveston Bay Foundation, Webster
Jim Stansel, Texas A&M-Beaumont
Cynthia Stevenson, GBF, Houston

Interested Public (continued)
Vernon Turner, Trinity Bay Conservation District, Anahuac
Kay Willcox, Anahuac
Pudge Willcox, CLCND, Anahuac
Laura Yarbrough, USDA-NRCS, Anahuac
Billy Yarbrough, farmer, Liberty

Region H Water Planning Group Members
David Jenkins, Stowell
Michael S. Sullivan, Houston
Ernest Rebuck, TWDB, Austin

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Doris Davis, Brown & Root

13 May 1999, San Jacinto College-South, Houston

Interested Public
Steven Anderson, GBEP, Webster
Don Braddock, Chocolate Bayou Water Co., Alvin
Jace Houston, Subsidence District, Friendswood
Leo Jaehnig, Chevron Chemical Co., Baytown
Mike Palmer, Brazoria Co. Ag. Ext., Alvin
David W. Plaisance II, Clear Lake City Water Authority, Houston
Joseph L. Slack, Lake Jackson
R. E. Tillman, Brazoria Co. Ag. Ext., Angleton

Region H Water Planning Group Members
Jack Harris, Brazoria County Commissioner, Pearland
Jarrett O. Woodrow, TPWD, Houston

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
Jeff Taylor, Brown & Root

7.4 Summary of Public Meetings, February 28 – March 2, 2000

During the period February 28 – March 2, 2000, four public meetings were held by the Region H Water Planning Group (RWPG) to inform the public of progress in developing a regional water plan and to receive public comments. Meetings were held at widely dispersed locations to provide maximum accessibility to the residents of the region. The meetings are summarized briefly below. The presentation slides and handouts from these meetings are at Appendix C.

Walker County Courthouse, Huntsville, 28 February 2000

The Walker County meeting was not as well attended as in the past. Judge Wagamon said that the Texas Department of Transportation was holding a public meeting at the same time on important highway improvements.

After a brief presentation by Jeff Taylor, several speakers discussed the demand indicated in the Texas Water Development Board (TWDB) database for a power plant. It was noted that the plant could be one that settled in Grimes rather than Walker County or could be one that was proposed but has not yet materialized. Taylor suggested that the importance for water planning is that without that plant, groundwater likely is sufficient to meet future water demands in Walker County. If there is a power plant, a management strategy for additional surface water supplies will be needed.

There also was a discussion of the definition of "non-municipal." Taylor explained that it is a demand not associated with a city, such as manufacturing, irrigation, mining, power and livestock. He suggested each of the attendees pick up the handouts for each of the 15 counties. The handouts contain all of the water use groups in that county and then the non-municipal categories that show water shortages.

As Taylor presented the analysis of freshwater inflow needs, he responded to a question about the meaning of "MaxH". He said that MaxH stands for the maximum fisheries harvest to be achieved if everything is done right, a quantity of about 5.2 million acre-feet per year (maf/yr). Historically, the bay has received this amount about 66% of the time. The Galveston Bay Freshwater Inflows Group (GBFIG) has recommended that if the MaxH flow could be accomplished at least 50% of the time, then that would be acceptable. He noted that the historical average inflows are 10 maf/yr and the historical minimum flow is about 1.8 maf/yr. He added that it's important to define not only how much, but the quality, seasonality and the locale of freshwater inflows into the bay.

Taylor then introduced the work to be done on management strategies to meet water shortages and sketched out the remaining schedule for preparing the draft regional water plan. He noted that comments or questions on any of the items from this meeting could be directed to Mr. Adams by April 1.

Taylor asked whether and how the drought affects livestock ranchers in Leon, Madison and Walker counties. He noted that the demand and supply numbers suggest that there is not problem in those counties. He said that the planning team needs to know if that is an issue.

Mr. Teer noted that the drought does have a very comprehensive effect on the cattle industry in Leon County, even though there is ample water available. Ranchers are dependent on natural rainfall to supply the stock ponds and to irrigate the pastures. They can't afford the groundwater.

Taylor responded that that's the type of message that a legislature needs to hear. That was one of the purposes of doing Senate Bill 1 planning at the local level. He said that there are few existing mechanisms to fund building groundwater supplies to service the livestock industry. However, he noted that doesn't mean it must be that way tomorrow. If that's the issue, if there is available groundwater and it's just a function of paying to get it to the end users, the cattle industry, that that ought to be noted in the plan.

An unidentified speaker commented that it sounds as if the water is needed for more than stock ponds. Mr. Teer clarified that ranchers need to grow the feed, the hay, and not everyone is equipped to irrigate their pastures and certainly can't afford public water. An unidentified speaker commented that during the last drought of record, many small cattle ranchers just got out of the business. Taylor said that if the State of Texas defines maintaining that industry as an important enough goal, then maybe funds can be found to accomplish that goal.

Callaway asked for an explanation of what was happening to uncommitted groundwater shown on the table for Fort Bend County. Taylor said that this anomaly was being caused by fluctuations in irrigation water demand, but that it did not represent a large amount of water. He noted that while Fort Bend has been considering a groundwater conservation district, these numbers do not assume that district exists. If that district is created and passes regulations restricting groundwater availability, then the water shortages indicated would increase.

Mr. Stout commented on the difficulty of increasing groundwater withdrawals in an area already experiencing subsidence. He noted that it would also be difficult to build a bunch of reservoirs. Taylor said that he was not going to presuppose the answer on management strategies, but that it ought to be possible to increase groundwater withdrawals in some areas and for some time periods. Mr. Adams added that Region H is looking at areas in which groundwater has not been mined in the past. As an example, Taylor said that the numbers show that The Woodlands has a shortage in the year 2050 of about 2 MGD, so if the decision were made to pump groundwater an additional 2 MGD, The Woodlands would have enough water. However, the County of Montgomery, has a shortfall of 52,000 acre-feet, or roughly 50 MGD, which is a significant shortage. He said that rather than looking just at The Woodlands, the RWPG needs to look at the county as a whole.

Nolan Ryan Center, Alvin, 29 February 2000

The Nolan Ryan Center was a new meeting site for Region H, and proved to be a popular location. The Alvin meeting had the highest attendance of the four meetings, and a large number

of attendees had not previously attended a Region H public meeting. Brazoria County Commissioner Harris opened the meeting.

Jeff Taylor began with a brief description of Region H water planning and the Senate Bill 1 process. He noted that handout materials provided details of his presentation on the analysis of water supply and demand for each of the fifteen counties. He said that the presentation this evening would cover all of Region H, but would focus on communities in Galveston, Harris, Fort Bend and Brazoria counties.

Taylor presented information on currently available water supplies, environmental water needs, and possible solutions – called water management strategies - to water shortages. An incorporated city or town, generally with a population of 1,000 or more, is defined as a "water user group." Taylor said that in Region H, there are about 170 "water user groups." Additionally, there are non-municipal water use categories: irrigation, manufacturing, mining, power, and livestock. The task is to define these demands and then look at how much supply is available to meet those demands. After the demand/supply comparison, the communities that are projected to have water shortages are identified, and these communities are the focus for developing strategies to fix the problems.

As an overview, Region H water demand is projected to grow to about 3.2 million acre-feet by the year 2050. Right now, in the 15 counties in Region H, current supplies of groundwater and surface water total about 3.5 million acre-feet. It would appear that there is no water shortage. However, the communities that need water are not necessarily the communities that have these water supplies. Regional water planning is addressing ways to ensure that user groups that need water can obtain water.

Taylor noted that of the more than 170 water user groups, over half of them have projected shortages in the long term (2050). Although Region H has substantial quantities of available water supplies, there will be localized shortages to be addressed. Region H will need to figure out how to move, transfer, or share, currently uncommitted water supplies to those entities that need them. He also noted that Region H, when compared to the other 15 regions in the State, has the most people and the largest water demand of any of the regions and is one of the biggest contributors to the State's economy.

Taylor presented information in three broad categories: groundwater dependent counties that will have adequate groundwater to meet growth for the next 50 years; groundwater dependent counties that will not have sufficient groundwater supplies to meet growth needs; and surface water dependent counties. He presented information on specific communities and specific non-municipal water users.

He then presented information on water available to address the shortages. He noted that Leon and Madison counties were the only counties with substantial uncommitted groundwater supplies. He then reviewed surface water supplies available to the Region.

Taylor then addressed environmental water needs in Region H. He said that the State of Texas has recognized that bays and estuaries are important economic generators for the State. He noted that Galveston Bay is the second most productive estuary in the United States and contributes a lot of revenue to the Region. He recounted the work of the Galveston Bay Freshwater Inflows Group in addressing freshwater inflows needed for the Bay to sustain its productivity over the long term. He said that the average historical inflow to the Bay from all sources is about 10 million acre-feet per year, while the maximum harvest is achieved with 5.2 million acre-feet per year. The group is working with the RWPG to define how that need can be met.

A question was asked about whether the group was defining what they Bay needs and then backing into how much water is left to meet shortages. Taylor noted that looking at environmental flows is very different from looking at consumptive use shortages, and the management strategies are very different. While the issues are interrelated, they must be analyzed separately and then balanced together. He said that it probably would be at least another year before the Freshwater Inflows Group could recommend management strategies.

He said that the next step for the RWPG is to define management strategies to address the shortages and to address the Galveston Bay Freshwater Inflow Needs. The Senate Bill 1 process requires very specific information: who has the shortage, how much water is needed and exactly how will that amount of supply be met, with cost estimates. He provided a list of some of the management strategies that are being looked at. He itemized extending or expanding existing contract agreements; contractual transfers; developing new groundwater or surface water sources; wastewater reclamation and reuse; aggressive conservation programs; interbasin transfer of supplies; and other strategies that someone may define. He said that each of the water user groups were being asked to advise the RWPG if they have water supply plans they are already working on.

Upon question, Taylor explained that some communities in the lower Brazoria area were shown with water shortages even though the Brazosport Water Authority has adequate water supply because many of the communities need to extend or expand their contracts beyond their current terms and amounts. Others of those communities or industries are not customers of BWA.

Taylor responded to another question about growth in Brazoria County. He said that significant growth is occurring in the projections shown.

A question was raised about whether the Brazoria cities will stay on groundwater. Taylor replied that there is an assumption that Gulf Coast Water Authority option agreements are exercised over time. He pointed out that GCSA has option agreements with Pearland, Sugar Land, Missouri City, Fort Bend WCID No. 1 and Stafford. A speaker noted that Alvin is the only city that shows up on the map of shortages. Another asked if Alvin is projected to stay on groundwater, and Taylor responded affirmatively. On question about Manvel, Taylor replied that Manvel's supply is sufficient.

There was a discussion of the effects of continued groundwater pumpage in northern Brazoria County on subsidence in Fort Bend, Galveston and Harris counties. It was noted that a potential new subsidence district is an institutional change that is not currently in the Region H work.

There was a discussion about whether water supplies are physically available when water contracts are being extended or increased, particularly in the lower Brazoria area. Taylor said that supply reliability and availability during dry weather were taken into consideration. He pointed out that extending contracts is a tool to look at shortages to see if other management strategies, such as building reservoirs, need to be developed. He said it also alerts communities that they need to take care of contracting for their future water needs.

Another speaker questioned whether water quality had been looked at. Taylor said that in general the quality was looked at for groundwater, but not for surface water. He requested that anyone who has had problems with water quality, such as saltwater intrusion, contact the RWPG and let them know.

There was a question about other factors considered in determining surface water availability: Galveston Bay needs or water available in bayous or other streams. Taylor responded that all reliable supplies were included: reservoirs, and reliable river supplies. Supplies deemed unreliable were not included. Freshwater inflow needs are not yet accounted for, but will not affect the reliable supplies. Much of the flows to the Bay are stormwaters that are flowing through the reservoirs and are not controlled. In addition, return flows coming from treatment plants are inflows to the Bay. There are many streams and bayous that are not developed water supply sources that contribute freshwater to the Bay. Taylor reiterated that the aim of the water supply table is to define reliable supplies and use only those supplies to meet projected demands.

A question was raised about Brazos River flows. Taylor said that they include the natural flow of the river plus and releases contracted for from the Brazos River Authority. Another speaker noted that BWA does not have contracts with BRA, so their supply would be run of river, their permitted Brazos River supply. It was noted that BWA water comes through Dow reservoirs, increasing their reliability.

Taylor then laid out the schedule to complete the Regional Water Plan. He asked for comments if there are any concerns about the work. In response to questions, he said that tables with detailed information can be made available upon request.

A speaker questioned whether there was any thought of using reservoirs on small streams in the lower part of the region. Taylor responded that the management strategies are not complete yet. He said that reservoirs are being looked at from two perspectives: major reservoirs, such as the proposed Allen's Creek Reservoir with yield of about 100,000 acre-feet or 90-100 million gallons per day, and also smaller off-channel storage to improve reliability of water rights, particularly in the lower Brazos River. Taylor said that a hydraulic model of the lower Brazos indicates that of the total 800,000 acre-feet of water rights, only about 500,000 acre-feet are reliable. Who gets the water is based on seniority of water rights. Where and whether reservoirs on smaller streams would make sense would be determined by where the water shortages exist.

The question was raised about coordination with neighboring, particularly upstream regions. Taylor said engineers for both regions are using the same model. Mr. Rebuck from the Texas Water Development Board commented that the regional plans will all be integrated into a State Water Plan for submission to the Legislature. Taylor added that the TWDB is charged with resolving any conflicts between the regional plans.

One speaker commented that, with the tables as presented, most people wouldn't notice that water supplies are coming from entirely different watersheds. Taylor responded that the way the table looks could be changed. He said that as management strategies are developed, that type of concern would be more apparent.

There was discussion of moving Trinity River water down into Galveston and Brazoria counties or Brazos River water over to communities not now served. It was noted that conveyance facilities would be important. Taylor pointed out that the City of Houston currently supplies water in Fort Bend County and Galveston County. He said that Region H is entirely dependent on moving water to where it is needed.

Taylor noted that the regional water planning process is designed to have updates every five years. If there are institutional changes, such as new groundwater districts, or new subsidence district regulations, they will be taken into account in future updates to the regional plan. Rebuck noted that the RWPGs have the option to make recommendations for legislative changes.

In response to question about interbasin transfers, Taylor said that a law following on SB-1 provided that while interbasin transfers can occur, the water transfer becomes junior in its water right to all other permits. He suggested that in the short term future, interbasin transfers would be limited. He noted that in some river basins, there might be cases where no downstream water rights exist, and so a junior rights provision would have no effect. There was a discussion about whether this provision would be rescinded.

There was a question about increasing return flows in the water models. Taylor said that the models absolutely show increasing return flows and water usage increases.

Houston-Galveston Area Council, Houston, 1 March 2000

On behalf of Region H, Mark Lowry presented a brief description of SB-1 planning and then discussed the process followed to develop population and water demand projections, to identify major water providers and available water supplies and management strategies to meet water needs. He noted that regional water plans will be reevaluated at five-year intervals.

A speaker questioned whether the absence of available groundwater in Harris County reflects restrictions by the Harris-Galveston Coastal Subsidence District. Lowry responded that that is correct. He added that Fort Bend groundwater available does not reflect any restrictions from that Subsidence District because there are no existing restrictions. If regulations in Fort Bend

restrict groundwater in the future, then those restrictions would have to be accounted for in future updates of the regional water plan.

Another speaker asked if the HGCSD schedule for converting from groundwater to surface water is reflected in the projections for Harris and Galveston counties. Lowry said that schedule was taken into account.

Lowry then addressed the topic of environmental water needs, which are not categorized as a specific water user group, but are important to the region's economic livelihood. He noted that because of return flows, environmental flows cannot simply be added to water required for other needs to reach total water needs. He presented the recommendation from the Galveston Bay Freshwater Inflows Group.

A speaker questioned whether the data indicated that it is possible to have too much freshwater for maximum bay productivity. Lowry responded that was correct. He noted that location, seasonality, quality and amount are all important factors in determining inflows for bay productivity. He said that management strategies would need to be developed to meet those conditions.

Lowry presented a list of potential water management strategies being considered by Region H. He said the first strategy is extending or expanding current water supply contracts. He noted that water management strategies are important, because the TWDB will look for strategies in the regional plan when making financing decisions.

A speaker asked about the amount of water conservation that is taken into account in the water use projections, and the added amount that could be achieved with "aggressive" water conservation. Lowry replied that about 7-10 percent reduction in demand is built into the projections, and that another 10 percent might be achievable.

In response to question, Lowry said that an example of aggressive conservation would be an automatic lawn sprinkler program to reduce outside water usage. Another speaker suggested that pricing programs are very effective. Other methods included plumbing retrofit programs and residential and industrial water use audit programs. Lowry added that the City of Houston has had an aggressive conservation program aimed at detecting and repairing leaks in fountains or pools in its system.

A speaker asked if there were studies of the average amount of loss in city systems. Lowry responded that both TWDB and Texas A&M had active programs in that area. Ernie Rebuck added that TWDB has a staff person who will visit with cities to help them reduce leaks. He suggested that a 10 percent loss was probably a good target. Gary Oradat from the City of Houston said that their system is operating at about 15 percent pumpage loss from leaks. Another speaker said his community operates with about 12 percent pumpage loss. Mr. Oradat added that line breaks caused by cable contractors damaging or severing lines is a problem. He said that illegal taps remain a problem. Judge Bilski suggested that fire hydrants and fire event also affect pumpage loss.

Lowry concluded by giving the schedule for completing the regional water plan by January 5, 2001. He suggested that additional comments be sent to Jim Adams, the RWPG chair. Mr. Adams said that October is a realistic drop-dead deadline for comments.

A speak asked if oyster and shrimp harvest is considered to be the critical factor in determining environmental flow in the Galveston Bay estuary. Callaway replied that inflow requirements were based on looking a six species that represent the entire ecological system. Mr. Adams added that the inflow needed for maximum oyster harvest might not be the same as for the maximum shrimp harvest.

There was a discussion of how median and average inflows to the bay were calculated from the 50 years of monthly data. There was a question about whether the difference between the recommended inflows and average inflows could be developed and diverted. Callaway responded that GBFIG is still working on that and other management questions.

Another speaker asked if the inflows data included return flows. Callaway responded that it did.

There was a discussion of water quality standards as they relate to rainfall, return flows and nutrients in the inflows.

Judge Bilski asked for further discussion of potential reservoir development, particularly the Allen's Creek project. Lowry responded that the RWPG had looked at potential reservoir sites, but has not yet looked extensively at particular reservoirs. Mr. Adams noted that Allen's Creek reservoir was likely to be included in the plan.

In response to a question, Lowry discussed the effect of the junior water rights provision on interbasin transfers as a management strategy.

Judge Bilski brought up the topic of groundwater conservation districts. She said that Austin County is looking at the possibility of joining with neighboring counties to form a district. She asked how that would be dealt with in the management strategies. Mr. Adams responded that it wouldn't be taken into account until the district is created. Judge Bilski noted that it would be good to know that there is consideration of the long-term needs, beyond 50 years, before any supplies are used elsewhere.

A speaker asked if it is the responsibility of the TWDB to make sure that one part of the state doesn't hold another part of the state hostage. Mr. Adams said that the TWDB is charged with resolving conflicts between the plans.

Wallisville Heritage Park, Chambers County, 2 March 2000

Chairman Adams opened the meeting. Mark Lowry made the presentation for Region H.

A speaker questioned the irrigation water use projections. Lowry said the Region H has revised the projections provided by the TWDB by looking at current usage information. The Region H projections are slightly higher than the original projections.

Mr. Sullivan asked Lowry for more comment on the shortage projected for Baytown in Chambers County. Lowry said that cities located in more than one county are separated into each of the counties. He said that the Baytown shortage probably could be met simply by extending and expanding the city's current contract for water supply.

One speaker commented that oysters are impacted by freshwater inflows more than other species because they cannot relocate. Lowry said that the GBFIG has requested that the RWPG not consider any strategies that would prevent the max harvest amount from being reached at least 50 percent of the time.

In response to question, Lowry said water supplies are being looked at during drought of record supply availability. Demand conditions are not drought of record, but are low rainfall with expected conservation.

In response to question about supplies for Winnie and Stowell, Lowry responded that their supplies were provided by the Lower Neches Valley Authority in neighboring Region I.

A speaker questioned whether Region H is looking at regionalizing cities that are on individual wells. Lowry replied that that was not part of the planning effort at this time. If there is enough groundwater to continue to serve the demands, no shortage is noted. In response to question, John Seifert added that groundwater quality is generally better to the west than to the east.

A speaker questioned the steps that Region H would take to address freshwater inflow needs. Lowry described the state's water availability modeling effort that will help address how freshwater inflow needs can be met.

A speaker suggested that scenarios of management strategies, similar to the effort undertaken by the Lower Colorado River Authority, for providing freshwater inflows need to be analyzed. Another speaker responded that estuaries are different and what works in one won't necessarily work in others. Another speaker said that the institutional process could work.

Jeff Taylor commented that the freshwater inflows analysis must take into account the movement of water between basins and flows from the coastal basins and all the things that make Galveston Bay unique. Any solution must address that.

A late arrival asked about water for agriculture. Lowry summarized his earlier presentation. A specific question was raised about how Harris County water users would be treated. Lowry responded that the RWPG would develop management strategies for any user group with an identified shortage.

A speaker asked if the zeroes in the tables indicate that there is not shortage. Lowry said that is the case. He said that negative numbers indicate a shortage that will require a management strategy.

There was a discussion of the classification of aquaculture operations as industrial rather than agricultural by the Texas Natural Resource Conservation Commission. Lowry confirmed that the RWPG was using the classifications as they exist. The speaker suggested that the classification for aquaculture needs to be changed because of discharge permitting requirements.

A speaker questioned the shortages shown for Liberty and Cleveland. Lowry responded that those cities need additional well and storage facilities to meet their demand.

A speaker commented on the fact that people will wait until the draft plan is produced to show up and object to something rather than attending the earlier meetings. Lowry said that an enormous attempt has been made to publicize the meetings, but at every meeting someone shows up who just heard about the regional water planning effort.

Table 7-3: Attendance at Public Meetings, February-March 2000

28 February 2000, Walker County Courthouse, Huntsville

Interested Public
Jim R. Sims, Trinity River Authority, Huntsville
Bob Stout, The Woodlands Operating Co.
Barbara Taylor, Riverside Water
Basil R. Vincent, Lake Area Tourism Councils
Charles Wagamon, Walker County Judge
Frederick M. Weiwzieke, Riverside

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
William Teer, Southeast WSC, Centerville

Consulting Team
Glenda Callaway, Ekistics Corporation
Jennifer Elms, Turner Collie & Braden
Daomean Lin, Turner Collie & Braden
Mark Lowry, Turner Collie & Braden
Becky Olive, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Jeff Taylor, Brown & Root

Table 7-3: Attendance at Public Meetings, February-March 2000 (continued)

29 February 2000, Nolan Ryan Center, Alvin

Interested Public
Will Berry, PEDC, Pearland
Phyllis Blankenberg, Alvin-Manvel Chamber of Commerce
Matt Bochat, Brazoria Co. Extension Agent-Agriculture
Don Braddock, Chocolate Bayou Water, Alvin
Dave Buzan, TPWD
Dick Carter, City of Alvin
William Dulm...Jr., Rice Farmer, Alvin
Paul Golden, Alvin
M. G. Hoiseth, Alvin
Aubrey Horner, C&R Drainage District #3
Charles Johnson, Freeport
Ricky Kubeczka, C&R Drainage District #3
Hassan Moghaddam, Walsh Engineering, Inc., Pearland
Mike Palmer, Alvin
Lucy Pannell, Texas-New Mexico Power, Alvin
Tom Reid, Mayor, City of Pearland
W. Earl Ryan, Danbury Fish Farms
Leroy Slacalek, Ft. Bend Farm Bureau
Larry Stanley, Brazoria County
Tom Stansel, Alvin
Neal Stanton, Stanton's Shopping Center, Brazoria
Doyle Swindell, Alvin
Richard E. Tillman, Brazoria County Extension Service
Clayton Trent, Trent WW
C. J. Waller, L&W Excavation, Manvel
W. Ross Werlla, Rosenberg
Michael Wright, The Facts, Clute
Jim Young, Guidry News

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Jack Harris, Brazoria County Commissioner
Carolyn Johnson, Dow/TCC
Tom Manison, Friendswood
Ernest Rebuck, TWDB
Woody Woodrow, TPWD

Consulting Team
Glenda Callaway, Ekistics Corporation
Bruce Davidson, Turner Collie & Braden
Mike Garmon, Turner Collie & Braden
Mark Lowry, Turner Collie & Braden
John Nelson, LBG-Guyton Associates
Jeff Taylor, Brown & Root
Ann Wood, Brown & Root

Table 7-3: Attendance at Public Meetings, February-March 2000 (continued)

1 March 2000, Houston-Galveston Area Council

Interested Public
Carolyn Bilski, Austin County Judge
Joe Bilski, City of Sealy
Jim Dannenbaum, Dannenbaum Engineering Co.
Carl Masterson, Houston-Galveston Area Council
Kenneth Roberson, HCUD #15, Houston
A. Unterharnscheidt, Houston Canoe Club

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
John Bartos, Galveston Bay Foundation, Houston
James Murray, Exxon-Mobil, Baytown
Gary Oradat, City of Houston

Region H Water Planning Group Members (continued)
Ernest Rebuck, TWDB
C. Harold Wallace, West Harris County WSC
Chad Norris, TPWD (alternate)

Consulting Team
Glenda Callaway, Ekistics Corporation
Ed Copeland, Turner Collie & Braden
Alan Potok, Turner Collie & Braden
Mark Lowry, Turner Collie & Braden
John Nelson, LBG-Guyton Associates
Becky Olive, Turner Collie & Braden
David Parkhill, Brown & Root
Jeff Taylor, Brown & Root
Ann Wood, Brown & Root

2 March 2000, Wallisville Heritage Park, Wallisville

Interested Public
Henry Azar, CLCND, Mont Belvieu
John B. Cheesman, Jr., CLCND, Anahuac
Bobby Edwards, Aquaculture, Stowell
Guy C. Jackson III, Coastal Oyster Leaseholders Assn., Anahuac
Jim Kirkham, CLCND, Anahuac
Kevin Ladd, Wallisville Heritage Park
Linda Shead, Galveston Bay Foundation, Webster
Kay Willcox, Anahuac
Pudge Willcox, CLCND, Anahuac

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
David Jenkins, Stowell
Michael S. Sullivan, Houston
Ernest Rebuck, TWDB, Austin
Woody Woodrow, TPWD

Consulting Team
Glenda Callaway, Ekistics Corporation
Ed Copeland, Turner Collie & Braden
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Ann Wood, Brown & Root
Jeff Taylor, Brown & Root

7.5 Public Review and Comment on Initially Prepared Plan

Identification of Libraries

The RHWPG contacted each of the County Judges in the region and requested their assistance in identifying the public library in each county that would be most appropriate for placing a copy of the initially prepared Draft Regional Water Plan for public review. The libraries selected, together with the County Clerk's office in each county, are listed in Table 7-4.

Public Notice and Press Releases

As required by Section 357.12 of the Texas Administrative Code, notice of the upcoming public hearings on the initially prepared Draft Regional Water Plan was provided by several means.

- Notice of the public hearings, written comment period, and location of copies of the Draft Plan for public review were posted in each county in the region. (See Figure 7-1.)

- Paid ads providing notice of the public hearings, written comment period, and location of copies of the Draft Plan for public review were placed in 14 newspapers in the region.

- In accordance with 31 TAC section 357.12(5)(A-E), direct notice by first-class mail was made to the following:
  (a) 140 Mayors
  (b) 15 County Judges
  (c) 5 Special districts and river authorities in the region as identified by the Texas Natural Resources Conservation Commission (TNRCC)
  (d) 1,347 Community water systems as identified by TNRCC
  (e) 353 Water rights holders as identified by TNRCC

In addition, based on 31 TAC Sec. 357.5(h), direct mail notice of the public hearings was also given to 158 holders of water rights in designated special resource waters (Brazos River system).

The public hearings and elements of the Draft Regional Water Plan were chronicled in the June and September issues of the *Region H Update* newsletter mailed to approximately 800 individuals and organizations; press releases were issued to more than three dozen area newspapers, and television and radio stations. (Both the Houston Chronicle and the Huntsville Item assisted in the public information effort by carrying major front-page articles on water related issues in the weeks just before and during the public hearings.) The hearings also were posted on the TWDB website.

Distribution of Documents for Review and Comment

The six task reports that comprise the initially prepared Draft Regional Water Plan were placed in the designated public repositories listed in Table 7-4 on August 18, 2000. (The task report on public involvement was included at that time as an appendix to the Task 5 report.) These documents were also placed on the TWDB website. Subsequently, an Executive Summary was added to the documents available on the TWDB website.

Table 7-4: Public Repositories of the Region H Regional Water Plan

AUSTIN COUNTY
County Clerk
County Courthouse
1 East Main
Bellville, TX 77418

AUSTIN COUNTY
Gordon Library
917 Circle Drive
Sealy, TX 77474

BRAZORIA COUNTY
County Clerk
County Courthouse
111 East Locust
Angleton, TX 77511

BRAZORIA COUNTY
Angleton Public Library
401 East Cedar
Angleton, TX 77515

CHAMBERS COUNTY
County Clerk
County Courthouse
Anahuac, TX 77514

CHAMBERS COUNTY
Chambers County Library
– Main Branch
202 Cummings
Anahuac, TX 77514

FORT BEND COUNTY
County Clerk
301 Jackson
Richmond, TX 77469

FORT BEND COUNTY
George Memorial Library
1001 Golfview
Richmond, TX 77469

GALVESTON COUNTY
County Clerk
County Courthouse
722 Moody
Galveston, TX 77550

GALVESTON COUNTY
Rosenberg Library
2310 Sealy
Galveston, TX 77550

HARRIS COUNTY
County Clerk
Harris County Administration Building
1001 Preston Avenue
Houston, TX 77002

HARRIS COUNTY
Houston Public Library
1st Floor, Bibliographic Information Center
500 McKinney
Houston, TX 77002

LEON COUNTY
County Clerk
Leon County Courthouse
Centerville, TX 75833

LEON COUNTY
Leon County Library
129 East Main
Centerville, TX 75833

LIBERTY COUNTY
County Clerk
County Courthouse
1923 Sam Houston
Liberty, TX 77575

LIBERTY COUNTY
Sam Houston Regional Library
and Research Center
FM1011
Liberty, TX 77575

Table 7-4: Public Repositories of the Region H Regional Water Plan (continued)

MADISON COUNTY
County Clerk
101 West Main, Room 102
Madisonville, TX 77864

MADISON COUNTY
Madison County Library
605 South May
Madisonville, TX 77864

MONTGOMERY COUNTY
County Clerk
County Courthouse
301 N. Thompson
Conroe, TX 77301

MONTGOMERY COUNTY
Montgomery County Central Library
104 Interstate 45 North
Conroe, TX 77301

POLK COUNTY
County Clerk
County Courthouse, 1st Floor
101 West Church
Livingston, TX 77351

POLK COUNTY
Murphy Memorial Library
601 West Church
Livingston, TX 77351

SAN JACINTO COUNTY
County Clerk
County Courthouse
#1 Highway 150
Coldspring, TX 77331

SAN JACINTO COUNTY
Coldspring Library
220 South Bonham
Coldspring, TX 77331

TRINITY COUNTY
County Clerk
County Courthouse
1st and Main
Groveton, TX 75845

TRINITY COUNTY
Blanche K. Werner Library
Highway 19
Trinity, TX 75862

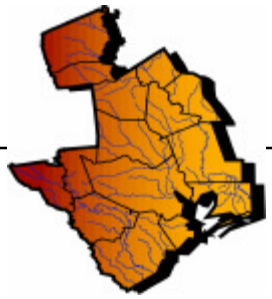
WALKER COUNTY
County Clerk
County Courthouse
1100 University Avenue
Huntsville, TX 77340

WALKER COUNTY
Huntsville Public Library
1216 – 14th Street
Huntsville, TX 77340

WALLER COUNTY
County Clerk
County Courthouse
836 Austin Street
Hempstead, TX 77445

WALLER COUNTY
Waller County Library -
Brookshire/Pattison
3815 Sixth Street
Brookshire, TX 77423

Figure 7-1 Public Hearing Notice



Notice of Public Hearing
Region H Draft Regional Water Plan

A public hearing will be held at four locations in Region H to receive public comment on a Draft Regional Water Plan. The Region H Water Planning Group prepared the Draft Regional Water Plan as part of a 16-region statewide effort initiated by Senate Bill 1 in 1997, and administered by the Texas Water Development Board. Counties in Region H are: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Leon, Liberty, Madison, Montgomery, Polk (part), San Jacinto, Trinity (part), Walker, and Waller.

The Draft Regional Water Plan provides information on water needs and water supplies for communities, industry and agriculture and addresses environmental considerations for the 15-county Region H area. The Draft Plan identifies water management strategies to meet shortages. After comments are received and considered, the Region H RWPG will adopt the Regional Water Plan and submit it to the TWDB by January 5, 2001, to become part of the State Water Plan.

Hearing comments will be received at meetings held September 18 – 21, 2000. Comments may also be made in writing to Mr. Jim Adams, Chair, Region H Water Planning Group, P. O. Box 329, Conroe, Texas 77305. Written comments will be accepted at the offices of SJRA through September 26, 2000. A copy of the Draft Regional Water Plan will be available for review at the office of the County Clerk and in one public library in each county within Region H for 30 days prior to the hearing.

Monday, September 18, 7 p.m.
Nolan Ryan Center
Alvin Community College
Near Highway 35/Highway 6
Alvin, Texas

Tuesday, September 19, 7 p.m.
Walker County Courthouse
1100 University Avenue
Huntsville, Texas

Wednesday, September 20, 3 p.m.
E. B. Cape Center
City of Houston Dept. of Public Works
4501 Leeland
Houston, Texas

Thursday, September 21, 7 p.m.
White's Memorial Park
I-10 @ Hwy 562/61
Chambers County, Texas

The Region H Regional Water Planning Group meets on the first Wednesday of each month. For further information, contact Mr. Jim Adams, RWPG Chair, at SJRA, 936-588-1111, or Glenda Callaway at Ekistics Corporation, 713-520-9031. Information also is available at the TWDB website www.TWDB.state.tx.us.

7.6 Summary of Public Hearing and Written Comments, September 2000

Overview

The Region H WPG chose to hold a public hearing on its initially prepared Draft Regional Water Plan at four locations in the region. This allowed comments to be made for the record at sites and times that might be more convenient to the public than at one central hearing. The hearing sites were: Nolan Ryan Center at Alvin Community College, Walker County Courthouse, City of Houston E. B. Cape Center for Public Works Excellence, and White's Memorial Park in Chambers County. Three of the hearings were held at 7:00 p.m., and one (Houston) at 3:00 p.m.

Proceedings at each of the public hearing sites followed a similar format.

- Welcome and Introductions: Jim Adams, RHWPG Chair, welcomed attendees and made introductions at three of the meetings. Judge Charles Wagamon welcomed attendees and introduced elected officials at the Walker County Courthouse.
- A brief presentation by the consulting team: Jeff Taylor, Brown & Root, and Mark Lowry, Turner, Collie and Braden, alternated making the presentation, emphasizing the recommended management strategies. (Copies of presentation slides are included as Appendix D.)
- Formal comments or questions by attendees who registered to speak.
- Information on the written comment period and process for adopting the Plan: Glenda Callaway, Ekistics Corporation, emphasized that the RHWPG would be open to comments and questions throughout its process, but that comments to be included with the submission of the initially prepared Draft were needed by September 26.
- Informal dialogue: including discussion of responses that were known at the time.

Handouts for each meeting consisted of a copy of the Executive Summary, a copy of Appendix E to Task 5, and a copy of the presentation slides.

A certified court reporter prepared a formal record of proceedings at each hearing site in conjunction with a computer assisted real-time translation during the hearing. Summaries of formal comments are based on these proceedings. Attendance at the Public Hearing sites is shown in Table 7-5.

It was announced in the public notice and at each public hearing site that written comments on the initially prepared Draft Regional Water Plan would be accepted through September 26, 2000 for inclusion in the published draft plan. Sixteen written comments were received during that period. Three additional written comments were received after that date. Table 7-6 lists the individuals and organizations that provided written comments.

Table 7-5

ATTENDANCE AT PUBLIC HEARINGS, SEPTEMBER 2000

18 September 2000, Nolan Ryan Center, Alvin

Interested Public
Doug Balkum, Councilman, City of Alvin
Corbin Ballast, City of Lake Jackson
David Behm, Legacy Land Trust, Friendswood
Don Braddock, Chocolate Bayou Water, Alvin
Dick Carter, City of Alvin
Jim Coate, Southwood Estates, Inc., Pearland
Larry Drabek, Alvin
Susan Drabek, Alvin
David Finklea, Greater Houston Partnership, Houston
Bob Garrett, Waters Davis Soil Cons. Board
Jay Gilbert, Santa Fe
Jimmie Gilbert, City of Pasadena
Betty Hambright, Brookside Village
Lydia Heard, Houston
Ruth Hertel, City of Angleton
Paul Hofmann, City of Alvin
Stephanie Hrabar, Houston
Mike Kelly, TBA Water, Houston
Albert Kuchar, Rice Farming, Danbury
Rodney A. Kuchar, Farming, Danbury
Don Lane, BP, Alvin
Troy Lewis, City of Alvin
David Minze, Farming/Irrigation, Katy
Gordon Myers, Gulf Coast Water Authority, Texas City
Mike O'Day, O'Day Drilling Co., Pearland
Mike Palmer, International Paper Co., Alvin
Paul W. Rhodes, private utility co., Alvin
Gerald Roberts, City of Angleton

Interested Public (continued)
Wayne Sabo, City of Manvel
Paul Schumann, City of Sugar Land
John Speer, Tigner Irrigation, Angleton
David Spoer, Angleton
Joe M. Sweeny, Alvin
Michael Wright, The Facts, Clute
Frank Tigner, Tom Tigner Ranch, Angleton
Tom Tigner, Tigner Irrigation, Angleton
J. R. Tyson, Councilman, City of Alvin
Pris Weeks, EIH/EHCL, Houston
Fred Werner, US Fish & Wildlife Service, Houston
Nathan Zainfeld, Brookside Village
Kenneth Zenahr, Danbury Fish Farms, Danbury

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Jack Harris, Brazoria County Commissioner
Carolyn Johnson, Dow
Tom Ray, BRA
Ernest Rebuck, TWDB

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Andy Sterbenz, Brown & Root
Jeff Taylor, Brown & Root

Table 7-5 (continued)

19 September 2000, Walker County Courthouse, Huntsville

Interested Public
Joe Adams, San Jacinto County Judge, Coldspring
W. B. Avery, Custom Marine & Machine, Onalaska
Jim Beel, Conroe Bay Assn., Willis
Herschel Brannen, Trinity
Pat Brown, The Woodlands GREEN
Dave Buzan, Texas Parks & Wildlife Dept., Austin
Mark Chalker, landowner, Bedias
Mary Chalker, landowner, Bedias
Keith L. Cogler, TRA-retired, Huntsville
Bill Daugette, City of Huntsville
Debra Daugette, City of Huntsville
John N. Demel, Utility Dept., City of Panorama Village
Lewis DeVore, Cove Marina, Riverside
Scott Ehni, landowner, Trinity
Bob Echert, Huntsville
Pat Echert, Huntsville
Dale Evans, Councilmember, City of Panorama Village
Jeff Farris, Madisonville
B. J. Gaines, Jr., Walker County, Huntsville
J. J. Greeson, Custom Marine & Machine, Onalaska
Wesley Grossie, Huntsville
Harry C. Hallows, farmer, Midway
Byran Hayes, Huntsville Item
R. D. Heppes, landowner, Huntsville
Mike Hornsby, Pyramid Cattle Co., Normangee
John Howard, rancher, Iola
David Kleimann, Montgomery County, Willis
Dan Lynam, Conroe Bay Assn., Willis
Jeff Markham, Markham Realty, Huntsville
Eddie Martinez, Westwood Shores MUD, Trinity
Charles E. Morgan, P.E., Texas Dept. of Criminal Justice, Buffalo
Walter Nelson, Huntsville
Phil Palmer, Waterwood MUD, Huntsville
Phil Patchett, City of Trinity
John Pulvino, landowner, Tinity
J. A. Remeny, Huntsville

Interested Public (continued)
Billy Richardson, TRA, Point Blank
Marie G. Ristroph, Spring Creek Watershed Initiative, Pinehurst
Frank Robinson, Huntsville
George Russell, Sierra/TCONR, Huntsville
Sue Russell, Huntsville
Jerry Sirkin, Spring
Jim R. Sims, Trinity River Authority, Huntsville
Robert Stevens, Trinity River Authority, Huntsville
C. Tyler, landowner, Trinity
Charles H. Wagamon, Walker County Judge, Huntsville
John Webb, Dodge Oakhurst Water, Dodge
Mike Wegner, City of Huntsville
Frederick M. Weiwzieke, Riverside
Tom Weyer, City of Huntsville
Steve Widner, City of Huntsville
Boyd Wilder, City of Huntsville
Doris Williams, landowner, Bedias
Marvin Williams, landowner, Bedias
Gerald Wransity, The Woodlands

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
Jeff Henson, TPWD, Bryan (alternate)
Robert Bruner, Huntsville
Ernest Rebuck, TWDB, Austin
Steve Tyler, Trinity
Danny Vance, TRA, Arlington

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Jeff Taylor, Brown & Root

Table 7-5 (continued)

20 September 2000, E. B. Cape Center, Houston

Interested Public
Wayne Ahrens, Dannenbaum Engr., Houston
Dominic G. BeNoba, City of Houston
Tony Brown, Baytown Area Water Auth., Baytown
Dave Buzan, Texas Parks & Wildlife Dept., Austin
Marilyn Christian, Harris County Health Dept., Houston
Kaye Corprew, Coats Rose, Houston
Jim Dannenbaum, Dannenbaum Engr., Houston
Mike Ellington, Town of Woodloch, Conroe
Dan Feldstein, Houston Chronicle
Charles Fredieu, City of Houston
Art Garden, Harris Co. MUD 81, Houston
Lisa Gonzalez, UHCL-EIH, Houston
Philip Goodwin, Skinner Nurseries, Houston
Stephanie Hrabar, Houston, Texas
Roger Hulbert, City of Houston
Bob Johnson, CH2M Hill, Houston
Jeff Jordan, Houston
Jim Kachtick, Greater Houston Partnership, Houston
Carolyn Keenan, Houston
Todd Larson, Montgomery Watson, Houston
Diane Lincoln, Mayor, Town of Woodloch
Brandt Mannchen, Houston Sierra Club
Les Mauldin, Creekside Nursery, Waller
Edward McCall, CDM, Houston
Dave Moldal, National Wildlife Federation, Austin
Clint Moore, North Harris Co. Regional Water Auth., Spring
Itc Nguyen, Houston
Tom Ramsey, Klotz Assoc., Houston
Robert Reynolds, Houston

Interested Public (continued)
Linda Shead, Galveston Bay Foundation, Webster
Larry Smalley, Klotz Assoc., Houston
Joe Taylor, Quail Valley U.D., Missouri City
J. W. Weatherford, Weatherford Farms, Stafford
Blu Whipple, The Woodlands
Ray Zobel, Malcomson Road U.D., Tomball

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
John Bartos, Galveston Bay Foundation, Houston
Gary Oradat, City of Houston
Ernest Rebuck, TWDB, Austin
Gary Stobb, Harris Co., Houston

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
David Parkhill, Brown & Root
Mike Reedy, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Andy Sterbenz, Brown & Root
Jeff Taylor, Brown & Root

Table 7-5 (continued)

21 September 2000, White's Memorial Park, Chambers County

Interested Public
John B. Cheesman, Jr., Anahuac
Billy Edwards, Trinity Bay Soil & Water Cons. Dist., Stowell
Bobby Edwards, Stowell
Ford J. Frost, Houston
Sue Hawthorne, The Progress, Anahuac
John Jenkins, TRA, Hankamer
Charles Jones, Jones & Allen Farms, Winnie
R. Kit Jones, Trinity Bay Cons. District, Anahuac
David Paulissen, Trinity Bay Cons. Dist., Anahuac
David Plaisance, Clear Lake City Water Auth., Houston
Linda Shead, Galveston Bay Foundation, Webster
J. E. Sherman, Devers Canal, Devers
Reggie Sutton, aide to Sen. David Bernsen, Beaumont
Pudge Willcox, CLCND, Anahuac

Region H Water Planning Group Members
Jim Adams, SJRA, Conroe
David Jenkins, Stowell
Ernest Rebuck, TWDB, Austin
Danny Vance, TRA, Arlington

Consulting Team
Glenda Callaway, Ekistics Corporation
Mark Lowry, Turner Collie & Braden
John Seifert, LBG-Guyton Associates
Andy Sterbenz, Brown & Root
Jeff Taylor, Brown & Root
Brad Winkler, Brown & Root

Table 7-6

Written Comments on Initially Prepared Plan
Received August 18 – September 26, 2000

Hon. Joe Adams, County Judge, San Jacinto County
Pat Brown, The Woodlands
Hon. Susan Combs, Commissioner, Texas Department of Agriculture, Austin
Eddy D. Edmondson, President, Texas Nursery & Landscape Association, Austin
Myron J. Hess, Counsel, National Wildlife Federation, Gulf States Natural Resource Center, Austin
Billy Howe, Associate Legislative Director, Texas Farm Bureau
Hon. Troy Lewis, Mayor, and Hon. J. R. Tyson, Councilmember, City of Alvin, on behalf of Mid-Brazoria County Regional Water Planning Group
Brandt Mannchen, Sierra Club, Houston Regional Group
Les Mauldin, Creekside Nursery, Hempstead
Carlos H. Mendoza, Project Leader, Clear Lake Field Office, U.S. Department of the Interior, Fish and Wildlife Service
Craig Nisbett, P.E., Public Works Director, City of Lake Jackson
Marianne Pape, Houston
Wayne J. Sabo, City Administrator, City of Manvel
Andrew Sansom, Executive Director, Texas Parks and Wildlife Department, Austin
Linda Shead, P.E., Executive Director, Galveston Bay Foundation, Webster
William C. Wade, Clute
Mary Ellen Whitworth, P.E., Executive Director, Bayou Preservation Association, Houston
Marvin and Doris Williams, Bedias
Norman Young, Coldspring

Comments

September 18, 2000, 7:00 p.m., Nolan Ryan Center, Alvin. A total of 51 people attended the public hearing; three made formal comments. After the comment period, informal discussion addressed the need for funding to implement the Plan, clarification of the rule of capture for groundwater and water rights for surface water, and subsidence.

(1) Stephanie Hrabar, Ph.D., geologist, speaking for herself, said that she had spent nine hours reviewing the reports making up the draft Regional Water Plan.

a. As a member of the lay public, she found the material difficult to comprehend.

b. She was concerned that there was a lack of balance between the urban and rural and suburban interests.

c. She objected to the lack of attention to water quality in the reports and is concerned about contamination of groundwater supplies.

d. She requested a listing and description with contact persons for all agencies with jurisdiction/responsibilities for water in Region H. She also requested identification of the federal, state and local natural resource agencies with technical expertise that would be reviewing the documents.

e. She is concerned that Harris County has no comprehensive land use plan and cannot understand how a 50-year water plan can be prepared for a county with no plan.

(2) J. R. Tyson, Councilmember, City of Alvin, speaking for the Mid-Brazoria County Water Planning Group, thanked the RHWPG for working with the Mid-Brazoria group and recognizing its planning effort. He said that the Alvin City Manager would comment further.

(3) Paul Hofmann, City Manager, City of Alvin, commented that the Mid-Brazoria group had been working for several months to do additional analysis of water supply and facility planning for that sub-regional area. He noted that a grant application to the Texas Water Development Board for facility planning had recently been approved.

a. He asked that the RHWPG acknowledge in its Plan the fact that the Mid-Brazoria County Water Planning Group has been created.

b. He noted that members of the Mid-Brazoria group are very interested in a reconsideration of population projections after the 2000 Census.

September 19, 2000, 7:00 p.m.,Walker County Courthouse, Huntsville. A total of 64 people attended the public hearing in Huntsville; 15 gave formal comments or questions. After the comment period, informal discussion topics included water conservation measures and potential aquifer contamination from oil and gas wells.

(1) Marie Gibbens Ristroph, resident of Pinehurst spoke for herself and is affiliated with the Spring Creek Watershed Initiative. The Initiative is interested in preserving the waterway, preventing flooding and encouraging sustainable development.

a. The Initiative is encouraging the use of cisterns, gray water usage, and the use of native plants to reduce irrigation needs.

b. The Initiative wants to be involved in long range water planning.

(2) Phil Palmer, real estate and manager of Waterwood MUD, a resort subdivision on the north end of Lake Livingston, commented that the Lake is an important economic factor in the area.

a. He noted that the level of the Lake affects recreational activities and requested that the RHWPG strongly consider maintaining the level of Lake Livingston.

b. He commented that drops in the level of the Lake will affect property values and tax base resulting in tax increases.

c. He suggested that the 10 million people coming to the region will need a place to get away from it all and Lake Livingston should be given high regard as a recreational asset.

(3) George Russell, Sierra Club and Texas Committee on Natural Resources, Huntsville, suggested that transferring water from the Trinity River to the San Jacinto Basin was like taking money from savers and giving it to wasters.

a. He commented that there is no need for the Bedias Reservoir and no need to take water out of Lake Livingston to give to another basin.

b. He said that no interbasin transfers are needed; people should move to where there is water.

c. He said that people should not waste water, and pointed to urban landscaping practice as a big waster of water.

(4) Pat Brown, The Woodlands GREEN, spoke as a concerned citizen.

a. Is there a way to use groundwater for drinking water and lake water for other uses?

b. Do groundwater projections to 2050 take into account the increase in development and cement coverage over the recharge area of the aquifers?

c. She is concerned about borrowing water from other areas since as drought periods increase in the future, areas that have water now may need it for their own use.

d. She suggested that incentives might be given to users of large amounts of water to develop more water-efficient processes.

(5) John Pulvino, Lake Livingston homeowner, based his comments on the Executive Summary.

a. He asked how much analysis was given to tourism and recreation, since it was noted that this was an important part of the economy.

b. He said that it appeared that more analysis and concern was given to the southern part of the region than to the northern part.

c. He asked what was meant in the allocation of uncommitted supplies by the phrase "until the existing uncommitted MWP water supplies are exhausted."

(6) Scott Ehni, Lake Livingston landowner, Trinity, said some of his questions already had been answered.

a. He objected to the strategy of contracting for 200,000 acre-feet of water from the Lake Livingston to cover future water needs of a population that does not yet exist when property owners are currently using it and will be affected when water levels in the Lake decline; the cost should be calculated before selling the water.

b. He commented that people should be discouraged from moving someplace where there isn't enough water.

c. He is concerned about projected inflows and the impact Bedias Reservoir or any upstream reservoir will have on inflows to Lake Livingston and on lake level.

(7) Byron Hays, Huntsville Item, asked if any study had been done that exactly describes what the lake level at Lake Livingston will be given certain specific acre-feet that are retained in the lake-- where would the shoreline lie?

(8) Charles Morgan, Texas Department of Criminal Justice, Buffalo, is responsible for water for prisons in the area.

a. He asked if concentrations of prison populations (such as the five prisons with 13,000 prisoners in the Palestine area) were taken into account in calculating water demands.

b. He is concerned about determining if groundwater wells will continue to be dependable.

c. He asked if more water could be taken from Lake Houston and diverted west rather than taking more water from Lake Livingston.

d. He suggested that xeriscaping could conserve water and should be encouraged in the Plan.

e. He said that reclaimed wastewater could be used for irrigation and suggested that some reconsideration of Texas Natural Resource Conservation Commission rules might be needed.

(9) Mark T. Chalker is a landowner from Bedias, in northern Walker County.

a. He is concerned about the location of Bedias Creek Reservoir.

b. He would like to know the area to be covered with water.

c. Given the reservoir is planned for 2030, he wants to know when landowners would have to leave.

(10) Dave Buzan, Texas Parks and Wildlife Department, Austin, expressed appreciation to the RHWPG for their deliberations and for including freshwater inflow needs and ecologically unique stream segments in the Plan.

(11) Lewis DeVore, Cove Marina, Riverside, noted that his business depends on the pool level of Lake Livingston.

a. He is concerned by the lack of discussion about conservation in the Plan.

b. He asked if people have a right to waste water if they are willing to pay for it.

c. He asked if there could be allotments of water, with use over that amount carrying some sort of penalty.

(12) David Kleimann, Willis, spoke for himself and commented on several issues related to the Subsidence Districts.

a. He thinks conservation must be looked at seriously.

b. He is concerned that Groundwater Conservation Districts may become management districts.

c. He concerned about the loss of water from system leaks in Houston.

(13) Dan Lynam, Conroe Bay Civic Association, Willis.

a. He wants to know how the lake levels for Lake Conroe will be affected.

b. He asked if current conditions are going to be normal conditions.

(14) Herschel Brannen, Trinity County.

a. Referring to Task 5, Appendix E, he noted that projected growth for livestock and irrigation for Walker and surrounding counties is flat and asked why agriculture is not growing.

(15) John Webb, Dodge Oakhurst Water Supply.

a. He wants to know if the Plan will affect groundwater in his area.

September 20, 2000, 3:00 p.m., E. B. Cape Center, Houston. A total of 47 people attended the public hearing in Houston; seven gave formal comments or questions. After the comment period, informal discussion topics included funding for implementation; groundwater rule of capture; Subsidence District issues; City of Houston rate structure; analysis of project environmental impacts; development of the State Water Plan from the regional plans; future of RWPGs; and why water shortages exist when there is a regional water surplus.

(1) Stephanie Hrabar, geologist, speaking for herself, thanked the people who took the time to serve on the RHWPG, especially the volunteers, and noted that interdisciplinary communication is difficult.

a. She thinks that the documents are not clear.

b. She thinks that both water and air quality are issues relevant to water supply that should be addressed.

c. She commented that the rule of capture encourages mining of groundwater and ignores effects such as subsidence.

d. She suggests including maps of the location of (1) active and abandoned surface mining activities for coal, uranium, salt and sulfur; (2) abandoned and productive oil and gas fields that have injections wells, disposal wells; (3) chemical disposal wells; (4) solid waste disposal sites.

e. She commented that the Executive Summary introduction (p. 1) should mention that water supply is critical to public health.

f. She is concerned that unique stream "segments" may not be the same as segments identified by TNRCC.

g. She is concerned that TNRCC has responsibilities for water and was not represented on the RHWPG.

(2) Brandt Mannchen, speaking for the Houston Sierra Club, noted that he will also submit written comments.

a. He suggests thinking outside the box and putting people where the water is, as well as considering the carrying capacity of a particular area.

b. He is concerned that the recommended municipal conservation is very low.

c. He is concerned that some natural areas were not adequately mentioned (Columbia Bottomlands and the Sam Houston National Forest) and suggested that additional streams in the

Sam Houston National Forest should be considered for designation segments with unique ecological value.

d. He objected to the recommended strategy of the Bedias Reservoir and transfer to SJRA because of its impact on the Sam Houston National Forest.

e. He objected to a proposal (not in the Draft Plan) to transfer water from Lake Livingston to Rock Creek in Grimes County that would pass through the Sam Houston National Forest.

f. He objected to basing the study on unrealistic assumptions that cause a crisis mode response.

g. He objected to the difficulty in obtaining a hard copy of the full document and to the 30-day comment period, suggested a 60-day comment period instead or at least 45 days.

(3) Dave Moldal, National Wildlife Federation, Austin, said that he would also submit written comments. He noted that NWF has 45,000 members in Texas and is committed to protecting the state's abundant fish and wildlife resources and are concerned about how water development affects those resources.

a. He said that an effective water plan must strike a balance between human, commercial, and environmental water needs.

b. He urged the RHWPG to give full and serious consideration to the environmental impacts of both existing and proposed water development projects.

c. He applauded the RHWPG for recommending aggressive conservation for some municipalities, but suggested that it should be applied more broadly.

d. He objected to the lack of analysis of what actions are needed to ensure sufficient freshwater inflows to Galveston Bay or in and near the tidal portion of the Brazos River.

e. He said the Plan does not address impacts to water quality and the aquatic ecosystem from interbasin transfers and reservoirs and on private and commercial recreational activities, tourism and commercial fishery activities from the loss of freshwater inflows.

f. He said that the Plan does not address drought management measures to limit demand during water short periods.

g. He said that agricultural conservation measures should be extended beyond the three counties with water shortages.

h. He objected to the lack of assessment of environmental impacts associated with reservoir construction for the three recommended reservoirs.

i. He said that the Little River Reservoir conflicts with a potentially ecologically significant stream segment.

j. He commented that the existence of a surplus of water for the region as a whole called into question undertaking projects that are very expensive and environmentally destructive before a comprehensive review of environmental water needs is undertaken.

(4) Dave Buzan, Texas Parks and Wildlife Department, Austin, thanked the RHWPG for its efforts and for including consideration of ecologically unique stream segments and freshwater inflows to bays in their water plan. He encouraged them to continue to consider those ecologically important systems and freshwater inflows to bays in their further deliberations.

(5) Les Mauldin represents Creekside Nursery, a wholesale nursery in Waller County, and part of an important economic sector of the State.

a. He does not find that the nursery/floral part of agriculture is accounted for in the Executive Summary.

b. He said that the USDA and the Texas Agriculture Code considers nursery/floral as part of agriculture rather than industrial, and the Water Plan should reflect that.

(6) Linda Shead, Galveston Bay Foundation, Webster, expressed appreciation for the inclusion of findings of the Galveston Bay Freshwater Inflows Group in the Plan and for the recommendation to continue funding that effort. She noted that freshwater and wetlands are crucial ingredients in the productivity of Galveston Bay, the State's most productive estuary.

a. She asked that the RHWPG continue to consider freshwater inflows to the bay, and also to consider the importance of instream flows and the value they add to habitat and recreation.

b. She applauded the RHWPG for including ecologically unique stream segments and suggested that they continue to consider additional designations as new data are collected.

c. She suggested that additional aggressive conservation could be pursued.

d. She noted that good and effective ways to quantify aesthetic and recreational and natural habitat values of the region's resources are needed.

e. She thanked the RHWPG for finding a creative way to include freshwater inflows in the report even though the TWDB did not include environmental water in their table formats.

f. She commented on the importance of finding a balance of interests, applauded the RHWPG for its efforts, and said that a balance or solution can't be found unless it is looked for.

(7) Jack Weatherford, Weatherford Farms, Stafford, asked for an explanation of how the Subsidence District fits into the picture of groundwater rule of capture.

<u>September 21, 2000, 7:00 p.m.,White's Memorial Park, Chambers County.</u> A total of 24 people attended the public hearing at White's Park; three gave formal comments or questions. After the comment period, informal discussion topics included irrigation supply in Chambers County; projected rice crop acreage; changes and amendments to the Water Plan; junior water rights and 50-year in-basin needs provisions with respect to interbasin transfers; the City of Houston to Gulf Coast Water Authority contract; agricultural water conservation; and Allen's Creek Reservoir.

(1) Linda Shead, Galveston Bay Foundation, Webster.

a. The Foundation is pleased that the RHWPG took the initiative to address freshwater inflows to Galveston Bay, accepted the recommendations of the Galveston Bay Freshwater Inflows Group, and recommended funding to continue that effort.

b. She applauded the designation of ecologically unique stream segments and suggested that additional streams be considered for designation when data are available to assess their value, noting that no streams in Chambers County were designated.

(2) Bobby Edwards, Stowell, spoke on behalf of himself.

a. He is concerned because the Plans refers to "getting appropriate administrative procedures from the legislature.... " and he has had bad experiences with TNRCC using administrative procedures.

b. He has reviewed the Plan and has found no fatal flaw.

(3) David Paulissen, general manager of the Trinity Bay Conservation District, Anahuac, said that over the past few months TBCD has had demand requirements and projections independently prepared. He said that he had found no conflicts, but wanted to make sure that the RHWPG had a copy of the TBCD report. He thanked the RHWPG for their work.

Written Comments Received August 18 - September 26, 2000.

Sixteen written comments were received by 5:00 p.m. September 26, 2000. Three additional letters were received during the Texas Water Development Board review of the initially prepared plan. Copies of those submissions follow.

Responses to Public Comments Received

All commentors who provided address information will receive a letter of response thanking them for taking the time to review the Initially Prepared Regional Water Plan and provide comments and encouraging their continued participation in the ongoing planning process. Responses to their specific concerns are set out below. Responses are organized by hearing site followed by responses to written comments received.

Responses to Public Comments from September 18, 2000, Alvin

(1) Stephanie Hrabar, PhD.

a. Ms. Hrabar commented that the material was difficult to comprehend. Every effort was made to keep "technical jargon" out of the reports. Two additional reviews were conducted before the final report was approved. A table of abbreviations was prepared and added to the front of each report following the table of contents.
b. Ms. Hrabar was concerned about a lack of balance between urban, rural and suburban interests. The Region H Water Planning Group contains representatives from urban, rural and suburban areas, as well as representatives from diverse interest groups. The planning process itself follows rules established by the Texas Water Development Board, which are basically to identify projected demands, identify available supply, identify shortages and identify strategies to meet or reduce unmet demands. The projected growth in this Region's urban areas exceeded the available supply, so the plan does focus on solving the water supply shortages in those urban areas.
c. Ms. Hrabar asked about water quality being omitted from the study. A section on water quality has been added to the Task 1 Report.
d. Ms. Hrabar asked which agencies have jurisdiction in the planning process. The Regional Water Planning Process is established by the State of Texas, and administered by the Texas Water Development Board. The plans are reviewed by the Texas Natural Resource Conservation Committee and the Texas Parks and Wildlife Department. The Texas Department of Agriculture also reviews the plans. A listing of points of contact for each of these agencies was added to the Task 1 Report and the Executive Summary.
e. Ms. Hrabar expressed concern about planning for Harris County, which does not have a land use plan. Regional Water Planning is an ongoing process, and updated plans will be prepared every five years. This process allows the Region to make revisions as growth patterns and projections change over time.

(2) J. R. Tyson, Councilman, City of Alvin, speaking for the Mid-Brazoria County Water Planning Group.

a. Mr. Tyson thanked the group for working with the Mid-Brazoria County Water Planning Group. No response is required.

(3) Paul Hoffman, City Manager, City of Alvin, speaking for the Mid-Brazoria County Water Planning Group.

a. Mr. Hoffman asked that Mid-Brazoria be acknowledged in the plan. The Task 1 Report was revised to specifically identify the Mid-Brazoria County Water Planning Group.

b. Mr. Hoffman asked that population projections be revised based on the 2000 census. The results of the 2000 census will be incorporated in the next update of the plan.

Responses to Public Comments from September 19, 2000, Huntsville

(1) Marie Gibbens Ristroph, resident of Pinehurst and affiliated with the Spring Creek Watershed Initiative.

a. Ms. Ristroph said that the Spring Creek Watershed Initiative is advocating conservation and reuse, and they would like to be involved in long-term water planning. The RHWPG appreciates the efforts of conservation groups, and encourages them to attend the RHWPG meetings and become involved in the process.

(2) Phil Palmer, manager of Waterwood MUD.

a. Mr. Palmer pointed out the recreational value of Lake Livingston, and asked that lake levels be maintained. The RHWPG acknowledges the recreational value of Lake Livingston which was constructed as a water supply reservoir. During times of high demand the water stored in Lake Livingston is meant to be conveyed for use.
b. Mr. Palmer commented that reduced lake levels affect property values and tax base. The RHWPG acknowledges the importance of reservoirs to local economies. The high water demands and low water supplies reflected in the plan are based on drought-of-record conditions. In an average or wet year, lake levels (and revenues generated) should not be affected.

(3) George Russell, Sierra Club and Texas Committee on Natural Resources.

a. Mr. Russell stated that there is no need to transfer water from Lake Livingston to another basin. Lake Livingston is a water supply reservoir, built by the City of Houston for the express purpose of transferring water supply to Houston.
b. Mr. Russell stated that population should move to areas with water rather than move water to the population. The location of population growth is beyond the control or mandate of the RHWPG or the State.
c. Mr. Russell strongly advocated water conservation. The Regional Plan includes water conservation for all user groups and advanced conservation for those with projected shortages. The report text was revised to present this more clearly.

(4) Pat Brown, the Woodlands GREEN.

a. Ms. Brown asked about conjunctive use of ground and surface water. Within our region, the decision to use ground or surface water is usually an economic one (whichever is less expensive to provide). The exception to this is in counties affected by subsidence, where a scheduled conversion to surface water is taking place.
b. Ms. Brown asked if we are paving over our groundwater recharge areas. The recharge areas for the aquifers in this region are in the northern, generally rural counties, where extensive development is not projected. Region H is more fortunate than some others in that respect.
c. Ms. Brown expressed concern about how transfers affect the losing basin. The regional plan utilizes local water sources before recommending transfers from other areas. Before a

transfer from one basin to another will be permitted by the State, a detailed analysis of the basin of origin must be conducted to ensure that it's long term water needs are met.

d. Ms. Brown suggested implementing incentives to encourage conservation by large water users. Industries are trending toward more water-efficient processes as they strive to reduce process costs. The RHWPG has recommended that the legislature address this issue and provide some guidance for local governments implementing these programs.

(5) John Pulvino, Lake Livingston homeowner.

a. Mr. Pulvino asked about the analysis conducted on tourism and recreation. Tourism and recreation information used in the report came from the Texas State Comptroller's Office and the local council of governments. One of the items discussed by the RHWPG was the lack of previous studies on the relationship of recreation/tourism and available water resources, such as Lake Livingston. Conducting such a study was beyond the scope and budget of this planning effort.

b. Mr. Pulvino stated that it appeared more analysis and concern was given to the southern portion of the region. The Regional Water Plan focuses on the areas with projected water shortages, which are predominantly in the southern and western counties. The northern and eastern counties receive equal attention in the Task 1, 2 and 3 Reports, where population, supply and demands are addressed. Beginning with the Task 4 Report, only those user groups with projected shortages are mentioned.

c. Mr. Pulvino asked what is meant by the phrase "until the existing uncommitted MWP water supplies are exhausted." The allocation of uncommitted MWP supplies was reworded to read “until existing supplies are fully allocated.” The available supply is defined as the firm (drought) yield of a reservoir

(6) Scott Ehni, Lake Livingston landowner.

a. Mr. Ehni objected to the sale of 200,000 ac-ft/yr of water from Lake Livingston to Houston, when Houston does not have a projected shortage. The City of Houston is looking beyond the 50-year planning horizon in wanting to secure supplies against future needs. Houston has more than enough supply to meet the demands within the city limits. As a regional water provider, the City must consider its growing customer base. It is much less expensive to enter a long-term contract agreement than it is to develop an additional water supply source. The price of the contract is listed as unknown because the two parties are still in negotiations.

b. Mr. Ehni stated that growth should be discouraged in areas without sufficient water. The siting of population growth is beyond the control or mandate of the RHWPG or the State.

c. Mr. Ehni asked about the affects of Bedias Reservoir on Lake Livingston. New upstream reservoirs will have some impact on Lake Livingston, but these impacts have not been studied in depth. Impact analysis will be included in the initial planning studies for any proposed reservoir.

(7) Byron Hays, The Huntsville Item.

a. Mr. Hays asked if a study had been done relating Lake Livingston storage volumes to lake levels. Tables were not developed as a part of this planning effort. Lake levels fluctuate, and historic data is available from the USGS showing recorded lake levels. The magnitude of

these fluctuations is of less concern than their frequency and duration. Even during the drought of record in the 1950's, there were periods where the lakes in Texas were full.

(8) Charles Morgan, Texas Department of Criminal Justice, Buffalo.

a. Mr. Morgan asked if prison populations were included in the plan. It was confirmed with the TWDB that institutional populations (such as prisons or colleges) are included in the municipal county-other populations.
b. Mr. Morgan expressed concern about groundwater availability for five TDCJ units in the Palestine area. That area is served by the Wilcox aquifer, which will not be affected by the projected use in this region.
c. Mr. Morgan asked about transferring water west from Lakes Houston or Conroe instead of from Lake Livingston. The currently unused supplies in Lakes Houston and Conroe are projected to be fully utilized during the 50-year planning period, so they are not available for transfer to the western portions of the region. Lake Livingston is projected to have available supply, so transfer options were considered for that source.
d. Mr. Morgan advocated conservation and xeriscaping. The plan was reworded to better explain the expected water conservation included in the demand projections, and the advanced water conservation recommended for user groups with projected shortages.
e. Mr. Morgan advocated increased use of reclaimed wastewater. Wastewater reclamation is a recommended strategy for manufacturing in Harris County. It is a potential strategy for other users, but there is a concern about the reduction of return flows to streams and reservoirs. The return flow concerns will need to be addressed in future studies.

(9) Mark T. Chalker, landowner in Bedias.

a. Mr. Chalker asked about the size and location of Bedias Reservoir. The proposed reservoir would sit on Bedias Creek south of Madisonville, and would cover approximately 27,400 acres. Additional information on this management strategy can be found in the Task 5 and Task 6 Reports.
b. Mr. Chalker asked when landowners would be affected by reservoir construction. The reservoir is recommended based on earlier studies, and additional, more detailed studies would be required before the water rights and construction permits could be issued. It will likely be fifteen to twenty years before the land acquisition begins for this project.

(10) Dave Buzan, Texas Parks and Wildlife Department, Austin.

a. Mr. Buzan thanked the region for recommending unique stream segments. No response is required.

(11) Lewis DeVore, Cove Marina, Riverside.

a. Mr. DeVore was concerned about the lack of conservation mentioned in the plan. The plan was reworded to better explain the expected water conservation included in the demand projections, and the advanced water conservation recommended for user groups with projected shortages.
b. Mr. Devore recommended a system of water allotments and penalties for over-use. These actions may be included in a water providers' water conservation and drought contingency plans. The State has required all public water suppliers to prepare drought contingency plans

and submit them to the TNRCC by October 2000. These plans will be addressed in the Regional Water Plan during the next planning cycle.

(12) David Kleimann, Willis.

a. Mr. Kleimann advocated conservation. The plan was reworded to better explain the expected water conservation included in the demand projections, and the advanced water conservation recommended for user groups with projected shortages.
b. Mr. Kleimann expressed concern that Groundwater Districts may become management districts. Groundwater Conservation Districts are formed to protect the resource. In Harris, Galveston and Fort Bend Counties where subsidence is an issue, the districts are taking actions to reduce the use of groundwater. The northern counties in the region have abundant supplies of groundwater and are looking at forming districts to prevent unregulated export of groundwater to other areas. In either case, these districts are controlled locally and can only regulate activities within their jurisdiction.
c. Mr. Kleimann expressed concern about the City of Houston's water leaks that were in the news. Nationally, most public water utilities lose ten to fifteen percent of their total flows to unaccounted losses, which include leaks, fire flows, hydrant flushing, and illegal connections. Houston made the news for two reasons. First, they had an above-average number of leaks at one time. Second, they occurred during a period of peak demand, so the losses made a greater impact on the system. Most of Region H is covered with Beaumont clay, which has a high shrink-swell potential. During a prolonged dry period, the shrinking soils place stress on buried pipes, creating more leaks and breaks than in an average year.

(13) Dan Lynam, Conroe Bay Civic Association, Willis.

a. Mr. Lynam asked how the plan would affect Lake Conroe levels, and if current conditions will become the norm. Lake levels fluctuate, and historic data is available from the USGS showing recorded lake levels. The magnitude of these fluctuations is of less concern than their frequency and duration. The effects of increased demands on these fluctuations were not modeled during this planning effort.

(14) Herschel Brannen, Trinity County.

a. Mr. Brannen asked why livestock and agricultural use are not projected to increase during the planning period. These projections came from Texas A&M and the TWDB, and are based on historic usage rates. However, there is sufficient groundwater in Trinity County to meet increased livestock demands should that occur.

(15) John Webb, Dodge Oakhurst Water Supply.

a. Mr. Webb asked if the plan would affect groundwater in Walker County. Walker County is not projected to have any shortages during the planning period.

<u>Responses to Public Comments from September 20, 2000, Houston</u>

(1) Stephanie Hrabar, Geologist.

a. Ms. Hrabar commented that the documents are not clear. Every effort was made to keep "technical jargon" out of the reports. Two additional reviews were conducted before the final

report was approved. A table of abbreviations was prepared and added to the front of each report following the table of contents.

b. Ms. Hrabar said that water quality and air quality need to be addressed. A section on water quality has been added to the Task 1 Report. Air quality has become an important issue related to growth and, through water quality effects, may be important to water supply, but it is beyond the scope addressed by the current water planning effort.
c. Ms. Hrabar commented on the rule of capture. The RHWPG has supported the rule of capture in areas where it works to allocate local groundwater supplies. The RHWPG supports the creation of groundwater conservation districts where management of the groundwater supply is necessary, for instance, because of subsidence or to prevent depletion of the aquifer.
d. Ms. Hrabar suggested that additional maps be included. This suggestion will be considered in the next update of the Regional Water Plan.
e. Ms. Hrabar commented that the Executive Summary should mention that water supply is critical to public health. The text of the Executive Summary has been revised.
f. Ms. Hrabar was concerned about stream segment designations. The "unique stream segments" recommended for designation are those recommended by TPWD as modified by the RHWPG and do not coincide with stream segments and segment numbers assigned to some streams by TNRCC. Given the different purposes of the designations, this should not be a problem.
g. Ms. Hrabar was concerned about lack of representation for TNRCC on the RHWPG. TNRCC chose to not have representatives on each of the 16 RWPGs because of staff time constraints, but participated in the development of planning guidelines and will review the regional water plans.

(2) Brandt Mannchen, Houston Sierra Club.

a. Mr. Mannchen suggests putting people where the water is and considering the carrying capacity of an area. The location of population growth is beyond the control or mandate of the RHWPG or the State. Carrying capacity is a concept that must be defined within a set of both natural and technological constraints. Water management strategies selected in the Regional Water Plan are technologically feasible. The decisions as to whether to pursue any given water project will depend on an assessment of the economic, cultural, and environmental costs involved based on project-level analysis.
b. Mr. Mannchen is concerned that recommended municipal conservation is low. The Regional Plan includes expected water conservation for all user groups and advanced conservation for those with projected shortages. The report text was revised to present this more clearly.
c. Mr. Mannchen is concerned that some natural areas were not adequately mentioned and suggested that additional streams in the Sam Houston National Forest be considered by designation as ecologically unique. The discussions of natural areas in the Task 1 Report and the Task 3 Report were expanded. The recommended streams were drawn from information provided by TPWD which covered 259 streams in Region H. Updates of the Regional Water Plan will consider new information about streams of ecological value as it becomes available.
d. Mr. Mannchen objected to Bedias Reservoir and the transfer to SJRA because of impact on the Sam Houston National Forest. Projects included in recommended management strategies will be subjected to detailed project-level analysis and reviews by regulatory agencies and

the public before final decisions to proceed are made. Impact studies will be part of those analyses.

e. Mr. Mannchen objected to a proposal to transfer water from Lake Livingston to Rock Creek in Grimes County. That proposal is not among the selected management strategies.
f. Mr. Mannchen objected to basing the Regional Water Plan on unrealistic assumptions that cause a crisis mode response. The Region H Water Plan is based on careful consideration of projected water needs and water supplies during time of drought. The analysis of economic impact of not meeting those water needs used worst-case assumptions to illustrate the possible magnitude of impact from not meeting any of the water needs. The choice of management strategies was not dependent on that economic impact analysis.
g. Mr. Mannchen objected to the difficulty in obtaining a hard copy of the draft plan and suggested a 60-day comment period. The RHWPG agrees that this initial planning period has been very compressed. Region H will seek to provide a longer comment period and greater availability of hard copy during the next plan update.

(3) Dave Moldal, National Wildlife Federation, Austin.

a. Mr. Moldal commented that an effective water plan must strike a balance between human, commercial, and environmental water needs. RHWPG agrees.
b. Mr. Moldal urged full and serious consideration to the environmental impacts of both existing and proposed water development projects. The RHWPG has seriously considered environmental impacts in all of its deliberations and supports continued analysis of environmental water needs. Proposed projects included in recommended management strategies will be subjected to detailed project-level analysis and reviews by regulatory agencies and the public before final decisions to proceed are made. Impact studies will be part of those analyses.
c. Mr. Moldal suggested that aggressive conservation be applied more broadly. A considerable amount of conservation is built into the water needs projections. The RHWPG is concerned about the ability to implement aggressive conservation programs in the areas where it is most needed – primarily in county-other and smaller communities. A recommendation to address this has been added to the Task 6 Report.
d. Mr. Moldal objected to the lack of analysis of specific actions to ensure freshwater inflows to Galveston Bay or to the tidal portion of the Brazos River. The RHWPG has supported the efforts of the Galveston Bay Freshwater Inflows Group (GBFIG) and incorporated GBFIG's recommended inflows statement into the Water Plan. A recommendation is included in the Task 6 Report to continue support of GBFIG's work to address the specific actions needed. The RHWPG plans to address freshwater inflow needs to the tidal portion of the Brazos River in the next update to the Water Plan.
e. Mr. Moldal said the Plan does not address adverse impacts of interbasin transfers and reservoirs. Impacts from diversions and impoundments were noted for each management strategy. Great specificity of impacts can come only from project-level analysis. Proposed projects also will be subjected to reviews by regulatory agencies and the public before final decisions to proceed are made.
f. Mr. Moldal said that the Plan does not address drought management measures to limit demand. Mr. Moldal is correct that there is no regional drought contingency plan.

Drought contingency plans are implemented by localities, who were required to file their plans with TNRCC by October 2000. This is an area the RHWPG plans to strengthen during the next Regional Water Plan update.

g. Mr. Moldal said that agricultural conservation measures should be extended beyond the three counties with water shortages. In general, sufficient groundwater exists to meet agricultural water needs outside the three counties with water shortages during times of drought, thus no water management strategies are required. The RHWPG encourages conservation by all water users.
h. Mr. Moldal objected to the lack of assessment of environmental impacts associated with construction for the three recommended reservoirs. Proposed projects included in recommended management strategies will be subjected to detailed project-level analysis and reviews by regulatory agencies and the public before final decisions to proceed are made. Impact studies for both construction and operation phases will be part of those analyses.
i. Mr. Moldal commented that the Little River Reservoir conflicts with a potentially ecologically significant stream segment. Review of the Region G Water Plan indicates that Region G did not recommend Little River for designation as an ecologically unique stream segment.
j. Mr. Moldal commented that an overall surplus of water in the region called into question moving forward with projects before a comprehensive review of environmental water needs is completed. The RHWPG has recognized the importance of additional studies for environmental water needs. It also has recognized the long lead times required for proper analysis and review of proposed water development projects. The RHWPG and project sponsors plan to pursue both.

(4) Dave Buzan, Texas Parks and Wildlife Department, Austin.

a. Mr. Buzan thanked the RHWPG for including ecologically unique stream segments and freshwater inflows to bays in the Regional Water Plan and encouraged the RHWPG to continue considering them in future deliberations. The RHWPG has included recommendations about support for further environmental studies in the Task 6 Report.

(5) Les Mauldin, Creekside Nursery, Waller County.

a. Mr. Mauldin commented that he could not find the nursery/floral part of agriculture accounted for in the Executive Summary. Water use by nursery/floral operations has been accounted for under manufacturing/industrial water use.
b. Mr. Mauldin commented that the Regional Water Plan should be consistent with USDA and Texas Agriculture Code, which consider nursery/floral as part of agriculture rather than industry. Water use classifications are designated at the state level. If this change is effected, it will be reflected in the next Plan update.

(6) Linda Shead, Galveston Bay Foundation, Webster.

a. Ms. Shead asked that the RHWPG continue considering freshwater inflows to the bay and also the value of instream flows to habitat and recreation. The RHWPG has included a recommendation for continued support for studies addressing environmental water needs and for the efforts of GBFIG.

b. Ms. Shead applauded the RHWPG for including ecologically unique stream segments and asked that they consider additional designations as new data are collected. New information on ecologically important streams can be considered in the next five-year plan update.
c. Ms. Shead suggested that additional aggressive conservation could be pursued. A considerable amount of conservation is built into the water needs projections. The RHWPG is concerned about the ability to implement aggressive conservation programs in the areas where it is most needed – primarily in county-other and smaller communities. A recommendation to address this has been added to the Task 6 Report.
d. Ms. Shead noted that good and effective ways to quantify aesthetic and recreational and natural habitat values of the region's resources are needed. The RHWPG agrees, and as studies are completed that contribute to the ability to quantify those values, that information will be incorporated into plan updates.
e. Ms. Shead thanked the RHWPG for finding a creative way to include freshwater inflows in the report even though the TWDB table formats did not include environmental water. No response is required.
f. Ms. Shead commented on the importance of finding a balance of interests and thanked the RHWPG for looking for that balance. No response is required.

(7) Jack Weatherford, Weatherford Farms, Stafford.
a. Mr. Weatherford asked for an explanation of how the Subsidence District fits into the picture of groundwater rule of capture. In the counties of Harris, Galveston and Fort Bend, the two subsidence districts have the authority to regulate the withdrawal of groundwater in order to prevent subsidence. The groundwater rule of capture is operative when there is no groundwater conservation district, such as the subsidence districts, whose groundwater management activities override the rule of capture.

<u>Responses to Public Comments from September 21, 2000, Chambers County</u>

(1) Linda Shead, Galveston Bay Foundation, Webster.
a. Ms. Shead thanked the RHWPG for addressing freshwater inflows to Galveston Bay, for accepting the recommendations of the GBFIG, and for recommending continued funding to support that effort. No response is required.
b. Ms. Shead applauded the recommendation of ecologically unique stream segments and suggested that additional streams be considered for designation when data are available to assess their value, noting that no Chambers County streams were included. New information on ecologically important streams can be considered in the next five-year plan update.

(2) Bobby Edwards, Stowell.
a. Mr. Edwards is concerned about bad past experiences with administrative procedures of TNRCC, and that the RHWPG might be seeking additional administrative procedures. The RHWPG operates within the rules and guidelines of the TWDB.
b. Mr. Edwards has reviewed the plan and found no fatal flaw. No response is required.

<u>Responses to Written Comments Received</u>
(1) Hon. Joe Adams, County Judge, San Jacinto County.

a. Judge Adams expressed concerns over the economic impacts of low lake levels on San Jacinto County. This issue was discussed extensively by the RHWPG. Unfortunately, no previous studies had been conducted on these impacts, and the scope of this project did not allow for initiating a new economic study. The IMPLAN model used to assess the economic impacts of not addressing water needs looked at water supply shortages on consumptive uses. Because the Regional Water Plan was prepared to ensure water demands are met during a drought period, it is expected that water supply reservoirs will be used to capacity. However, lake levels should not be permanently reduced. Rather, low lake levels are seen as a temporary condition resulting from periods of extended drought, just as flooding results from periods of extended rain. Now that demands on reservoirs have been projected, the normal pool elevations can be determined for periods of average rainfall, as well as the impacts on existing shorelines and facilities. This cannot be completed in time for inclusion in this Regional Water Plan, but these impacts can be included in the first update of the plan.

(2) Pat Brown, Woodlands GREEN.

a. Ms. Brown's first concern was that the planning process did not begin with a calculation of the region's carrying capacity, and then limit growth based upon that capacity. Carrying capacity is a concept that must be defined within a set of both natural and technological constraints. Water management strategies selected in the Regional Water Plan are technologically feasible. The decision to pursue any particular water project will depend on an assessment of the economic, cultural, and environmental costs involved based on project-level analysis. The limits of existing water resources within the region were discussed by the RHWPG, but it was understood that population growth occurs due to many factors, with available natural resources being only one. The RHWPG did not wish to recommend that the state dictate where future populations can and cannot live, therefore the plan was developed to meet the projected demands.

b. Ms. Brown's second concern was the limited amount of wastewater reuse within the plan. Many of the industries in our region do recycle flows through their plants in order to reduce water costs. The amount of recycling is balanced with the cost of treating wastewater before returning it to a stream or estuary (the more it is reused the more treatment it requires). Wastewater reuse was recommended along the Houston Ship Channel, where supply from municipal wastewater plants are available and the recycled water will still be returned to the estuary. Extensive reuse was not recommended for upstream portions of the region, mainly due to the downstream need for those return flows. Reuse for landscape and golf course irrigation is encouraged, provided that the safety standards established by the Texas Natural Resources Conservation Commission are met.

c. Ms. Brown called attention to the fact that water conservation is recommended for most of Montgomery County, but not for the Woodlands. A significant amount of conservation is, in fact, expected to occur throughout the region, but it is not readily apparent in the draft reports. The projected water demands used for the plan assume "below average rainfall and expected conservation." That conservation comes from low-flow plumbing fixtures, graduated water rates and expected improvements in industrial and irrigation conservation methods, and amounts to almost a twenty-percent savings. Advanced conservation, which includes practices such as increased public education and water supply system audits, was

recommended only for those communities with shortages, but there is no reason that every community cannot choose to implement some or all of these measures.

d. Ms. Brown suggests that Harris County, which accounts for 48 percent of the projected demand, should bear a proportional share of the accountability. In fact, the plan placed the responsibility for increasing conservation and developing new supplies on those water user groups with projected shortages. Those communities that developed water supply projects in the past with an eye towards future growth are now realizing the benefits from those investments.

(3) Hon. Susan Combs, Commissioner, Texas Department of Agriculture.

a. Commissioner Combs noted that the Region H irrigation projections are greater than those in the Trans-Texas Water Plan, which is a direct result of the diversity of representation on the RHWPG. The RHWPG is made up of representatives of the varied water interest groups. The agricultural representatives did an outstanding job of educating the RHWPG about the potential for continued production within Region H.

b. Commissioner Combs recommended that the state fund incentives to implement agricultural conservation. The RHWPG discussed irrigation conservation at great length, particularly the issue of funding and assistance to farmers. The recommendation that the state fund implementation incentives for irrigation conservation has been included in the Task 6 Report.

c. Commissioner Combs asked that nursery and floral use be classified as agricultural use rather than as manufacturing. This distinction is made in the planning guidelines set out by the Texas Water Development Board. The RHWPG has concentrated on making sure that there is adequate water supply for the next fifty years for nursery/floral water uses however they are classified. If a change in classification is effected, it will be reflected in the next updated water plan.

(4) Eddy D. Edmondson, President, Texas Nursery & Landscape Association.

a. Mr. Edmonson recommends that floriculture and horticulture be listed as agricultural and not industrial water use. The placement of these uses under the manufacturing use category is consistent with the planning guidelines set out by the Texas Water Development Board. The RHWPG has concentrated on making sure that there is adequate water supply for the next fifty years for nursery/floral water uses however they are classified. If a change in classification is effected, it will be reflected in the next updated water plan.

(5) Myron J. Hess, Counsel, National Wildlife Federation.

a. Mr. Hess is concerned about the recommendation of new reservoir projects while the region has a net projected surplus. However, this surplus is predominantly in the northeast portion of the region, while the projected shortages are mainly in the western and southern portions of the region. Also, a significant portion of the projected surplus is distributed among numerous water contracts and water rights holders, and cannot be consolidated and moved to meet projected demands. Therefore, the region ends up with an effective shortage.

b. Mr. Hess favors additional water conservation. The RHWPG agrees that water conservation is a critical element in the plan. All water users are expected to attain a certain amount of water conservation. However, the plan does not include a projection of water demands with

no conservation in place, and so the amount of demand reduction is not apparent. Many people have commented on this omission, and text of the report has been clarified.

The savings from advanced water conservation measures for municipalities are not constant over time because some of the "advanced" measures later fall in the "expected" category, and are already accounted for. Because advanced conservation requires additional efforts by the local government and water suppliers, it is recommended only for those municipalities with shortages. However, the City of Houston, which does not have a projected shortage, has already elected to implement advanced conservation methods.

Mr. Hess recommends that irrigation conservation be applied to all counties with significant rice farming. While the planning group encourages all irrigators to take conservation steps, the RHWPG has limited the requirement to those counties with projected shortages. Should funding assistance become available to farmers, the next plan update may include agriculture in other counties.

c. Mr. Hess points out that the plan does not address specific drought management actions to be taken should trigger conditions be reached. As the RHWPG looked at the demand projections, the difference between water demands in drought and normal years was small (five to ten percent lower). While drought measures will be required for individual communities due to treatment and conveyance limitations, the region as a whole will require all of the additional supplies recommended in the plan. Therefore, drought management was not addressed. The State has required all public water suppliers to prepare drought contingency plans and submit them to the TNRCC by October 2000. These plans will be addressed in the Regional Water Plan during the next planning cycle.
d. Mr. Hess is concerned about environmental flows and inflows to the bays and estuaries. The RHWPG relied upon previously prepared reports and studies for information, and agrees that additional specific studies are required. The RHWPG is still addressing the issue of how to allocate flows against environmental needs, since they are not currently included in the state's list of water user groups. Clarifying revisions to the text were made when possible.
e. Mr. Hess identified omissions from Appendix C of the Task 3 Report. The listing will be updated accordingly.
f. Mr. Hess raised several concerns about the discussion of social, environmental and economic impacts in the Task 5 Report. Text revisions were made when possible. Some of the environmental questions Mr. Hess raised will require additional study that was not funded in this planning process.
g. Mr. Hess commented on the proposed management strategies. In regard to contractual transfers, the water right or contract holders who were considered were not specifically listed. Additional transfers were not made for a variety of reasons. These included: surpluses in Chambers County that were not easily transported to areas with shortages; surpluses existing in numerous small contracts that were significant only in the aggregate; and water users holding rights or contracts in anticipation of long-term growth beyond the planning period. This management strategy will be revisited with each update of the plan.

Mr. Hess expressed numerous concerns about the proposed and recommended reservoir projects. The plan is based upon a review of previously prepared project studies, and

detailed future studies will be required. Should those studies reveal unacceptable impacts related to a project, the planning group will amend its recommendations.

Mr. Hess raises a concern about the discharge plan for reject water from the proposed wastewater reclamation facility. This discussion will be clarified in the report.

Mr. Hess's concerns about the San Jacinto River Authority / City of Houston Water Transfer may be well founded. This strategy was discarded because the parties did not come to agreement.

Mr. Hess has concerns about the Luce Bayou Interbasin Transfer. This transfer is specifically permitted in the City of Houston's Lake Livingston water right. However, the Texas Natural Resources Conservation Commission is the approval agency for all conveyance facility plans, and they have the responsibility of ensuring that any and all environmental impacts are reduced and mitigated.

Mr. Hess has concerns about the City of Houston / Trinity River Authority contract agreement. The demand projections for the region show that Houston will not need this water until 2050 at the earliest. The City of Houston is securing existing water supplies to meet long term potential growth. When the City applies for an interbasin transfer permit, all of the issues he raised will be addressed.

Mr. Hess has concerns about the other considered interbasin transfers to and from the Trinity River Basin. These projects were not recommended as management strategies for many of the same reasons he identified.

h. Mr. Hess expressed concerns about the designation of unique reservoir sites and unique streams. The implications of designating unique reservoir sites do not appear as restrictive as he suggests, since identifying a site is not a commitment to construct the reservoir. Designating unique streams, however, does carry implications of future restrictions applied to those streams**.** The planning group has requested clarification on this issue. New information on ecologically important streams can be considered in the next five-year plan update.

i. Mr. Hess' observation about the recommendation to end cancellation of water rights is accurate. Wording of the text will be revised.

j. Mr. Hess is concerned about the recommendation to continue the Rule of Capture. This recommendation is included in support of the rural portions of the region, which have adequate groundwater supplies. As stated in the recommendation, the rule of capture should remain subordinate to resource management by local groundwater districts.

(6) Mr. Billy Howe, Associate Legislative Director, Texas Farm Bureau.

a. Mr. Howe commented on interbasin transfers and the affect of increased water costs on irrigators. Region H is already dependent on interbasin transfers from both the Brazos and the Trinity Rivers. The RHWP recommendations for future interbasin transfers were made only after conservation, reuse and new supply development strategies were selected. The

RHWPG has recommended that the state fund future studies that will provide more options for irrigators to make optimal use of the water they already have.

(7) Hon. Troy Lewis, Mayor, City of Alvin.

a. Mr. Lewis is concerned about the accuracy of population growth projections. The RHWPG shares your concerns about accurately representing population growth throughout the unincorporated areas of the region. A recommendation to the Water Development Board that the population projections be updated as soon as the 2000 Census data becomes available has been included in the Task 6 Report, and all local governments are encouraged to participate in the next five-year update of the plan.

b. Mr. Lewis requests that a locally prepared plan be incorporated into the Regional Water Plan. The RHWPG appreciates the efforts made in initiating regional water planning for Mid-Brazoria County. The RHWPG understands the benefits of locally prepared plans, and looks forward to incorporating those results in the regional plan. Recognition of the Mid-Brazoria Water Planning Group has been added to the Task 1 Report.

(8) Brandt Mannchen, Conservation Committee, Houston Sierra Club.

a. Mr. Mannchen's first concern was about the public participation process and the availability of the report for review. The public participation process began two years ago, with a series of public meetings held to introduce the public to the planning process. Those that attended the meetings received handout materials and copies of our newsletter. Additional public meetings and meetings with organizations were held when the population and demand projections were developed, and when the supply projections were developed. The final series of public hearings were held to review the draft plan. The RHWPG at its monthly meetings has welcomed public comments throughout the planning process. As for the availability of the report documents for review, the placement of reports in county clerks offices and libraries is required under the regional water planning rules per 31 TAC 357.12(b). Additional copies were not initially made, but are now available from our consultant team at cost. The RHWPG is committed to full public participation and will continue to seek expanded communication with the public during the next five-year update of the plan.

b. Mr. Mannchen has concerns about the recommendation of new reservoirs while the region is projected to have a net surplus of water. What is not readily apparent in the executive summary is that the surplus exists in the northeast portion of the region, while the shortages occur in the western and southern portions of the region.

c. Mr. Mannchen suggests limiting populations to the carrying capacity of the region. Carrying capacity is a concept that must be defined within a set of both natural and technological constraints. Water management strategies selected in the Regional Water Plan are technologically feasible. The decisions as to whether to pursue any given water project will depend on an assessment of the economic, cultural, and environmental costs involved based on project-level analysis. The location of population growth is beyond the control or mandate of the RHWPG or the State.

d. Mr. Mannchen is correct that the Executive Summary does not discuss interaction with the adjoining regions. Region H directly interacts with Region G through the Brazos River Authority, and with Region C through the Trinity River Authority. These river authorities sit

on the regional water planning groups in both regions and have been involved in the planning process since the beginning. Region I has a liaison member of the RHWPG, and several joint meetings between Region H and Region I have occurred. This interaction was overlooked and will be described in the final report.

e. Mr. Mannchen expressed concern about the Sam Houston National Forest. Several of the management strategies considered included proposals for a pipeline from Lake Livingston along the Highway 190 right-of-way, but the planning group recommended against each of these. The development of Bedias Reservoir was recommended to meet the projected needs of Montgomery County. The transfer of this water is not anticipated to have a significant impact on the portion of the West Fork of the San Jacinto River within the National Forest. This recommendation is based upon a review of existing studies, and detailed follow-on work remains to be completed. If the project studies reveal the impacts will be unacceptable, the RHWPG will consider alternative supply strategies in the next five-year update of the plan.

f. Mr. Mannchen expressed similar concern about the need to protect the other natural areas in the region. While these protections are not expressly covered in the plan, they are not deliberately omitted, and will be incorporated in future updates as new information becomes available and appropriate protective strategies are addressed.

g. Mr. Mannchen states that there are more than six valuable stream segments in the region. The RHWPG agrees. Clarification from the state as to the full implications of designating streams as unique has been requested. Once those implications are known, the RHWPG will consider adding other stream segments from the list compiled by the Texas Parks and Wildlife Department or from new information. Mr. Mannchen's recommendation about streamside zone protection being needed will be considered for future updates of the plan.

h. Mr. Mannchen's comment about demands not being the same as needs is technically accurate. For purposes of the Regional Water Plan, the terms "demand" and "need" are used interchangeably, and refer to projected water demands in both cases.

i. Mr. Mannchen is concerned about the estimated costs of the various strategies. The RHWPG has assembled estimates within the guidelines set out by the Water Development Board that are as realistic as possible. All prices shown have been converted to 1999 dollars as the standard for comparison.

j. Mr. Mannchen is correct that there are many impacts to be addressed when an interbasin transfer is recommended. Our recommendations are based upon previously prepared studies and existing transfer permits. The Texas Natural Resources Conservation Commission is the approving agency for future transfer permits, and their regulations require the impacts to both the source and destination basins be identified and addressed.

k. Mr. Mannchen expressed concern about water conservation and it's inclusion in the plan. A minimum level of conservation is expected from all water users. This reduction is not readily apparent because the water demands without conservation were not included in the plan report. However, a per capita demand reduction of 15 - 20% is realized, when compared to earlier per capita projections made without conservation. The City of Houston has elected to implement an advanced conservation program, which further decreases the demand projections. Advanced conservation is recommended for communities with projected shortages, which is why the level of conservation seems small. This discussion will be clarified in the report.

l. Mr. Mannchen is concerned about the river authorities and engineering consultants running the study and potential conflicts of interest. The RHWPG is made up of representatives from various water interest groups, including agriculture, county government, electric generating utilities, environmental groups, industries, municipalities, river authorities, small businesses, water districts, water utilities and the public-at-large. No one interest group has a majority or a veto vote. The consultant team prepares reports at the direction of the RHWPG, and does not have a vote on the plan. All of the meetings are open to the public, and are advertised in accordance with the Texas Open Meetings Act.

m. Mr. Mannchen objected to basing the Regional Water Plan on unrealistic assumptions of the economic impact model. The Region H Water Plan is based on careful consideration of projected water needs and water supplies during time of drought. The analysis of economic impact of not meeting those water needs used worst-case assumptions to illustrate the possible magnitude of impact from not meeting any of the water needs. The choice of management strategies was not dependent on that economic impact analysis.

n. Mr. Mannchen states that livestock water demands should decrease. The RHWPG does not agree with your prediction of livestock water demands.

o. Mr. Mannchen is concerned about changing the notification requirements for plan amendments. It is not the intent of the group to exclude anyone from the review process, but to reduce the notification requirements for amendments that are truly local in nature.

p. Mr. Mannchen is concerned about introducing flexibility in the management strategies. The current planning guidelines allow the planning group to recommend only one strategy or set of strategies to meet a community's projected needs for the first 30 years of the planning period. Many community master plans do not look beyond five or ten years. The RHWPG would prefer to recommend several strategies for these communities, all of which would meet the planning guidelines and criteria. Once the community or local water authority adopts one and adds it to their master plan, the RHWPG would update the regional plan accordingly. This would result in fewer amendments to the plan.

q. Mr. Mannchen is opposed to removing barriers to interbasin transfers of water. Region H already depends on interbasin transfers of water, both from the Trinity River Basin and from the Brazos River Basin. Region H also has recognized the importance of instream flows and flows to bays and estuaries. Proposed interbasin transfers will be scrutinized at the project level by regulatory agencies and the public to ensure that the transfers do not negatively affect the basin of origin.

r. Mr. Mannchen suggests that the current RHWPG be expanded. The RHWPG had lengthy deliberation about its membership, which must represent all interests affected by water supply as well as the widespread geography of this region. The number of members was set in the bylaws at a maximum of 25 to provide a workable size group while meeting the objectives of representation.

s. Mr. Mannchen objects to the recommendation for implementation funding. The RHWPG thinks that state funding assistance is needed to implement recommended management strategies, including reservoir projects. This does not mean that unwarranted projects will be built. Project level reviews will still occur.

t. Mr. Mannchen is concerned about the brine disposal associated with desalination. Plant location decisions are based as much upon disposal options as upon proximity to a water

source. However, when the brine can successfully be disposed of, a coastal desalination facility can have a more reliable supply than a reservoir, with fewer environmental impacts.

u. Mr. Mannchen is concerned about the affects of sedimentation on reservoirs and on coastal erosion. This has been studied in the past and remains an area of concern. Mr. Mannchen's recommendation to not build more reservoirs until this issue is resolved could result in growing populations overusing groundwater. In a coastal region subject to subsidence, this will also contribute to coastal erosion.

(9) Les Mauldin, Creekside Nursery, Hempstead.

a. Mr. Mauldin recommends that nursery and floral be listed as agricultural and not industrial water use. The placement of these uses under the manufacturing use category is consistent with the planning guidelines set out by the Texas Water Development Board. If this change is effected at the state level, it will be reflected in the next Plan update.

(10) Carlos H. Mendoza, Project Leader, Clear Lake Field Office, U.S. Fish and Wildlife Service.

a. Mr. Mendoza commented that environmental studies are required for the proposed reservoirs and inter-basin transfers. Of the projects listed, only Allen's Creek Reservoir currently is in the permitting process. The RHWPG understands that the planning and approval process for the remaining projects may take years to complete. The RHWPG also agrees that additional environmental flow studies for estuaries are required, and has recommended that the state continue funding for these studies. The inclusion of these projects as management strategies in the Region H Water Plan is the first of many steps that must be taken before they can be implemented.
b. Mr. Mendoza pointed out the omission of the Trinity River National Wildlife Refuge in our description of the region. The Task 1 Report will be updated accordingly.
c. Mr. Mendoza recommends adding the freshwater inflow requirements for Galveston Bay to the Task 2 Report. The inflow requirements are already included in the report, but may be difficult to find. They are included as Table 2A in Appendix A, which summarizes the recommended minimum and optimal flows for the bay.
d. Mr. Mendoza suggests adding a Table of Contents and clarifying the freshwater inflow definitions in the Task 3 Report, and adding a Table of Abbreviations to each Task Report. These changes and additions will be made.
e. Mr. Mendoza expresses a concern about freshwater inflows not being directly addressed in the Task 4 report. Although the unused portions of existing water rights will meet some of these flows, a formal analysis of these flows has not been completed. Text will be clarified when possible.
f. Mr. Mendoza suggests that environmental mitigation costs be included in the estimated cost of reservoirs and interbasin transfers. Estimates of environmental mitigation costs are included. These initial estimates may be low. The cost estimates for reservoirs used in the regional water plan are based upon previous studies. The cost of interbasin transfer strategies were calculated as part of this report, and the mitigation costs are calculated using topographic map data and average land costs. The RHWPG agrees that detailed environmental studies and cost estimates should be prepared for all of the recommended strategies.

g. Mr. Mendoza recommends that the state designate an agency to manage water use for Galveston Bay. The Galveston Bay Freshwater Inflows Group is assisting the RHWPG in developing management strategies to meet freshwater inflow needs, and Mr. Mendoza's recommendation will be forwarded to GBFIG. When their work is complete, GBFIG will make management recommendations to the RHWPG for incorporation in an updated Regional Water Plan.

(11) Craig Nisbett, P.E., Public Works Director, City of Lake Jackson.

a. Mr. Nisbett is concerned about the allocation of groundwater for Lake Jackson. The starting point for determining the available groundwater for Brazoria County, was the historic peak groundwater use, as recorded by the Texas Water Development Board. The peak usage for Lake Jackson was recorded in the late 1980's, just before the city began purchasing water from the Brazosport Water Authority. Groundwater supplies were then increased proportionally for all municipalities, until the sustainable yield of the aquifer was met. Because this method did not address existing well-field capacity, Lake Jackson was not allocated more than this proportional increase. The RHWPG understands that the current use of surface water in your area was based upon concerns over the quality of the groundwater. For more groundwater supply to be allocated to Lake Jackson, an equal amount of supply must be taken away from other groundwater users. Because this issue does not affect the first five years of the planning period, the RHWPG will revisit all of the groundwater users in southern Brazoria County and reflect the changes in the first periodic update of the plan.

(12) Marianne Pape, Houston.

a. Ms. Pape asked for information about the proposed Bedias Reservoir. The Bedias Reservoir is located on Bedias Creek in the Trinity River Basin, at the junction of Madison, Walker and Grimes Counties. It would impound water above Lake Livingston, and is recommended as a source of supply for the San Jacinto River Basin. This interbasin transfer will require the additional construction of a pump station and pipeline to move this water over the basin divide and into the San Jacinto River.
b. Ms. Pape commented that better use should be made of San Jacinto River water. The RHWPG encourages efficient use of all water. Demands in the San Jacinto basin exceed water supply in that basin.
c. Ms. Pape asked for the name of the state contact. The RHWPG has developed this plan under the guidance of the Texas Water Development Board, whose liaison with Region H is Mr. Ernest Rebuck, P.E.
d. Ms. Pape asked where a copy of the Plan can be obtained. Copies of the Draft Regional Water Plan are available for public review in your county at the Harris County Clerk's Office, 1001 Preston Ave, Houston, at the main branch of the Houston Public Library, and on the Texas Water Development Board website, www.twdb.state.tx.us. A copy of the complete 7-volume report may be purchased from the Region H consultant team, whose project manager is Mr. Jeff Taylor at Brown & Root Services.

(13) Wayne Sabo, City Administrator, City of Manvel.

a. Mr. Sabo observed that the population projections for some portions of Region H, and his portion of Brazoria County in particular, are low. The RHWPG has recommended to the

Water Development Board that these estimates be revised when the 2000 census data becomes available. The City of Manvel is encouraged to review the revised projections once they are prepared and to participate in the next five-year plan update.

(14) Andrew Sansom, Executive Director, Texas Parks and Wildlife Department, Austin.

a. Mr. Sansom thanked the RHWPG for recommending streams for designation as unique ecological stream segments and addressing freshwater inflows to Galveston Bay. The RHWPG would like to thank the Texas Parks and Wildlife Department for their ongoing support of the planning process, particularly in the area of unique stream segments. The data and analysis provided to the RHWPG was invaluable in the decision process. The planning group has requested clarification of the implications of the designation and will consider new information on ecologically important streams and additional designations in the next five-year plan update.

(15) Linda R. Shead, P.E., Executive Director, Galveston Bay Foundation, Webster.

a. Ms. Shead expressed concern about implementation of two recommended management strategies before their impacts on instream flows and freshwater inflows into Galveston Bay are known. The RHWPG has recommended several management strategies that may divert water from the Trinity River and affect these flows. However, none of these is recommended for immediate implementation. As more information about the impacts becomes available, the RHWPG may modify the plan or implement additional strategies to protect the bay. The RHWPG continues to support the work of the Galveston Bay Freshwater Inflows Group to address the issue of how to allocate flows for environmental needs.
b. Ms. Shead suggested that addition streams be considered for designation as ecologically unique. The planning group has requested clarification of the implications of the designation and will consider new information on ecologically important streams and additional designations in the next five-year plan update.
c. Ms. Shead commented on the level of conservation in the plan. It is difficult to see the amount of savings anticipated from "expected conservation" because the demand projection with no conservation is not shown. This makes the additional savings under "advanced conservation" seem understated. The text will be revised to clarify this.

(16) Mr. William C. Wade, Clute.

a. Mr. Wade is concerned about the treatment capacity of the Brazosport Water Authority. Growth and demand projections indicate that there is insufficient groundwater in southern Brazoria County to meet future demands. Therefore, the municipalities in that area must rely more on surface water in the future. The Brazosport Water Authority is currently the only provider of treated surface water in the area, and their inclusion in the Region H plan allows them to approach the Texas Water Development Board for assistance in plant expansions. The municipalities in the area may elect to purchase water from the Brazos River Authority and treat it independently of the BWA. Should that be their choice, that change will be incorporated into updates of the regional plan.
b. Mr. Wade is concerned about saltwater intrusion into the Dow reservoirs. The RHWPG is aware of this issue and is working to develop strategies to address saltwater intrusion in the next five-year plan update.

(17) Mary Ellen Whitworth, P.E., Executive Director, Bayou Preservation Association, Inc.

a. Ms. Whitworth supports the designation of Armand Bayou as a unique stream segment. No response is required.
b. Ms. Whitworth supports freshwater inflows of sufficient magnitude to support a productive healthy Galveston Bay. The RHWPG has supported the efforts of the Galveston Bay Freshwater Inflows Group (GBFIG) and incorporated GBFIG's recommended inflows statement into the Water Plan. A recommendation is included in the Task 6 Report to continue support of GBFIG's work to address the specific actions needed
c. Ms. Whitworth is a strong supporter of water conservation measures. The RHWPG also supports water conservation. The Regional Plan includes expected water conservation for all user groups and advanced conservation for those with projected shortages. The City of Houston, which does not have a shortage during the planning period, has elected to implement advanced conservation and this is reflected in the plan's demand projections.

(18) Marvin and Doris Williams, Bedias.

a. Mr. And Ms. Williams advocate stronger conservation education and guidelines. The RHWPG agrees. A minimum level of conservation is expected from all water users. This reduction is not readily apparent because the water demands with no conservation were not included in the plan report. The City of Houston has elected to implement an advanced conservation program, which further decreases the demand projections. Because all communities are projected to meet the expected conservation targets, the advanced conservation measures recommended in the plan seem small. This discussion will be clarified in the report.
b. Mr. and Mrs. Williams expressed concerns about the development of Bedias Reservoir, and the rights of the current landowners. The recommendation of this reservoir for development is only the beginning of a long process of environmental, hydrologic and economic study. During that process, the property rights of the current landowners should be addressed, and the landowners will be allowed to provide input and comments. If finally constructed, the public agency constructing the reservoir will purchase the required land, and will be required by the state to ensure that the landowners receive just compensation.
c. Mr. and Mrs. Williams asked about the potential impacts on groundwater, should surface water be moved within the region. No major impacts are foreseen at this time, but that issue will be further addressed during the planning studies for the recommended projects. The Texas Natural Resources Conservation Commission requires these studies, and will not approve a water rights permit for projects that adversely affect existing water resources.

(19) Norman Young, Coldspring.

a. Mr. Young has concerns about the environmental impacts of developing new reservoirs in the region. While it is true that the region is projected to have a net surplus of water supply in 2050, not all of this supply is available to meet needs in areas with projected shortages. A significant portion of the surplus exists in the Lake Livingston - Lake Wallisville system, while the demands are in the southwestern portion of the region. Construction of a conveyance system from Lake Livingston to the areas of need would impact the Sam Houston National Forest, as well as the Lower Trinity River Basin. Even if completed, the

supply made available would not be sufficient to meet all projected demands. Any new supply strategy recommended will have some environmental impacts. The RHWPG will work to ensure those impacts are minimized. The RHWPG also is open to alternate strategies should they arise in the future.

b. Mr. Young expressed concern about the level of conservation included in the plan. A minimum level of conservation was expected from all water users. This reduction is not apparent because the water demands with no conservation were not included in the report. The City of Houston has elected to implement an advanced conservation program, which further decreased the demand projections. Because all communities are projected to meet the expected conservation targets, the advanced conservation measures recommended in the plan seem small. This discussion will be clarified in the report.