

TRANS-TEXAS WATER PROGRAM

SOUTHEAST AREA

Technical Memorandum

Contractual Transfers

March 24, 1998

**Sabine River Authority of Texas
Lower Neches Valley Authority
San Jacinto River Authority
City of Houston
Brazos River Authority
Texas Water Development Board**

Preface

This document is a product of the Trans–Texas Water Program: Southeast Area. The program’s mission is to propose the best economically and environmentally beneficial methods to meet water needs in Texas for the long term. The program’s four planning areas are the Southeast Area, which includes the Houston-Galveston metropolitan area, the South-Central Area (including Corpus Christi), North-Central Area (including Austin) and the West-Central Area (including San Antonio).

The Southeast Area of the Trans–Texas Water Program draws perspectives from many organizations and citizens. The Policy Management Committee and its Southeast Area subcommittee guide the program; the Southeast Area Technical Advisory Committee serves as program advisor. Local sponsors are the Sabine River Authority of Texas, the Lower Neches Valley Authority, the San Jacinto River Authority, the City of Houston and the Brazos River Authority.

The Texas Water Development Board is the lead Texas agency for the Trans–Texas Water Program. The Board, along with the Texas Natural Resource Conservation Commission, the Texas Parks & Wildlife Department and the Texas General Land Office, set goals and policies for the program pertaining to water resources management and are members of the Policy Management Committee.

This is the final version of this document.

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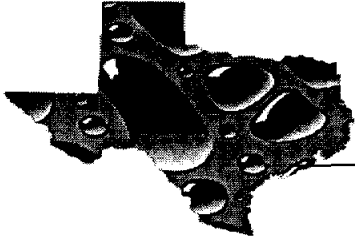
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1. Introduction

The Trans-Texas Water Program (TTWP) Southeast Area Phase I Report identified thirteen water management alternatives for possible inclusion in the final TTWP Southeast Area Water Management Plan. This memorandum presents the analysis for one type of the water management strategies, contractual transfers.

A contractual water transfer is the temporary or permanent transfer of water supplies, from one party to another, which may or may not involve an exchange of water rights. The primary advantage of contractual transfers is the opportunity to reduce or defer the construction of major new water conveyance facilities. Contractual transfers make the most efficient use of existing water supplies by allocating available supplies to entities needing the water.

Four specific contractual transfer alternatives were recommended for further study in Phase II of the TTWP Southeast Area. These four alternatives include:

- Replacing Brazos River water owned by the Gulf Coast Water Authority with other available supplies.
- Replacing Lake Conroe water owned by City of Houston with other available supplies.
- Replacing City of Houston and Trinity River Authority water with other

available supplies in order to meet West-Central study area needs.

- Transferring irrigation water supplies to municipal or industrial purposes.

The contractual transfers analyzed in this study focus on securing available “excess” water supplies and conveying these supplies into regions of need, especially where such conveyance can be wholly or partially made through contractual mechanisms without the need for actual physical conveyance. Details beyond the scope of this study include: determination of specific contracting entities; terms of necessary agreements; and determination of necessary retail water system improvements required to convey supplies to end users. This study does however provide analysis of the availability of excess supplies and generally illustrate methods of conveying raw water supplies to areas of need. The value of this study will be to illustrate possible opportunities for water suppliers to secure additional water resources without full development of major water projects.

The TTWP Planning Information Update report indicates that within the entire 32 county study area, the largest sub-area of water supply need is within the Houston region. Water supply shortages within the Houston region are projected to occur as early as year 2020 in the Brazos basin, and significant shortages are projected to occur within the San Jacinto basin by year 2040. This technical memorandum

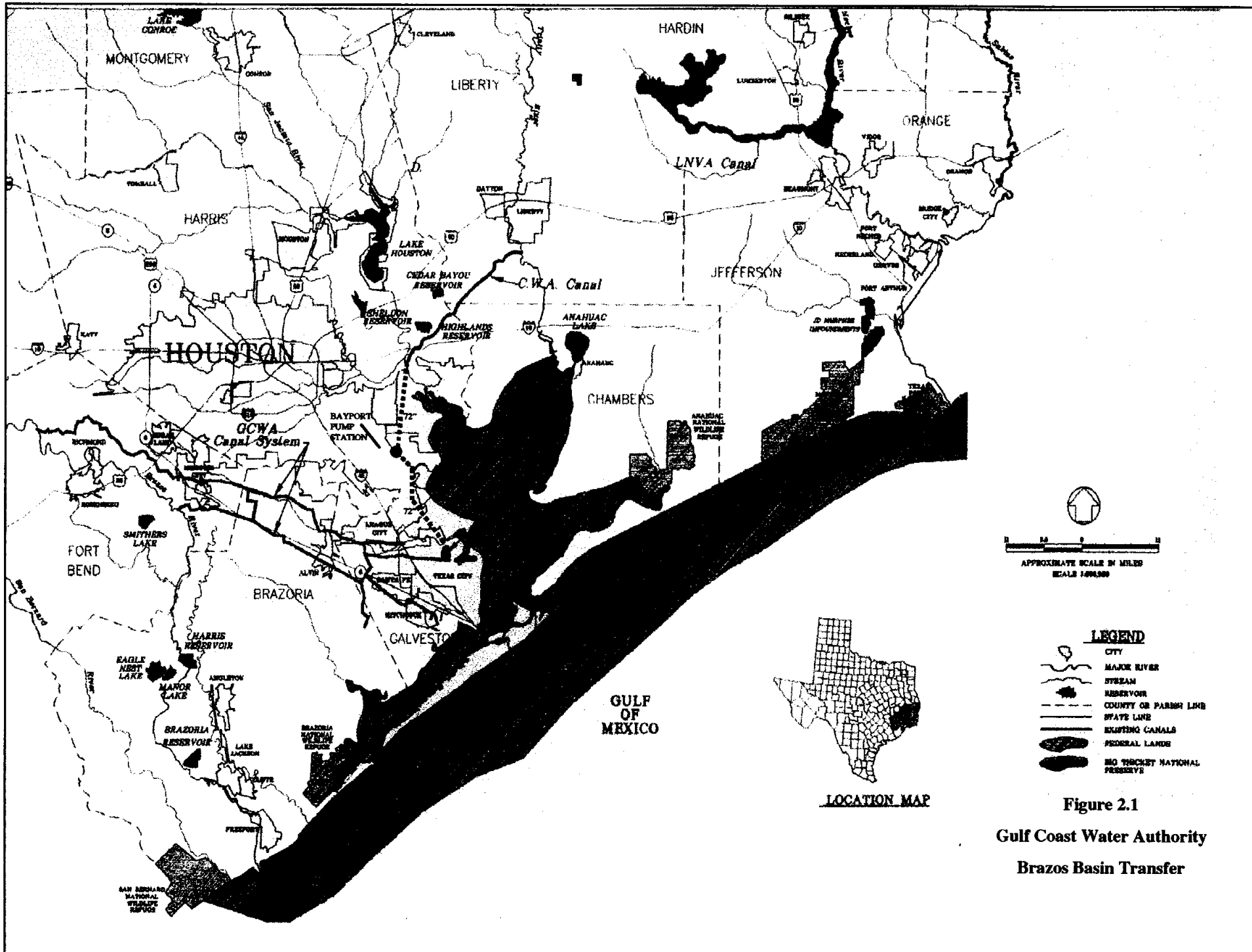


Figure 2.1
Gulf Coast Water Authority
Brazos Basin Transfer

2.3 Trinity Basin- CWA System and Trinity Supplies

The TTWP Planning Information report also illustrated that through year 2050, excess water supplies would exist in the Trinity river basin. An additional supply of approximately 153,000 acre-feet per year is projected to remain available within the Trinity River by year 2050.

Based on these observations, this contractual transfer investigated the conveyance of 122 mgd from the Trinity River to the GCWA's Texas City Reservoir.

The Coastal Water Authority (CWA) owns and operates a water conveyance system which originates at the Trinity River Pump Station on the Trinity River – just south of the Cities of Liberty and Dayton. A twenty-two mile canal transports Trinity River water southwest from Liberty County. There is a canal turnout, the Cedar Point Lateral (CPL), which serves irrigation and industrial customers in Chambers County. The remainder of the main canal extends into Harris County.

Water is transferred to the southwest by canal from the Trinity River to the Lynchburg Reservoir located at Interstate-10 and the Houston Ship Channel. Water conveyed to the Lynchburg Reservoir is pumped southward to City of Houston industrial and municipal customers. The Bayport reservoir and pump station exist at the southernmost terminus of the CWA system. The Bayport pump station conveys water to Bayport industries.

The GCWA Reservoir lies almost directly south of the Bayport Reservoir.

The distance measured along Highway 146 totals approximately 15.75 miles.

Therefore, use of the CWA system was considered for initiating this contractual transfer opportunity.

2.4 Contractual Transfer Scheme

The proposed conveyance system would consist of the following:

- Divert Trinity River water at the CWA Trinity River Pump Station
- Convey water through the CWA Main Canal
- Repump water at the CWA Lynchburg Pump Station
- Convey water through transmission mains to the Bayport Pump Station
- Repump water at the Bayport Pump Station
- Convey water through transmission mains to the GCWA Texas City Reservoir

The existing CWA system only has sufficient capacity to serve the ultimate water supply needs of the City of Houston customers. Water supplied through this contractual transfer is considered to be in excess of that currently planned for service through the CWA system. Improvements therefore would be needed at each of the CWA system facilities to accommodate the 122 mgd flow. However, this transfer scheme can take advantage of the following "economy-of-scale" factors: 1) CWA right-of-way used by existing facilities; 2) the existing capacity of the CWA Main Canal; and 3) expansion capabilities of existing CWA pumping facilities. Various improve-

ments would be necessary to the CWA facilities including to the canal to heighten the canal berms in order to convey increased flows and to the pump stations to add additional pumping capacity. The following specific facility improvements are proposed for this transfer:

- Trinity River Raw Water Intake and Pump Station Expansion (122 mgd)
- Enlargement of CWA Main Canal
- Lynchberg Pump Station Expansion (122 mgd)
- Transmission Main (72-inch) to Bayport (13 miles)
- Bayport Pump Station Expansion (122 mgd)
- Highway 146 Transmission Main (72-inch) to Texas City Reservoir (16 miles)

2.5 Other Issues

Environmental impacts associated with this contractual transfer will be relatively moderate. Required construction activities will be located within rights-of-ways of existing facilities. A number of creek and bayou crossings will occur in addition to construction of the Trinity River raw water intake and a pipeline tunnel beneath the Houston Ship Channel. These activities will each require state and federal permits. Preliminary field surveys and literature review did not reveal significantly sensitive environmental habitats near the location of proposed improvements.

Institutionally, the major issues of this contractual transfer involve the water authorities, their facilities, the de-

mands placed upon those facilities, and the allocation of necessary water supplies. Specifically:

- The willingness of GCWA to receive its water from an alternate source.
- The willingness of CWA to expand and use their present facilities for this transfer.
- The value of the existing capacity of the CWA facilities as compared to the needs of the GCWA supplies

This transfer would require execution of an agreement between the GCWA and the Trinity River Authority (or other water rights owner) for contractual use of available Trinity River water supplies. A cost will be associated with securing dependable water supplies for this transfer. This analysis has not included this cost in the assessment. Another agreement would be required between the GCWA and CWA for expansion and use of the CWA facilities. The agreement with CWA would also require a payment for services associated with use of the CWA system. This cost was also excluded from this analysis.

2.6 Cost Estimate

Table 2.1 shows the total construction cost needed for this contractual transfer. As configured, this transfer would convey approximately 136,600 acre-feet per year of water supply. As shown, the cost is estimated as approximately \$100 million. The associated annual operations and maintenance cost is approximately \$15 million. A life cycle cost analysis was performed to illustrate the present worth cost of this strategy. The fol-

lowing financial factors were used in the life cycle cost analysis:

- Capital costs were assumed to be financed over 30 years at an interest rate of 8.5 percent per year.
- The discount rate was set at 4.5 percent.
- The inflation rate was set at 4.5 percent.

Table 2.2 shows that the total present worth cost of this contractual transfer strategy ranges from \$0.55 per thousand gallons in the first year of operation to \$0.40 per thousand gallons in the last year. The annual average water cost of this strategy is approximately \$455 per acre-foot.

2.7 Conclusions

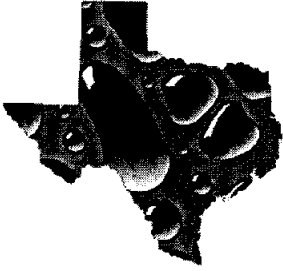
The GCWA/Brazos contractual transfer could potentially replace approximately 122 mgd (136,600 ac-ft/yr) of Brazos river water at the Texas City Reservoir with Trinity River water supplies. This strategy makes available new supplies of 136,600 ac-ft/yr into the Brazos basin. The TTWP Planning Information Update report suggests that the Brazos basin is projected to be the first subregion within the Houston area that will experience water supply shortfalls. These shortfalls, projected to occur by year 2020, are expected to exceed 162,000 ac-ft/yr through the end of the 2050 planning period. If enacted, this contractual transfer could satisfy the majority of the projected water supply shortfall within the Brazos basin.

Table 2-1: Probable Cost of GCWA/Brazos Transfer

<i>Facility</i>	<i>Size</i>	<i>Construction Cost</i>
CWA Canal Improvements	varies	6,500,000
Trinity River Pump Station	122 mgd	11,400,000
Lynchberg Booster Pump Station	122 mgd	4,500,000
Transmission Main (13 miles)	72-inch	24,000,000
Bayport Booster Pump Station	122 mgd	4,500,000
Transmission Main (16 miles)	72-inch	29,600,000
Subtotal		\$80,500,000
Engineering and Contingency (25%)		\$20,125,000
Total		\$100,625,000

Table 2.2: GCWA/Brazos Transfer – Life Cycle Cost Analysis

YEAR	YIELD (ac-ft / yr)	BOND PAYMENTS (\$1,000)	O & M COSTS (\$1,000)	TOTAL COST (\$1,000)	UNIT COST (\$/1,000 gal)	PRESENT VALUE (1995\$ / 1,000 gal)
2005	136,664	\$14,541	\$23,295	\$37,835	\$0.85	\$0.55
2006	136,664	\$14,541	\$24,343	\$38,884	\$0.87	\$0.54
2007	136,664	\$14,541	\$25,438	\$39,979	\$0.90	\$0.53
2008	136,664	\$14,541	\$26,583	\$41,124	\$0.92	\$0.52
2009	136,664	\$14,541	\$27,779	\$42,320	\$0.95	\$0.51
2010	136,664	\$14,541	\$29,029	\$43,570	\$0.98	\$0.51
2011	136,664	\$14,541	\$30,336	\$44,876	\$1.01	\$0.50
2012	136,664	\$14,541	\$31,701	\$46,241	\$1.04	\$0.49
2013	136,664	\$14,541	\$33,127	\$47,668	\$1.07	\$0.48
2014	136,664	\$14,541	\$34,618	\$49,159	\$1.10	\$0.48
2015	136,664	\$14,541	\$36,176	\$50,716	\$1.14	\$0.47
2016	136,664	\$14,541	\$37,804	\$52,344	\$1.18	\$0.47
2017	136,664	\$14,541	\$39,505	\$54,046	\$1.21	\$0.46
2018	136,664	\$14,541	\$41,282	\$55,823	\$1.25	\$0.46
2019	136,664	\$14,541	\$43,140	\$57,681	\$1.30	\$0.45
2020	136,664	\$14,541	\$45,082	\$59,622	\$1.34	\$0.45
2021	136,664	\$14,541	\$47,110	\$61,651	\$1.38	\$0.44
2022	136,664	\$14,541	\$49,230	\$63,771	\$1.43	\$0.44
2023	136,664	\$14,541	\$51,445	\$65,986	\$1.48	\$0.43
2024	136,664	\$14,541	\$53,761	\$68,301	\$1.53	\$0.43
2025	136,664	\$14,541	\$56,180	\$70,721	\$1.59	\$0.42
2026	136,664	\$14,541	\$58,708	\$73,249	\$1.64	\$0.42
2027	136,664	\$14,541	\$61,350	\$75,891	\$1.70	\$0.42
2028	136,664	\$14,541	\$64,110	\$78,651	\$1.77	\$0.41
2029	136,664	\$14,541	\$66,995	\$81,536	\$1.83	\$0.41
2030	136,664	\$14,541	\$70,010	\$84,551	\$1.90	\$0.41
2031	136,664	\$14,541	\$73,161	\$87,701	\$1.97	\$0.40
2032	136,664	\$14,541	\$76,453	\$90,994	\$2.04	\$0.40
2033	136,664	\$14,541	\$79,893	\$94,434	\$2.12	\$0.40
2034	136,664	\$14,541	\$83,488	\$98,029	\$2.20	\$0.40
TOTAL	4,099,920	\$436,224	\$1,421,132	\$1,857,355		



3. City of Houston/San Jacinto

3.1 Background

A potential contractual transfer was analyzed for the San Jacinto basin between the City of Houston and the San Jacinto River Authority (SJRA) as outlined in the Southeast Study Area Phase I Report (March, 1994).

The Phase I report indicated that the San Jacinto basin (Figure 3.1) does not have sufficient in-basin surface water supplies. Surface water demands in the southern San Jacinto basin are partially served by Trinity River supplies through an existing interbasin transfer via the Coastal Water Authority Main Canal. Although the northern San Jacinto basin relies heavily on groundwater to meet current demands, it is projected that future limitations on groundwater use will require importation of surface water to the northern San Jacinto basin area as well.

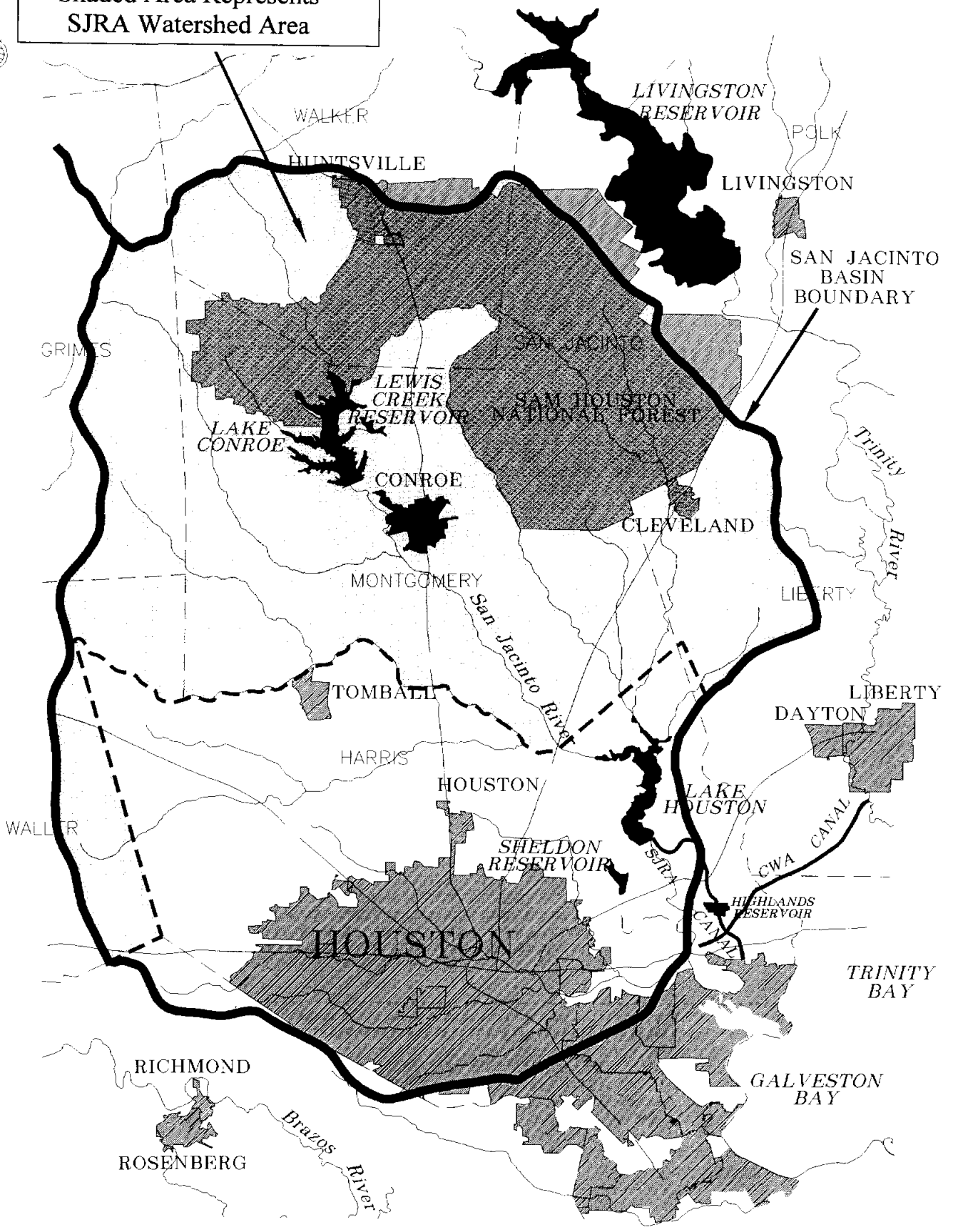
This transfer opportunity investigates replacing SJRA Lake Conroe water supplies that are currently conveyed to meet industrial customer demands in the southern San Jacinto basin. Lake Conroe supplies could then be used to serve the projected urbanization of Montgomery County in the northern San Jacinto basin.

3.2 Water Demands

Water demands within the SJRA service area have been compiled geographically for the northern and southern portions of the basin. Northern demands are primarily municipal. Currently, Montgomery County demands represent slightly more than 50% of the total demands in the northern basin area, and the projected future Montgomery County demands for the year 2050 are expected to reach 75% of total northern San Jacinto basin demands. The SJRA currently provides water utility service to the Woodlands, a large master-planned community within Montgomery County. The SJRA has a formal jurisdiction that includes all of Montgomery County, so it is the logical provider of future surface water supplies within that county.

Southern basin demands contracted by the SJRA are primarily industrial and are served by the Highlands Canal system. Future industrial demands are based on projections from the TTWP Planning Information Update report for the manufacturing use category within Harris County, based on two-digit Standard Industrial Classification (SIC) codes. Table 3.1 shows the projected water demands in the SJRA service area.

Shaded Area Represents
SJRA Watershed Area



25 0 5 10 15 20 25

SCALE IN MILES

Figure 3.1
San Jacinto Basin
Trans-Texas Water Program

FIG. 3.1 (REVISED) 10/11/10

Table 3.1: SJRA Water and Demand Supply (ac-ft/year)

	Demand			Supply		
	Montgomery County	Southern	Total	Montgomery County	Southern Supply	Total
1990	34,590	71,902	106,492	73,330	111,000	184,330
2000	46,701	78,016	124,717	73,330	111,000	184,330
2010	54,594	84,130	138,724	73,330	111,000	184,330
2020	65,095	90,245	154,340	73,330	111,000	184,330
2030	75,883	96,359	172,242	73,330	111,000	184,330
2040	88,571	102,474	191,045	73,330	111,000	184,330
2050	103,055	108,588	211,643	73,330	111,000	184,330

3.3 Water Supply

The TTWP Phase I report indicated that available groundwater supply through the year 2050 in the northern San Jacinto basin is approximately 94,700 ac-ft/yr. Approximately 40,000 ac-ft/yr of that groundwater supply is available in Montgomery County. There are two major surface water supply reservoirs in the San Jacinto basin; Lake Conroe with a firm yield of 99,950 ac-ft/yr, and Lake Houston with a firm yield of 151,400 ac-ft/yr. Additionally, there exists approximately 55,000 ac-ft/yr of “run-of-river” surface water supply in the San Jacinto basin. This run-of-river water can be diverted at any location downstream of Lake Houston. Therefore, the San Jacinto River basin has a total water supply of approximately 401,100 ac-ft/yr and approximately 140,000 ac-ft/yr of this supply could be utilized in Montgomery County. The remaining 261,100 ac-ft/yr is available for use in the rural areas of the northern San Jacinto basin or in Harris County.

The total permitted water rights of Lake Conroe are 100,000 ac-ft/yr. The SJRA owns 33 percent of these water rights (33,333 ac-ft/yr), and the remaining water rights (66,667 ac-ft/yr) are owned by the City of Houston. The City of Houston owns the entire permitted diversions from storage in Lake Houston (151,400 ac-ft/yr). The SJRA diverts “run-of-river” water from Lake Houston (based on their prior right of 55,000 ac-ft/yr). The SJRA recently purchased 86,000 ac-ft/yr of Trinity River water rights from the Devers Canal Rice Producers Association (DCRPA). Approximately 56,000 ac-ft/yr of these water rights can be used by the SJRA’s southern San Jacinto basin customers. The remaining 30,000 ac-ft/yr is under contractual obligation to the DCRPA. Therefore, the SJRA has total surface water rights within the San Jacinto basin of approximately 144,333 ac-ft/yr and the City of Houston has San Jacinto water rights of approximately 218,067 ac-ft/yr. Based on the ownership of surface water rights, the available quantity

of water supply in Montgomery County is reduced. When the City of Houston's Lake Conroe water rights are removed from use in Montgomery County, a total available water supply for Montgomery County becomes approximately 73,300 ac-ft/yr. The SJRA therefore has approximately 111,000 ac-ft/yr to serve its industrial customers in the southern San Jacinto basin and 73,330 ac-ft/yr to serve its Montgomery County customers.

3.4 Water Supply Availability

To determine the need and extent of a contractual transfer, it is necessary to determine the availability of water supplies in relationship to the location of the projected demand needs.

Table 3.1 shows the comparison on Montgomery County projected water demands to available water supplies. This table shows that existing water supplies should be sufficient to serve the county through approximately year 2030 at which time demands will exceed supplies. At the end of the planning period, Montgomery County is projected to have a water supply deficit of approximately 29,700 acre-feet per year.

In addition to SJRA customer water needs in Montgomery County, SJRA industrial water customers exist in southeastern Harris County. SJRA serves these industrial customers through surface water contracts from their Highland's Canal system. Prior to acquisition of the DCRPA Trinity river water rights, these industrial demands had essentially exhausted the SJRA's

existing Lake Conroe and run-of-river water supplies.

Table 3.1 shows that in total, there are only sufficient existing water supplies to serve projected SJRA customer demands approximately through year 2035. There are sufficient supplies to meet all of the southern basin industrial customers but insufficient supplies to meet the long-term demands of Montgomery County.

The SJRA has an agreement with the City of Houston to convey the 56,000 ac-ft/yr through the Coastal Water Authority Main Canal. The City of Houston currently plans to use its share of Lake Conroe water rights (66,667 ac-ft/yr) and Lake Houston water rights (151,400 ac-ft/yr) in northern Harris County to supply its projected surface water customers.

3.5 Contractual Transfer Scheme

The SJRA has essentially completed one aspect of this contractual transfer since development of the TTWP Phase II scope of work. The SJRA has purchased Trinity River water rights from the Devers Canal Rice Producers Association. Even though the SJRA can now meet its southern San Jacinto basin customer demands, a future water supply limitation is projected to exist for the future northern basin customers. Completion of this contractual transfer requires that a transfer of water supplies occur between the City of Houston's Lake Conroe and the SJRA's southern San Jacinto basin water supplies.

The SJRA has the opportunity to transfer some of its southern basin water

rights for existing City of Houston rights in Lake Conroe. The contractual transfer would consist of the City of Houston trading its 66,667 acre-feet per year supply in Lake Conroe for an appropriate amount of San Jacinto River Authority supplies. The SJRA supplies would be allocated from a portion of their available 55,000 acre-foot per year run-of-river supplies and their 56,000 acre-feet per year Trinity River supplies. The City of Houston could convey the SJRA supplies through Lake Houston or the CWA main canal. The SJRA could divert the City of Houston supplies directly from Lake Conroe.

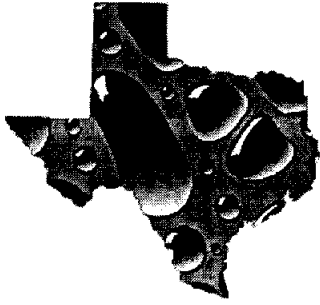
3.6 Other Issues

There are no environmental impacts associated with this proposed contractual transfer. All of the physical facilities necessary to implement the transfer are in place. The actual transfer is a paper transfer of agreed quantities of water supplies between the City of Houston and the SJRA. From a regulatory perspective, this contractual transfer could potentially occur with

out the need for any additional TNRCC water use permit. Both the City of Houston and SJRA could execute wholesale water contracts for delivery of equivalent amounts of surface water. Institutional issues are associated with the nature of necessary contractual agreements structured between the City of Houston and the SJRA. The primary issues will involve equity and the value of system facilities and water supplies involved in the transfer.

3.7 Cost Estimate

This proposed contractual transfer requires no construction of physical facilities. The only cost issue that must be resolved is associated with the value that the City of Houston places on the water within Lake Conroe and that the SJRA places on its Trinity River water or San Jacinto "run-of-river" water supplies. Factors impacting these decisions include water quality and/or the operational cost associated with conveyance of or treatment of either supply. All of these types of "soft" or system costs are outside the scope of this evaluation.



4. City of Houston and Trinity River Authority/Trinity

4.1 Background

This contractual transfer opportunity is based upon the concept of water “wheeling”. The ultimate purpose of water wheeling is to reduce the physical conveyance costs incurred by two or more parties by cooperatively re-allocating water supplies to address common water supply problems.

A contractual transfer opportunity is presented through the strategic location and large capacity of the Lake Livingston reservoir. Specifically, this contractual transfer focuses on “trading” Lake Livingston supplies owned by the City of Houston and/or the Trinity River Authority with Sabine and/or Neches supplies that would be purchased by water suppliers in the West-Central area of Texas. Lake Livingston is the only reservoir with sufficient yield to supply the projected demands identified for the West-Central Texas area. This water wheeling strategy would facilitate the transfer of water from the Sabine and Neches basins to the West-Central Area (Scenarios 1 and 2) as reported in the TTWP report “*Engineering Analysis of the Interbasin Transfer Strategy*.” That report describes the conceptual level analysis and costs of the interbasin transfer. The reader is referred to that study for more detail on each transfer scenario concept. It is the intent of this contractual transfer discussion to identify the parties involved in

such a transfer and briefly describe the transfer method and the institutional issues related to this water wheeling strategy.

4.2 Contractual Transfer Scheme

Due to the shortage of water in the San Antonio area, a transfer of water supplies could be beneficial by as early as 2020 from the TTWP Southeast Area. While the Houston area is expected to have a deficit of about 59,000 acre-feet in 2030, it is assumed that this shortage could be resolved through currently available Trinity River transfers or other local water management strategies. However, a significant shortage of water supplies could exist in the Houston area by 2040. One alternative which could be used to address these shortages is the transfer of water from eastern Texas. These two potential future water transfers (San Antonio region and Houston region) form the basis of this water wheeling analysis.

In this analysis, two West-Central area demand scenarios are considered:

- Scenario 1 is the transfer of water beginning in 2020 and ultimately delivering 600,000 acre-feet by the year 2050.
- Scenario 2 considers transferring 300,000 acre-feet beginning in 2030.

The TTWP report titled, “*Environmental Analysis of Potential Transfer Routes*” evaluated 16 different interba-

sin transfer routes and identified the preferred route based on environmental issues. That report concluded that from an environmental perspective, there were no potential interbasin transfer routes that could convey water from the San Jacinto basin to the Brazos basin better than a direct transfer from the Trinity basin to the Brazos basin. In comparison to the Trinity to Brazos basin route, the San Jacinto to Brazos basin routes had:

- Longer route distances.
- More river crossing impacts.
- More urban-related impacts (existing Houston development already places constraints on acceptable route locations)
- More prime farmland impacts

However, one significant limitation to the Trinity basin to Brazos basin water transfer is that there are currently no available uncommitted water supplies in Lake Livingston or the Trinity River basin. Lake Livingston water supplies are essentially owned, in total, by the Trinity River Authority and the City of Houston and are generally committed to existing needs and future growth in the Houston area.

Large quantities of Lake Livingston supplies are consequently diverted downstream of the reservoir below the Cities of Dayton and Liberty (see Figure 4.1). Therefore, this contractual transfer opportunity is to replace Lake Livingston supplies currently diverted in the lower Trinity River basin with east Texas supplies and therefore make that same quantity of supply in Lake Livingston available to be conveyed to

the Brazos basin for use by West-Central Texas water suppliers. The advantage to be gained by this contractual transfer is to reduce the overall conveyance cost and potentially allow use of a route that has the least environmental impacts associated with delivering water west of the TTWP Southeast Area.

4.3 Other Issues

In order for this contractual transfer to function, a number of institutional issues need to be addressed. This type of water transfer requires the cooperation of at least three parties:

- East Texas water supplier
- Trinity River Authority or City of Houston, and
- West-Central Texas water supplier

Each party can be expected to be concerned with, at a minimum, the following issues:

- Environmental impacts
- Basin-of-origin concerns
- Water valuation
- Water cost equity

Environmental issues would primarily be associated with instream flow impacts to the Trinity River downstream of Lake Livingston to the existing diversion points by the Trinity River Authority and City of Houston. Additionally, environmental impacts of constructing interbasin conveyance facilities will occur. These impacts are discussed in detail in the report on *Environmental Analysis of Potential Transfer Routes*.

Basin-of-origin, water valuation and water cost equity concerns will also exist for this type of large-scale regional water transfer. Regional water transfer issues are discussed in the TTWP report *Equity Issues Related to Water Transfers*, (January, 1998). While these issues are significant, they are not insurmountable. Regional large-scale water transfers of this type have been implemented in areas throughout the United States.

The equity report concludes that resolution of these issues requires a long lead time and recommends an approach based on *informed negotiation with compensation and mitigation for impacts*. Refer to the equity report for a detailed discussion of the institutional, financial, environmental and engineering issues associated with this type of transfer.

4.4 Cost Estimate

The physical facilities necessary to accomplish this contractual transfer have been illustrated in the *Engineering*

Analysis of the Interbasin Transfer Strategy report. Under this concept, a large quantity of east-Texas water supply (600,000 acre-feet per year for Scenario 1 or 300,000 acre-feet per year for Scenario 2) must be conveyed into the lower Trinity River basin from an east Texas supplier. An equal quantity of water is then conveyed from Lake Livingston to the Brazos basin.

The capital cost of Scenario 1 and Scenario 2 was computed as \$790.8 million and \$522.9 million, respectively. The incremental cost of conveying water supplies west of the Southeast Area versus only conveying water supplies to the Houston region (Scenario 3) can be determined by subtracting the capital cost of Scenario 3 (\$215.4 million) from either Scenario 1 or 2. Therefore the incremental cost of contractually transferring 600,000 and 360,000 acre-feet per year to the Brazos basin for use by the West-Central regions is approximately \$575.4 million and \$307.5 million, respectively. This equates to a water cost of approximately \$1025 and \$960 per acre-foot for Scenario 1 and 2, respectively.

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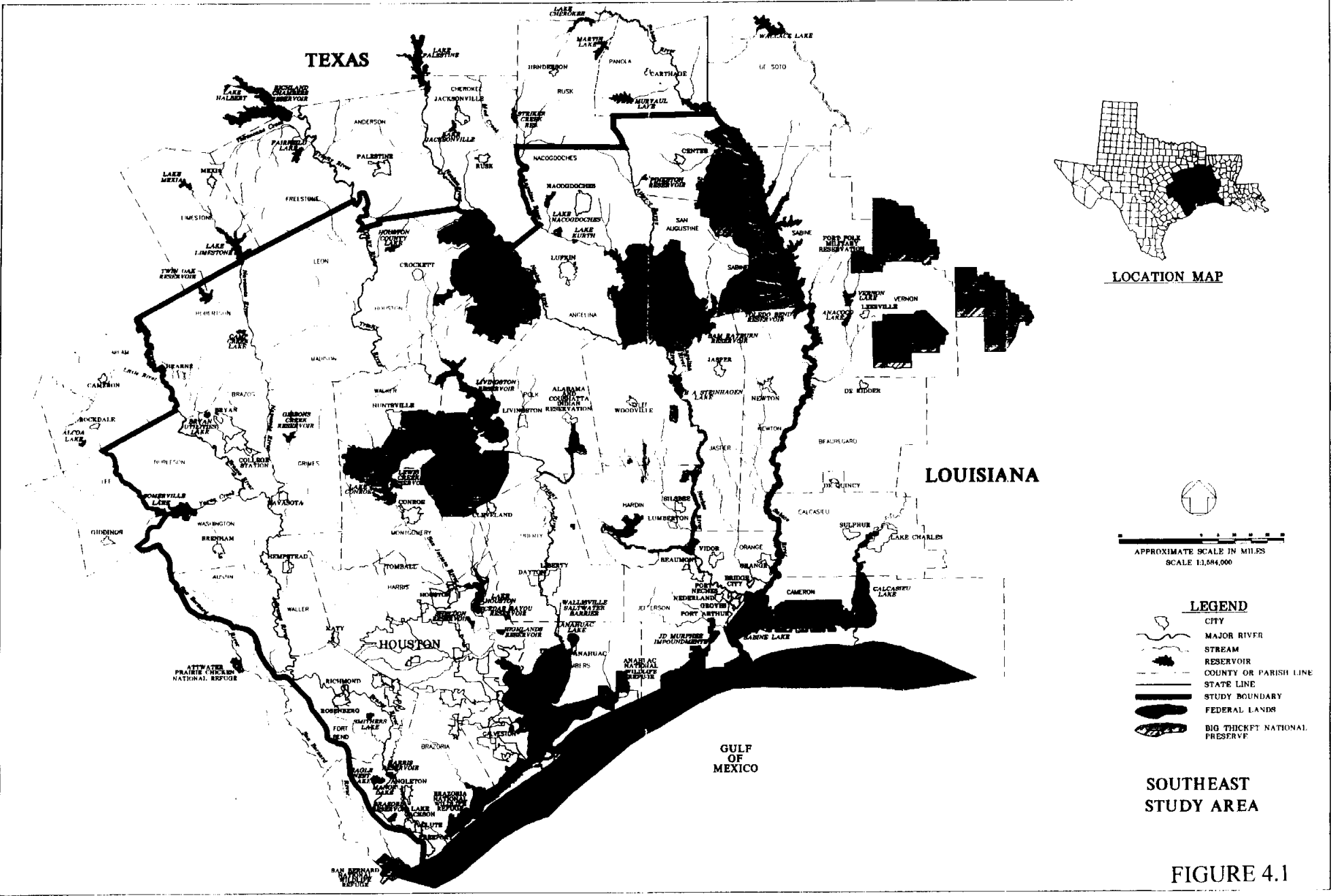
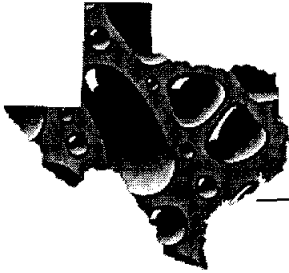


FIGURE 4.1



5. Irrigation Transfers

5.1 Background

One of the contractual transfer opportunities identified in the TTWP Phase I report focused on irrigation water supplies which are expected to potentially become available as the region's irrigation demands decrease. The TTWP Planning Information Update report projects irrigation demands to decrease by as much as 10% in the Sabine basin and as much as 45% in the lower Neches basin. Each of the TTWP Southeast Area river basins were analyzed to determine a projected quantity of future available irrigation water supplies. The analysis only considered reliable "senior" irrigation water rights supplies which could potentially be permitted for municipal or industrial uses.

5.2 Sabine Basin

The Sabine River Authority (SRA) is the only water rights permit owner within the lower Sabine basin with significant quantities of potentially available irrigation rights. The SRA owns 96,700 ac-ft/yr of irrigation rights. Existing irrigation contracts are principally held with rice and crawfish farming operations in Orange County.

Irrigation demands for Orange County from the TTWP Planning Information

Update Report (Sept. 1996) are anticipated to range from 3,400 ac-ft/yr in 1990 to approximately 2,900 ac-ft/yr in year 2050. While a slight initial increase in Orange County irrigation demand is projected from 1990 to the year 2000, a steady decrease from year 2000 to year 2050 results in an overall decline in irrigation demand of approximately 15%. If these rates of change are applied to the current SRA irrigation demands, values are projected to decrease from an actual demand in 1990 of 5,700 ac-ft/yr, to a year 2050 demand of 4,800 ac-ft/yr.

A comparison of existing available SRA irrigation water rights to these projected irrigation demands results in surplus irrigation water supplies in excess of 90,000 ac-ft/yr. These available supplies currently exist and should remain available throughout the planning period.

5.3 Neches Basin

Similarly, the Lower Neches Valley Authority is the only permit owner within the lower Neches basin with significant irrigation rights. The LNVA owns 436,360 ac-ft/yr of irrigation rights. Irrigation contracts have historically made up approximately 60% of the total LNVA demand (Inter-basin Water Transfer Study, Freese & Nichols, Inc. 1993). The LNVA canal system is located primarily in Jefferson County with the westernmost segments

extending into Liberty and Chambers Counties. The majority of the LNVA irrigators are located along the Neches main canal in Jefferson County (Inter-basin Water Transfer Study, Freese & Nichols, Inc. 1993).

Projections of irrigation demands within Jefferson County are based on the TTWP Planning Information Update report and are shown in Table 5.1. A projected steady decrease from year 1990 to year 2050 results in an overall decline in irrigation demand of about 47%. Table 5.1 shows the LNVA irrigation demands based on the Jefferson County irrigation demand trends, starting with the actual LNVA irrigation demand in 1993 (reference Inter-basin Water Transfer Study, Freese & Nichols, Inc. 1993). Projected available irrigation-related water supplies are computed by comparing projected demands to the existing LNVA irrigation water rights (436,360 ac-ft/yr).

The quantity of water which may be available for contractual transfer from the LNVA irrigation supply surplus in each decade is shown in Table 5-1. As shown, available excess water supplies are projected to increase from 229,000 to 327,000 ac-ft/yr.

5.4 Trinity Basin

The TTWP Phase 1 report identified four permit holders in the lower Trinity basin which met the initial screening criteria of significant irrigation supplies. These four entities are:

- Chambers-Liberty Counties Navigation District (CLCND)
- Dayton Canal Company (DCC)

- Devers Canal Rice Producers Association (DCRPA)
- Trinity River Authority (TRA).

These four entities represent over 87% of the 1990 irrigation demand in Chambers and Liberty Counties, the principal irrigation area in the lower Trinity Basin.

Since completion of the Phase 1 report, the DCRPA water rights (86,000 ac-ft/yr) were sold to the San Jacinto River Authority (SJRA) in late 1994. Approximately 30,000 ac-ft/yr are planned for future use by the DCRPA. The SJRA plans to use 56,000 ac-ft/yr of these Trinity rights to serve their customers within the San Jacinto basin, making those supplies unavailable for further contractual transfer.

Irrigation in the lower Trinity basin primarily occurs in Liberty and Chambers Counties. Projections of irrigation demands in Chambers and Liberty County from the TTWP Planning Information Update report are shown in Table 5-2. Both counties are expected to have a steady decrease in irrigation water need from year 1990 to year 2050. The overall decline in irrigation demand is approximately 35%.

The CLCND, DCC, DCRPA, and TRA, each own 68,820, 33,000, 30,000, and 134,450 ac-ft/yr of irrigation rights, respectively, from the main stem of the Trinity river. The total available irrigation water rights in the lower Trinity basin are 266,270 ac-ft/yr. The declining rates of irrigation water need were applied to existing 1990 water use for the CLCND, DCC, DCRPA, and TRA, irrigation demands. Table

5.2 shows the projections of the irrigation demands for these four entities based on Chambers and Liberty County trends, starting with the actual irrigation demands in 1990.

Table 5.2 also illustrates the quantity of water that may eventually be available from each entity for a potential contractual transfer from the Trinity basin surplus of irrigation water supplies. As shown, total available supplies are projected to increase from approximately 128,000 to 177,000 ac-ft/yr at the end of the planning period.

5.5 San Jacinto-Brazos Basin

The Chocolate Bayou Water Company (CBWC) and the Gulf Coast Water Authority are the only significant irrigation permit owners within the San Jacinto-Brazos basin with potentially surplus water supplies. The CBWC owns 145,000 ac-ft/yr and the GCWA owns 80,000 ac-ft/yr of Brazos mainstem rights. Both entities have additional tributary water rights within the San Jacinto-Brazos basin which assists each to serve their customers; however, only main stem rights are evaluated in this analysis. Irrigation contracts are principally held with rice farming operations in Galveston and Brazoria County. Over-appropriation of the Brazos River has resulted in regulatory rules stipulating that water rights with priority dates later than 1958 are to be considered unreliable supplies during drought conditions. The GCWA's 80,000 ac-ft/yr have a priority date that dates earlier than 1958; however, only 65,000 ac-ft/yr of the CBWC's 145,000 ac-ft/yr have a priority date prior to 1958.

Projections of irrigation demands within Galveston and Brazoria County are shown in Table 5.3. A steady decrease in Brazoria and Galveston County projected irrigation demands from the year 1990 - 2050 results in an overall decline in irrigation demand of approximately 22% and 33%, respectively. Table 5.3 shows projections for irrigation demands for both CBWC and GCWA based on the Galveston and Brazoria county trends, starting with their actual irrigation demands in 1990. Table 5.3 also illustrates the resulting irrigation water supplies potentially available for contractual transfer. Projected irrigation demands for the CBWC exceed their available Brazos River mainstem water rights through the planning period; therefore, these supplies are not included in Table 5-3. Available GCWA irrigation water supplies range from 26,300 to 44,400 ac-ft/yr.

The TTWP Planning Information Update report indicates that the Brazos basin would exhibit significant water supply shortfalls through the planning period. It can be anticipated that the available GCWA irrigation water rights will be converted into municipal and industrial rights and used by the GCWA to meet some of the projected Brazos basin water supply shortfall.

5.6 Other Issues

All of the entities identified in this analysis maintain their irrigation water rights in the most downstream locations of their respective river basins. Transfer of these supplies should have minimal impact on any other senior rights holders in each basin. However,

amendments to existing irrigation permits will typically be required and the impact, if any, on other water rights permits will have to be identified and resolved satisfactorily.

The environmental impacts associated with transfer of Trinity River supplies will focus on instream flow and Galveston Bay estuary impacts. Detailed analysis would be required to determine the extent of any impacts. Environmental impacts associated with any proposed conveyance system would be a factor for the LNVA and SRA water supplies. These environmental impacts are discussed in detail in the TTWP report entitled *Environmental Analysis of Potential Transfer Routes*.

A number of social and economic issues may also exist associated with the contractual transfer of irrigation water supplies. Projected reductions in irrigation water demand are an indicator of a declining agricultural industry. The health of Texas Gulf Coast agriculture is a function of economic market forces. The entire agricultural business community is impacted by the decline of the primary industry. Indirect (secondary and third-party) impacts could potentially occur as a result of the contractual transfer of irrigation water supplies. These types of transfers should ideally occur subsequent to the decline of the industry as opposed to preceding and potentially precipitating an increase in the decline of the agricultural business of a region. Impacts associated with agricultural to urban water transfers have been documented in the literature and is included in a TTWP report entitled Equity Is-

ues Related to Water Transfers (January 1998). In general, these types of issues should be investigated in detail before consideration of future irrigation contractual water transfers.

5.7 Costs

Transfer of any of the four Trinity River water rights supplies into the San Jacinto basin, the area of greatest demand need, could occur without the need to construct substantial new facilities. This advantage results from the fact that CWA currently supplies significant irrigation demands in the Trinity and Trinity-San Jacinto coastal basins through their existing conveyance system. All supplies resulting from a contractual transfer could be conveyed through these existing conveyance facilities. Therefore, in terms of timing, transfer of Trinity River irrigation supplies should occur prior to contractual transfer of SRA or LNVA supplies.

Transfers of excess LNVA and SRA irrigation supplies require construction of the recommended interbasin conveyance system outlined in the *Engineering Analysis of the Interbasin Transfer Strategy (March 1998)* report. The \$215.4 million conveyance system (Scenario 3) would be required to achieve the transfer of these LNVA and SRA excess irrigation supplies, resulting in a cost of approximately \$955 per acre-foot.

5.8 Summary of Findings

Potential water supplies which may become available for a contractual transfer due to projected decreases in irrigation demands were calculated for

eight major water right owners in the Southeast Study area. Table 5.4 shows those irrigation supplies which are considered to be reliable and are expected to become available in the Sabine, Neches, Trinity and Brazos River basins of the Southeast study area.

The key findings of this contractual transfer of irrigation rights are:

- There are significant, reliable supplies which could become available if the projected reduction in irrigation demands actually occur.

- Decreases in demand are projected to change rapidly within the first decade and then changes will be gradual.
- In 2050, there will be approximately 178,000 acre-feet per year, which will be available within the Trinity basin.
- Irrigation supplies from the LNVA represent approximately 50% (327,300 acre feet per year) of the total irrigation supplies.

Table 5-1: Neches Basin Irrigation Projections

	Projections (acre-feet per year)						
	1990	2000	2010	2020	2030	2040	2050
Jefferson County Irrigation Demands	211,061	144,576	131,414	120,150	117,157	114,336	111,535
LNVA Irrigation Customer Demands	206,441	141,411	128,537	117,520	114,593	111,833	109,094
LNVA Irrigation Available Supplies	229,919	294,949	307,823	318,840	321,767	324,527	327,266

Table 5-2: Trinity Basin Irrigation Projections

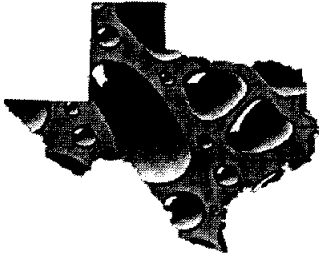
	Projections (acre-feet per year)						
	1990	2000	2010	2020	2030	2040	2050
Chamber/Liberty Co. Demands	155,102	131,728	120,124	110,041	106,573	103,216	99,970
Individual Irrigation Demands							
CLCND	50,500	43,869	39,541	35,799	34,556	33,355	32,196
DCC	29,000	23,719	21,911	20,325	19,742	19,175	18,626
DCRPA	30,000	24,537	22,667	21,025	20,422	19,836	19,268
TRA	28,521	23,327	21,549	19,989	19,416	18,859	18,318
Projected Available Supply							
CLCND	18,320	24,951	29,279	33,021	34,264	35,465	36,624
DCC	4,000	9,281	11,089	12,675	13,258	13,825	14,374
DCRPA	0	5,463	7,333	8,975	9,578	10,164	10,732
TRA	105,929	111,123	112,901	114,461	115,034	115,591	116,132
TOTAL	128,249	150,817	160,601	169,132	172,135	175,045	177,863

Table 5-3: San Jacinto-Brazos Irrigation Projections

	Projections (acre-feet per year)						
	1990	2000	2010	2020	2030	2040	2050
Galveston/Brazoria Demands	124,259	120,950	112,567	105,116	101,304	97,631	94,092
Individual Irrigation Demands							
GCWA	53,644	47,158	43,222	39,778	38,339	36,949	35,611
CBWC	89,333	88,659	82,739	77,459	74,649	71,942	69,334
TOTAL	142,977	135,817	125,961	117,237	112,988	108,891	104,944
Projected Available Supply							
GCWA	26,356	32,842	36,778	40,222	41,661	43,051	44,389

Table 5-4: Prospective Irrigation Supplies for Contractual Transfer (acre-feet per year)

Owner	Available Supplies						
	1990	2000	2010	2020	2030	2040	2050
SRA	90,976	90,336	90,961	91,492	91,617	91,741	91,859
LNVA	229,919	294,949	307,823	318,840	321,767	324,527	327,266
DCC	4,000	9,281	11,089	12,675	13,258	13,825	14,374
DCRPA	0	5,463	7,333	8,975	9,578	10,164	10,732
TRA	105,929	111,123	112,901	114,461	115,034	115,591	116,132
CLCND	18,320	24,951	29,279	33,021	34,264	35,465	36,624
GCWA	26,356	32,842	36,778	40,222	41,661	43,051	44,389
Total	475,500	568,943	596,163	619,687	627,181	643,363	641,378



This analysis evaluated the general feasibility of implementing four types of contractual transfers. The scope of the analysis was limited to identifying the potential structure of the contractual transfer and general benefits which might be realized, and did not include development of detailed terms of a specific transfer agreement. Potential contractual transfers range from simple execution of agreements between two parties for the re-allocation of existing supplies to more complex transfers including construction of physical facilities that allow replacement of supplies. The analysis suggests that several of the contractual transfer types are potentially viable and should be considered by water suppliers in the future. Each of the contractual transfer types successfully provides for the re-allocation or replacement of available supplies from one location to another. The key findings of this contractual transfer management strategy analysis are listed below:

6.1 GCWA/Brazos

- The GCWA/Brazos contractual transfer could potentially replace approximately 122 mgd (136,600 ac-ft/yr) of Brazos River water at the Texas City Reservoir with Trinity River water supplies, making available that same quantity of new supply into the Brazos basin.
- The GCWA/Brazos transfer requires construction of water system improvements with a construction cost of

6. Conclusions

approximately \$100 million. The per unit cost of developing this project is approximately \$455 per acre-foot.

6.2 City of Houston/San Jacinto

- The City of Houston/San Jacinto contractual transfer provides for the re-allocation of existing water supplies between the City of Houston and the SJRA. The purpose of this transfer is to satisfy the long-term water needs of Montgomery County through year 2050 by allocating all of the City's Lake Conroe water supplies (66,667 ac-ft/yr) to the SJRA. In exchange, the SJRA would contract an appropriate quantity of their current supplies within the lower San Jacinto River basin to the City of Houston.
- There are no physical facilities needed to accomplish the City of Houston/San Jacinto basin transfer; therefore no capital cost is required. Likewise, no environmental impacts are associated with this strategy because all of the existing water supplies, water facilities, and permits are in place to accomplish the necessary contractual transfers. However, there are a number of institutional issues associated with valuation of water supplies and future use of water system facilities that would have to be determined by each of the contracting parties.

6.3 City of Houston/Trinity

- The City of Houston and Trinity River Authority/Trinity basin contractual transfer could provide the mechanism to facilitate conveyance of large quantities of water supply from the

TTWP Southeast Area to the West-Central Area. This transfer utilizes the strategic location and capacity of Lake Livingston to provide for the transfer of 300,000 or 600,000 ac-ft/yr from the Trinity basin to the Brazos basin. This contractual transfer consists of conveying east Texas water supplies via interbasin transfer into the lower Trinity River basin for use by the City of Houston and the Trinity River Authority. These supplies would supplant existing City of Houston and TRA water supplies in Lake Livingston and therefore allow conveyance of similar quantities of supply to the Brazos basin for use by TTWP West-Central water supply entities.

- The incremental capital cost of supplying 300,000 and 600,000 ac-ft/yr to the West-Central Area is approximately \$307.5 million and \$575.4 million, resulting in a water cost of approximately \$1025 and \$960 per acre-foot, respectively.

6.4 Irrigation

- Irrigation contractual transfers are possible due to the expectation that a significant decrease in water demand will occur for irrigation interests with senior water rights from the Sabine, Neches, Trinity, and Brazos Rivers. Potentially available irrigation water supplies are projected to increase from approximately 475,000 ac-ft/yr in year 1990 to over 641,000 ac-ft/yr in year 2050. These available supplies are established within existing water rights permits and are reliable senior rights that could be used for municipal and industrial water use purposes.

- Based on the location of these irrigation supplies, it is expected that the Brazos basin supplies (44,400 ac-ft/yr) will remain in that basin and be permitted for municipal and industrial uses. No new water system improvements would be necessary to make these supplies available to the region.
- A total of approximately 178,000 ac-ft/yr of irrigation supplies are projected to become available within the lower Trinity basin. These supplies would have to be transferred to municipal and industrial water suppliers, but no significant new water system improvements would be necessary to make use of these supplies.
- Approximately 418,300 ac-ft/yr of irrigation supplies are projected to be available within the lower Neches and Sabine River basins. These supplies represent over 50% of the total available irrigation supplies within the entire TTWP Southeast Area. Use of these supplies would require construction of an interbasin conveyance system with a capital cost of approximately \$215.4 million and a water cost of approximately of \$955 per acre-foot. Significant institutional and equity issues would also require resolution in order to implement those contractual transfer opportunities.