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Chapter 7 – Long-Term Protection of the State's Water Resources, Agricultural Resources and Natural Resources

The Region H Water Planning Group balanced meeting water needs with good stewardship of the water, agricultural and natural resources within the region. The RHWPG recommended water conservation as the first strategy applied to meet every projected shortage. In the strategy selection process, the yield and environmental impact of projects were given greater consideration than the unit cost of water.

In this plan, existing in-basin supplies are fully utilized prior to recommending new water supply projects or interbasin transfers. In the new interbasin transfer strategies, only the minimum amount of water supply required to meet the projected demands is recommended. Wastewater reuse is a recommended strategy in Harris County as an alternative to the importation of additional water supplies.

The RHWPG believes that local groundwater conservation districts are best-suited to manage groundwater resources in which the individual districts have the responsibility to regulate. This plan recommends using groundwater up to the local sustainable yield or to the restrictive limit established under subsidence district regulations, to meet local demands, but does not recommend the exportation of groundwater from its county of origin.

The affects of the recommended water management strategies on specific resources are discussed in further detail within this chapter.

7.1 Water Resources within Region H

Water resources available by basin within Region H are discussed in further detail below.

7.1.1 Neches-Trinity Coastal Basin

The Neches-Trinity Coastal Basin has numerous creeks and bayous which flow into East Bay. Many of these creeks and bayous provide water for irrigation and it is expected that this irrigation use will continue. Additional supplies are transferred into the Neches-Trinity Basin by the Lower Neches Valley Authority (water from the Sam Rayburn Reservoir – B.A. Steinhagen Lake System) and by the Chambers-Liberty Counties Navigation District (CLCND) (water from the Trinity River). This plan recommends the reallocation of existing supplies before increasing the transfer of water from the Trinity to meet the projected demands. Additional supplies from the Trinity are not recommended, which will affect the return flows location within Galveston Bay. No other impacts by these strategies are foreseen.

Groundwater supplies within the Neches-Trinity Basin come from the Gulf Coast Aquifer. The plan reflects using but not exceeding the sustainable yield of the aquifer in this basin.

7.1.2 Trinity River Basin

The Trinity River serves both Regions C and H. Within Region H, the Lake Livingston-Wallisville Saltwater Barrier System represents one half of the available surface water supply. This plan recommends using approximately 95% of the firm yield of this system, in addition to the full use of all

water rights below the Lake. Achieving the full yield of Lake Livingston is dependent upon return flows from the upper basin. Region C is recommending wastewater reuse as a water management strategy (WMS) in the upper basin, which will limit these flows, but is also recommending the import of new supplies into the upper basin. As discussed in *Chapter 3* and *Appendix 3C*, return flows from the upper basin are projected to decrease from 2020 to 2040 due to increased reuse. As demands in the upper basin increase in 2050 and 2060, return flows are projected to rise. In combination, the upper basin additional supply and reuse strategies should have a long-term neutral effect on the Lake Livingston supply.

This plan recommends transferring much of the Trinity River supply west into the adjacent coastal basin and the San Jacinto Basin. This will result in decreased flows in the lower Trinity Basin during drought periods. Senior water rights below Lake Livingston are protected by the Lake's operating rules. Return flows from these transfers will still reach Galveston Bay, but will return via the San Jacinto Basin.

Groundwater in the lower Trinity Basin predominantly comes from the Gulf Coast Aquifer as well as from the Carrizo-Wilcox, the Sparta, the Queen City and the Yegua-Jackson Aquifers. The plan reflects using but not exceeding the sustainable yield of the Gulf Coast Aquifer in this area. In addition, the other aquifers are only used to meet local demands. The export of groundwater from its source county is not recommended in this plan.

7.1.3 Trinity-San Jacinto Coastal Basin

The Trinity-San Jacinto Coastal Basin is relatively small, with Cedar Creek being the most significant stream. There are several surface water rights for irrigation within the basin along with a substantial saline water right for cooling water from Galveston Bay. Both of these uses are expected to continue throughout the planning period. This plan recommends the reallocation of existing supplies before increasing the transfer of water from the Trinity River to meet the projected demands, which will affect the return flows location within Galveston Bay. No other impacts from the transfers are foreseen.

The groundwater supply source within this basin is the Gulf Coast Aquifer. The plan reflects using but not exceeding the sustainable yield of the aquifer in this basin. In Harris County, the Harris-Galveston Subsidence District regulations further restrict the use of groundwater to address land subsidence. These groundwater pumpage restrictions are reflected in the plan.

7.1.4 San Jacinto River Basin

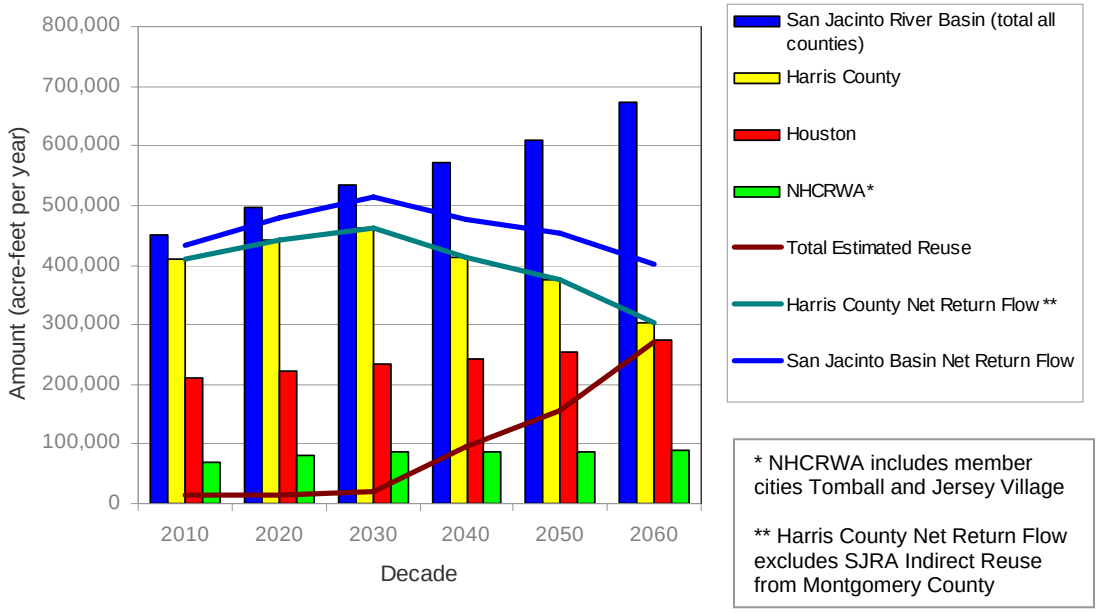
The San Jacinto River Basin contains Lakes Houston and Conroe. These reservoirs make up approximately one tenth of the total surface water available in the region. This plan recommends fully utilizing the yield of these reservoirs and other surface water rights within the San Jacinto Basin. In addition, the plan calls for the interbasin transfer of supply from the Trinity River to meet projected demands. Full use of the existing water rights will reduce stream flows during drought conditions. However, this will be mitigated by increased return flows and return flows from imported supply.

Wastewater reuse is a recommended water management strategy in Harris County. An estimate of municipal return flows throughout the planning period is shown in *Figure 7-1*, below, and detailed in *Appendix 7D*. Wastewater Reuse for Industry is recommended to begin by year 2060. The impact of initially diverting this reuse supply may be mitigated by tidal effects in the stream segment where the water is currently discharged. The brine produced by the additional treatment process will be discharged into the Houston Ship Channel, impacting the salinity in the brackish zone. Further investigation will be required to determine the full environmental impacts of the brine discharge. Reuse projects associated with local Groundwater Reduction Plans (GRPs) are expected to begin as early as 2010. Municipal Non-potable Reuse is recommended by 2030. Houston and NHCRWA Indirect Wastewater Reuse strategies are recommended to begin as early as year 2040. Municipal water demand in Harris County is expected to almost double during the planning period, and the

recommended reuse volume from the San Jacinto Basin is projected to be approximately 40% of the potential available municipal discharge. This indirect reuse is not expected to be implemented all at once, but rather as a series of small projects over several decades. Therefore, no shock effect of a new large diversion will be realized, and return flows in the San Jacinto Basin will remain near the year 2010 levels.

Figure 7-1

Estimated Municipal Return Flows and Reuse



The groundwater supply source in the San Jacinto Basin is the Gulf Coast Aquifer. The current regional water plan reflects using but not exceeding the sustainable yield of the aquifer in this basin. In Harris County, the Harris-Galveston Subsidence District regulations further restrict the use of groundwater to address land subsidence. These groundwater pumpage restrictions are reflected in the plan.

7.1.5 San Jacinto-Brazos Coastal Basin

The San Jacinto-Brazos Coastal Basin encompasses all of Galveston County, most of Brazoria County, and portions of Harris and Fort Bend Counties. The coastal basin contains numerous streams and bayous which flow into Galveston Bay and West Bay. Major bayous contributing to Galveston Bay include Clear Creek, Dickinson Bayou and Chocolate Bayou. Bastrop Bayou, located at the western edge of the basin, flows into Christmas Bay. There are numerous surface water rights for irrigation, mining and manufacturing within the basin and these uses are expected to continue throughout the planning period. Water from the Brazos River is transferred into the coastal basin to meet current demands. The Gulf Coast Water Authority (GCWA) maintains and operates canals and off-channel reservoirs within the coastal basin.

This plan recommends increasing the transfer of water from the Brazos to meet the projected growth in demands of Brazoria and Galveston Counties, which will increase the return flows to Galveston Bay. The GCWA Off-channel Reservoir, which would be located in Brazoria County, is a recommended strategy, and would store water from the existing GCWA canal systems. The reservoir will not require a new water right permit and will add efficiency to the GCWA canal system. The

project would likely have a minimal impact on seasonal low flows in the Brazos River, since diversions from the Brazos would be limited by existing permits. The Fort Bend County Off-channel Reservoir and the Brazoria County Off-channel Reservoir are recommended to meet demands in Brazoria, Fort Bend and Galveston counties beginning in 2030. The projects would divert peak flows reducing the net flow through the basin but will have limited impact on seasonal low flows.

Finally, seawater desalination is included as a recommended strategy to meet manufacturing demands in Brazoria County. This strategy will meet a portion of the demands and will potentially increase stream flows, since the return flows from desalination are not associated with a diversion from the source streams. No other surface water impacts are foreseen.

The groundwater supply source in the San Jacinto Basin is the Gulf Coast Aquifer. The plan reflects using, but not exceeding the sustainable yield of the aquifer in this basin. In Fort Bend, Galveston and Harris Counties, regulations enacted by the Fort Bend Subsidence District and the Harris-Galveston Subsidence District further restrict the use of groundwater to address land subsidence. These groundwater pumpage regulations are reflected in the plan.

7.1.6 Brazos River Basin

The Brazos River Basin is the second largest basin in the state (after the Rio Grande), primarily serving Regions O, G and H. The Brazos River Authority operates a system of reservoirs within the middle and upper basin, which provide a portion of the lower basin supply. There are also numerous water rights on the Brazos River and its tributaries which provide water for municipal, manufacturing, irrigation, mining and steam electric power uses. This plan recommends full use of the existing water rights in the lower basin as well as developing new sources of supply.

The Brazos River Authority has identified additional yield that can be realized by operating their reservoirs as a system. This strategy would allow the Brazos River Authority to divert interruptible flows to meet customer needs when these flows are available in lieu of releasing water from reservoir storage. During drought periods, more stored water would then be available, thus increasing the total yield of the Brazos River Authority system. This WMS will reduce the peak flows in the lower Brazos due to the increase in diversions. However, when base flows are below the median value, the BRA would release flows to meet customer demands. This would result in increased flows in the river segments above the customer diversion points, and should have no effect below those diversions.

Four new off-channel reservoirs are included in the 2011 Plan as recommended water management strategies. The recommended strategies include Allens Creek, located in Austin County, the Brazoria County Off-channel Reservoir, the Fort Bend County Off-channel Reservoir and the Dow Off-channel Reservoir. The Dow Off-channel Reservoir will store water diverted using Dow Chemical's existing water rights and will be used to meet manufacturing demands in Brazoria County. The three remaining off-channel reservoirs will divert peak flows in the Brazos Basin. The Little River Off-channel Reservoir, located in Milam County, would divert flows from the Little River in the Brazos Basin. This off-channel reservoir is an alternative strategy in the 2011 RWP. The Little River Off-channel Reservoir would divert peak flows when the source stream is above a set base flow. This will reduce the net flow within the basin, but the impacts during drought or seasonal low flow periods would be limited.

As discussed in the San Jacinto-Brazos coastal basin description above, seawater desalination is included in the plan as a recommended strategy in Brazoria County. This would meet a portion of the manufacturing demands within the lower basin, and may be expanded in the future to meet increased demands. The increase in return flows from this source will mitigate, but not remedy, the reduction in base flows due to full use of water rights in the basin.

To protect water quality in the lower Brazos Basin, particularly at the diversion points serving the southwestern portion of Brazoria County, the construction of a saltwater barrier is recommended.

The Brazos River is the only river basin in Region H not protected from the seasonal tidal influence of saltwater by a saltwater barrier or other impoundment structure. Basin salinity modeling performed by the TWDB has shown that the saltwater influence will move farther upstream under full use of water rights. This project will mitigate that effect and still allow flows to pass into the small Brazos River estuary.

Groundwater within this basin predominantly comes from the Gulf Coast Aquifer, as well as the Carrizo-Wilcox, the Brazos Alluvium, the Sparta and the Queen City Aquifers. The plan reflects using but not exceeding the sustainable yield of the Gulf Coast and Brazos Alluvium Aquifers in this area. The Carrizo-Wilcox, the Sparta and the Queen City Aquifers are only used to meet local demands. The export of groundwater from its source county is not recommended in this plan. In Fort Bend County, regulations enacted by the Fort Bend Subsidence District further restrict the use of groundwater from the Gulf Coast Aquifer to address land subsidence. These regulations are reflected in the plan.

7.1.7 Brazos-Colorado Coastal Basin

The Brazos-Colorado Coastal Basin contains the San Bernard River and its tributary streams. There are several surface water rights along the San Bernard River for manufacturing and irrigation uses. Both of these uses are expected to continue. However, there is a surplus in manufacturing water available. This plan recommends allocating a portion of the manufacturing surplus to meet the mining demand within the coastal basin. The remaining surplus of manufacturing water will remain with the water right holder. Municipal demands are supplied surface water from the Brazos River. No net change to basin flows is expected.

The groundwater supply source in San Jacinto Basin is the Gulf Coast Aquifer. The plan reflects using but not exceeding the sustainable yield of the aquifer in this basin.

7.2 Agricultural Resources within Region H

Region H has approximately 4,000,000 acres of land in farms, with about one third of that land in production during any given year. Although this has remained constant over the past two decades, the crops and water usage within those farms has changed. Sugar Land is no longer surrounded by its namesake cane fields, and the Imperial Sugar Mill in that city closed its doors in 2004.

Data from the USDA Census of Agriculture is provided in *Appendix 7A*. The data shows that since 1987, irrigated acreage within Region H has declined by 45%. This decline is driven by economic factors, but the cost of water is among them. Rice, which is the most water-intensive crop raised in the region, has declined in price in recent years. Therefore, the rice price reduction has driven the reduction in irrigation. A rise in price could easily halt the decline in the irrigation demand.

Additionally, the region has approximately 1.55 million acres of productive timberland. This has declined by approximately 36,000 acres over the past decade. Rural land data obtained from the Texas Cooperative Extension at Texas A&M University is also provided in *Appendix 7A*. It indicates that rural land use is increasing in the northern portion of the region, while decreasing in Montgomery and the southern counties due to urbanization. In many counties, native rangeland is being converted to improved, non-irrigated pasture.

This plan holds the projected irrigation demand fairly constant over the planning period, declining from 450,175 acre-feet per year in 2010 to 430,930 acre-feet per year in 2060 (a change of under 5 percent, and consistent with the observed development patterns in the southern half of the region). Region H is able to meet those demands from a combination of existing supplies, and recommended interruptible supplies from existing sources, conservation, Allens Creek Reservoir and off-channel reservoir projects in Fort Bend and Brazoria counties. The need for financial assistance to realize the conservation goal is addressed in *Chapter 8* under legislative recommendations. Providing

interruptible water is expected to preserve local agricultural resources by providing irrigators with water at a cheaper rate when surface water supplies are available. Many irrigators in Region H, specifically those in Brazoria County, contract water on a year-to-year basis. The water provided under these contracts is generally less expensive than contracts for firm water supplies. To reflect the economics of irrigation water supplies in Brazoria County, an interruptible water supply strategy was developed to meet irrigation demands that typically contract irrigation water on a year-to-year basis.

7.3 Natural Resources within Region H

Region H contains many natural resources, and the WMS recommended in this plan are intended to protect those resources while still meeting the projected water needs of the region. The impacts of recommended strategies on specific resources are discussed below.

7.3.1 Threatened and Endangered Species

Region H has abundant habitat areas within the Sam Houston National Forest, the Big Thicket Nature Preserve, several National Wildlife Refuges, and significant undeveloped areas. Numerous native and migratory species live within these habitats, including over ten threatened and endangered aquatic species (listed in *Appendix 7B*).

The water management strategies (WMS) recommended in this water plan will have some impacts upon wetlands habitats. In the 2006 Region H Water Plan, two reservoir projects were recommended. The Little River Off-channel Reservoir, located within the Little River watershed, and Allens Creek Reservoir, both with the potential to impact wetlands habitat. However, the potential impacts at these proposed sites are less than on the main stem of a river. In the current plan, the Fort Bend and Brazoria Off-channel Reservoirs have replaced the Little River Off-channel Reservoir to increase the future surface water supply in the Brazos. The Little River Off-channel Reservoir is still included in the plan as an alternative strategy. At the Allens Creek site in Austin County, habitats for the White-faced Ibis, Wood Stork and Houston Toad may be inundated and require mitigation. It should be pointed out that the Allens Creek project was modified by the project sponsor to avoid impacting Alligator Hole, a wetland segment adjacent to the project site. The current plan includes the Allens Creek Reservoir as a recommended water management strategy. Although the Brazoria and Fort Bend Off-channel reservoir sites have not been defined, it is anticipated that these strategies may inundate wetland and endangered species habitats requiring mitigation.

The transfer of supply from Lake Livingston into the San Jacinto Basin is recommended in this plan. While the recommended amount is less than the full yield of the reservoir, it will still impact the lake level during dry periods as well as wetlands along the periphery of the reservoir. Habitats for the Wood Stork and Alligator Snapping Turtle may be affected during drought periods, but no permanent impacts to these habitats are foreseen.

The recommended conveyance from the Trinity to the San Jacinto Basin is the Luce Bayou Transfer. This project includes a pump station, pipeline, 23.6 miles of canal and an outfall into Lake Houston. The current alignment will disturb undeveloped forest areas near the Trinity River, farm lands, and more developed areas near Lake Houston. By limiting the use of bed and banks conveyance, the current Luce Bayou strategy attempts to minimize impacts on wetlands and avoid them wherever possible.

Texas Parks and Wildlife Department Resource Protection Division prepared an evaluation of the WMS considered in the 2001 Region H Plan. That assessment, which is the most recent available, addresses terrestrial species as well as the aquatic species addressed above, and is included as *Appendix 7C*.

7.3.2 Parks and Public Lands

As described in *Chapter 1*, Region H contains over 325,000 acres of state and national forests, over 107,000 acres of coastal wildlife refuges, and over 12,000 acres of Texas wildlife management areas. The RHWPG was fortunate that none of the recommended strategies required water supply projects within or conveyances through these areas. The transfer of supply from Lake Livingston into the San Jacinto basin has the potential to reduce flows through the Trinity River National Wildlife Refuge during drought periods. The transfer may also include an interbasin pipeline route potentially impacting lands in the Sam Houston National Forest (SHNF) increasing possible environmental impacts from construction and maintenance activities.

7.3.3 Impacts of Water Management Strategies on Unique Stream Segments

Region H recommended eight stream segments for designation as unique in the 2006 Water Plan. The streams recommended were:

- Armand Bayou in Harris County
- Austin Bayou in Brazoria County
- Bastrop Bayou in Brazoria County
- Big Creek in Fort Bend County
- Big Creek in San Jacinto County
- Cedar Lake Creek in Brazoria County
- Menard Creek in Polk and Liberty Counties
- Oyster Bayou in Chambers County

All of these segments occur within riparian conservation areas, and there are no water management strategies that divert additional water from or above these streams. Additionally, terrestrial strategies such as brush control or salt cedar removal are not recommended within Region H, so the riparian habitats should not be affected. Finally, there is some concern that overuse of groundwater would impact spring flows within the Sam Houston National Forest. Region H does not recommend the export of groundwater from any county, and encourages the formation of groundwater conservation districts to actively manage these resources. The western portion of the National Forest lies in Walker and Montgomery Counties, which both have active groundwater conservation districts. The southern portion of the National Forest is in San Jacinto and Liberty Counties, which are currently working towards forming a groundwater conservation district.

The current unique stream segments and an analysis of all proposed stream segments is provided in *Chapter 8*.

7.3.4 Impacts of Water Management Strategies on Galveston Bay

The Galveston Bay estuary is arguably the most significant natural resource within Region H, providing habitat for a rich diversity of permanent and migratory species, recreational and tourism use, employment for fisherman and the tourism industry, and serves as the gateway to the second busiest port in the U.S.

As discussed in *Chapter 4*, Galveston Bay is affected by the water plans for both Region C (in the Upper Trinity River Basin) and for Region H (in the Lower Trinity and San Jacinto River Basins. The Galveston Bay Freshwater Inflows Group has defined target frequencies for inflows to the estuary, based upon salinity and harvest models developed by the TCEQ and TPWD. In 2008, the Region H

Planning Group authorized a study to analyze the impact of individual strategies on Bay and Estuary (B&E) inflows from individual water management strategies. The study analyzed the impacts on inflows to Galveston Bay and instream flows to identify the impacts from future strategies. The effects of the 2006 Regional Water Plans on the Bay are summarized in *Table 7-1*below. While the table indicates that the combined plans will maintain overall flows into Galveston Bay, it does not reflect the change in inflow locations. The transfer of water from the Trinity River Basin into the San Jacinto basin will relocate return flows from Trinity Bay to Upper Galveston Bay. This may have some impact on the oyster beds located within Trinity Bay. The increase of flows into Upper Galveston Bay should be less of a concern, because that flow will occur in the Houston Ship Channel (a dredged channel that is significantly deeper than the rest of the estuary). As a continuation of the environmental flows investigation performed in 2008, the impact of water management strategies on bay and estuary inflows was analyzed on a decadal basis. The decadal environmental flows investigation is presented in *Chapter 4*.

Table 7-1

Overall Frequencies of Meeting Monthly Inflow Targets

Inflow Target	Max H	Min Q	Min Q-Sal
Historical Frequency	66%	78%	82%
GBFIG Target Frequency	50%	60%	75%
Naturalized Flow	68%	67%	83%
Existing Diversions with Full Return Flows	63%	58%	79%
Full Authorized Diversions with Return Flows	59%	53%	75%
Full Authorized Diversions with no Return Flows	43%	43%	56%
Future 2060 Conditions with Return Flows and all Recommended WMS	62%	59%	77%

7.3.5 Energy Reserves

Oil, gas and other energy reserves are considered natural resources of the state. While Region H is home to a large portion of the nation's petrochemical industry, the amount of actual oil and gas mining within Region H is small compared to other portions of the state. In this plan, Region H was able to identify reliable supplies to meet all projected mining and manufacturing demands throughout the planning period. No adverse affect on this resource is foreseen.

Appendix 7A

Agricultural Census Data
1987 - 2007

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Agricultural Census Data

The Data presented on the following tables was obtained from the U.S. Department of Agriculture, National Agricultural Statistics Service.

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Appendix 7A
Agricultural Census Data

Table 7A-1 Land in Farms (acres)

	1987	1992	1997	2002	2007	% Change (1987 - 2007)
Austin	347,215	337,351	367,432	367,497	333,928	-3.83%
Brazoria	537,077	563,993	566,809	613,891	528,957	-1.51%
Chambers	306,606	251,249	241,933	274,853	267,343	-12.81%
Fort Bend	363,823	422,464	431,582	415,251	382,740	5.20%
Galveston	98,924	102,229	104,941	127,280	103,387	4.51%
Harris	374,759	308,344	311,005	304,868	259,039	-30.88%
Leon	499,334	482,165	514,724	562,615	569,101	13.97%
Liberty	362,794	342,213	306,783	304,574	297,855	-17.90%
Madison	222,574	243,989	223,690	244,524	273,109	22.70%
Montgomery	188,284	193,885	193,375	197,892	169,914	-9.76%
Polk	144,390	141,215	135,988	129,956	131,664	-8.81%
San Jacinto	91,209	82,721	84,620	93,497	95,492	4.70%
Trinity	133,122	109,635	98,748	104,724	108,974	-18.14%
Walker	269,832	213,923	183,988	206,311	224,050	-16.97%
Waller	276,750	242,901	238,110	277,000	271,004	-2.08%
Region H	4,216,693	4,038,277	4,003,728	4,224,733	4,016,557	-4.75%

Table 7A-2 Total Cropland (acres)

	1987	1992	1997	2002	2007	% Change (1987 - 2007)
Austin	155,357	161,996	161,192	134,793	96,559	-37.85%
Brazoria	195,681	221,812	203,341	224,640	186,201	-4.84%
Chambers	109,707	120,193	118,316	134,492	115,588	5.36%
Fort Bend	162,516	191,148	193,138	194,001	152,112	-6.40%
Galveston	38,242	38,543	30,285	45,773	21,819	-42.94%
Harris	162,421	142,216	118,827	124,340	91,438	-43.70%
Leon	144,407	175,179	182,633	184,627	121,142	-16.11%
Liberty	183,670	163,630	159,841	156,413	127,704	-30.47%
Madison	72,388	84,345	79,105	91,864	39,646	-45.23%
Montgomery	43,583	49,621	47,711	57,776	33,782	-22.49%
Polk	37,013	37,294	42,208	44,673	23,720	-35.91%
San Jacinto	20,252	24,432	28,355	35,427	21,027	3.83%
Trinity	46,740	54,531	49,188	42,771	27,340	-41.51%
Walker	56,318	59,530	60,192	61,715	37,146	-34.04%
Waller	121,223	118,632	116,477	124,431	103,518	-14.61%
Region H	1,549,518	1,643,102	1,590,809	1,657,736	1,198,742	-22.64%

Table 7A-3 Irrigated Land (acres)

	1987	1992	1997	2002	2007	% Change (1987 - 2007)
Austin	3,026	3,781	4,954	3,541	1,559	-48.48%
Brazoria	33,271	38,682	29,596	17,138	11,980	-63.99%
Chambers	24,748	32,127	24,894	16,152	11,508	-53.50%
Fort Bend	13,291	16,415	17,039	15,751	8,339	-37.26%
Galveston	4,713	3,120	1,449	1,703	614	-86.97%
Harris	13,630	15,749	10,454	7,295	7,037	-48.37%
Leon	492	485	1,667	1,383	2,831	475.41%
Liberty	21,302	29,142	14,092	11,828	5,313	-75.06%
Madison	311	135	208	243	456	46.62%
Montgomery	163	406	474	1,287	2,262	1287.73%
Polk	121	36	377	99	1,440	1090.08%
San Jacinto	76	132	104	292	943	1140.79%
Trinity	55	14	52	213	310	463.64%
Walker	161	170	325	600	885	449.69%
Waller	5,461	8,187	8,120	11,908	9,904	81.36%
Region H	120,821	148,581	113,805	89,433	65,381	-45.89%

Table 7A-4 Land in Irrigated Farms (acres)

	1987	1992	1997	2002	2007	% Change (1987 - 2007)
Austin	21,782	26,550	39,537	24,162	12,755	-41.44%
Brazoria	198,605	172,446	157,328	117,411	89,055	-55.16%
Chambers	179,509	132,618	92,798	82,026	58,872	-67.20%
Fort Bend	67,502	65,470	71,369	70,799	60,685	-10.10%
Galveston	20,682	13,121	5,556	9,669	3,213	-84.46%
Harris	72,078	62,473	54,502	37,006	15,395	-78.64%
Leon	7,574	3,848	11,700	9,167	19,257	154.25%
Liberty	148,439	138,307	92,453	50,930	36,442	-75.45%
Madison	6,164	3,388	5,784	2,117	15,449	150.63%
Montgomery	1,451	3,158	1,942	11,239	14,485	898.28%
Polk	545	144	4,331	1,137	4,492	724.22%
San Jacinto	518	597	973	1,991	2,644	410.42%
Trinity	870	112	240	922	1,411	62.18%
Walker	4,686	2,322	21,121	5,970	26,555	466.69%
Waller	54,443	49,874	40,666	45,540	56,102	3.05%
Region H	784,848	674,428	600,300	470,086	416,812	-46.89%

Table 7A-5 Land in Irrigated Farms, Harvested Cropland (acres)

	1987	1992	1997	2002	2007	% Change (1987 - 2007)
Austin	4,053	4,425	8,201	5,857	4,398	8.51%
Brazoria	53,866	55,395	42,533	42,074	31,452	-41.61%
Chambers	30,954	35,563	26,550	18,611	11,482	-62.91%
Fort Bend	26,078	26,899	29,735	31,805	17,904	-31.34%
Galveston	6,214	3,421	1,445	1,538	524	-91.57%
Harris	18,996	20,609	12,691	13,837	6,794	-64.23%
Leon	621	507	1,834	1,601	3,633	485.02%
Liberty	52,409	56,736	39,882	30,840	12,485	-76.18%
Madison	1,461	(D)	1,496	571	1,070	-26.76%
Montgomery	229	618	577	1,209	6,374	2683.41%
Polk	147	36	365	230	868	490.48%
San Jacinto	96	157	131	315	1,194	1143.75%
Trinity	75	22	51	241	250	233.33%
Walker	190	108	(D)	802	4,107	2061.58%
Waller	11,009	17,854	13,835	15,388	13,399	21.71%
Region H	206,398	222,350	179,326	164,919	115,934	-43.83%

Table 7A-6 Rice (hundredweight)

	1987	1992	1997	2002	2007	% Change (1987 - 2007)
Austin	159,111	207,445	175,843	130,601	0	-100.00%
Brazoria	1,535,740	1,713,898	1,134,188	1,013,213	572,285	-62.74%
Chambers	1,070,528	1,276,063	949,505	713,173	639,692	-40.25%
Fort Bend	575,994	676,342	658,485	803,346	278,716	-51.61%
Galveston	221,713	127,871	51,563	75,527	(D)	N/A
Harris	564,625	584,225	356,432	107,876	62,265	-88.97%
Leon	0	0	0	0	0	N/A
Liberty	983,301	1,267,760	604,582	464,751	193,188	-80.35%
Madison	0	0	0	0	0	N/A
Montgomery	0	0	0	0	0	N/A
Polk	0	0	0	0	0	N/A
San Jacinto	0	0	0	0	0	N/A
Trinity	0	0	0	0	0	N/A
Walker	0	0	0	0	0	N/A
Waller	285,531	413,337	468,471	679,960	581,785	103.76%
Region H	5,396,543	6,266,941	4,399,069	3,988,447	2,327,931	-56.86%

Table 7A-7 Rural Land Use Data (acres)

Austin

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	408,229	403,425	-4,804
Dryland Crop	38,799	31,967	-6,832
Irrigated Crop	5,772	7,069	1,297
Improved Pasture	49,156	100,738	51,582
Native Rangeland	296,906	250,155	-46,751
Other	17,354	12,895	-4,459
Timberland	242	601	359

Brazoria

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	556,123	539,461	-16,662
Dryland Crop	28,873	15,951	-12,922
Irrigated Crop	128,456	113,888	-14,568
Improved Pasture	9,189	36,189	27,000
Native Rangeland	365,001	347,751	-17,250
Other	24,159	25,102	943
Timberland	445	580	135

Chambers

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	273,197	261,713	-11,484
Dryland Crop	13,578	2,573	-11,005
Irrigated Crop	123,057	98,269	-24,788
Improved Pasture	8,635	9,069	434
Native Rangeland	104,669	115,276	10,607
Other	9,489	24,193	14,704
Timberland	13,769	12,333	-1,436

Fort Bend

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	355,487	342,356	-13,131
Dryland Crop	101,106	82,210	-18,896
Irrigated Crop	28,450	32,186	3,736
Improved Pasture	17,570	27,083	9,513
Native Rangeland	205,765	197,004	-8,761
Other	2,518	3,746	1,228
Timberland	78	127	49

Galveston

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	92,147	101,154	9,007
Dryland Crop	224	286	62
Irrigated Crop	33,027	26,804	-6,223
Improved Pasture	7,861	8,293	432
Native Rangeland	50,942	64,593	13,651
Other	93	1,178	1,085
Timberland	0	0	0

Harris

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	185,785	174,053	-11,732
Dryland Crop	21,043	11,379	-9,664
Irrigated Crop	14,193	7,534	-6,659
Improved Pasture	18,750	18,671	-79
Native Rangeland	87,904	80,519	-7,385
Other	5,350	19,822	14,472
Timberland	38,545	36,128	-2,417

Leon

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	648,488	680,099	31,611
Dryland Crop	0	0	0
Irrigated Crop	0	0	0
Improved Pasture	252,522	0	-252,522
Native Rangeland	378,783	530,129	151,346
Other	0	123,892	123,892
Timberland	17,183	26,078	8,895

Liberty

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	598,553	620,610	22,057
Dryland Crop	56,107	56,202	95
Irrigated Crop	52,500	31,146	-21,354
Improved Pasture	44,556	66,827	22,271
Native Rangeland	146,663	146,543	-120
Other	9,151	2,988	-6,163
Timberland	289,576	316,904	27,328

Madison

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	607,484	607,904	420
Dryland Crop	9,811	12,068	2,257
Irrigated Crop	6,979	5,746	-1,233
Improved Pasture	18,831	30,318	11,487
Native Rangeland	268,424	549,798	281,374
Other	303,439	9,974	-293,465
Timberland	0	0	0

Montgomery

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	368,389	330,118	-38,271
Dryland Crop	0	0	0
Irrigated Crop	0	0	0
Improved Pasture	6,264	10,111	3,847
Native Rangeland	89,981	98,227	8,246
Other	157	128	-29
Timberland	271,987	221,652	-50,335

Polk

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	524,757	483,590	-41,167
Dryland Crop	0	0	0
Irrigated Crop	0	0	0
Improved Pasture	48,163	85,309	37,146
Native Rangeland	49,205	3,725	-45,480
Other	247	533	286
Timberland	427,142	394,023	-33,119

San Jacinto

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	195,044	199,223	4,179
Dryland Crop	509	2,056	1,547
Irrigated Crop	33	25	-8
Improved Pasture	26,130	37,753	11,623
Native Rangeland	40,627	38,683	-1,944
Other	284	12	-272
Timberland	127,461	120,694	-6,767

Trinity

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	388,395	391,412	3,017
Dryland Crop	1,288	79	-1,209
Irrigated Crop	0	0	0
Improved Pasture	22,191	20,448	-1,743
Native Rangeland	109,149	100,744	-8,405
Other	25	893	868
Timberland	255,742	269,248	13,506

Walker

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	312,570	320,913	8,343
Dryland Crop	0	0	0
Irrigated Crop	0	0	0
Improved Pasture	22,508	56,278	33,770
Native Rangeland	156,454	122,914	-33,540
Other	0	173	173
Timberland	133,608	141,548	7,940

Waller

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	370,737	367,294	-3,443
Dryland Crop	71,451	66,715	-4,736
Irrigated Crop	37,210	28,855	-8,355
Improved Pasture	53,409	55,035	1,626
Native Rangeland	187,884	197,177	9,293
Other	5,711	5,076	-635
Timberland	15,072	14,436	-636

Region H Total

Landuse Type	Acres in 1992	Acres in 2001	10 year change
All	5,885,385	5,823,325	-62,060
Dryland Crop	342,789	281,486	-61,303
Irrigated Crop	429,677	351,522	-78,155
Improved Pasture	605,735	562,122	-43,613
Native Rangeland	2,538,357	2,843,238	304,881
Other	377,977	230,605	-147,372
Timberland	1,590,850	1,554,352	-36,498

Appendix 7B

Threatened and Endangered Species within Region H

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Threatened and Endangered Species within Region H

Listed below are the state- and federally-listed aquatic threatened and endangered aquatic species within Region H, by county. A description of each threatened and endangered species is listed on the following pages.

Species	County														
	Austin County	Brazoria County	Chambers County	Fort Bend County	Galveston County	Harris County	Leon County	Liberty County	Madison County	Montgomery County	Polk County	San Jacinto County	Trinity County	Walker County	Waller County
Alligator Snapping Turtle	X	X	X	X	X	X	X	X	X	X	X	X		X	X
American Peregrine Falcon	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Artic Peregrin Falcon	X	X	X		X	X	X	X	X	X	X	X		X	X
Atlantic Hawksbill Sea Turtle		X	X		X	X									
Bald Eagle	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Black Rail		X			X	X									
Brown Pelican*		X	X		X	X									
Corkwood		X	X	X											
Correll's false dragon-head					X					X					
Creek Chubsucker								X		X	X	X	X	X	X
Green Sea Turtle		X	X		X	X									
Houston Toad	X					X	X	X	X						
Interior Least Tern	X		X				X		X						X
Kemps Ridley Sea Turtle		X	X		X	X									
Leatherback Sea Turtle		X	X		X	X									
Loggerhead Sea Turtle		X	X		X	X									
Paddlefish							X	X	X	X	X	X	X	X	
Piping Plover		X	X		X			X		X	X		X	X	
Reddish Egret		X	X		X										
Sharpnose shiner		X													X
Swallow-tailed Kite		X	X		X			X			X	X		X	
Timber/Canebrake Rattlesnake			X	X	X	X	X	X		X	X	X		X	X
West Indian manatee		X													
White-faced Ibis	X	X	X	X	X	X		X		X			X		X
Wood Stork	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

* Delisted in November, 2009 by United States Fish and Wildlife Service

Description of Threatened and Endangered Species

Alligator Snapping Turtle (*Macrochelys temminckii*) - deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October

American Peregrine Falcon *(Falco peregrinus anatum)*- year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands

Artic Peregrin Falcon *(Falco peregrinus tundrius)*- migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands

Atlantic Hawksbill Sea Turtle *(Eretmochelys imbricate)-* Gulf and bay system, warm shallow waters especially in rocky marine environments, such as coral reefs and jetties, juveniles found in floating mats of sea plants; feed on sponges, jellyfish, sea urchins, mollusks, and crustaceans, nests April through November

Bald Eagle (*Haliaeetus leucocephalus*) - found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Black Rail (*Laterallus jamaicensis*) - salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous year's dead grasses; nest usually hidden in marsh grass or at base of Salicornia

Corkwood (*Leitneria floridana*) – small, sparingly-branched, dioecious, deciduous shrub or small tree; forms thickets of stick-like erect stems, the diameter of each at base rarely to 12 or 13 cm; found in narrow zone between brackish marsh and contiguous coastal pine-hardwood; brackish or freshwater swamps or thickets; flowers in spring

Correll's false dragon-head (*Physostegia correllii*) – wet soils including roadside ditches and irrigation channels; flowering June-July

Creek Chubsucker (*Erimyzon oblongus*) - small rivers and creeks of various types; seldom in impoundments; prefers headwaters, but seldom occurs in springs; young typically in headwater rivulets or marshes; spawns in river mouths or pools, riffles, lake outlets, upstream creeks

Green Sea Turtle *(Chelonia mydas)* - Gulf and bay system; shallow water seagrass beds, open water between feeding and nesting areas, barrier island beaches; adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds; nesting behavior extends from March to October, with peak activity in May and June

Houston Toad (Bufo houstonensis) - endemic; species sandy substrate, water in pools, ephemeral pools, stock tanks; breeds in spring especially after rains; burrows in soil when inactive; breeds February-June

Interior Least Tern (*Sterna antillarum athalassos*) – this subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Kemps Ridley Sea Turtle *(Lepidochelys kempii)-* Gulf and bay system, adults stay within the shallow waters of the Gulf of Mexico; feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August

Leatherback Sea Turtle *(Dermochelys coriacea)-* Gulf and bay systems, and wide-ranging open water sea turtle; omnivorous, shows a preference for jellyfish; nests from November to February, but not known to nest in Gulf of Mexico, just forages

Loggerhead Sea Turtle *(Caretta caretta)-* Gulf and bay system primarily for juveniles, adults are most pelagic of the sea turtles; omnivorous, shows a preference for mollusks, crustaceans, and coral; nests from April through November

Paddlefish (*Polyodon spathula*) - prefers large, free-flowing rivers, but will frequent impoundments with access to spawning sites; spawns in fast, shallow water over gravel bars; larvae may drift from reservoir to reservoir

Piping Plover *(Charadrius melodus)* - wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

Reddish Egret *(Egretta rufescens)* - resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Sharpnose shiner *(Notropis Oxyrhynchus)*- endemic to Brazos River drainage; also, apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom a combination of sand, gravel, and clay-mud

Swallow-tailed Kite (*Elanoides forficatus*) - lowland forested regions, especially swampy areas, ranging into open woodland; marshes, along rivers, lakes, and ponds; nests high in tall tree in clearing or on forest woodland edge, usually in pine, cypress, or various deciduous trees

Timber/Canebrake Rattlesnake *(Crotalus horridus)-* swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

West Indian manatee *(Trichechus manatus)-* Gulf and bay system; opportunistic, aquatic herbivore

White-faced Ibis (*Plegadis chihi*) - prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

Wood Stork (*Mycteria americana*) - forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

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Appendix 7C

Texas Parks and Wildlife Department Analysis of Water Management Strategies Recommended in the 2001 Region H Water Plan

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Texas Parks and Wildlife Department

Analysis of Water Management Strategies

Recommended in the 2001 Region H Water Plan

The Resource Protection Division of the Texas Parks and Wildlife Department prepared the attached document: Region H Strategies – Preliminary Assessment, Internal Working Memorandum, 2001.

The following changes between the 2001 Region H Plan and this update to the plan should be noted:

- The final impoundment plan for Allens Creek Reservoir, as submitted and approved in the water right application, was changed from the outline included in the 2001 Region H Water Plan. The project footprint was reduced to avoid Alligator Hole.

- Bedias Creek Reservoir and the related Interbasin Transfer from Bedias to Lake Conroe is not a recommended strategy in the 2006 Plan or the 2011 update to the Region H plan.

- Little River Reservoir has been replaced in the 2006 update to the Region H Plan with an off-channel reservoir in the Little River Basin. The Little River Off-channel Reservoir was replaced in the 2011 update to the Region H Plan with the Millican Lake/Reservoir on the Navasota River. The Little River Off-Channel Reservoir is included in the 2011 Plan as an Alternative Water Management Strategy.

- The SJRA/Lake Livingston Diversion was not a recommended strategy in the 2001 and 2006 Region H Plan, nor is it recommended in the 2011 update.

- The Sabine to Region H Interbasin Transfer was not a recommended strategy in the 2001 and 2006 Region H Plan, nor is it recommended in the 2011 update. It is however, listed as an alternative strategy.

- The COH/GCWA transfer strategy was recommended in the 2006 Region H Water Plan, but is not included in the 2011 Plan Update as a recommended or alternative water management strategy.

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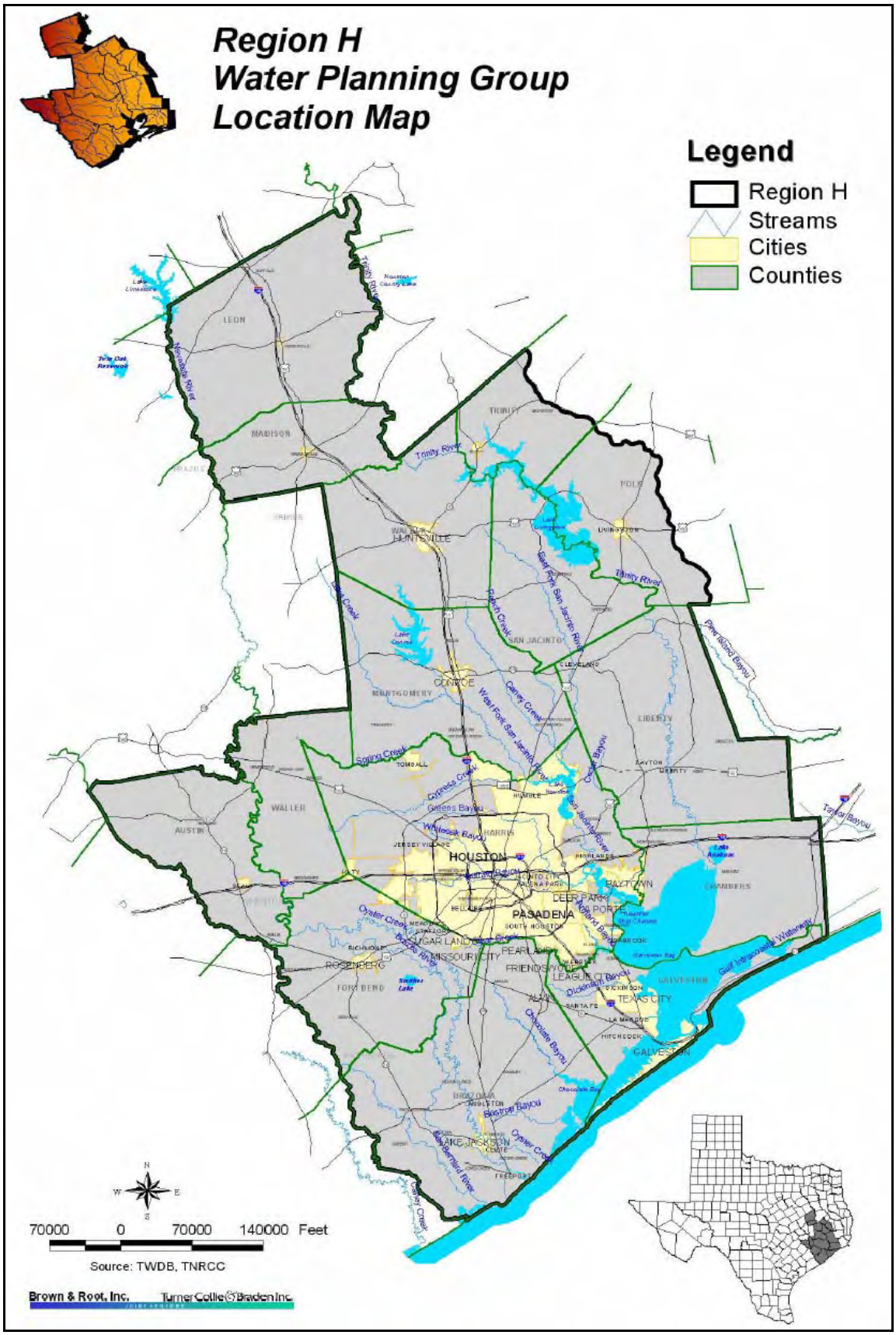
Texas Parks and Wildlife Department
Region H Strategies – Preliminary Assessment
Internal Working Memorandum
2001


Region H
Water Planning Group
Location Map
Legend
Region H
Streams
Cities
Counties
HOUSTON
PASADENA
CONROE
HUNTSVILLE
GALVESTON
TEXAS CITY
LAKE JACKSON
70000 0 70000 140000 Feet
Source: TWDB, TNRCC
Brown & Root, Inc.
Turner Collie & Braden Inc

Region H		Houston RWPG	
Proposed Project / Strategy	**acre/feet**	**Concerns/Potential Impacts**	**Date Needed**
Allens Creek Reservoir (BRA/Houston)	99,650/yr	Loss/alteration of habitat to inundation (8,250 acres); Reduced instream flows and freshwater inflows; Pipeline construction from reservoir (bed and banks, wetlands, terrestrial habitat, rare species)	Now
Bedias Creek Reservoir (SJRA/TRA)	90,700/yr	Loss/alteration of habitat to inundation ; Reduced instream flows; Pipeline construction from reservoir (bed and banks, wetlands, terrestrial habitat, rare species)	2030
Little River Reservoir (BRA/GCWA)	129,000/yr	Loss/alteration of habitat to inundation; Reduced instream flows; Pipeline construction from reservoir (bed and banks, wetlands, terrestrial habitat, rare species)	????
Luce Bayou transfer (City of Houston)	75,000/yr	8 miles of rectification; Reduced flows in Trinity River; Reduced freshwater inflows to Trinity Bay; Increased flows in Luce Bayou; Loss/alteration of habitat	2020
SJRA/City of Houston contract	67,029/yr	Reduced instream flows between Conroe and Lake Houston; Alteration/loss of habitat; Pipeline construction?	2030
SJRA/Lake Livingston Diversion	75,000/yr	Rectification of stream channel and increased flows in San Jacinto River; Reduced instream flows downstream of Lake Livingston; Reduced freshwater inflows to Trinity Bay; Pipeline construction?	2030
TRA/City of Houston contract	200,000/yr	CWA canal or Luce Bayou	2040
Bedias transfer	90,700/yr	Rectification of and increased flows in Mock Branch and West Fork San Jacinto River; Pipeline construction (bed and banks, wetlands)	2030
GCWA/City of Houston contract (Trinity River water to Galveston)	23,000/yr	Reduced freshwater inflows to Trinity Bay; Pipeline construction (bed and banks, wetlands, rare species)	2050
Sabine transfer for all water user groups	101,500 - 453,100/yr	Interbasin transfer; Pipeline construction (bed and banks, wetlands, loss of habitat, rare species, cultural resources); movement of exotic species or species not native to receiving basin	2010-2050

STRATEGY: Allens Creek Reservoir

SPONSOR: Brazos River Authority, City of Houston

SUMMARY

DESCRIPTION: The reservoir site is located on Allens Creek, a tributary to the Brazos River, in Austin County. A permit has been issued for this project to the TWDB for industrial purposes for the consumptive use of 46,256 acre-feet per year. The Brazos Rivber Authority (BRA) and the City of Houston (COH) have recently submitted a permit amendment to increase the project yield, change the use type and become project sponsors. The BRA is in the process of purchasing the entire site from Reliant Energy (this may have already been accomplished). The project is configured as a scalping reservoir that would divert stormwater flows from the Brazos River and impound these flows into the reservoir to create storage yield. Maximum dam height is 53 feet and the conservation storage capacity is approximately 145,500 acre-feet at an elevation of 121.0 feet msl.

COST: $157.3 million (1999)

STARTING DECADE: 2000

QUANTITY OF WATER: 99,650 acre-feet per year

LAND IMPACTED: 7,000 acres (Region H Plan, 2001); 8,250 acres (Bauer et al, 1991)

PURPOSE: Municipal, Industrial, and Irrigation Water Supply and Recreation

ISSUES AFFECTING FEASIBILITY: The Texas Legislature has designated this site as a Unique Reservoir Site. The Water Planning Group rated environmental impacts moderate to small and also reported no endangered species have been found on the site. TPWD's Wildlife Diversity Program reports the following rare species may be found in Austin County:

Houston Toad (State and Federally Endangered)
American Peregrine Falcon (State Endangered/Federally Delisted)
Arctic Peregrine Falcon (State Threatened/Federally Delisted)
Attwater's Greater Prairie Chicken (State and Federally Endangered)
Bald Eagle (State and Federally Threatened)
Henslow's Sparrow (State Species of Concern)
Mountain Plover (State Species of Concern)
White-faced Ibis (Federal Species of Concern/State Threatened)
White-tailed Hawk (Federal Species of Concern/State Threatened)
Whooping Crane (State and Federally Endangered)
Wood Stork (Federal Species of Concern/State Threatened)
Plains Spotted Skunk (State Species of Concern)

Smooth Green Snake (Federal Species of Concern/State Threatened)
Texas Garter Snake (State Species of Concern)
Texas Horned Lizard (Federal Species of Concern/State Threatened)
Timber/Canebrake Rattlesnake (Federal Species of Concern/State Threatened)

Diversion of floodflows from the Brazos River will result in the reduction/alteration of instream flows and freshwater inflows to the Gulf of Mexico. There is a USGS gage on the Brazos River upstream of the project location near the City of Hempstead (USGS gage # 08111500) and another gage downstream near the City of Richmond (USGS gage # 08114000). At times, flows in the Brazos River in the project area are affected by reservoirs on the Brazos River at Waco and by reservoirs on the Lampasas and Little Rivers above Cameron. Median monthly flows (cfs), minimum flows (cfs), and maximum flows (cfs) from the aforementioned gages are presented below:

Monthly median flows (cfs) as reported from USGS gage # 08111500 near Hempstead, TX for the Period of Record (1938 to current year):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2840	3790	3370	3840	7400	5500	2190	1430	1440	1450	1670	2380

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
386	483	425	922	953	1027	817	714	453	180	318	299

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
55994	54748	50455	42857	69861	51960	18998	11507	18028	24832	29487	41594

Monthly median flows (cfs) as reported from USGS gage # 08114000 near Richmond, TX for the Period of Record (1922 to current year):

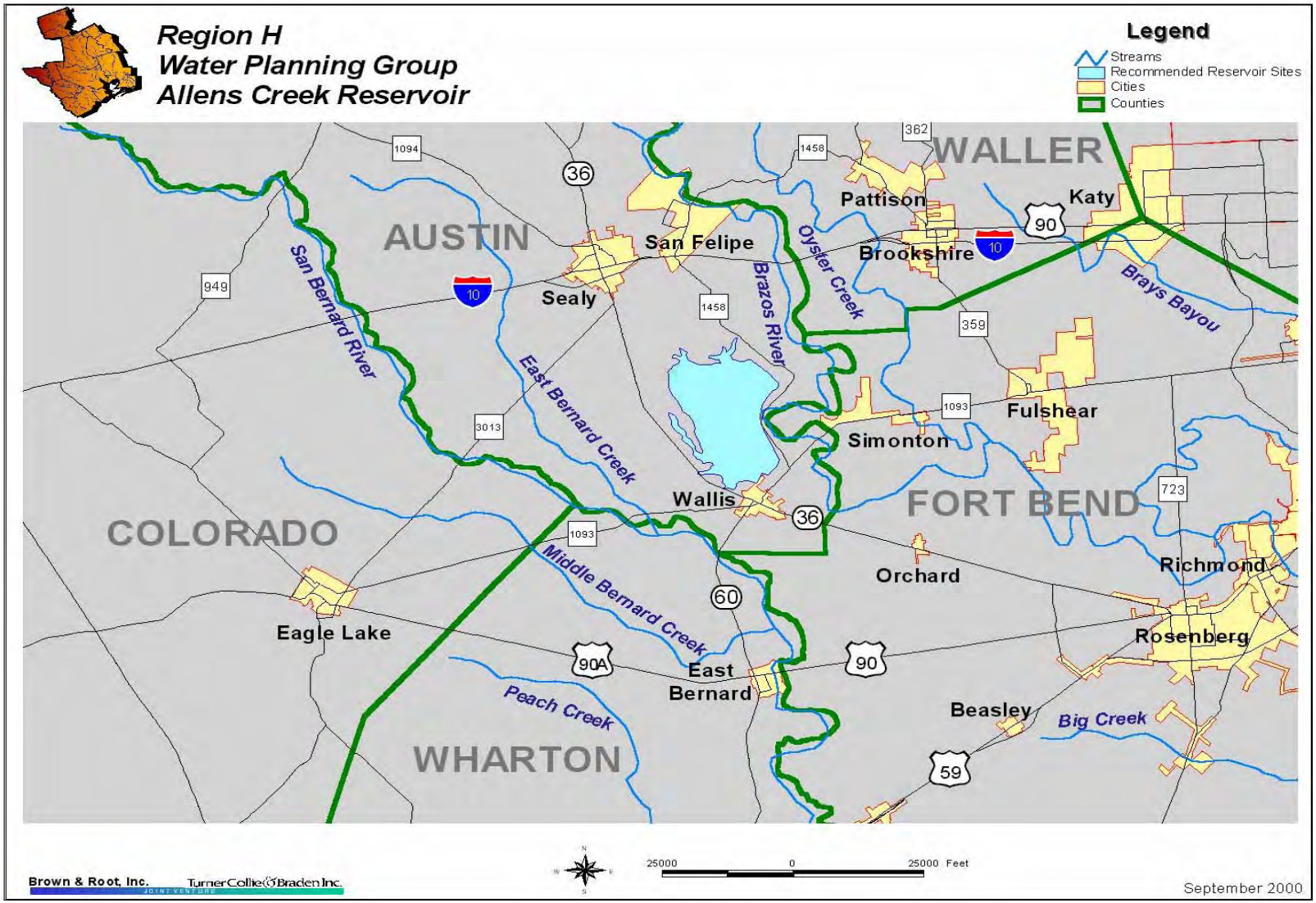
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3540	4600	4400	4300	7310	5900	2360	1440	1570	1700	2000	2595

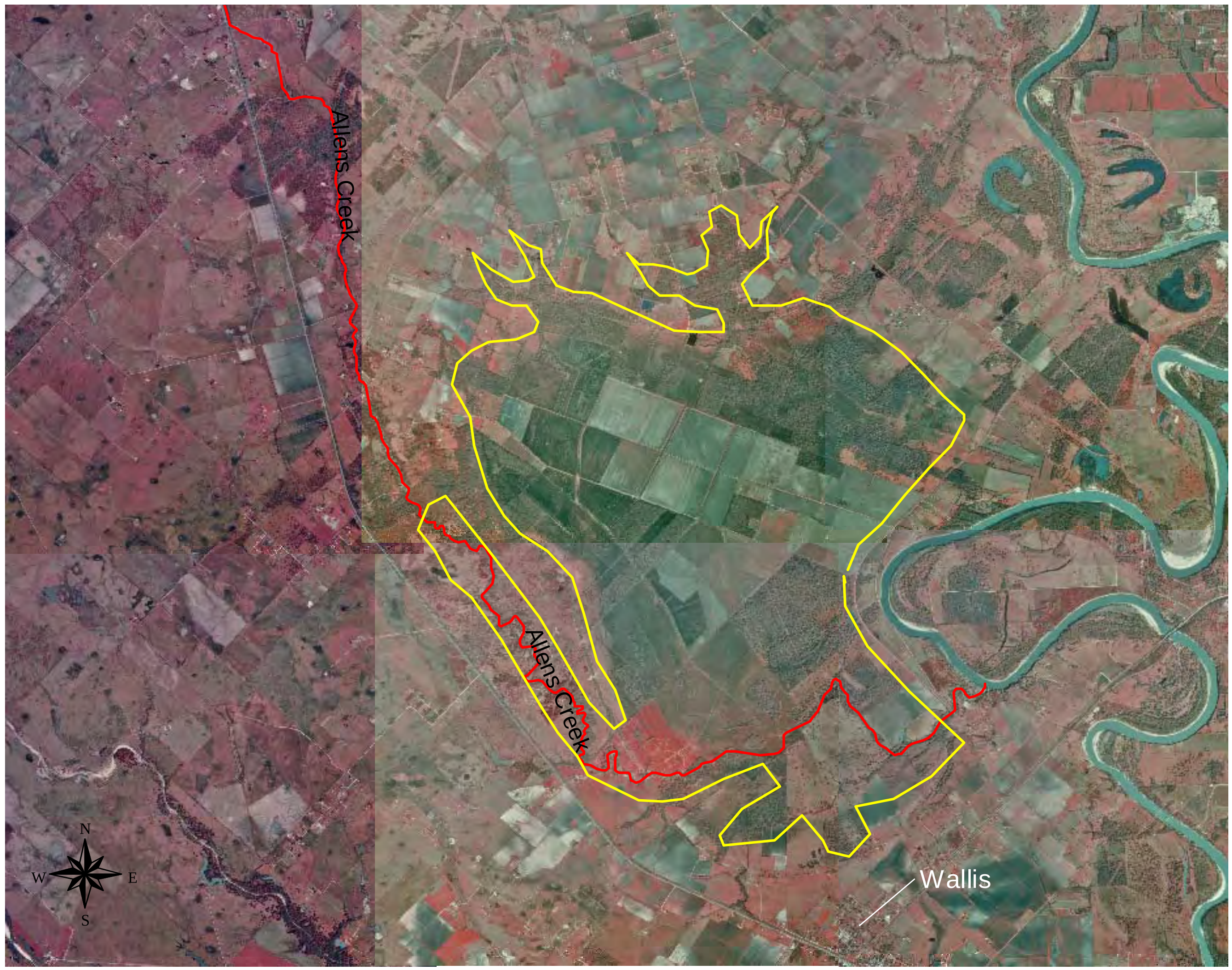
Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
542	527	445	453	818	603	221	141	414	202	366	479

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60497	54407	54052	41900	77197	58350	21261	11802	19847	28763	32360	52865


Region H
Water Planning Group
Allens Creek Reservoir
Legend
Streams
Recommended Reservoir Sites
Cities
Counties
WALLER
AUSTIN
COLORADO
WHARTON
FORT BEND
Pattison
Katy
San Felipe
Brookshire
Sealy
Fulshear
Simonton
Wallis
Orchard
Richmond
Rosenberg
Eagle Lake
East Bernard
Beasley
San Bernard River
Brazos River
Oyster Creek
Brays Bayou
East Bernard Creek
Middle Bernard Creek
Peach Creek
Big Creek
1094
1458
362
36
90
10
949
359
1093
3013
723
60
90A
59
25000
0
25000 Feet
Brown & Root, Inc.
Turner Collie & Braden Inc.
JOINT VENTURE
September 2000


Allens Creek
Allens Creek
Wallis
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W
E
S

STRATEGY: Bedias Creek Reservoir

SPONSOR: San Jacinto River Authority, Trinity River Authority

SUMMARY

DESCRIPTION: The reservoir site is located principally within Madison County in the Trinity River Basin and includes Bedias and Caney Creeks. 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 is proposed to have a conservation storage capacity of 181,000 acre-feet and would inundate about 13,000 acres.

COST: $132 million (1999)

STARTING DECADE: 2030

QUANTITY OF WATER: 90,700 acree-feet per year

LAND IMPACTED: 27,400 acres

PURPOSE: Municipal Water Supply and Flood Control

ISSUES AFFECTING FEASIBILITY:

Several rare species have been documented in the area and others are likely to occur in the project area. Documented and probable rare species that may be impacted by this project are listed below:

Documented Species:
Bald Eagle (State and Federally Threatened)
Red-cockaded Woodpecker (State and Federally Endangered)
Interior Least Tern (State and Federally Endangered)
Louisiana Pine Snake (State Threatened)
Reddish Egret Federal Species of Concern/State Threatened)
White-faced Ibis (Federal Species of Concern/State Threatened)
Wood Stork (Federal Species of Concern/State Threatened)
Arctic Peregrine Falcon (State Threatened/Federally Delisted)
Texas Horned Lizard (Federal Species of Concern/State Threatened)
Alligator Snapping Turtle (Federal Species of Concern/State Threatened)
Timber Rattlesnake (Federal Species of Concern/State Threatened)
Creek Chubsucker (Federal Species of Concern/State Threatened)
Blue Sucker (Federal Species of Concern/State Threatened)
Navasota Ladies Tresses (State and Federally Endangered)

Probable Species:

Paddlefish (Federal Species of Concern/State Threatened)
Bachman's Sparrow (Federal Species of Concern/State Threatened)
Plains Spotted Skunk (State Species of Concern)
Texas Garter Snake (State Species of Concern)
Houston Toad (State and Federally Endangered)
Southeastern Myotis (State Species of Concern)

Various habitat types will be lost due to construction of Bedias Reservoir. The Cover Type and the estimated amount of acreage lost as presented in Frye and Curtis (1990) are listed below:

Cover Type:	**Acres Lost:**
Mixed Bottomland Hardwood Forest (Priority 2)	7,328
Grasses/Parks	7,036
Post Oak-Elm-Hackberry Forest	6,851
Other	3,460
Total	24,675

Construction of Bedias Reservoir will also significantly reduce instream flows and alter aquatic habitat within Bedias Creek. There is a USGS streamflow gage (#08065800) on Bedias Creek near the City of Madisonville. Monthly median flows, monthly minimums, and monthly maximums (cfs) from this gage for the period of record are reported below:

Monthly median flows (cfs) as reported from USGS gage # 08065800 near Madisonville, TX (October 1967 to current):

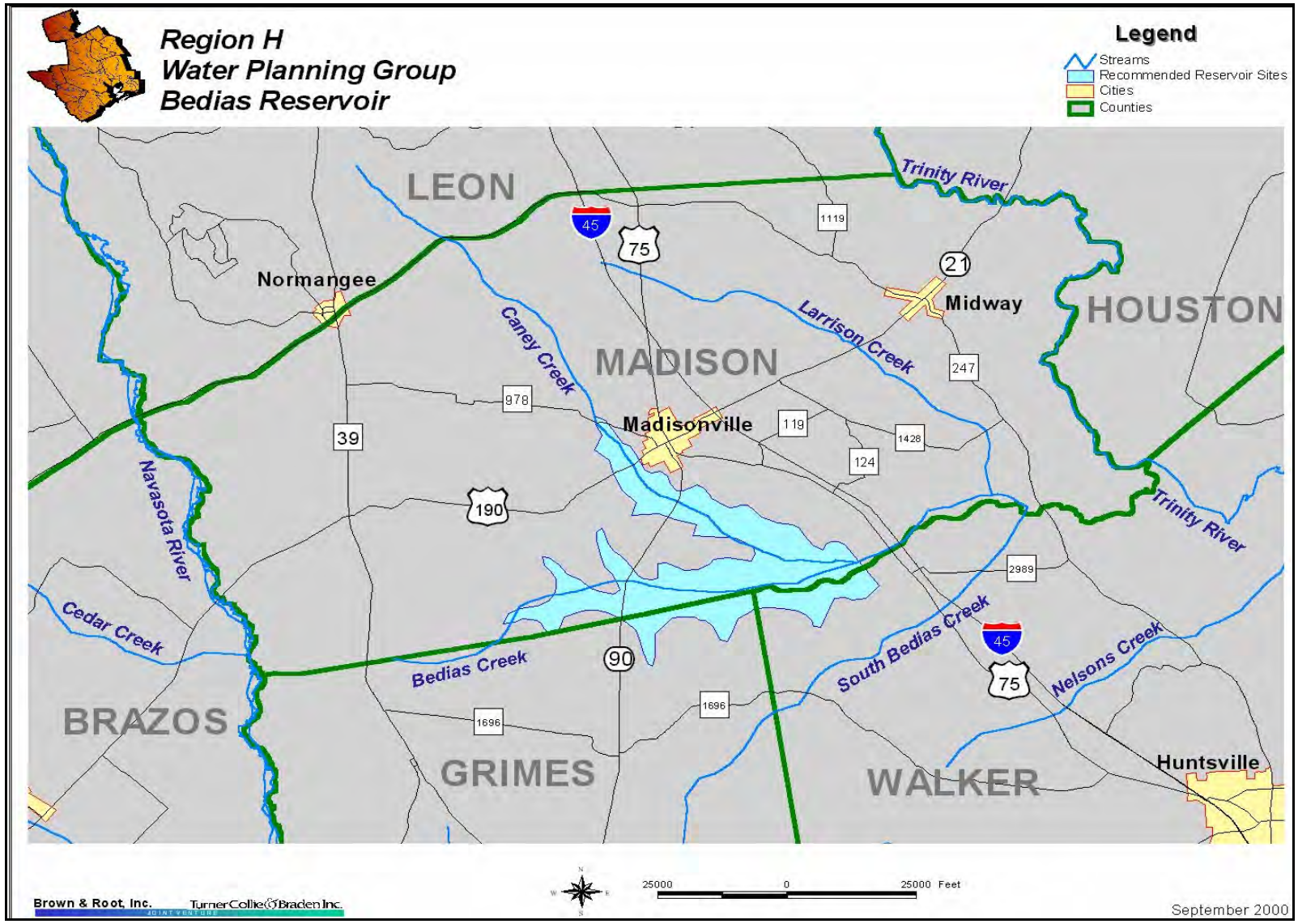
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
30	38	28	18	24	7.8	1.1	0.4	0.64	0.77	4.3	16

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.0	3.8	3.1	2.3	2.7	0.43	0.01	0	0	0	0.03	0.2

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	1580	908	1333	1046	1745	260	266	1551	3021	932	983


Region H
Water Planning Group
Bedias Reservoir
Legend
Streams
Recommended Reservoir Sites
Cities
Counties
LEON
MADISON
HOUSTON
BRAZOS
GRIMES
WALKER
Normangee
Madisonville
Midway
Huntsville
Trinity River
Caney Creek
Larrison Creek
Navasota River
Cedar Creek
Bedias Creek
South Bedias Creek
Nelsons Creek
45
75
21
39
190
90
1119
247
978
119
1428
124
2989
1696
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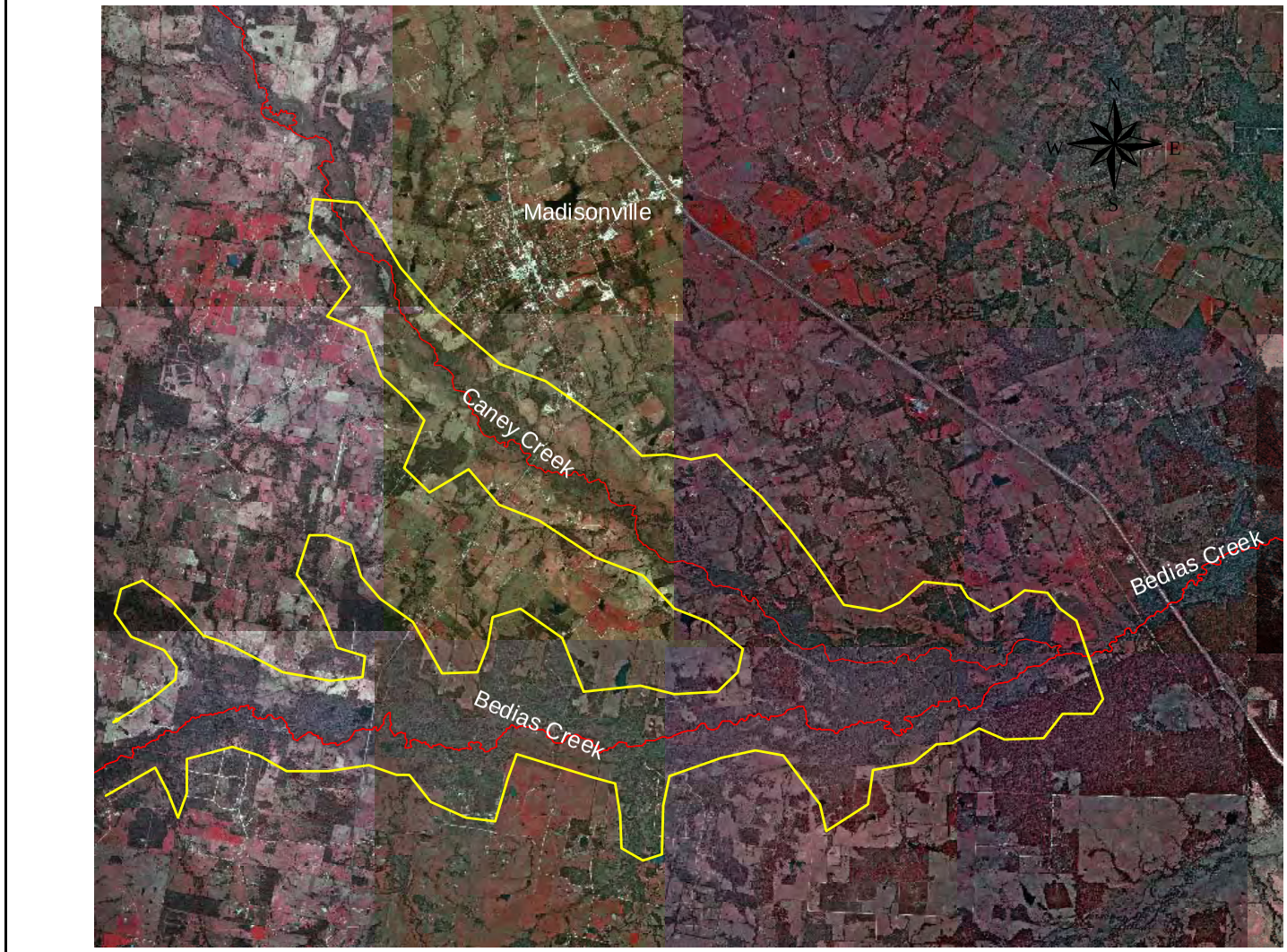
25000 Feet
Brown & Root, Inc.
Turner Collie & Braden Inc.
JOINT VENTURE
September 2000


N
W
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S
Madisonville
Caney Creek
Bedias Creek
Bedias Creek

STRATEGY: Little River Reservoir

SPONSOR: Brazos River Authority, Gulf Coast Water Authority

SUMMARY

DESCRIPTION: The reservoir site is located on the Little River just upstream of its confluence with the Brazos River within Milam County. The reservoir would have a surface area of 35,000 acres and a storage volume of about 930,000 acre-feet. Currently, the upstream drainage of approximately 7,500 square miles lacks any major impoundments.

COST: $361 million (1999)

STARTING DECADE: 2000

QUANTITY OF WATER: 129,000 acre-feet per year

LAND IMPACTED: 35,000 acres

PURPOSE: Municipal Water Supply

ISSUES AFFECTING FEASIBILITY: Construction of reservoir will result in loss/alteration of 35,000 acres. The habitat types and acreage affected have not been surveyed, although bottomland hardwoods likely comprise a large portion. Several rare species may be present in the project area, including:

Houston Toad (State and Federally Endangered)
American Peregrine Falcon (State Endangered/Federally Delisted)
Arctic Peregrine Falcon (State Threatened/Federally Delisted)
Interior Least Tern (State and Federally Endangered)
Zone-tailed Hawk (Federal Species of Concern/State Threatened)
Guadalupe Bass (State Species of Concern)
Texas Horned Lizard (Federal Species of Concern/State Threatened)
Navasota Ladies Tresses (State and Federally Endangered)
Parks' Jointweed (State Species of Concern)

The reservoir will also impound a currently free-flowing river, thus significantly altering instream flows and aquatic habitats. Alteration of aquatic habitat will likely affect some aquatic organisms, such as freshwater mussels. Little River is known to contain a thriving mussel population (J. Henson, pers. comm.). Nationally, 67% of freshwater mussels are rare or imperiled (Nature Conservancy, 1996). There is a USGS gage (#08106500) on Little River near the City of Cameron. Monthly median flows, monthly minimums, and monthly maximums (cfs) from this gage for the period of record are reported below:

Monthly median flows (cfs) as reported from USGS gage # 08106500 near Cameron, TX (1916 to current year):

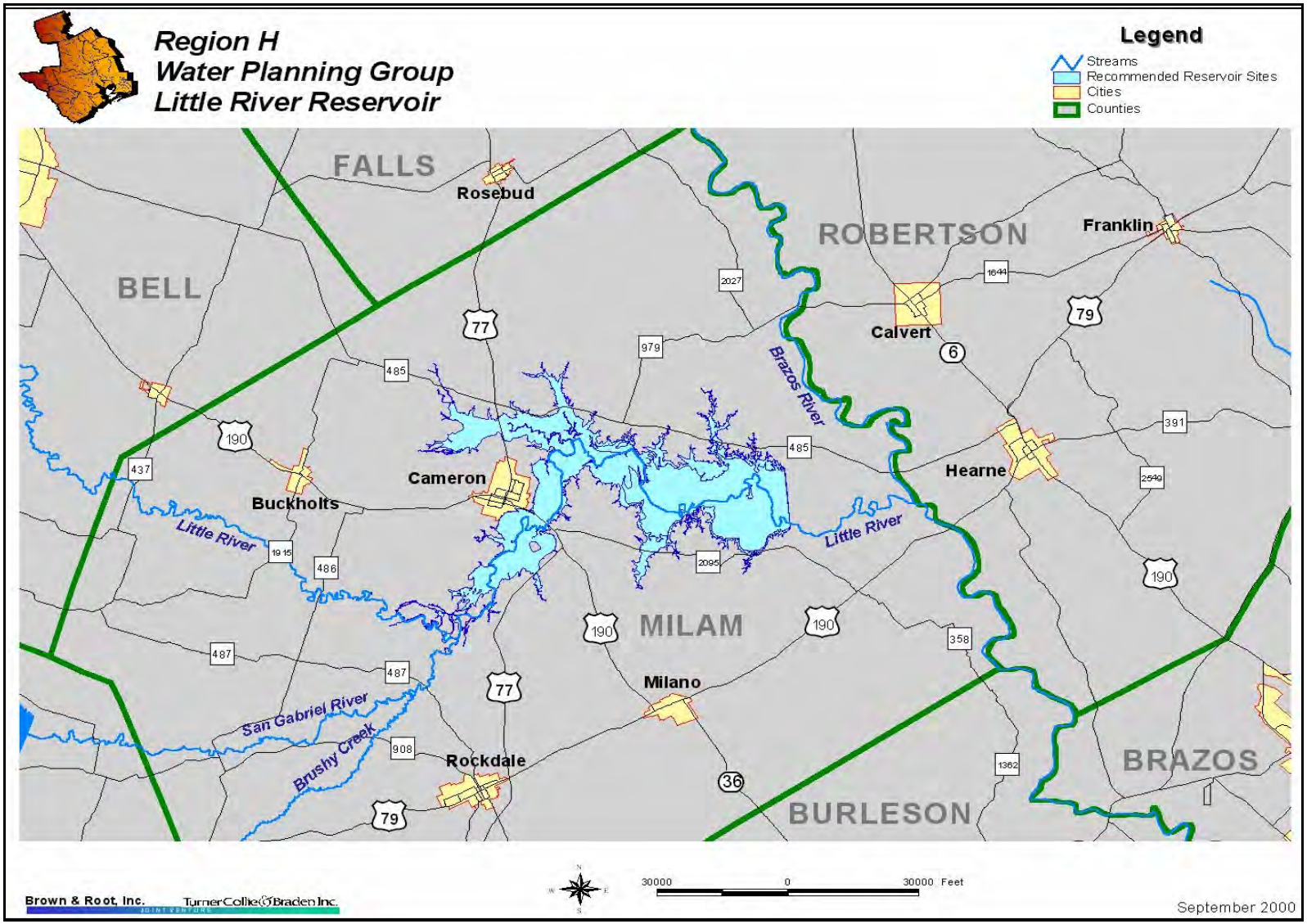
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
435	581	685	950	1520	1130	463	190	192	186	282	302

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25	41	23	16	132	15	1.6	2.2	2.1	0.77	15	23

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9662	13031	14423	13887	17385	11326	9426	5106	26298	10139	8506	9923


Region H
Water Planning Group
Little River Reservoir
Legend
Streams
Recommended Reservoir Sites
Cities
Counties
FALLS
Rosebud
ROBERTSON
Franklin
BELL
Calvert
Brazos River
Cameron
Buckholts
Hearne
Little River
Little River
MILAM
Milano
San Gabriel River
Brushy Creek
Rockdale
BRAZOS
BURLESON
77
190
79
6
36
485
487
486
1915
2095
2027
979
1644
391
2549
358
1362
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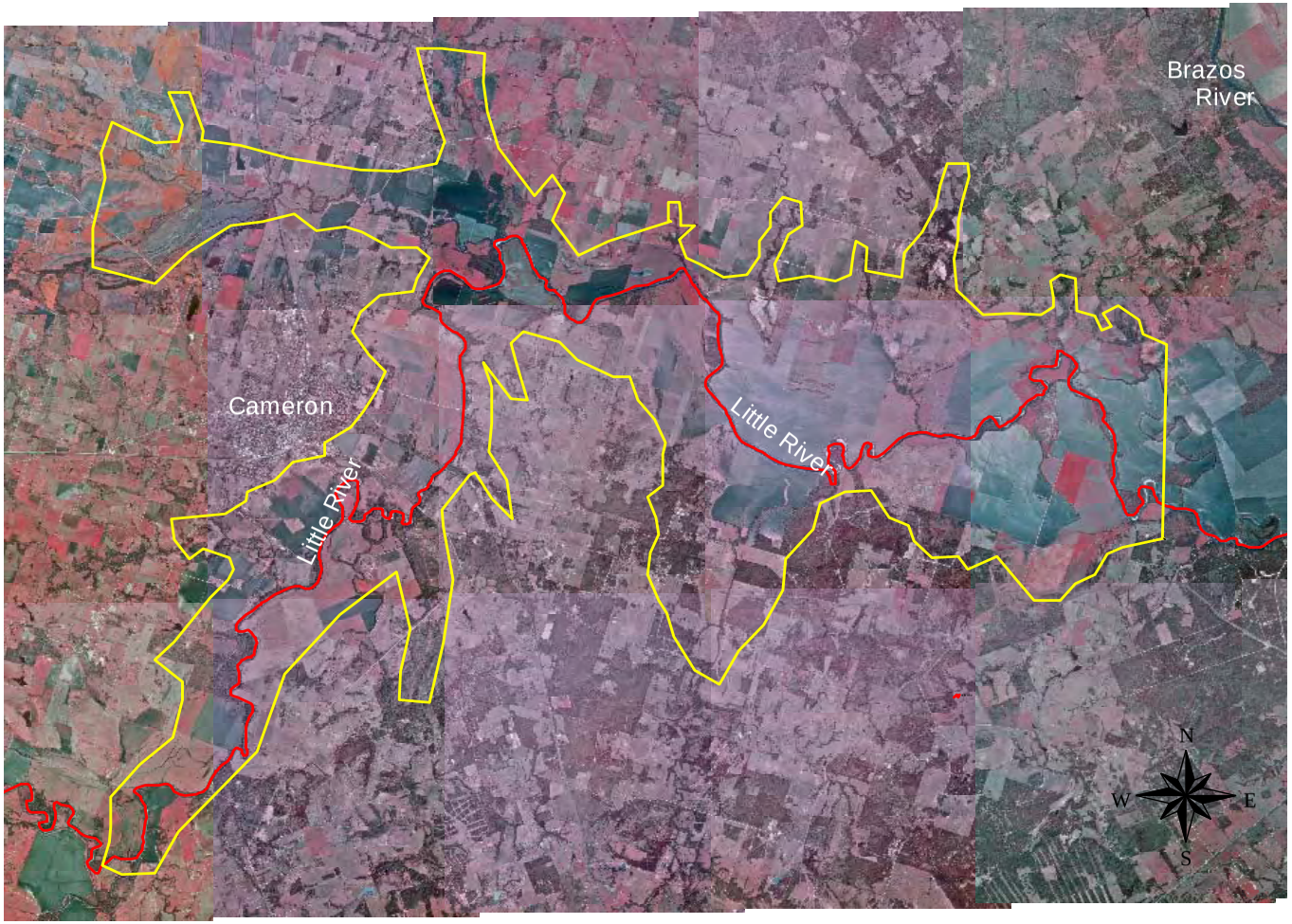
Brown & Root, Inc.
Turner Collie & Braden Inc.
JOINT VENTURE
September 2000


Brazos
River
Cameron
Little River
Little River
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S

STRATEGY: Luce Bayou Transfer

SPONSOR: City of Houston

SUMMARY

DESCRIPTION: The City of Houston has planned the Northeast Water Purification Plant (NEWPP) to supply need in the northern parts of Harris County. The NEWPP will take its raw water directly from Lake Houston. The City's East Water Purification Plant (EWPP) and a group of industries also draw raw water supplies from Lake Houston. By the year 2020, demands will exceed the City's raw water supplies currently available in Lake Houston.

Supplies owned by the City of Houston in the Trinity River are sufficient to meet the shortfall, however, no conveyance system exists to deliver Trinity River water to Lake Houston. The Luce Bayou strategy will supply Trinity River water to the upstream end of Luce Bayou. From there, the water will flow to and be available from Lake Houston.

Luce Bayou diversion facilities will consist of a pumping station with river intake at Capers Ridge on the west bank of the Trinity River approximately 11 miles north of Liberty. A pipeline segment followed by an earthen canal will carry the flow from the pumping station to the upstream end of Luce Bayou. To accommodate the increased flow (220 MGD by 2050), the Luce Bayou channel will be widened, deepened and straightened from its headwaters to its confluence with Tarkington Bayou.

COST: $84 million (1999)

STARTING DECADE: 2020

QUANTITY OF WATER: 302,500 acre-feet per year

SUPPLY SOURCE: Trinity River

ISSUES AFFECTING FEASIBILITY: Construction of the Luce Bayou project will require rectification of approximately eight miles of Luce Bayou, altering the aquatic habitat and ecology in that segment, and possibly in downstream segments. The mixing of Trinity River water and San Jacinto River water in Lake Houston may have an adverse impact on the lake's ecology. Increased use of stored water from Lake Livingston may result in periodic or prolonged low lake levels, which may adversely impact the lake's ecology and/or recreational activities.

Land use in the Lake Houston drainage basin is about 73% forest and 14% pasture. Luce Bayou is bordered by one of the highest quality bottomland hardwood forests remaining in the Houston area. The Region H plan states "wetlands mitigation may be required to offset losses due to pumping station, pipeline, and canal construction." This is true, however, the rectification of Luce Bayou and subsequent impacts to riparian habitats will

also likely require significant mitigation. Mitigation may also be required for impacts to rare species, as several may be present in the project area, including:

Houston Toad (State and Federally Endangered)
American Peregrine Falcon (State Endangered/Federally Delisted)
Arctic Peregrine Falcon (State Threatened/Federally Delisted)
Reddish Egret (Federal Species of Concern/State Threatened)
White-faced Ibis (Federal Species of Concern/State Threatened)
Wood Stork (Federal Species of Concern/State Threatened)
Attwater's Greater Prairie Chicken (State and Federally Endangered)
Bald Eagle (State and Federally Threatened)
Henslow's Sparrow (State Species of Concern)
Mountain Plover (State Species of Concern)
Piping Plover (State and Federally Endangered)
Black Rail (State Species of Concern)
Brown Pelican (State and Federally Endangered)
Snowy Plover (State Species of Concern)
Swallow-tailed Kite (Federal Species of Concern/State Threatened)
Creek Chubsucker (Federal Species of Concern/State Threatened)
Plains Spotted Skunk (State Species of Concern)
Rafinesque's Big-eared Bat (Federal Species of Concern/State Threatened)
Southeastern Myotis (State Species of Concern)
Alligator Snapping Turtle (Federal Species of Concern/State Threatened)
Timber Rattlesnake (Federal Species of Concern/State Threatened)
Smooth Green Snake (Federal Species of Concern/State Threatened)
Texas Garter Snake (State Species of Concern)
Corkwood (State Species of Concern)
Giant Sharpstem Umbrella-sedge (State Species of Concern)
Houston Daisy (State Species of Concern)
Threeflower Broomweed (State Species of Concern)

Increased flows in Luce Bayou, which are estimated to be as high as 220 MGD (341 cfs) by the year 2050, will greatly affect aquatic organisms and may result in erosion problems. There is a USGS gage (#08071280) on Luce Bayou near the City of Huffman. Monthly median flows, monthly minimums, and monthly maximums (cfs) from this gage for the period of record are reported below:

Monthly median flows (cfs) as reported from USGS gage # 08071280 near Huffman, TX (May 1984 to current year):

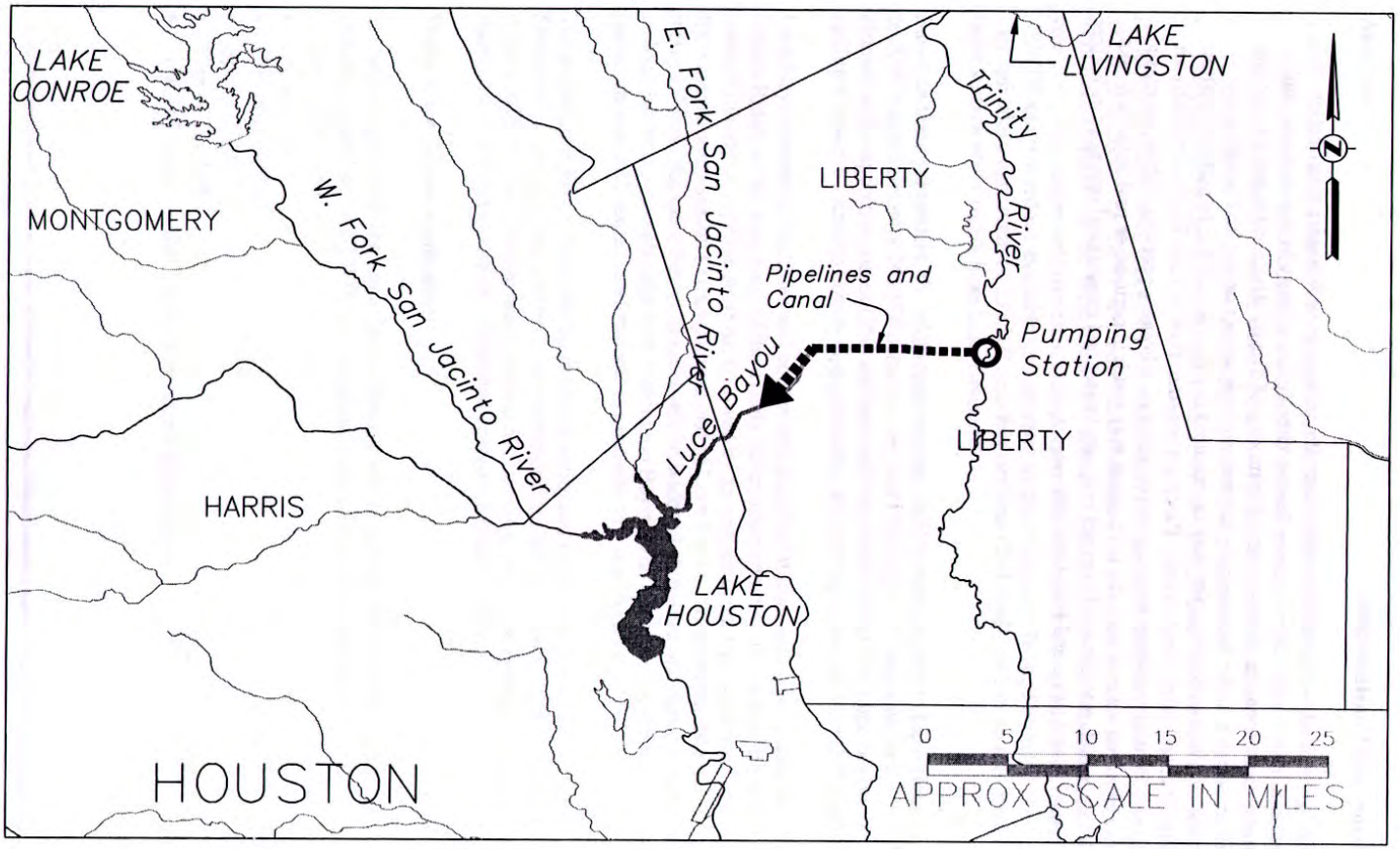
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
61	50	62	14	10	6.7	2.7	1.1	1.6	1.6	8.4	31

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.1	1.3	1.6	3.1	0.57	0.12	0.01	0.35	0.03	0.01	0.17	1.4

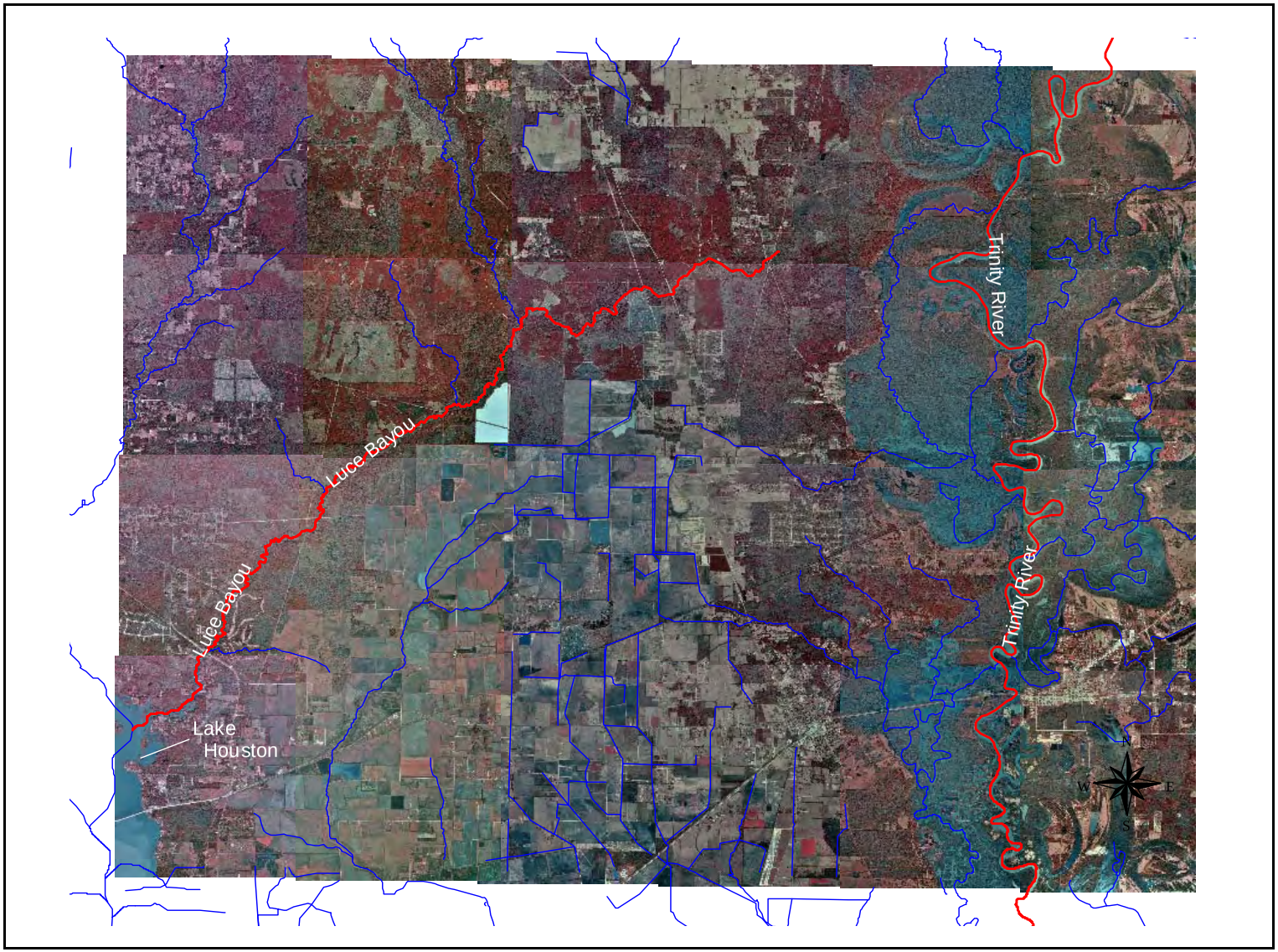
Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
826	980	878	1047	2443	1965	333	102	394	2988	1416	862



LUCE BAYOU
INTERBASIN TRANSFER
TRINITY TO SAN JACINTO

FIGURE 1


Trinity River
Luce Bayou
Luce Bayou
Trinity River
Lake
Houston
N
W
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STRATEGY: San Jacinto River Authority/City of Houston Contract

SPONSOR: San Jacinto River Authority, City of Houston

SUMMARY

DESCRIPTION: This contractual transfer would consist of a water exchange between the San Jacinto River Authority (SJRA) and the City of Houston that would allow the SJRA to capture the City of Houston's water supplies within Lake Conroe so as to meet the SJRA Northern region water needs. In exchange, the SJRA would transfer a like quantity of water supplies from either or both of the SJRA San Jacinto run-of-river and/or Trinity River water supplies.

Lake Conroe has water rights associated with its water that is owned by the SJRA (32,921 acre-feet per year) and the City of Houston (67,029 acre-feet per year). The City of Houston owns all of the water rights within Lake Houston (168,000 acre-feet per year) and the SJRA owns the 55,000 acre-feet per year of run-of-river water rights that are diverted at Lake Houston. Additionally, SJRA owns 56,000 acre-feet per year of Trinity River water rights that are diverted at the Coastal Water Authority (CWA) canal. Therefore, the SJRA has a total of 143,921 acre-feet per year of surface water rights.

COST: Unknown, potentially zero

STARTING DECADE: 2000

QUANTITY OF WATER: 67,029 acre-feet per year

SUPPLY SOURCE: Lake Conroe

ISSUES AFFECTING FEASIBILITY: Use of this strategy will reduce the quantity of instream flows in the segment of the West Fork San Jacinto River between Lake Conroe and Lake Houston. There are two USGS gage stations located on the West Fork San Jacinto River near the City of Conroe, one downstream of Lake Conroe (USGS gage # 08067650) and one further downstream (USGS gage # 08068000). There is also a USGS gage station on the West Fork San Jacinto River upstream of Lake Houston near the City of Porter (USGS gage # 08068090). Monthly median flows, monthly minimums, and monthly maximums (cfs) from these gages for the period of record are reported below:

Monthly median flows (cfs) as reported from USGS gage # 08067650 downstream of Lake Conroe near Conroe, TX (1972 to current year):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
73	236	19.5	4.35	12	2.5	0.92	0.60	1.6	3.4	8.2	100

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0.16	0	0	0	0	0	0	0

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1776	1349	856	1815	1899	1143	231	124	820	601	3003	1023

Monthly median flows (cfs) as reported from USGS gage # 08068000 near Conroe, TX (July 1939 to current year):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
192	241	156	114	122	66	34	26	30	32	60	136

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
19.7	22.5	20.4	26.0	18.9	15.4	11.2	7.96	6.3	8.1	10.4	21.5

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3360	3258	2319	5446	4153	3086	977	1899	1945	7836	6834	3484

Monthly median flows (cfs) as reported from USGS gage # 08068090 upstream of Lake Houston near Porter, TX (May 1984 to current year):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
348	394	245	134	130	102	52.5	44	45	47	101	236

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
41.5	37.8	34.2	60.7	59.4	31.8	17.2	16.1	23.3	22.2	29.8	42.7

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3199	3763	2041	2229	2174	3169	535.9	222.5	323.3	10908	8244	1881

Reductions in instream flows will likely cause alteration/loss of aquatic habitat and may impact aquatic organisms as well as riparian habitats. Several rare species may be found in Montgomery County, including:

American Peregrine Falcon (State Endangered/Federally Delisted)
Arctic Peregrine Falcon (State Threatened/Federally Delisted)
Bachman's Sparrow (Federal Species of Concern/State Threatened)
Bald Eagle (State and Federally Threatened)
Swallow-tailed Kite (Federal Species of Concern/State Threatened)
Henslow's Sparrow (State Species of Concern)
Red-cockaded Woodpecker (State and Federally Endangered)
White-faced Ibis (Federal Species of Concern/State Threatened)

Wood Stork (Federal Species of Concern/State Threatened)
Creek Chubsucker (Federal Species of Concern/State Threatened)
Paddlefish (Federal Species of Concern/State Threatened)
Plains Spotted Skunk (State Species of Concern)
Rafinesque's Big-eared Bat (Federal Species of Concern/State Threatened)
Southeastern Myotis (State Species of Concern)
Alligator Snapping Turtle (Federal Species of Concern/State Threatened)
Timber Rattlesnake (Federal Species of Concern/State Threatened)
Texas Garter Snake (State Species of Concern)
Louisiana Pine Snake (Federal Candidate for listing/State Threatened)
Correll's False Dragonhead (State Species of Concern)

STRATEGY: San Jacinto River Authority/Lake Livingston Diversion

SPONSOR: San Jacinto River Authority

SUMMARY

DESCRIPTION: This strategy involves diverting flows from Lake Livingston into the West Fork San Jacinto River, which will then be conveyed into Lake Conroe. From Lake Conroe, these supplies will be used to either serve the San Jacinto River Authority (SJRA) Northern basin demands or can be conveyed through the SJRA East Canal and Highlands system to meet water needs within the SJRA Southern basin. The assumption is that the SJRA will secure approximately 75,000 acre-feet per year from a water source within the Trinity basin.

This strategy is an interbasin transfer and as such will be subject to the junior water rights provision of Senate Bill 1. The needed conveyance system would consist of the following facilities:

1) a raw water intake in Lake Livingston near the Town of Point Blank
2) a raw water pump station (70 mgd capacity)
3) approximately 30 miles of 60-inch transmission main

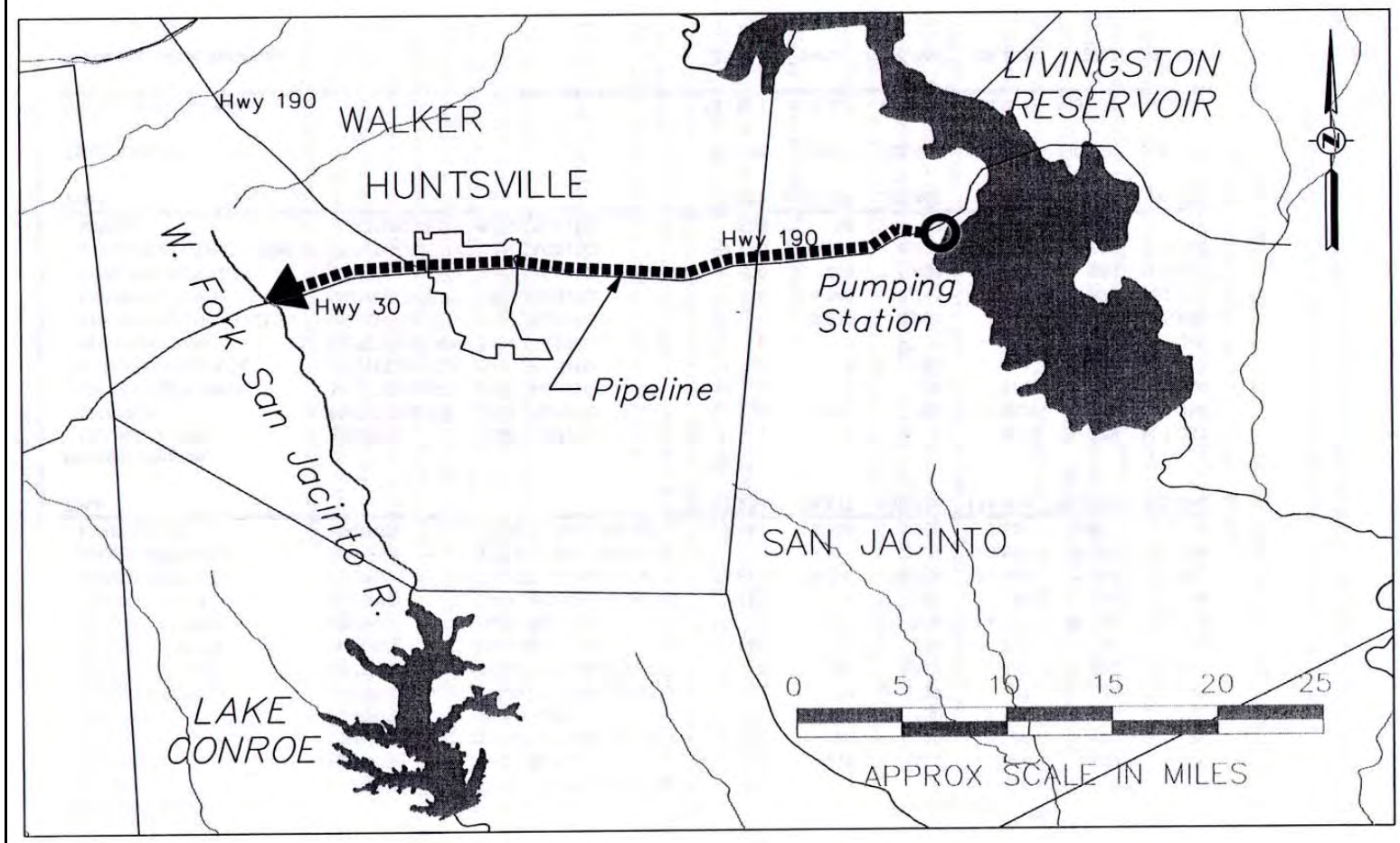
COST: $133,800,000

STARTING DECADE: 2030

QUANTITY OF WATER: 75,000 acre-feet per year

SUPPLY SOURCE: Trinity River water supplies

ISSUES AFFECTING FEASIBILITY: Environmental concerns related to this project include construction within the upper West Fork San Jacinto River channel and rectification of some segment of the river will likely be required. Increased use of stored water from Lake Livingston may result in periodic or prolonged low lake levels. This strategy (as well as many others) would decrease freshwater inflows to the Trinity Bay estuary as water will be leaving the Trinity River Basin.



LAKE LIVINGSTON TO LAKE CONROE
INTERBASIN TRANSFER

FIGURE 1

STRATEGY: Trinity River Authority/City of Houston Contract Agreement

SPONSOR: Trinity River Authority, City of Houston

SUMMARY

DESCRIPTION: The Trinity River Authority (TRA) is projected to have uncommitted surface water supplies (255,392 acre-feet per year) from their water rights within the Lake Livingston-Wallisville Salt Water Barrier system through 2050. This water supply exists as stored water within Lake Livingston. Through financial considerations associated with the 1964 construction contract for the Lake Livingston-Wallisville Salt Water Barrier project, the City of Houston has a preferred position relative to purchase of uncommitted water supplies from TRA's share of the Livingston-Wallisville system.

Diversion of these water supplies can occur either directly from Lake Livingston or at any point downstream of Lake Livingston. Two potential diversion points and conveyance routes include use of the existing Coastal Water Authority (CWA) canal system at the Trinity River Pump Station and/or a new potential route from the Trinity River to Lake Houston via Luce Bayou. If the Luce Bayou system is required to provide supply to the proposed Northeast Water Purification Plant (as is discussed under the Luce Bayou Diversion plan earlier in this document), then the CWA canal system would have sufficient excess capacity because previously utilized Lake Livingston flows would be diverted into Luce Bayou thereby freeing up capacity to convey up to 200,000 acre-feet per year.

COST: Unknown

STARTING DECADE: after 2030

QUANTITY OF WATER: up to 200,000 acre-feet per year

SUPPLY SOURCE: Trinity River water supplies

ISSUES AFFECTING FEASIBILITY: Additional transfer of Trinity River water supplies into the San Jacinto River basin will decrease freshwater inflows into the Trinity Bay estuary and may negatively impact wetland, aquatic, and riparian habitats. Several rare species may be found in Liberty and/or Chambers County, including:

American Peregrine Falcon (State Endangered/Federally Delisted)
Arctic Peregrine Falcon (State Threatened/Federally Delisted)
Bachman's Sparrow (Federal Species of Concern/State Threatened)
Bald Eagle (State and Federally Threatened)
Interior Least Tern (State and Federally Endangered)
Piping Plover (State and Federally Endangered)
Swallow-tailed Kite (Federal Species of Concern/State Threatened)
Henslow's Sparrow (State Species of Concern)

Red-cockaded Woodpecker (State and Federally Endangered)
White-faced Ibis (Federal Species of Concern/State Threatened)
Wood Stork (Federal Species of Concern/State Threatened)
Plains Spotted Skunk (State Species of Concern)
Rafinesque's Big-eared Bat (Federal Species of Concern/State Threatened)
Southeastern Myotis (State Species of Concern)
Alligator Snapping Turtle (Federal Species of Concern/State Threatened)
Timber Rattlesnake (Federal Species of Concern/State Threatened)
Texas Diamondback Terrapin (State Species of Concern)
Atlantic Hawksbill Sea Turtle (State and Federally Endangered)
Green Sea Turtle (State and Federally Threatened)
Gulf Saltmarsh Snake (State Species of Concern)
Kemp's Ridley Sea Turtle (State and Federally Endangered)
Leatherback Sea Turtle (State and Federally Endangered)
Loggerhead Sea Turtle (State and Federally Threatened)
Smooth Green Snake (Federal Species of Concern/State Threatened)
Corkwood (State Species of Concern)
Scarlet Catchfly (State Species of Concern)
Texas Windmill-grass (State Species of Concern)

Instream flows downstream of the CWA canal diversion point will also decrease as a result of additional transfers. The Coastal Water Authority's diversion point is located downstream of the City of Dayton. There is a USGS gage station (gage #08067000) on the Trinity River near the City of Liberty; however, there are no USGS gages downstream of the CWA diversion point. Monthly median flows, monthly minimums, and monthly maximums (cfs) from the gage near the City of Liberty for the period of record are reported below:

Monthly median flows (cfs) as reported from USGS gage # 08067000 near Liberty, TX (October 1940 to current year):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
19300	19000	20050	23650	21000	21800	14100	10000	9140	22750	20400	17000

Monthly Minimum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20317	10769	5139	21685	8311	14490	9135	---	---	26320	16912	14005

Monthly Maximum (cfs):

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
55526	42183	47913	31300	56261	31591	9135	---	---	26320	31800	29416

STRATEGY: Bedias Reservoir – SJRA Interbasin Transfer

SPONSOR: San Jacinto River Authority, Trinity River Authority

SUMMARY

DESCRIPTION: This strategy consists of defining the facilities necessary to impound and transport water supplies from the Trinity River basin to the upper San Jacinto River basin. The impoundment of water in the Trinity River basin involves the construction of Bedias Creek Reservoir by TRA and SJRA. The SJRA will require additional facilities to convey a portion of the created supplies into the West Fork of the San Jacinto River for use by SJRA. A transmission system, consisting of the following, was defined to convey approximately 75,000 acre-feet per year:

1) A raw water intake at the southeast end of the dam
2) A raw water pump station (70 mgd capacity)
3) Approximately 15 miles of 60-inch transmission main
4) Approximately 2 miles of channel improvements to Mock Branch (tributary to the West Fork San Jacinto River), where water will be discharged for conveyance to Lake Conroe.

COST: $194,340,000

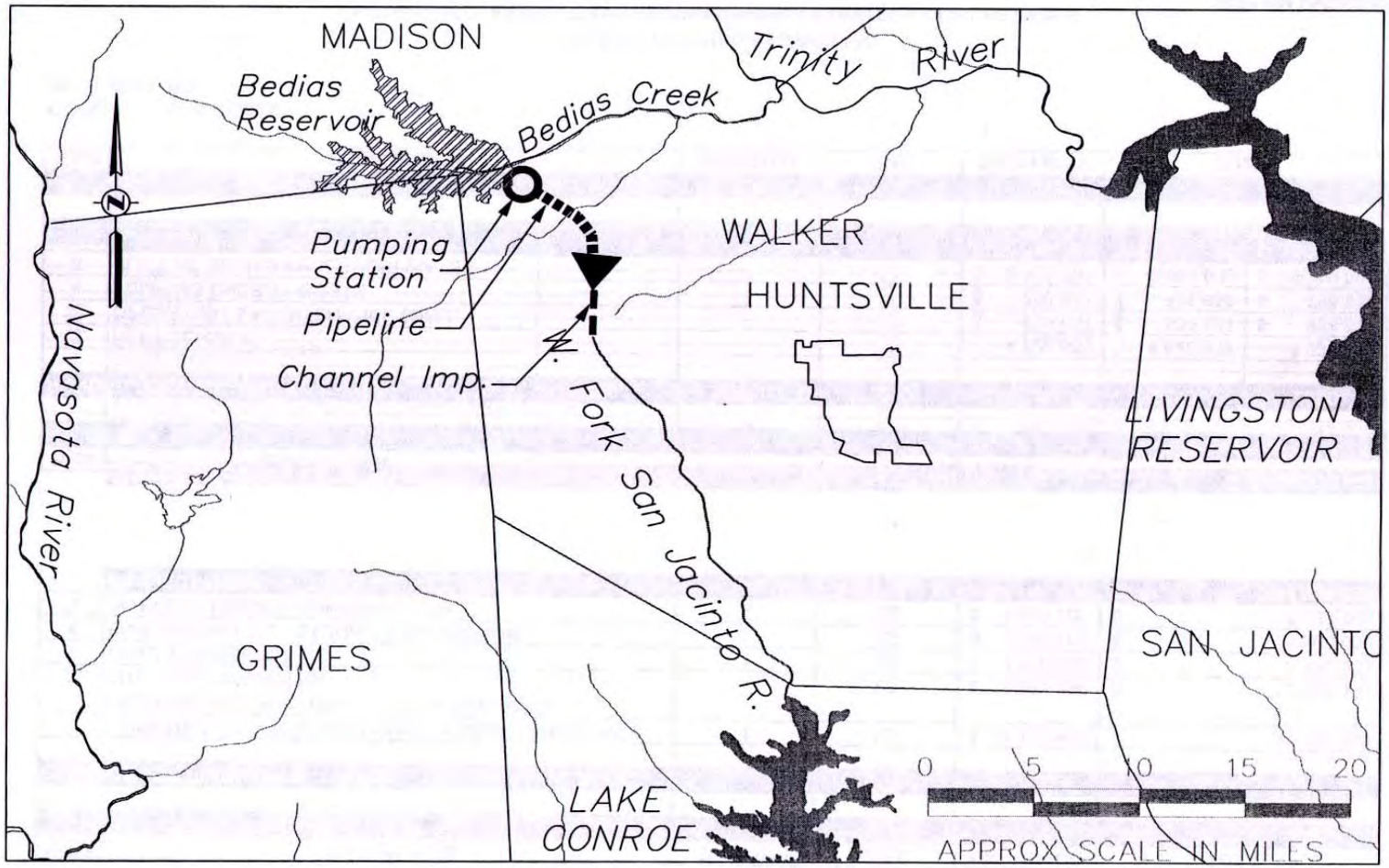
STARTING DECADE: 2030

QUANTITY OF WATER: 90,700 acre-feet per year
75,000 acre-feet per year to SJRA
15,700 acre-feet per year to TRA

SUPPLY SOURCE: Bedias Creek Reservoir (to be created)

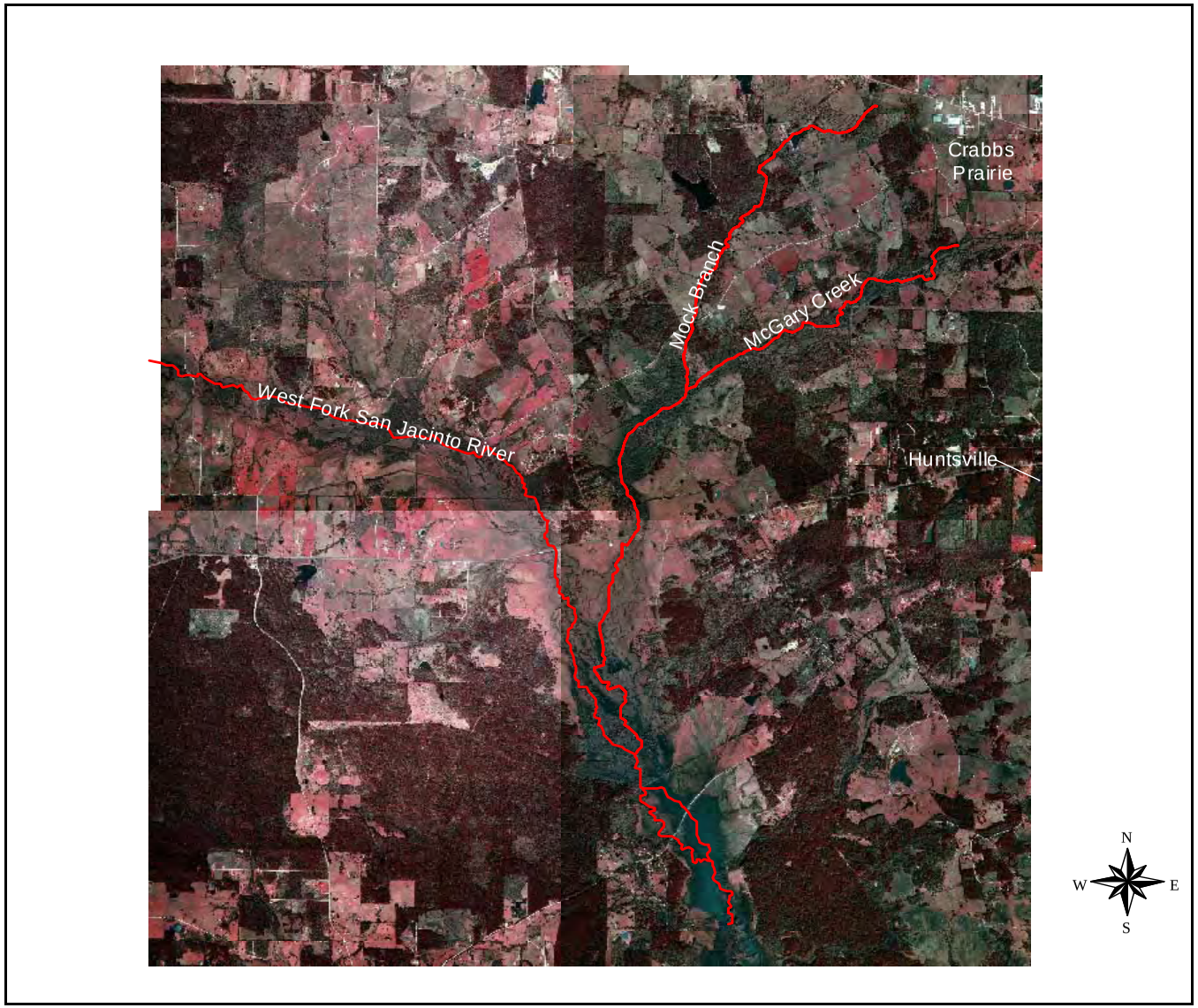
ISSUES AFFECTING FEASIBILITY: Issues related to the construction of Bedias Reservoir were discussed previously. The transfer of water to the San Jacinto River basin will require rectification of Mock Branch and may require rectification of some segment of McGary Creek and the West Fork San Jacinto River, which will affect aquatic, riparian, and wetland habitats. Increased flows in Mock Branch as well as McGary Creek and the West Fork San Jacinto River may also negatively impact these habitats and the aquatic community. Pipeline construction will have impacts to terrestrial, wetland, and aquatic habitats. This project will also likely decrease freshwater inflows to the Trinity River estuary as water is leaving the Trinity basin.

*No mention is made of McGary Creek in the Environmental Concerns section related to this project within the Region H water plan.



BEDIAS RESERVOIR TO LAKE CONROE
INTERBASIN TRANSFER

FIGURE 1


Crabbs
Prairie
Mock Branch
McGary Creek
West Fork San Jacinto River
Huntsville
N
W
E
S

STRATEGY: Gulf Coast Water Authority/City of Houston Contract

SPONSOR: Gulf Coast Water Authority, City of Houston, Coastal Water Authority

SUMMARY

DESCRIPTION: Under this strategy the Gulf Coast Water Authority (GCWA) will purchase Trinity River water from the City of Houston and convey that water from the Coastal Water Authority (CWA) Bayport Reservoir to the Texas City Reservoir owned by the GCWA. This will require the development of a conveyance system between the reservoirs, which was defined to consist of the following:

1) A raw water pump station (25 mgd capacity)
2) Approximately 16 miles of 36-inch transmission main
3) Two channel crossings at Clear Lake and Dickinson Bayou

COST: $63,270,000

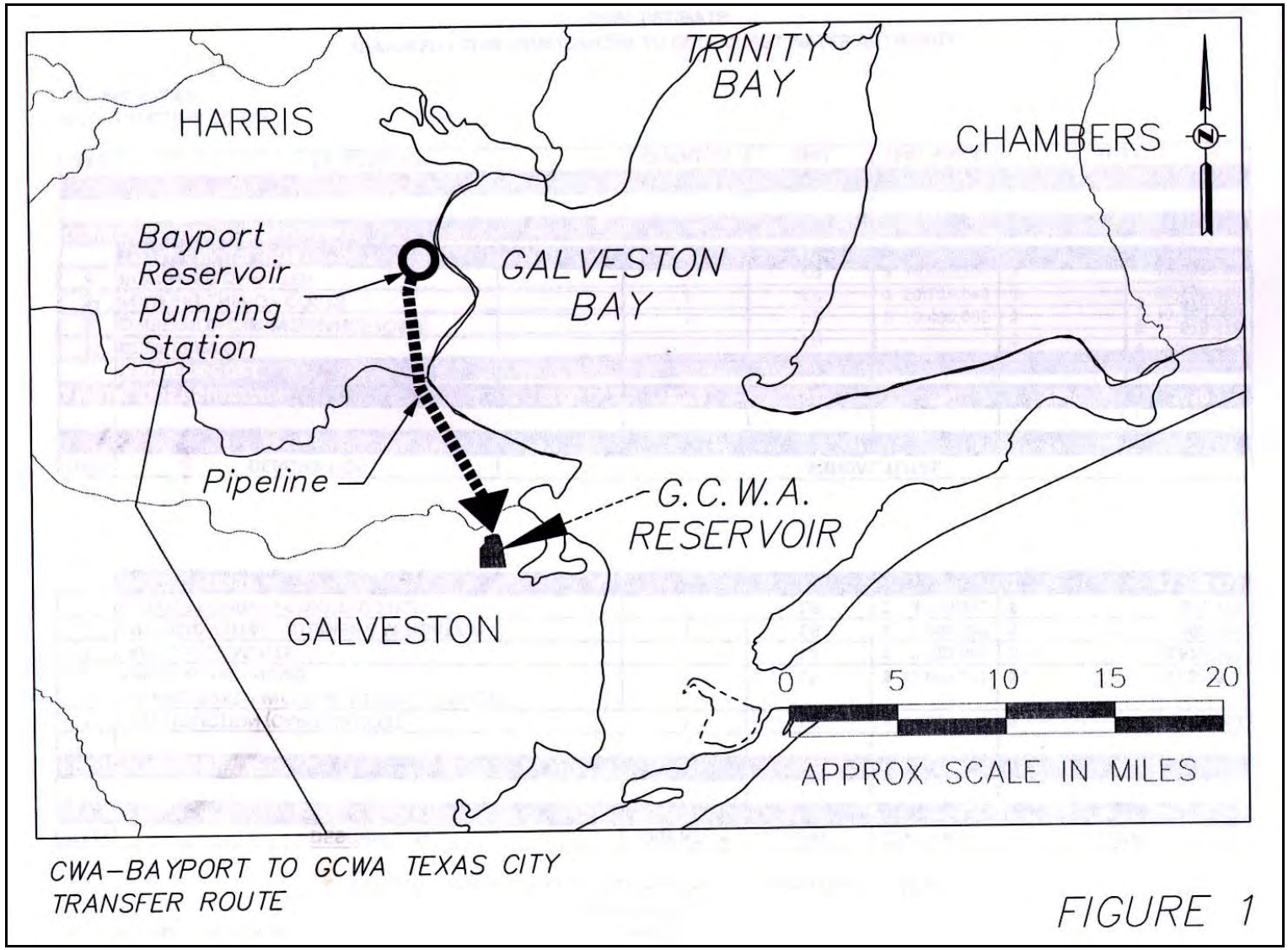
STARTING DECADE: 2040

*this strategy may be initiated earlier to allow the GCWA to allocate more of its Brazos River supplies to Fort Bend and Brazoria County WUG demands.

QUANTITY OF WATER: 23,000 acre-feet per year

SUPPLY SOURCE: City of Houston (Trinity River water supplies)

ISSUES AFFECTING FEASIBILITY: While the ultimate outfall of this water still remains in the Galveston Bay estuary, the timing and location of the freshwater inflow will be altered. The inflow would be moved from Upper Trinity Bay to western Galveston Bay. From the description of this project in the Region H water plan it is not clear how the water will be conveyed from the Trinity River to the Bayport Reservoir.



CWA–BAYPORT TO GCWA TEXAS CITY
TRANSFER ROUTE

FIGURE 1

STRATEGY: Sabine River to Region H Interbasin Transfer

SPONSOR: SJRA, BRA, GCWA, and the City of Houston

SUMMARY

DESCRIPTION: Under this strategy surplus raw water supplies in the Sabine Basin would be transferred to the major water providers within the San Jacinto Basin (the City of Houston and the San Jacinto River Authority) and in the Brazos River Basin (the Brazos River Authority and the Gulf Coast Water Authority) that have projected supply deficits. Water will be pumped from the Sabine River upstream of the City of Orange and conveyed via Sabine River Authority canals to the Lower Neches Valley Authority (LNVA) canal system at the LNVA First Lift Pumping Station north of Beaumont. LNVA canals will carry the flow west and discharge it into the Trinity River upstream of the Coastal Water Authority Trinity River Pumping Station. New canals, pumping stations, and pipelines will need to be constructed where it is not feasible to use existing facilities.

The Region H plan surmises that with Sabine River water to replenish the lower Trinity water, additional withdrawals can be made from Lake Livingston. An integral part of this strategy is a pipeline from Lake Livingston discharging into Rocky Creek. Rocky Creek is a tributary to the Navasota River downstream of Gibbons Creek Lake and the Navasota empties into the Brazos River. This transfer would supply the projected BRA and GCWA shortfalls in Region H.

The City of Houston's supply deficits would be alleviated by delivery of Sabine River water to the Trinity River upstream of the existing CWA Trinity River Pumping Station near Dayton. The TRPS will pump the water to CWA's Lynchburg Reservoir from which it will be distributed to the City of Houston's East and Southeast Water Purification Plants.

Delivery of Sabine River water to the lower Trinity River would allow SJRA to take their 56,000 acre-feet per year from Lake Livingston, instead of the current method of pumping Trinity River water through the CWA canal system that supplies the Lynchburg Reservoir. However, the SJRA has a projected additional shortfall of 18,600 acre-feet per year. The SJRA will need to exchange this amount of Sabine water delivered to the lower Trinty River for an equivalent quantity of water in Lake Livingston. The 74,600 acre-feet per year of water needed can then be delivered to the upper reaches of the West Fork San Jacinto River via Lake Livingston to Rocky Creek pipeline described above.

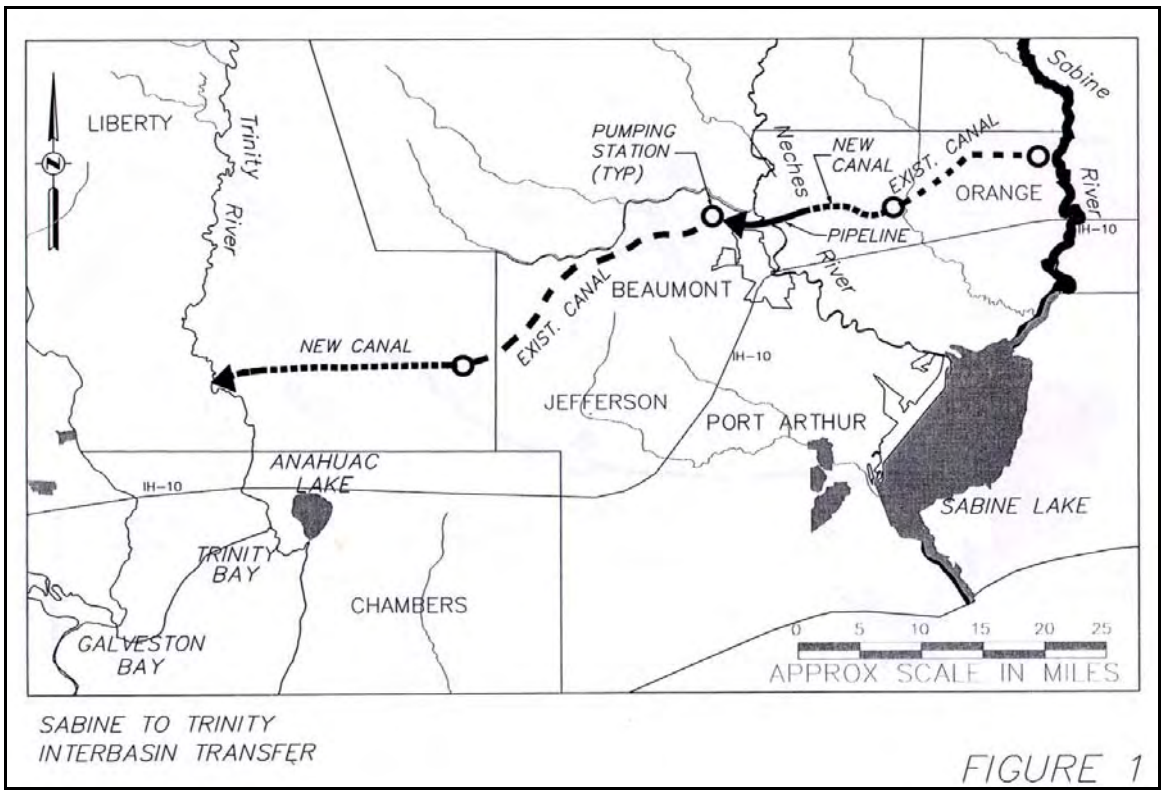
COST: $809,944,000

STARTING DECADE: 2010

QUANTITY OF WATER: 101,500 acre-feet per year in 2010, increasing to 453,100 acre-feet per year by 2050

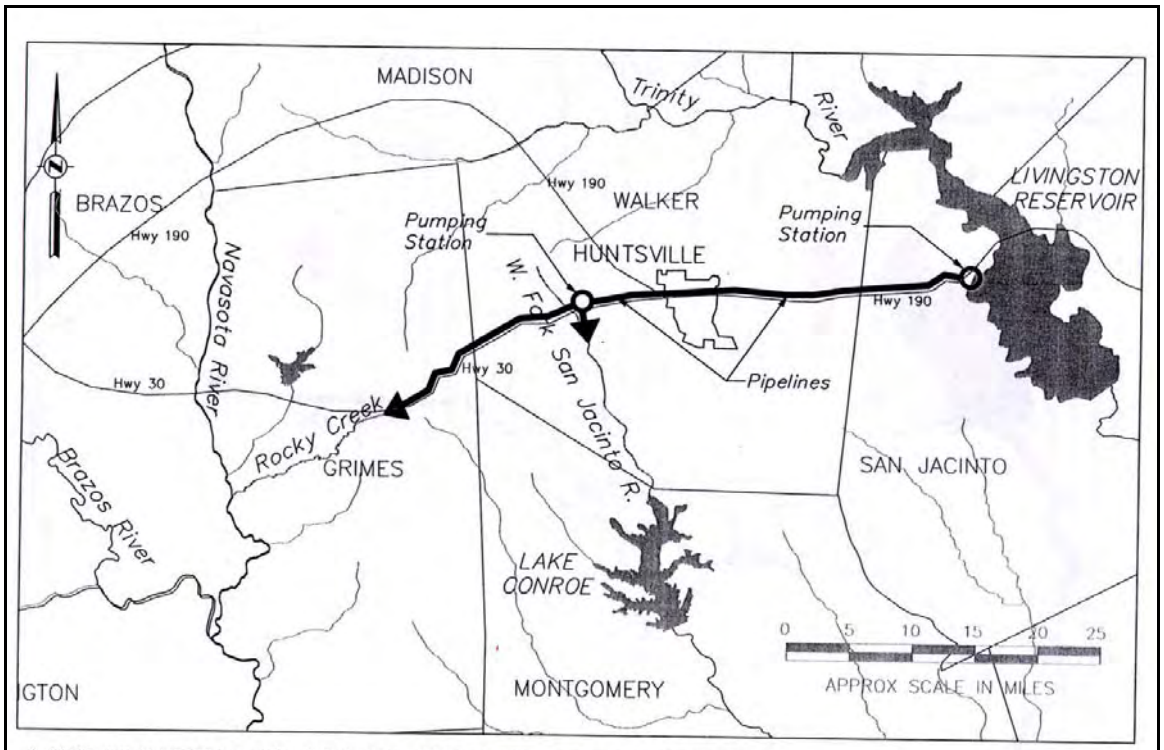
SUPPLY SOURCE: Sabine River

ISSUES AFFECTING FEASIBILITY: The transfer of this quantity of water out of the Sabine River Basin will significantly reduce freshwater inflows to the Sabine Lake estuary. This strategy will require further study to fully assess the potential ecological effects on the estuary. Also, the State of Louisiana and local Sabine Lake interests have historically voiced concern about a large-scale water transfer of this type.



SABINE TO TRINITY
INTERBASIN TRANSFER

FIGURE 1



LAKE LIVINGSTON TO BRAZOS AND SAN JACINTO RIVERS
INTERBASIN TRANSFER

FIGURE 2

Other Potential Water Management Strategies for Region H

1) Municipal Water Conservation
2) Irrigation Conservation
3) Wastewater Reclamation/Reuse
4) Desalination

Appendix 7D

Estimated Municipal Return Flows and Recommended Reuse

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Estimated Municipal Return Flows and Reuse

To evaluate the effects of recommended reuse strategies on stream-flows, current and future municipal return flows were estimated. Currently, 60% of municipal water supply returns to streams and bayous via wastewater treatment plants. As water saving fixtures reduce in-home use, that return percentage was assumed to decline to 50%. As can be seen in the table, the total municipal wastewater return flow is expected to increase from 605,000 ac-ft/yr in the year 2010 to 922,000 ac-ft/yr in the year 2060. In Harris County and the surrounding areas, these municipal return flows are a significant portion of the in-stream freshwater flow, and for some streams the only source of flows during drought periods.

Wastewater reuse is permitted for the San Jacinto River Authority in Montgomery County, and is recommended in Harris County for industry, the City of Houston, the North Harris County Regional Water Authority, and in smaller volumes for several additional WUGs. Total reuse supplied from return flows in the San Jacinto basin should increase from 14,944 ac-ft/yr in 2010 to 272,582 ac-ft/yr in 2060.

Table 7D-1 shows the estimated municipal return flows for each county, and for Houston and the NHCRWA, which are recommended for significant future reuse. As can be seen, the net return flow from Harris County will decline as reuse projects come on-line, but not below 70% of the current county return flow. The San Jacinto Basin overall will also see declines in net return flow as reuse projects come on-line, but is not projected to drop below 90% of the current return flow levels.

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Appendic 7D
Estimated Municipal Return Flows and Recommended Reuse

	Municipal Water Demand						Estimated Municipal Return Flow					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
							58%	**56%**	**54%**	**52%**	**50%**	**50%**
Counties												
Austin	4,123	4,658	5,027	5,191	5,278	5,446	2,391	2,608	2,715	2,699	2,639	2,723
Brazoria	47,184	53,523	59,656	65,134	71,567	78,598	27,367	29,973	32,214	33,870	35,784	39,299
Chambers	4,985	5,854	6,648	7,338	8,067	8,863	2,891	3,278	3,590	3,816	4,034	4,432
Fort Bend	109,869	143,023	174,552	208,691	251,533	300,689	63,724	80,093	94,258	108,519	125,767	150,345
Galveston	46,090	47,390	47,818	47,487	47,393	47,641	26,732	26,538	25,822	24,693	23,697	23,821
Harris	709,300	789,397	868,320	948,412	1,030,899	1,119,593	411,394	442,062	468,893	493,174	515,450	559,797
Leon	2,128	2,376	2,489	2,456	2,414	2,437	1,234	1,331	1,344	1,277	1,207	1,219
Liberty	10,470	11,759	12,980	14,211	15,629	17,362	6,073	6,585	7,009	7,390	7,815	8,681
Madison	1,793	1,867	1,921	1,954	2,010	2,075	1,040	1,046	1,037	1,016	1,005	1,038
Montgomery	74,871	98,947	122,197	146,984	180,292	219,432	43,425	55,410	65,986	76,432	90,146	109,716
Polk	5,062	5,632	6,046	6,335	6,693	7,088	2,936	3,154	3,265	3,294	3,347	3,544
San Jacinto	3,153	3,616	3,964	4,120	4,207	4,251	2,317	2,571	2,709	2,645	2,559	2,538
Trinity	1,203	1,260	1,255	1,206	1,145	1,102	698	706	678	627	573	551
Walker	16,920	16,607	17,244	16,240	16,042	15,786	9,814	9,300	9,312	8,445	8,021	7,893
Waller	5,713	7,003	8,469	10,084	12,093	14,454	3,314	3,922	4,573	5,244	6,047	7,227
Total Estimated Return Flows							605,349	668,577	723,405	773,141	828,087	922,821
WUGs with Reuse WMS greater than 50,000 afy												
HOUSTON	389,082	429,218	467,036	506,047	547,787	593,096	225,668	240,362	252,199	263,144	273,894	296,548
NHCRWA*	116,062	136,903	152,789	161,456	164,968	169,178	67,316	76,666	82,506	83,957	82,484	84,589
San Jacinto River Basin												
(total for all counties)	774,979	885,100	991,261	1,100,192	1,217,947	1,347,121	449,488	495,656	535,281	572,100	608,974	673,561
Reuse WMS												
Montgomery County GRP							0	759	943	1015	1,017	1,018
Municipal Non-potable Reuse***							0	0	5,488	11,480	18,207	25,302
NHCRWA - Indirect Reuse							0	0	0	18800	46000	89,000
SJRA-Indirect							14,944	14,944	14,944	14,944	14,944	14,944
Wastewater Reuse for Industry							0	0	0	0	0	67,200
Houston - indirect Reuse							0	0	0	48,290	75,118	75,118
Total Estimated Reuse							**14,944**	**15,703**	**21,375**	**94,529**	**155,286**	**272,582**
Harris County Net Return Flow****							411,394	441,303	462,462	413,589	375,108	302,159
San Jacinto Basin Net Return Flow							434,544	479,953	513,906	477,571	453,688	400,979

* includes Jersey Village and Tomball (member cities)
** includes portions within San Jacinto Basin
*** includes portions within San Jacinto Basin
**** excludes SJRA indirect Resue from Montgomery County