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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 the more 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 increasing the transfer of water from the Trinity to meet the projected demands, 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 90% 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 may limit these flows, but is also recommending the import of new supplies into the upper basin.

In combination, the upper basin strategies should have a 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 lakes 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 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 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 Coastal Subsidence District regulations further restrict the use of groundwater to address land subsidence. These groundwater pumpage restrictions are reflected in the plan.

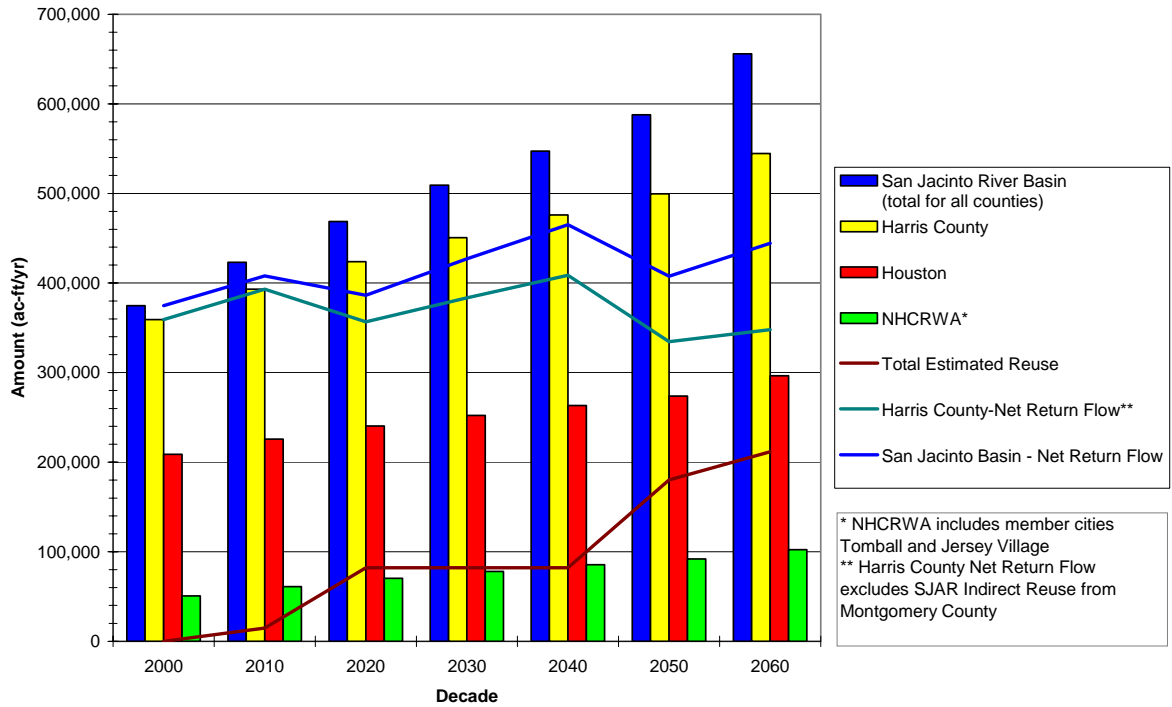
7.1.4 San Jacinto River Basin

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. Direct reuse for industry is recommended to begin by year 2020. This will consume all new return flows, holding flows into the San Jacinto River and Upper Galveston Bay at the year 2000 level. The impact of initially diverting this reuse supply will be mitigated by tidal effects in the stream segment where the water is currently discharged. Additionally, the brine produced by the additional treatment process will be discharged into the Houston Ship Channel. This will be a deep discharge into the dredged channel and will not directly mix with the upper freshwater layer. Indirect wastewater reuse

is 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 is 20% of the potential available 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 affect of a new large diversion will be realized, and return flows will again remain near the year 2000 levels.

Figure 7-1: Estimated Municipal Return Flows and Reuse



The groundwater supply source in 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 Coastal 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) and the Chocolate Bayou Water Company maintain and operate 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. Also recommended is a transfer from the City of Houston to Galveston County, which would allow the GCWA to reallocate a portion of their Brazos River supply to Fort Bend County. This would not affect the total use and return flows within Galveston County, but would reduce the amount transferred from the Brazos basin. Finally, seawater desalination is recommended within Brazoria County. This 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 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 Coastal 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 reservoir 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.

Two new off-channel reservoirs are recommended in this plan. Allens Creek Reservoir, which is located in Austin County, would divert flows from the Brazos River. Little River Reservoir, located in Milam County, would divert flows from the Little River. Both of these projects 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 recommended in Brazoria County, as part of the Governor's demonstration project initiative. This will meet a portion of the municipal and manufacturing demands within the lower basin, and may be expanded in the future to meet increased municipal

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 further 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 the basin flows are 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 town 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 26%. 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 463,000 acre-feet per year in 2000 to 430,000 acre-feet per year in 2060 (a change of under 10 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, conservation, and the BRA System Operations WMS. The BRA Systems Operation WMS is the least costly of the new supply options. The need for financial assistance to realize the conservation goal is addressed in Chapter 8 under legislative recommendations.

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, but the impacts are reduced from the 2001 plan. In the 2001 Region H Water Plan, three new reservoir projects were recommended. Two of those projects, Bedias and Little River, were main-stem reservoirs which would affect bottomland hardwood areas. In the current plan, the introduction of new WMS allowed the replacement of these projects on the recommendations list, although both remain viable alternatives for future consideration. Little River Reservoir was replaced with a combination of system operations of the BRA System, and an off-channel reservoir within the Little River watershed. This off-channel reservoir still has the potential to impact wetlands habitat, as does Allens Creek Reservoir, which is also in the plan. However, the potential impacts at these proposed sites are less than on the main stem of a river. At the Little River site in Milam County, habitats for the Houston Toad and Interior Least Tern may be inundated and require mitigation. 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 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 and those 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 for transfers from the Trinity to the San Jacinto basin is the Luce Bayou Transfer. This project includes a pump station, pipeline, canal and finally the use of the bed and banks of Luce Bayou to move water into Lake Houston. Adding flow to Luce Bayou may inundate seasonal wetlands, and has the potential to cause backwater effects in Creek Chubsucker habitats. However, this project will not begin flowing at full capacity at inception. Initial flows will be within the normal range of flows in the bayou. As these flows are increased over time, the peripheral wetlands should naturally migrate with the waters edge.

Texas Parks and Wildlife Department Resource Protection Division prepared an evaluation of the WMS considered in the 2001 Region H Plan. That assessment addresses terrestrial species as well as the aquatic species addressed above, and is included at 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. No other direct impacts of the plan are foreseen.

7.3.3 Impacts of Water Management Strategies on Unique Stream Segments

Region H recommended six stream segments for designation as unique in the 2001 Water Plan. The streams recommended were:

- Armand Bayou in Harris 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

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 recommendations for stream segments to be designated as unique are 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 4.5, 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. The affects of the 2001 Regional Water Plans on the Bay were modeled, and the results are summarized in Table 7-1, below. While the table indicates that the combined plans will increase 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).

This plan recommends one less water management strategy in the Trinity basin than the scenario modeled. Bedia Reservoir was recommended in the 2001 Region H Water Plan, with the yield being transferred into Montgomery County. This was replaced through reallocation of existing supplies, and the addition of wastewater reuse within Harris County. Those two changes (reuse and elimination of the transfer) will reduce the return flows into Upper Galveston Bay, but are not expected to reduce the total inflows below the target frequencies. The removal of Bedia Reservoir will increase the projected inflows to Trinity Bay. However, Region C is considering additional wastewater reuse in their 2006 Water Plan. The amount of reuse recommended must be determined before an assessment of the impacts on Galveston Bay can be made.

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 | 68% | 67% | 83% |
| Current Conditions | 64% | 59% | 79% |
| Full Diversions with Return Flows | 65% | 59% | 81% |
| Full Diversions with no Return Flows | 43% | 42% | 55% |
| Full Diversions w RF And Region C & H Strategies | 71% | 67% | 87% |

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 supply to meet all projected mining and manufacturing demands throughout the planning period. No adverse affect on this resource is foreseen.