REGION H
Water Planning Group

Interruptible Supply Study

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for

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Contents

List of Tables

List of Figures

List of Appendices

Section 1 – Introduction

Surface water supply planning in Texas, and with some exceptions the State's surface water rights permitting system, is based on the concept of "firm yield". The firm yield of a particular surface water source is defined as the amount of water that can be provided each year during drought-of-record hydrologic conditions, assuming full utilization and consumption of existing water rights and assuming that any environmental flow requirements are fully satisfied (e.g., instream flows, bay and estuary inflow).[1] The concept of firm yield, as applied in water supply planning and water rights permitting, represents a very conservative approach to surface water availability and allocation that is intended to provide a high degree of water supply reliability, particularly for domestic, municipal, and "high value" uses (e.g., industry, power generation) in order *"…to ensure a secure and dependable source of water supply for uses necessary to protect the public health, safety, and welfare*".[2]

The Texas Water Development Board's (TWDB) guidelines for regional water supply planning recommend "firm" water supplies to be considered as available for allocation to meet future needs for all types of water uses. TWDB will also allow the use of "safe yield" for planning purposes subject to approval by the Executive Director.[1] Generally speaking, but with exceptions, the Texas Commission on Environmental Quality (TCEQ) also limits allocation of surface water to the firm or dependable yield of a stream or reservoir. While this represents a sound and conservative approach for water users that require supplies with a high degree of reliability, some types of water uses, such as irrigated agriculture, may be able to utilize surface water supplies that are less than fully dependable. This is explicitly recognized in TCEQ rules for surface water rights permitting, which allow issuance of water rights permits for irrigation use that are less than 100 percent reliable during critical drought periods. Specifically, in consideration of applications for new irrigation use permits, TCEQ applies a "75/75" rule where:

> *"Approximately 75 percent of the water requested must be available approximately 75 percent of the time when distributed on a monthly basis and based on the available historic stream flow record."*[3]

Given the common definition of "firm" or "safe" yield it is apparent that under "normal" hydrologic conditions there likely is significantly more surface water available from a given source than that considered fully reliable or firm during extreme (i.e., drought-of-record) drought conditions. This gives rise to several important policy questions:

- Could additional surface water supplies be made available for allocation on an interruptible basis, that is, subject to full or partial curtailment during drought?
- If so, what types of water demands could be met with surface water supplies that are less than firm?
- Could "interruptible" water supplies be allocated to existing users of "firm" surface water supplies, for certain types of uses (e.g., irrigation), in order to free up firm water supplies for other uses (e.g., municipal, industrial).

The Region H Water Planning Group (RHWPG) requested and received funding from the TWDB to

[1] Texas Water Development Board, Exhibit B – Guidelines for Regional Water Plan Development. pp 18-19.
[2] 30 TAC (TAC), Section 297.42 (e).
[3] 30 TAC, Chapter 297 – Section 297.42 (c).

conduct three studies in advance of the third five–year update of the Region H water supply plan. One study focused on evaluating the impacts of future water management strategies on freshwater inflows to Galveston Bay and on evaluating the impacts of instream flow requirements for future water management strategies. A second study focused on evaluating the potential impacts of drought management strategies on surface water reservoirs within Region H. The third study, which is the subject of this report, focused on evaluation of the feasibility of using available interruptible surface water supplies as a substitute for existing firm surface water supplies for certain uses, notably irrigated agriculture.

The approach to executing the scope of work for the interruptible water supply study was organized into two sequential phases. The initial phase represents a technical assessment of the viability of a water management strategy that would involve the substitution of interruptible water supplies for firm water supplies currently allocated to agricultural irrigation in order to free up those firm supplies for municipal or industrial use. This assessment included analysis of the availability of both permitted and unpermitted interruptible surface water supplies within Region H and evaluation of whether available interruptible supplies can be matched spatially with existing irrigation demands that are being met with firm surface water supplies.

The second phase of the study was to evaluate the legal, regulatory, and institutional constraints and the potential economic impacts associated with this potential new water management strategy. In consultation with the RHWPG and TWDB staff, it was agreed that the extent of the second phase of the study would be dependent upon the findings from the first phase. Specifically, it was determined that if the proposed interruptible water supply strategy has little or no technical viability then the second phase would be unnecessary.

The initial “viability assessment” phase of the interruptible water supply study included several tasks:

- Evaluate and quantify potential uses for interruptible water supplies within Region H;
- Evaluate and quantify the availability and dependability of existing permitted interruptible supplies in Region H;
- Evaluate and quantify the availability and dependability of un-permitted interruptible supplies in Region H;
- Compare amounts and locations of interruptible supplies to amounts and locations of irrigation demand to evaluate the potential extent of interruptible supply use;
- Evaluate and quantify additional firm yield supplies made available for municipal and industrial purposes as a result of implementing the proposed strategy; and
- Evaluate the impacts of using of interruptible supplies on the size and timing of other water management strategies in Region H.

It should be noted that evaluation of other potential uses of available interruptible surface water supplies was beyond the scope of this study. For example, interruptible water supplies could potentially be made reliable for municipal or industrial use through the development of off-channel reservoir storage, by committing existing reservoir storage to “firm up” interruptible run-of-river supplies, or through a conjunctive use strategy where groundwater or another water source is used when interruptible surface water is not available.

Section 2 – Potential Uses for Interruptible Water Supplies

Texas Commission on Environmental Quality administrative rules for “issuance and conditions of water rights” presents a conservative approach to water availability and reliability in terms of the agency’s review and approval of applications for new surface water permits or for increases in the authorized diversion amount of existing permits. Section 297.42 of TCEQ rules, in their entirety, pertaining to water availability states:

> *(a) Except as provided by Texas Water Code (TWC), Section 11.1381, and Section 297.19 of this title (relating to Term Permit Under Texas Water Code "11.1381 and 11.153, 11.155), an application for a new or increased appropriation will be denied unless there is a sufficient amount of unappropriated water available for a sufficient amount of the time to make the proposed project viable and ensure the beneficial use of water without waste.*
>
> *(b) A new water right may be conditioned as appropriate to protect instream uses, water quality, aquatic and wildlife habitat, and freshwater inflows to bays and estuaries as provided by TWC, Sections 11.147, 11.150, 11.152, and 16.059.*
>
> *(c) For the approval of an application for a direct diversion from a stream without sufficient on or off channel water storage facilities for irrigation, approximately 75% of the water requested must be available approximately 75% of the time when distributed on a monthly basis and based upon the available historic stream flow record. Lower availability percentages may be acceptable if the applicant can demonstrate that a long-term, reliable, alternative source or sources of water of sufficient quantity and quality are economically available to the applicant to make the proposed project viable and ensure the beneficial use of state water without waste.*
>
> *(d) Projects that are not required to be based upon the continuous availability of historic, normal stream flow include, but are not limited to: the artificial recharge of the Edwards Aquifer under TWC, Section 11.023(c); conjunctive ground and surface water management projects such as aquifer storage and recovery projects; diversions or impoundments at times of above- normal stream flow (e.g., "scalping" operations) for seasonal or supplemental use; a system operation in conjunction with other water rights; non-consumptive instream uses; or other similar type projects. The required availability of unappropriated water for these special type projects shall be determined on a case-by-case basis based upon whether the proposed project can be viable for the intended purposes and the water will be beneficially used without waste.*
>
> *(e) For an application for an on-channel storage facility to be authorized for domestic or municipal water use, the proposed diversion right of the reservoir must be equal to its firm yield. The purpose of this limitation is to ensure a secure and dependable source of water supply for uses necessary to protect the public health, safety, and welfare (see also 30 TAC Section 290.41(b) requiring public water systems to have a "safe" yield capable of supplying the maximum daily demands during extended periods of peak usage and "critical hydrologic conditions"). Such reservoir may be authorized in excess of its firm yield when the implementation of a drought management plan or alternative sources of water supply such as groundwater, other reservoir systems, or other means are available to satisfy water needs during drought periods when the reservoir's normal supply capabilities would be exceeded.*

(f) Except for an application for an emergency, temporary, seasonal, or term permit, or as provided by this section, the commission may require an applicant to provide storage sufficient to yield the requested annual diversion.

(g) In order to make the optimum beneficial use of available water, a water right may be granted based upon the availability of return flows or discharges. However, a water right granted upon return flows or discharges that may cease in the future because of new or increased direct reuse (i.e., the lawful reuse of water before it is returned or discharged into the stream) or that may cease for other lawful reasons will be granted with the express provision that the water available for the water right is dependent upon potentially interruptible return flows or discharges.

While several exceptions are enumerated, taken as a whole TCEQ rules on water availability represent a policy that favors a firm or safe yield concept as the basis for issuance of new water rights or increases to existing water rights, particularly for domestic and municipal uses. A notable exception, however, is stated in Subsection (c), which recognizes that less than fully reliable water supplies are suitable for allocation to irrigation use. In essence, State policy acknowledges that allocation of less than fully reliable surface water supplies to irrigated agriculture is appropriate, that it is a viable means for increasing the beneficial use of limited State waters, and that the risk of irrigation water shortages and the attendant economic impacts are acceptable. Accordingly, the focus of this study, in terms of the identification of potential uses of interruptible surface water supplies within Region H, is solely on irrigated agriculture.

The following sections provide an overview of historical and projected irrigation water demands within Region H; describe the major types of irrigated crops produced within the region; and describe the seasonal water use patterns of those crops.

2.1 Historic and Projected Irrigation Demands in Region H

The majority of irrigation water use in Region H occurs in Brazoria, Chambers, Liberty, and Fort Bend counties[4]. The recorded irrigation use for each county is provided in Table 1. Surface water accounts for nearly all of the agricultural irrigation use in Chambers, Brazoria and Liberty counties and approximately two-thirds of the water used in Fort Bend County for irrigation. Groundwater is a significant portion of irrigation use in Fort Bend County and is also used in relatively small amounts in Brazoria and Liberty counties.

Table 1. Major Demand Centers Historic Irrigation Use

County	1996 Irrigation Use (acre-ft)	2003-2006 Maximum Annual Irrigation Use (acre-ft)	Percent of Irrigation Demand met with Surface Water
Chambers	117,777	105,475	100%
Brazoria	149,188	109,804	97%
Liberty	82,901	70,442	98%
Fort Bend	53,455	46,800	65%

From 1987 to 2002 irrigation demands within Region H declined by more than 50 percent. Further decreases from 464,300 acre-feet per year in 2000 to 430,930 AFY in 2060 are forecasted due to increasing costs of water supply and declining agricultural commodity prices.[5] Projected 2060

[4] 2006 Region H Water Plan Chapter 1-12
[5] 2006 Region H Water Plan Chapter 1-23

irrigation demands are shown by basin in Table 2 below. Also shown is the percentage of projected irrigation demand that is expected to be supplied from surface water. More than 70 percent the total projected irrigation demand in Region H is projected to occur within the San Jacinto-Brazos, Trinity, and Neches-Trinity basins, where the principal source of supply is surface water. Projected irrigation demands in the Brazos-Colorado, San Jacinto and the Trinity-San Jacinto Basins are projected to be met primarily with groundwater supplies.

Table 2. Projected Future Irrigation Surface Water Demands

Basin	2060 Total Demands (AFY)	Percent of Demand from Surface Water
Brazos-Colorado	33,490	0%
Brazos	27,064	55%
San Jacinto-Brazos	126,935	81%
San Jacinto	36,475	3%
Trinity-San Jacinto	24,593	27%
Trinity	87,498	87%
Neches-Trinity	91,558	96%
Neches	3,317	96%
Total	430,930	70%

2.2 Crop Types

The major types of irrigated crops produced in Region H are rice, soybeans, vegetables, and cotton. Historically, the predominant crop produced in Region H has been rice, which is relatively water-intensive, accounting for approximately 72 percent of total irrigated acreage in the region during 2002. Much of the acreage in rice production is concentrated in the lower portions of Region H basins where the majority of rice irrigation demands are met from surface water sources. There are also relatively small amounts of irrigated acreage in corn, sorghum, cotton, and hay in the northern portions of the region. Estimates of irrigated acreage and “on-farm” water use by crop type during the year 2000 is provided in Table 3.[6]

Table 3. Irrigated Acres by Crop Type

Crop Type	Irrigated Acreage	Water Demand (in acre-feet per year)
Rice	57,860	234,442
All other crops	7,950	1,8276
Cotton	2,946	2,946
Vegetables	1,297	2,598
Hay-Pasture	811	1,550
Pecans	307	511
Corn	252	126

[6] http://www.twdb.state.tx.us/assistance/conservation/ASPApps/regions.asp?reg=H

Crop Type	Irrigated Acreage	Water Demand (in acre-feet per year)
Vegetables (deep)	123	82
Other orchard	121	68
Peanuts	102	34
Vineyard	13	9

2.3 Seasonal Irrigation Patterns

Unlike other types of water uses (e.g., municipal) which occur throughout the year, crop irrigation is typically seasonal, corresponding to the growing season for each crop type. As shown in Figures 1 through 4, the typical seasonal pattern is for the majority of the demand to occur during the summer months. Seasonal irrigation patterns are also influenced by location with some crops showing a much less pronounced seasonal peak when grown in the coastal plain areas than in inland areas (see Figures 3 and 4). One explanation for this difference may be that the coastal areas receive greater rainfall, on average, during the growing seasons for these crops.

The seasonality of irrigation demand patterns is important to the analysis of the availability of interruptible surface water supply. Simply stated, seasonal peak irrigation demands, which are typically greatest during drought conditions, generally occur at the same time as low stream flow conditions. Accordingly, in some areas, permitted irrigation water rights cannot be fully satisfied during critical drought periods and there may not be any unpermitted stream flows available for allocation to irrigation use that meet the TCEQ's 75-75 reliability test.

It's important to recognize that many existing irrigation water rights are for run-of-river diversions that are less than firm during extreme hydrologic conditions. In fact, it is common within Region H and elsewhere along the Texas Gulf Coast for irrigators to contract for water supply on a year-to-year basis from suppliers that hold underlying water rights that are not fully reliable.[7] In some cases, these water rights are "firmed up" contractually with more reliable water supplies, perhaps from upstream reservoir storage, also typically on an annual basis.[8] During drought periods, when interruptible surface water supplies and back-up supplies may be limited or entirely unavailable, irrigation diversions must be reduced to match the available supply. In such circumstances, the suppliers of water for irrigation would take measures to reduce water demand perhaps by contractually limiting the amount of land that can be irrigated or by other pro rata allocation mechanisms. Importantly, because of the lower reliability of interruptible water supplies, the price charged to irrigators for an interruptible water supply is often much lower than the price that firm water supplies command.

[7] 2006 Region H Water Plan, 1-23
[8] 2006 Region H Water Plan, 4-7

Figure 2-1. Rice Irrigation Patterns

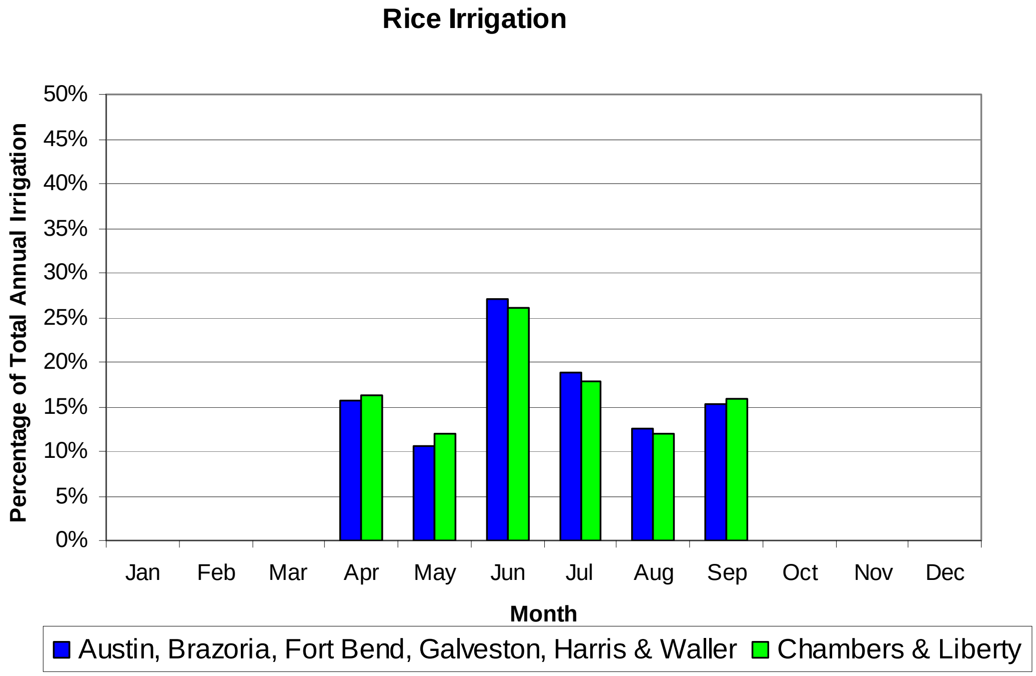


Figure 2-2. Cotton Irrigation Patterns

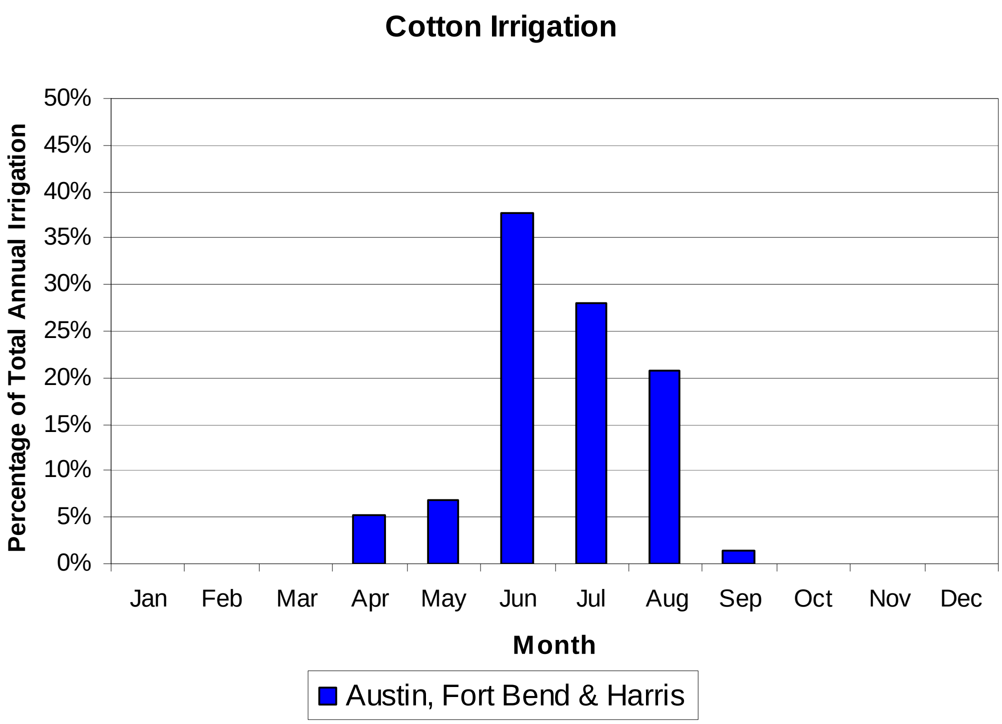


Figure 2-3. Sorghum Irrigation Patterns

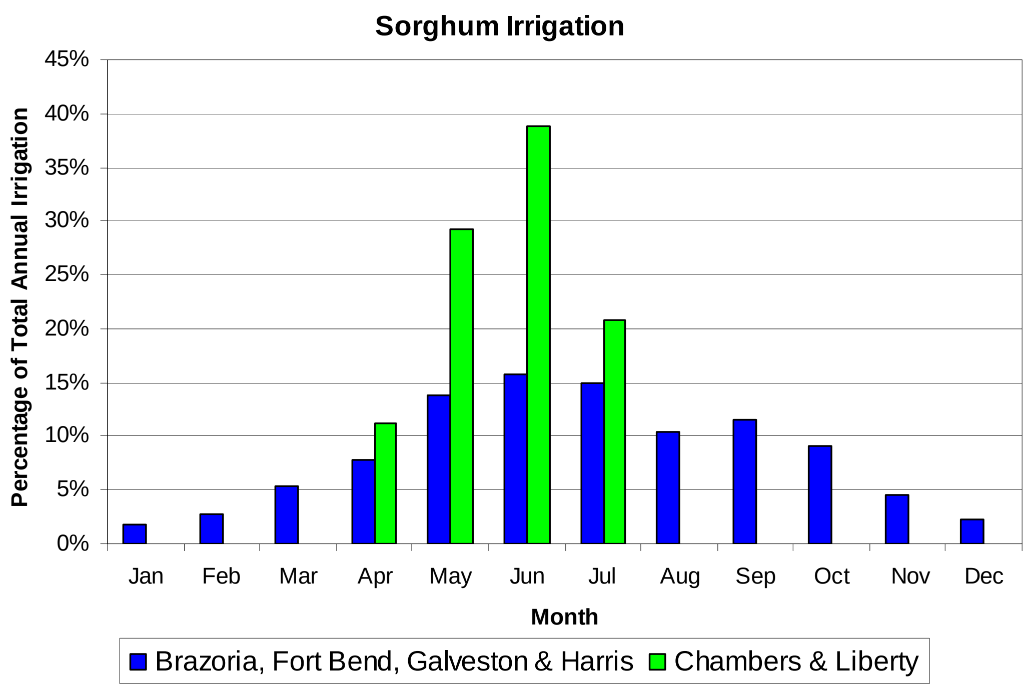
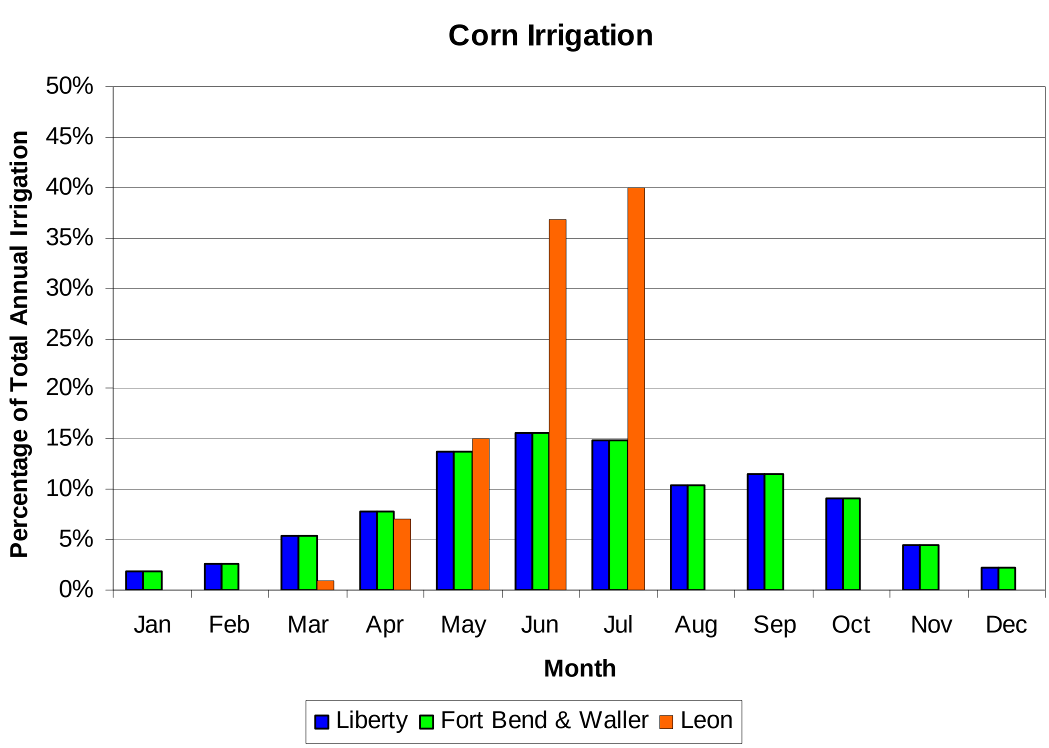


Figure 2-4. Corn Irrigation Patterns



Section 3– Availability and Dependability of Interruptible Surface Water Supplies

A major element of this study was to conduct an analysis of the availability and dependability of interruptible surface water supplies in Region H. Using the appropriate TCEQ Water Availability Models (WAM) for each of the basins and coastal basins within Region H, this analysis was performed to quantify the availability of both permitted and unpermitted interruptible water supplies. The WAMs are numerical models that simulate a set of monthly diversion targets relative to historic inflows. Existing water rights are modeled according to seniority based on the date of permit issuance with the most senior water rights satisfied first. For modeling purposes, firm yield is defined as the minimum quantity of water that can be diverted on an annual basis over the period-of-record for each basin.

3.1 Permitted Interruptible Surface Water Supply

In order to quantify permitted interruptible water supplies, existing water rights were first modeled to verify the firm yield of each right and then analyzed with application of the TCEQ 75-75 rule to identify amounts greater than the firm yield and up to the full authorized diversion of each right. The analysis of the interruptible portion of each right was performed first on an annual basis and then on a monthly basis and the 75-75 reliability test was checked directly from the WAM output. The annual test determines the percentage of time that 75 percent of the annual diversion target is met over time when distributed on a monthly basis. If 75 percent of the target diversion when distributed on a monthly basis can not be met in at least 75 percent of the years, a monthly test is performed. During a monthly test, the analysis determines the frequency that a water right's monthly diversions can be fully met. The monthly test is generally a more liberal qualifier and does not consider the magnitude of monthly diversions. For Instance, water rights with greater variations in monthly diversion patterns, such as irrigation rights, can often met 75% of monthly diversion targets in 75% of the months simulated over the period of record, but can not met 75% of the annual diversion target in 75% of the years due to the magnitude of shortages that occur during months with peak diversions. This can result in an over estimation of a water right's reliability, particularly irrigation water rights which often have a monthly diversion pattern that can resembles monthly irrigation patterns presented in Section 2. The results presented in this section are based on the more stringent annual 75-75 test.

In order to assess the amount of existing permitted interruptible water supplies under varying assumptions regarding diversion amounts and return flows, the analysis was conducted using WAM Runs 3 and 8 where:

- **WAM Run 3 –** represents the full authorized (permitted) diversion use with no return flows.
- **WAM Run 8 –** represents annual diversions that are equal to the maximum reported water use over the last ten years, representing "current conditions", and a minimum return flow ratio for the last five years.

In consultation with TWDB staff it was determined that the use of WAM Run 1, which represents the full authorized diversions with current return flows, would not add value to the analysis insofar as Runs 3 and 8 provide a bracketing of results, with Run 1 values falling in between.

The tables below summarize the firm yield and interruptible supply for the major surface water sources located within Region H. Tables 4 and 5 present the base Run 3 and 8 results, respectively. Firm yield results from the Run 3 models represent the minimum annual diversion among all of the calendar years modeled. The firm yield results from Run 8 models represent the minimum annual diversions that are available assuming the current level of diversions and the current level of return flows. As a result some water rights may record a lower minimum annual diversion in the Run 8 models than in the Run 3 models. For example, in the Run 8 model approximately 47,000 acre-ft is assumed to be diverted form Lake Conroe under current conditions. The current diversion levels are lower than the permitted diversion of 100,000 afy. In the Run 3 model, the firm yield of the reservoir is 74,300. As a result, the firm yield of the lake is higher in the Run 3 model (100,000 afy) than in the Run 8 model (47,000 afy). In both cases the interruptible supply available is calculated as the amount of water above the firm yield and below the permitted diversion. The interruptible supply available in each scenario is 53,000 afy and 25,600 afy in Run 8 and Run 3 respectively.

Table 6 presents estimates of permitted reliable and interruptible supplies based on the minimum annual diversions presented in the 2006 Region H water Plan. The reliable yields represent the minimum annual diversions of run-of-river rights and the firm yield of available surface water reservoir supplies. The interruptible supply available to water rights with reliability greater than 75-75 was calculated as the amount greater than the reliable yield and below the permitted yield.

As indicated, the greatest quantities of permitted firm and interruptible water supply are found in the Trinity Basin. Significant quantities of permitted interruptible water are also found in the Brazos Basin, the San Jacinto-Brazos Coastal Basin, and the San Jacinto Basin. There are only relatively small quantities of permitted interruptible water supply in the other Region H coastal basins. In the San Jacinto-Brazos Coastal Basin the interruptible portion of the existing permitted supplies is greater than the firm yield. This is due to the fact that during drought of record conditions many run-of river rights have firm yields that are significantly lower than their permitted diversions. This indicates that some of the coastal streams and bayous are over-appropriated when considering drought of record conditions.

Water rights with reliable yields of 500 acre-ft per year or greater were allocated to meet projected demands in the 2006 Region H plan. A summary of the reliable yields and interruptible supplies available to major surface water rights in each basin is presented in the following sections. Appendix A contains summary tables that include estimates of existing permitted interruptible supplies.

Table 4. Analysis of Existing Surface water Sources using WAM Run 3

	Brazos-Colorado	Brazos	San Jacinto-Brazos	San Jacinto	Trinity-San Jacinto	Trinity	Neches-Trinity
Basin Diversion Target	0	866,351	120,919	342,237	43,983	1,633,630	68,172
Firm Yield	12,019	537,252	29,187	203,281	34,312	911,565	21,753
Interruptible Supply	0	278,997	47,303	73,885	3,624	711,920	2,272

Table 5. Analysis of Existing Surface Water Sources Using Run 8

	Brazos-Colorado	Brazos	San Jacinto-Brazos	San Jacinto	Trinity-San Jacinto	Trinity	Neches-Trinity
Basin Diversion Target	0	866,351	120,919	342,237	43,983	1,633,630	68,172
Firm Yield	12,019	495,183	27,969	233,274	32,414	768,689	17,611
Interruptible Supply	0	293,995	64,646	53,060	5,791	860,653	9,837

Table 6. Analysis of Existing Surface Water Sources Using 2006 Minimum Annual Diversions

	Brazos-Colorado	Brazos	San Jacinto-Brazos	San Jacinto	Trinity-San Jacinto	Trinity	Neches-Trinity
Basin Diversion Target	48,400	866,351	120,919	342,237	43,983	1,633,630	68,172
Firm Yield	12,019	472,103	37,061	297,300	34,232	1,571,030	21,701
Interruptible Supply	0	212,977	40,579	25,700	3,557	52,417	2,809

3.1.1 Brazos- Colorado Coastal Basin

The 2006 Region H Water Plan identified two existing water rights on the lower San Bernard River, located within the Brazos-Colorado Coastal Basin, that supply water to industrial users in Region H. The portion of the water rights that is contracted to industrial users in Region H is estimated to total 12,019 acre-feet per year. This contracted supply is fully reliable during the drought of record. There are no permitted interruptible supplies in this basin. As shown in Table 8 below, the contracted supplies from the San Bernard Run-of-River are used to meet industrial demands in the Brazos-Colorado Coastal Basin. There are no irrigation water rights in the Brazos-Colorado Basin that could trade firm supplies for interruptible supplies.

Table 7. Analysis of Existing Water Rights in the Brazos-Colorado Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	12,019	12,019	12,019
Interruptible Supply	0	0	0

Table 8. Major Brazos-Colorado Coastal Basin Water Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
SAN BERNARD RIVER RUN-OF-RIVER	3461303421	Industrial	16,400	8,519	0
SAN BERNARD RIVER RUN-OF-RIVER	3461303423	Industrial	32,000	3,500	0

3.1.2 Brazos River Basin

Water rights in the Brazos Basin with a “firm” yield greater than 500 acre-feet per year total 472,103 acre-feet per year. The interruptible portion of these water rights totaled 267,095 acre-feet per year. An additional 138,913 acre-feet per year of firm supply is available to users in Region H through the Brazos River Authority/Army Crops of Engineers (BRA/COE) System which consists of several reservoirs in the Brazos Basin upstream of Region H. The supplies from the BRA/COE System are allocated for use within Region H through individual contracts between users and the Brazos River Authority. The supply amounts included in the 2006 Regional Water Plan were provided by the

Brazos G Water Planning Group.[9]

Table 9. Analysis of Existing Water Rights in the Brazos Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	537,252	495,183	472,103
Interruptible Supply	278,997	293,995	212,977

The Brazos Basin supplies shown below are reported only for supplies located in Region H and do not include supplies located upstream of Region H in the BRA/COE System. The "firm" run-of-river supplies in the Brazos Basin total 472,103 acre-ft per year. The interruptible portion of the run-of-river rights totals approximately 212,977 acre-ft per year. An additional 99,650 acre-ft of firm supply is projected to be available to Region H from the proposed Allens Creek Reservoir.

The Gulf Coast Water Authority holds two water rights (3461205168 & 3461205171) with a total "firm" supply of 171,103 acre-ft per year and an interruptible supply of approximately 52,739 acre-ft per year. Supplies from the multi-use water rights are projected to be used to meet primarily municipal and industrial demands. Other demands that are projected to be supplied by water from these water rights include mining and steam-electric and approximately 1,207 acre-ft allocated for irrigation uses that generally include golf courses and country clubs as opposed to irrigated farmland. Other multi-use water right holders include the supplies from Texas Genco (346125320) that are contracted to the Richmond Irrigation Company, Dow Chemical (3461205328B), the future Allens Creek Reservoir supplies (12900) and the Chocolate Bayou Water Company (346125322B). Texas Genco owns water rights 346125320 and 3461205325 with "firm" yields of 29,920 and 34,300 respectively and over 10,000 acre-ft of interruptible supply. The water right also contains a surplus of firm supply that could be contracted by municipal and industrial users. The Dow Chemical (3461205328B) "firm" supplies total 148,061 acre-ft per year with an interruptible supply of 122,204 acre-ft per year; the supplies are allocated to industrial customers. Supplies from the future Allens Creek Reservoir consist of 99,650 acre-ft of "firm" supplies projected to meet municipal and industrial demands within Region H. The Chocolate Bayou Water Company (CBWC) holds water rights in the Brazos Basin (3461205322B) consisting of 63,812 acre-ft of "firm" run-of-river supplies and approximately 27,954 acre-ft of interruptible supplies that satisfy the annual 75-75 reliability requirement.

According to the 2006 Region H Water Plan, the 63,812 acre-ft CBWC supplies (3461205322B) shown in the table below were allocated exclusively to irrigation demands. Since the adoption of the 2006 Region H Plan, the CBWC supplies have been amended to allow diversions for multiple uses including municipal use. It is likely that some of the "firm" supplies will be contracted to municipal users in the San Jacinto – Brazos Basin. Firm supplies that have previously been contracted on a year-to-year basis by irrigation users may be supplied with a combination of "firm" and interruptible supplies as availability permits. During droughts, irrigators may have to reduce their irrigated acreage or contract water from an alternative source of supply.

Table 10. Major Brazos River Basin Water Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
BRAZOS RIVER RUN-OF-RIVER	3461205168	Multi-use	99,932	98,805	127
BRAZOS RIVER RUN-OF-	3461205171	Multi-use	125,000	72,388	52,612

[9] 2006 Region H Water Plan, chapter 3-30

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
RIVER					
BRAZOS RIVER RUN-OF-RIVER	3461205320	Multi-use	40,000	29,920	10,080
BRAZOS RIVER RUN-OF-RIVER	3461205322B	Multi-use	155,000	63,812	27,954
BRAZOS RIVER RUN-OF-RIVER	3461205325	Steam Elec	34,300	34,300	0
BRAZOS RIVER RUN-OF-RIVER	3461205328B	Multi-use	305,631	148,061	100,221
BRAZOS RIVER RUN-OF-RIVER	3461205366	Municipal	45,000	23,017	21,983
BRAZOS RIVER RUN-OF-RIVER	3461205492	Irrigation	1,800	1,800	0
ALLENS CREEK RESERVOIR	12900	Multi-use	99,650	99,650	0

3.1.3 San Jacinto-Brazos Coastal Basin

Surface water rights in the San Jacinto-Brazos Coastal basin totaling 120,919 acre-feet per year were analyzed using Run 3. Water rights with a firm annual diversion of 500 acre-feet per year or greater resulted in a basin firm yield of 37,061 acre-feet per year during the drought of record. The interruptible portion of the 75-75 reliable water rights totals 40,579 acre-feet per year.

Table 11. Analysis of Existing Water Rights in the San Jacinto- Brazos Coastal Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	29,187	27,969	37,061
Interruptible Supply	47,303	64,646	40,579

Table 12 below lists the run-of-river supplies available in the San Jacinto – Brazos Basin. The total “firm” yield is 30,627acre-ft per year with an interruptible supply of approximately 40,579 acre-ft per year. The supplies listed below are owned almost exclusively by private irrigators with the exception of the multi-use water right (3461105357A) owned by the Chocolate Bayou Water Authority (CBWC). In the 2006 Region H Water Plan, the majority of the “firm” supply from the CBWC was allocated to manufacturing with approximately 2,935 acre-ft per year allocated to irrigation use. In addition to the supplies listed below 2,120 acre-ft per year of saline water is reliable during the drought of record and used by Reliant Energy at their power plant in Webster, Texas.

The irrigation water rights permitted solely for irrigation use total 8,729 afy. These water rights are held by private irrigators making it unlikely that they would consider trading a firm asset for an interruptible supply. An additional 2,935 afy of irrigation supplies are projected to be provided by the Chocolate Bayou Water Company (3461105357A). The CBWC also contains approximately 17,000 afy of interruptible supply that could be contracted by irrigators in lieu of “firm” supplies. The potential use of interruptible supplies available at the CBWC diversion point would free almost 3,000 afy for municipal use in the San Jacinto – Brazos Basin.

Table 12. Major San Jacinto Brazos Coastal Basin Water Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105169	Multi-use	12,000	3,842	8,158
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105170	Multi-use	18,159	6,890	11,269
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105343	Irrigation	3,262	711	262
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105344	Irrigation	1,482	962	520
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105346	Irrigation	2,813	1,360	1,452
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105352	Irrigation	3,620	3,347	273
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105357A	Multi-use	57,500	17,600	17,000
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3461105364	Irrigation	968	766	202
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3411104449	Irrigation	2,000	558	1,442
SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3411104509	Irrigation	2,925	1,025	0

3.1.4 San Jacinto River Basin

Surface water rights in the San Jacinto River basin totaled 346,344 acre-feet per year and recorded a “firm” yield of 297,300 acre-feet per year during the drought of record. The interruptible portion of water rights with a reliability of 75-75 or greater totaled 25,700 acre-feet per year.

Table 13. Analysis of Existing Water Rights in the San Jacinto Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	203,281	233,274	297,300
Interruptible Supply	73,885	53,060	25,700

The major surface water sources in the San Jacinto Basin are listed below. The total permitted yield of Lake Houston (168,000 acre-ft per year) is available during the drought of record due to the lake’s downstream location and seniority compared to other water rights. Lake Conroe however, has a firm yield of 74,300 acre-ft per year and an interruptible supply of 25,700 acre-ft per year. The San Jacinto River Authority (SJRA) owns a run-of-river water right (3461004964) that is assumed 100% reliable by a fixed right agreement with the City of Houston. Physically, the diversions are made from Lake Houston. Supplies from the three reservoirs are projected to be used primarily to meet municipal, industrial and steam electric power demands.

Of the three major water rights in the San Jacinto Basin, only Lake Conroe contains interruptible supplies that may potentially be used to meet irrigation demands in the San Jacinto Basin. However, little irrigation is projected to be used in the Basin; approximately 1,235 afy is projected to be supplied from the three sources for irrigation use. In addition, there are no major irrigation water rights in the basin that may be capable of “swapping” firm irrigation supplies for interruptible supplies.

Table 14. Major San Jacinto River Basin Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
CONROE LAKE/RESERVOIR	10060	Multi-use	100,000	74,300	25,700
SAN JACINTO RIVER RUN-OF-RIVER	3461004964	Multi-use	55,000	55,000	0
HOUSTON LAKE/RESERVOIR	10030	Multi-use	168,000	168,000	0

3.1.5 Trinity San Jacinto Coastal Basin

Surface water rights in the Trinity-San Jacinto Coastal basin totaled 44,374 acre-feet per year. Water rights totaling over 500 acre-feet per year yielded a "firm" yield of 34,232 acre-feet per year during the drought of record. 30,000 acre-ft of the firm supply is permitted by Texas Genco to divert saline water from Cedar Bayou. Irrigation rights account for the remaining 4,232 acre-ft of firm water.[10] The interruptible portion of water rights with a reliability of 75-75 or greater totaled 3,557 acre-feet per year.

Table 15. Analysis of Existing Water Rights in the Trinity-San Jacinto Coastal Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	34,312	32,414	34,232
Interruptible Supply	3,624	5,791	3,557

HL&P has a permit to divert 30,000 acre-ft per year of saline water for use at the Cedar Bayou Plant. The remaining water rights are irrigation rights with a total reliable yield of 3,232 acre-ft per year with an interruptible supply of 3,557 acre-ft per year.

Table 16. Major Trinity-San Jacinto Coastal Basin Water Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	3460903909	Irrigation	1,402	685	717
TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	3460903918	Irrigation	2,777	1,084	1,416
TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	3460903922	Irrigation	1,500	628	172
TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	3460903923	Irrigation	954	626	328
TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	3460903924	Irrigation	2,133	1,209	924
TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	3460903926	Manufacturing	30,000	30,000	0

3.1.6 Trinity River Basin

Region H surface water rights in the Trinity River basin totaled 1,635,649 acre-feet per year. Water

[10] 2006 Region H Water Plan Chapter 3-27

rights totaling over 500 acre-feet per year recorded a “firm” yield of 1,571,030 acre-feet per year during the drought of record. 1,344,000 AFY of firm yield was available from Lake Livingston and 227,030 AFY available from run-of river supplies. The interruptible portion of the 75-75 reliable water rights totaled 52,417 acre-feet per year.

Table 17. Analysis of Existing Water Rights in the Trinity Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	911,565	768,689	1,571,030
Interruptible Supply	711,920	860,653	52,417

As shown below, the majority of the surface water supplies in the Trinity Basin are located in Lake Livingston owned by the Trinity River Authority and the City of Houston. 38,000 afy was purchased by the City of Houston from the American Rice Growers Co-op Association (3460804277) and is projected to meet irrigation demands in Liberty County. The Chambers-Liberties Navigational District (CLCND) owns approximately 58,820 afy in Trinity run-of-river supplies and 54,127 afy of supplies from Lake Anahuac (3460804279). Approximately 68,438 acre-ft is projected to be used to meet municipal, irrigation and mining demands. An additional 40,582 afy of surplus reliable supply is projected to be available. 56,000 afy of which was purchased by the San Jacinto River Authority (SJRA) from the Devers Canal (3410805271) and is projected to be allocated to municipal and manufacturing users in Montgomery and Harris Counties. The remaining 2,500 afy of reliable run-of-river supply is projected to be used to meet irrigation demands in Liberty County.

Approximately 74,575 afy of reliable supplies are projected to be contracted by irrigation users from sources in the Trinity Basin by the year 2060. 39,075 afy is projected to be supplied from Lake Livingston, 33,000 afy from water right 3460804277 and 33,939 afy from water right 3460804279. The largest amount of interruptible supply (33,927 afy) is available from water right 3460804279; the water right also contains approximately 40,582 afy of surplus reliable supplies. Recent trends in the basin have indicated a decline in irrigation demand resulting in the selling of irrigation water rights to municipal water providers. The SJRA purchase of 56,000 for municipal and manufacturing use, and the proposed CLCND permit amendment to add municipal and industrial use categories to 80,000 afy of irrigation rights for use in the Trinity – San Jacinto Basin indicate that the excess firm irrigation water rights in the basin can be made available to municipal users without the need for interruptible supplies as an alternative source.

Table 18. Major Trinity River Basin Water Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
TRINITY RIVER RUN-OF-RIVER	3410805271	Multi-use	58,500	58,500	0
LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	084H0	Multi-use	403,200	403,200	0
LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	084H0	Multi-use	985,800	967,310	18,490
TRINITY RIVER RUN-OF-RIVER	3460804277	Irrigation	38,000	33,000	0
TRINITY RIVER RUN-OF-RIVER	3460804279	Multi-use	142,947	109,020	33,927

3.1.7 Neches-Trinity Coastal Basin

Surface water rights in the Neches-Trinity Coastal basin totaling 69,554 acre-feet per year were analyzed using RUN 3. Water rights totaling over 500 acre-feet per year yielded a “firm” yield of

21,702 acre-feet per year during the drought of record; all of the reliable supplies are owned mainly by private irrigators. In addition, the U.S. Fish and Wildlife Service hold a water right for 12,305 AFY of firm supply for the Anahuac Wildlife Refuge. The interruptible yield of the 75-75 reliable water rights totaled 2,809 acre-feet per year.

Reliable irrigation supplies of approximately 21,702 afy are not located near interruptible municipal water rights. While individual private irrigation water rights include interruptible supplies, there is not enough interruptible water available from either industrial or municipal water rights to indicate a viable “swap”.

Table 19. Analysis of Existing Water Rights in the Neches-Trinity Coastal Basin

	WAM Run 3	WAM Run 8	2006 Plan
Firm Yield	21,753	17,611	21,701
Interruptible Supply	2,272	9,837	2,809

Table 20. Major Neches-Trinity Coastal Basin Water Rights

Source Name	Source ID	Use	Permitted Amount (AFY)	Reliable Yield (AFY)	Interruptible Supply (AFY)
NECHES-TRINITY RIVER RUN-OF-RIVER	3410704290	Irrigation	1,249	1,069	180
NECHES-TRINITY RIVER RUN-OF-RIVER	3410704291	Irrigation	1,220	1,078	142
NECHES-TRINITY RIVER RUN-OF-RIVER	3410705016	Irrigation	1,250	901	349
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704287	Irrigation	4,900	2,528	0
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704293	Irrigation	2,265	1,626	639
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704294	Irrigation	674	573	101
NECHES-TRINITY RIVER RUN-OF-RIVER	3410704295	Irrigation	1,400	1,205	195
NECHES-TRINITY RIVER RUN-OF-RIVER	3410704299	Irrigation	1,834	1,173	0
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704300	Irrigation	875	805	70
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704304	Manufacturing	7,560	4,660	243
NECHES-TRINITY RIVER RUN-OF-RIVER	3410704306	Irrigation	2,100	1,818	282
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704308	Irrigation	1,109	771	0
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704309	Irrigation	2,118	711	0
NECHES-TRINITY RIVER RUN-OF-RIVER	3410704311	Irrigation	2,700	2,093	607
NECHES-TRINITY RIVER RUN-OF-RIVER	3460704312	Irrigation	1,754	691	0

3.2 Unpermitted Interruptible Surface Water Supply

The availability and dependability of unpermitted interruptible supply was also evaluated and quantified using the TCEQ WAM Run 3 model for each Region H basin. The analysis was not performed for WAM Run 8 because any future applications for appropriation of unpermitted interruptible supplies, without a term limit, would necessarily be required to use the “full authorized diversion with no return flow scenario” as the basis for the application.

In order to establish a maximum and a minimum estimate of the quantities of unpermitted interruptible surface water supply in each basin, a “dummy” water right with a junior priority date was added to each model at specific “control points” at both an upstream and a downstream location in each basin (see Figure 5). Diversion quantities represented by the dummy water rights were increased incrementally until reaching a level where the dummy right fails to satisfy the 75-75 rule, the result being the estimated unpermitted interruptible supply at each control point. For coastal basins, several upstream and downstream locations were selected to quantify and bracket the quantities of unpermitted interruptible supplies available in various bayous.

The results of the analysis for WAM Run 3 are presented in Table 21 below. As indicated, unpermitted interruptible water is only available in the downstream areas of the coastal basins, with the exception of a relatively small quantity of unpermitted interruptible water in the upstream area of the Neches-Trinity Coastal Basin. The analysis also demonstrates that the Brazos and Trinity basins are fully appropriated, at least in terms of the availability of unpermitted flows that meet the 75-75 reliability test. While the WAM Run 3 results for the San Jacinto Basin show a significant quantity of unpermitted interruptible supply (247,000 acre-feet per year), it should be noted that the City of Houston and the San Jacinto River Authority have a permit application pending before TCEQ seeking appropriation of remaining unpermitted flows in the basin.

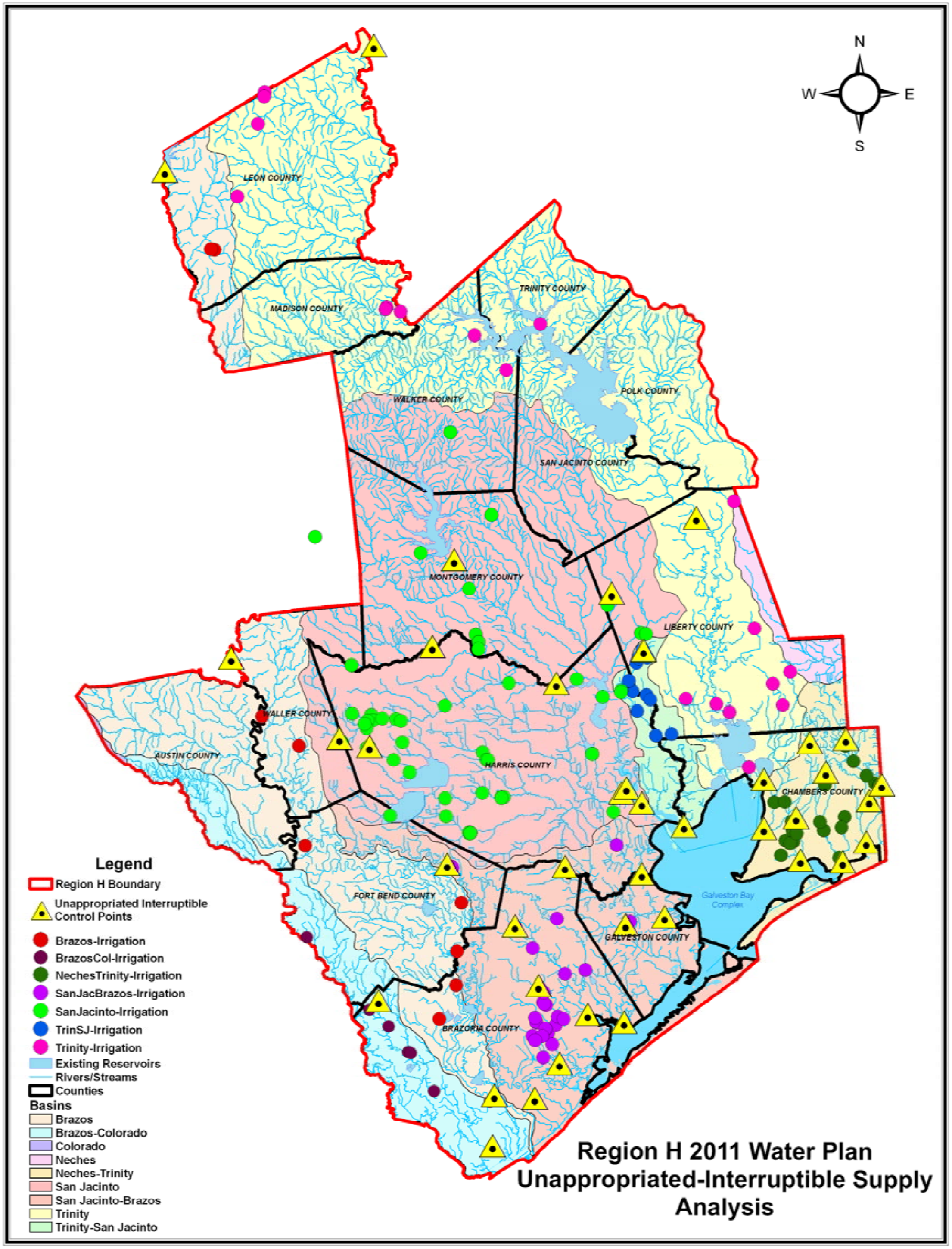
Because new permits for currently unpermitted interruptible supplies would likely include conditions for protection of environmental flows, the WAM Run 3 analysis was also performed with environmental flow constraints. Environmental flows were specified in the WAM Run 3 model for each basin as an instream flow requirement with higher seniority than potential new permits for interruptible water. The flows represented by the instream flow requirements were calculated using the Lyons method, which is a statistical “desk-top” approach that is commonly used by TCEQ to define environmental flow conditions for new water rights permits or permit amendments. The Lyons method uses 40 percent of the historical median-daily averaged flows by month for October through February and 60 percent of the historical median-daily averaged flows by month for March through September.[11] The result is a single flow value for each month of the year, which for modeling purposes, can be used to constrain the unappropriated water available to a new water right for diversion. As shown in Table 21, with environmental flow constraints there are no (zero) unpermitted interruptible surface water flows in any of the Region H basins. The implication is that all remaining unpermitted flows that have at least 75-75 reliability would be reserved for maintenance of environmental flows assuming the Lyons method was used as the benchmark for environmental flow needs.

[11] Study Commission on Water for Environmental Flows, “Science Advisory Committee Report on Water for Environmental Flows”, October 2004.

Table 21. Basin Wide Unpermitted Interruptible Supplies WAM Run 3

Basin	Unpermitted Interruptible Supplies (AFY) without Environmental Flows		Unpermitted Interruptible Supplies (AFY) with Environmental Flows	
	Downstream	Upstream	Downstream	Upstream
Brazos-Colorado	1,125	0	0	0
Brazos	0	0	0	0
San Jacinto-Brazos	20,000	0	0	0
San Jacinto	247,000	0	0	0
Trinity-San Jacinto	5,400	0	0	0
Trinity	65	0	0	0
Neches-Trinity	8,973	484	0	0

Figure 3-1. Location of Control Points and Existing Irrigation Diversions



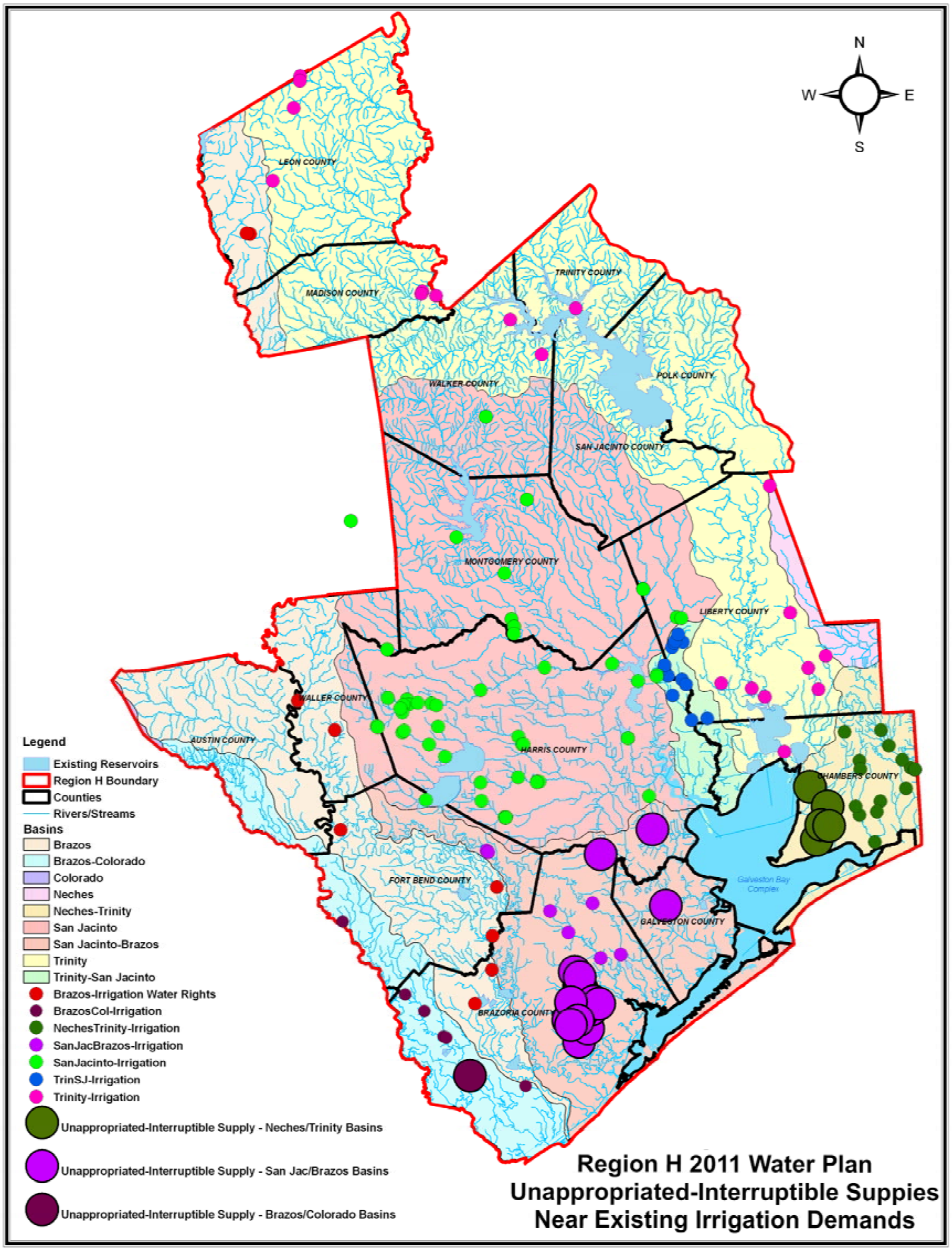
In order to assess whether unpermitted interruptible water is available in proximity to existing diversions, the WAM Run 3 models were also used to analyze the availability of unpermitted interruptible water at control points near existing irrigation diversions. These irrigation diversion control points are also shown in Figure 3-1. The proximity of available interruptible supply to existing irrigation diversions is important. Location is important for a strategy that involves the swapping of unpermitted interruptible water supplies for firm water supplies, because this strategy is not likely economically feasible if new infrastructure is required to convey and/or divert the water. As a practical matter, unpermitted interruptible water supplies would have to be available for diversion at existing facilities.

The results of this analysis are presented in Table 22. Absent any environmental flow constraints, there are only very modest quantities of unpermitted interruptible water supply in proximity to existing irrigation diversions in the Colorado-Brazos, San Jacinto-Brazos, and Neches-Trinity basins. Unpermitted interruptible supplies identified in the downstream portions of the Trinity-San Jacinto Coastal Basin (see Table 21) are not generally in proximity to existing irrigation diversions, which are located in upstream areas (see Figure 6). And, of course, with environmental flow constraints considered, there are no unpermitted interruptible supplies available.

Table 22. Unpermitted Interruptible Supplies in Proximity to Existing Irrigation Diversions

Basin	Unpermitted Interruptible Supply
Colorado-Brazos	<700 ac-ft/yr in one location
Brazos	0 ac-ft/yr
San Jacinto-Brazos	2,200 to 15,000 ac-ft/yr in 11 locations (max 20,000 total)
San Jacinto	0 ac-ft/yr
Trinity-San Jacinto	0 ac-ft/yr
Trinity	0 ac-ft/yr
Neches-Trinity	75 to 530 ac-ft/yr in four locations

Figure 3-2. Location of Unpermitted Interruptible Supply



Section 4– Strategy Viability Assessment

There are several critical considerations that affect the viability or feasibility of a strategy to swap or trade existing firm irrigation water rights for less reliable interruptible water supplies. First, interruptible water supplies, either permitted or unpermitted, would need to be available in proximity to existing irrigation diversion locations and demands. Second, existing firm irrigation water supplies would need to be available and accessible to potential municipal or industrial users. And third, an acceptable quid-pro-quo would need to be established between the parties to a water swap transaction, that being the holders of existing firm irrigation water rights permits and the entity seeking to acquire firm irrigation water rights for conversion to municipal or industrial use. Each of these considerations is discussed further below.

4.1 Availability and Accessibility of Interruptible Water Supplies

For a firm-interruptible water-trading strategy to be viable there must be either permitted or unpermitted interruptible water supply available to trade and that water must be accessible to irrigators that are currently using firm irrigation water rights. The analysis of permitted interruptible water supply presented in Section 3.1 indicates that there is little viability in proposing a trade of firm irrigation supplies for interruptible portions of municipal and industrial water rights.

The analysis shows that few firm supplies are available for trade in the San Jacinto Basin, and interruptible municipal and industrial water rights are not present in the Trinity – San Jacinto and the Neches – Trinity Basin in magnitudes that would support a trade with firm irrigation water rights. In the Brazos Basin a significant amount of interruptible supply is located near existing irrigation use. However, the “swap” of firm irrigation water rights for interruptible water rights is no longer viable after the purchase of the Chocolate Bayou Water Company (CBWC) water rights. The CBWC water rights included approximately 63,812 afy of reliable supply contracted by irrigators on a year-to-year basis. Since the purchase, the water rights have been amended to include multi-use and will be used to meet municipal demands in the San Jacinto – Brazos Basin. The water right also included approximately 27,954 afy of interruptible supplies that could be contracted by irrigators when the supply is available. Approximately 17,000 afy of interruptible supply is available at CBWC diversion locations in the San Jacinto – Brazos basin that could be contracted to irrigators freeing up approximately 2,935 afy of reliable supplies for municipal use. 8,729 afy of “firm” irrigation supply is held in the Brazos - San Jacinto Basin by private irrigators who would be unlikely to trade firm water rights for interruptible supplies. Similar to the purchase of the CBWC water rights, the purchase of firm irrigation water rights for conversion to municipal and industrial use has also been seen in the Trinity Basin. The San Jacinto Water Authority has purchased 56,000 afy of reliable run-of-river supply from the Devers Canal Rice Producers Association for municipal and industrial use. Similar market forces and declines in irrigation demands have prompted the proposed permit amendment to 80,000 afy of irrigation rights held by the Chambers-Liberty Counties Navigation District to include municipal and industrial use in the Trinity – San Jacinto Basin.

In general, the analysis of moving firm irrigation water to municipal use focuses largely on the location of irrigation diversion points in relation to municipal diversion points. Water rights permitted for multiple use categories provide the best option for implementing a trade between irrigation and municipal water supplies because existing infrastructure could be utilized to convey interruptible supplies to irrigators. Moving firm water from downstream diversion points to upstream locations has the potential to reduce the amount of firm water available under the amended water right and may open the right up to environmental flow constraints.

With regard to unpermitted interruptible water supplies, the results of the water availability analysis presented in Section 3.2 indicates that only relatively small quantities of unpermitted interruptible water are potentially available and accessible to irrigators that are currently using firm water rights. Specifically, If one assumes that environmental flow conditions would be imposed on any new water rights, the analysis shows that that there are no interruptible supplies within Region H available for allocation to irrigation use. All of the unpermitted interruptible water that meets the 75-75 reliability test would be reserved for maintenance of environmental flows.

In terms of access to interruptible water supplies by irrigators, a reasonable assumption is that irrigation diversion and conveyance infrastructure must already be in place. The underlying premise is that the costs of developing new infrastructure to divert and/or convey interruptible supplies to irrigation users would be prohibitive in light of the relatively low economic value of interruptible water supplies and the limited ability of agricultural users to pay for such improvements.

4.2 Availability and Accessibility of Firm Water Supply

A second consideration is that existing firm irrigation rights would have to be accessible to municipal or industrial users. Generally, a firm irrigation water right that is located in the same basin as the municipal or industrial user could be considered accessible, particularly if the required diversion and conveyance infrastructure is already in place. However, with some exceptions, transfers of firm irrigation water rights from one basin to another would not be feasible as the water right being transferred would become junior in priority date to all other water rights in the basin of origin. The effect would be to downgrade the reliability of the water right from firm to interruptible, thereby severely diminishing or eliminating its value as a source of municipal or industrial use. A notable exception is that new interbasin transfers from a basin to an adjoining coastal basin maintain their original priority date and hence their reliability and value. From a regulatory perspective, firm irrigation water rights in the Trinity Basin could therefore potentially be converted to municipal or industrial use and transferred to users in the Trinity-San Jacinto Coastal Basin. Potentially, existing or proposed Coastal Water Authority water diversion and conveyance infrastructure could be used to accomplish such a transfer.

4.3 Structure and Terms of Water Trade Transactions

The viability of a strategy to trade firm irrigation water supplies for less reliable interruptible supplies would also be influenced by the structure and terms of transactions between the parties to a trade. While every transaction would have unique circumstances to address, there are a number of conditions and issues that would be common to all such transactions including:

- **Existence of a "willing buyer, willing seller" relationship.** Both parties to water swap transaction would only be expected to engage each other voluntarily and seek to maximize their individual interests through negotiation.

- **Level of compensation.** Ideally, the result of a negotiated water trade would be a transaction in which both parties achieve real "gains" and neither would incur real or perceived "losses". The principal issue would be the level of compensation that would be required, and in what form, to create a gain for the party that is "giving up" a firm water supply. A portion of that compensation would be the interruptible water supply received in exchange for the firm supply. The issue then would likely focus on the "residual" compensation required to make up for the economic losses associated with irrigation water shortages during severe drought. Assuming the interruptible water supply just satisfies the TCEQ's 75-75 reliability criteria, the question becomes what level of compensation would be required to make up for the curtailment of irrigation water supply during times of shortage. A number of factors could influence that determination including estimates of any economic losses to the irrigation water supplier (e.g., loss of revenues from irrigation water sales) and estimates of any "net" economic losses that individual irrigators would experience as a result of reduced production of agricultural commodities. Valuation of losses to individual irrigators could be problematic given the variations in the type of crops grown and the variability of crop production rates and commodity prices from year to year. There is also that possibility that "third" parties would expect or demand compensation. For example, land in agricultural production is often owned by one party and farmed by another under a lease arrangement, which raises the question as to whether compensation would need to be provided to both. Similarly, a sustained reduction or complete cessation of irrigated crop production during a protracted severe drought could result in impacts to a larger "community" of stakeholders and interests (e.g., wage employees of irrigators, seed and fertilizer suppliers, implement dealers, banks, etc.).

- **Structure of Compensation.** In addition to issues associated with the level of compensation, a water trade transaction would also need to address the "how" of compensation. One approach would be a transaction structured as a sale of water rights where compensation is a combination of the transfer of interruptible water rights along with a monetary payment for the net loss of value associated with transferring firm water rights. Another approach might be structured as a "dry-year option", where the holder of an irrigation right would exchange those rights for interruptible rights with a compensation structure that might include a one-time payment, annual option payments, and additional compensatory payments during periods of curtailment.

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Section 5 – Impact of the Use of Interruptible Supplies on Other Water Management

The use of an interruptible supply strategy to trade firm irrigation water right supplies for interruptible municipal and industrial supplies has little viability in Region H. In the Trinity and the Brazos Basins, the water rights for firm irrigation water have been purchased by municipal providers. In another case, the Chamber-Liberty Counties Navigation District has sought an amendment to include municipal and industrial use to 80,000 afy of irrigation rights. The conversion of a portion of these rights to meet municipal demands in the Trinity - San Jacinto Basin is the result of a lack of irrigation demand.

Although the there is little viability in supplying interruptible municipal water rights in exchange for firm irrigation rights, the use of interruptible supplies is not a new concept in Region H. Currently, many irrigators utilize supplies that are not fully reliable backed up with annual contracts for firm supplies as needed. Irrigation Conservation has been recommended as a water management strategy in counties with projected irrigation shortages. In lieu of implementing conservation measures, irrigators may choose to reduce their irrigated acreage during drought conditions or contract firm supplies from another source. Due to the purchase and amendment of the Chocolate Bayou Water Company water rights, there exists the potential to further utilize existing interruptible supplies for irrigation as firm supplies are contracted to Municipal demands. The decrease in available firm irrigation supplies in the Brazos Basin may have the effect of expanding the use of irrigation conservation measures or increase the reductions in irrigated acreage during drought.

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Section 6 – Conclusions

The viability assessment of a water management strategy that would involve the substitution of interruptible water supplies for firm water supplies currently allocated to agricultural irrigation in order to free up those firm supplies for municipal or industrial use indicated that there are few opportunities within Region H to implement the Strategy. This assessment included analysis of the availability of both permitted and unpermitted interruptible surface water supplies within Region H and evaluation of whether available interruptible supplies can be matched spatially with existing irrigation demands that are being met with firm surface water supplies.

The analysis of existing water rights revealed quantities of existing permitted interruptible water in the Brazos, San Jacinto – Brazos, San Jacinto and the Trinity Basin that could potentially be used to supply agricultural irrigation demands. The largest quantity of interruptible supply is found in the Brazos Basin which could be utilized in both the Brazos and the San Jacinto – Brazos Basins through existing infrastructure.

Analysis of unpermitted interruptible supplies near existing irrigation diversion points demonstrated that un-appropriated interruptible water was only available in the downstream locations of the coastal basins. Further investigation with environmental flow restrictions showed that un-permitted interruptible supplies were not available.

Comparisons of the amounts and locations of interruptible supplies and irrigation demands revealed little opportunity to provide irrigators with municipal interruptible water supplies in exchange for firm irrigation supplies. The Trinity – San Jacinto and the Neches – Trinity Coastal Basins contained some interruptible supply in existing irrigation water rights but did not have municipal and industrial water rights with interruptible supplies that could be traded for firm irrigation supplies. The San Jacinto Basin contains some interruptible supply in Lake Conroe but does not have firm irrigation water rights that could be swapped. The Trinity Basin contains a large amount of Irrigation supply that could be used to meet municipal and industrial demands. Due to a surplus of irrigation supplies in the basin, this will most likely be accomplished by water right re-designation, amending firm irrigation water right permits to be used for municipal and industrial use in the Trinity – San Jacinto Basin. The San Jacinto Brazos Basin contains several water rights owned by private irrigators making a “trade” of interruptible supply for the firm irrigation supply unlikely. Even if a potential trade was implemented it would only provide 8,729 afy of additional firm supply for municipal use. Possibly the most viable strategy would have been available in the Brazos Basin, prior to the amendment of the Chocolate Bayou Water Company water rights. The water rights were originally permitted and contracted for irrigation use. With the amendment to the water rights allowing diversions for multiple uses, there is no longer a need to trade interruptible water for the firm irrigation supplies. As municipal demands increase, they will out-compete irrigators for contracts of firm water.

Based on the results of this study, a Water Management Strategy based on a trade of firm irrigation water rights for interruptible supplies is not viable in Region H because of the following:

1. Locations of municipal interruptible supplies and firm irrigation water rights are not consistent in respect to amounts and locations for a viable “trade”.

2. The current Region H Plan therefore does not include water management strategies that would be affected by “trading” firm irrigation water rights for interruptible supplies to free up firm supplies for municipal and industrial use.

3. Historically, firm irrigation water rights have been purchased or re-designated for municipal and industrial use by local water providers without the need to supplement interruptible water in place of the firm irrigation water rights.

4. Irrigation Conservation has already been implemented as a strategy to allow current users of interruptible water supplies the options of implementing conservation measures, reducing irrigated acreage during droughts, or contracting firm supplies from another source.

5. Current TWDB policy for regional water supply planning requires that all identified water supply needs, based on drought-of-record conditions, be satisfied except in cases where there are no feasible strategies. The use of irrigation conservation as a water management strategy allows irrigators flexibility to pursue demand and supply options during drought conditions.

APPENDIX A

Analysis of Existing Interruptible Supplies

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Table A - 1
Analysis of Existing Surface Water Sources Using WAM Run 3

WR NUMBER	SOURCE ID	SOURCE NAME	DIVERSION TARGET RUN 3 (AFY)	FIRM YIELD (AFY)	75-75 INTERRUPTIBLE SUPPLY (AFY)	OVERALL INTERUPTIBLE SUPPLY (AFY)
NECHES-TRINITY BASIN			32,523	21,753	2,272	10,771
10704290001	3410704290	NECHES-TRINITY RIVER RUN-OF-RIVER	1,249	1,037	212	212
10704291401	3410704291	NECHES-TRINITY RIVER RUN-OF-RIVER	1,220	1,078	143	143
10705016401	3410705016	NECHES-TRINITY RIVER RUN-OF-RIVER	1,250	1,012	238	238
60704287401	3460704287	NECHES-TRINITY RIVER RUN-OF-RIVER	4,900	2,528	0	2,372
60704293401	3460704293	NECHES-TRINITY RIVER RUN-OF-RIVER	1,780	1,626	154	154
60704294401	3460704294	NECHES-TRINITY RIVER RUN-OF-RIVER	674	573	101	101
60704295401	3410704295	NECHES-TRINITY RIVER RUN-OF-RIVER	1,400	1,199	201	201
60704299001	3410704299	NECHES-TRINITY RIVER RUN-OF-RIVER	1,834	1,172	0	662
60704300401	3460704300	NECHES-TRINITY RIVER RUN-OF-RIVER	875	805	70	70
60704304401	3460704304	NECHES-TRINITY RIVER RUN-OF-RIVER	7,560	4,660	243	2,900
60704306401	3410704306	NECHES-TRINITY RIVER RUN-OF-RIVER	2,100	1,817	283	283
60704308001	3460704308	NECHES-TRINITY RIVER RUN-OF-RIVER	1,109	771	0	338
60704309401	3460704309	NECHES-TRINITY RIVER RUN-OF-RIVER	2,118	711	0	1,407
60704311401	3410704311	NECHES-TRINITY RIVER RUN-OF-RIVER	2,700	2,072	628	628
60704312001	3460704312	NECHES-TRINITY RIVER RUN-OF-RIVER	1,754	691	0	1,063
TRINITY BASIN			1,629,342	911,565	711,920	717,777
10805271001	3410805271A	TRINITY RIVER RUN-OF-RIVER	58,500	33,718	24,782	24,782
60804248001	084H0	LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	403,200	264,309	138,891	138,891
60804261001	084H0	LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	986,695	540,433	445,367	446,262
60804277001	3460804277	TRINITY RIVER RUN-OF-RIVER	38,000	14,918	18,120	23,082
60804279001	3460804279	TRINITY RIVER RUN-OF-RIVER	142,947	58,186	84,761	84,761
TRINITY-SAN JACINTO BASIN			38,766	34,313	3,624	4,453
60903909401	3460903909	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	1,402	769	633	633
60903918401	3460903918	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	2,777	976	1,524	1,802
60903922001	3460903922	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	1,500	661	286	839
60903923401	3460903923	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	954	694	260	260
60903924401	3460903924	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	2,133	1,213	920	920
60903926001	3460903926	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	30,000	30,000	0	0
SAN JACINTO BASIN			378,000	203,281	73,885	174,719
61004963001	10060	CONROE LAKE/RESERVOIR	100,000	26,115	73,885	73,885
61004964001	3461004964	SAN JACINTO RIVER RUN-OF-RIVER	110,000	9,167	0	100,833
61004965001	10030	HOUSTON LAKE/RESERVOIR	168,000	168,000	0	0
SAN JACINTO-BRAZOS BASIN			106,644	29,434	47,303	77,210
C5169_1	3461105169	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	12,000	0	12,000	12,000
C5170_1	3461105170	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	18,159	5,619	12,540	12,540
C5343_1	3461105343	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3,836	743	247	3,093
C5344_1	3461105344	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	1,482	1,320	162	162
C5346_1	3461105346	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,845	2,215	631	631
C5352_1	3461105352	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3,620	3,271	349	349
C5357_1	3461105357A	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	57,500	14,086	19,032	43,414
C5364_1	3461105364	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	968	734	234	234
P4201_1	3411104449	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,000	1,200	800	800
P4216_1	3411104509	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	4,233	247	1,308	3,987
BRAZOS BASIN			966,313	537,252	278,997	429,061
C5168_1	3461205168	BRAZOS RIVER RUN-OF-RIVER	99,932	94,943	4,989	4,989
C5171_1	3461205171	BRAZOS RIVER RUN-OF-RIVER	125,000	60,892	64,108	64,108
C5320_1	3461205320	BRAZOS RIVER RUN-OF-RIVER	40,000	26,827	13,173	13,173
C5322_1	3461205322B	BRAZOS RIVER RUN-OF-RIVER	155,000	57,769	35,792	97,231
C5325_1	3461205325	BRAZOS RIVER RUN-OF-RIVER	34,300	34,300	0	0
C5328_1	3461205328B	BRAZOS RIVER RUN-OF-RIVER	365,631	147,853	129,152	217,778
C5366_1	3461205366	BRAZOS RIVER RUN-OF-RIVER	45,000	13,217	31,783	31,783
C5492_1	3461205492	BRAZOS RIVER RUN-OF-RIVER	1,800	1,800	0	0
ALLENS_1			99,650	99,650	0	0

Table A - 2
Analysis of Existing Surface water Supplies Using WAM Run 8

WR NUMBER	SOURCE ID	SOURCE NAME	DIVERSION TARGET RUN 3 (AFY)	DIVERSION TARGET RUN 8 (AFY)	FIRM YIELD (AFY)	75-75 INTERRUPTIBLE SUPPLY (AFY)	OVERALL INTERUPTIBLE SUPPLY (AFY)
NECHES-TRINITY BASIN			32,523	25,961	18,346	3,274	9,837
10704290001	3410704290	NECHES-TRINITY RIVER RUN-OF-RIVER	1,249	710	663	47	586
10704291401	3410704291	NECHES-TRINITY RIVER RUN-OF-RIVER	1,220	0	0	0	1,220
10705016401	3410705016	NECHES-TRINITY RIVER RUN-OF-RIVER	1,250	400	400	0	850
60704287401	3460704287	NECHES-TRINITY RIVER RUN-OF-RIVER	4,900	4,015	2,592	1,423	2,308
60704293401	3460704293	NECHES-TRINITY RIVER RUN-OF-RIVER	1,780	1,220	1,220	0	560
60704294401	3460704294	NECHES-TRINITY RIVER RUN-OF-RIVER	674	335	335	0	339
60704295401	3410704295	NECHES-TRINITY RIVER RUN-OF-RIVER	1,400	1,200	1,200	0	200
60704299001	3410704299	NECHES-TRINITY RIVER RUN-OF-RIVER	1,834	1,834	1,286	548	548
60704300401	3460704300	NECHES-TRINITY RIVER RUN-OF-RIVER	875	0	0	0	875
60704304401	3460704304	NECHES-TRINITY RIVER RUN-OF-RIVER	7,560	7,540	4,750	143	163
60704306401	3410704306	NECHES-TRINITY RIVER RUN-OF-RIVER	2,100	2,100	1,826	274	274
60704308001	3460704308	NECHES-TRINITY RIVER RUN-OF-RIVER	1,109	1,109	718	391	391
60704309401	3460704309	NECHES-TRINITY RIVER RUN-OF-RIVER	2,118	2,070	713	0	48
60704311401	3410704311	NECHES-TRINITY RIVER RUN-OF-RIVER	2,700	2,325	2,046	279	654
60704312001	3460704312	NECHES-TRINITY RIVER RUN-OF-RIVER	1,754	1,103	597	170	821
TRINITY BASIN			1,629,342	768,904	768,689	215	860,653
10805271001	3410805271A	TRINITY RIVER RUN-OF-RIVER	58,500	58,500	58,285	215	215
60804248001	084H0	LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	403,200	50,911	50,911	0	352,289
60804261001	084H0	LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	986,695	555,180	555,180	0	431,515
60804277001	3460804277	TRINITY RIVER RUN-OF-RIVER	38,000	32,540	32,540	0	5,460
60804279001	3460804279	TRINITY RIVER RUN-OF-RIVER	142,947	71,773	71,773	0	71,174
TRINITY-SAN JACINTO BASIN			38,766	34,563	32,975	1,588	5,791
60903909401	3460903909	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	1,402	1,402	741	661	661
60903918401	3460903918	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	2,777	138	138	0	2,639
60903922001	3460903922	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	1,500	490	422	68	1,078
60903923401	3460903923	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	954	1,560	700	860	253
60903924401	3460903924	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	2,133	973	973	0	1,160
60903926001	3460903926	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	30,000	30,000	30,000	0	0
SAN JACINTO BASIN			378,000	324,940	233,274	0	53,060
61004963001	10060	CONROE LAKE/RESERVOIR	100,000	46,940	46,940	0	53,060
61004964001	3461004964	SAN JACINTO RIVER RUN-OF-RIVER	110,000	110,000	18,334	0	0
61004965001	10030	HOUSTON LAKE/RESERVOIR	168,000	168,000	168,000	0	0
SAN JACINTO-BRAZOS BASIN			106,644	79,848	27,969	37,850	64,646
C5169_1	3461105169	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	12,000	12,000	0	12,000	12,000
C5170_1	3461105170	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	18,159	18,159	5,619	12,540	12,540
C5343_1	3461105343	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3,836	3,836	743	247	247
C5344_1	3461105344	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	1,482	1,200	1,160	40	322
C5346_1	3461105346	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,845	1,901	1,270	631	1,575
C5352_1	3461105352	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3,620	2,700	2,496	204	1,124
C5357_1	3461105357A	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	57,500	36,429	14,168	11,701	32,772
C5364_1	3461105364	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	968	0	0	0	968
P4201_1	3411104449	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,000	1,294	806	488	1,194
P4216_1	3411104509	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	4,233	2,329	1,706	0	1,904
BRAZOS BASIN			866,663	773,621	495,183	200,952	293,995
C5168_1	3461205168	BRAZOS RIVER RUN-OF-RIVER	99,932	99,932	99,932	0	0
C5171_1	3461205171	BRAZOS RIVER RUN-OF-RIVER	125,000	124,678	70,961	53,717	54,039
C5320_1	3461205320	BRAZOS RIVER RUN-OF-RIVER	40,000	40,000	34,880	5,120	5,120
C5322_1	3461205322B	BRAZOS RIVER RUN-OF-RIVER	155,000	118,765	64,187	54,578	90,813
C5325_1	3461205325	BRAZOS RIVER RUN-OF-RIVER	34,300	34,300	34,300	0	0
C5328_1	3461205328B	BRAZOS RIVER RUN-OF-RIVER	365,631	345,386	184,642	83,258	103,504
C5366_1	3461205366	BRAZOS RIVER RUN-OF-RIVER	45,000	8,761	4,481	4,279	40,519
C5492_1	3461205492	BRAZOS RIVER RUN-OF-RIVER	1,800	1,800	1,800	0	0

Table A - 3
Analysis of Existing Surface Water Sources Using 2006 Minimum Annual Diversions

WR NUMBER	SOURCE ID	SOURCE NAME	DIVERSION TARGET RUN 3 (AFY)	FIRM YIELD (AFY)	75-75 INTERRUPTIBLE SUPPLY (AFY)	OVERALL INTERUPTIBLE SUPPLY (AFY)
NECHES-TRINITY BASIN			33,009	21,701	2,809	11,308
10704290001	3410704290	NECHES-TRINITY RIVER RUN-OF-RIVER	1,249	1,069	180	180
10704291401	3410704291	NECHES-TRINITY RIVER RUN-OF-RIVER	1,220	1,078	142	142
10705016401	3410705016	NECHES-TRINITY RIVER RUN-OF-RIVER	1,250	901	349	349
60704287401	3460704287	NECHES-TRINITY RIVER RUN-OF-RIVER	4,900	2,528	0	2,372
60704293401	3460704293	NECHES-TRINITY RIVER RUN-OF-RIVER	2,265	1,626	639	639
60704294401	3460704294	NECHES-TRINITY RIVER RUN-OF-RIVER	674	573	101	101
60704295401	3410704295	NECHES-TRINITY RIVER RUN-OF-RIVER	1,400	1,205	195	195
60704299001	3410704299	NECHES-TRINITY RIVER RUN-OF-RIVER	1,834	1,173	0	661
60704300401	3460704300	NECHES-TRINITY RIVER RUN-OF-RIVER	875	805	70	70
60704304401	3460704304	NECHES-TRINITY RIVER RUN-OF-RIVER	7,560	4,660	243	2,900
60704306401	3410704306	NECHES-TRINITY RIVER RUN-OF-RIVER	2,100	1,818	282	282
60704308001	3460704308	NECHES-TRINITY RIVER RUN-OF-RIVER	1,109	771	0	338
60704309401	3460704309	NECHES-TRINITY RIVER RUN-OF-RIVER	2,118	711	0	1,407
60704311401	3410704311	NECHES-TRINITY RIVER RUN-OF-RIVER	2,700	2,093	607	607
60704312001	3460704312	NECHES-TRINITY RIVER RUN-OF-RIVER	1,754	691	0	1,063
TRINITY BASIN			1,628,447	1,571,030	52,417	57,417
10805271001	3410805271A	TRINITY RIVER RUN-OF-RIVER	58,500	58,500	0	0
60804248001	084H0	LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	403,200	403,200	0	0
60804261001	084H0	LIVINGSTON-WALLISVILLE LAKE/RESERVOIR	985,800	967,310	18,490	18,490
60804277001	3460804277	TRINITY RIVER RUN-OF-RIVER	38,000	33,000	0	5,000
60804279001	3460804279	TRINITY RIVER RUN-OF-RIVER	142,947	109,020	33,927	33,927
TRINITY-SAN JACINTO BASIN			38,766	34,232	3,557	4,534
60903909401	3460903909	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	1,402	685	717	717
60903918401	3460903918	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	2,777	1,084	1,416	1,694
60903922001	3460903922	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	1,500	628	172	872
60903923401	3460903923	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	954	626	328	328
60903924401	3460903924	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	2,133	1,209	924	924
60903926001	3460903926	TRINITY-SAN JACINTO RIVER RUN-OF-RIVER	30,000	30,000	0	0
SAN JACINTO BASIN			323,000	297,300	25,700	25,700
61004963001	10060	CONROE LAKE/RESERVOIR	100,000	74,300	25,700	25,700
61004964001	3461004964	SAN JACINTO RIVER RUN-OF-RIVER	55,000	55,000	0	0
61004965001	10030	HOUSTON LAKE/RESERVOIR	168,000	168,000	0	0
SAN JACINTO-BRAZOS BASIN			104,729	37,061	40,579	67,668
C5169_1	3461105169	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	12,000	3,842	8,158	8,158
C5170_1	3461105170	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	18,159	6,890	11,269	11,269
C5343_1	3461105343	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3,262	711	262	2,551
C5344_1	3461105344	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	1,482	962	520	520
C5346_1	3461105346	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,813	1,360	1,452	1,452
C5352_1	3461105352	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	3,620	3,347	273	273
C5357_1	3461105357A	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	57,500	17,600	17,000	39,900
C5364_1	3461105364	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	968	766	202	202
P4201_1	3411104449	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,000	558	1,442	1,442
P4216_1	3411104509	SAN JACINTO-BRAZOS RIVER RUN-OF-RIVER	2,925	1,025	0	1,900
BRAZOS BASIN[1]			806,663	472,103	212,977	434,211
C5168_1	3461205168	BRAZOS RIVER RUN-OF-RIVER	99,932	98,805	127	1,127
C5171_1	3461205171	BRAZOS RIVER RUN-OF-RIVER	125,000	72,388	52,612	52,612
C5320_1	3461205320	BRAZOS RIVER RUN-OF-RIVER	40,000	29,920	10,080	10,080
C5322_1	3461205322B	BRAZOS RIVER RUN-OF-RIVER	155,000	63,812	27,954	91,188
C5325_1	3461205325	BRAZOS RIVER RUN-OF-RIVER	34,300	34,300	0	0
C5328_1	3461205328B	BRAZOS RIVER RUN-OF-RIVER	305,631	148,061	100,221	157,571
C5366_1	3461205366	BRAZOS RIVER RUN-OF-RIVER	45,000	23,017	21,983	21,983
C5492_1	3461205492	BRAZOS RIVER RUN-OF-RIVER	1,800	1,800	0	0
ALLENS_1	12900	ALLENS CREEK RESERVOIR	99,650	0	99,650	99,650

Notes:
1. Summary does not include Allens Creek

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APPENDIX B

TWDB Comments

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ATTACHMENT 1

TWDB Contract No. 0704830693

Region H, Region-Specific Studies 1 - 3:

TWDB Comments on Draft Final Region-Specific Study Reports:

1. **Environmental Flows Investigations for Region H**
2. **Impact of Drought Management Strategies on Surface Water Reservoirs in Region H**
3. **Interruptible Water Supplies**

Region-Specific Study Number 1: Environmental Flows Investigations for Region H

1. Page ES-3, Max H definition: Please replace "annual inflows" with "sequence of monthly inflows" to more correctly define Max H.

2. Page ES-3, Min Q definition: Please replace "minimum annual inflow" with "sequence of monthly inflows that minimizes annual volume needed" to more correctly define Min Q

3. Page ES-3, Min Q-Sal definition: Please replace entire definition with "sequence of monthly inflows that maintains B&E salinity constraint". The Min Q-Sal condition has no harvest or production goal, but merely meets the constraint.

4. Page ES-4, 1st paragraph: Please provide reference for GBFIG-proposed frequencies. Also, please provide how the GBFIG document defines "frequency of attainment".

5. Page ES-4, last paragraph: Please more clearly explain how seasonal Frequency of Target Attainment (FTA) was developed and presented in Figure ES-3, noting if the monthly flows were summed and if the same was done for seasonal target flows. Also, please note that based on Figure ES-1, March might better belong in the winter season than in the spring season.

6. Page ES-8, 2nd paragraph, 2nd sentence: Please clarify that the frequency goals are those as defined by GBFIG and evaluated in the report.

7. Page ES-12, 1st sentence: TWDB conducted a Streamflow Assessment for the 2007 State Water Plan. Please correct the reference in this sentence.

8. Pages ES-14 and 4-3, Tables ES-7 and 4-2: Footnote 1 states that the flow was estimated to be below the Lyons flow. The tables show Lyons flow to be 1,217 cfs, and the observed flow to be <10,000 cfs. Please clarify the observed flow value.

9. Page ES-17, Instream Flows Conclusion 3: This conclusion states that "Despite this flow condition, there were no indications of impaired stream health ...". Please explain if there was any indication that the observed low flows had occurred for significant enough time for there to be an ecological response. Also, please explain if this flow condition is a significant factor in using the TCEQ Surface Water Quality Monitoring procedures.

10. Page 3-8, 2nd paragraph, 1st sentence: The sentence states "It was assumed that B&E inflow targets are achieved by any flow that equals or exceeds the target flow; thus, flow cannot be too high for the target, but can be too low." Since this statement applies to the Max H target, it appears to be inaccurate. Fisheries harvest has been shown to decrease with an excessive volume of fresh water (i.e. flow can be too high for the target). Please clarify or revise the statement.

11. Page 5-3, Figure 5-1: In the figure title, please consider clarifying by changing "Trinity Basin B&E Discharge" to "Trinity Basin B&E Median Monthly Discharge".

<u>Region-Specific Study Number 2: Impact of Drought Management Strategies on Surface Water Reservoirs in Region H</u>

1. Page 2-2, last sentence: Refers to "Figure 1". Please correct all figure references (e.g. to 'Figure 2-1') throughout report.

2. Page 2-3, 1st line and Figure 2-1: Please elaborate on the reasonableness and basis for the assumption that "non-seasonal (e.g., indoor) water uses are more or less the same in each community," considering the variations in city sizes and socioeconomic conditions. In addition, please note this assumption ignores the influence of commercial water use, which is also a part of per capita water use for some entities.

3. Sections 4 and 5: Please consider clarifying in Section 5 the impacts to "storage capacity" or "full permitted capacity" in Section 4.

4. Page 5-2, Table 5 (and similar tables thereafter): Please consider providing an explanation of how a decimal point of months is obtained with WAM's monthly time step of simulation.

5. Section 7: Please clarify in the text that the graphs in this section are based upon firm yield of these reservoirs.

6. Page 7-4, Table 22: In Table 22, the meaning of 'Impact' is unclear from the limited table content. Please clarify the meaning of the 'Impact' field.

7. Page 8-1, 6th paragraph; and page 8-2, bullet #6: The basis for the conclusion that the "stretching of water supplies due to drought contingency measures are relatively insignificant in terms of annual increased supply and certainly non significant in the context of long-term water planning." does not appear to be supported by the analysis (e.g. 150,000 acre-feet of water at Lake Livingston per figure 7-1) especially considering that long-term regional water planning is based on addressing limited term, drought-of-record conditions. Please substantiate or modify the conclusion.

8. Appendix E: Please indicate what units the values represent in this appendix.

Region-Specific Study Number 3: Interruptible Water Supplies

1. Page 1-1, 2nd paragraph, 1st sentence: The planning guidelines of the TWDB allow for the use of "safe yield" for planning purposes if approved by the Executive Administrator. Please clarify this statement in the final report.

2. Page 3-1, 2nd paragraph, lines 11-12: Please consider clarifying the statement that the monthly test "does not consider the magnitude of monthly diversions".

3. Page 3-2, 3rd paragraph, last sentence: Please consider elaborating on why over-appropriation is indicated if the interruptible supply portion exceeds firm yield.

4. Page 3-3, 5th sentence: The word "form" should be "from". Please correct.

5. Page 3-3, Table 8: Please verify the permitted amount for the two water rights presented in the table.

6. Page 3-12. Figure 3-1 is also identified as Figure 5. Please clarify the figure numbering.

7. Page 3-13, 1st paragraph, 2nd line: Reference is made to Figure 2.1 and should be made to Figure 3-1. Please correct.

8. Page 3-14. Figure 3-2 is also identified as Figure 6. Please clarify the figure numbering.

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KBR

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Memorandum

Date	July 2009
To	J. Kevin Ward Executive Administrator Texas Water Development Board 1700 North Congress Avenue Austin, TX 78701
From	Karim El Kheiashy, P.E.
Subject	Response to TWDB Comments on Region H 1st Biennium Interruptible Supply Study Draft Report for 2011 Regional Water Planning Round

The following text addresses TWDB comments on the Region H Interruptible Supply Study and is intended to supplement edits to the report text. TWDB comments are in italics, with KBR responses in regular text.

1. *Page 1-1, 2nd paragraph, 1st sentence: The planning guidelines of the TWDB allow for the use of "safe yield" for planning purpose if approved by the Executive Administrator. Please clarify this statement in the final report.*

   This change has been made in Section 1.1.

2. *Page 3-1, 2nd paragraph, lines 11-12: Please consider clarifying the statement that the monthly test "does not consider the magnitude of monthly diversions".*

   The following text has added to Section 3.1. "The monthly test is generally a more liberal qualifier and does not consider the magnitude of monthly diversions. For Instance, water rights with greater variations in monthly diversion patterns, such as irrigation rights, can often met 75% of monthly diversion targets in 75% of the months simulated over the period of record, but can not met 75% of the annual diversion target in 75% of the years due to the magnitude of shortages that occur during months with peak diversions. This can result in an over estimation of a water right's reliability, particularly irrigation water rights which often have a monthly diversion pattern that can resembles monthly irrigation patterns presented in Section 2."

3. *Page 3-2, 3rd paragraph, last sentence: Please consider elaboration on why over appropriation is indicated if the interruptible supply portion exceeds firm yield.*

   The presence of large interruptible supplies in the San Jacinto – Brazos Coastal Basin is the result of firm yields that are significantly lower than the permitted diversion of the water rights. While during normal or average hydrological periods a larger portion of the permitted diversions may be met, the basin is over-appropriated when considering drought conditions. The result of the over appropriation is evident by firm yield that are significantly lower than permitted diversions.

KBR

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The following text has added to Section 3.1. "In the San Jacinto-Brazos Coastal Basin the interruptible portion of the existing permitted supplies is greater than the firm yield. This is due to the fact that during drought of record conditions many run-of river rights have firm yields that are significantly lower than their permitted diversions. This indicates that some of the coastal streams and bayous are over-appropriated when considering drought of record conditions."

4. *Page 3-3, 5th sentence: The word "form" should be "from" Please correct.*

   This change has been made in Section 3.1.1.

5. *Page 3-3, table 8: Please verify the permitted amount for the two water rights presented in the table.*

   This change has been made in Section 3.1.1.

6. *Page 3-12. Figure 3-1 is also identified as Figure 5. Please clarify the figure numbering.*

   This change has been made in Section 3.2.

7. *Page 3-13, 1st paragraph, 2nd line: Reference is made to Figure 2.1 and should be made to Figure 3-1. Please correct.*

   This change has been made in Section 3.2.

8. *Page 3-14. Figure 3-2 is also identified as Figure 6. Please clarify the figure numbering.*

   This change has been made in Section 3.2.