Section 3
Evaluation of Current
Water Supplies in the Region

3.1 Surface Water Supplies

Streamflow in the Brazos River and its tributaries, along with reservoirs in the Brazos River Basin, comprise a vast supply of surface water in the Brazos G Region. Diversions and use of this surface water occurs throughout the entire region with over 1,000 water rights currently issued. These water rights provide authorization for an owner to divert, store and use the water, however, they do not guarantee that a dependable supply will be available from the water source. The availability of water to a water right is dependent on several factors including hydrologic conditions (i.e., rainfall, runoff, springflow), priority date of the water right, quantity of authorized storage, and any special conditions associated with the water right (i.e., instream flow conditions, maximum diversion rate).

3.1.1 Texas Water Right System

The State of Texas owns the surface water within the state watercourses and is responsible for the appropriation of these waters. Surface water is currently allocated by the TNRCC for the use and benefit of all people of the state. Texas water law is based on the riparian and prior appropriation doctrines. The riparian doctrine extends from the Spanish and Mexican governments that ruled Texas prior to 1836. After 1840, the riparian doctrine provided landowners the rights to make reasonable use of water for irrigation or for other consumptive uses. In 1889, the prior appropriation doctrine was first adopted by Texas, which is based on the concept of "first in time is first in right." Over the years, the riparian and prior appropriation doctrines resulted in an essentially unmanageable system. Various types of water rights existed simultaneously and many rights were unrecorded. In 1967, the Texas Legislature passed the Water Rights Adjudication Act that merged the riparian water rights into the prior appropriation system, creating a unified water permit system. The adjudication process took many years, stretching into the late 1980s before it was finally completed. In the end, Certificates of Adjudication were issued for entities recognized as having legitimate water rights. Today, individuals or groups seeking a new water right must submit an application to the TNRCC. The TNRCC determines if the water right will be issued and under what conditions. The water rights grant a certain quantity of water to be diverted and/or stored, a priority date, and other restrictions. Other restrictions may include a maximum diversion rate and instream flow restrictions to protect existing water rights and provide environmental protection.

The priority date of a water right is essential to the operation of the water rights system. Each right is issued a priority date based on the date of first capture or the appropriation date. When diverting or storing water for use, all water right holders must adhere to the priority system. A right holder must pass all water to downstream senior water rights when conditions are such that the senior water rights would not be satisfied otherwise.

3.1.2 Types of Water Rights

There are various types of water rights: Certificates of Adjudication, permits, short-term permits, or temporary permits. Certificates of Adjudication were issued in perpetuity for approved claims during the adjudication process. This type of water right was issued based on historical use rather than water availability. As a consequence, the amount of water to which rights exist exceeds the amount of water available during a drought for some streams. The TNRCC issues new permits only where normal flows are sufficient to meet the requested amount. Permits, like Certificates of Adjudication, are issued in perpetuity and may be bought and sold like other property interests. Short-term permits may be issued by the TNRCC in areas where waters are fully appropriated, but not yet being fully used. Term permits are usually issued for 10 years and may be renewed if, after 10 years, other water right holders are still not using water in the basin. Temporary permits are issued for up to 3 years. Temporary permits are issued mainly for road construction projects, where water is used to suppress dust, to compact soils, and to start the growth of new vegetation.

Water rights can include the right to divert and/or store the appropriated water. A run-of-the-river water right provides for the diversion of streamflows and does not include storage of water for use during dry periods. These rights have no authorization to store water, only the right to take water from the stream. A run-of-the-river right may be limited by streamflow, pumping rate, or diversion location.

Water rights including provisions for storage of water allow a water right holder to impound streamflows for use at a later time. The storage provides water for use during dry periods, when water may not be available due to hydrologic conditions or because current flows are required to be passed to downstream senior water rights.

While most water rights are diverted and used within the river basin of origin, water rights that divert from one river basin to another basin require an interbasin transfer permit. Several types of transfers that receive special consideration include emergency transfers, transfers of water from a river basin for use in an adjoining coastal basin (such as from the Brazos River Basin to the San Jacinto-Brazos Coastal Basin), diversions of less than 3,000 acft/yr, and diversions within any city or county that has any portion in the basin of origin.

3.1.3 Water Rights in the Brazos River Basin

A total of 1,118 water rights exist in the Brazos River Basin, with a total authorized diversion of 2,266,000 acft/yr. It is important to note that a small percentage of the water rights make up a large percentage of the authorized diversion volume. In the Brazos River Basin, 39 water rights (3.4 percent) make up 2,025,000 acft/yr (89 percent) of the authorized diversion volume. The remaining 1,079 water rights primarily consist of small irrigation rights distributed throughout the river basin. Figure 3-1 shows a comparison of significant water rights in the Brazos River Basin by number of rights and diversion volume.

Figure 3-1. Comparison of Water Rights in the Brazos River Basin

Region G includes the vast majority of the water rights in the Brazos River Basin. A total of 985 water rights (88 percent) exist in Region G, making up 1,343,000 acft/yr (59 percent) of the total authorized diversion in the river basin. Region H, located downstream of Region G, has a total of only 59 water rights (4.7 percent) in the Brazos River Basin, but makes up 872,000 acft/yr (38.0 percent) of the total authorized diversions. Other regions make up a small percentage of the remaining water rights and total authorized diversion, as shown in Figure 3-2. The authorized diversions in Region H generally consist of very large, senior priority, run-of-the-river water rights. In comparison, Region G has a larger volume of water rights; however, the water rights are generally junior in priority to those downstream in Region H. Therefore, in times of drought, when streamflows are low, diversions of water from streams in Region G may be restricted for several of the water right holders. A comparison of the quantity of authorized diversions relative to the priority date of the water rights in Region G and Region H is presented in Figure 3-3. A summary of major water rights in Region G and Region H is provided in Tables 3-1 and 3-2, respectively. Major water rights are defined as having an authorized diversion of greater than 10,000 acft/yr or 5,000 acft of authorized storage. Figure 3-4 shows the location of major water rights in the Brazos River Basin, and a list of all water rights, summarized by County and Planning Region, is provided in Appendix G.1 and G.2.

While Region H includes a large quantity of senior priority water rights, most of these water rights have very little storage associated with them and, therefore, may be described primarily as run-of-the-river water rights. The water rights in Region G are generally junior to those water rights in Region H; however, there is a substantial volume of reservoir storage associated with the water rights in Region G to provide a firm supply. The total authorized storage in the Brazos River Basin is 3,969,000 acft, with 3,626,000 acft (91 percent) located in Region G. In Region H, the quantity of reservoir storage is 86,000 acft, or 2.2 percent of the total authorized storage volume in the river basin. The large quantity of reservoir storage in Region G provides for a firm supply of water during drought conditions, when streamflows are low and may be required to be passed through to downstream senior water rights in Region H. Figure 3-5 presents a comparison of the total authorized storage and annual diversion volume for Region G and Region H.

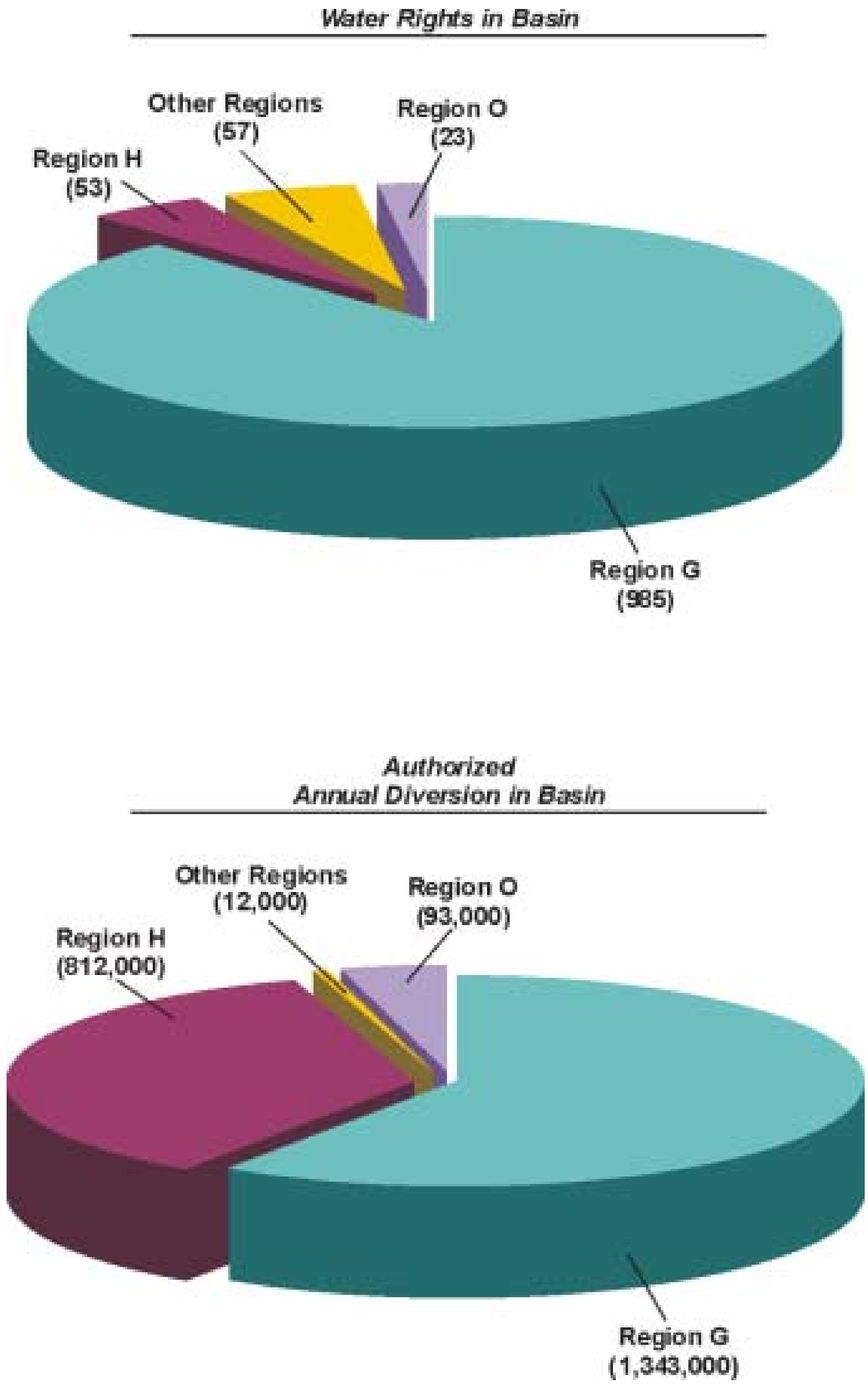

Figure 3-2. Comparison of Significant Water Rights in the Brazos River Basin by Number of Rights and Diversion Volume

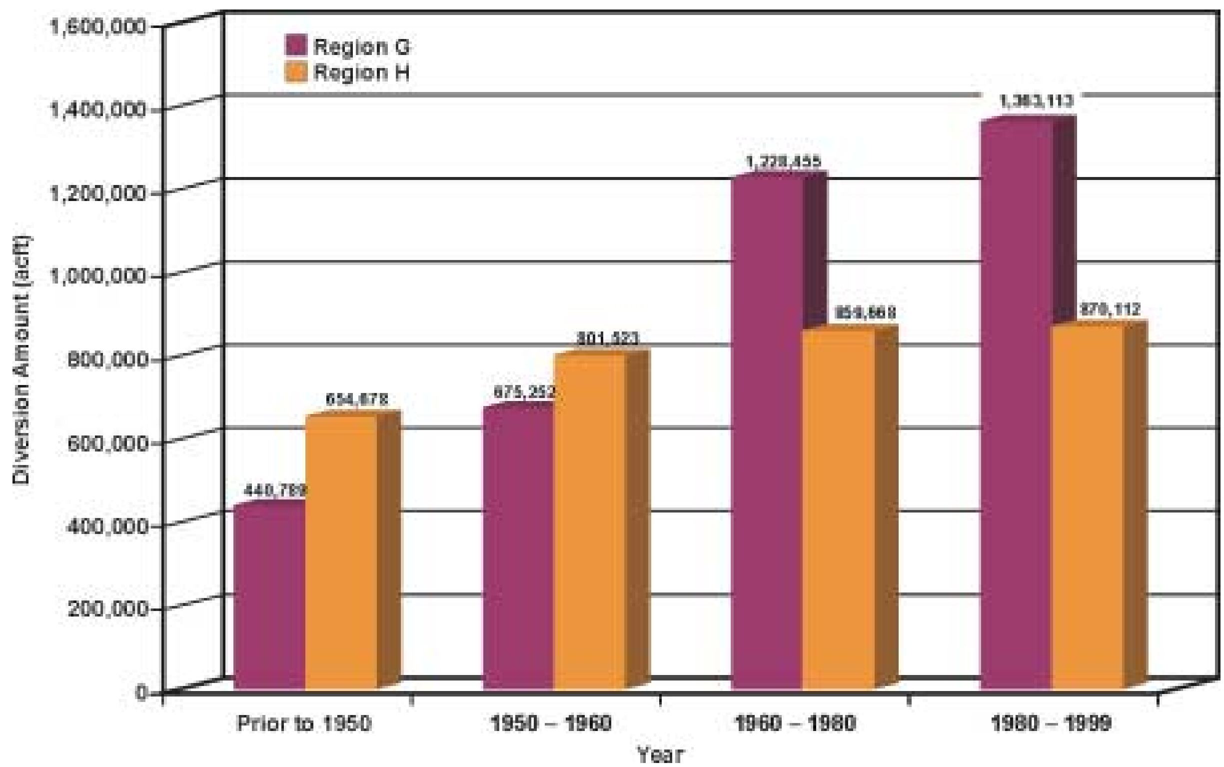

Figure 3-3. Comparison of Cumulative Diversion Volume and Priority Date for Regions G and Region H

Table 3-1.
Major Water Rights in Region G Brazos Basin

Water Right No.	*Name*	*Annual Diversion Volume (acft/yr)*	*Reservoir Storage Capacity (acft)*	*Priority Date*	*Facility*	*County*
003758	Aluminum Co of America	18,000		12/12/51	Lake Alcoa	Milam
005272	Aluminum Co of America	14,000	15,650	12/12/51	Lake Alcoa	Milam
005287	Bistone Municipal WSD	2,887	9,600	4/15/57	Lake Mexia	Limestone
		65		4/15/57		Limestone
	Total	2,952	9,600			
002939	Brazos Electric Cooperative	38,800		2/7/49	Poage Plant	Bell
005155	Brazos River Authority	230,750	724,739	4/6/38	Possum Kingdom Lake	Palo Pinto
005156	Brazos River Authority	64,712	155,000	2/13/64	Lake Granbury	Hood
005157	Brazos River Authority	18,336	50,000	8/30/82	Lake Whitney	Hill
005158	Brazos River Authority	13,896	52,400	10/25/76	Lake Aquilla	Hill
005159	Brazos River Authority	19,658	59,400	12/16/63	Lake Proctor	Comanche
005160	Brazos River Authority	100,257	457,600	12/16/63	Lake Belton	Bell
005161	Brazos River Authority	67,768	235,700	12/16/63	Lake Stillhouse Hollow	Bell

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Table 3-1 (continued)

Water Right No.	Name	Annual Diversion Volume (acft/yr)	Reservoir Storage Capacity (acft)	Priority Date	Facility	County
005162	Brazos River Authority	13,610	37,100	2/12/68	Lake Georgetown	Williamson
005163	Brazos River Authority	19,840	65,500	2/12/68	Lake Granger	Williamson
005164	Brazos River Authority	48,000	160,110	12/16/63	Lake Somerville	Washington
005165	Brazos River Authority		217,494	5/6/74	Lake Limestone	Robertson
		65,074	7,906	9/4/79	Lake Limestone	Robertson
	Total	65,074	225,400			
004139	City of Abilene		60	8/3/49		Jones
		30,000	548	8/22/55	Diversion from Clear Fork of Brazos R.	Jones
	Total	30,000	608			
004161	City of Abilene	30,690	73,960	3/25/37	Fort Phantom Hill	Jones
002938	City of Temple	15,804	500	10/30/15		Bell
		20,000	___	1/11/57		Bell
	Total	35,804	500			
002315	City of Waco	39,100	104,100	1/10/29	Lake Waco	McLennan
		19,100	___	4/16/58	Lake Waco	
		900	___		Lake Waco	McLennan
005099	Brazos River Authority	20,770	87,962	9/12/86	Lake Waco Enlargement	
	Total	79,870	192,062			
004031	Palo Pinto Co MWD 1	10,000	34,250	7/3/62	Lake Palo Pinto	Palo Pinto
		6,000		7/3/62		Palo Pinto
		2,500	9,874	9/8/64		Palo Pinto
	Total	18,500	44,124			
004097	Texas Utilities Electric Co	23,180	151,500	4/25/73	Squaw Creek Reservoir	Somervell
004342	Texas Utilities Electric Co	12,000	37,800	8/21/26	Tradinghouse Steam Electric Station	McLennan
		15,000	___	9/16/66	Tradinghouse Steam Electric Station	McLennan
	Total	27,000	37,800			
004345	Texas Utilities Electric Co		8,000	3/6/51	Lake Creek Steam Electric Station	McLennan
		10,000	500	3/5/52	Lake Creek Steam Electric Station	McLennan
	Total	10,000	8,500			
005298	Texas Utilities Electric Co	13,200	30,319	7/1/74	Twin Oak Steam Electric Station	Robertson
002936	US Dept of Army	10,000	12,000	8/24/53	Lake Belton	Bell
		2,000	___	8/23/54		Bell
	Total	12,000	12,000			
004213	West Central Texas MWD	52,800	317,750	5/28/57	Hubbard Creek Lake	Stephens
		3,200	___	8/14/72		Stephens
	Total	56,000	317,750			
	Total	1,045,227	2,868,642			

Table 3-2.
Water Rights in Region H, Downstream of Region G Brazos River Basin

Water Right Number	*Name*	*Annual Diversion Volume (ac-ft/yr)*	*Reservoir Storage Capacity (ac-ft)*	*Priority Date*	*Facility*	*County*
005168	Gulf Coast Water Authority	99,932		1/15/26		Fort Bend
005171	Gulf Coast Water Authority	75,000		2/1/39		Fort Bend
		50,000		12/12/50		Fort Bend
	Total	125,000				
005320	Richmond Irrigation Co	12,000		10/23/26		Fort Bend
		28,000		10/23/26		Fort Bend
	Total	40,000				
005322	Chocolate Bayou Water Co	10,000	864	2/8/29		Fort Bend
		145,000	0	2/8/29		Fort Bend
	Total	155,000	864			
005325	Houston L&P	28,711	18,750	12/16/55	Smithers Lake	Fort Bend
005328	Dow Chemical Co	20		4/4/60		Brazoria
		3,136		3/8/76		Brazoria
		20,000		2/28/29		Brazoria
		150,000		2/14/42		Brazoria
			10,200	2/14/42	Harris Reservoir -- Off-Channel	Brazoria
		7,500	600	4/3/51	Buffalo Camp	Brazoria
			21,700	4/7/52	Brazoria Reservoir — Off-Channel	Brazoria
		65,000		4/4/60		Brazoria
		1,800		2/14/42		Brazoria
		58,175	30	2/14/42	Oyster Creek Reservoir	Brazoria
	Total	305,631	32,530			
005332	US Department of Energy	52,000		4/27/81	Bryan Mound SPR Site	Brazoria
005366	Brazosport Water Authority	45,000		4/4/60		Brazoria
	Total	851,274	52,144			

A total of 48 major reservoirs, with a capacity greater than 5,000 acft, exist in the river basin. The U.S. Army Corps of Engineers owns several of these reservoirs in the basin, including Lake Georgetown, Lake Aquilla, Lake Granger, Lake Proctor, Lake Somerville, Lake Waco, Lake Belton, Lake Stillhouse Hollow, and Lake Whitney. These reservoirs were built for the primary purpose of flood control, however, they also included other benefits including water supply. For purposes of water supply, the USCOE has contracted conservation storage in each reservoir to the BRA. The BRA owns the water right permit for each reservoir and manages the

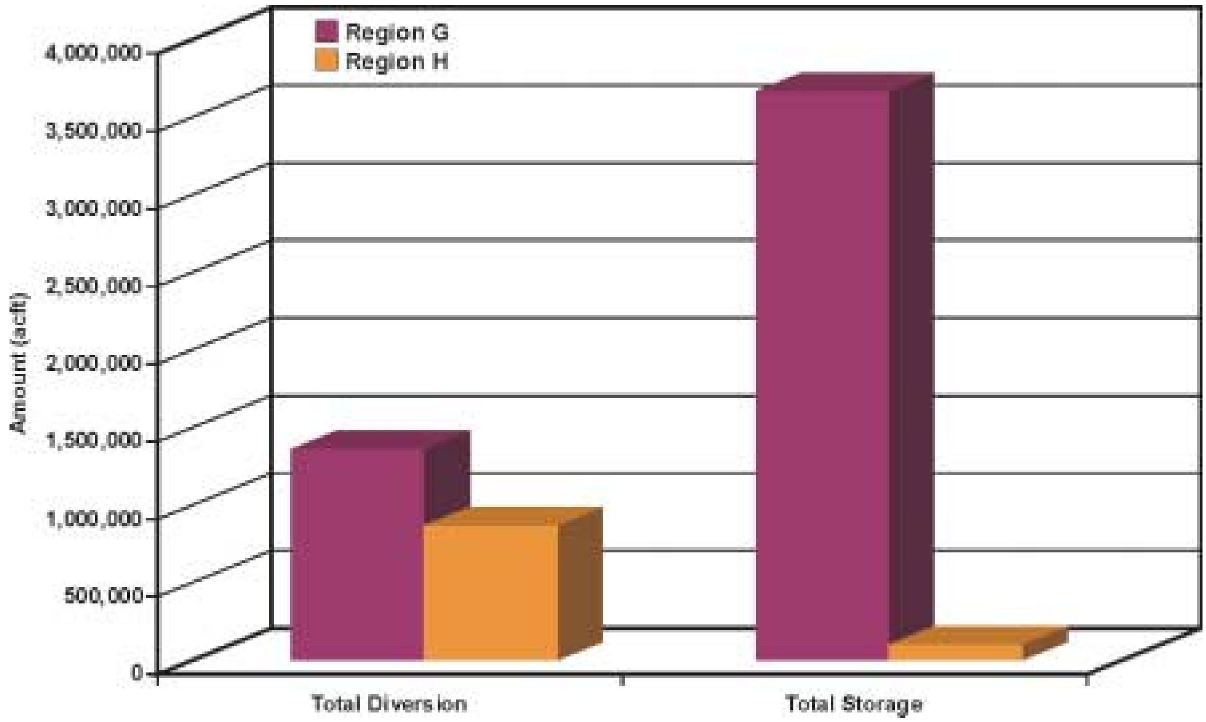

Figure 3-5. Comparison of Storage and Diversion Volume for Regions G and H

water supply conservation storage in each reservoir. Other major reservoirs in the basin that provide municipal, industrial, and irrigation water supply are owned by the BRA, City of Waco, City of Abilene, City of Mineral Wells, Palo Pinto County MWD No. 1, West Central Texas MWD, City of Cisco, City of Breckenridge, City of Sweetwater, City of Cleburne, and City of Stamford. A summary of major reservoirs in the Brazos River Basin is presented in Table 3-3 and the locations of the reservoirs were shown in Figure 3-4.

A number of interbasin transfer permits exist in the Brazos River Basin. These permits include both authorizations for diversions from the Brazos River Basin to adjacent river basins and from adjacent river basins to the Brazos River Basin. Most of the interbasin transfer permits are obviously located along the basin divide. Examples of interbasin transfers that authorize diversions from an adjacent river basin to the Brazos River Basin include: Lake Meredith (Canadian River Basin) to the Lubbock and Plainview areas in Lubbock and Hale County; Oak Creek Reservoir (Colorado River Basin) to the City of Sweetwater in Nolan County; and Lake Travis (Colorado River Basin) to the City of Cedar Park in Williamson County. Interbasin

Table 3-3. Major Reservoirs[1] of the Brazos River Basin

Reservoir	Water Right Owner	Authorized Storage (acft)	Authorized Diversion (acft)	Priority Date	County	Planning Region
Abilene	City of Abilene	11,868	1,675	1/23/18	Taylor	G
Alcoa Lake	Aluminum Co. of America	15,650	14,000	12/12/51	Milam	G
Alan Henry	Brazos River Authority	115,937	35,200	10/5/81	Garza	O
Aquilla	Brazos River Authority	52,400	13,896	10/25/76	Hill	G
Belton	Brazos River Authority	457,600	100,257	12/16/63	Bell	G
Brazoria Reservoir–Off-Channel	Dow Chemical	21,700	0	4/7/52	Brazoria	H
Cisco	City of Cisco	45,000	1,971	4/16/20	Eastland	G
			56	9/5/78		
Daniel	City of Breckenridge	11,400	2,100	4/26/46	Stephens	G
Dansby Power Plant	City of Bryan	15,227	850	5/30/72	Brazos	G
Eagle Nest Lake	T L Smith Trust Et Al	18,000	4,000	1/15/48	Brazoria	H
		11,315	1,800	9/9/93		
Fort Phantom Hill	City of Abilene	73,960	30,690	3/25/37	Jones	G
Georgetown	Brazos River Authority	37,100	13,610	2/12/68	Williamson	G
Gibbons Creek Power	Texas Municipal Power	26,824	9,740	2/22/77	Grimes	G
		5,260		3/9/89		
Graham/Eddleman	City of Graham	4,503	5,000	11/21/27		
		39,000	15,000	11/15/54	Young	G
		8,883		9/16/57		
Granbury	Brazos River Authority	155,000	64,712	2/13/64	Hood	G
Granger	Brazos River Authority	65,500	19,840	2/12/68	Williamson	G
Harris Reservoir–Off-Channel	Dow Chemical	10,200	0	2/14/42	Brazoria	H
Hubbard Creek Lake	West Central Texas MWD	317,750	52,800	5/28/57	Stephens	G
			3,200	8/14/72		
Leon	Eastland Co WSD		1,265	5/17/31		
		28,000	2,438	3/21/52	Eastland	G
			2,598	3/25/86		
Limestone	Brazos River Authority	217,494	65,450	5/1/74	Robertson	G
		7,906		9/4/79		
Miller's Creek	North Central Texas MWA	30,696	5,000	10/1/58	Baylor	B
Palo Pinto	Palo Pinto Co. MWD 1	34,250	10,000	7/3/62	Palo Pinto	G
		9,874	2,500	9/8/64		
			6,000	7/3/62		
Pat Cleburne Reservoir	City of Cleburne	25,600	5,760	8/6/62	Johnson	G
			240	3/29/76		
Possum Kingdom	Brazos River Authority	724,739	230,750	4/6/38	Palo Pinto	G
Proctor	Brazos River Authority	59,400	19,658	12/16/63	Comanche	G

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Table 3-3 (continued)

Reservoir	Water Right Owner	Authorized Storage (acft)	Authorized Diversion (acft)	Priority Date	County	Planning Region
Smithers Lake	Houston L&P	18,750	28,711	12/16/55	Fort Bend	H
Somerville	Brazos River Authority	160,110	48,000	12/16/63	Washington	G
Squaw Creek Reservoir	Texas Utilities Electric Co.	151,500	23,180	4/25/73	Somervell	G
Stamford	City of Stamford	60,000	10,000	6/8/49	Haskell	G
Stillhouse Hollow	Brazos River Authority	235,700	67,768	12/16/63	Bell	G
Sweetwater	City of Sweetwater	10,000	3,740	10/17/27	Nolan	G
Tradinghouse Steam	Texas Utilities Electric Co.	37,800	12,000	8/21/26	McLennan	G
			15,000	9/16/66		
Twin Oak Steam Electric	Texas Utilities Electric Co.	30,319	13,200	7/1/74	Robertson	G
Waco	City of Waco	104,100	39,100	1/10/29	McLennan	G
			19,100	4/16/58		
			900	2/21/79		
	Brazos River Authority	87,962	20,770	9/12/86		
Whitney	Brazos River Authority	50,000	18,336	8/30/82	Hill	G
White River Reservoir	White River MWD	33,160	6,000	9/22/58	Crosby	O
		5,072		11/21/60		
		6,665		8/16/71		

[1] Major Reservoirs are defined as having a capacity greater than 10,000 acft

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transfers authorized for diversion from the Brazos River Basin to other river basins include: Lake Mexia in Limestone County to part of the City of Mexia that lies in the Trinity River Basin; Teague City Lake in Freestone County to part of the City of Teague that lies in the Trinity River Basin; and Lake Granbury in Hood County to part of Johnson County that lies in the Trinity River Basin. A summary of interbasin transfers associated with the Brazos River Basin is presented in Table 3-4.

3.1.4 Water Supply Contracts

Many entities within Region G obtain surface water through water supply contracts. These supplies are usually obtained from entities that have surface water rights to provide a specific quantity of water each year to a buyer for an established unit price. The BRA is the largest provider of water supply contracts in Region G with 661,901 acft/yr permitted from its system of reservoirs in the Brazos River Basin. The BRA contracts raw water to various entities for long-term supply as well as short-term supply for municipal, industrial, and irrigation uses.

Table 3-4.
Summary of Interbasin Transfers
Associated with the Brazos River Basin

River Basin of Origin	Location of Use			Description	Authorized Diversion (acft/yr)	Priority Date
	River Basin	Planning Region	County			
Brazos	Trinity	G	Johnson	Lake Granbury to Johnson County	2,600	11/7/86
Brazos	Trinity	G	Limestone	Lake Mexia to part of Mexia	N/A	N/A
Brazos	Trinity	C	Freestone	Teague City Lake to part of Teague	N/A	N/A
Brazos	Colorado	G	Lampasas	Brazos River to City of Lampasas	180	6/23/14
Brazos	Trinity	N/A	N/A	Lake Possum Kingdom to Trinity Basin	5,240	4/6/38
Canadian	Brazos	O	Lubbock	Lake Meredith to Lubbock Co. Area	151,200	1/30/56
Colorado	Brazos	G	Fisher	Lake J B Thomas to Fisher Co.	N/A	N/A
Colorado	Brazos	G	Nolan	Oak Creek Res. to Lk Trammel/Sweetwater	3,000	N/A
Colorado	Brazos	G	Callahan	Lake Clyde to Clyde	200	2/2/65
Colorado	Brazos	G	Taylor	Lake O H Ivie to Abilene	15,000	2/2/78
Colorado	Brazos	G	Williamson	Lake Austin to Williamson Co.	N/A	N/A
Colorado	Brazos	G	Williamson	Lake Travis to Cedar Park	16,500	N/A
Colorado	Brazos	G	Williamson	Lake Travis to Leander	6,400	N/A
Colorado	Brazos	F	Fisher	Snyder to City of Rotan	N/A	N/A
Red	Brazos	B	Archer	Small Lakes to Megargel	N/A	N/A
Red	Brazos	B	Archer	Lake Cooper & Olney to Olney	35	8/11/80
Red	Brazos	O	Floyd	Lake MacKenzie to Floydada & Lockney	N/A	N/A
Trinity	Brazos	C	Parker	Lake Weatherford to part of Weatherford	N/A	N/A

Other water right holders that contract large quantities of raw water supply to other entities include the West Central Texas MWD and the Palo Pinto County MWD No. 1. The West Central Texas MWD contracts raw water from Lake Hubbard Creek for municipal use to the City of Abilene, Albany, Anson, and Breckenridge. The City of Abilene contracts raw water from Fort Phantom Hill Reservoir to West Texas Utilities for industrial use as well as municipal supply to several other surrounding cities and water supply corporations. The Palo Pinto County MWD No. 1 contracts raw water from Lake Palo Pinto for industrial use to Brazos Electric Co-op. A summary of the BRA's existing long-term raw water supply contracts in Region G is presented in Table 3-5. A detailed list of BRA's existing long-term water supply contracts is provided in Appendix G.4.

Table 3-5.
Summary of the Brazos River Authority
Long-term Water Supply Contracts[1]

Reservoir	Municipal Use (acft)	Industrial Use (acft)	Irrigation Use (acft)	Total Contracts (acft)
Aquilla	11,403	0	0	11,403
Belton	100,032	0	200	100,232
Georgetown	13,440	0	0	13,440
Granbury	22,790	40,000	0	62,790
Granger	8,525	5,000	15	13,540
Limestone	8,209	46,600	0	54,809
Possum Kingdom	20,975	117,142	570	138,687
Proctor	7,889	0	10,270	18,158
Somerville	4,619	0	0	4,619
Stillhouse	67,286	300	182	67,768
Whitney	5,450	0	60	5,510
System	32,668	99,000	5,625	137,293
Total	303,286	308,042	16,922	628,250

[1] Brazos River Authority Long-Term Water Supply Contracts as of 12/1/99

3.2 Reliability of Supply

Hydrologic conditions are a primary factor that affects the reliability of a water right. Severe drought periods have been experienced in all areas of Region G in the Brazos River Basin. The drought of record for most areas of Region G occurred in the 1950s with other smaller duration drought periods occurring in the 1960s, 1970s, 1980s and even recently in the 1990s. Figure 3-6 shows annual streamflow for the Brazos River at South Bend (Young County) in the upper part of Region G. The median annual streamflow for the period 1939 to 1998 at this location is 492,900 acft/yr. The minimum annual streamflow of 48,980 acft/yr occurred in 1952. It is important to note that a severe drought period began in 1993 and continues today. The average streamflow over the 6-year period of 1993 to 1998 of 302,700 acft/yr is the lowest average streamflow recorded over any 6-year period at the South Bend gage, representing 61 percent of the median annual streamflow.

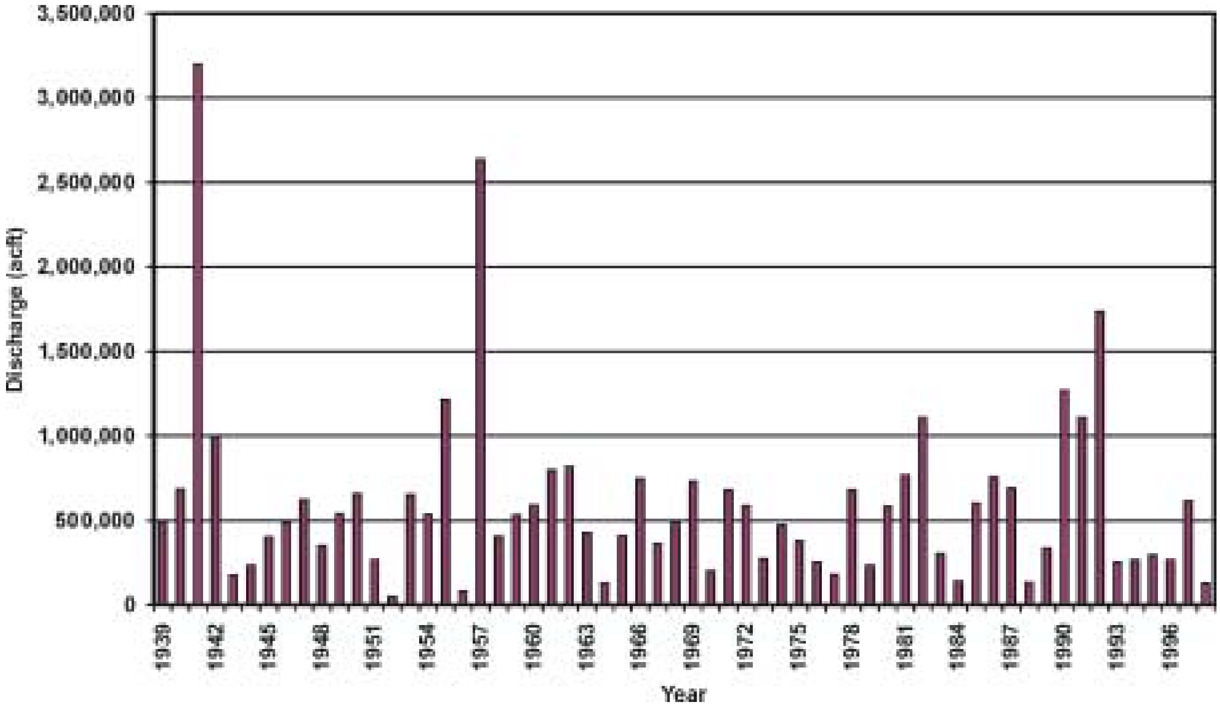

Figure 3-6. Annual Discharge at Brazos River South Bend Gage

At the lower end of the region, drought conditions were most severe during the drought of the 1950s. Over the period of 1924 to 1999, the median annual streamflow recorded for the Brazos River at Richmond (Fort Bend County) was 5,485,800 acft/yr (Figure 3-7). During the drought of the 1950s, streamflow averaged 1,700,000 acft/yr, or 31 percent of the median annual streamflow. The minimum annual streamflow of 892,000, 16 percent of the median streamflow, occurred in 1951 at Richmond. These two gages, located at opposite ends of Region G are indicative of the types of extremes that occur throughout the region, including tributary streams.

Water rights downstream of Region G, located in Region H, also play a role in determining the reliability of supply in Region G. These water rights are located along the coastal region and represent some of the largest and most senior priority water rights in the Brazos River Basin. The senior priority of these water rights relative to other water rights in the Brazos River Basin require that flows at their diversion point be adequate to provide sufficient water to meet the permitted diversion. If flows are insufficient at their respective diversion points, then water rights located upstream that are junior in priority may be restricted from diverting or impounding flow.

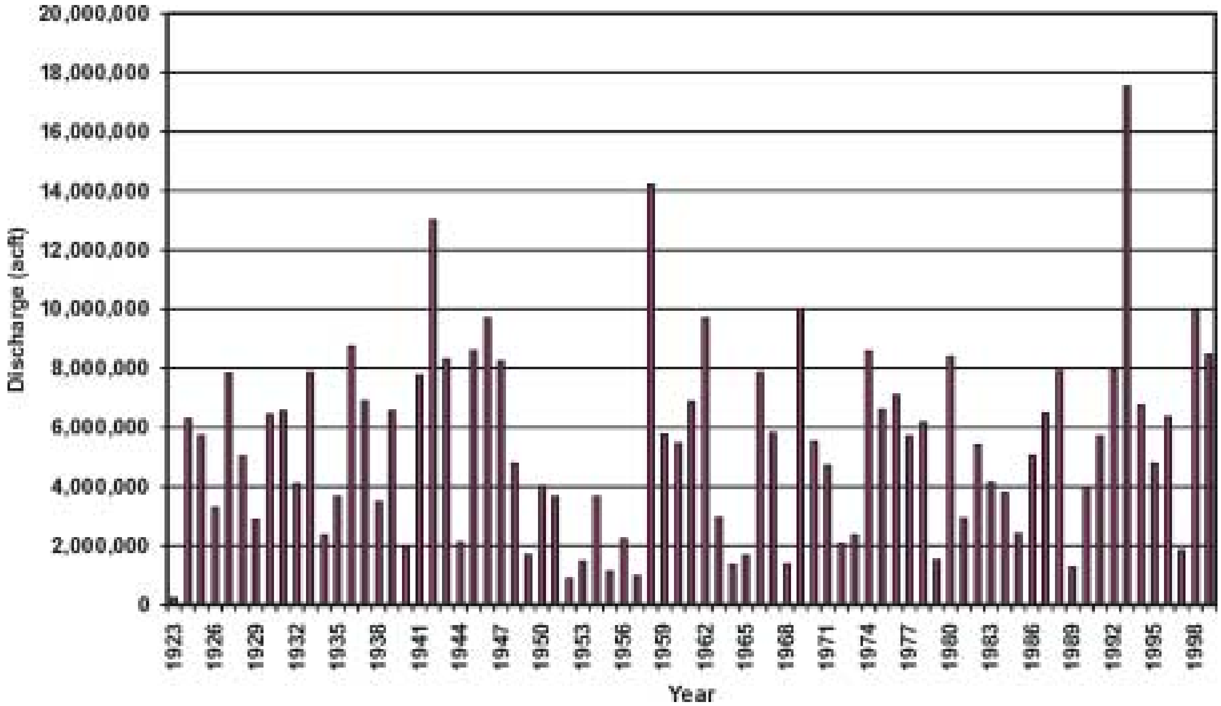

Figure 3-7. Annual Discharge at Brazos River Richmond Gage

The reliability of a water right is typically represented in terms of the percent of time that a specific quantity of water is available for diversion and use. Municipal and industrial water suppliers typically require a very high reliability for their water sources. In most cases, interruption to water supply is not acceptable, requiring the reliability of the supply to be 100 percent of the time. Municipal and industrial supplies are commonly based on firm yield. Firm yield is defined as the quantity of water that can be diverted for use during a repeat of the most severe drought of record without interruption of service. In some cases, municipalities have decided to use safe yield as a measurement of reliability of supply. Safe yield is defined as the amount of water that can be diverted for use during a repeat of the most severe drought of record without interruption of service and with a 1-year supply of water in reserve (reservoir storage). For purposes of this study, firm yield was used for municipal water supplies in order to provide a common basis for comparison.

The firm yield of run-of-the-river water rights was based on the minimum annual supply that could be diverted over a historical period of record. For reservoirs, the firm yield may decrease over time as a result of sedimentation. Rivers and streams naturally carry sediment from upstream to downstream. When a reservoir is constructed on the stream channel, the sediment will fall out of solution and accumulate on the floor and walls of the reservoir. This accumulation reduces the volume of water that can be stored in the reservoir, which in turn, reduces the firm yield available for diversion. Sedimentation rates have been measured for several reservoirs over a period of time and estimated sedimentation rates have been made for other reservoirs. For the 50-year planning period, the reduction in firm yield for future sedimentation was considered where data was available. Firm yield for existing reservoirs is presented for the year 2000 and for the year 2050.

3.3 Water Availability

3.3.1 Methods of Determining Water Availability

Determination of water availability for existing water rights is based on a rather complex function of location, hydrologic conditions, diversion volume, reservoir storage, and priority date. Computer models that are capable of analyzing these inter-relationships are typically employed to determine water availability for water rights. For this study, detailed site-specific engineering studies were referenced for water availability and firm yield data for existing water rights when they were available. Sources of this data for existing water rights included the BRA, TWDB, and private consulting engineers. Where no site-specific studies existed for reservoirs and run-of-the-river water rights, water availability estimates were developed using a computer model for the Brazos River Basin. The Water Rights Analysis Package (WRAP) computer model was developed at Texas A&M University for the Brazos River Basin. The WRAP model is designed for use as a water resources management tool. The model can be used to evaluate the reliability of existing water rights and to determine unappropriated streamflow potentially available for a new water right permit. WRAP simulates the management and use of streamflow and reservoirs over a historical period of record, adhering to the water right priority system. Water availability computations are performed at 18 control points located throughout the river basin. The control points for the Brazos River Basin WRAP model are located at Lake Hubbard, South Bend streamgage (Brazos River), Lake Possum Kingdom, Lake Granbury, Lake Whitney, Lake Waco, Lake Aquilla, Lake Proctor, Lake Belton, Lake Stillhouse Hollow, Lake Georgetown, Lake Granger, Cameron streamgage (Little River), Lake Somerville, Bryan streamgage (Brazos River), Hempstead streamgage (Brazos River), Lake Limestone, and the

Richmond streamgage (Brazos River). Figure 3-8 shows the location of the control points for the Brazos River Basin WRAP model.

The model performs calculations at each control point. Flows over the historical period of 1900 to 1984 were simulated, accounting for water right diversions and reservoir operations. All water rights in the Brazos River Basin were included in the model. Water rights data available from the TNRCC was revised and updated in the WRAP model after a thorough review of Certificates of Adjudication and permits for major water rights in the river basin. For reservoirs, the year 2050 firm yield was used in the model for computation of water availability to existing water rights. A summary of firm yield data for major reservoirs in the WRAP model is presented in Table 3-6.

3.3.2 WRAP Model Results for Existing Water Rights

The results of the WRAP Model include water availability estimates for each water right. Summaries of water available to municipal and industrial run-of-the-river water rights (including small reservoirs) is presented in Tables 3-7 and 3-8, respectively. Water availability is expressed in terms of the minimum annual supply, which is defined as the water available during the most severe drought year over the 85-year simulation period of 1900 to 1984. Water availability estimates for irrigation water rights and other uses were grouped by county in the Brazos River Basin. For irrigation water rights, the minimum annual supply and the quantity of water that is available 75 percent of the time were calculated. The results of water availability for each county for each type of use are presented in Table 3-9.

3.3.3 WRAP Model Results for Unappropriated Flow

Water potentially available to a new water right permit was calculated by the WRAP Model at each model control point. This unappropriated flow was computed assuming no instream flow restrictions and all existing water rights are fully exercised. Unappropriated flow was computed for each month of each year for the 1900 to 1984 simulation period. The quantity of unappropriated flow varies throughout the river basin depending on the control point location. Summaries of unappropriated flow for the Brazos River at the South Bend gage and Richmond gage are shown in Figure 3-9 and Figure 3-10, respectively. These two control points represent the conditions at the extreme upper and lower ends of the river basin. As shown in Figure 3-9, unappropriated flow is not available at the South Bend gage location for most years, especially

Table 3-6.
Firm Yields for Major Reservoirs in Brazos Basin

Reservoir	Water Right Owner	County	Year 2000 Yield	Year 2050 Yield
Abilene[1]	City of Abilene	Taylor	1,450	1,120
ALCOA[2]	ALCOA	Milam	9,002	9,002
Alan Henry[3]	Brazos River Authority	Garza	26,100	20,600
Aquilla[3,4]	Brazos River Authority	Hill	13,478	5,114
Belton[3]	Brazos River Authority	Bell	106,511	103,961
Pat Cleburne[12]	City of Cleburne	Johnson	5,890	5,210
Cisco[1]	City of Cisco	Eastland	500	370
Lake Creek Steam-Electric[5]	Texas Utilities	McLennan	4,858	4,858
Daniel[6]	City of Breckenridge	Stephens	2,500	2,100
Dansby Power Plant[7]	City of Bryan	Brazos	0	0
Graham/Eddleman[8]	City of Graham	Young	8,400	8,400
Fort Phantom Hill[9]	City of Abilene	Jones	26,872	26,012
Georgetown[3]	Brazos River Authority	Williamson	14,711	14,609
Gibbons Creek[7]	Texas Municipal Power	Grimes	0	0
Granbury[3]	Brazos River Authority	Hood	66,819	62,790
Granger[3]	Brazos River Authority	Williamson	19,220	13,540
Hubbard Creek[9]	West Texas MWD	Stephens	43,399	38,349
Kirby[8]	City of Abilene	Taylor	300	300
Leon[1]	Eastland Co. WSD	Eastland	4,500	2,500
Limestone[3]	Brazos River Authority	Robertson	64,646	58,475
Mexia[2]	Bistone Municipal WSD	Limestone	4,111	100
Miller's Creek[1]	North Central Texas MWA	Baylor	3,100	2,034
Mineral Wells[8]	City of Mineral Wells	Parker	1,500	1,500
Palo Pinto[10]	Palo Pinto MWD No. 1	Palo Pinto	14,560	12,233
Possum Kingdom[3]	Brazos River Authority	Palo Pinto	263,253	252,288
Post Dam (North Fork) [1]	White River MWD	Garza	10,600	10,600
Proctor[3]	Brazos River Authority	Comanche	21,897	20,826
Somerville[3]	Brazos River Authority	Washington	41,191	38,641
Squaw Creek[7]	Texas Utilities	Somervell	0	0
Stamford[13]	City of Stamford	Haskell	2,930	2,350
Stillhouse Hollow[3]	Brazos River Authority	Bell	71,044	68,137
Sweetwater[1]	City of Sweetwater	Nolan	1,400	467
Tradinghouse[5]	Texas Utilities	McLennan	12,000	12,000
Twin Oaks[7]	Texas Utilities	Robertson	0	0
Waco[11]	City of Waco	McLennan	81,120	79,870
White Reservoir[1]	White River MWD	Crosby	4,000	3,870
Whitney[3]	Brazos River Authority	Hill	18,336	18,336

1 Texas Water Development Board, "Water for Texas, Today and Tomorrow", December 1990.
2 HDR Engineering, Inc., Water Rights Analysis Package (WRAP) Model for Brazos River Basin, December 1999.
3 Brazos River Authority, Firm Yield of Brazos River Authority System for SB1, May 1999.
4 Lake Aquilla's projected firm yield for 2050 is based on the sedimentation rate experienced over a recent short-term period. Sedimentation of Lake Aquilla is being monitored by BRA and potential solutions are being evaluated.
5 HDR Engineering, Inc., Water Rights Analysis Package (WRAP) Model for Brazos River Basin, December 1999. Firm yield based on minimum annual supply from Brazos River.
6 Texas Water Development Board, "Water for Texas", August 1997.
7 Steam-electric reservoir has no firm yield.
8 Texas Water Development Board, "Water for Texas", August 1997.
9 Freese & Nichols Study prepared for West Central Texas MWD's Drought Contingency Plan, 1999.
10 HDR Engineering, Inc., "Yield Studies of Lake Palo Pinto and Turkey Peak Reservoir Site", March 1986.
11 HDR Engineering, Inc., "Reservoir Operation Studies for Proposed Lake Bosque Project and Lake Waco Enlargement", June 1985.
12 Freese & Nichols, Inc., Cleburne Long Range Water Supply Planning Study, 1996.
13 Freese & Nichols, Inc., City of Stamford, 2000.

Table 3-7.
Summary of Water Availability for Municipal
Run-of-the-River and Small Reservoir Water Rights

County	Water Right Owner	Authorized Annual Diversion (acft)	Minimum Annual Supply (acft)	Year of Priority Date
Bell	City of Temple	15,804	8,418	1915
Bosque	City of Clifton	2,604	1,523	1963, 1996
Callahan	City of Baird	550	0	1949
Comanche	ERW Inc et al	200	200	1925
Eastland	Eastland Co. WSD	450	450	1919
Eastland	City of Cisco	1,000	0	1954
Erath	Tarrant Investment	60	0	1973
Erath	Thurber Lake Resort	20	0	1973
Falls	City of Marlin	1,500	1,500	1948
Falls	City of Marlin	3,500	3,500	1956
Falls	City of Rosebud	224	64	1961
Hamilton	City of Hamilton	614	614	1923
Hood	H D Howard	35	0	1976
Johnson	City of Cleburne	720	0	1985
Jones	City of Abilene	3,000	0	1954, 1955
Jones	City of Hamlin	300	0	1939
Jones	City of Anson	542	0	1950
Knox	City of Benjamin	34	34	1929
Lampasas	City of Lampasas	3,760	1,692	1914
Limestone	City of Groesbeck	2,500	152	1921
McLennan	City of Waco	5,600	5,600	1914
McLennan	City of Crawford	55	55	1983
McLennan	City of Mart	500	500	1985
McLennan	City of Robinson	13,100	5,895	1986
Milam	City of Cameron	2,792	2,792	1914
Milam	City of Thorndale	60	60	1961
Milam	City of Thorndale	100	100	1966
Milam	City of Thorndale	150	112	1982
Nolan	City of Sweetwater	2,000	116	1914
Palo Pinto	City of Graford	5	5	1932
Palo Pinto	City of Graford	50	50	1957
Palo Pinto	City of Strawn	160	160	1937
Palo Pinto	City of Gordon	115	0	1973
Palo Pinto	City of Gordon	245	0	1991
Palo Pinto	City of Gordon	45	0	1978
Shackelford	City of Moran	90	90	1923
Shackelford	City of Albany	600	600	1941
Shackelford	Marshall R. Young	21	21	1926
Throckmorton	City of Throckmorton	600	0	1940
Throckmorton	City of Woodson	60	0	1963
Young	City of Newcastle	250	0	1966

Table 3-8.
Summary of Water Availability for Industrial
Run-of-the-River and Small Reservoir Water Rights

County	Water Right Owner	Authorized Annual Diversion (acft)	75% Reliability Annual Supply (acft)	Minimum Annual Supply (acft)	Year of Priority Date
Brazos	Texas A&M University	420	420	0	1970
Comanche	Belve Bean	11	11	11	1961
Eastland	Fred Hagaman et al	100	100	0	1926
Eastland	City of Eastland	50	50	50	1919
Eastland	City of Cisco	56	12	0	1986
Eastland	Eastland Co. WSD	350	0	0	1986
Falls	City of Marlin	2,000	2,000	920	1956
Fisher	Bruce & Patsy Cox	26	0	0	1966
Grimes	Texas Municipal Power	6,000	6,000	275	1980
Grimes	Texas Municipal Power	200	200	0	1982
Grimes	Texas Municipal Power	100	100	0	1993
Grimes	Texas Municipal Power	10	10	0	1993
Hamilton	Seth Moore	2	2	2	1944
Jones	Nelson Pruett	7	7	0	1948
Lampasas	Ray A. Jones	48	48	23	1914
Milam	Joe Glaser	100	100	0	1976
Nolan	H&H Feedlot	45	29	0	1958
Palo Pinto	J&J Moore	12	12	0	1972
Robertson	Texas New Mexico Power Co.	131	131	80	1987
Robertson	Texas New Mexico Power Co.	327	327	0	1989
Shackelford	Dawson Oil	50	50	50	1925
Stephens	Breckenridge Gasoline	97	97	59	1926
Taylor	Billy Jay et al	241	241	241	1964
Taylor	West Texas Utilities	360	139	119	1967
Taylor	West Texas Utilities	2,500	2,500	2,500	1928
Washington	Waldo Neinstedt	20	0	0	1981
Williamson	A C Stearns Estate	203	203	126	1945
Young	Wilkinson	27	0	0	1966
Young	Crow et al	76	0	0	1967
Young	Crow et al	6	0	0	1977
Young	Parker & Parslety	376	0	0	1987

Table 3-9.
Summary of Water Availability by County for Irrigation Run-of-the-River and Small Reservoir Water Rights

County	Authorized Annual Diversion (acft)	75% Reliability Annual Supply (acft)	Minimum Annual Supply (acft)
Bell	4,798	4,332	837
Bosque	9,367	7,879	3,823
Brazos	12,862	12,862	661
Burleson	5,580	5,580	375
Callahan	90	35	0
Comanche	14,258	4,932	2,224
Coryell	2,064	1,066	676
Eastland	2,545	806	602
Erath	6,138	3,881	640
Falls	9,532	9,532	1,550
Fisher	841	526	94
Grimes	1,471	1,471	103
Hamilton	3,774	1,396	609
Haskell	1,316	80	0
Hill	1,348	1,348	184
Hood	4,284	3,718	757
Johnson	247	247	0
Jones	6,425	601	222
Kent	554	0	0
Knox	2,213	2,064	7
Lampasas	1,743	1,351	390
Lee	96	11	20
Limestone	13	13	6
McLennan	7,362	6,812	2,193
Milam	8,444	8,188	1,717
Nolan	90	90	40
Palo Pinto	3,662	2,799	1,935
Robertson	15,296	15,296	1,678
Shackelford	168	31	0
Somervell	1,146	765	175
Stephens	1,172	134	116
Stonewall	8	8	0
Taylor	288	88	0
Throckmorton	9	9	0
Washington	2	0	0
Williamson	1,451	942	161
Young	1,268	143	60

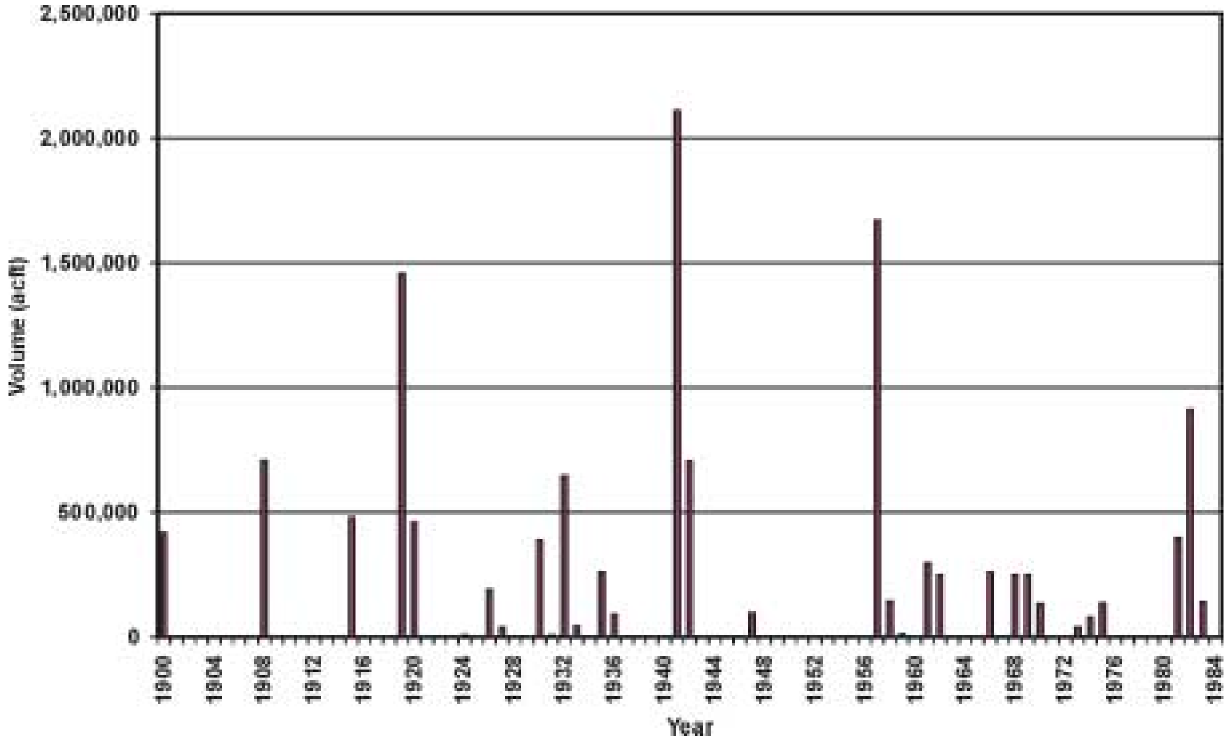

Figure 3-9. Estimate of Unappropriated Flow at South Bend Gage

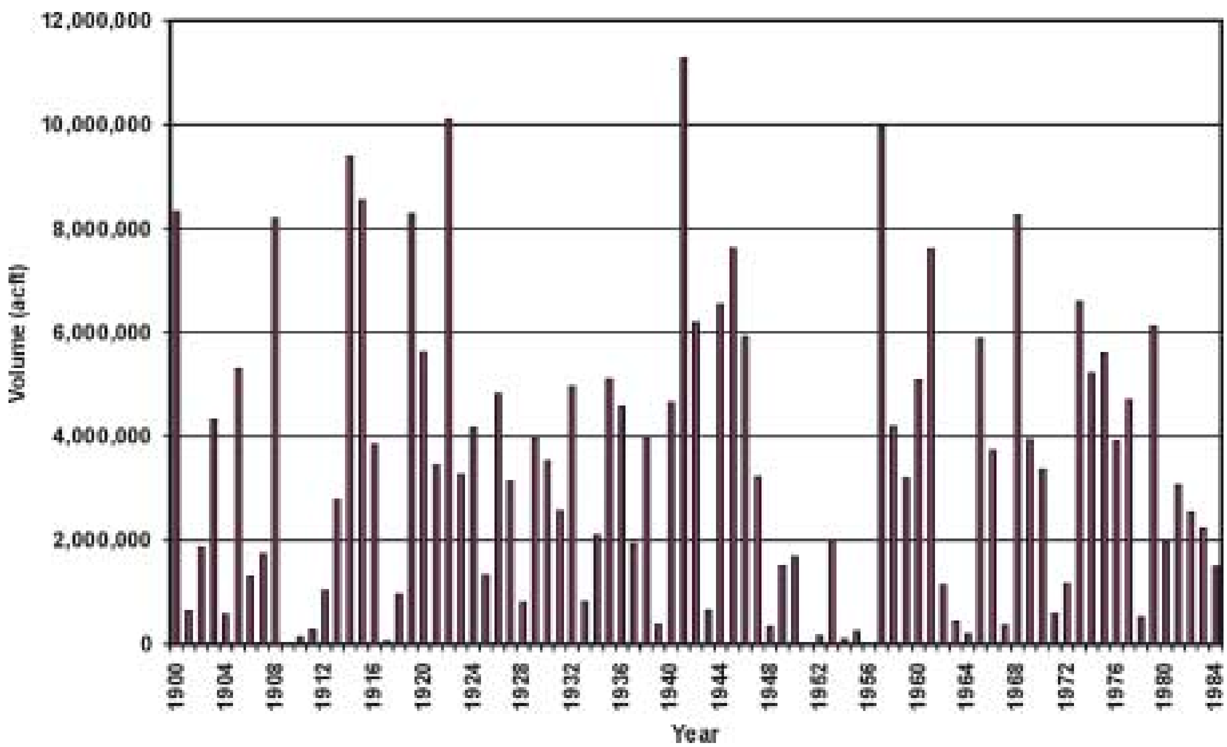

Figure 3-10. Estimate of Unappropriated Flow at Richmond Gage

during the drought years. Conversely, unappropriated flow is potentially available in most years at the Richmond gage at the lower end of the river basin and in large quantities. Unappropriated flow is not available at the Richmond gage during the severe drought year of 1951, which is the lowest flow year during the 1900 to 1984 period. Table 3-10 provides a summary of unappropriated flow potentially available at each WRAP Model control point. The results are presented as average availability for the overall period (1900-84) and drought period of 1947 to 1956. Detailed annual unappropriated flow estimates are provided in Appendix G.9.

Table 3-10. Summary of Unappropriated Flow at WRAP Model Control Points

Control Point	Unappropriated Flow Estimate (acft/yr)	
	Average (1900 to 1984)	Drought Average (1947 to 1956)
Lake Hubbard	4,529	0
South Bend Gage	154,146	9,786
Possum Kingdom	169,220	9,786
Lake Granbury	295,541	36,372
Lake Whitney	462,620	50,420
Lake Aquilla	52,455	8,709
Lake Waco	195,286	24,872
Lake Proctor	47,608	608
Lake Belton	245,754	18,175
Lake Stillhouse Hollow	123,054	10,650
Lake Georgetown	44,410	7,723
Lake Granger	135,248	27,848
Cameron Gage	899,333	167,689
Bryan Gage	2,250,310	490,528
Lake Somerville	155,828	43,026
Lake Limestone	120,392	24,142
Hempstead Gage	3,217,166	909,490
Richmond Gage	3,446,573	924,288

3.4 Water Quality

The Brazos River Basin WRAP Model addresses the quantity of water available for existing water rights. However, water quality issues for some sources of water for existing water rights and contracts may limit the availability of water for certain beneficial uses. The principal water quality issue in the Brazos River Basin is generally associated with total dissolved solids (TDS) and chloride (Cl) concentrations on the main stem of the Brazos River. Water sources with TDS and Cl concentrations exceeding TNRCC Drinking Water Standards of 1,000 mg/l and 300 mg/l, respectively, are generally considered as low quality and may require higher cost advanced treatment methods for use as a municipal or industrial supply.

Stream segments in the Brazos River Basin that have low quality water and water rights that divert water from these segments were identified. The stream segments were identified using water quality data available from the TNRCC and U.S Geological Survey (USGS). On the main stem of the Brazos, the Texas Water Quality Inventory Data (1996) indicated that the segment downstream of Lake Whitney to the Navasota River has low quality water. However, long-term data (Table 4.5-1) shows that good water quality in the mainstem of the Brazos River begins downstream of Lake Whitney. A review of USGS data at the Highbank stream gaging station in Falls County indicates that the concentrations of TDS and Cl are better than TNRCC Drinking Water Standards, therefore, the stream segment below the Highbank gage was not included as a low quality segment. A summary of the stream segments that have high TDS and/or Cl concentrations are summarized in Table 3-11 and shown in Figure 3-11.

Water rights that exist in stream segments with high concentrations of TDS and/or Cl are summarized in Table 3-12. The largest impacts in terms of quantity of supply are associated with Lake Possum Kingdom, Lake Granbury, and Lake Whitney. These reservoirs have a combined 2050 firm yield of 333,414 acft/yr. Advanced treatment is being utilized by some of the water right and contract holders that divert water directly from these reservoirs in order to meet drinking water standards. Other contract holders divert stored water released from these reservoirs at locations farther downstream at which point the water quality is improved as it blends with downstream tributary streamflow. Table 3-12 summarizes those water rights and water supply contracts that were found to be potentially impacted by low quality water sources.

Table 3-11.
Summary of Stream Segments with
High Chloride and Total Dissolved Solids Concentrations

Segment No.	Segment Name	Texas Water Quality Inventory - 1996 Data						Texas Water Quality Standard	
		Chloride (mg/l)			TDS (mg/l)			Chloride	TDS
		Min	Avg	Max	Min	Avg	Max	(mg/l)	(mg/l)
1203	Lake Whitney	260	336	490	901	1,103	1,528	670	1,500
1204	Brazos River below Lake Granbury	240	395	493	861	1,259	1,508	750	1,600
1205	Lake Granbury	220	406	630	1,112	1,365	1,534	1,000	2,500
1206	Brazos R. below Possum Kingdom	154	481	760	335	1,505	2,041	1,020	2,300
1207	Possum Kingdom Lake	234	574	850	869	1,455	2,047	1,200	3,500
1208	Brazos R. above Possum Kingdom	130	1,892	5,300	611	3,510	5,900	5,000	12,000
1217	Lampasas R. above Stillhouse Hollow	38	101	219	298	445	679	480	840
1223	Leon River below Lake Leon	86	286	560	121	418	898	480	1,240
1232	Clear Fork Brazos River	38	587	1,230	988	2,394	4,020	1,250	4,900
1233	Hubbard Creek Reservoir	177	258	450	590	625	735	350	750
1235	Lake Stamford	121	237	600	98	959	2,250	580	2,100
1238	Salt Fork Brazos River	5,900	17,598	37,000	1,729	31,385	65,700	23,000	40,000
1241	Double Mountain Fork Brazos River	100	1,053	2,500	630	3,980	9,920	2,500	5,500
1242	Brazos River below Lake Whitney	18	225	390	203	686	1,152	450	1,400
1253	Navasota River below Lake Mexia	80	158	246	375	659	862	440	1,350

3.4.1 Point and Nonpoint Source Pollution Water Quality

A number of stream segments and lakes in Brazos G Regional Water Planning Area do not meet water quality standards due to point and/or nonpoint source pollution. Water quality that does not meet designated uses, such as public water supply, contact recreation, and aquatic life support is very important to water supply considerations. The Texas Natural Resource Conservation Commission (TNRCC) and the U.S. Environmental Protection Agency (EPA) (40 CFR 130.7) have the responsibility to identify water bodies that do not meet, or are not expected to meet, applicable water quality standards for designated uses.[1] These stream segments and

[1] Texas Natural Resource Conservation Commission, *TMDL Guidance Document Outline*. TNRCC Web Site, http://www.tnrcc.state.tx.us

lakes are on the Clean Water Act, Section 303(d) list as impaired or threatened water bodies.[2] The summary of these segments is contained in Table 3-12.[3] The TNRCC has the responsibility to identify and prioritize water bodies that may require a Total Maximum Daily Load (TMDL) allocation to address the cause and source of a water quality impairment. Overall priorities of "high" were assigned to Aquilla Reservoir for atrazine in finished drinking water, and to the Bosque River and North Bosque River for high nutrient loading and other pollutants. A TMDL for Aquilla Reservoir has been initiated. As of August 31, 2000 TNRCC was developing a TMDL for the Bosque River and North Bosque River, including tributaries.

These water quality issues are beyond the scope of Senate Bill 1 regional water planning activities. The Brazos G Regional Water Planning Group encourages TNRCC and EPA to take responsibility and aggressively pursue their obligation to restore water quality to meet intended uses.

Table 3-12.
DRAFT Texas 2000 Clean Water Act Section 303(d) List (August 31, 2000)
Brazos G Regional Water Planning Area

Segment Number	Segment Name	Overall Priority	Source	Parameter of Concern	Segment Summary
1209A	Bryan Municipal Lake (Brazos County)	M	Point	Toxicity in ambient sediment, arsenic in water	Significant effects in ambient sediment toxicity tests sometimes occur, indicating that conditions are not optimum for aquatic life (L/NS). The average arsenic concentration in water exceeds the human health criterion for water and fish (M/NS).
1209B	Fin Feather Lake (Brazos County)	M	Point	Toxicity in ambient sediment, arsenic in water	Significant effects in ambient sediment toxicity tests sometimes occur, indicating that conditions are not optimum for aquatic life (L/NS). The average arsenic concentration in water exceeds the human health criterion for water and fish (M/NS).
1209C	Carters Creek (Brazos County)	L	Point and Nonpoint	Pathogens	Bacteria levels sometimes exceed the criterion to assure the safety of contact recreation (L/NS).
1209D	Unnamed tributary to Bryan Municipal Lake (Brazos County)	M	Point	Arsenic in water	The average arsenic concentration in water exceeds the human health criterion for water and fish (M/NS).
1210	Lake Mexia	L	Nonpoint	Depressed dissolved oxygen	Dissolved oxygen concentrations are sometimes lower that the criterion to assure optimum conditions for aquatic life (L/NS).
1213	Little River	T-m	Nonpoint	Atrazine in finished drinking water	All water quality measurements support use as a public water supply; however, atrazine concentrations in finished drinking water indicate contamination of source water and represent a threat to future use (T-m).

[2] Texas Natural Resource Conservation Commission, *State of Texas 1999 Clean Water Act Section 303(d) List and Schedule for Development of Total Maximum Daily Loads*. SFR-58/99, April 1, 1999.
[3] Texas Natural Resource Conservation Commission, *DRAFT Texas 2000 Clean Water Act Section 303(d) List (August 31, 2000)*. TNRCC Web Site, http://www.tnrcc.state.tx.us.

Table 3-12 (Continued)

Segment Number	Segment Name	Overall Priority	Source	Parameter of Concern	Segment Summary
1214	San Gabriel River	L	Point	Chloride	The average chloride concentration exceeds the criteria established to safeguard general water quality uses (L/CN).
1218	Nolan Creek South Nolan Creek	M	Point	Pathogens	Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (M/NS).
1221	Leon River below Proctor Lake	M	Nonpoint	Pathogens, total dissolved solids	In 125 miles downstream of the South Fork Leon River, bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (M/NS). The average concentration of dissolved solids exceeds the criterion established to safeguard general water quality uses (L/CN).
1222	Proctor Lake	L	Nonpoint	Depressed dissolved oxygen	Dissolved oxygen concentrations are occasionally lower than the criterion established to assure optimum conditions for aquatic life (L/PS).
1222A	Duncan Creek (Comanche County)	L	Nonpoint	Depressed dissolved oxygen, pathogens	Dissolved oxygen concentrations are occasionally lower than the criterion established to assure optimum conditions for aquatic life (L/NS). Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS).
1226	North Bosque River	H	Point and Nonpoint	Pathogens, chlorophyll α	In 75 miles of the segment from the upper segment boundary downstream through the City of Clifton, bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS). According to water quality data contributed by the Texas Institute for Applied Environmental Research, elevated levels of chlorophyll α occur throughout the segment at frequencies great enough to cause a concern (H/NS). TIAER data also indicate that excessive nutrient levels are entering the segment from tributary watersheds.
1226A	Duffau Creek (Erath and Bosque Counties)	L	Nonpoint	Pathogens	Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS).
1226B	Meridian Creek (Bosque County)	L	Nonpoint	Pathogens	Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS).
1226D	Neils Creek	L	Nonpoint	Pathogens	Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS).
1229	Paluxy River/ North Paluxy River	L	Nonpoint	Total dissolved solids	The average concentration of total dissolved solids exceeds the criterion established to safeguard general water quality uses (L/CN).
1233	Hubbard Creek Reservoir	M	Nonpoint	Sulfate	The average concentration of sulfate exceeds the criterion established to safeguard general water quality uses (M/CN).
1242	Brazos River below Whitney Lake	M	Nonpoint	Pathogens	In the Lake Brazos area near the City of Waco, bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (M/NS).
1243	Salado Creek	L	Nonpoint	Depressed dissolved oxygen, total dissolved solids	From FM 2268 downstream to the end of the segment, dissolved oxygen concentrations are occasionally lower than the criterion established to assure optimum conditions for aquatic life (L/PS). In the same portion of the segment, the concentration of total dissolved solids exceeds the criterion established to safeguard general water quality uses (L/CN).

Table 3-12 (Continued)

Segment Number	Segment Name	Overall Priority	Source	Parameter of Concern	Segment Summary
1244	Brushy Creek	M	Point	Total dissolved solids	The average concentration of total dissolved solids exceeds the criterion established to safeguard general water quality uses (M/CN).
1245	Upper Oyster Creek	M	Point, Nonpoint	Depressed dissolved oxygen, pathogens	Dissolved oxygen concentrations are occasionally lower than the criterion established to assure optimum conditions for aquatic life (M/PS). Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (M/NS).
1254	Aquilla Reservoir	H	Nonpoint	Atrazine and alachlor in finished drinking water, depressed dissolved oxygen	The average concentrations of atrazine in finished drinking water exceeds the maximum contaminant level for primary drinking water standards (H/NS). Contamination is present in untreated reservoir (source) water, and represents a failure of the water body to support the public water supply use. Alachlor concentrations in finished drinking water indicate contamination of source water and represent a threat to future use (T-m). Dissolved oxygen concentrations are occasionally lower than the criterion established to assure optimum conditions for aquatic life (L/PS).
1255	Upper North Bosque River	H	Point and Nonpoint	Pathogens, chloride, sulfate, total dissolved solids, ammonia nitrogen, nitrite+nitrate nitrogen, chlorophyll α, orthophosphorus, and total phosphorus	Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS). Average chloride, sulfate, and total dissolved solid concentrations exceed the criteria established to safeguard general water quality uses (L/CN). According to water quality data contributed by the Texas Institute for Applied Environmental Research (TIAER), elevated levels of ammonia nitrogen, nitrite+nitrate nitrogen, chlorophyll α, orthophosphorus, and total phosphorus occur from the city of Stephenville downstream to the end of the segment at frequencies great enough to cause a concern (H/NS). TIAER data also indicate that excessive nutrients are entering the segment from tributary watersheds and that small reservoirs (PL-566 structures) in the watershed exceed screening criteria for phosphorus and chlorophyll α.

Explanation of Column Headings:

Segment Number: This is the classified segment number to a water body or a portion of a water body in the Texas Surface Water Quality Standards. A letter designation following the segment number indicates an unclassified water body that is located within the watershed of the classified segment whose number is shown before the letter.

Segment Name: The name of the water body.

Overall Priority: The overall priority rank of the water body for TMDL development is shown in this column. If there are multiple impairments, the highest rank assigned for an individual becomes the overall rank.

Impaired waters: H = high, M = medium, L= low

Threatened waters: T-h = threatened-high, T-m = threatened-medium

Parameters of Concern: Those pollutants or water quality conditions for which screening procedures indicate an existing impairment, or a threat of within the next two years.

Segment Summary: The priority level for each pollutant is shown in parentheses, as in the overall priority column. Following the priority level will be the designation “NS” for water bodies that are not supporting their uses as designated in the Texas Surface Water Quality Standards, or the designation “PS” for water bodies that are partially supporting their designated uses. For water bodies listed for nonattainment or partial attainment of numeric or narrative criteria designed to support general water quality, the designation “CN” for criteria not supported, or “CP” for criterial partially supported, will follow the priority ranking.

3.5 Groundwater Availability

Fifteen aquifers underlie parts of the Brazos G planning region, including six of the major and nine of the minor aquifers in Texas.[4] As presented earlier, Figures 1-9 and 1-10 show locations of the major and minor aquifers. A description of each aquifer, including groundwater availability, is presented in Appendix A. Table 3-14 summarizes groundwater availability by aquifer and by area. Table 3-15 is a compilation of groundwater availability by county. The availability estimates do not include saline water (greater than 1,000 milligrams per liter of total dissolved solids) and assumes a uniform distribution of withdrawals.

[4] Texas Water Development Board, *Water for Texas*, 1997

Table 3-13.
Municipal Surface Water Supply Potentially Impacted by High TDS and Chloride Concentrations

Segment No.	Description	Water Right or Contract Owner	Water Right No	Permitted Diversion (acft/yr)	Contract Amount (acft/yr)	County of Use
1203	Lake Whitney	Brazos River Authority	5157	18,336		
		City of Cleburne			4,700	Johnson
		City of Whitney			750	Hill
		Fred T. Owen, Jr.			60	Hill
		Lakeside Domestic Use			20	
		TOTAL		18,336	5,530	
1205	Lake Granbury	Brazos River Authority	5156	64,712		
		Acton MUD[1]			3,000	Hood
		City of Granbury[1]			7,121	Hood
		Johnson Co. FWSD No. 1[1]			2,665	Johnson
		Johnson Co. Rural WSC[1]			5,944	Johnson
		City of Godley			95	Johnson
		City of Rio Vista			65	Johnson
		Southwest Water Service, Inc.[1]			300	Hood
		Lakeside Domestic Use			150	Hood
		TOTAL		64,712	19,340	
1207	Possum Kingdom	Brazos River Authority	5155	230,750		
		City of Graham			1,000	Young
		City of Granbury[1]			6,679	Hood
		City of Lorena			1,000	McLennan
		City of Marlin			1,200	Falls
		City of Rosebud			100	Falls
		Double Diamond			1,000	Palo Pinto
		Fossen, Ford & Fossen			10	Palo Pinto
		Jowell Bailey			6	Palo Pinto
		Lakeside Domestic Use			375	Palo Pinto
		Mr. Leo H. Cook			5	Palo Pinto
		Pickwick Association, Inc.			20	Palo Pinto
		Sportsman's World MUD[2]			125	Palo Pinto
		Wanda Marquis			5	Palo Pinto
		West Side Water Group			5	Palo Pinto
		Acton MUD[1]			7,800	Hood
		Texas Parks & Wildlife Dept.			800	Palo Pinto
		TOTAL		230,750	21,401	
1223	Leon River	Eastland Co. WSD	3470	5,450		
		Various Users – Eastland Co.			450	
		TOTAL		5,450	450	
1235	Lake Stamford	City of Stamford	4179	10,000		
		City of Stamford			556	Jones
		City of Stamford			11	Haskell
		City of Hamlin			1,120	Jones
		City of Lueders			51	Jones
		City of Lueders			1	Shackelford
		Ericksdahl WSC			31	Jones
		Ericksdahl WSC			4	Shackelford
		Ericksdahl WSC			2	Haskell
		Paint Creek WSC			87	Haskell
		Paint Creek WSC			5	Jones
		Sagerton WSC			73	Haskell
		TOTAL		10,000	1,941	
1253	Brazos River below Lake Whitney	City of Robinson	5085	13,100		McLennan
		City of Waco	4340	5,600		McLennan
1253	Navasota River below Lake Mexia	Bistone WSC	5287	3,000		Limestone
		City of Groesbeck	5289	2,500		Limestone

[1] Utilizing advanced treatment (desalination) at Lake Granbury.
[2] Utilizing advanced treatment (desalination).

Table 3-14.
Groundwater Availability from BGRWPA Aquifers

Aquifer	*2050 Availability (acft/yr)*	*Typical Range in Well Yields (gpm)*
Western Area		
Seymour	69,893	100 to 1,000
Dockum	3,484	100 to 400
Blaine	1,333	less than 25
Edwards-Trinity (Plateau)	800	5 to 300
Subtotal:	75,510	
Central Area		
Trinity	77,563	50 to 500
Edwards (BFZ)	5,000	200 to 2,000
Woodbine	2,432	50 to 150
Marble Falls	4,183	less than 100
Ellenburger-San Saba	551	
Hickory	NA	NA
Subtotal:	89,729	
Southeastern Area		
Brazos River Alluvium	66,700	250 to 500
Carrizo-Wilcox	280,936	100 to 3,000
Queen City	3,459	200 to 500
Sparta	10,333	200 to 600
Gulf Coast	28,296	300 to 800
Subtotal:	389,724	
Other and Undifferentiated	2,915	—
Total:	557,878	

NA indicates not determined.

The distribution of groundwater availability is summarized by dividing the BGRWPA into three areas. As tabulated in Table 3-14 and shown in Figure 3-12, the groundwater is poorly divided with about 14 percent occurring in the western area, about 16 percent in the central area, and about 70 percent of in the eastern area.

3.5.1 Western Area

In the western area only part of the area is underlain by a major or minor aquifer, as shown in Figures 1-9 and 1-10. Together, the four aquifers (Blain, Dockum, Edwards-Trinity (Plateau), and Seymour) can supply up to 75,510 acft/yr. Of the four aquifers, the Seymour Aquifer has nearly 93 percent of the supplies and is scattered in six counties; however, about

Table 3-15.
Groundwater Availability in BGRWPA Counties and Aquifers

County	Aquifer	Availability (acft/yr)
Bell	Edwards-BFZ(Austin)	1,315
	Trinity	2,169
	Subtotal:	3,484
Bosque	Brazos River Alluvium	2,500
	Trinity	1,718
	Subtotal:	4,218
Brazos	Brazos River Alluvium	12,500
	Carrizo-Wilcox	46,458
	Gulf Coast	1,177
	Queen City	645
	Sparta	2,107
	Subtotal:	62,887
Burleson	Brazos River Alluvium	9,400
	Carrizo-Wilcox	46,458
	Queen City	672
	Sparta	1,666
	Subtotal:	58,196
Callahan	Trinity	3,787
	Subtotal:	3,787
Comanche	Trinity	21,976
	Subtotal:	21,976
Coryell	Trinity	1,791
	Subtotal:	1,791
Eastland	Trinity	4,853
	Subtotal:	4,853
Erath	Trinity	20,165
	Subtotal:	20,165
Falls	Brazos River Alluvium	15,600
	Carrizo-Wilcox	4,406
	Trinity	161
	Subtotal:	20,167
Fisher	Dockum	102
	Seymour	7,010
	Subtotal:	7,112
Grimes	Brazos River Alluvium	1,700
	Carrizo-Wilcox	6,789
	Gulf Coast	14,083
	Queen City	462
	Sparta	2,044
	Subtotal:	25,078

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Table 3-15 (continued)

County	Aquifer	Availability (acft/yr)
Hamilton	Trinity	2,146
	Subtotal:	2,146
Haskell	Seymour	22,866
	Subtotal:	22,866
Hill	Trinity	2,383
	Woodbine	1,433
	Subtotal:	3,816
Hood	Trinity	6,163
	Subtotal:	6,163
Johnson	Trinity	2,053
	Woodbine	866
	Subtotal:	2,919
Jones	Seymour	7,950
	Subtotal:	7,950
Kent	Dockum	102
	Seymour	5,668
	Subtotal:	5,770
Knox	Blaine	1,333
	Seymour	24,134
	Subtotal:	25,467
Lampasas	Ellenburger-San Saba	551
	Marble Falls	4,183
	Trinity	2,145
	Subtotal:	6,879
Lee	Carrizo-Wilcox	46,458
	Queen City	1,240
	Sparta	3,900
	Subtotal:	51,598
Limestone	Carrizo-Wilcox	37,451
	Trinity	66
	Woodbine	33
	Subtotal:	37,550
McLennan	Brazos River Alluvium	15,600
	Trinity	1,718
	Woodbine	100
	Subtotal:	17,418

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Table 3-15 (concluded)

County	Aquifer	Availability (acft/yr)
Milam	Carrizo-Wilcox	46,458
	Trinity	321
	Subtotal:	46,779
Nolan	Dockum	3,280
	Edwards-Trinity (Plateau)	600
	Subtotal:	3,880
Palo Pinto	Trinity	286
	Subtotal:	286
Robertson	Brazos River Alluvium	6,300
	Carrizo-Wilcox	46,458
	Queen City	440
	Sparta	616
	Subtotal:	53,814
Shackelford		0
	Subtotal:	0
Somervell	Trinity	1,233
	Subtotal:	1,233
Stephens	Other Aquifer	705
	Subtotal:	705
Stonewall	Seymour	2,265
	Subtotal:	2,265
Taylor	Edwards-Trinity (Plateau)	200
	Trinity	679
	Subtotal:	879
Throckmorton	Other Aquifer	364
	Subtotal:	364
Washington	Brazos River Alluvium	3,100
	Gulf Coast	13,036
	Subtotal:	16,136
Williamson	Edwards-BFZ(Austin)	3,685
	Trinity	1,750
	Other Aquifer	665
	Subtotal:	5,935
Young	Other Aquifer	1,181
	Subtotal:	1,181
Total:		557,878

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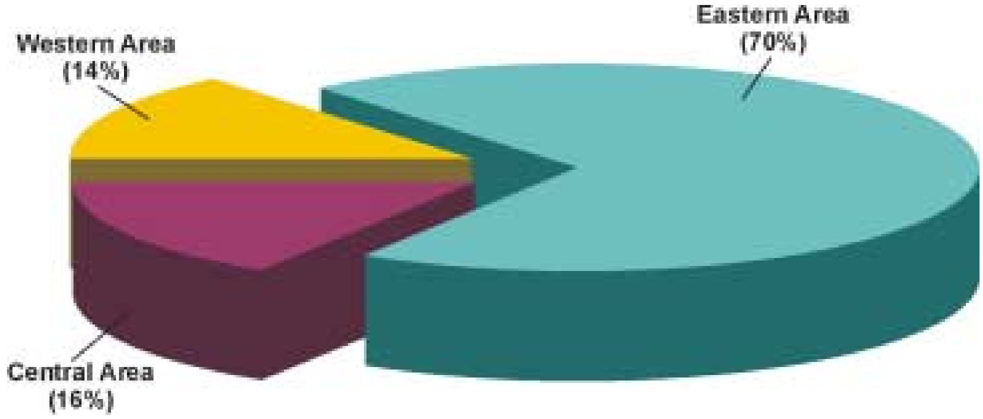

Figure 3-12. Distribution of Groundwater by Area — 554,963 acft/yr

67 percent of the supply is in Knox and Haskell Counties (Figure 3-13). The Dockum Aquifer exists only on the western fringe and has less than 5 percent of the groundwater supply in the area. Undifferentiated aquifers underlie some of the area, including all of Shackelford, Stephens, Throckmorton, and Young Counties. At best, the undifferentiated aquifers can provide only meager supplies for livestock and domestic uses.

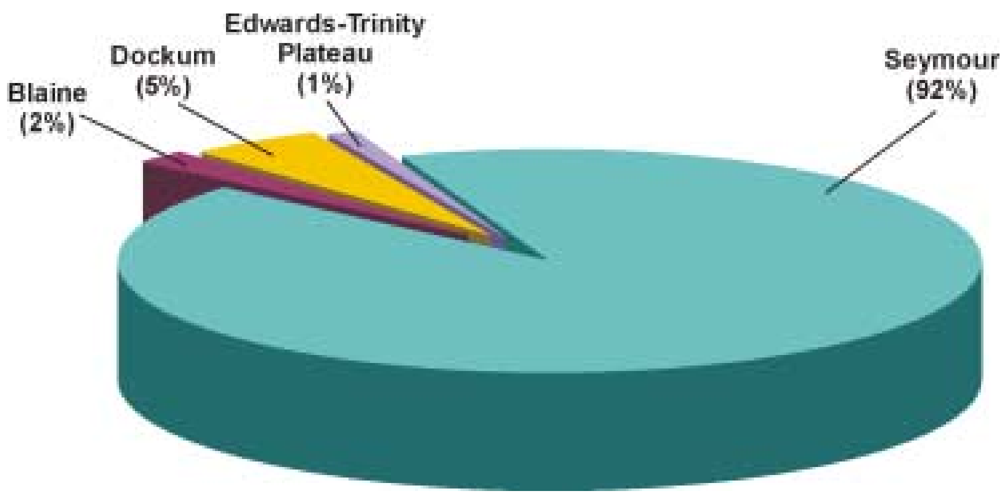

Figure 3-13. Groundwater Availability in the Western Area — 75,510 acft/yr

3.5.2 Central Area

In the central area, major or minor aquifers exist in the southeastern two-thirds of the area, as shown in Figures 1-9 and 1-10. Together, the five aquifers (Edwards-Balcones Fault Zone-Austin, Ellenburger-San Saba, Marble Falls, Trinity, and Woodbine) can provide up to 89,729 acft/yr. Of the five aquifers, the Trinity Aquifer is most extensive and has about 86 percent of the supplies (Figure 3-14). Although the Trinity Aquifer as a whole can provide 77,563 acft/yr, local areas have been severely over-drafted and cannot yield substantial supplies in the current planning period. None of the other aquifers can provide more than 5 percent of the groundwater supply in the area.

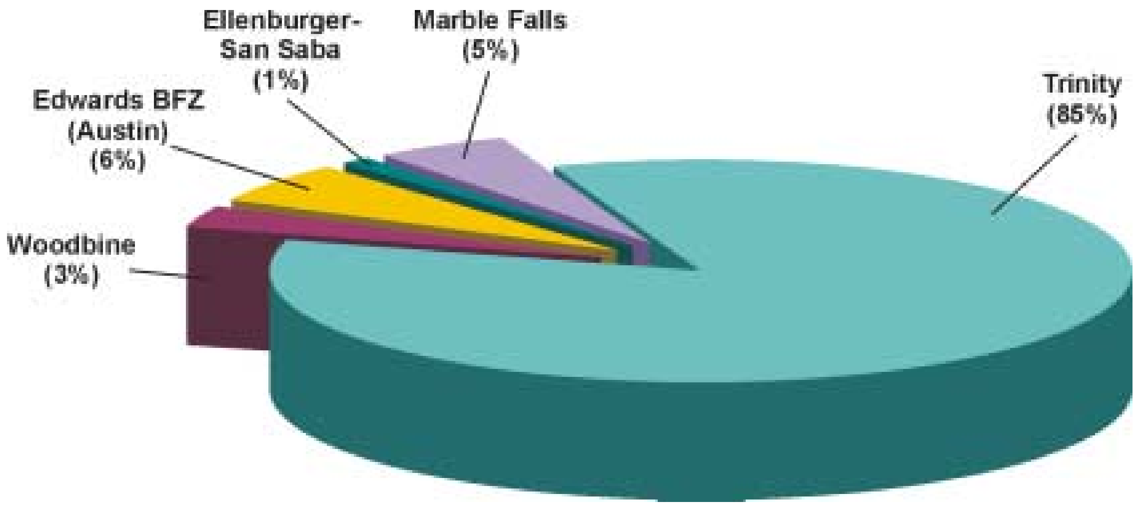

Figure 3-14. Groundwater Availability in the Central Area — 89,729 acft/yr

3.5.3 Eastern Area

In the eastern area, major or minor aquifers exist throughout the area except in the western fringe, as shown in Figures 1-9 and 1-10. Together, the five aquifers (Brazos River Alluvium, Carrizo-Wilcox, Gulf Coast, Queen City, and Sparta) can provide up to 389,724 acft/yr. Of the five aquifers, the Carrizo-Wilcox Aquifer is most extensive and has about 72 percent of the supplies (Figure 3-15). The Brazos River Alluvium has about 17 percent of the supplies.

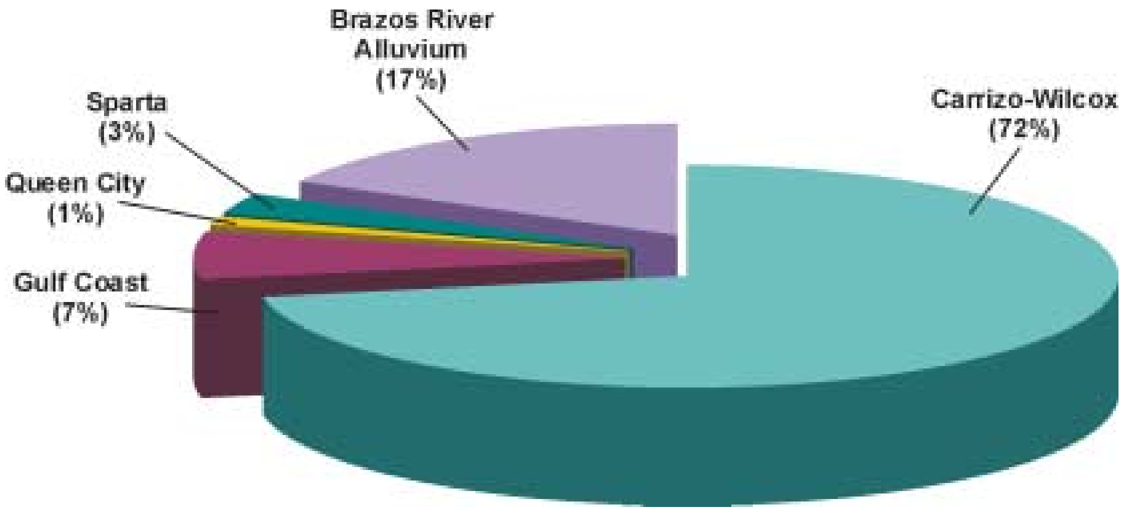

Figure 3-15. Groundwater Availability in the Eastern Area — 389,724 acft/yr

3.5.3.1 Carrizo-Wilcox Groundwater Model

The Carrizo-Wilcox Aquifer is of major significance to Brazos G regional water planning due to large, undeveloped water availability and its potential importance in meeting the Eastern Area water demands. Therefore, a groundwater computer model specific to the Brazos G portion of the Carrizo-Wilcox Aquifer was developed to verify the groundwater availability projections provided in Table 3-15. A description of the groundwater model and the simulation results are provided in a separate report.

Simulations were performed for historical and future demand projections and development alternatives contained in the Brazos G Water Plan. Simulations included withdrawals from the Carrizo-Wilcox Aquifer of about 100,000 acft/yr through 1998 and up to about 280,000 acft/yr through 2050. Based on historical withdrawals and future demand projections, the largest artesian pressure declines are going to occur in the Bryan-College Station area with a maximum artesian pressure decline of more than 400 feet over the period 1950 through 2050. To date, about 200 feet of decline has already occurred in this area. Declines of over 300 feet are anticipated in Milam and Lee Counties over the 1950 to 2050 period. Other areas in the Brazos G region are anticipated to experience lower declines primarily due to less demand. Within the Brazos G region, these declines are anticipated to be primarily in the Simsboro zone of the Carrizo-Wilcox Aquifer. Declines in other zones of the Carrizo-Wilcox

Aquifer (Carrizo, Calvert Bluff and Hooper) are anticipated to be much smaller due to less projected pumpage.

Model simulations indicate all Carrizo-Wilcox groundwater demands included in the Brazos G Water Plan can be met with significant reserves remaining well past the 50-year planning horizon. The Brazos G Carrizo-Wilcox groundwater availability projections are generally based on the 1997 *State Water Plan* (Plan) prepared by the TWDB. The model results indicate significantly more water is available than the 1997 estimates. As with any larger scale groundwater development, additional evaluations and planning are recommended such that appropriate technical, economic and environmental issues can be more fully considered.

3.5.4 Data and Information Needs

To make major improvements in the accuracy and reliability of existing groundwater availability estimates, the following data, analyses, and tools are suggested.

- Water levels measurements
    - Frequency (daily or monthly): At a relatively few and key locations, water level data for long periods of time provide documentation on trends and a means of determining if the trends can or should be modified.
    - Coverage: Infrequent (annual) water level measurements made at many locations over a relatively short period of time provides a key data element in constructing water level maps that can show the regional flow patterns and extent of influence from pumping centers.
- Recharge
    - Outcrop areas: Estimates, actually assumptions at this time, can be greatly improved by establishing a data collection network of precipitation gages and shallow water level monitoring wells in the outcrop areas.
    - Streams: Estimates can be made by conducting streamflow gain-loss studies and the establishment of monitoring networks to measure stage and discharge of stream and water levels in nearby shallow wells.
    - Cross-formational flow: These estimates would be made with existing hydrogeologic information, development of models and a rather dense network of water level monitoring wells.
- Discharge
    - Wells: The existing estimates of pumpage are believed to be rather inaccurate. In the calculation of availability, withdrawals are very strong control in aquifer conditions and directly influence the results.
    - Streams and wetlands areas: Estimates can be improved with rather dense networks of water level monitoring wells and flow-net analyses.

- Modeling: The best way in developing a water budget for an aquifer and the calculation of groundwater availability is the development of a groundwater flow model. Once the model has been tested, it is very useful in testing various groundwater development scenarios.
- Water Quality: Networks of wells and periodic sampling are needed in areas where the water is vulnerable to contamination. This is most important in outcrop areas where there is considerable activity and development.

3.6 Drought Trigger Levels

As required by SB1, each regional water plan must address drought management and for each water supply source within the region. This includes both groundwater and surface water sources. Where possible, existing drought management plans have been reviewed to develop consistent trigger conditions and management actions for each source.

For surface water sources (i.e., reservoirs), a single drought trigger was identified based on reservoir content or water surface elevation. The trigger levels for water supply reservoirs are listed in Table 3-16. For each trigger listed in Table 3-16, there is a management action associated with it that would be enacted when the trigger level is reached.

For groundwater sources, the monitoring of water levels on a regular basis provides critical data necessary to manage the water supply for municipal, industrial or irrigation demands. Historical water levels combined with water demand or pumping data allow management to establish different trigger levels for the various stages of drought. Monthly water use data would allow management to establish trigger water levels during the year and appropriate actions to take once trigger water levels are exceeded. Each user would determine the management of the water supply based on the level of drought. Specific monitoring wells for municipal supplies were not identified due to the variability of well condition, access, economics and location to pumping wells.

Table 3-17 summarizes the general recommendations of the Brazos G Regional Water Planning Group regarding the identification and initiation of drought responses to water supply sources in the Brazos G Region. As the regional planning group is a planning body only, with no implementation authority, it is emphasized that these drought responses are only recommendations. Local public and private water suppliers and water districts have been required to adopt a Drought Contingency Plan by TNRCC that contains drought triggers and

Table-3.16.
Drought Trigger Conditions by Surface Water Source

Reservoir	Trigger for Initial Drought Response[1]	Action
Lake Abilene	Water surface elevation is below 1994-ft.	Approximately 5 % of Abilene's municipal water supply is from Lake Abilene under normal conditions. In drought conditions, water from Lake Fort Phantom Hill and/or Hubbard Creek Reservoir will compensate for reduced supply from Lake Abilene.
Alcoa Lake	Steam-Electric Cooling Reservoir - No Drought Contingency Plan required	No Drought Contingency Plan required .
Lake Alan Henry	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Aquilla Reservoir	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Lake Belton	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Lake Cisco	Content is equal to or less than 40% of capacity.	Inform public by mail and through the news media that a trigger condition has been reached and that water users should look for ways to reduce water consumption voluntarily. Advise public of the trigger condition weekly. Request water users to insulate pipes rather than allowing water to flow to keep pipe from freezing.
Lake Daniel	Water surface elevation is at 1266 or below feet msl.	Develop a drought Information Center and designate an Information Person. Advise the public of the drought condition and publicize the availability of information from the Information Center. Encourage voluntary reduction of water use. Contact commercial users and explain the necessity for initiation of strict conservation methods. Make adjustments to the program to meet changing conditions.
Lake Fort Phantom Hill	Water surface elevation below 1624.9-ft (11-ft below spillway)	Implement Drought Contingency Plan - Water Alert – Landscape irrigation and swimming pool filling is restricted to 7-day schedule. Vehicle washing only by bucket or commercial car wash. Ornamental fountains, hard surface washing, and other "waste of water" activities are restricted.
Lake Georgetown	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.

Table-3.16 (continued)

Reservoir	***Trigger for Initial Drought Response[1]***	***Action***
Gibbons Creek Reservoir	Steam-Electric reservoir - No Drought Contingency Plan required	No action required.
Lake Graham/ Eddleman	Water surface elevation at or below 1064 feet msl.	Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on certain water uses.
Lake Granbury	Total storage in all system reservoirs is at or below 75% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, water in storage could be reduced to 60% or less capacity in the next 12 months.	All currently defined system reservoirs will be reviewed for possible redefinition as local-use reservoirs. Should any reservoir be so redefined, new active water supply capacities will be evaluated. Modifying or otherwise altering maintenance and repair schedules if these are used to declare a reservoir local-use only. If the redefined active water supply capacity still falls within the range of drought declaration, a specific drought contingency plan will be developed for managing all system reservoirs to deal with the problems anticipated as a result of the declared drought condition. A drought contingency plan will consider the desirability of actions such as those listed for a local-use reservoir.
Lake Granger	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Hubbard Creek Reservoir	Content is below 60% capacity	Implement Drought Contingency Plan. Communicate drought conditions to the public and promote voluntary conservation. Inform users of minimum probable time interval before next drought stage.
Lake Leon	Content at or below 50% of storage capacity.	Inform all wholesale customers to initiate voluntary water restrictions and invoke stage 1 of their drought contingency plans. Reduce or discontinue flushing of water mains.
Lake Limestone	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Miller's Creek Reservoir	Storage is at or below 9,000 acft.	Implement Drought Contingency Plan. Achieve a voluntary 10% reduction in water use. Contact wholesale water customers to initiate voluntary measures and to discuss supply and demand conditions. Provide weekly report to news media.
Lake Palo Pinto	Water surface elevation is equal to or less than 858 feet msl.	Voluntary water conservation. Inform public by media and mail. Set up Information Center.
Pat Cleburne Reservoir	Content is equal to or less than 75% of conservation storage capacity (Lake Level 729.2 feet)	Activate the Drought Information Center and designate an Information Supervisor. Advise the public of the drought condition and publicize the availability of information from the drought Information Center. Encourage voluntary reduction of water use. Contact Commercial users and explain the necessity for initiation of strict conservation methods.

Table-3.16 (continued)

Reservoir	*Trigger for Initial Drought Response*[1]	*Action*
Possum Kingdom Reservoir	Total storage in all system reservoirs is at or below 75% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, water in storage could be reduced to 60% or less capacity in the next 12 months.	All currently defined system reservoirs will be reviewed for possible redefinition as local-use reservoirs. Should any reservoir be so redefined, new active water supply capacities will be evaluated. Modifying or otherwise altering maintenance and repair schedules if these are used to declare a reservoir local-use only. If the redefined active water supply capacity still falls within the range of drought declaration, a specific drought contingency plan will be developed for managing all system reservoirs to deal with the problems anticipated as a result of the declared drought condition. A drought contingency plan will consider the desirability of actions such as those listed for a local-use reservoir.
Lake Proctor	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Lake Somerville	Total storage in all system reservoirs is at or below 75% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, water in storage could be reduced to 60% or less capacity in the next 12 months.	All currently defined system reservoirs will be reviewed for possible redefinition as local-use reservoirs. Should any reservoir be so redefined, new active water supply capacities will be evaluated. Modifying or otherwise altering maintenance and repair schedules if these are used to declare a reservoir local-use only. If the redefined active water supply capacity still falls within the range of drought declaration, a specific drought contingency plan will be developed for managing all system reservoirs to deal with the problems anticipated as a result of the declared drought condition. A drought contingency plan will consider the desirability of actions such as those listed for a local-use reservoir.
Squaw Creek Reservoir	Steam-Electric Cooling Reservoir - No Drought Contingency Plan required	No Drought Contingency Plan required
Lake Stamford	Content is equal to 12,276 acft, water elevation is 12 feet below spillway	All customers are asked to curtail use of water for nonessential purposes on a voluntary basis.
Lake Stillhouse Hollow	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.
Lake Sweetwater	Content equals 20,379 acft, or water elevation is 10 feet below spillway.	All customers are asked to curtail use of water for nonessential purposes on a voluntary basis.
Tradinghouse Creek Reservoir	Steam-Electric Cooling Reservoir - No Drought Contingency Plan required	No Drought Contingency Plan required
Twin Oak Reservoir	Steam-Electric Cooling Reservoir - No Drought Contingency Plan required	No Drought Contingency Plan required
Lake Waco	Content is at or below 50% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, indicate that water in storage could be reduced to 40% or less of capacity in the next 12 months.	Implement Drought Contingency Plan. Notify all water contract holders of reservoir level. Contact and request appropriate actions of the TNRCC, USGS, Corps of Engineers, and water contract holders.

Table-3.16 (continued)

Reservoir	*Trigger for Initial Drought Response*[1]	*Action*
Lake Whitney	Total storage in all system reservoirs is at or below 75% of capacity and estimates of current annual demands coupled with inflows and evaporation representative of the drought of record, water in storage could be reduced to 60% or less capacity in the next 12 months.	All currently defined system reservoirs will be reviewed for possible redefinition as local-use reservoirs. Should any reservoir be so redefined, new active water supply capacities will be evaluated. Modifying or otherwise altering maintenance and repair schedules if these are used to declare a reservoir local-use only. If the redefined active water supply capacity still falls within the range of drought declaration, a specific drought contingency plan will be developed for managing all system reservoirs to deal with the problems anticipated as a result of the declared drought condition. A drought contingency plan will consider the desirability of actions such as those listed for a local-use reservoir.

[1]For some sources, only initial drought response trigger condition is listed (i.e., Stage 1 conditions). In some cases, entities have other trigger levels for more severe drought conditions.

responses unique to their entity. Furthermore, those entities have the authority and responsibility to manage their particular water supply within bounds created by applicable law. Accordingly, the RWPG encourages each entity to review their respective plans with due consideration of the recommendations summarized in Table 3-17.

As noted in Table 3-17, the Trinity (counties other than Callahan and Eastland Counties), Dockum, Blaine, Woodbine, Marble Falls, Ellenburger-San Saba, Hickory, Brazos River Alluvium, Carrizo-Wilcox, Queen City, Sparta, and Gulf Coast Aquifers have little or no response to transient hydrologic drought conditions because of the very large quantity of water in storage and/or relatively long distance from recharge areas. However, all the aquifers, both locally and regionally, are subject to unacceptable long-term depletion or lowering of water levels. If this occurs, there is likely to be sufficient time to develop alternative sources of supply.

As with any source of water supply, limited capacity of production, treatment and distribution facilities may necessitate expedited expansions or implementation of water conservation measures during dry periods when water demands are unusually great.

Table 3-17.
Identification and Initiation of Drought Responses for Groundwater Sources

Source of Water Supply	***Factors to be Considered in Initiating Drought Response(s)***	***Potential Drought Response***
Seymour Aquifer	• Water level in TWDB Monitoring Well 21-35-702 (Haskell County) • Trigger water level is 30 feet below measuring point • Limit of water production, treatment and distribution facility	• Evaluate local groundwater levels • Implementation of current Drought Contingency Plans • Increase reliance on alternative supplies • Reduce irrigation acreage
Edwards-Trinity (Plateau) Aquifer	• Water level in TWDB Monitoring Well 29-47-701 (Nolan County) • Trigger water level is 35 feet below measuring point • Limit of water production, treatment and distribution facility	• Evaluate local groundwater levels • Implementation of current Drought Contingency Plans • Increase reliance on alternative supplies
Trinity Aquifer (Callahan and Eastland Counties)	• Water level in TWDB Monitoring Well 31-43-702 (Eastland County) • Trigger water level is 25 feet below measuring point • Limit of water production, treatment and distribution facility	• Evaluate local groundwater levels • Implementation of current Drought Contingency Plans • Increase reliance on alternative supplies • Reduce irrigation acreage
Edwards (BFZ) Aquifer	• Water level in TWDB Monitoring Well 58-35-204 (Williamson County) • Trigger water level is 150 feet below measuring point • Limit of water production, treatment and distribution facility	• Evaluate local groundwater levels • Implementation of current Drought Contingency Plans • Increase reliance on alternative supplies
• Trinity Aquifer (Counties other than Callahan and Eastland Counties) • Dockum Aquifer • Blaine Aquifer • Woodbine Aquifer • Marble Falls Aquifer • Ellenburger-San Saba Aquifer • Hickory Aquifer • Brazos River Alluvium • Carrizo-Wilcox Aquifer • Queen City Aquifer • Sparta Aquifer • Gulf Coast Aquifer	• In most all areas, water supplies from these aquifers are not constrained by drought conditions • Unacceptable drawdown in specific well fields • Acceptable long-term drawdown of regional water levels • Limit of water production, treatment and distribution facility	• Evaluate local groundwater levels • Implementation of current Drought Contingency Plans • Increase reliance on alternative supplies • Reduce irrigation acreage