3. Analysis of Water Supply Currently Available to Region C

This section describes Task 3 of the Senate Bill One regional planning process in Region C, which is the analysis of water supplies currently available to the region. The available supplies will be compared to the projected water demands described in Section 2 in order to determine the region's water supply needs. In its guidelines for Senate Bill One planning, the Texas Water Development Board requires that each region develop three tables to present the information on the current water supplies (TWDB Tables 4, 5, and 6). These tables are included in Appendices I, J, and K:

- TWDB Table 4 (Appendix I) gives water supply sources available to Region C, whether or not they are currently connected.
- TWDB Table 5 (Appendix J) gives the currently connected supplies available to water user groups.
- TWDB Table 6 (Appendix K) gives the currently connected supplies available to major water providers.

Current water rights as listed by TNRCC[10] were reviewed in the development of TWDB Tables 4, 5, and 6. Hydrological information for the historical drought of record was also obtained and reviewed. Historical hydrologic information was used to evaluate the supply available if previous reliable studies were not available.

The remainder of this section covers the water supply currently available to Region C. Section 3.1 is a summary of the overall water supply availability. Section 3.2 is a general discussion of water availability by user group. Section 3.3 is a general discussion of water availability for the five major water providers in the region. Section 3.4 discusses the impacts of recent droughts in Region C, and Section 3.5 summarizes the water supply available.

3.1 Overall Water Supply Availability

Table 3.1 and Figure 3.1 summarize the overall water supply availability in Region C, which is described in greater detail in Appendix I. Table 3.1 and Figure 3.1 show the following:

- Region C is currently using most of the supply available on a reliable basis from reservoirs in the region, which provided almost ¾ of the water used in 1996.
- Over half of the water supply available to Region C is from in-region reservoirs.
- Region C is currently using less than half of the total reliable groundwater supply available in the region. However, TWDB Table 4 in Appendix I shows that more than the reliable supply is being used in some aquifers and some counties.

Table 3.1
Overall Water Supply Availability in Region C

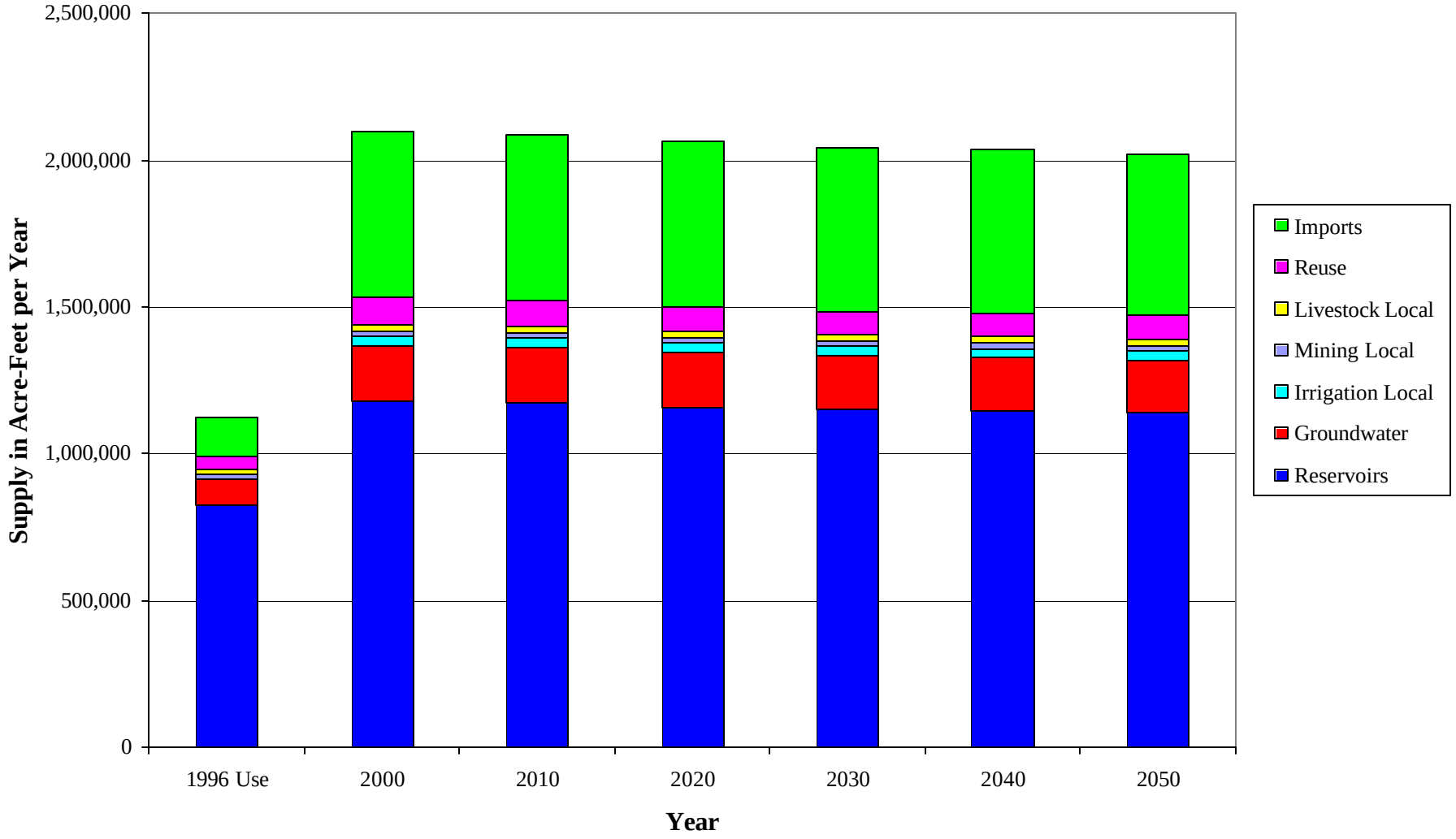
Source	Water Supply Available in Acre-Feet Per Year					
	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Reservoirs in Region C	1,179,455	1,174,409	1,158,994	1,153,142	1,146,807	1,137,917
Groundwater	186,710	186,399	186,548	180,210	180,448	180,670
Irrigation Local Supply	33,300	31,632	31,632	31,632	31,632	31,632
Mining Local Supply	19,534	19,534	19,534	19,534	19,534	19,536
Livestock Local Supply	18,843	18,843	18,843	18,843	18,843	18,843
Reuse	94,543	90,243	85,343	80,843	81,343	81,572
Imports	566,470	564,477	562,566	560,407	558,289	552,468
REGION C TOTAL	2,098,855	2,085,537	2,063,360	2,044,611	2,036,896	2,022,638

- Groundwater is slightly less than 9 percent of the overall supply available to Region C.
- Local supplies are about 3 percent of the overall supply available to Region C.
- Currently authorized reuse is about 4 percent of the overall supply available to Region C.
- Importation of water from other regions is over 28 percent of the water available to Region C.
- If all available supplies can be utilized, Region C would have 2,022,636 acre-feet per year available in 2050.

The information in Table 3.1 and Figure 3.1 was developed on the basis of the following assumptions:

Reservoirs in Region C. All major reservoirs in Region C were included, as were smaller reservoirs used for municipal supply. (Major reservoirs are those with over 5,000 acre-feet of conservation storage.) The water supply available was limited to currently permitted diversions[12] or firm yield, whichever is less. (The firm yield is the greatest amount a reservoir could have supplied without shortage during a repeat of historical hydrologic conditions.) Firm yields from previous Texas Water Development analyses [37] or from previous studies by others were adopted where possible, with some additional yield studies conducted for this project. The specific yield for each reservoir and the source of the data are given in Appendix I. It should be noted that the firm yields listed do not consider inflows from return flows of treated wastewater. Since these return flows could be reused directly rather than discharged to the stream, they are not considered to be a reliable source of supply. However, many reservoirs in Region C

Figure 3.1
Overall Water Supply Availability in Region C by Source



currently have substantial return flows in their watersheds, and these return flows supplement project yields, at least on an interim basis.

Groundwater. Groundwater availability by county and basin was taken from previous TWDB analyses [38]. The only changes from previous TWDB groundwater availability figures were as follows:

- The addition of 2,919 acre-feet per year of available water in Fannin County from the "other/undifferentiated" aquifer in the Red River Basin, as described in Appendix I.
- The use of average annual recharge for 2050 water availability for the Trinity Aquifer, as described in Appendix I.

The groundwater availability figures included over 90,000 acre-feet per year of water from the Carrizo-Wilcox aquifer in Freestone County. The historical use from this source has been less than 3,000 acre-feet per year, and it is not clear that the full supply shown to be available by TWDB will ever be developed.

Irrigation Local Supply. The local irrigation availability is based on existing surface water rights for irrigation not associated with major reservoirs [10]. The TNRCC is currently developing Water Availability Models to determine the reliable supply available for existing water rights in Texas. However, the Water Availability Models for Region C basins are not yet available, and local supplies for irrigation were estimated as described in Appendix I. (The irrigation local supply available exceeds the projected irrigation water use in some counties.)

Mining Local Supply. The local mining supply is based on water rights for mining not associated with major reservoirs and on diversions from sources which may not require permits such as quarries and gravel pits filled by groundwater. The maximum historical use from these small local sources (according to TWDB records) is assumed to be available in the future. (TWDB's projected mining use can be non-consumptive in some cases, with most of the diversion returned to the sources. For this reason, small water sources can supply a significant amount of water.)

Livestock Local Supply. Most surface water used for livestock is taken from stock ponds (which do not require water rights permits) or directly from streams. The maximum historical use from these sources (according to TWDB records [9]) is assumed to be available in the future.

Reuse. The reuse listed as available to the region is for existing projects based on current permits and authorizations. Categories of reuse include (1) currently permitted and operating indirect reuse projects, in which water is reused after being returned to the stream; (2) existing indirect reuse for industrial purposes; and (3) authorized direct reuse projects for which facilities are already developed. The specific reuse projects included are discussed in Appendix I. It is likely that reuse will increase dramatically in Region C over the next 50 years, but proposed and potential direct reuse projects are not included as currently available supplies. For many reservoirs in Region C, return flows of treated wastewater serve to supplement project yields. In some cases, where permitted diversions exceed yields without return flows, water suppliers can make use of those return flows as long as they continue to occur. However, these are not considered to be reliable supplies for the future because of possible direct reuse of wastewater effluent.

Imports. The supply available from imports is limited to current Texas Natural Resource Conservation Commission (TNRCC) water rights [12] or the firm yield, whichever is less. The specific sources for imports are described in Appendix I.

Unpermitted Reservoir Yields. In addition to the water supply availability summarized in Table 3.1, Texas Water Development Board Table 4 in Appendix I includes information on "unpermitted reservoir yields." This is in response to TWDB's requirement that the table be based on firm yields for all existing reservoirs, whether or not the existing water rights allow use of the full firm yield. By far the largest unpermitted reservoir yield in Region C is Texas' share of the yield of Lake Texoma. Most of the conservation storage of Lake Texoma is currently reserved for hydropower generation. If all of the conservation storage were to be converted to water supply use, Texas' share of the additional yield beyond current permits would be almost 650,000 acre-feet per year as of 2050. It is highly unlikely that all of this water could be made available for water supply in Region C:

- Previous conversions of conservation storage to municipal use have been opposed by hydropower generators, recreational users of the lake, and the state of Oklahoma.
- Water in Lake Texoma is relatively high in dissolved solids, requiring desalination or blending before it can be used as a municipal supply.

However, the currently unpermitted yield of Lake Texoma is a considerable resource, and it is possible that some of that potential supply will be useful to Region C in the future.

3.2 Water Availability by Water User Group

As part of the Senate Bill One planning process, the Texas Water Development Board requires development of TWDB Table 5, a table presenting water availability for each water user group by river basin and zone. (Water user groups are cities, "county other" municipal uses, and countywide manufacturing, irrigation, mining, livestock, and steam electric uses.) TWDB Table 5 is included in Appendix J. Unlike the overall water availability figures in TWDB Table 4, the availability figures by water user group in TWDB Table 5 are limited by existing physical facilities, including raw water transmission facilities and groundwater wells. The table shows the amount of supply available to each user group from each source by decade based on existing physical facilities.

The development of TWDB Table 5 requires more or less arbitrary assumptions on the distribution of available supplies. (For example, if countywide pumping from an aquifer exceeds available supply, which water user groups are assumed to have access to the supply and which are assumed to have a shortage? If a reservoir does not have enough firm yield to supply all of the water user groups it serves, which water user groups are assumed to have access to the supply and how much is available to each group?)

In developing TWDB Table 5, several important points regarding the availability of water for water user groups in Region C became apparent:

- Most water user groups will need additional facilities over the next 50 years to meet growing demands.
- Current groundwater use in several areas exceeds the long-term reliable supply projected by TWDB. (Table 3.2 shows areas in which the 1996 use exceeds the projected reliable supply by county, aquifer and river basin.) In these areas, other sources of supply will be needed to allow reduced dependence on groundwater.
- There are several significant water supplies that can be made available by the development of additional water transmission facilities. Examples include Moss Lake in Cooke County, Irving's share of Lake Chapman in the Sulphur Basin, Upper Trinity Regional Water District's share of Lake Chapman, Dallas' share of Lake Fork in the Sabine Basin and Dallas' share of Lake Palestine in the Neches Basin.
- There are also many significant water supplies that cannot be fully utilized until additional raw water transmission facilities are developed.
- Some of the supply available to the region as a whole may not be used fully in the period covered by this water supply plan. One example is the substantial amount of groundwater TWDB shows to be available from the Carrizo-Wilcox aquifer in Freestone

County. This supply is significantly in excess of projected water use in Freestone County and may not be economically available to other users.

3.3 Water Availability by Major Water Provider

As part of the Senate Bill One planning process, the Texas Water Development Board requires development of TWDB Table 6, a table presenting water availability for each designated major water provider. TWDB Table 6 is included in Appendix K. The designated major water providers in Region C are the City of Dallas, Tarrant Regional Water District, North Texas Municipal Water District, the City of Fort Worth, and the Trinity River Authority. Unlike the overall water availability figures in TWDB Table 4, the availability figures by major water provider in TWDB Table 6 are limited by existing physical facilities, including raw water transmission facilities and groundwater wells. The table shows the amount available to each major water provider from each source by decade based on existing physical facilities. Table 3.3 provides some summary information on the sources of supply available to the major water providers in Region C.

Table 3.2

Areas in Which 1996 Groundwater Use Exceeds Texas Water Development Board Projections of Water Availability

County	Aquifer	River Basin (s)	1996 Use (Ac-Ft)	TWDB Availability in Ac-Ft/Yr	
				2000	2050
Cooke	Trinity	Red & Trinity	6,809	4,529	3,753
Denton	Trinity	Trinity	10,006	6,114	5,123
Denton	Woodbine	Trinity	1,845	1,010	1,010
Ellis	Woodbine	Trinity	2,656	1,832	1,832
Grayson	Trinity	Red & Trinity	9,325	3,434	3,088
Grayson	Woodbine	Red & Trinity	5,954	5,710	5,710
Kaufman	Nacatoch	Sabine & Trinity	249	184	184
Parker	Trinity	Trinity	5,500	2,633	2,172
Tarrant	Trinity	Trinity	14,616	4,996	4,996

Dallas Water Utilities

The City of Dallas used over 438,000 acre-feet of water in 1996. (Approximately 290,000 acre-feet were used in Dallas, with 148,000 acre-feet sold to other water suppliers.) The city's major

Table 3.3
Water Supplies Available to Major Water Providers in Region C

Major Water Provider	Source	Estimated 1996 Use/ (Acre-Feet)	Water Available (Ac-Ft/Yr)		Comments
			2000	2050	
Dallas Water Utilities	Elm Fork/Lake Grapevine	238,708	220,420	203,290	Currently overdrafting.
	Ray Hubbard/Tawakoni	199,862	250,225	245,340	
	Subtotal	**438,570**	**470,645**	**448,630**	Currently connected.
	White Rock Lake	0	3,000	3,000	Assumed irrigation only. Not connected.
	Lake Fork (Dallas)	0	120,000	120,000	Import. Not yet connected.
	Lake Palestine (Dallas)	0	112,700	109,600	Import. Not yet connected.
	Subtotal	**438,570**	**706,345**	**681,230**	
Tarrant Regional Water District	Lake Bridgeport Local	3,019	15,000	15,000	
	West Fork less Bridgeport Local	75,350	86,600	81,700	
	Benbrook Lake	4,650	6,833	6,000	
	Cedar Creek/ Richland-Chambers	162,313	385,000	382,700	Needs additional transmission facilities for full use.
	Subtotal	**245,332**	**493,433**	**485,400**	
North Texas Municipal Water District	**Total System**	**185,948**	**270,743**	**260,043**	
City of Fort Worth	**Tarrant Regional Water District System**	**157,344**	**-**	**-**	Future availability depends on distribution of TRWD supply.
Trinity River Authority	Joe Pool Lake	6,860	16,900	16,300	
	Navarro Mills Lake	6,236	19,400	19,130	
	Bardwell Lake	4,976	9,600	8,100	
	Lake Livingston	12,682	16,000	16,000	Upstream diversion for TXU Electric (Lake Fairfield).
	Reuse/Las Colinas	2,433	8,000	8,000	Irrigation.
	Reuse/Waxahachie	0	3,400	5,129	
	TRWD Ellis County	0	-	-	Future availability depends on distribution of TRWD supply.
	TRWD Tarrant County	23,970	-	-	Future availability depends on distribution of TRWD supply.
	Subtotal	**57,157**	**73,300 + TRWD supply**	**72,659 + TRWD Supply**	
Total Supply for Major Water Providers (Without Double Counting TRWD Sales to Fort Worth and TRA)		**903,037**	**1,543,821**	**1,499,332**	

supply sources include their Elm Fork/Lake Grapevine system (Lake Ray Roberts, Lake Lewisville, Dallas' share of Lake Grapevine, and Dallas' other water rights on the Elm Fork of the Trinity River), Lake Ray Hubbard/Lake Tawakoni, White Rock Lake, Lake Fork, and Lake Palestine. White Rock Lake is not currently used for municipal water supply, and the city does not plan to use it for municipal supply in the future. Lake Fork and Lake Palestine are significant supply sources that are not currently connected to the city's system. The estimated reliable supply for Dallas from currently connected sources is 470,600 acre-feet per year as of the year 2000. However, this does not include the yield available to the city from return flows of treated wastewater into the lakes. Dallas is currently developing plans for a transmission system to connect the Lake Fork supply to their system, which should be constructed and in operation in the next few years. Counting only irrigation use from White Rock Lake, Dallas' system has a projected reliable supply from current sources of 681,230 acre-feet per year in 2050.

Tarrant Regional Water District

The Tarrant Regional Water District used over 245,000 acre-feet of water in 1996. The District's major water supply sources include the West Fork lakes (Lake Bridgeport, Eagle Mountain Lake and Lake Worth, which is actually owned by Fort Worth), Benbrook Lake, Cedar Creek Lake, and Richland-Chambers Lake. The Tarrant Regional Water District system has a projected reliable supply of 485,400 acre-feet per year as of 2050 based on firm yield operation. (Tarrant Regional Water District plans and operates its water supply on the basis of safe yield, which is a more conservative approach and results in a lower reliable supply.)

North Texas Municipal Water District

The North Texas Municipal Water District used almost 186,000 acre-feet of water in 1996. The District's sources of supply include Lake Lavon, Lake Texoma, Lake Chapman, and reuse of treated wastewater effluent discharged into the Lake Lavon watershed. The North Texas Municipal Water District system has a projected reliable supply from current sources of 260,043 acre-feet as of 2050.

City of Fort Worth

The City of Fort Worth receives almost all of its water supply from the Tarrant Regional Water District. (The city has a water right for Lake Worth and a run-of-the-river water right on

the Clear Fork of the Trinity River. However, under current operating policies neither of these water rights would provide a reliable water supply during a drought. The city does have authorization for one reuse project.) Fort Worth used over 157,000 acre-feet from the District in 1996. The amount of water available to Fort Worth in the future will depend on how the supplies available to the Tarrant Regional Water District are divided. (In 1996, Fort Worth used almost 65 percent of the water provided by the Tarrant Regional Water District. Sixty-five percent of the Tarrant Regional Water District's 2050 supply would be about 315,000 acre-feet per year.)

Trinity River Authority

The Trinity River Authority used over 57,000 acre-feet of water in 1996. The TRA has water rights in Navarro Mills Lake, Joe Pool Lake, and Lake Bardwell in Region C. TRA also imports water from Lake Livingston in Region H (by an upstream diversion from the Trinity River) and has permits and authorization for three reuse projects, two of which are in operation. TRA purchases water from the Tarrant Regional Water District for its Tarrant County water supply project and has plans to purchase water from TRWD for use in Ellis County. As of 2050, TRA's independent supply in Region C from current sources is projected to be 72,659 acre-feet, in addition to the water it purchases form the Tarrant Regional Water District.

As of 2050, the total projected independent supply from current sources for these five major water providers (without double counting water provided by Tarrant Regional Water District to Fort Worth and TRA) is almost 1,500,000 acre-feet per year – almost three-quarters of the total supply available to the region. The 1996 use by these major providers was over 903,000 acre-feet - about 80 percent of the region's total water use.

3.4 Impacts of Recent Droughts in Region C

Region C has experienced summer droughts and high water use in four of the last five years – 1996, 1998, 1999, and 2000. Winter and spring runoff filled most area lakes after the 1996 and 1998 droughts, but these short-term droughts have provided a test of local water supplies. Lessons learned from recent droughts include the following:

- Short-term droughts like those of recent years have put some stress on major reservoirs in Region C. Most major reservoirs in Region C are designed for a 5 to 7 year drought like that of the 1950's.

- The dry summers in 1996, 1998, 1999, and 2000 showed that the low water use of the early 1990's in Region C was a result of mild summers rather than a change in water use patterns. For many Region C suppliers, 1998 was a year of record per capita water use.
- The high demands of 1996, 1998, 1999, and 2000 exposed supply limitations for many smaller suppliers depending on overused groundwater supplies. As a result, many smaller suppliers are developing additional well capacity and/or seeking to purchase water from larger, regional suppliers.
- The high demands of 1996, 1998, 1999, and 2000 exposed treatment and distribution system limitations for many Region C water suppliers. Many area suppliers are making significant investments to overcome these limitations.
- Because most water supply systems were able to provide the needed supplies, the most significant economic impacts of the recent droughts were on agricultural production. Because there is very little irrigation water use in Region C, natural variations in rainfall are likely to continue to affect agricultural production in the region.

3.5 Summary of Current Water Supply in Region C

1. Total water use in Region C in 1996 was over 1,100,000 acre-feet. About 74 percent of the region's 1996 water use came from in-region reservoirs.
2. Region C water suppliers are currently using most of the reliable supply available from in-region reservoirs. Some in-region reservoirs are being overdrafted, with current use in excess of reliable supplies that would be available in an extended drought. (In all cases where this is being done, the water suppliers have or are developing access to other supplies.)
3. The projected reliable water supply available to Region C in 2050 from current sources will be about 2,023,000 acre-feet per year. (This figure does not consider supply limitations due to the capacities of current raw water transmission facilities and wells.) The sources of supply for Region C in 2050 include:
    - 1,138,000 acre-feet per year (56%) from in-region reservoirs
    - 181,000 acre-feet per year (9%) from groundwater
    - 70,000 acre-feet per year (3%) from local supplies
    - 82,000 acre-feet per year (4%) from reuse
    - 552,000 acre-feet per year (28%) from imports from other regions
4. The supply available to Region C from existing sources in 2050 is significantly less than the projected 2050 water use, which is about 2,537,000 acre-feet per year.
5. If the supply limitations due to the capacities of current raw water transmission facilities and wells are considered, the available supply for Region C is much less. Most water user groups will have to make improvements to these facilities to provide for projected needs.

6. Several major water supplies will require additional raw water transmission facilities before they can be utilized fully.

7. Current groundwater use in a number of areas exceeds the projected long-term water supply availability. Supplies from other sources will be needed in these areas so that groundwater use can be reduced.

8. Some sources of supply will probably not be utilized fully during the period covered by this plan.

9. The five major water providers in Region C (City of Dallas, Tarrant Regional Water District, North Texas Municipal Water District, City of Fort Worth, and Trinity River Authority) provided over 903,000 acre-feet of water in 1996 (80% of the total provided in the region). They have 74% of the 2050 water supply currently available to the region.

10. The recent drought summers of 1996, 1998, 1999, and 2000 have caused very high water use for many Region C water suppliers. These short-term droughts have put stress on some of the region's major reservoirs, which are designed for a 5 to 7 year drought like that of the 1950's. The high demands also exposed supply limitations for many smaller suppliers (especially those dependent on groundwater) and exposed treatment and distribution limitations for other suppliers.