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Regional Equations for Estimating Mean Annual and Mean Seasonal Runoff for Natural Basins in Texas, Base Period 1961–90

Water-Resources Investigations Report 00–4064

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By Jennifer Lanning-Rush

U.S. GEOLOGICAL SURVEY
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In cooperation with the Texas Natural Resource Conservation Commission

Austin, Texas
2000

U.S. DEPARTMENT OF THE INTERIOR

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Regional Equations for Estimating Mean Annual and Mean Seasonal Runoff for Natural Basins in Texas, Base Period 1961–90

By Jennifer Lanning-Rush

Abstract

Regional equations were developed for estimating mean annual and mean seasonal runoff for natural basins in Texas. The equations, which are based on the statistical relation between streamflow and basin characteristics, use streamflow data and basin characteristics from U.S. Geological Survey streamflow-gaging stations within natural basins and with a least 8 years of data during 1961–90. The State was divided into 11 hydrologic regions on the basis of previous studies. The final equations for estimating mean annual and mean seasonal runoff were developed from 228 streamflow-gaging stations. Contributing drainage area and mean annual or mean seasonal precipitation were determined to be the most significant basin characteristics in each region.

INTRODUCTION

The Safe Drinking Water Act Amendments of 1996 (Public Law 104–182) require that each State prepare a source-water assessment for all public water supplies [sections 1453 and 1428(b)]. States are required to determine (1) the drinking-water sources, (2) the origin of both existing and potential contaminants to drinking-water sources, and (3) the intrinsic susceptibility of drinking-water sources to contamination. The U.S. Geological Survey (USGS), in cooperation with the Texas Natural Resource Conservation Commission (TNRCC), began a study in 1998 to develop a method for estimating mean annual and mean seasonal runoff for water-supply intakes within natural drainage basins in Texas. The results of this study are needed to evaluate and manage the supply of the State's surface-water resources as part of the Texas source-water assessment.

Purpose and Scope

The purpose of this report is to present and qualify multivariate regional equations to estimate runoff volume for natural basins in Texas. The equations estimate mean annual and mean seasonal runoff on the basis of the statistical relation between streamflow and basin characteristics. The streamflow data and basin characteristics are from USGS continuous-record, streamflow-gaging stations within natural basins and with at least 8 years of data during 1961–90. For this report, a natural basin is defined as a basin with less than 10-percent impervious cover, less than 10-percent of its drainage area controlled by reservoirs, and no other human-related factors that would affect streamflow. Some continuous-record, streamflow-gaging stations were omitted from the study because (1) drainage areas are greater than 10,000 square miles, (2) annual runoff might be affected by reservoirs, (3) substantial amounts of withdrawal or return flow from the basin might occur, (4) streamflow is lost as recharge along the Edwards aquifer, (5) springflow can affect runoff volumes, or (6) records cannot be extended (discussed later in "Record Extension" section). Also included in the study are streamflow-gaging stations in New Mexico and Oklahoma that are less than 25 miles from the Texas border, within a natural basin, and with 30 years of record during 1961–90. The 228 gaging stations that met this criteria are shown on plate 1.

Background

Natural runoff varies principally according to temporal and areal variations in precipitation but is also influenced by topography, climate, soil characteristics, geology, and evapotranspiration. Texas is a large region with considerable climatic and physiographic variability. The mean annual precipitation differs little from north to south but differs greatly from west to east.

Accordingly, runoff can vary tremendously across the State.

Annual precipitation, in this report, represents the calendar year instead of the USGS water year (October 1 to September 30). The seasonality of precipitation was accounted for by developing equations representing each of the four seasons as follows: (1) spring—April, May, and June; (2) summer—July, August, and September; (3) fall—October, November, and December; and (4) winter—January, February, and March.

To account for the areal variability in climate and physiography, the State was divided into regions for this study. Asquith and Slade (1995) delineated hydrologic regions (fig. 1 at end of report) on the basis of areas with similar climatic and physiographic characteristics. To define their regions, Asquith and Slade considered regions presented by Carr (1967), Kier and others (1977), and Schroeder and Massey (1977). The hydrologic regions developed by Asquith and Slade (1995) were considered suitable for this study with some modifications because of insufficient streamflow data in regions 1, 2, 6, and 8. Regions 1 and 2 were combined for this study because they have similar climates. Streamflow-gaging stations in region 9 that are within 50 miles of the region 6 boundary also were included in analysis for region 6 because of similar physiography. Stations within 30 miles and upstream of region 8 that are in the Trinity and Brazos River Basins also were included in analysis for region 8. Stations used in analysis for more than one hydrologic region are noted in table 1 at end of report.

STREAMFLOW DATA

The base period 1961–90 was used to coincide with the latest global standard normals period. Thirty-year periods (1941–70, 1951–80, 1961–90) are standards used by the World Meteorological Organization (WMO) to report climatological standard normals (World Meteorological Organization, 1984). The National Climatic Data Center (NCDC) computes normals for the United States every decade (Guttman, 1989). To further justify use of this base period, an analysis was made for all streamflow stations within natural basins in Texas with at least 50 years of data. The analysis indicates that the 1961–90 period adequately represents average streamflow conditions in Texas.

Record Extension

If streamflow records for the 30-year period were incomplete for a station (short-term station), the records were extended using a station with streamflow record for that missing period (base station). The line of organic correlation (LOC) (Helsel and Hirsch, 1992) was used to estimate missing records during the 30-year period 1961–90. The LOC is analogous to an ordinary least-squares regression, except that ordinary regression minimizes the squared vertical deviations of the dependent variable (streamflow at short-term station) from the regression line, whereas the LOC technique minimizes the areas of the right triangles formed by the horizontal and vertical deviations from the regression line. The LOC is commonly used and recommended for estimation of missing records (Helsel and Hirsch, 1992).

For each short-term station, a base station was selected that would provide the basis of all the missing data. No base station was used to extend missing record at a short-term station unless the two stations had at least 5 concurrent years of streamflow. Further criteria common to the short-term and base stations included (1) contributing drainage area within 2 log cycles of each other, (2) location within the same hydrologic region or at least within 200 miles of each other, and (3) correlation coefficient of at least 0.5 for mean annual streamflow of each station. The base station was chosen from a set of stations compiled on the basis of linearity of the relation between mean annual streamflow data points for the short-term and base stations. Estimated streamflows for the short-term station are perfectly correlated with the concurrent base station streamflows, but the actual relation between short-term and base stations is highly variable. Therefore, the excluded records will be less reliable than actual gaged records. In an effort to compensate for the fact that the extended record has considerable error, each short-term station used in the final weighted regression analyses (discussed later) was given a weight factor equal to the total number of actual gaged years during 1961–90. Table 1 includes the weight factors assigned to each streamflow-gaging station in the study.

Basin Characteristics

Six basin characteristics were identified as possible independent variables for regression equation development. The six basin characteristics selected on the basis of availability, probable hydrologic significance,

and results of related studies (Asquith and Slade, 1995, Raines, 1998, Thomas and Benson, 1970) are:

A—Contributing drainage area (in square miles) is the geographical area enclosed by a topographic divide from which all surface runoff drains into the stream above the gaging station. Data is stored in the Basin Characteristics File of the USGS Water Data Storage and Retrieval System (WATSTORE). (Calculated using the largest-scale USGS topographic maps available, usually 1:24,000.)

L—Stream length (in miles) is the distance measured along the longest mapped channel from the gaging station to the headwaters, based on USGS topographic maps (scale, 1:100,000).

SL—Stream slope (in feet per mile) is the ratio of (1) the change in elevation of the longest mapped channel from the station to the headwaters to (2) the length of the longest mapped channel, based on USGS topographic maps (scale, 1:100,000).

SH—Basin shape factor is the ratio of the square of the stream length (L) to the contributing drainage area (A), which mathematically represents the ratio of the longest mapped channel length to the mean width of the basin.

MAP—Mean annual precipitation on the basin for 1961–90 (in inches), as determined from data published by the NCDC (fig. 2 [at end of report], data from Owenby and Ezell, 1992).

MSP—Mean seasonal precipitation on the basin for 1961–90 (in inches), as determined from data published by the NCDC (figs. 3 to 6 [at end of report], data from Owenby and Ezell, 1992).

REGIONAL EQUATIONS FOR ESTIMATING MEAN ANNUAL AND MEAN SEASONAL RUNOFF

During multiple-regression analysis, it is important that the various independent variables not be highly correlated with other independent variables. Not adhering to this requirement could yield unstable values for the regression coefficients, which might lead to difficulties in interpreting the effectiveness of various independent variables included in the equation. However, it is not possible to use basin characteristics that are entirely independent of each other because many natural topographic and climatic variables exhibit some degree of interdependence. The data were transformed to common logarithms to produce more linear relations among the dependent and independent variables. A simple correlation matrix of the basin characteristics was completed to investigate the amount of interdependence among the variables for each hydrologic region. Several variables indicated relatively high interdependence; some examples include positive correlation between contributing drainage area and main-channel length and between basin shape factor and main-channel length and inverse correlation between contributing drainage area and main-channel slope. Of the highly correlated basin characteristics, those with correlation coefficients greater than 0.8, only the most significant characteristics were used in the final regression equations for a particular hydrologic region.

The final equations (table 2 at end of report) for estimating mean annual and mean seasonal runoff were developed using weighted least-squares (WLS) regression of streamflow data and basin characteristics from 228 streamflow-gaging stations. In WLS regression, each dependent variable is given a weight representative of its relative accuracy (error). The greater weights are assigned to values that have greater accuracy (less error). The weight factor for each station is the total number of gaged years for the 1961–90 base period. Weight factors in this study range from 8 to 30. In most of the regression equations, contributing drainage area was the most significant explanatory variable, and mean annual or mean seasonal precipitation was the next most significant variable. The final equations were modified to use the same independent variables within each hydrologic region. In these instances, variables that were significant in most of the equations for any given season were selected as key variables, and the regressions were repeated using the key variables as the only independent variables. The final regression equations developed for each annual and seasonal period, in each region, are listed in table 2. Also listed in the table are the ranges of independent variables and standard errors associated with each equation.

Regression equations of the following form were derived:

$$\log Q_x = a + b \log A + c \log B + \ldots n \log M, \quad (1)$$

where

Q_x = mean runoff, in cubic feet per second, for either annual, spring, summer, fall, or winter;

a = regression constant;

b,c,...n = regression coefficients; and

A,B,...M = basin characteristics.

The equations were transformed from logarithm form by taking antilogarithms; the resulting equations have the following form:

$$Q_x = 10^a A^b B^c \ldots M^n .$$

Independent variables (basin characteristics) were included in the equation analysis if the F statistic[1] was greater than 5. The WLS regression also provided statistical measures of the suitability of the equations, such as, standard errors of estimate and coefficients of determination (r-squared). In general, smaller standard errors and larger coefficients of determination result in more reliable equations.

The equations listed in table 2 are based on the range of independent variables associated with the stations in the study, and therefore, the equations might have considerable error for sites with basin characteristics outside of these ranges and should not be used for such sites. Probability plots and residual plots were used to verify each equation in each region. It is preferable that the mean annual runoff equations be used to calculate the mean annual runoff, rather than summing the four estimated mean seasonal runoffs, because the annual equations have less error than the seasonal equations.

SUMMARY

Regional equations for estimating mean annual and mean seasonal runoff for natural basins are needed for the Texas source-water assessment. The equations are based on the statistical relation between streamflow and basin characteristics.The streamflow data and basin characteristics are from USGS continuous-record, streamflow-gaging stations within natural basins and with a least 8 years of data during 1961–90. The State was divided into 11 hydrologic regions on the basis of previous studies; however, regions 1 and 2 were combined for this study because of their similar climate. Some stations were used in the analysis for more than one region.

The base period of 1961–90 was used for the streamflow data to coincide with the latest global standard normals period. Records for short-term stations (incomplete for the base period) were extended using records from base stations (complete for the base period). Six basin characteristics were identified as possible independent variables for regression equation development.

The final equations for estimating mean annual and mean seasonal runoff were developed using weighted least-squares regression of streamflow data and basins characteristics from 228 streamflow-gaging stations. The same independent variables were used within each region. Contributing drainage area and mean annual or mean seasonal precipitation were determined to be the most significant basin characteristics in each region.

[1]F statistic—A test statistic (ratio of the variation explained by the independent variable to the variation not unexplained). The larger the value of F, the stronger the evidence for rejection of the null hypothesis that the regression coefficient of the independent variable is zero (Ott, 1993).

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Note: Regions 1 and 2 combined for this study.

Figure 1. Hydrologic regions of Texas (modified from Asquith and Slade, 1995).

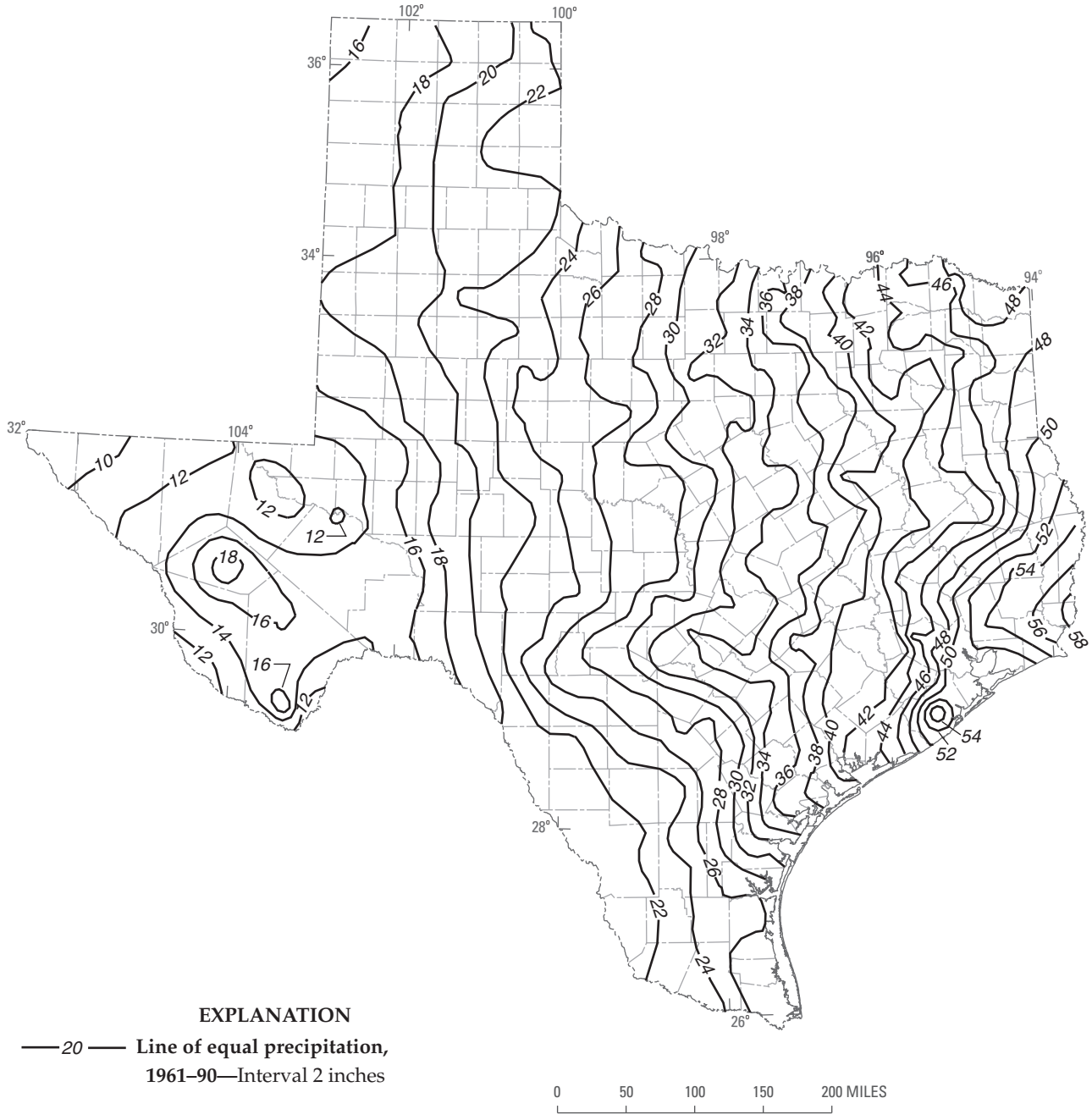

Figure 2. Mean annual precipitation, 1961–90 (data from Owenby and Ezell, 1992).

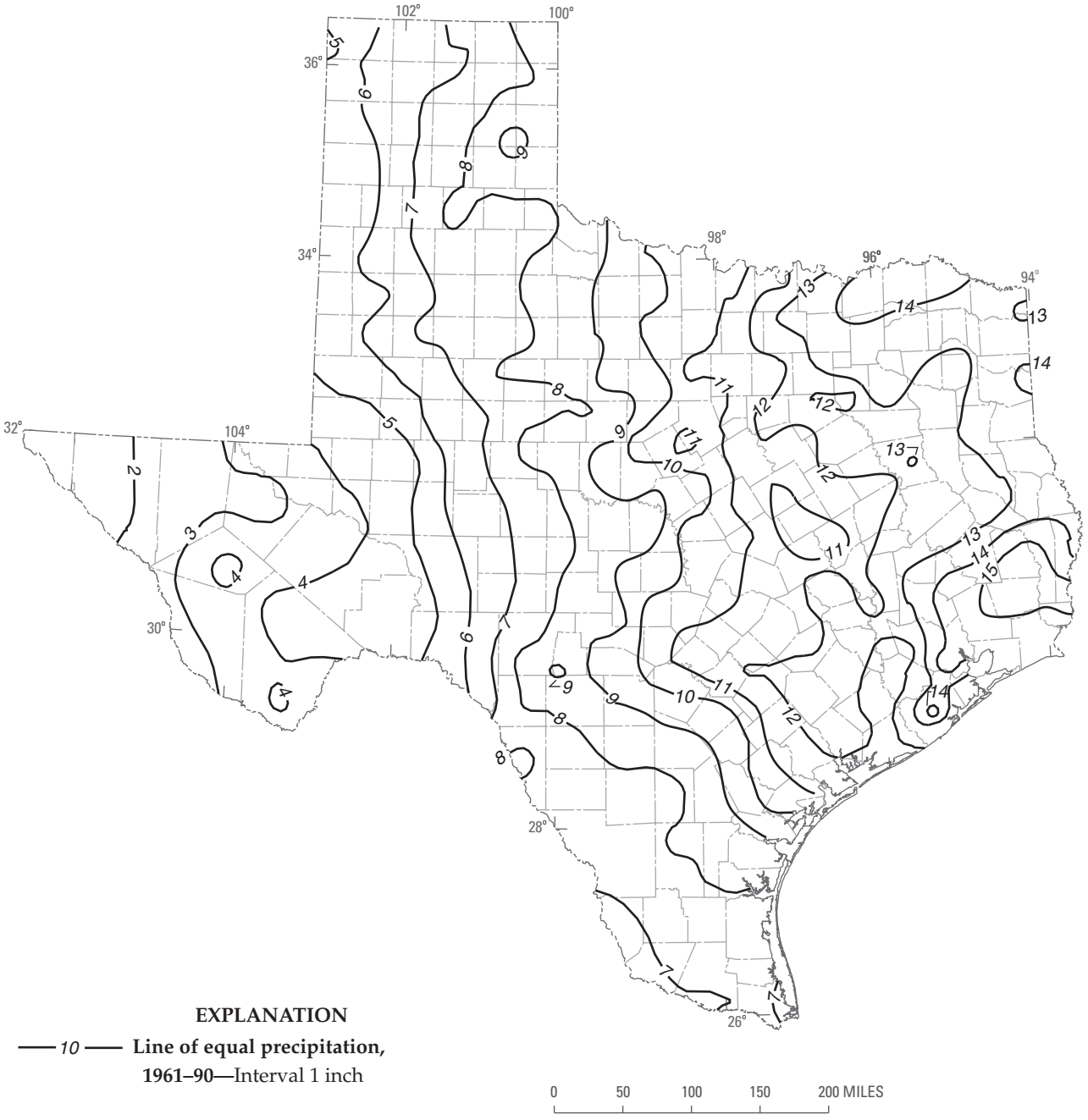

Figure 3. Mean spring precipitation, 1961–90 (data from Owenby and Ezell, 1992).

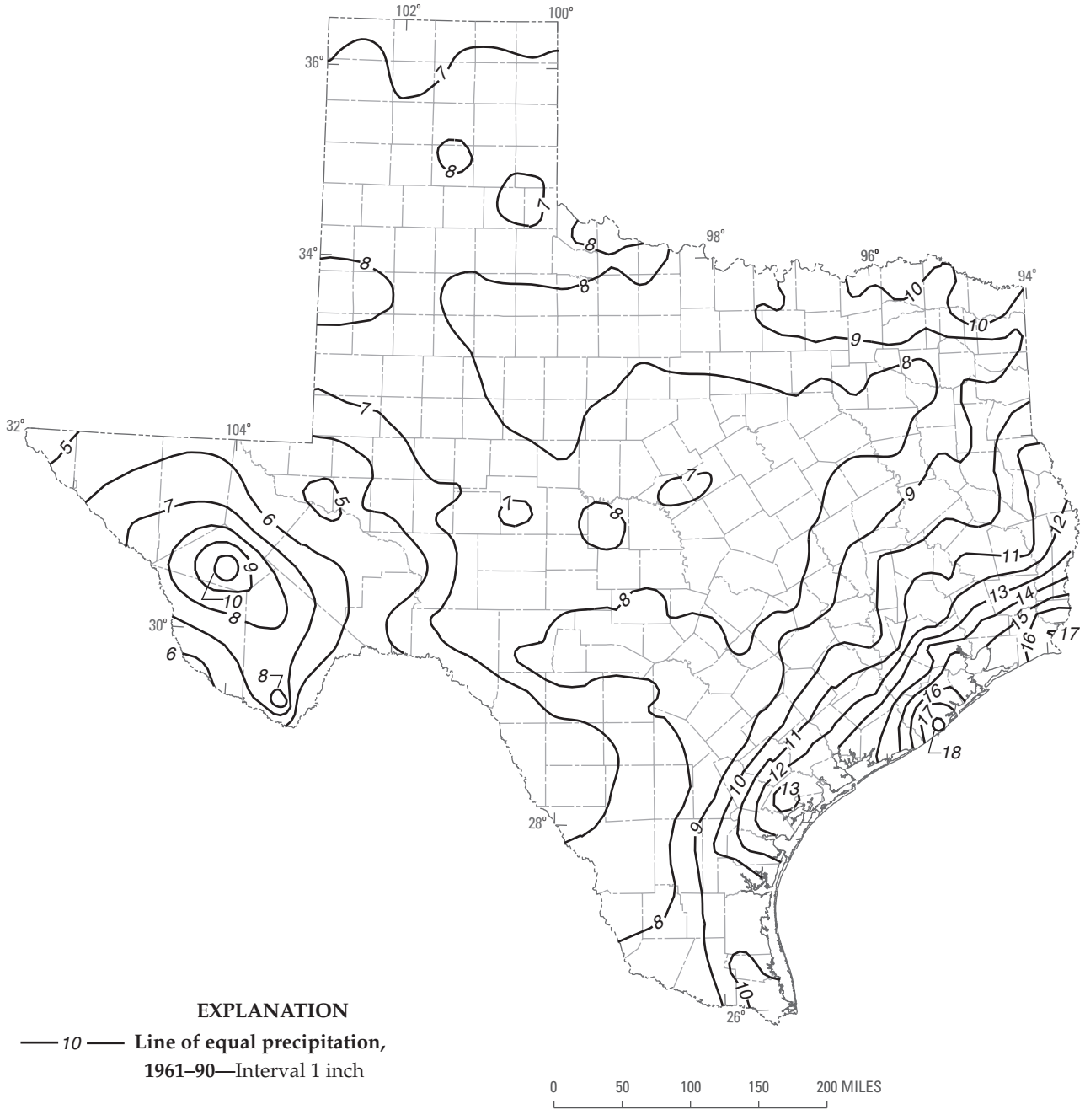

Figure 4. Mean summer precipitation, 1961–90 (data from Owenby and Ezell, 1992).

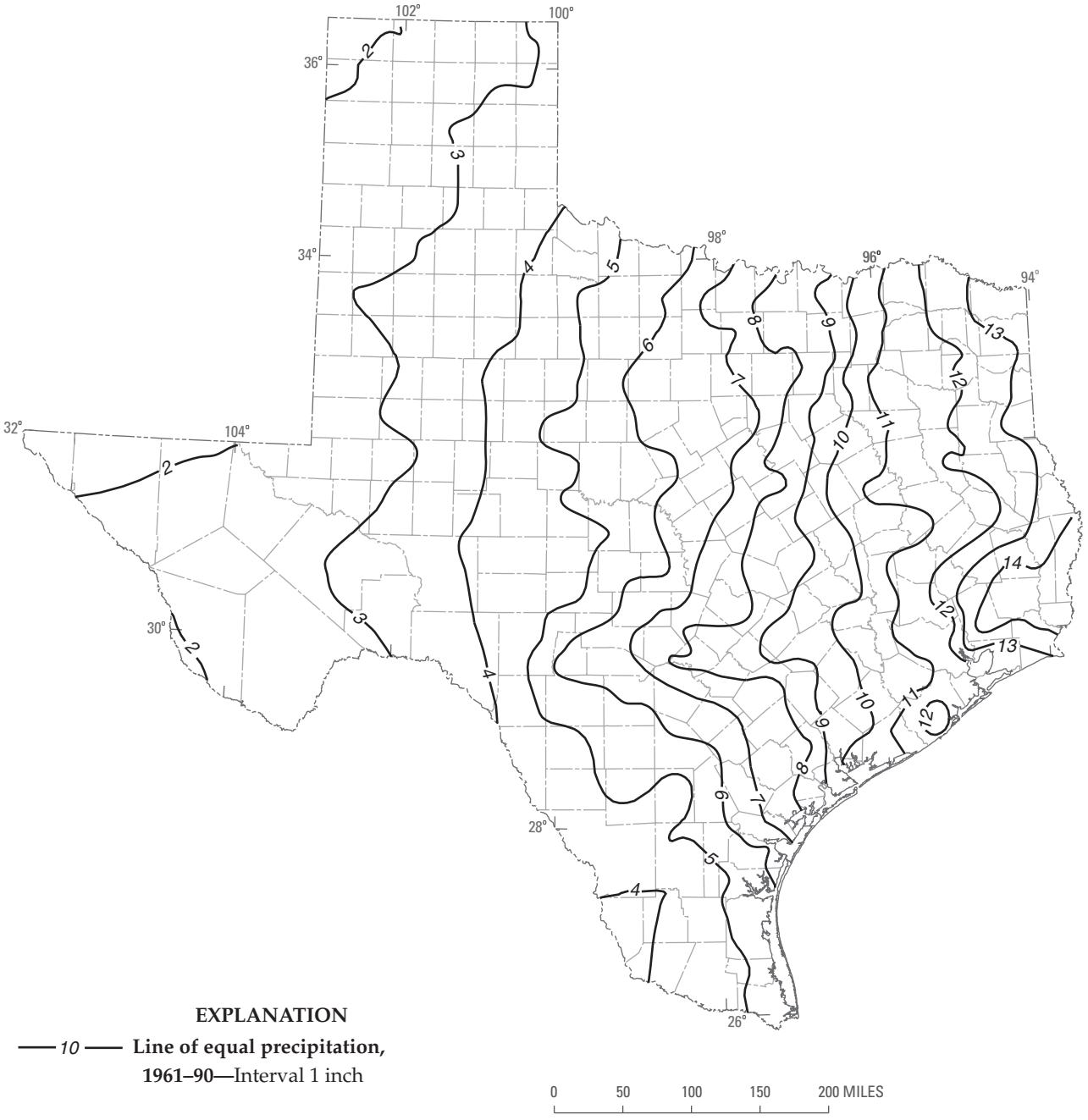

Figure 5. Mean fall precipitation, 1961–90 (data from Owenby and Ezell, 1992).

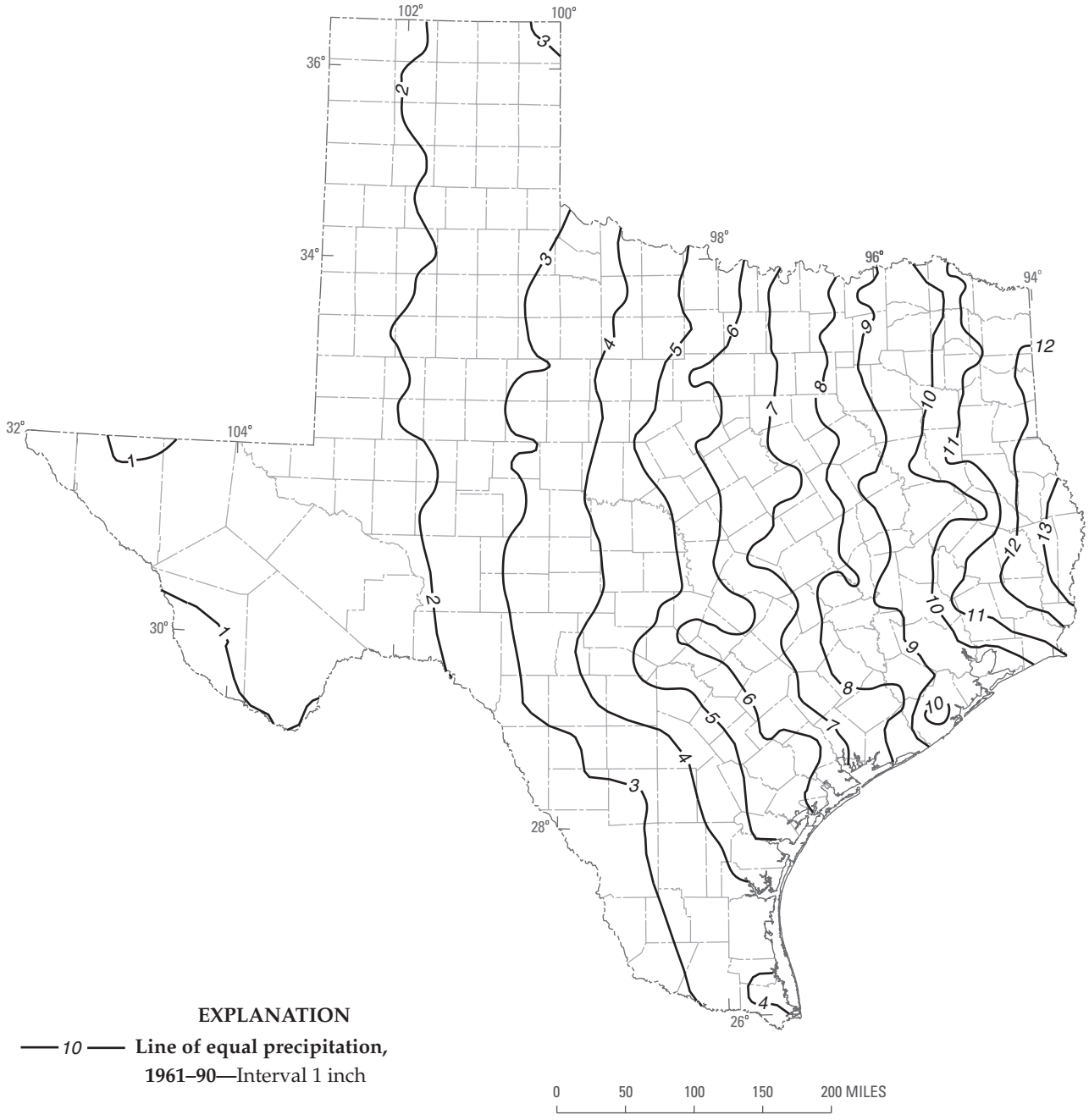

Figure 6. Mean winter precipitation, 1961–90 (data from Owenby and Ezell, 1992).

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

[mi^2, square miles; mi, miles; ft/mi, feet per mile; in., inches; ft^3/s, cubic feet per second; annual—calendar year; spring—April, and March]

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
07154500	1	Cimarron River near Kenton, Oklahoma	1		36°55'37"	102°57'32"	1961	1990	30
07227920	2	Dixon Creek near Borger, Texas	1	07300500	35°39'53"	101°21'02"	1975	1989	15
07232500	3	Beaver River near Guymon, Oklahoma	1		36°43'23"	101°29'31"	1961	1990	30
07233500	4	Palo Duro Creek near Spearman, Texas	1	07154500	36°12'08"	101°18'20"	1961	1979	19
07297910	5	Prairie Dog Town Fork Red River near Wayside, Texas	1	07300500	34°50'15"	101°24'49"	1968	1990	23
07298200	6	Tule Creek near Silverton, Texas	1	07232500	34°32'36"	101°25'46"	1965	1973	9
07299200	7	Prairie Dog Town Fork Red River near Lakeview, Texas	1	07300500	34°34'23"	100°44'43"	1964	1979	16
07299540	8	Prairie Dog Town Fork Red River near Childress, Texas	1	07300500	34°34'09"	100°11'37"	1966	1978	13
07299570	9	Red River near Quanah, Texas	3	07300500	34°24'47"	99°44'03"	1961	1978	18
07299670	10	Groesbeck Creek at State Highway 6 near Quanah, Texas	3	07308200	34°21'16"	99°44'24"	1963	1990	28
07300500	11	Salt Fork Red River at Mangum, Oklahoma	1		34°51'30"	99°30'30"	1961	1990	30
07301410	12	Sweetwater Creek near Kelton, Texas	1	07300500	35°28'23"	100°07'14"	1963	1990	28
07307800	13	Pease River near Childress, Texas	3	07308200	34°13'39"	100°04'24"	1961	1990	25
07308200	14	Pease River near Vernon, Texas	3	07307800	34°10'44"	99°16'40"	1961	1982	22
07311500	15	Deep Red Run near Randlett, Oklahoma	3		34°13'16"	98°27'11"	1961	1990	30
07311600	16	North Wichita River near Paducah, Texas	3	07307800	33°57'02"	100°03'52"	1962	1982	21
07311700	17	North Wichita River near Truscott, Texas	3		33°49'14"	99°47'10"	1961	1990	30
07311790	18	South Wichita River at Ross Ranch near Benjamin, Texas	3	07311800	33°39'18"	100°00'49"	1971	1979	9
07311800	19	South Wichita River near Benjamin, Texas	3		33°38'39"	99°48'02"	1961	1990	30
07311900	20	Wichita River near Seymour, Texas	3	07311700	33°42'01"	99°23'18"	1961	1979	19
07315200	21	East Fork Little Wichita River near Henrietta, Texas	3	08051000	33°48'46"	98°05'05"	1965	1990	26
07315700	22	Mud Creek near Courtney, Oklahoma	7		34°00'22"	97°34'01"	1961	1990	30
07316200	23	Mineral Creek near Sadler, Texas	7	08049700	33°42'08"	96°50'51"	1969	1976	8
07332500	24	Blue River near Blue, Oklahoma	7		34°00'00"	96°14'24"	1961	1990	30
07332600	25	Bois d'Arc Creek near Randolph, Texas	7	07343000	33°28'32"	96°12'52"	1964	1985	22
07336750	26	Little Pine Creek near Kanawha, Texas	10	07343000	33°50'26"	95°15'55"	1970	1980	11
07336800	27	Pecan Bayou near Clarksville, Texas	10	07342500	33°41'07"	94°59'41"	1963	1977	15
07342470	28	South Sulphur River near Commerce, Texas	7	07342500	33°13'11"	95°51'45'	1980	1990	11
07342500	29	South Sulphur River near Cooper, Texas	10		33°21'20"	95°35'39"	1961	1990	30
07343000	30	North Sulphur River near Cooper, Texas	10		33°28'29"	95°35'15"	1961	1990	30
07343200	31	Sulphur River near Talco, Texas	10		33°23'10"	95°07'56"	1961	1990	30
07343300	32	Cuthand Creek near Bogata, Texas	10	07342500	33°32'51"	95°10'22"	1964	1974	11
07343500	33	White Oak Creek near Talco, Texas	10	07342500	33°19'20"	95°05'33"	1961	1972	12
07344486	34	Brushy Creek at Scroggins, Texas	10	08017200	32°58'32"	95°11'03"	1979	1990	12
07345000	35	Boggy Creek near Daingerfield, Texas	10	07346140	33°02'10"	94°47'15"	1961	1977	17

Footnote at end of table.

streamflow data, 1961–90

May, and June; summer—July, August, and September; fall—October, November, and December; winter—January, February,

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
1	1,038	104	26.2	10.42	16.38	5.59	7.19	1.97	1.63	18.20	26.05	39.06	5.77	1.91
2	134	27.3	23.55	5.56	20.6	7.53	7.56	2.91	2.6	1.98	4.49	2.58	0.23	0.61
3	1,175	203	14.8	35.07	16.65	6.12	7.07	1.9	1.56	10.50	18.99	11.66	6.14	5.21
4	440	78.43	10.17	13.98	17.48	6.48	6.74	2.21	2.05	12.05	25.32	14.31	7.68	0.90
5	930	211.12	11.24	47.93	17.67	6.02	7.36	2.51	1.78	35.15	42.07	70.26	24.49	3.80
6	190	29.97	6.84	4.73	19	6.89	7.33	2.8	1.98	6.77	22.36	4.20	0.32	0.21
7	2,023	267.34	10.87	35.33	18.8	6.68	7.5	2.68	1.94	65.69	150.43	84.90	15.72	11.72
8	2,956	308.17	10.38	32.13	18.89	6.76	7.41	2.73	1.99	88.33	195.11	110.09	25.68	22.42
9	3,552	346.44	9.87	33.79	19.11	6.86	7.4	2.81	2.04	113.42	236.57	125.72	53.86	37.51
10	303	42.06	10.22	5.84	22.87	7.95	7.86	4.09	2.97	15.58	19.77	20.48	16.06	6.00
11	1,357	132	13.8	12.84	22.18	8.57	7.44	3.48	2.69	78.63	159.98	46.81	56.11	51.61
12	267	45.23	15.89	7.66	22.05	8.65	7.4	3.21	2.79	14.77	22.59	7.02	13.68	15.78
13	2,195	108.4	16.22	5.35	21.15	7.63	7.53	3.51	2.48	56.71	97.54	60.67	50.69	17.96
14	2,929	179.28	11.6	10.97	21.82	7.78	7.58	3.75	2.71	111.08	197.00	125.84	88.10	33.36
15	617	64.2	8.51	6.68	28.61	10.44	8.31	5.46	4.4	162.44	291.07	105.75	154.26	98.67
16	540	61.14	14.49	6.92	22.84	8.11	7.71	4.07	2.95	22.60	42.66	21.91	16.50	9.33
17	937	95.9	11.12	9.82	23.43	8.26	7.72	4.33	3.12	62.98	91.97	76.69	57.86	25.39
18	499	75.6	11.76	11.45	23.75	8.23	8.23	4.18	3.11	13.35	20.32	13.46	13.60	6.01
19	584	103.2	9.63	18.24	24.01	8.29	8.2	4.33	3.19	40.67	62.30	47.25	38.91	14.20
20	1,874	155.18	7.57	12.85	24.02	8.38	7.91	4.46	3.27	151.94	219.00	181.38	137.82	69.55
21	178	31.32	8.9	5.51	31.75	10.87	8.31	7.05	5.52	30.32	63.54	11.61	22.51	23.62
22	572	45	6.5	3.54	33.57	11.96	8.88	7.05	5.68	177.36	390.67	56.18	106.30	156.27
23	26	11.09	16.57	4.73	37.1	11.98	9.23	8.45	7.44	7.77	11.90	2.09	3.91	13.18
24	476	112	5.99	26.35	40.53	13.8	9.76	9.27	7.7	316.17	516.03	110.08	284.33	354.22
25	72	17.97	10.41	4.49	42.93	14.17	9.77	10.05	8.94	59.29	79.94	25.03	67.48	64.72
26	75.4	19.6	6.53	5.1	46.89	14.45	10.02	11.96	10.46	64.23	66.60	10.62	85.55	94.17
27	100	27.52	5.48	7.57	47.28	14.53	9.66	12.34	10.75	76.91	99.64	6.00	83.48	118.52
28	189	33.95	6.57	6.1	42.97	13.74	9.56	10.59	9.08	171.54	259.52	57.97	141.44	227.20
29	527	64.94	4.75	8	43.47	13.7	9.57	10.89	9.31	439.69	651.21	114.88	441.98	550.69
30	276	41.32	6.83	6.18	43.98	13.88	9.84	10.97	9.29	252.39	361.65	81.54	261.41	304.96
31	1,365	109.28	3.54	8.75	43.95	13.55	9.76	11.23	9.41	1395.50	2054.69	348.08	1433.69	1745.56
32	69	20.47	7.85	6.07	44.9	13.39	9.84	12.08	9.59	64.28	85.93	8.66	67.09	95.47
33	494	69.05	3.94	9.65	44.38	13.5	9.19	11.98	9.71	399.35	641.40	55.23	408.47	492.31
34	23.4	6.43	24.49	1.77	42.9	13.12	8.25	11.4	10.13	10.16	11.88	3.77	12.50	12.49
35	72	17.48	6.94	4.25	46.97	13.62	9.52	12.79	11.04	69.46	83.98	12.90	54.24	126.73

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
07346045	36	Black Cypress Bayou at Jefferson, Texas	10	07346070	32°46'40"	94°21'26"	1969	1990	22
07346050	37	Little Cypress Creek near Ore City, Texas	10	07346070	32°40'21"	94°45'03"	1964	1990	27
07346070	38	Little Cypress Creek near Jefferson, Texas	10		32°42'50"	94°20'44"	1961	1990	30
07346140	39	Frazier Creek near Linden, Texas	10	07345000	33°03'14"	94°17'24"	1966	1990	25
08017200	40	Cowleech Fork Sabine River at Greenville, Texas	7		33°07'58"	96°04'36"	1961	1990	30
08017300	41	South Fork Sabine River near Quilan, Texas	7		32°53'52"	96°15'11"	1961	1990	30
08018730	42	Burke Creek near Yantis, Texas	10	08049700	32°59'26"	95°37'18"	1979	1989	11
08019000	43	Lake Fork Creek near Quitman, Texas	10	07343000	32°45'47"	95°27'46"	1961	1979	19
08020200	44	Prairie Creek near Gladewater, Texas	10	08070500	32°28'45"	94°57'14"	1969	1976	8
08020700	45	Rabbit Creek at Kilgore, Texas	10	07346070	32°23'17"	94°54'11"	1964	1976	13
08022400	46	Socagee Creek near Carthage, Texas	10	07346070	32°13'54"	94°05'31"	1963	1973	11
08023200	47	Tenaha Creek near Shelbyville, Texas	10	08066170	31°45'56"	94°05'02"	1961	1980	20
08029500	48	Big Cow Creek near Newton, Texas	11		30°49'08"	93°47'07"	1961	1990	30
08030000	49	Cypress Creek near Buna, Texas	11	08066170	30°25'52"	93°54'28"	1961	1983	23
08031000	50	Cow Bayou near Mauriceville, Texas	11	08041500	30°11'10"	93°54'30"	1961	1986	26
08031200	51	Kickapoo Creek near Brownsboro, Texas	10	07342500	32°18'34"	95°36'19"	1963	1989	27
08033300	52	Piney Creek near Groveton, Texas	11	08068500	31°08'25"	95°05'11"	1962	1989	28
08033900	53	East Fork Angelina River near Cushing, Texas	10	08041500	31°51'36"	94°49'23"	1965	1989	25
08037050	54	Bayou LaNana at Nacogdoches, Texas	10	08070000	31°36'58"	94°38'28"	1965	1990	24
08038000	55	Attoyac Bayou near Chireno, Texas	10	08070000	31°30'15"	94°18'15"	1961	1989	26
08039100	56	Ayish Bayou near San Augustine, Texas	10	08066170	31°23'46"	94°09'03"	1961	1985	25
08039500	57	Angelina River at Horger, Texas	11	07343200	31°02'08"	94°07'48"	1966	1973	8
08041500	58	Village Creek near Kountze, Texas	11		30°23'52"	94°15'48"	1961	1990	30
08041700	59	Pine Island Bayou near Sour Lake, Texas	11	08071000	30°06'21"	94°20'04"	1968	1990	23
08042800	60	West Fork Trinity River near Jacksboro, Texas	3	07311700	33°17'36"	98°04'43"	1961	1973	13
08049550	61	Big Bear Creek near Grapevine, Texas	7	08049700	32°54'48"	97°07'44"	1968	1979	12
08049700	62	Walnut Creek near Mansfield, Texas	7		32°34'51"	97°06'06"	1961	1990	30
08051000	63	Isle Du Bois Creek near Pilot Point, Texas	7	07315200	33°24'23"	97°00'45"	1961	1984	24
08051500	64	Clear Creek near Sanger, Texas	7	07342500	33°20'21"	97°10'51"	1961	1980	20
08061540	65	Rowlett Creek near Sachse, Texas	7	08051000	32°57'35"	96°36'51"	1969	1990	22
08062900	66	Kings Creek near Kaufman, Texas	7	07343000	32°30'48"	96°19'44"	1964	1971	8
08064700	67	Tehuacana Creek near Streetman, Texas	7 [1](8)	08095400	31°50'54"	96°17'23"	1969	1990	22
08064800	68	Catfish Creek near Tennessee Colony, Texas	7 [1](8)	08049700	31°52'51"	95°52'07"	1963	1989	27
08065200	69	Upper Keechi Creek near Oakwood, Texas	7 [1](8)	08095300	31°34'11"	95°53'17"	1963	1990	28
08065700	70	Caney Creek near Madisonville, Texas	8	07343000	30°56'12"	95°56'07"	1964	1976	13

Footnote at end of table.

streamflow data, 1961–90—Continued

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
36	365	53.37	3.75	7.8	46.6	13.55	8.98	12.73	11.34	308.40	439.55	47.66	236.43	509.95
37	383	47.76	4.47	5.96	44.44	12.95	8.66	12.01	10.82	276.68	416.53	48.64	194.09	447.45
38	675	85.52	3.14	10.84	45.31	13.13	8.75	12.31	11.12	488.42	751.43	82.30	322.47	797.50
39	48	11.22	10.53	2.62	48.37	14.11	9.33	13.07	11.86	40.23	51.16	5.59	33.24	70.94
40	77.7	19.03	8.96	4.66	42	13.41	9.41	10.17	9.01	63.28	99.27	21.65	55.49	76.69
41	78.7	18.48	8.88	4.34	40.27	13.27	8.65	9.67	8.68	80.89	131.77	22.87	72.08	96.85
42	33.1	9.77	10.41	2.88	45.33	14.17	9.38	11.92	9.86	19.04	30.70	3.93	12.09	29.43
43	585	50.05	4.92	4.28	43.37	13.66	8.6	11.34	9.77	413.88	635.68	51.24	385.19	583.41
44	48.9	14.11	14.88	4.07	43.97	12.94	8.5	11.65	10.88	22.44	26.24	8.62	16.58	38.33
45	75.8	13.91	13.91	2.55	45.04	12.94	8.75	12.26	11.09	47.96	68.28	12.53	32.90	78.14
46	82.6	18.17	6.86	4	50.66	14.22	10.12	13.88	12.44	62.74	53.95	24.95	52.75	119.31
47	97.8	19.69	9	3.96	49.93	13.67	11.23	12.7	12.33	69.04	76.51	18.88	54.16	126.63
48	128	25.84	12.06	5.22	53.51	14.21	11.97	13.92	13.41	126.56	134.66	64.41	118.99	188.18
49	69.2	18.24	4.5	4.81	54.97	14.89	12.9	14.08	13.1	77.98	73.64	21.04	74.23	143.02
50	83.3	25.2	2.6	7.62	56.64	15.08	14.45	14.26	12.85	100.96	111.95	43.64	79.76	168.48
51	232	35.52	4.34	5.44	41.4	12.91	7.7	11.26	9.53	137.93	230.06	15.95	101.87	203.82
52	79	21.2	7.58	5.69	43.76	12.33	10.06	11.35	10.02	42.02	56.81	12.12	30.15	69.00
53	158	27.23	7.47	4.69	45.25	13.01	8.84	12.03	11.37	110.82	138.68	39.83	91.19	173.59
54	31.3	13.16	13.46	5.54	45.05	12.85	9.2	11.86	11.14	30.24	41.31	6.18	24.51	48.95
55	503	76.14	4.44	11.52	47.57	13.24	10.27	12.3	11.76	406.99	518.47	128.56	340.20	640.73
56	89	22.18	10.06	5.53	50.34	13.6	11.37	12.76	12.61	86.83	98.00	18.43	71.20	159.68
57	3,486	184.31	2.35	9.74	46.24	13.03	9.62	12.17	11.42	2208.62	3099.38	875.44	1205.67	3654.00
58	860	78.56	4.47	7.18	52.83	15.4	11.33	13.97	12.13	877.99	1106.19	409.65	667.64	1328.48
59	336	54.83	2.27	8.95	54.94	15.1	14.06	14.3	11.48	411.40	524.45	255.24	377.64	488.28
60	683	63.11	5.35	5.83	30.56	10.77	8.25	6.51	5.03	107.87	271.47	30.50	51.92	77.60
61	29.6	14.88	16.76	7.48	35.21	12.09	8.13	7.87	7.12	4.92	10.13	0.70	3.30	5.54
62	62.8	18.94	15.07	5.71	35.12	12.1	7.95	7.8	7.27	16.38	40.75	3.98	6.74	14.05
63	266	31.48	8.34	3.73	38.96	13.06	9.24	8.7	7.96	136.74	221.12	61.33	143.72	120.79
64	295	48.56	10.13	7.99	36.14	12.19	9.02	8.12	6.81	82.34	133.47	34.79	78.61	82.50
65	120	23.57	12.11	4.63	39.35	13.54	9.09	8.73	7.99	92.83	150.86	34.01	81.50	104.94
66	233	33.31	6.6	4.76	39.82	12.6	8.36	10.2	8.66	239.47	336.03	37.46	303.93	280.46
67	142	24.06	10.77	4.08	40.11	12.09	8.61	10.55	8.86	76.29	136.85	23.36	60.76	84.19
68	207	31.23	6.72	4.71	40.07	12.44	7.33	11.09	9.21	101.27	148.22	24.20	82.76	149.91
69	150	28.42	8.31	5.39	40.74	11.96	8.43	11	9.35	71.25	114.35	13.51	57.70	99.43
70	112	24.82	10.31	5.5	40.68	12.11	9.12	10.54	8.91	68.54	96.00	51.11	41.58	85.49

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
08065800	71	Bedias Creek near Madisonville, Texas	8	08117500	30°53'03"	95°46'39"	1968	1990	23
08066170	72	Kickapoo Creek near Onalaska, Texas	11	08031000	30°54'25"	95°05'18"	1967	1990	24
08066200	73	Long King Creek at Livingston, Texas	11	08070000	30°42'58"	94°57'31"	1964	1990	27
08066300	74	Menard Creek near Rye, Texas	11	08070000	30°28'52"	94°46'46"	1967	1990	24
08066400	75	Big Creek near Shepherd, Texas	11	08070000	30°30'59"	94°59'06"	1967	1989	23
08067500	76	Cedar Bayou near Crosby, Texas	11	08031000	29°58'20"	94°59'10"	1972	1990	19
08068000	77	West Fork San Jacinto River near Conroe, Texas	11	08068500	30°14'40"	95°27'25"	1961	1972	12
08068500	78	Spring Creek near Spring, Texas	11		30°06'37"	95°26'10"	1961	1990	30
08068520	79	Spring Creek at Spring, Texas	11		30°05'31"	95°24'21"	1961	1990	30
08068720	80	Cypress Creek at Katy-Hockley Road near Hockley, Texas	11	08078000	29°57'00"	95°48'29"	1976	1990	13
08068740	81	Cypress Creek at House-Hahl Road near Cypress, Texas	11	08078000	29°57'32"	95°43'03"	1976	1990	15
08068780	82	Little Cypress Creek near Cypress, Texas	11	08078000	30°00'57"	95°41'50"	1983	1990	8
08068800	83	Cypress Creek at Grant Road near Cypress, Texas	11	08068500	29°58'24"	95°35'54"	1983	1990	8
08070000	84	East Fork San Jacinto River near Cleveland, Texas	11		30°20'11"	95°06'14"	1961	1990	30
08070500	85	Caney Creek near Splendora, Texas	11		30°15'34"	95°18'08"	1961	1990	30
08071000	86	Peach Creek at Splendora, Texas	11	08070500	30°13'57"	95°10'05"	1961	1977	17
08072300	87	Buffalo Bayou near Katy, Texas	11	08115000	29°44'35"	95°48'24"	1978	1990	13
08072730	88	Bear Creek near Barker, Texas	11	08115000	29°49'50"	95°41'12"	1978	1990	13
08078000	89	Chocolate Bayou near Alvin, Texas	11		29°22'09"	95°19'14"	1961	1990	30
08079600	90	Double Mountain Fork Brazos River at Justiceburg, Texas	3	08080500	33°02'18"	101°11'50"	1963	1990	28
08080500	91	Double Mountain Fork Brazos River near Aspermont, Texas	3		33°00'29"	100°10'49"	1961	1990	30
08080700	92	Running Water Draw at Plainview, Texas	1	07232500	34°10'44"	101°42'08"	1962	1978	17
08081200	93	Croton Creek near Jayton, Texas	3	07311800	33°17'18"	100°25'52"	1961	1986	26
08081500	94	Salt Croton Creek near Aspermont, Texas	3	07311800	33°24'03"	100°24'29"	1961	1977	17
08082100	95	Stinking Creek near Aspermont, Texas	3	07311800	33°14'00"	100°12'47"	1966	1983	18
08082180	96	North Croton Creek near Knox City, Texas	3	07311800	33°22'59"	100°04'51"	1966	1986	21
08082500	97	Brazos River at Seymour, Texas	3	08080500	33°34'51"	99°16'02"	1961	1973	13
08082700	98	Millers Creek near Munday, Texas	3	08051000	33°19'45"	99°27'53"	1964	1990	27
08083100	99	Clear Fork Brazos River near Roby, Texas	3	08080500	32°47'15"	100°23'18"	1963	1990	28
08083240	100	Clear Fork Brazos River at Hawley, Texas	3	08080500	32°35'53"	99°48'53"	1968	1989	22
08083245	101	Mulberry Creek near Hawley, Texas	3	08128000	32°34'04"	99°47'32"	1969	1989	21
08084800	102	California Creek near Stamford, Texas	3	08080500	32°55'51"	99°38'32"	1963	1990	28
08086050	103	Deep Creek at Moran, Texas	3	07300500	32°33'33"	99°10'11"	1964	1975	12
08086100	104	Hubbard Creek near Albany, Texas	3	07300500	32°41'21"	99°09'52"	1963	1975	13
08086150	105	North Fork Hubbard Creek near Albany, Texas	3	08105000	32°42'27"	99°16'29"	1964	1990	27

Footnote at end of table.

streamflow data, 1961–90—Continued

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
71	321	37.84	7.8	4.46	41.27	12.25	9.43	10.68	8.91	185.19	260.66	61.95	176.15	241.98
72	57	12.82	12.8	2.88	45.64	12.92	10.66	11.6	10.46	42.14	57.16	11.37	40.57	59.46
73	141	22.07	10.7	3.46	47.69	13.47	10.93	12.32	10.97	98.97	134.82	29.14	87.19	144.71
74	152	39.18	7.54	10.1	51.93	14.8	11.62	13.63	11.88	118.49	158.15	52.46	88.87	174.48
75	38.8	14.45	18.16	5.38	49.63	14.49	11.19	12.88	11.07	26.37	38.08	12.24	21.01	34.16
76	64.9	16.34	2.81	4.11	52.16	14.98	13.23	13.42	10.53	57.29	83.95	42.29	53.25	49.66
77	828	56.73	5.09	3.89	44.85	12.99	10.9	11.38	9.58	478.34	596.18	174.59	480.36	662.24
78	409	51.18	6.15	6.4	43.49	12.46	10.86	11.24	8.93	222.28	305.23	106.71	200.22	276.96
79	419	54.75	5.93	7.15	43.58	12.49	10.88	11.25	8.96	222.28	305.23	106.71	200.22	276.96
80	110	25.8	5.85	6.05	41.6	12.11	10.25	10.98	8.26	47.77	65.84	23.16	34.80	67.27
81	131	31.72	4.96	7.68	42.41	12.16	10.43	11.24	8.58	63.25	90.86	33.41	48.24	80.48
82	41	12.91	5.84	4.07	43.93	12.3	10.88	11.66	9.09	21.37	34.59	10.98	14.76	25.15
83	214	41.89	5.01	8.2	43.46	12.28	10.74	11.52	8.92	97.04	145.49	44.97	67.42	130.29
84	325	45.22	5.51	6.29	47.38	13.9	10.98	12.26	10.24	227.66	313.70	93.81	189.02	314.12
85	105	30.24	8.79	8.71	47.68	13.92	11.68	12.07	10.01	80.88	110.52	40.46	71.60	100.95
86	117	30.45	9.91	7.93	49.26	14.47	11.63	12.43	10.73	80.79	99.06	43.74	67.84	112.50
87	63.3	11.65	4.08	2.14	40.25	11.26	10.38	10.46	8.15	42.29	44.56	41.91	41.25	41.45
88	21.5	10.11	4.96	4.76	43.32	11.48	11.61	11.16	9.07	15.47	18.94	11.12	15.19	16.63
89	87.7	17.36	2.74	3.44	48.26	12.87	15.04	11.16	9.19	111.37	138.98	141.76	75.60	89.13
90	244	36.99	16.67	5.61	20.26	6.96	7.64	3.4	2.26	28.92	47.05	43.68	20.54	4.41
91	1,864	326.26	7.41	57.11	18.43	5.91	7.68	3.02	1.82	137.04	217.46	203.72	100.20	26.77
92	382	134.24	9.07	47.17	18.51	6.64	7.25	2.86	1.76	3.62	10.35	1.14	2.95	0.05
93	290	62.55	18.99	13.49	22.57	7.62	8.14	3.91	2.9	14.44	23.67	19.01	11.32	3.77
94	64.3	14.78	23.31	3.4	22.54	7.74	7.92	3.92	2.96	5.34	7.74	8.39	3.78	1.43
95	88.8	24.85	10.69	6.96	23.02	7.94	7.63	4.36	3.09	5.13	9.36	4.08	5.40	1.68
96	251	56.74	11.85	12.83	23.77	8.19	8.13	4.26	3.19	18.65	17.08	34.33	19.84	3.35
97	5,972	448.91	7.4	33.74	19.51	6.35	7.75	3.31	2.1	282.89	443.07	381.21	237.65	69.63
98	104	29.54	7	8.39	26.52	8.88	8.71	5.07	3.86	7.10	13.50	9.46	3.24	2.21
99	228	38.86	13.09	6.62	23.86	8.1	8.41	4.44	2.91	11.11	17.47	15.53	8.30	3.14
100	1,416	107.32	7.37	8.13	24.28	7.76	8.7	4.61	3.21	59.99	90.03	73.37	50.56	26.02
101	205	49.71	17.69	12.06	24.67	7.65	8.78	4.85	3.39	10.98	12.92	18.26	8.14	4.60
102	478	64.88	7.58	8.81	24.54	8.36	8.22	4.65	3.31	37.05	57.53	48.83	27.65	14.19
103	228	38.25	16.47	6.42	25.05	7.93	7.2	5.63	4.29	15.44	21.64	6.79	10.53	22.79
104	454	50.8	13.76	5.68	25.81	8.29	7.55	5.66	4.31	33.78	52.08	15.95	21.72	45.36
105	39.3	13.39	36.26	4.57	28.45	9.58	8.82	5.61	4.44	6.45	7.09	11.53	3.17	4.03

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
08086212	106	Hubbard Creek below Albany, Texas	3	07299570	32°43'58"	99°08'25"	1967	1990	24
08086260	107	Pecan Creek near Eolian, Texas	3	08017200	32°35'01"	99°01'57"	1967	1975	9
08086290	108	Big Sandy Creek above Breckenridge, Texas	3	08101000	32°38'54"	99°00'15"	1976	1990	15
08088100	109	Salt Creek at Olney, Texas	3	08061540	33°22'13"	98°44'40"	1961	1977	17
08088300	110	Briar Creek near Graham, Texas	3	07315200	33°12'43"	98°37'06"	1961	1989	29
08088450	111	Big Cedar Creek near Ivan, Texas	3	07332500	32°49'39"	98°43'25"	1966	1989	24
08091500	112	Paluxy River at Glen Rose, Texas	7	08049700	32°13'53"	97°46'37"	1961	1982	22
08093250	113	Hackberry Creek at Hillsboro, Texas	7	08049700	32°00'20"	97°08'59"	1980	1990	11
08093500	114	Aquilla Creek near Aquilla, Texas	7 [1](8)	08049700	31°50'40"	97°12'04"	1961	1982	22
08095300	115	Middle Bosque River near McGregor, Texas	7 [1](8)	08101000	31°30'33"	97°21'56"	1961	1985	25
08095400	116	Hog Creek near Crawford, Texas	7 [1](8)	08064700	31°33'20"	97°21'22"	1961	1979	19
08098300	117	Little Pond Creek near Burlington, Texas	8	08049700	31°01'35"	96°59'17"	1963	1982	20
08099300	118	Sabana River near De Leon, Texas	4	08061540	32°06'50"	98°36'19"	1961	1979	19
08101000	119	Cowhouse Creek at Pidcoke, Texas	4 [1](8)		31°17'05"	97°53'05"	1961	1990	30
08103800	120	Lampasas River near Kempner, Texas	4 [1](8)	08101000	31°04'54"	98°00'59"	1963	1973	11
08103900	121	South Fork Rocky Creek near Briggs, Texas	4 [1](8)	08171000	30°54'41"	98°02'12"	1964	1990	27
08104000	122	Lampasas River at Youngsport, Texas	4 [1](8)	08101000	30°57'26"	97°42'30"	1961	1973	13
08104700	123	North Fork San Gabriel River near Georgetown, Texas	8	08171000	30°39'42"	97°42'40'	1969	1979	11
08104900	124	South Fork San Gabriel River at Georgetown, Texas	8	08171000	30°37'32"	97°41'27"	1969	1990	22
08105000	125	San Gabriel River at Georgetown, Texas	8	08171000	30°39'14"	97°39'18"	1961	1973	13
08105100	126	Berry Creek near Georgetown, Texas	8	08171000	30°41'28"	97°39'21"	1968	1990	23
08105400	127	San Gabriel River near Circleville, Texas	8	08171000	30°37'43"	97°28'23"	1968	1976	9
08105700	128	San Gabriel River at Laneport, Texas	8	08171000	30°41'39"	97°16'43"	1966	1979	14
08108200	129	North Elm Creek near Cameron, Texas	8	08171000	30°55'52"	97°01'13"	1963	1972	10
08109700	130	Middle Yegua Creek near Dime Box, Texas	8	08171000	30°20'21"	96°54'16"	1963	1990	28
08109800	131	East Yegua Creek near Dime Box, Texas	8	08171000	30°24'26"	96°49'02"	1963	1990	28
08110100	132	Davidson Creek near Lyons, Texas	8	08068500	30°25'10"	96°32'24"	1963	1990	28
08110430	133	Big Creek near Freestone, Texas	7 [1](8)	08049700	31°30'25"	96°19'31"	1979	1990	12
08111700	134	Mill Creek near Bellville, Texas	11	08068500	29°52'51"	96°12'18"	1964	1990	27
08115000	135	Big Creek near Needville, Texas	11		29°28'35"	95°48'45"	1961	1990	30
08116400	136	Dry Creek near Rosenburg, Texas	11	08115000	29°30'42"	95°44'48"	1961	1979	19
08117500	137	San Bernard River near Boling, Texas	11		29°18'48"	95°53'37"	1961	1990	30
08120500	138	Deep Creek near Dunn, Texas	3	08080500	32°34'25"	100°54'27"	1961	1986	26
08126500	139	Colorado River at Ballinger, Texas	4	08150000	31°43'58"	99°57'13"	1961	1968	8
08127000	140	Elm Creek at Ballinger, Texas	4	08190000	31°44'57"	99°56'51"	1961	1981	21

Footnote at end of table.

streamflow data, 1961–90—Continued

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
106	613	56.36	12.75	5.18	26.47	8.61	7.84	5.67	4.35	60.41	86.13	74.43	41.26	39.82
107	26.4	13.72	26.78	7.13	26.27	8.48	7.06	6.12	4.61	2.17	3.96	0.83	0.52	3.34
108	280	88.7	8.1	28.1	26.27	8.51	7.1	6.06	4.6	23.86	28.55	9.20	40.64	17.05
109	11.8	4.5	13.13	1.71	28.67	10.53	7.89	5.75	4.5	5.19	14.88	1.37	2.82	1.70
110	24.2	12.14	15.41	6.09	30.38	10.95	8.36	6.26	4.81	4.66	9.58	3.90	3.00	2.15
111	97	26.06	13.47	7	28.04	9.4	7.38	6.38	4.88	13.52	17.43	9.21	18.81	8.63
112	410	57.73	13.64	8.13	30.95	10.82	7.53	6.67	5.93	56.47	119.93	17.79	34.89	53.28
113	57.9	14.69	9.15	3.73	35.15	11.82	7.5	8.3	7.53	32.83	64.21	8.59	28.51	30.03
114	308	38.85	8.19	4.9	34.85	11.8	7.48	8.2	7.37	105.21	228.43	28.74	71.00	92.67
115	182	31.47	19.39	5.44	33.31	11.15	7.91	7.6	6.65	73.30	121.44	37.68	48.63	85.44
116	78.2	34.53	17.2	15.25	32.87	11.17	7.94	7.27	6.49	28.77	51.24	11.90	19.81	32.14
117	23	13.87	12.06	8.36	34.5	11.03	7.69	8.74	7.04	12.53	24.72	2.63	10.05	12.74
118	264	55.41	12.37	11.63	29.24	10.43	7.46	6.15	5.2	26.59	51.30	15.16	11.15	28.75
119	455	71.88	13.24	11.36	29.47	9.93	7.21	6.58	5.75	81.58	151.39	37.70	50.72	86.51
120	818	65.33	13.46	5.22	29.45	9.92	7.2	6.81	5.52	121.97	222.89	43.89	59.41	161.70
121	33.3	11.44	36.15	3.93	30.66	10.17	7.49	7.13	5.87	10.49	18.30	4.29	5.04	14.32
122	1,240	101.61	10.49	8.33	30.03	10.01	7.33	6.96	5.73	199.77	378.10	65.67	108.30	247.04
123	248	47.7	16.3	9.17	32.15	10.77	7.75	7.42	6.21	66.66	106.57	29.84	56.59	73.62
124	133	38.03	19.84	10.88	32.41	10.99	7.71	7.53	6.18	48.06	87.07	22.29	33.91	48.99
125	405	52.23	16.02	6.73	32.31	10.86	7.75	7.48	6.22	142.76	227.53	40.40	117.31	185.82
126	83.1	28.01	16.04	9.44	33.42	10.78	8.12	7.79	6.73	24.94	39.01	9.40	17.01	34.34
127	599	66.06	14.6	7.29	32.74	10.88	7.84	7.63	6.39	171.31	234.08	110.62	111.24	229.31
128	738	84.12	12.68	9.59	33.09	10.97	7.82	7.79	6.51	236.25	393.30	83.23	187.35	281.14
129	44.8	22.08	10.25	10.88	34.19	10.9	7.69	8.62	6.98	26.55	45.55	12.41	26.24	22.00
130	236	41.08	6.79	7.15	34.96	11.3	7.8	8.94	6.92	51.32	92.08	9.71	46.27	57.20
131	244	34.84	7.25	4.97	36.88	12.02	8.12	9.19	7.55	56.27	99.78	15.64	42.32	67.34
132	195	39.52	8.3	8.01	38.77	12.63	8.42	9.49	8.23	64.56	113.59	14.10	47.81	82.76
133	57.1	19	7.25	6.32	40.72	11.92	8.64	10.92	9.24	43.76	49.54	15.57	56.82	53.11
134	376	44.62	8.01	5.3	41.13	12.63	9.54	10.43	8.53	223.31	375.53	68.51	190.41	258.78
135	42.8	14.47	2.83	4.89	43.53	11.9	12.56	10.81	8.26	37.19	40.72	35.26	39.87	32.90
136	8.65	5.83	3.38	3.93	44.11	12.02	12.87	10.83	8.39	9.77	12.49	9.34	9.52	7.74
137	727	83.45	4.01	9.58	41.52	11.85	11.12	10.38	8.17	496.21	597.79	437.53	480.66	468.87
138	188	45.17	14.02	10.85	21.97	7.66	7.96	3.97	2.38	11.09	22.50	16.14	3.63	2.07
139	6,160	195.95	4.3	6.23	21.54	7.23	7.77	3.95	2.59	60.92	105.24	91.71	32.35	14.36
140	450	43.96	16.49	4.29	25.72	8.84	8.2	5.05	3.63	36.82	62.38	34.96	34.48	15.47

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
08128000	141	South Concho River at Christoval, Texas	4		31°11'15"	100°30'06"	1961	1990	30
08128400	142	Middle Concho River above Tankersley, Texas	4	08134000	31°25'38"	100°42'39"	1962	1990	29
08129300	143	Spring Creek above Tankersley, Texas	4		31°19'48"	100°38'24"	1961	1990	30
08130500	144	Dove Creek at Knickerbocker, Texas	4		31°16'24"	100°37'45"	1961	1990	30
08131400	145	Pecan Creek near San Angelo, Texas	4	08128000	31°18'32"	100°26'44"	1962	1986	25
08133500	146	North Concho River at Sterling City, Texas	4	08134000	31°49'48"	100°59'36"	1961	1985	25
08134000	147	North Concho River near Carlsbad, Texas	4		31°35'33"	100°38'12"	1961	1990	30
08144500	148	San Saba River at Menard, Texas	4		30°55'08"	99°47'07"	1961	1990	30
08144600	149	San Saba River near Brady, Texas	4	08144500	31°00'14"	99°16'07"	1980	1990	11
08148500	150	North Llano River near Junction, Texas	4	08150000	30°31'06"	99°48'39"	1961	1977	17
08150000	151	Llano River near Junction, Texas	4		30°29'51"	99°43'19"	1961	1990	30
08150700	152	Llano River near Mason, Texas	4	08150000	30°39'38"	99°06'32"	1969	1990	22
08150800	153	Beaver Creek near Mason, Texas	4	08101000	30°38'36"	99°05'44"	1964	1990	27
08151500	154	Llano River at Llano, Texas	4		30°45'04"	98°40'10"	1961	1990	30
08152000	155	Sandy Creek near Kingsland, Texas	4	08153500	30°33'30"	98°28'19"	1967	1990	24
08152900	156	Pedernales River near Fredericksburg, Texas	5	08153500	30°13'13"	98°52'10"	1980	1990	11
08153500	157	Pedernales River near Johnson City, Texas	5		30°17'30"	98°23'57"	1961	1990	30
08154700	158	Bull Creek at Loop 360 near Austin, Texas	5	08115000	30°22'19"	97°47'04"	1979	1990	12
08155300	159	Barton Creek at Loop 360, Austin, Texas	5	08200000	30°14'40"	97°48'07"	1978	1990	13
08158700	160	Onion Creek near Driftwood, Texas	5	08171000	30°04'59"	98°00'29"	1980	1990	11
08158810	161	Bear Creek below Farm Road 1826 near Driftwood, Texas	5	08200000	30°09'19"	97°56'23"	1980	1990	11
08158840	162	Slaughter Creek at Farm Road 1826 near Austin, Texas	5	08200000	30°12'32"	97°54'11"	1979	1990	12
08160800	163	Redgate Creek near Columbus, Texas	9	08115000	29°47'56"	96°31'55"	1963	1990	28
08162600	164	Tres Palacios River near Midfield, Texas	9	08078000	28°55'40"	96°10'15"	1971	1990	20
08163500	165	Lavaca River at Hallettsville, Texas	9		29°26'35"	96°56'39"	1961	1990	30
08164000	166	Lavaca River near Edna, Texas	9		28°57'35"	96°41'10"	1961	1990	30
08164300	167	Navidad River near Hallettsville, Texas	9	08164000	29°28'00"	96°48'45"	1962	1990	29
08164350	168	Navidad River near Speaks, Texas	9	08164000	29°19'18"	96°42'32"	1982	1989	8
08164450	169	Sandy Creek near Louise, Texas	9	08164000	29°09'34"	96°32'47"	1978	1990	13
08164500	170	Navidad River near Ganado, Texas	9	08164000	29°01'32"	96°33'08"	1961	1979	19
08164503	171	West Mustang Creek near Ganado, Texas	9	08164000	29°04'17"	96°28'01"	1978	1990	13
08164600	172	Garcitas Creek near Inez, Texas	9	08164000	28°53'28"	96°49'08"	1971	1990	20
08164800	173	Placedo Creek near Placedo, Texas	9	[1](6) 08164000	28°43'30"	96°46'07"	1971	1990	20
08165300	174	North Fork Guadalupe River near Hunt, Texas	5	08167000	30°03'36"	99°23'40"	1968	1990	23
08165500	175	Guadalupe River at Hunt, Texas	5	08167000	30°04'08"	99°19'23"	1966	1990	25

Footnote at end of table.

streamflow data, 1961–90—Continued

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
141	354	33.85	13.37	3.24	21.27	6.88	7.1	4.35	2.94	25.52	25.16	26.69	28.90	21.32
142	1,611	102.12	7.61	6.47	18.83	5.74	7.13	3.71	2.25	18.50	21.44	27.90	15.19	9.46
143	405	54.5	13.36	7.33	20.83	6.71	7.17	4.1	2.85	13.36	14.36	16.81	12.05	10.22
144	198	33.72	15.66	5.74	21.35	6.94	7.22	4.22	2.97	16.57	19.63	16.01	17.20	13.42
145	81.1	19.76	23.24	4.82	21.01	7.1	6.62	4.35	2.94	2.72	1.94	5.55	2.16	1.23
146	568	48.27	10.6	4.1	19.25	6.07	7.48	3.41	2.29	5.19	7.04	9.87	1.64	2.22
147	1,191	83.8	9.44	5.9	19.9	6.37	7.42	3.68	2.43	12.31	13.66	23.48	8.17	3.92
148	1,128	58.72	9.55	3.06	23.11	7.39	7.66	4.61	3.45	51.73	38.11	92.59	44.78	31.46
149	1,626	100.26	8.87	6.18	23.75	7.67	7.75	4.72	3.61	83.67	78.45	100.80	96.58	58.86
150	914	54.71	11.87	3.27	23.4	7.71	7.49	4.83	3.37	80.76	87.03	121.48	68.51	46.01
151	1,851	74.29	9.98	2.98	24.03	7.89	7.71	4.97	3.46	201.04	213.93	237.10	210.10	143.01
152	3,242	128.04	8.79	5.06	24.74	8.24	7.67	5.14	3.69	298.84	338.25	345.13	305.96	206.01
153	215	33.9	25.74	5.35	27.45	9.18	7.82	6.15	4.3	16.34	24.38	13.29	14.14	13.53
154	4,192	159.74	8.24	6.09	25.29	8.45	7.65	5.34	3.85	397.60	480.97	400.47	389.01	319.96
155	346	48.34	24.84	6.75	29.38	10	7.95	6.6	4.83	54.47	91.96	24.59	45.79	55.54
156	369	38.86	17.64	4.09	28.59	9.28	8.32	6.54	4.45	50.28	80.22	35.95	46.69	38.28
157	901	79.69	14.57	7.05	29.9	10.06	8.19	6.82	4.83	192.02	326.10	129.36	160.09	152.53
158	22.3	9.4	47.82	3.96	31.63	11	7.41	7.49	5.73	10.55	11.82	3.95	16.75	9.71
159	116	43.53	18.84	16.33	31.74	10.94	7.59	7.6	5.61	53.71	108.13	5.84	46.94	53.92
160	124	31.99	21.02	8.25	33.05	11.13	8.03	8.02	5.87	50.85	85.80	15.06	41.09	61.45
161	12.2	5.49	55.55	2.47	32.48	11.16	7.76	7.83	5.73	4.32	6.48	1.62	4.78	4.39
162	8.24	4.2	52.32	2.14	31.94	11.06	7.59	7.66	5.63	3.85	5.96	1.06	4.74	3.63
163	17.3	7.61	18.11	3.35	41.66	12.75	10.29	9.93	8.69	5.23	8.94	1.96	4.08	5.92
164	145	30.55	3.33	6.44	43.28	11.89	13.5	10.19	7.7	128.15	126.25	146.41	132.28	107.68
165	108	25.23	12.18	5.89	37.56	12.4	9.48	8.51	7.17	55.18	94.83	49.39	40.78	35.72
166	817	85.59	5.44	8.97	38.21	12.43	10.2	8.59	6.99	365.55	631.89	238.25	295.83	296.21
167	332	37.31	8.35	4.19	38.32	12.31	9.74	8.87	7.4	143.43	247.28	87.01	111.36	128.08
168	437	53.39	6.27	6.52	38.78	12.39	9.97	8.94	7.48	194.66	156.01	255.67	132.95	233.98
169	289	55.48	5.97	10.65	40.99	12.5	11.12	9.4	7.97	179.81	244.18	134.50	148.75	191.80
170	826	92.67	4.78	10.4	40	12.53	10.69	9.2	7.58	589.69	960.01	473.63	421.68	503.42
171	178	39.05	2.77	8.56	41.52	12.22	11.74	9.63	7.93	109.15	136.96	100.94	104.62	94.07
172	91.7	24.98	6.83	6.81	37.17	11.93	11.38	7.97	5.89	45.95	79.94	37.10	35.69	31.09
173	68.3	21.57	4.72	6.81	38.61	11.83	12.49	8.39	5.9	53.55	64.39	70.98	48.40	30.44
174	168	27.57	20.35	4.53	28.44	8.89	8.94	6.34	4.27	36.01	36.92	41.73	41.84	23.56
175	288	33.85	19.1	3.98	28.68	8.96	8.98	6.39	4.35	70.67	73.77	85.95	71.98	50.96

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
08166000	176	Johnson Creek near Ingram, Texas	5	08167000	30°06'00"	99°16'58"	1962	1990	29
08167000	177	Guadalupe River at Comfort, Texas	5		29°58'10"	98°53'33"	1961	1990	30
08167500	178	Guadalupe River near Spring Branch, Texas	5		29°51'38"	98°22'58"	1961	1990	30
08167600	179	Rebecca Creek near Spring Branch, Texas	5	08103900	29°55'06"	98°22'10"	1961	1973	13
08171000	180	Blanco River at Wimberley, Texas	5		29°59'39"	98°05'19"	1961	1990	30
08172000	181	San Marcos River at Luling, Texas	9	[1](6)	08171000	29°39'54"	97°38'59"	1961	1983	23
08174600	182	Peach Creek below Dilworth, Texas	9	[1](6)	08163500	29°28'26"	97°18'59"	1961	1979	19
08175000	183	Sandies Creek near Westhoff, Texas	9	[1](6)		29°12'54"	97°26'57"	1961	1990	30
08176900	184	Coleto Creek at Arnold Road near Schroeder, Texas	9	[1](6)	08164000	28°51'41"	97°13'34"	1979	1990	12
08177000	185	Coleto Creek near Schroeder, Texas	9	[1](6)	08175000	28°49'53"	97°11'10"	1961	1979	19
08177300	186	Perdido Creek at Farm Road 622 near Fannin, Texas	9	[1](6)	08163500	28°45'05"	97°19'01"	1979	1990	12
08178880	187	Medina River at Bandera, Texas	5		08200000	29°43'26"	99°04'13"	1983	1990	8
08179000	188	Medina River near Pipe Creek, Texas	5		08167000	29°40'31"	98°58'33"	1961	1982	22
08179100	189	Red Bluff Creek near Pipe Creek, Texas	5		08200000	29°40'51"	98°57'19"	1961	1981	21
08181400	190	Helotes Creek at Helotes, Texas	5		08200000	29°34'42"	98°41'29"	1969	1990	22
08183900	191	Cibolo Creek near Boerne, Texas	5		08171000	29°46'26"	98°41'50"	1963	1977	15
08185000	192	Cibolo Creek at Selma, Texas	5		08186000	29°35'38"	98°18'39"	1961	1980	20
08186000	193	Cibolo Creek near Falls City, Texas	9	[1](6)		29°00'50"	97°55'48"	1961	1990	30
08186500	194	Ecleto Creek near Runge, Texas	9	[1](6)	08175000	28°55'12"	97°46'19"	1963	1989	27
08189200	195	Copano Creek near Refugio, Texas	9	[1](6)	08189500	28°18'12"	97°06'44"	1971	1990	20
08189300	196	Medio Creek near Beeville, Texas	9	[1](6)	08189500	28°28'58"	97°39'23"	1963	1977	15
08189500	197	Misson River at Refugio, Texas	9	[1](6)		28°17'30"	97°16'44"	1961	1990	30
08189700	198	Aransas River near Skidmore, Texas	9	[1](6)	08189500	28°16'56"	97°37'14"	1965	1990	26
08189800	199	Chiltipin Creek at Sinton, Texas	9	[1](6)	08189500	28°02'48"	97°30'13"	1971	1990	20
08190000	200	Nueces River at Laguna, Texas	5			29°25'42"	99°59'49"	1961	1990	30
08190500	201	West Nueces River near Brackettville, Texas	5			29°28'21"	100°14'10"	1961	1990	30
08194200	202	San Casimiro Creek near Freer, Texas	6		08189500	27°57'53"	98°58'00"	1963	1990	28
08194600	203	Nueces River at Simmons, Texas	6		08189500	28°25'16"	98°17'03"	1966	1977	12
08195000	204	Frio River at Concan, Texas	5			29°29'18"	99°42'16"	1961	1990	30
08196000	205	Dry Frio River near Reagan Wells, Texas	5			29°30'16"	99°46'52"	1961	1990	30
08198000	206	Sabinal River near Sabinal, Texas	5			29°29'35"	99°29'49"	1961	1990	30
08200000	207	Hondo Creek near Tarpley, Texas	5			29°34'10"	99°14'47"	1961	1990	30
08201500	208	Seco Creek at Miller Ranch near Utopia, Texas	5		08200000	29°34'23"	99°24'10"	1962	1990	29
08205500	209	Frio River near Derby, Texas	6			28°44'11"	99°08'40"	1961	1990	30
08206600	210	Frio River at Tilden, Texas	6		08205500	28°28'02"	98°32'50"	1979	1990	12

Footnote at end of table.

streamflow data, 1961–90—Continued

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
176	114	19.8	25.03	3.44	27.83	8.73	8.67	6.08	4.35	28.37	28.32	34.02	29.31	21.83
177	839	68.87	15.01	5.65	29.56	9.2	9.02	6.65	4.69	247.00	293.03	253.98	239.30	201.70
178	1,315	131.27	10.85	13.1	30.94	9.8	8.98	7.08	5.08	413.65	555.88	371.23	362.04	365.46
179	10.9	5.57	77.79	2.84	33.44	11.09	8.52	7.9	5.93	5.49	10.53	1.71	3.62	6.10
180	355	60.39	19.02	10.27	33.72	11.09	8.43	8.08	6.12	147.65	223.43	87.12	123.68	156.39
181	838	124.26	13.07	18.43	34.17	11.54	8.29	8.22	6.12	382.43	565.52	245.36	348.29	370.56
182	460	50.28	7.83	5.5	36.12	12.08	8.6	8.73	6.71	145.77	256.05	44.96	148.65	133.39
183	549	54.54	8.3	5.42	32.9	10.88	8.67	7.39	5.96	130.72	224.45	104.72	99.54	94.15
184	357	47.53	10.35	6.33	33.68	10.79	9.31	7.66	5.92	58.46	107.89	39.57	42.44	43.93
185	369	50.98	8.3	7.04	33.65	10.78	9.31	7.65	5.91	95.51	133.21	126.42	78.58	43.82
186	28	8.58	17.21	2.63	32.08	10.35	9.02	7.36	5.35	6.01	9.77	4.92	6.12	3.23
187	427	51.78	19.83	6.28	29.22	9.41	8.67	6.51	4.63	131.05	229.04	83.78	109.19	102.20
188	474	64.33	17.49	8.73	29.75	9.59	8.71	6.63	4.82	186.42	211.25	213.37	170.84	150.21
189	56.3	13.3	48.84	3.14	32.4	10.48	8.96	7.39	5.57	12.17	20.05	11.15	8.16	9.32
190	15	8.74	56.7	5.09	32.23	10.63	8.67	7.42	5.51	3.85	6.87	2.57	3.39	2.58
191	68.4	17.71	35.58	4.59	33.86	10.83	9.28	7.89	5.86	38.60	41.48	38.73	36.10	38.08
192	274	67.14	18.32	16.45	33.99	11	8.98	8.07	5.94	18.77	32.45	20.71	11.68	10.25
193	827	142.8	11.9	24.66	31.69	10.29	8.44	7.44	5.52	131.01	224.51	102.01	109.10	88.42
194	239	56.11	7.66	13.17	30.94	9.91	8.52	6.95	5.56	36.60	60.50	38.82	25.94	21.12
195	87.8	27.61	4.4	8.68	38.49	11.08	13.52	7.99	5.9	42.01	48.10	59.27	40.08	20.58
196	204	38.21	8.59	7.16	29.6	9.31	9.18	6.25	4.86	16.72	12.11	45.25	4.02	5.49
197	690	80.15	5.98	9.31	33.78	10.13	11.29	7.01	5.35	151.76	172.39	248.13	126.59	59.93
198	247	31.82	9.59	4.1	31.22	9.42	10.35	6.5	4.95	33.53	40.04	67.62	17.67	8.82
199	128	14.64	5.83	1.67	33.71	9.55	12.12	6.74	5.3	39.88	49.44	69.83	26.50	13.73
200	737	65.39	17.21	5.8	26.52	8.71	8.42	5.72	3.67	167.74	171.60	190.56	191.22	117.57
201	694	64.77	15.15	6.04	24.34	8.27	7.96	4.91	3.2	36.13	32.52	76.12	33.88	1.99
202	469	42.53	9.03	3.86	21.75	7.19	7.36	4.41	2.79	55.89	82.02	70.23	67.16	4.14
203	8,561	305.23	7.08	10.88	22.83	7.73	7.24	4.82	3.04	393.40	138.11	772.10	532.16	131.23
204	389	49.65	22.73	6.34	27.77	8.78	8.68	6.24	4.07	138.53	160.69	145.44	143.81	104.20
205	126	35.51	26.7	10	27.57	9	8.58	6.13	3.86	35.89	45.72	37.83	36.81	23.21
206	206	35.15	28.28	6	27.91	8.99	8.37	6.26	4.29	73.09	91.84	83.20	65.02	52.31
207	95.6	17.33	41.84	3.14	28.53	9.53	8.06	6.33	4.61	41.66	67.94	40.21	28.77	29.73
208	45	14.82	40.29	4.88	28.17	9.27	8.16	6.3	4.44	19.04	26.18	21.86	15.33	12.78
209	3,429	140.26	13.22	5.74	26.18	8.85	7.59	5.8	3.94	149.03	235.03	200.14	100.73	60.21
210	4,493	205.11	10.11	9.36	25.55	8.61	7.49	5.68	3.77	183.89	277.41	253.92	131.35	72.89

Table 1. Basin characteristics for streamflow-gaging stations in or near Texas, with at least 8 years of mean annual

USGS station no.	Map no. (pl. 1)	USGS station name	Region no.	Base station no.	Latitude	Longitude	First year of record	Last year of record	Weight factor
08206700	211	San Miguel Creek near Tilden, Texas	6	08208000	28°35'14"	98°32'44"	1965	1990	26
08207000	212	Frio River at Calliham, Texas	6	08205500	28°29'31"	98°20'47"	1961	1980	20
08208000	213	Atascosa River at Whitsett, Texas	6		28°37'18"	98°17'02"	1961	1990	30
08211520	214	Oso Creek at Corpus Christi, Texas	6	08164000	27°42'40"	97°30'06"	1973	1990	18
08212400	215	Los Olmos Creek near Falfurrias, Texas	6	08189500	27°15'51"	98°08'08"	1968	1983	16
08374000	216	Alamita Creek near Presidio, Texas	2		29°31'15"	104°17'40"	1961	1990	30
08374500	217	Terlingua Creek near Terlingua, Texas	2		29°12'00"	103°36'15"	1961	1990	30
08405500	218	Black River above Malaga, New Mexico	2		32°13'48"	104°09'00"	1961	1990	30
08408500	219	Delaware River near Red Bluff, New Mexico	2		32°01'12"	104°03'00"	1961	1990	30
08431700	220	Limpia Creek above Fort Davis, Texas	2	08400000	30°36'48"	104°00'04"	1967	1986	20
08431800	221	Limpia Creek below Fort Davis, Texas	2	08374000	30°40'52"	103°47'30"	1963	1977	15
08433000	222	Barrilla Draw near Saragosa, Texas	2	08405500	30°57'28"	103°27'33"	1976	1983	8
08435700	223	Sunny Glen Canyon near Alpine, Texas	2	08128000	30°22'52"	103°44'08"	1969	1977	9
08435800	224	Coyanosa Draw near Fort Stockton, Texas	2	08374000	31°02'27"	103°08'15"	1965	1977	13
08447020	225	Independence Creek near Sheffield, Texas	2	08128000	30°27'07"	101°43'58"	1975	1984	10
08449000	226	Devils River near Juno, Texas	2	08449400	29°57'48"	101°08'42"	1964	1973	10
08449400	227	Devils River at Pafford Crossing near Comstock, Texas	2		29°40'35"	101°00'00"	1961	1990	30
08455000	228	Pinto Creek near Del Rio, Texas	2	08195000	29°08'45"	100°43'05"	1961	1968	8

[1] Station also was included in this region to enhance the analysis.

streamflow data, 1961–90—Continued

Map no. (pl. 1)	Contributing drainage area (A) (mi^2)	Main stream length (L) (mi)	Stream slope (SL) (ft/mi)	Basin shape factor (SH)	Precipitation (in.)					Estimated 1961–90 streamflow (ft^3/s)				
					Annual	Spring	Summer	Fall	Winter	Annual	Spring	Summer	Fall	Winter
211	783	85.18	8.05	9.27	25.58	8.69	7.56	5.66	3.67	56.33	103.32	67.86	38.85	15.29
212	5,491	221.33	9.64	8.92	25.48	8.59	7.51	5.63	3.75	231.80	355.96	282.16	170.60	118.48
213	1,171	92.21	6.33	7.26	27.26	9.16	8.02	5.86	4.22	115.56	201.95	132.18	73.23	54.89
214	90.3	11.77	4.74	1.53	31.09	8.75	11.51	5.98	4.85	28.08	28.80	50.11	21.44	11.97
215	476	64	11.18	8.6	23.42	7.88	8.03	4.18	3.33	5.62	4.27	16.83	0.59	0.78
216	1,504	101.6	40.69	6.86	14.93	3.57	7.79	2.51	1.06	20.67	14.16	57.20	10.09	1.22
217	1,070	98.53	29.97	9.07	17.1	4.1	8.85	2.8	1.35	63.99	66.56	156.07	29.53	3.80
218	343	56.7	47.6	9.37	15.48	3.71	8.2	2.3	1.27	13.00	12.62	21.10	9.38	8.92
219	689	60.2	39.5	5.26	13.45	3.1	7.1	2.1	1.15	10.45	9.05	20.88	8.52	3.34
220	52.4	11.39	129.62	2.48	20.65	4.6	11.62	3.01	1.42	2.24	1.89	6.27	0.81	0.00
221	227	31.03	70.63	4.24	18.38	4.17	10.19	2.73	1.29	3.73	2.69	10.27	1.49	0.47
222	612	84.55	12.77	11.68	16.74	3.86	8.93	2.63	1.32	9.09	0.24	35.45	0.23	0.42
223	29.7	8.07	119.52	2.19	18.85	4.3	10.43	2.81	1.31	0.41	0.00	1.17	0.45	0.00
224	1,182	89.16	26.9	6.73	15.93	3.87	8.09	2.67	1.3	4.22	8.82	7.91	0.10	0.05
225	763	62.35	27.1	5.1	19.92	6.31	6.65	4.34	2.62	13.31	13.69	9.71	18.78	11.06
226	2,730	112.27	10.17	4.62	20.69	6.14	7.69	4.15	2.71	175.79	84.15	441.29	94.87	82.84
227	3,961	146.02	9.95	5.38	20.9	6.35	7.72	4.15	2.68	365.11	263.06	606.69	354.06	236.63
228	249	44.23	17.43	7.85	21.03	7.64	6.35	4.22	2.82	39.07	24.25	104.74	9.99	17.30

Table 2. Regression equations for estimating mean annual and mean seasonal runoff for regions of Texas

[mi^2, square miles; in., inches; Q, mean runoff in cubic feet per second; ann, annual—calendar year; spr, spring—April, May, and June; sum, summer—July, August, and September; fall—October, November, and December; win, winter—January, February, and March; A, contributing drainage area in square miles; MAP, mean annual precipitation in inches; MSP, mean seasonal precipitation in inches; —, not applicable; +, analysis for this region also includes stations from other regions]

Region no.	Weighted least-squares regression equation	Range of indicated independent variables in corresponding region		Weighted standard error of estimate (percent)	Weighted standard error of estimate (log_{10} units)	No. of stations in analysis for equation
		Contributing drainage area (mi^2)	Precipitation[1] (in.)			
1, 2						
	$Q_{ann} = 10^{-6.048} A^{1.123} MAP_{ann}^{3.293}$		13.45 to 22.18	77	0.2954	24
	$Q_{spr} = 10^{-3.403} A^{1.135} MSP_{spr}^{2.055}$		3.10 to 8.65	112	.3911	24
	$Q_{sum} = 10^{-5.781} A^{1.307} MSP_{sum}^{3.939}$	29.7 to 3,961	6.35 to 11.62	118	.4041	24
	$Q_{fall} = 10^{-3.281} A^{1.092} MSP_{fall}^{2.561}$		1.90 to 4.34	213	.5686	24
	$Q_{win} = 10^{-3.805} A^{1.248} MSP_{win}^{3.225}$		1.06 to 2.82	282	.6434	24
3						
	$Q_{ann} = 10^{-4.240} A^{0.885} MAP_{ann}^{2.470}$		18.43 to 31.75	47	.1928	34
	$Q_{spr} = 10^{-3.196} A^{0.894} MSP_{spr}^{2.783}$		5.91 to 10.95	54	.2183	34
	$Q_{sum} = 10^{-4.439} A^{0.870} MSP_{sum}^{4.066}$	11.8 to 5,972	7.06 to 8.82	53	.2164	34
	$Q_{fall} = 10^{-2.255} A^{0.968} MSP_{fall}^{1.666}$		2.81 to 7.05	62	.2474	34
	$Q_{win} = 10^{-3.002} A^{1.005} MSP_{win}^{2.824}$		1.82 to 5.52	49	.2016	34
4						
	$Q_{ann} = 10^{-8.285} A^{0.913} MAP_{ann}^{5.300}$		18.83 to 30.66	56	.2272	22
	$Q_{spr} = 10^{-5.894} A^{0.920} MSP_{spr}^{5.572}$		5.74 to 10.43	53	.2152	22
	$Q_{sum} = 10^{-0.925} A^{0.895}$	33.3 to 6,160	—	73	.2843	22
	$Q_{fall} = 10^{-4.007} A^{1.013} MSP_{fall}^{3.808}$		3.41 to 7.13	87	.3251	22
	$Q_{win} = 10^{-3.269} A^{0.909} MSP_{win}^{3.906}$		2.25 to 5.87	73	.2829	22
5						
	$Q_{ann} = 10^{-0.211} A^{0.846}$		—	58	.2322	27
	$Q_{spr} = 10^{-3.131} A^{0.884} MSP_{spr}^{3.004}$		8.27 to 11.16	60	.2416	27
	$Q_{sum} = 10^{-0.669} A^{1.019}$	8.24 to 1,315	—	62	.2466	27
	$Q_{fall} = 10^{-0.257} A^{0.849}$		—	64	.2543	27
	$Q_{win} = 10^{-2.826} A^{0.915} MSP_{win}^{3.412}$		3.20 to 6.12	120	.4115	27
6+						
	$Q_{ann} = 10^{-6.320} A^{0.834} MAP_{ann}^{4.013}$		21.75 to 38.61	54	.2183	23
	$Q_{spr} = 10^{-4.700} A^{0.747} MSP_{spr}^{4.759}$		7.19 to 11.83	71	.2761	23
	$Q_{sum} = 10^{-3.569} A^{0.860} MSP_{sum}^{3.344}$	28.0 to 8,561	7.24 to 13.52	44	.1842	23
	$Q_{fall} = 10^{-3.756} A^{0.804} MSP_{fall}^{4.061}$		4.18 to 8.39	107	.3790	23
	$Q_{win} = 10^{-4.382} A^{0.976} MSP_{win}^{4.757}$		2.79 to 5.96	68	.2666	23

Table 2. Regression equations for estimating mean annual and mean seasonal runoff for regions of Texas—Continued

Region no.	Weighted least-squares regression equation	Range of indicated independent variables in corresponding region		Weighted standard error of estimate (percent)	Weighted standard error of estimate (log_{10} units)	No. of stations in analysis for equation
		Contributing drainage area (mi^2)	Precipitation[1] (in.)			
7						
	$Q_{ann} = 10^{-7.585} A^{0.997} MAP_{ann}^{4.609}$		30.95 to 42.97	33	0.1394	22
	$Q_{spr} = 10^{-4.546} A^{0.944} MSP_{spr}^{4.184}$		10.82 to 14.17	31	.1334	22
	$Q_{sum} = 10^{-4.750} A^{0.943} MSP_{sum}^{4.337}$	26.0 to 572	7.33 to 9.77	60	.2412	22
	$Q_{fall} = 10^{-3.879} A^{1.048} MSP_{fall}^{3.523}$		6.67 to 11.09	58	.2321	22
	$Q_{win} = 10^{-3.390} A^{1.061} MSP_{win}^{3.343}$		5.68 to 9.35	42	.1760	22
8+						
	$Q_{ann} = 10^{-3.628} A^{0.803} MAP_{ann}^{2.337}$		24.97 to 41.27	24	.1046	24
	$Q_{spr} = 10^{-2.463} A^{0.785} MSP_{spr}^{2.576}$		9.93 to 12.63	24	.1032	24
	$Q_{sum} = 10^{0.279} A^{0.773}$	23 to 1,240	—	31	.1318	24
	$Q_{fall} = 10^{-2.223} A^{0.812} MSP_{fall}^{2.198}$		6.58 to 11.09	34	.1434	24
	$Q_{win} = 10^{-1.509} A^{0.819} MSP_{win}^{1.788}$		5.73 to 9.24	25	.1089	24
9						
	$Q_{ann} = 10^{-8.742} A^{1.086} MAP_{ann}^{5.180}$		29.60 to 43.28	31	.1300	24
	$Q_{spr} = 10^{-6.136} A^{1.013} MSP_{spr}^{5.50}$		9.31 to 12.75	36	.1518	24
	$Q_{sum} = 10^{-4.723} A^{1.135} MSP_{sum}^{3.860}$	17.3 to 838	8.29 to 13.52	44	.1832	24
	$Q_{fall} = 10^{-4.934} A^{1.048} MSP_{fall}^{4.664}$		6.25 to 10.19	53	.2168	24
	$Q_{win} = 10^{-4.491} A^{1.074} MSP_{win}^{4.547}$		4.86 to 8.69	54	.2184	24
10						
	$Q_{ann} = 10^{-3.079} A^{1.066} MAP_{ann}^{1.701}$		41.40 to 50.66	18	.0787	24
	$Q_{spr} = 10^{-0.213} A^{1.104}$		—	21	.0889	24
	$Q_{sum} = 10^{-3.485} A^{1.051} MSP_{sum}^{2.651}$	23.4 to 1,365	7.70 to 11.37	40	.1665	24
	$Q_{fall} = 10^{-0.281} A^{1.046}$		—	31	.1307	24
	$Q_{win} = 10^{-1.478} A^{1.033} MSP_{win}^{1.440}$		9.29 to 12.61	21	.0892	24
11						
	$Q_{ann} = 10^{-3.616} A^{0.942} MAP_{ann}^{2.166}$		40.25 to 56.64	21	.0895	29
	$Q_{spr} = 10^{-1.731} A^{0.938} MSP_{spr}^{1.653}$		11.26 to 15.40	21	.0883	29
	$Q_{sum} = 10^{-4.829} A^{1.002} MSP_{sum}^{4.145}$	8.65 to 3,486	9.54 to 15.04	39	.1620	29
	$Q_{fall} = 10^{-1.512} A^{0.905} MSP_{fall}^{1.417}$		10.38 to 14.30	31	.1311	29
	$Q_{win} = 10^{-1.959} A^{0.973} MSP_{win}^{1.989}$		8.15 to 13.41	17	.0716	29

[1] Mean annual or mean seasonal precipitation for corresponding equation.

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