TEXAS
Stream Water Quality

Texas has diverse climatic and hydrologic conditions. Annual precipitation generally decreases from east to west, ranging from 56 inches at the eastern border near Beaumont to less than 8 inches at the western border (U.S. Geological Survey, 1986, p. 432–433). Consequently, streamflow is abundant in the eastern part of the State but is scarce in the west. Presently (1990), Texas has 187 reservoirs that have a capacity of more than 5,000 acre-feet.

In 1985, surface water supplied 12,900 million gallons per day or 64 percent of freshwater withdrawals in Texas (U.S. Geological Survey, 1990, p. 475–484). Of that quantity, 58 percent was used for thermoelectric power generation, 22 percent for irrigation, 14 percent for public supply, and 6 percent for industry and mining. Demand for freshwater in Texas varies by season, geographical area, and type of water use. Thermoelectric power generation and public-supply needs are continuous, whereas water use for irrigation is seasonal.

The water quality of a stream can be affected by the land uses in its basin. Agricultural activities are important contributors of nonpoint-source pollution; urban and industrial areas often contain

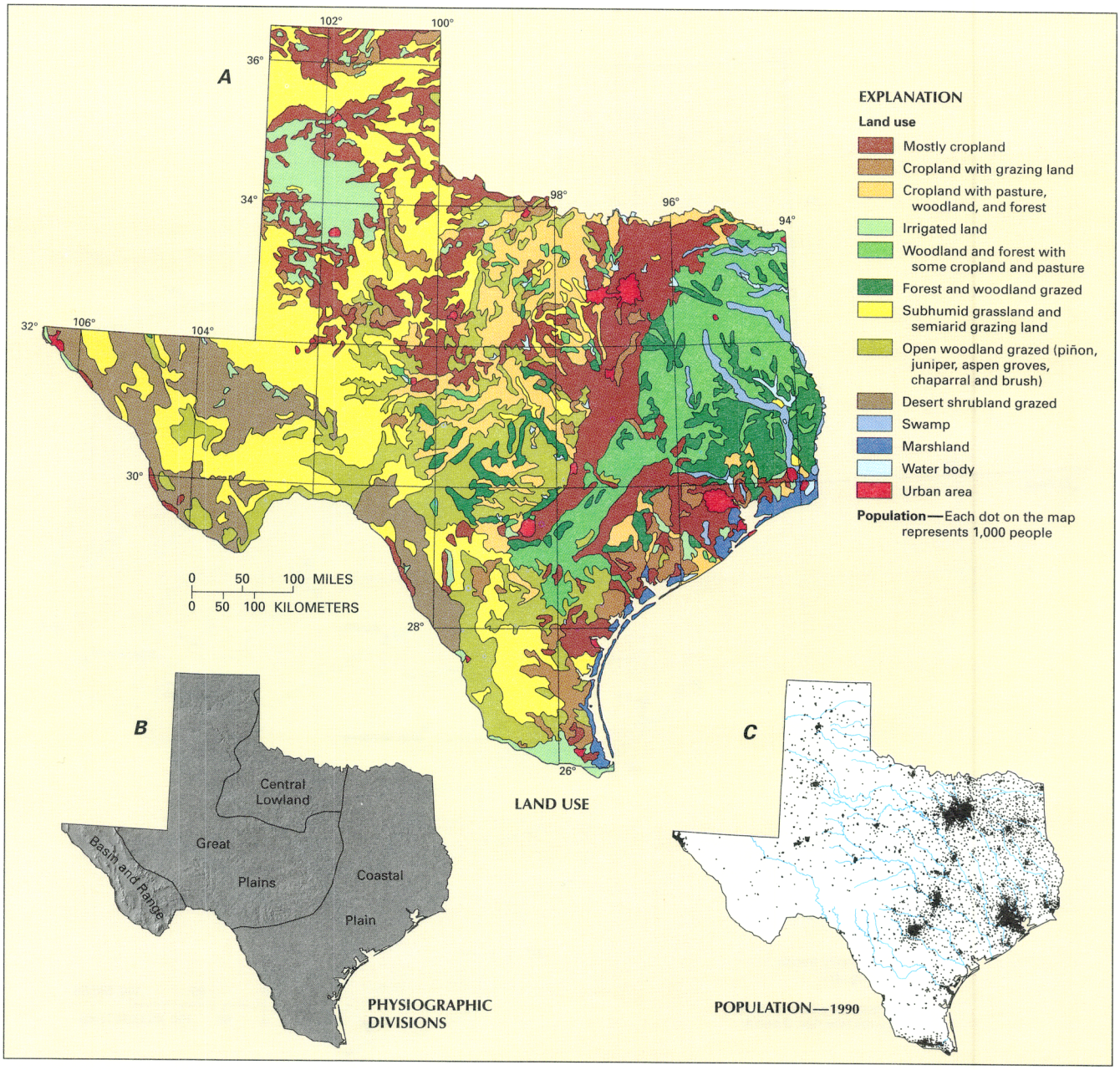


Figure 1. Land use, physiography, and population in Texas. *A*, Major land uses. *B*, Physiographic divisions. *C*, Population distribution in 1990. (Sources: *A*, Major land uses modified from Anderson, 1967. *B*, Physiographic divisions from Fenneman, 1946; landforms from Thelin and Pike, 1990. *C*, Data from U.S. Bureau of the Census 1990 decennial census files.)

many point- and nonpoint-source discharges. Land use (fig. 1*A*) in Texas is determined in large part by physiography (fig. 1*B*) and water availability.

Largely for reasons of water availability, most of Texas' population is in the eastern part of the State (fig. 1*C*). The 1990 population was about 17 million (U.S. Bureau of the Census 1990 decennial census files), a 52-percent increase from 1970. More than 8.5 million people relied on surface-water sources for public supply in 1985 (Solley and others, 1988, p. 13). The demand for water of adequate quality will continue to increase with the growing population.

WATER-QUALITY MONITORING

Water-quality data obtained from analyses of water samples collected at monitoring stations are stored in the U.S. Geological Survey's (USGS) National Water Information System and the U.S. Environmental Protection Agency's (EPA) national data base known as STORET. Water-quality and streamflow data are reported by water year—the 12 months from October 1 through September 30. A water year is identified by the calendar year in which it ends. For example, water year 1991 comprises October 1, 1990, through September 30, 1991.

The data used in this summary of Texas' stream water quality were obtained from water samples collected at 23 monitoring stations at which data collection is systematic and continuing (fig. 2). Analyses of water samples collected at 10 stations are the basis for the discussion and graphic summary (fig. 3) of stream water-quality conditions during water years 1987–89, and data from 20 stations are the basis for the discussion and graphic summary (fig. 4) of stream water-quality trends. Water samples were collected and analyzed by using standard methods approved by the USGS (Britton and Greeson, 1987; Fishman and Friedman, 1989; Ward and Harr, 1990) or by

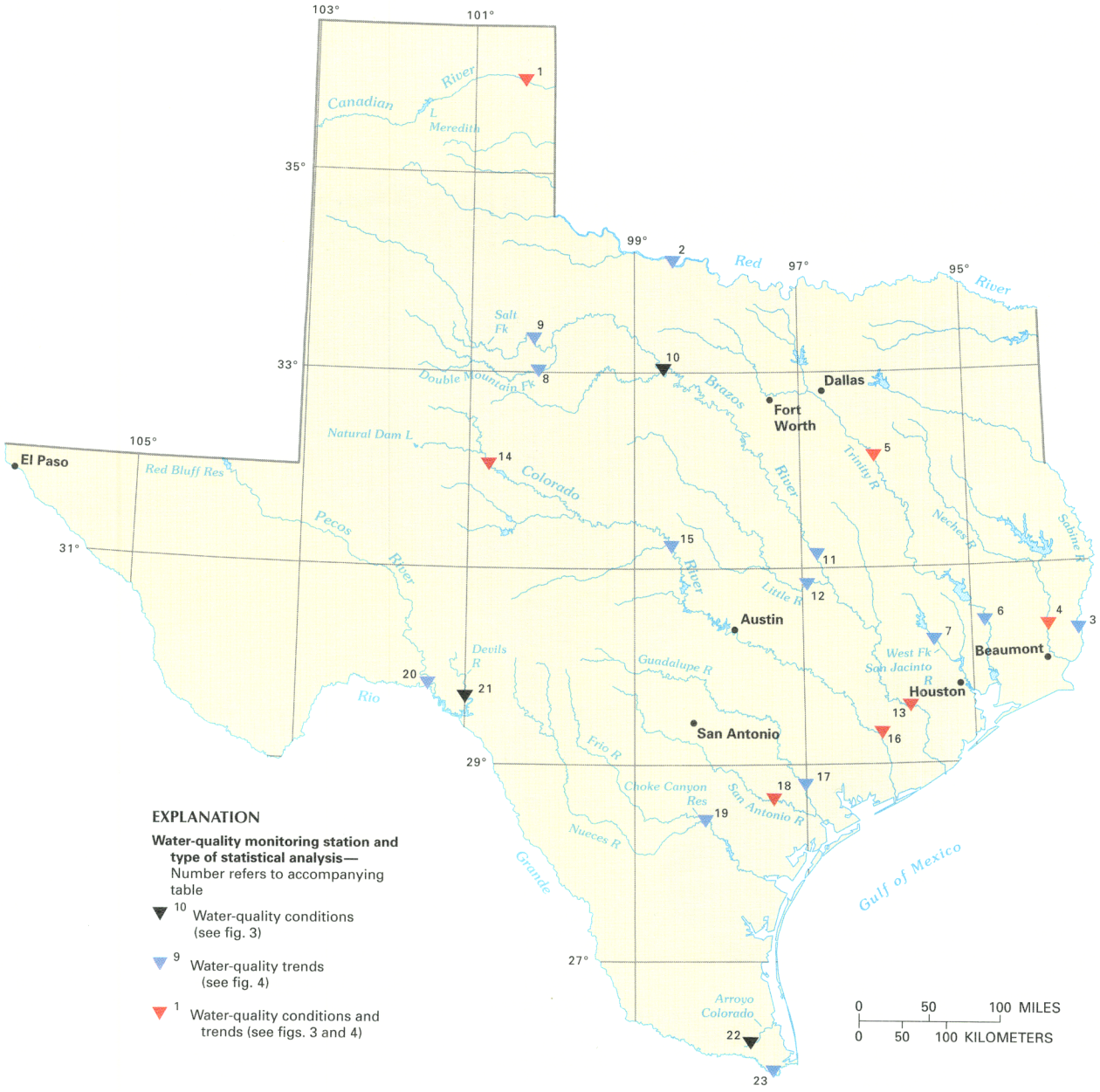


Figure 2. Selected water-quality monitoring stations, type of statistical analysis, and geographic features in Texas. (Sources: Major land uses modified from Anderson, 1967; other data from U.S. Geological Survey files.)

using equivalent methods. If a method of sample collection or analysis changed over time, data from an analysis were included in the evaluation of recent stream water quality or of stream water-quality trends only if the change in method did not affect the comparability of the data.

WATER-QUALITY CONDITIONS

The use of water from the western reaches of many of the State's rivers is limited by natural salinity. In some locations this problem has been worsened by the residual effects of past oil and gas exploration and production activities. Other water-quality degradation that limits water use originates in the populous urban areas of Austin, Dallas–Fort Worth, Houston, and San Antonio. Recently, the quantity and quality of inflows to coastal bays and estuaries have become a major issue.

In 1990, the Texas Water Commission (1990, p. 12) assessed the water quality in more than 16,000 miles of streams. Water-quality standards for beneficial uses designated by the State for purposes of water-quality monitoring and protection were not met in 16 percent of those stream miles. Nonpoint-contamination sources such as agriculture, oil and gas exploration and production, urban runoff, erosion, individual sewage-disposal systems, and animal grazing are the origin of most contamination in streams. The remaining contamination comes from point sources, natural sources, and unknown sources.

The following discussion of stream water quality in Texas is organized by river basin (fig. 3). Graphs in figure 3 summarize certain aspects of stream water quality in the basins for water years 1987–89. The graphs show frequency distributions of data values that represent concentrations of selected stream-water constituents. These constituents are fecal coliform bacteria, dissolved sulfate, dissolved chloride, dissolved solids, dissolved nitrite plus nitrate (as nitrogen), total phosphorus (as phosphorus), and suspended sediment. The data are reported in colonies per 100 milliliters (col/100 mL) and milligrams per liter (mg/L). Sources and environmental significance of each constituent are described in table 1.

Water quality at each monitoring station is the result of geological, chemical, biological, and hydrologic processes that occur over a large area. Water-quality problems that affect aquatic life or public health only locally are not fully represented in this summary. One such problem not addressed in this report is contamination from organic chemicals such as herbicides used in rice farming and industrial solvents.

CANADIAN RIVER

The Canadian River originates in northeastern New Mexico and flows eastward across the Great Plains region of the Texas Panhandle, draining mostly subhumid grassland and semiarid grazing land. There are two major reservoirs in the basin. Sanford Dam, which forms Lake Meredith, the larger reservoir, has caused decreased flow at site 1 near Canadian since 1965.

Median concentrations of sulfate (230 mg/L), chloride (720 mg/L) and dissolved solids (1,770 mg/L) at site 1 (fig. 3) indicate a slightly saline water. The saline water results from contact with geologic formations that were deposited in a marine environment and comes primarily from Cottonwood Creek and brine springs near the New Mexico–Texas border (Texas Water Commission, 1990, p. 161–163).

NECHES RIVER

The Neches River drains areas of forest and woodland in subhumid eastern Texas. Ten reservoirs having a capacity of 5,000 acre-feet or more store runoff from the relatively flat Texas Coastal Plain. Slow currents in some of the low-gradient, natural drainage channels of the lower reaches of the Neches River occasionally result in small dissolved-oxygen concentrations (Texas Water Commission, 1990, p. 247–248).

Smaller concentrations of the seven constituents were recorded in the Neches River at site 4 compared to those at most of the other monitoring stations (fig. 3). Dissolved-solids concentrations were relatively small (median, 101 mg/L) because of dilution by the large quantities of rain that fall in this basin and because no source of salinity is present in the mostly fluvial sediments that underlie the drainage basin.

Site no. on map	USGS station name and no.	Drainage area (square miles)	Major land use (see fig. 1)
1	Canadian River near Canadian (07228000)	22,866	Subhumid grassland and semiarid grazing land.
2	Red River near Burkburnett (07308500)	20,570	Mostly cropland.
3	Sabine River near Ruliff (08030500)	9,329	Grazed forest and woodland; swamp.
4	Neches River at Evadale (08041000)	7,951	Ditto.
5	Trinity River at Trinidad (08062700)	8,538	Cropland with pasture, woodland, and forest; urban areas.
6	Trinity River at Romayor (08066500)	17,186	Woodland and forest with some cropland and pasture.
7	West Fork San Jacinto River near Conroe (08068000)	828	Grazed forest and woodland.
8	Double Mountain Fork Brazos River near Aspermont (08080500)	8,796	Subhumid grassland and semiarid grazing land; mostly cropland.
9	Salt Fork Brazos River near Aspermont (08082000)	5,130	Subhumid grassland and semiarid grazing land; cropland with grazing land.
10	Brazos River near South Bend (08088000)	22,673	Cropland with pasture, woodland, and forest; grazed open woodland.
11	Brazos River near Highbank (08098290)	30,436	Mostly cropland.
12	Little River at Cameron (08106500)	7,065	Ditto.
13	Brazos River at Richmond (08114000)	45,007	Mostly cropland; cropland with grazing land; urban areas.
14	Colorado River above Silver (08123850)	14,910	Subhumid grassland and semiarid grazing land; cropland with grazing land.
15	Colorado River near San Saba (08147000)	31,217	Subhumid grassland and semiarid grazing land; cropland with pasture, woodland, and forest.
16	Colorado River at Wharton (08162000)	42,003	Cropland with grazing land; irrigated land.
17	Guadalupe River at Victoria (08176500)	5,198	Mostly cropland; woodland and forest with some cropland and pasture.
18	San Antonio River at Goliad (08188500)	3,921	Grazed open woodland; woodland and forest with some cropland and pasture; urban areas.
19	Nueces River near Three Rivers (08210000)	15,427	Grazed open woodland; cropland with pasture, woodland, and forest.
20	Pecos River near Langtry (08447410)	35,179	Grazed open woodland; subhumid grassland and semiarid grazing land.
21	Devils River at Pafford Crossing, near Comstock (08449400)	3,961	Grazed desert shrubland; subhumid grassland and semiarid grazing land.
22	Arroyo Colorado at Harlingen (08470400)	Indeterminate	Irrigated land; cropland with grazing land; urban areas.
23	Rio Grande at Brownsville (08445000)	176,333	Irrigated land; grazed open woodland.

Figure 2. Selected water-quality monitoring stations, type of statistical analysis, and geographic features in Texas—Continued.

TRINITY RIVER

The Trinity River drains cropland and pastures, large urban areas (including Dallas–Fort Worth), and land having extensive industrial development. Twenty-seven reservoirs store water for public supply and control flooding in the lower part of the river near the Gulf of Mexico. The Trinity River historically has had large values of biochemical oxygen demand and large concentrations of fecal coliform bacteria, nutrients, and suspended solids. Fishkills associated with large concentrations of contaminants and small dissolved-oxygen concentrations have occurred in the reach downstream from the Dallas–Fort Worth area (Texas Water Commission, 1990, p. 275–276).

At the upstream Trinity River monitoring station (site 5), the effects of urban development on stream water are apparent (Wells and others, 1986). Median concentrations of nitrite plus nitrate (2.60 mg/L), phosphorus (0.89 mg/L), and suspended sediment (134 mg/L) were among the largest at the 10 stations (fig. 3). At the downstream Trinity River monitoring station at Romayer (site 6, not shown in fig. 3), concentrations of fecal coliform bacteria (56 col/100 mL), the nutrients nitrite plus nitrate (0.20 mg/L) and phosphorus (0.16 mg/L), and suspended sediment (13 mg/L) were substantially smaller than those at site 5 because of dilution from runoff in the lower river basin.

BRAZOS RIVER

Almost all of the Brazos River drainage basin is in Texas. Within the State, the river system extends from the semiarid Great Plains near the New Mexico border to the Gulf of Mexico. The Brazos River drains cropland, grazing land, forest, and woodland and is regulated by 25 dams that form reservoirs that store water for irrigation, public supply, and flood control.

Water-quality data from an upstream monitoring station (site 10) and a downstream station (site 13) (fig. 3) illustrate the differences in water quality between the upper and lower Brazos River

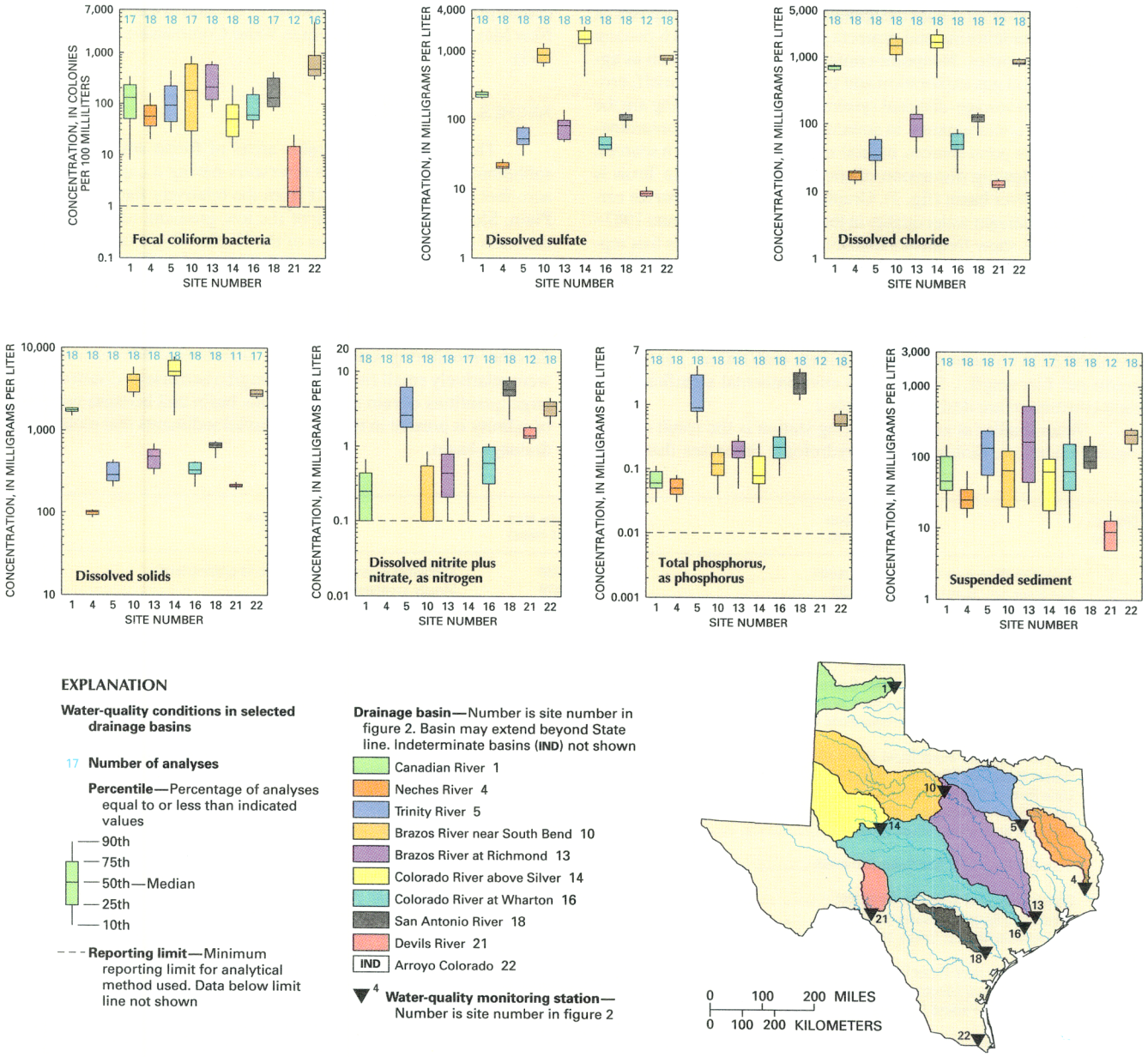


Figure 3. Water quality of selected streams in Texas, water years 1987–89. (Source: Data from U.S. Geological Survey files.)

basin. The upper basin overlies geologic formations that generally were deposited in a marine environment and contain deposits of gypsum and salts. These deposits are sources of chloride and sulfate in stream water, and large evaporation rates and arid conditions in the upper basin concentrate the dissolved minerals. As a result, large concentrations of sulfate, chloride, and dissolved solids (medians at site 10 of 880 mg/L, 1,500 mg/L, and 4,040 mg/L, respectively, for water years 1987–89) make surface water in the upper basin unsuitable for public supply without special treatment (Texas Water Commission, 1990, p. 373). In contrast, the lower basin is in the Coastal Plain, which generally was formed in a fluvial environment, has no major natural source of salinity, and receives more rainfall. Therefore, concentrations of sulfate (median, 82 mg/L), chloride (120 mg/L), and dissolved solids (484 mg/L) at site 13 were considerably smaller during water years 1987–89 than at site 10. Conversely, concentrations of nitrite plus nitrate, phosphorus, and suspended sediment increased from site 10 to site 13. The increase probably was the result of agricultural runoff and treated wastewater discharge by several municipalities along the river.

COLORADO RIVER

The Colorado River originates near the New Mexico border and flows across the State from the arid west to the more humid coastal region. The river drains subhumid grassland, semiarid grazing land, and some cropland in the upper reaches, whereas the lower basin contains woodlands, cropland, and pastures. Dams on the river form 14 major reservoirs that store water for irrigation, municipal supply, and flood control.

Geologic and climatic conditions in the Colorado River basin are similar to those of the Brazos River basin. Water quality also differs substantially between the upper and lower basins (Rawson, 1982). The median concentrations of sulfate (1,500 mg/L), chloride (1,700 mg/L), and dissolved solids (5,200 mg/L) at the upstream monitoring station (site 14) were the largest of those at the 10 water-quality monitoring stations (fig. 3). These large concentrations result from natural brine deposits and from oil-field drilling activities. As in the Brazos River, median concentrations of these three constituents downstream at the Coastal Plain monitoring station (site 16) were considerably smaller than those at the station located in the Great Plains. Also as in the Brazos River, the median nitrite plus nitrate concentration increased from the upstream to the downstream station (less than 0.10 mg/L at site 14 to 0.60 mg/L at site 16). The median phosphorus concentration increased from 0.08 mg/L to 0.22 mg/L from the upstream to the downstream station. Agricultural runoff and wastewater-treatment-plant discharge between the monitoring stations probably caused these increases. New treatment facilities in Austin are predicted to improve water quality in the Colorado River downstream from that city (Texas Water Commission, 1990, p. 445).

SAN ANTONIO RIVER

The San Antonio River drains woodland and forest, cropland, pasture, and the San Antonio urban area. Water quality in the upper reaches of the San Antonio River historically has been affected by municipal wastewater-treatment-plant effluent and urban runoff. Median concentrations of sulfate (100 mg/L), chloride (130 mg/L), and dissolved solids (667 mg/L) at site 18 are about in the middle of the range of concentrations at the 10 monitoring stations (fig. 3). However, the median concentrations of nitrite plus nitrate (5.80 mg/L) and phosphorus (2.20 mg/L) were the largest. The water quality at this station is expected to improve after the construction of additional wastewater-treatment facilities (Texas Water Commission, 1990, p. 519).

DEVILS RIVER

The Devils River drains desert, grazed shrubland, subhumid grassland, semiarid grazing land, and grazed open woodland. Samples collected at site 21, part of the USGS Hydrologic Bench-Mark Network, had the smallest or among the smallest concentrations of all of the constituents except nitrite plus nitrate (fig. 3). The median nitrite plus nitrate concentration (1.40 mg/L) at site 21 was exceeded only by medians at sites 5, 18, and 22, which are downstream from municipal wastewater-treatment plant outfalls. However, the origin

Table 1. Sources and environmental significance of selected water-quality constituents

[Source: Compiled by the U.S. Geological Survey, Office of Water Quality]

Constituent	Common sources	Environmental significance
Fecal coliform bacteria	Sources include effluent from sewage-treatment plants and runoff from pastures, feedlots, and urban areas.	Presence indicates contamination of water by wastes from humans and other warm-blooded animals.
Sulfate	Occurs in some rocks; also in mine runoff, industrial wastewater discharge, and atmospheric deposition.	Concentrations exceeding a natural, background level indicate contamination from human activity; in sufficient quantity, can cause water to be unsuitable for public supply; can harm aquatic organisms.
Chloride	Occurs in some rocks and ground-water discharge; also in road deicers, industrial and urban wastewater discharge, and atmospheric deposition.	Concentrations exceeding a natural, background level can cause water to be unsuitable for public supply, agriculture, and industry; can harm aquatic organisms.
Dissolved solids	A result of rock weathering; also in agricultural runoff and industrial discharge.	In sufficient quantity, can cause water to be unsuitable for public supply, agriculture, and industry; can harm aquatic organisms.
Nitrite plus nitrate	Nonpoint sources are agricultural and urban runoff; a major point source is wastewater discharge.	Plant nutrient that, in sufficient quantity, can cause algal blooms and excessive growth of higher aquatic plants in bodies of water; can cause water to be unsuitable for public supply.
Phosphorus	Occurs in some rocks and sediments; also in runoff and seepage from phosphate-rock mines, agricultural and urban runoff, and industrial and municipal wastewater discharge.	Plant nutrient that, in sufficient quantity, can cause algal blooms and excessive growth of higher aquatic plants in bodies of water.
Suspended sediment	A result of rock erosion; also induced by disturbances of land cover due to fires, floods, and human activities such as mining, logging, construction, and agriculture.	Can be detrimental to aquatic organisms; can fill reservoirs and impair recreational use of water.

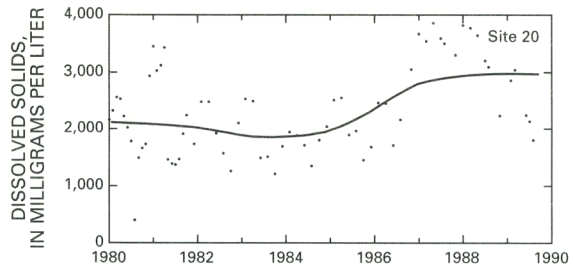
of this constituent at site 21 is natural decay of mesquite plants (E.M. McPherson, U.S. Geological Survey, oral commun., August 1990).

ARROYO COLORADO

The Arroyo Colorado receives municipal and industrial wastewater-treatment- plant effluent and return flows from irrigated land. Fecal coliform bacteria and nutrient concentrations frequently are large because the flow often is predominantly composed of effluent. Median concentrations of all constituents at site 22 were the largest or among the largest at the 10 monitoring stations (fig. 3). The median concentration of fecal coliform bacteria (480 col/100 mL) was the largest for any station, and concentrations exceeded 4,000 col/100 mL in 19 percent of the water samples collected at site 22.

WATER-QUALITY TRENDS

Trend analysis is a statistical procedure used to detect changes in stream water quality at a monitoring station over time. For this report, water-quality data from 20 monitoring stations (fig. 2) were analyzed for trends by using the seasonal Kendall test (Hirsch and others, 1982), a method used extensively by the USGS. The graph (shown below) of the dissolved-solids concentration in the Pecos River at site 20 illustrates the trend inferred from the concentration data and demonstrates the variation in water quality that is common in streams.



When possible, constituent-concentration data were adjusted for changes in streamflow to preclude identifying a trend in concentration that was caused only by a trend in streamflow. The data were not adjusted when (1) more than 10 percent of the samples had concentrations lower than the minimum reporting limit for the analytical method used or (2) streamflow was controlled substantially by human activities. When the concentration data could not be adjusted for streamflow, trends were determined directly from the concentration data.

Statewide trends in concentrations of selected stream-water constituents are shown on maps in figure 4. On each map, a trend is indicated at a monitoring station only if the data from that station were suitable for use in the trend analysis. For more information on the suitability criteria and on the trend-analysis procedure used for this report, see Lanfear and Alexander (1990). Additional information on water-quality trends in Texas is available in a report by Schertz (1990).

FECAL COLIFORM BACTERIA

Fecal coliform bacteria are used as indicators of fecal contamination from humans and other warm-blooded animals. Such contamination can introduce disease-causing viruses and bacteria into a stream. No trend in fecal coliform bacteria concentrations was detected at 14 monitoring stations from which data were suitable for trend analysis (fig. 4).

DISSOLVED SULFATE

The major natural sources of sulfate in streams are rock weathering, volcanoes, and biochemical processes (Hem, 1985, p. 113). Human activities such as mining, waste discharge, and fossil-fuel combustion also can be important sources. A shortened trend-analysis period was used for sulfate because data from analyses performed before water year 1982 are not comparable to data from subsequent years.

Sulfate concentrations had upward trends in the Trinity River at site 6, the West Fork San Jacinto River at site 7, the Colorado River at site 16, and the Pecos River at site 20 (fig. 4). A cause for the slight increase in the Trinity River at site 6 is not readily apparent. The small increase in the West Fork San Jacinto River at site 7 probably was caused by increasing effluent volume resulting from increasing population in the Houston metropolitan area. The increasing concentration at site 16 resulted mostly from releases of saline water from Natural Dam Lake in the upper Colorado River from September 1986 to August 1988 (R.M. Slade, Jr., U.S. Geological Survey, oral commun., August 1990). The increasing sulfate concentration in the Pecos River at site 20 likely was caused by increasing salinity in water released from Red Bluff Reservoir (Texas Water Commission, 1990, p. 573).

The decreasing sulfate concentration in the Nueces River at site 19 coincided with the beginning of legally required releases from Choke Canyon Reservoir in 1986. This reservoir, which is on the Frio River upstream from its confluence with the Nueces River, stores runoff from 36 percent of the Nueces River basin. The water in the reservoir consists mainly of stormwater that contains little dissolved solids. The released dilute reservoir water combines with more concentrated base flows from other tributaries in the basin to reduce variability and magnitude of stream-water concentrations in the Nueces River main stem.

Sulfate concentrations had no trend for water years 1982–89 in the Trinity River at site 5. However, a downward trend in concentrations is noticeable in graphs of data collected prior to 1982 (not shown), indicating probable wastewater-treatment improvement in the Dallas–Fort Worth area.

DISSOLVED CHLORIDE

Chloride is present in all natural waters but usually in low concentrations (Hem, 1985, p. 118). Except in streams that receive ground-water discharge high in chloride, concentrations of greater than a few milligrams per liter generally are the result of human activities (table 1).

Chloride concentrations in the Canadian River at site 1 in the Texas Panhandle and Brazos River at site 11 in central Texas had steady increases (fig. 4) that might have been a result of generally declining rainfall during the trend-analysis period. During periods of decreased rainfall and runoff, ground water, which generally contains more dissolved minerals, contributes a proportionately larger quantity of the streamflow. Concentrations at site 15 on the middle Colorado River had an upward trend because of releases of saline water from Natural Dam Lake near the end of the analysis period (R.M. Slade, Jr., U.S. Geological Survey, oral commun., August 1990). The chloride concentration in the Pecos River at site 20 increased owing to saline-water releases from Red Bluff Reservoir.

Chloride concentrations in the Neches River at site 4 had a downward trend for unknown reasons. Concentrations in the Nueces River at site 19 declined for the same reason as sulfate—stormwater releases from Choke Canyon Reservoir.

DISSOLVED SOLIDS

Dissolved solids in stream water result primarily from rock weathering but also can be introduced as a byproduct of human activities (table 1). Concentrations generally are greatest in streams draining basins underlain by rocks and soils that contain easily dissolved minerals.

Dissolved-solids concentrations had upward trends in the West Fork San Jacinto River at site 7 and the Pecos River at site 20 (fig. 4).

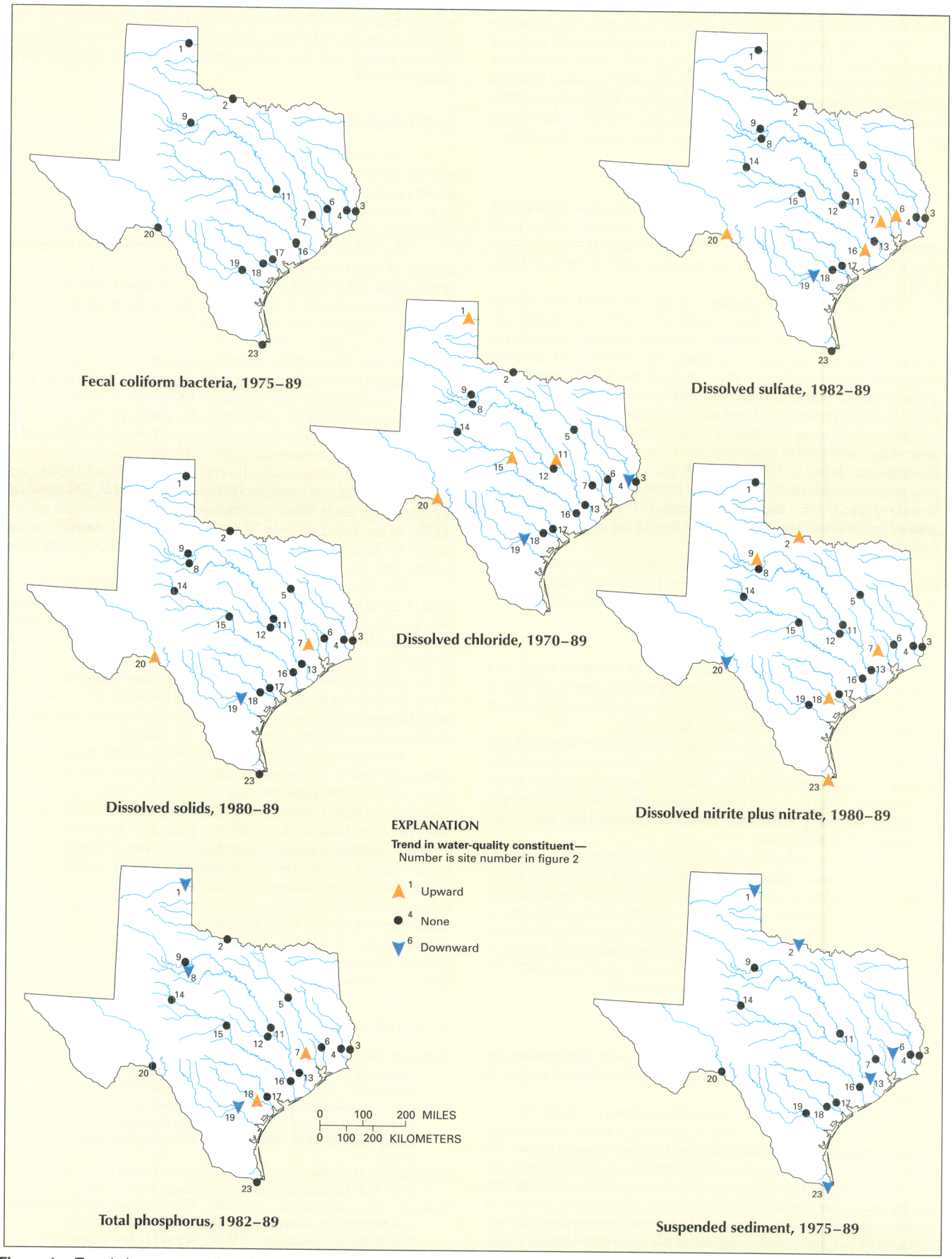


Figure 4. Trends in water quality of selected streams in Texas, by water years. (Source: Data from U.S. Geological Survey files.)

The moderately increasing dissolved-solids concentration in the West Fork San Jacinto River probably resulted from increases in wastewater-treatment-plant discharge from urban development north of Houston (Texas Water Commission, 1990, p. 329). The large increase in dissolved-solids concentrations in the Pecos River was a result of saline-water releases from Red Bluff Reservoir. Beginning in 1986, dissolved-solids concentrations had a downward trend in the Nueces River at site 19 owing to dilution from Choke Canyon Reservoir.

DISSOLVED NITRITE PLUS NITRATE

Nitrite and nitrate are oxidized forms of nitrogen that together normally constitute most of the dissolved nitrogen in well-aerated streams. Nitrite readily oxidizes to nitrate in natural waters; therefore, nitrate generally is by far the more abundant of the two (Hem, 1985, p. 124).

The increasing concentration in the West Fork San Jacinto River at site 7 (fig. 4) is similar to the trend in sulfate and dissolved-solids concentrations and probably is related to urban development in the Houston metropolitan area. Nitrite plus nitrate concentrations in the Salt Fork of the Brazos River at site 9 had a slight increase of unknown cause. Nitrite plus nitrate concentrations increased substantially in the San Antonio River at site 18, probably as a result of wastewater-treatment deficiencies in the San Antonio metropolitan area; these deficiencies gradually are being rectified (Texas Water Commission, 1990, p. 519). Although the upward trends in nitrite plus nitrate concentrations in the Red River at site 2 and in the Rio Grande at site 23 were statistically significant, the increases in concentrations in water samples collected during the trend-analysis period were minimal.

Nitrite plus nitrate concentrations had a downward trend in the Pecos River at site 20. The downward trend may have been the result of a reduction in nitrogen-fertilizer use in the basin.

TOTAL PHOSPHORUS

The total phosphorus concentration of a water sample is a measure of the concentration of all forms of phosphorus present in the sample, dissolved and particulate. Human activities (table 1) can be important sources of phosphorus in streams.

The increasing phosphorus concentration in the West Fork San Jacinto River at site 7 (fig. 4) probably resulted from urbanization in the Houston metropolitan area. Phosphorus concentrations in the San Antonio River at site 18 had an upward trend that probably was caused by increasing wastewater-treatment-plant effluent discharges from the San Antonio area.

Phosphorus concentrations had downward trends in the Canadian River at site 1 and in the Double Mountain Fork Brazos River at site 8 either because of reductions in fertilizer use or the upgrading of wastewater-treatment facilities. The decreasing concentration in the Nueces River at site 19 coincides with the beginning of releases from Choke Canyon Reservoir. Information concerning trends in phosphorus concentrations in Texas rivers for water years 1972–79 is provided in a report by Smith and others (1982).

SUSPENDED SEDIMENT

Suspended sediment is a product of erosion. The erosion can be either natural or the result of land-cover disturbances related to human activities (table 1).

The downward trend in suspended-sediment concentration in the Canadian River at site 1 (fig. 4) possibly was the result of decreased precipitation and runoff during the trend-analysis period. No cause is known for the substantial decrease in concentrations in the Red River at site 2. The downward trend in suspended-sediment concentrations at site 6 possibly was caused by a 45-percent increase in upstream reservoir storage capacity during the trend-analysis period. Suspended-sediment concentrations at the most downstream monitoring station on the Brazos River, site 13, decreased substantially during 1975–89, possibly because of a 50-percent increase in reservoir capacity on the Brazos River basin during this period. The Rio Grande at site 23 had a small decrease in suspended sediment, possibly because of less than average precipitation and runoff for water years 1984–89.

WATER-QUALITY MANAGEMENT

The Texas Water Code provides the Texas Water Commission with the authority to administer programs and policies to secure and preserve adequate water quality for surface and ground water in the State. The code also authorizes the Commission to adopt rules and regulations necessary to conduct the duties of the Commission.

The policy of the State is to protect, restore, and maintain a quality of water consistent with public health and enjoyment and propagation and protection of terrestrial and aquatic life. The State's water-pollution-control program is based on designating desired uses for stream segments and ensuring that these uses are attained. Numerical water-quality criteria are established to protect or secure the desirable uses. Waste loads are evaluated to determine the assimilative capacity of a stream segment and to determine wastewater-treatment levels necessary to meet instream criteria for a stream segment. These treatment levels are specified in mandatory discharge permits, and compliance is monitored through inspections and self-reporting procedures. When noncompliance is detected, enforcement ensues.

The Texas water-quality inventory (Texas Water Commission, 1990) is prepared and submitted biennially to the U.S. Congress and the EPA by the Texas Water Commission in accordance with section 305(b) of the Federal Clean Water Act. The report evaluates water quality in Texas, progress made in restoring and maintaining water quality, and the extent to which problems remain.

The Texas Water Commission is the lead agency for development of the nonpoint-source water-pollution program. The Commission has appointed a broad-based, diverse Nonpoint-Source Advisory Committee to determine the effect of the nonpoint-source water-pollution control effort in the State. Also, the Commission is active in the Galveston Bay National Estuary Program established by the Water Quality Act of 1987 to develop Comprehensive Conservation and Management Plans for estuaries of national significance that are threatened by pollution, development, or overuse.

Surface water-quality data are collected from more than 700 sites in the State as part of the Surface Water Quality Monitoring Program, which is the responsibility of the Texas Water Commission. Sampling includes collection of physiochemical, biological, and hydrologic data. Samples are collected from 359 designated stream, reservoir, and bay segments (some have more than one sampling site) to monitor for compliance with numerical water-quality criteria. Surface water is monitored to detect long-term trends, collect data to be used in characterizing aquatic resources by ecoregion, determine reservoir-bottom water quality, evaluate effects of acid rain, and detect toxics. A citizens' water-quality monitoring program is planned. The scope of surface-water monitoring is shifting from long-term trend monitoring to site-specific intensive surveys.

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