

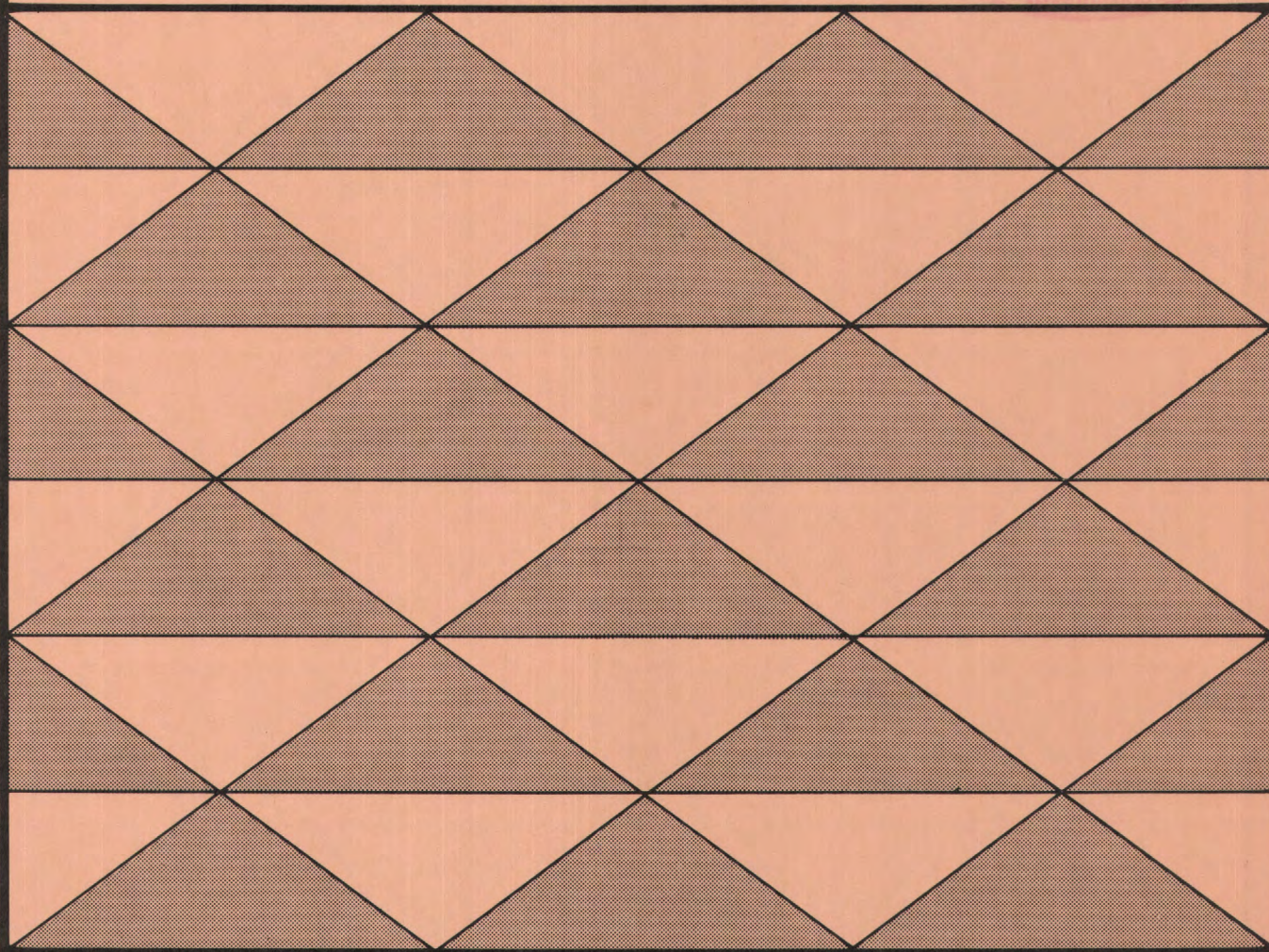
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**Water-Resources Investigations  
of the U.S. Geological Survey  
in Texas--Fiscal Year 1981**

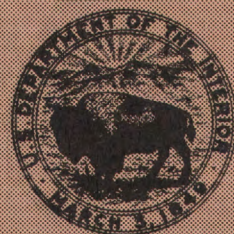
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WATER RESOURCES DIVISION



**GEOLOGICAL SURVEY  
U.S. DEPARTMENT OF THE INTERIOR  
OPEN-FILE REPORT 81-347**







WATER-RESOURCES INVESTIGATIONS OF THE U.S. GEOLOGICAL SURVEY

IN TEXAS--FISCAL YEAR 1981

Compiled by A. A. Mitchell and H. D. Buckner

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U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the

Texas Department of Water Resources

Open-File Report 81-347

Austin, Texas

March 1981

UNITED STATES DEPARTMENT OF THE INTERIOR

James G. Watt, Secretary

GEOLOGICAL SURVEY

Doyle G. Frederick, Acting Director

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# WATER-RESOURCES INVESTIGATIONS OF THE U.S. GEOLOGICAL SURVEY

IN TEXAS--FISCAL YEAR 1981

Compiled by

A. A. Mitchell and H. D. Buckner  
U.S. Geological Survey

## INTRODUCTION

Water-resources investigations in Texas consist of the collection of basic records through the hydrologic-data network, interpretive studies, and research projects. The hydrologic records and the results of investigations are published by the Geological Survey or by cooperating agencies. This report describes the water-resources projects and activities of the Geological Survey in Texas for the 1981 fiscal year (October 1, 1980 to September 30, 1981).

The Geological Survey's investigations of the water resources of Texas are under the general direction of Jack Rawson, Acting District Chief. The Texas District office is in the Federal Building, 300 East Eighth Street, Austin, Texas 78701.

Copies of unpublished records, hydrologic data prior to publication, and other unpublished reports may be obtained from the District office by request. Information regarding provisional records of stream discharge prior to publication and other hydrologic data collected within their respective areas may be obtained from the subdistrict offices in Austin, Fort Worth, Houston, San Antonio, and Wichita falls. Requests for information should be addressed as follows:

Jack Rawson, Acting District Chief  
U.S. Geological Survey  
300 East Eighth St., Rm. 649  
Austin, TX 78701  
Telephone: 512-397-5520

E. T. Baker, Jr., Subdistrict Chief  
U.S. Geological Survey  
300 East Eighth St., Rm. 867  
Austin, TX 78701  
Telephone: 512-397-5578

J. H. Eade, Subdistrict Chief  
U.S. Geological Survey  
1409 Knickerbocker Rd.  
San Angelo, TX 76901  
Telephone: 915-655-0616

E. E. Gann, Subdistrict Chief  
U.S. Geological Survey  
P.O. Box 6976  
Fort Worth, TX 76115  
Telephone: 817-334-5551

R. U. Grozier, Subdistrict Chief  
U.S. Geological Survey  
425 Isom Rd.  
Suite 234, North Plaza  
San Antonio, TX 78216  
Telephone: 512-344-9731

Robert K. Gabrysch, Subdistrict Chief  
U.S. Geological Survey  
2320 La Branch St., Rm. 1112  
Houston, TX 77004  
Telephone: 713-226-4671

J. O. Joerns, Subdistrict Chief  
U.S. Geological Survey  
318-320A Federal Bldg.  
Wichita Falls, TX 76301  
Telephone: 817-766-4052

#### COOPERATING AGENCIES

In Texas, the collection of most of the water-resources data and the conduct of most of the interpretive hydrologic investigations are accomplished in cooperation with Federal, State, and local agencies. Those agencies cooperating with the U.S. Geological Survey during fiscal year 1981 are:

Texas Department of Water Resources. Harvey D. Davis, Executive Director; A. L. Black, Chairman; John H. Garrett, Vice Chairman; Milton T. Potts, George W. McCleskey, Glen E. Roney, and W. O. Bankston, Members.

The University of Texas at Austin, Bureau of Economic Geology. W. L. Fisher, Director.

Pecos River Commission. Horace M. Babcock, Commissioner representing the United States and Chairman; Larry A. Vick, Commissioner representing Texas; and J. L. Cathey, Commissioner representing New Mexico.

Sabine River Compact Administration. Lamar Carroon, Commissioner representing the United States and Chairman; R. J. Palmer and Gerald R. Dyson for Louisiana; and J. M. Syler and Neilson Davis for Texas.

City of Austin. John German, Jr., Director of Engineering.

City of Garland. John G. Driskill, City Engineer.

City of Houston. J. A. Schindewolf, Director of Public Works.



Assistance in the form of funds or services is furnished by the following Federal agencies:

Environmental Protection Agency

International Boundary and Water Commission, United States and Mexico, U.S. Section

National Park Service

U.S. Army, Corps of Engineers, Fort Worth District, Texas

U.S. Army, Corps of Engineers, Galveston District, Texas

U.S. Army, Corps of Engineers, Tulsa District, Oklahoma

U.S. Water and Power Resources Services

Assistance in the form of funds or services is rendered through the Texas Department of Water Resources by the following cities and other cooperators:

Cities

Abilene	Corpus Christi	Houston
Alice	Dallas	Nacogdoches
Arlington	El Paso	San Angelo
Brady	Gainesville	San Antonio
Cleburne	Garland	Wichita Falls
Clyde	Graham	

Other Cooperating Agencies

Athens Municipal Water District

Bexar-Medina-Atascosa Counties Water Improvement District No. 1

Bistone Municipal Water Supply District

Brazos River Authority

Colorado River Municipal Water District

Other Cooperating Agencies--Continued

Dallas County

Dallas Power and Light Company

Edwards Underground Water District

Franklin County Water District

Freese and Nichols, Inc.

Greenbelt Municipal and Industrial Water Authority

Guadalupe-Blanco River Authority

Harris County Flood Control District

Harris-Galveston Coastal Subsidence District

Lavaca-Navidad River Authority

Lone Star Steel Company

Lower Colorado River Authority

Lower Neches Valley Authority

Mackenzie Municipal Water Authority

North Central Texas Municipal Water Authority

Northeast Texas Municipal Water District

Nueces River Authority

Orange County

Palo Pinto County Municipal Water District No. 1

Red Bluff Water Power Control District

Reeves County Water Improvement District No. 1

Sabine River Authority of Texas



Other Cooperating Agencies--Continued

San Antonio City Public Service Board  
San Antonio City Water Board  
San Antonio River Authority  
San Jacinto River Authority  
Tarrant County Water Control and Improvement District No. 1  
Texas Electric Service Company  
Texas Utilities Services Inc.  
The Woodlands Development Corporation  
Titus County Fresh Water Supply District No. 1  
Tom Green County Water Control and Improvement District No. 1  
Trinity River Authority  
Upper Guadalupe River Authority  
Upper Neches River Municipal Water Authority  
Upper Trinity Basin Water Quality Compact  
West Central Texas Municipal Water District  
Wichita County Water Improvement District No. 2  
Wood County

## COLLECTION OF HYDROLOGIC DATA

A continuing series of measurements and quantitative analyses are made of streamflow, reservoir contents, and estuarine flow. In addition, data are collected on the chemical quality of water and sediment in streams and reservoirs, water levels in wells, and land-surface subsidence.

Modern computer techniques are being used to compute, store, and disseminate hydrologic data. By the end of the 1981 fiscal year, the following installations will be in operation: Approximately 677 digital recorders at stream-gaging, tide-level, and rainfall stations; 15 conductivity (digital) recorders; 5 instruments for continuously monitoring and recording the water-quality characteristics of conductivity, water temperature, dissolved oxygen, and pH; and 6 continuous recorders for water temperature.

Ground-water data are collected at more than 1,300 observation wells. Water levels are measured continuously in 29 wells and periodically in about 1,000 wells; chemical-quality data are collected in about 300 wells; and subsidence data are collected in 13 wells.

### Surface-Water Records

#### Continuous-Record Streamflow and Reservoir-Content Stations

As of September 30, 1980, 544 stream-gaging, reservoir-content, and stage-only stations were in operation. During the 1981 fiscal year, 6 stream-gaging stations, 5 reservoir-content stations, and 1 stage-only station will be established; and 29 stream-gaging stations and 1 reservoir-content station will be discontinued. At the end of the 1981 fiscal year, 537 continuous-record stations will be in operation.

#### Partial-Record Stations

Low-flow partial-record stations.--As of September 30, 1980, 52 low-flow partial-record stations were in operation. During the 1981 fiscal year, one station will be established and eight stations will be discontinued.

Crest-stage partial-record stations.--As of September 30, 1980, two crest-stage partial-record stations were in operation. Two stations are scheduled to be established during the 1981 fiscal year.

Flood-hydrograph partial-record stations.--As of September 30, 1980, 47 flood-hydrograph partial-record stations were in operation. Two additional stations are scheduled to be established during the 1981 fiscal year and 4 stations are to be discontinued.



Flood-profile partial-record stations.--As of September 30, 1980, 18 flood-profile partial-record stations were in operation. One station will to be discontinued during the 1981 fiscal year.

Reconnaissance partial-record stations.--As of September 30, 1980, 6 reconnaissance partial-record stations were in operation. Two additional stations are scheduled to be established during the 1981 fiscal year.

Tide-level stations.--As of September 30, 1980, 33 tide-level stations were in operation. During the 1981 fiscal year, one station is scheduled to be established.

#### Continuous-Record Water-Quality Stations

As of September 30, 1980, 5 multiparameter water-quality monitors, 4 conductivity-temperature monitors, 15 conductivity monitors, and 6 temperature monitors were in operation. Two temperature monitors will be discontinued during the 1981 fiscal year; one conductivity monitor will be replaced with a conductivity-temperature monitor; and five conductivity-temperature monitors will be installed.

#### Daily Water-Quality Stations

Daily chemical-quality stations.--As of September 30, 1980, 91 daily conductivity stations were in operation. Sufficient samples were collected at most of these stations and at the conductivity monitoring stations to define the total daily loads of dissolved solids, chloride, and sulfate. Two stations will be discontinued during the 1981 fiscal year, and five stations will be converted to conductivity-monitoring stations.

Daily suspended-sediment stations.--As of September 30, 1980, eight daily suspended-sediment stations were in operation. One station will be discontinued during the 1981 fiscal year.

#### Periodic Water-Quality Stations

Periodic chemical-quality stations.--As of September 30, 1980, the periodic chemical-quality network consisted of stations at 41 sites on streams and 49 sites on reservoirs. Analyses of samples at most of these sites included only the major inorganic ions. During the 1981 fiscal year, one stream station and one reservoir station will be discontinued, and one reservoir station will be established. Periodic sampling at six reservoirs will be replaced by seasonal water-quality surveys.

Special periodic water-quality sampling sites.--Special periodic samples will be collected during the 1981 fiscal year at 159 sites on streams. Many of these sites are also daily or continuous conductivity-monitoring and urban stations. The analyses usually include major inorganic ions plus other selected properties or constituents such as BOD (biochemical oxygen demand), DO (dissolved oxygen), nutrients, pH, pesticides (in unfiltered water samples and bottom deposits), and minor elements.

Periodic suspended-sediment stations.--As of September 30, 1980, 58 periodic suspended-sediment stations were in operation. One station will be discontinued during the 1981 fiscal year.

#### Lake and Reservoir Studies

The program for the 1981 fiscal year provides for seasonal water-quality surveys of 33 reservoirs. On-site determinations will be made of specific conductance, dissolved oxygen, temperature, and pH. Samples for laboratory analyses for major inorganic ions plus other selected properties or constituents such as nutrients, minor elements, phytoplankton, and indicator bacteria will be collected from most of the reservoirs.



# Summary of Scheduled Changes in Data Stations

Type of record: Bp--periodic biologic; C--crest-stage partial-record; D--continuous-record streamflow; Dd--continuous-record (digital) streamflow; Dp--continuous-record (periodic) streamflow; G--stage only; H--flood-hydrograph partial-record; Hd--flood-hydrograph (digital) partial-record; L--low-flow partial-record; Op--periodic organic water quality; P--periodic pesticide; Qp--periodic chemical quality; R--reservoir content; T--tide level.

## New Stations Established, 1981 Fiscal Year

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
08018800 Lake Fork Reservoir near Quitman, Tex.	RQp	Texas Department of Water Resources	Station established to aid in the operation of Lake Fork Reservoir and for basin accounting.
08045850 Clear Fork Trinity River near Weatherford, Tex.	DdOp	Corps of Engineers, Fort Worth District	Station established to provide assistance in managing and metering inflow to Renbrook Lake.
08051130 Elm Fork Trinity River near Pilot Point, Tex.	C	....do....	Station established to obtain high water profiles and to aid in the definition of channel capacity.
08051160 Elm Fork Trinity River at County Truss bridge above Aubrey, Tex.	C	....do....	....Do....
08051190 Elm Fork Trinity River above Aubrey, Tex.	D	....do....	....Do....
08051200 Elm Fork Trinity River near Aubrey, Tex.	Dd	....do....	....Do....

# Summary of Scheduled Changes in Data Stations--Continued

## New Stations Established, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
08063045 Richland Creek near Irene, Tex.	DpOpQp	Corps of Engineers, Fort Worth District	Station established to provide assistance in managing and metering inflow to Navarro Mills Lake.
08063685 Waxahachie Creek near Waxahachie, Tex.	DpOpQp	....do....	Station established to provide assistance in managing and metering inflow to Bardwell Lake.
08074145 Bingle Road storm sewer at Houston, Tex.	HBpOpP Qp	City of Houston	Station established at the request of the city of Houston to de- fine flood volumes and peak discharges of a storm sewer of this size in an urban area.
08074540 Little Whiteoak Bayou at Trimble Street, Houston, Tex.	HdBpOp PQp	....do....	Station established as part of the Houston urban project study.
08104645 North Fork San Gabriel River near Liberty Hill, Tex.	OpQp	Corps of Engineers Fort Worth District	Station established to sample and analyze water quality inflow into Lake Georgetown.
08104650 Lake Georgetown near Georgetown, Tex.	RBpOp Qp	....do....	Station established to aid in the operation of Lake Georgetown, for basin accounting, and to periodically make analyses of water qual- ity in Lake Georgetown.

Summary of Scheduled Changes in Data Stations--Continued

New Stations Established, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
08105600 Granger Lake near Granger, Tex.	RBpOp Qp	Corps of Engineers Fort Worth District	Station established to aid in the operation of Granger Lake, for basin accounting, and to periodically make analyses of water quality of Granger Lake.
08106310 San Gabriel River near Rockdale, Tex.	Dd	....do....	Station converted from supplementary gage to regular gage to replace the gage, Brushy Creek near Rockdale.
08155240 Barton Creek at Lost Creek near Austin, Tex.	L	City of Austin	To provide data on ground-water surface- water interchange with respect to the Edwards aquifer study.
08159185 Dogwood Creek at Highway 95 near McDade, Tex.	HdBpOp PQp	--	To obtain background hydrologic data for determining the effects of lignite mining in the area.
08165150 Victoria Channel (Barge Canal) near Bloomington, Tex.	T	Corps of Engineers Galveston District	Station needed to de- fine the tidal range in stage for future con- struction work in the area by the Corps of Engineers.
08177920 San Antonio River at Dolorosa Street at San Antonio, Tex.	G	City of San Antonio	Station requested by the city of San Antonio for flood-forecasting purposes.



# Summary of Scheduled Changes in Data Stations--Continued

## New Stations Established, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
08178650 Elm Creek Reservoir Site 11, at San Antonio, Tex.	RBpOpP Qp	Edwards Underground Water District and the Texas Department of Water Resources.	Station established to provide runoff and re- charge data for the Edwards aquifer study.
08180700 Medina River near Macdona, Tex.	Dd	Texas Department of Water Resources.	Station will replace the present station Medina River near Somerset after comple- tion of Applewhite Reservoir on the Medina River.
08200990 Middle Verde Creek Reservoir near Hondo, Tex.	R	....do....	Station established to provide runoff and recharge data for the Edwards aquifer study.

# Summary of Scheduled Changes in Data Stations--Continued

Type of record: Bp--periodic biologic; D--continuous-record streamflow; Dd--continuous-record (digital) streamflow; F--flood-profile partial-record; Hd--flood-hydrograph (digital) partial-record; L--low-flow partial-record; Op--periodic organic water quality; P--periodic pesticides; Q--daily chemical quality; Qp--periodic chemical quality; Sp--periodic sediment; Tc--recorded temperature.

## Stations Discontinued, 1981 Fiscal Year

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
07299200 Prairie Dog Town Fork Red River near Lakeview, Tex.	S	University of Texas at Austin, Bureau of Economic Geology	Funds are not available to continue operation of this station.
07301200 McClellan Creek near McLean, Tex.	DdQp	Texas Department of Water Resources	Sufficient data have been collected to satisfy the project objectives.
07336750 Little Pine Creek near Kanawha, Tex.	DdSpTc	Corps of Engineers, Tulsa District	Funds are not available to continue operation of this station.
08042650 North Creek Sub- watershed No. 28-A near Jermyn, Tex.	D	Tarrant County Water Control and Improve- ment District No. 1, and the Texas Depart- ment of Water Resources	Sufficient data have been collected to satisfy the project objectives.
08042700 North Creek near Jacksboro, Tex.	Dd	....do....	....No....
08045800 Lake Weatherford near Weatherford, Tex.	Qp	Texas Department of Water Resources	....No....
08056500 Turtle Creek at Dallas Tex.	Dd	City of Dallas	....No....

# Summary of Scheduled Changes in Data Stations--Continued

## Stations Discontinued, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
08057090 White Rock Creek at Farm Road 544 near Plano, Tex.	F	City of Dallas	Sufficient data have been collected to satisfy the project objectives.
08057200 White Rock Creek at Greenville Avenue at Dallas, Tex.	Dd	....do....	....Do....
08057205 Storm Sewer at Arborside Drive and Moss Farm Lane, Dallas, Tex.	Hd	....do....	....No....
08057442 Prairie Creek at Jennie Lee Street, Dallas, Tex.	Hd	....do....	....No....
08057445 Prairie Creek at U.S. Highway 175, Dallas, Tex.	Dd	....do....	....No....
08057447 Hattfields Branch at Seagoville Road, Dallas, Tex.	Hd	....do....	....No....
08068100 West Fork San Jacinto River near Porter, Tex.	L	Texas Department of Water Resources	....Do....
08068600 Spring Creek near Humble, Tex.	L	....do....	....No....



# Summary of Scheduled Changes in Data Stations--Continued

## Stations Discontinued, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
08068750 Cypress Creek near Cypress, Tex.	L	Texas Department of Water Resources	Sufficient data have been collected to satisfy the project objectives.
08070200 East Fork San Jacinto River near New Caney, Tex.	L	....do....	....Do....
08070600 Caney Creek near New Caney, Tex.	L	....do....	....Do....
08071100 Peach Creek near New Caney, Tex.	L	....do....	....Do....
08071200 Tarkington Bayou near Dayton, Tex.	L	....do....	....Do....
08071300 Luce Bayou near Huffman, Tex.	L	....do....	....Do....
08074550 Little Whiteoak Bayou at Houston, Tex.	HdBpOp PQp	City of Houston	Station discontinued because of backwater condition (from White- oak Bayou). Station moved upstream.
08079000 Oyster Creek near Angleton, Tex.	Dd	Dow Chemical Co. and the Texas Department of Water Resources	Funds are not available to continue operation of this station.
08104000 Lampasas River at Youngsfort, Tex.	Dd	Texas Department of Water Resources	Station discontinued because of backwater from Stillhouse Hollow Lake.

# Summary of Scheduled Changes in Data Stations--Continued

## Stations Discontinued, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
08106300 Brushy Creek near Rockdale, Tex.	Dd	Corps of Engineers, Fort Worth District	Unable to define a stage-discharge rela- tionship because of poor location of gage. Gage moved downstream on San Gabriel River.
08110400 Navasota River near Groesbeck, Tex.	Dd	Bistone Municipal Water District and Texas Department of Water Resources	Station discontinued because of backwater from Lake Limestone.
08116650 Brazos River near Rosharon, Tex.	DdQBp OpPSP	Dow Chemical Com- pany and Texas Department of Water Resources	Funds are not avail- able to continue operation of this station.
08140800 Jim Ned Creek near Coleman, Tex.	Dd	Texas Department of Water Resources	Sufficient data have been collected to satisfy the project objectives.
08157000 Waller Creek at 38th Street, Austin, Tex.	Dd	....do....	....Do....
08157500 Waller Creek at 23d Street, Austin, Tex.	Dd	....do....	....No....
08159150 Wilbarger Creek near Pflugerville, Tex.	Dd	....do....	....Do....

# Summary of Scheduled Changes in Data Stations--Continued

## Stations Discontinued, 1981 Fiscal Year--Continued

Name of station	Type of record	Cooperation with USGS	Reason for discontinuance
08159175 Camp Creek tribu- tary near McDade, Tex. (formerly Big Sandy Creek tributary)	HdBpOp PQpSp	--	Station discontinued due to poor location.
08164500 Navidad River near Ganado, Tex.	DdQOpP	Corps of Engineers, Galveston District, and Texas Depart- ment of Water Resources.	Station discontinued because of backwater from Lake Texana.
08376300 Sanderson Creek at Sanderson, Tex.	Dd	Texas Department of Water Resources.	Funds are not avail- able to continue operation of this station.



## Ground-Water Records

A network of wells for observing fluctuations in ground-water levels, changes in the chemical quality of ground water, and subsidence of the land surface is maintained in areas of large-scale ground-water development. The periodic collection of ground-water data can be used in solving such specific problems as over-development and its relation to pumping costs, relationship of recharge to discharge of an aquifer, and relationship of the quality of ground water to the development and use of the water.

The observation-well network is confined to the areas of continuing ground-water studies in the Houston area, San Antonio area and Balcones Fault Zone, El Paso area, Orange County and adjacent areas, and Austin and adjacent areas. As of September 30, 1980, the Geological Survey was monitoring more than 1,300 wells in Texas. The types and numbers of selected observation wells maintained during the 1981 fiscal year by areas are as follows:

Area	Water levels		Chemical quality	Subsidence
	Periodic	Continuous		
Houston area	620	7	90	13
San Antonio area and Balcones Fault Zone	18	16	95	0
El Paso area	220	5	20	0
Orange County and adjacent areas	91	2	58	0
Austin and adjacent areas	29	1	19	0

## PROJECT STUDIES

### Hydrologic Studies of Small Watersheds

The U.S. Soil Conservation Service (SCS) has an extensive program of constructing floodwater-retarding structures in small watersheds in Texas. These structures, which are designed to control floodflows and sediment movement, will have varying but important effects on the natural surface- and ground-water resources of river basins, especially where a large number are built.

Hydrologic studies of SCS-developed areas in Texas, which began in 1951, have been made by the Geological Survey in 12 small watersheds to provide the needed data for analyses. The U.S. Soil Conservation Service, Texas Department of Water Resources, San Antonio River Authority, city of Dallas, and the Tarrant County Water Control and Improvement District No. 1 cooperated with the Geological Survey in these studies. The 12 study areas were chosen on a statewide basis to sample watersheds having different rainfall, topography, geology, and soils. In five of the study areas, stream-flow and rainfall records were collected prior to construction of the floodwater-retarding structures, thus affording the opportunity for analyses of the hydrologic conditions before and after construction.

The 12 study areas, which are in four major river basins, are North Creek, Elm Fork Trinity River, Little Elm Creek, Honey Creek, and Pin Oak Creek, all in the Trinity River basin; Green Creek, Cow Bayou, Little Pond-North Elm Creeks, in the Brazos River basin; Deep and Mukewater Creeks in the Colorado River basin; and Escondido and Calaveras Creek in the San Antonio River basin.

As of September 30, 1980, all of the hydrologic studies in the 12 small watersheds were completed. As funds and manpower become available, interpretive reports on the studies in each area will be prepared.

#### Urban-Hydrology Studies

In urban areas where residential, commercial, and industrial complexes may be subject to potentially destructive floods, lives and vast sums of money can be saved if metropolitan drainage systems and water-control facilities are properly planned.

Drainage systems that were constructed prior to urbanization may need to be redesigned to function properly under conditions of ultimate land development. Because of these requirements, hydrologic data are needed to define the effects of urbanization on the magnitude of floodflow from small drainage areas. Data are also needed to define the quality of storm runoff from urban watersheds.

The Geological Survey, in cooperation with State and local agencies, is conducting hydrologic studies in the Austin, Houston, and San Antonio areas. Hydrologic studies were completed in the Fort Worth area on September 30, 1977, and in the Dallas and Dallas County areas on September 30, 1979. These studies will provide data necessary for defining the changes in storm runoff resulting from progressive urban development and for defining flood boundaries and depths of inundation for floods of various magnitudes and frequencies. Water-quality data are also being obtained for studies of streamflow pollution by urban development.

## Austin Project

The Austin project began with a very small program in 1954 in cooperation with the Texas Department of Water Resources. The project initially involved the collection of rainfall and runoff data in the Waller Creek basin, a 4.13-square-mile urban watershed in Austin. Collection of rainfall and runoff data was begun in 1963 in the Wilbarger Creek basin, a 4.61-square-mile rural watershed 15 miles northeast of Austin. In 1966, the collection of runoff data in the Walnut Creek basin was added.

During the 1975 fiscal year, the project was extensively expanded in cooperation with the city of Austin. Streamflow and water-quality data were collected in the Bee, Bull, Barton, Bouldin, Shoal, Boggy, Walnut, Williamson, and Onion Creek watersheds, and in Town Lake. During the 1978 fiscal year, the project was further expanded to obtain data for definition of the effects of urbanization upon the local ground-water system.

As of fiscal year 1981, the program consists of: Continuous-streamflow data at 16 sites; flood hydrograph data at 151 sites; rainfall data at 29 sites; periodic streamflow water-quality data at 20 sites; water-quality surveys on Lake Austin and Town Lake; and reconnaissance water-quality sampling and water levels in about 50 wells. A report summarizing all data collection is published annually.

## Dallas Project

The Dallas project began in 1961, in cooperation with the city of Dallas. During the 1973 fiscal year, the following changes were made: Data collection at 87 flood-profile gages, 7 recording rain gages, and 1 flood-hydrograph gage was discontinued; and data collection began at 3 flood-hydrograph gages. An interpretive report "Effects of urbanization on floods in the Dallas, Texas, metropolitan area," based upon data collected in the project through September 1970, was completed during fiscal year 1974.

During the 1974 fiscal year, data collection was expanded in the Fivemile Creek drainage basin by the establishment of three flood-hydrograph (dual-digital) type stations and two weighing-type rainfall stations. Collection of rainfall and flood-stage or discharge data was also continued at 6 continuous-record stream-gaging stations, 13 flood-hydrograph stations, 2 flood-profile stations, and 29 recording rain-gage stations (including 9 gages at partial-record stations). This extensive hydrologic network covers the White Rock Creek, Turtle Creek, Bachman Branch, Joes Creek, Fivemile Creek, Cedar Creek, and Coombs Creek watersheds in Dallas.

During fiscal year 1978, data collection was expanded to cover a completely sewered residential area of 0.22 square mile. Streamflow and rainfall data are collected at the site using dual-digital recorders.



At the end of the 1979 fiscal year, the Geological Survey had collected sufficient data for the purposes of the project, and the network of hydrologic-data collection sites was discontinued. Most of the network is now being operated by the city of Dallas. The interpretive report will be prepared in the 1981 fiscal year by the Geological Survey.

A hydrologic-data report covering data collection in the 1979 fiscal year will also be prepared in 1981. This will be the last in a series of hydrologic-data reports for this project.

### Houston Project

The Houston project, which began in 1964, is in cooperation with the city of Houston and the Texas Department of Water Resources. The program was expanded during the 1969 fiscal year to include collection of water-quality data on the chemical quality, nutrients, BOD, pesticides, and sediment at five sites. During the 1972 fiscal year, periodic chemical-quality samples were collected at 6 additional sites, and samples for coliform bacteria counts and minor-element analyses were collected at 17 sites. The program was also expanded in 1972 to include collection of streamflow-quality and quantity data before development of a planned "satellite town" in the Panther Branch drainage basin about 25 miles north of Houston.

Analyses of hydrologic data collected through September 1969 were used in the report "Effects of urbanization on floods in the Houston, Texas, metropolitan area," published in April 1973.

During the 1977 fiscal year, all data collection in the Panther Branch drainage basin was discontinued; however it was resumed during the 1980 fiscal year. During the 1978 fiscal year, the data-collection and data-analysis programs were expanded. Three gaging stations were selected for use in special studies of channel-roughness coefficients (Mannings "n"). A small, completely sewered residential-drainage basin was instrumented for continuous-rainfall and streamflow-data collection. Eight digital rain-gage stations and one flood-hydrograph station, formerly operated by the Harris County Flood Control District, were also incorporated into the project. Seven continuous-record and two flood-hydrograph stations operated for another project for the Harris County Flood Control District were also incorporated into this project. During fiscal year 1980, the addition of another storm-sewered gaging site was added.

The report "Use of the STORM model for estimating the quantity and quality of runoff from the metropolitan area of Houston, Texas," was published during fiscal year 1979. The report "Techniques for estimating the magnitude and frequency of floods in the Houston, Texas, metropolitan area" was published during fiscal year 1980.

## San Antonio Project

The San Antonio project was initiated in 1968 in cooperation with the Texas Department of Water Resources with a data-collection network: Three continuous-record streamflow; four flood-profile; six flood-hydrograph (dual-digital); and nine recording rainfall stations. The data-collection program was expanded during the 1969 fiscal year to include samples collected and analyzed periodically from 11 streamflow sites. Results of these analyses were included in the annual hydrologic-data reports. Analyses were for: Standard chemical; nutrients; BOD; pesticides; and sediment. The program for 1971 was expanded slightly by the addition of a sediment station at Olmos Creek at Dresden Drive. In 1972, the gaging station at Olmos Reservoir was discontinued. In 1976, two flood-hydrograph stations with rain gages (dual-digital) were established in the Elm Creek watershed in cooperation with the Edwards Underground Water District, and data collection at Olmos Reservoir was resumed in cooperation with the Corps of Engineers.

Data collection during fiscal years 1977-79 continued at the 1976 level. During the 1980 fiscal year, the city of San Antonio assumed the funding in the project that was formerly provided by the Texas Department of Water Resources. One continuous-record stream-gaging station, one flood-hydrograph station, and two rainfall stations were discontinued; two flood-hydrograph stations and two rainfall stations were established. Also during the 1980 fiscal year, an additional flood-hydrograph station was established in cooperation with the Edwards Underground Water District. During fiscal year 1981, a continuous stage recorder will be installed on the reservoir in the Elm Creek basin in cooperation with the Edwards Underground Water District.

Hydrologic-data reports presenting tabular data for rates and volumes of rainfall and runoff, and data on the quality of the runoff will continue to be published annually.

### Chemical and Physical Characteristics of Water in Estuaries of Texas

This study began in October 1967 in cooperation with the Texas Department of Water Resources. The objectives of the study are to collect data on water temperature, pH, dissolved constituents, concentration of nutrients (phosphorus and nitrogen compounds), minor elements, water velocities and directions, and other data necessary to define the source and distribution of nutrients, current patterns and rates of movement, and the physical and organic water quality in areal distribution and time variation.

Two water-quality surveys for 10 estuaries from Port Arthur to Port Isabel will be made during fiscal year 1981.

To supplement tide-stage records being obtained by the U.S. Army Corps of Engineers, 33 additional tide and estuary stage gages are operated as part of the cooperative program with the Texas Department of Water Resources.

The hydrologic-data will be released to interested agencies on as timely a basis as possible and will be released in an annual hydrologic-data compilation. Interpretive reports will be prepared as the data warrant.

### Continuing Ground-Water Studies

The continuing ground-water studies are detailed studies that are designed to keep abreast of and to evaluate the effects of large withdrawals of ground water in the areas of concentrated pumping. The need for ground-water information in these areas is determined by the particular problems of the area, and the programs of continuing study are carefully planned to meet specific objectives.

#### Houston Area

The ground-water study in the Houston area, which began on a continuous basis in 1929, is in cooperation with the Texas Department of Water Resources, the city of Houston, and the Harris-Galveston Coastal Subsidence District. The program during fiscal year 1981 consists of inventorying all new large-capacity wells; making periodic measurements of water levels in about 620 observation wells; operating and maintaining 7 continuous water-level recorders and 13 compaction recorders; collecting water samples annually from about 90 wells for chemical analyses; conducting aquifer tests with new large capacity wells; and making an inventory of annual municipal, industrial, and irrigation pumpage.

The program for fiscal year 1981 is a continuation of the 1980 fiscal-year program at approximately the same scale except for the preparation of a 1975-79 ground-water data report.

#### El Paso Area

The ground-water study in the El Paso area began in 1935 in cooperation with the Texas Department of Water Resources and the city of El Paso. The program for the 1981 fiscal year is a continuation of the 1980 program and consists of measuring 161 wells annually, 22 quarterly, 7 monthly, and 5 continuously with water-level recorders; inventorying all new wells (excluding shallow irrigation wells); making aquifer tests with large capacity wells; and collecting water samples from about 20 wells. A ground-water data report for 1971-79, and a study of water-quality deterioration in some of the wells will be completed in 1981.

## San Antonio Area and Balcones Fault Zone

The ground-water study in the San Antonio area and Balcones Fault Zone which began in 1949, is in cooperation with the Texas Department of Water Resources and the Edwards Underground Water District. The objectives of the study are to appraise quantitatively the ground-water resources in the San Antonio area and along the Balcones Fault Zone from Kinney County to the Hays-Travis County line, and to continue to investigate the hydrology of the Edwards aquifer.

The 1981 program consists of continuing to collect and analyze the geologic and hydrologic data and to refine the previous evaluations. Items of work include the periodic measurements of water levels in 18 wells; operation and maintenance of continuous water-level recorders on 16 wells; collection of 90 samples for some but not all inorganic, biologic, and minor elements and pesticides; inventory of all large-capacity well pumpage and spring discharge; inventory of new wells; and mapping of the principal recharge area of the Edwards aquifer. A hydrologic-data report will be prepared in the 1981 fiscal year.

The hydrologic-data program for fiscal year 1981 will continue on about the same scale as the program in the 1980 fiscal year.

## Orange County and Adjacent Areas

The ground-water study in the Orange County area, which began in 1967, is in cooperation with the Texas Department of Water Resources and Orange County. The purpose of this study is to keep abreast of the effects of ground-water development in the area and especially to monitor the freshwater-saltwater interface as a guide to future development of ground water in Orange and adjacent counties to prevent further saltwater intrusion. The magnitude of industrial and municipal development in the area greatly increases the gravity of the situation.

The 1981 fiscal-year program consists of continuing the inventory of all large-capacity wells, including the collection of drillers' logs, electrical logs, and well-construction data; measurements of water levels in about 91 observation wells on a semiannual basis; and operation and maintenance of two continuous water-level recorders. In addition, water samples from about 58 wells will be collected for chemical analyses; and annual municipal and industrial pumpage will be inventoried.

The program for the 1981 fiscal year will continue on about the same scale as the program in the 1980 fiscal year. A five-year progress report for 1975-79 will be completed in the 1981 fiscal year.



## Other Interpretive Studies

### Hydrologic-Research Studies of the Edwards Aquifer

This ground-water study is in cooperation with the Texas Department of Water Resources and the San Antonio City Water Board. All indications are that the Edwards aquifer will in time become totally developed (in the amount of the natural recharge), and that it will then become necessary to integrate the use of water from the Edwards with water from other sources. At that time, it will be necessary to know in as much detail as possible how to get the most water from the Edwards with the least waste, with a minimum conflict between users, and with a minimum impact on those users who are in less favorable locations.

This study will provide for a detailed description of the geologic framework and the hydrology of the Edwards aquifer, thereby furnishing detailed information not now available to agencies that may be concerned with water management.

The program for 1981 will emphasize publication of reports on the analysis and interpretation of test-hole, geophysical, hydrologic, and geochemical data, and the interpretive report. The program will also include the planning of a digital-computer modeling study.

### Digital-Model Study of the Chicot and Evangeline Aquifers of the Texas Gulf Coast

The rapidly increasing demands on the ground-water resources of the Gulf Coast area have made it necessary to evaluate the major aquifers along the Gulf Coast of Texas. The study will result in four regional digital computer models, which will serve as a guide for the regional development and protection of the aquifers.

The program for the 1981 fiscal year will be to review and publish the final report.

## Miocene Aquifer Study - Gulf Coast Region of Texas

The increasing demands on the ground-water resources of the Texas Gulf Coast require a more detailed evaluation of the potential of the Miocene aquifers as a source of water supply. The study will result in a digital model that will serve as a useful tool to aid water planners in the regional development of these aquifers.

The 1981 fiscal-year program includes preparing a final report.

### Land-Surface Subsidence in the Texas Gulf Coast Area

Land-surface subsidence is occurring over a large part of the Texas Gulf Coast. As a result, part of the coastal area is subject to flooding by normal tides, and even larger areas may be inundated by hurricane tides. Also, the storm-drainage system is being damaged and is causing inland flooding problems.

A study of land-surface subsidence began in 1976 in cooperation with the Texas Department of Water Resources and the Harris-Galveston Coastal Subsidence District. The study is divided into two parts: (1) To determine the cause and extent of subsidence throughout the Texas coastal area; (2) to keep abreast of and to determine the cause and effect of subsidence in Harris and Galveston Counties. In fiscal year 1978, data were collected on land-surface subsidence throughout the Texas Gulf Coastal area. In the Harris and Galveston County areas, 13 compaction monitors and associated piezometers were maintained, a line of monuments was established from Pasadena to Katy to determine horizontal movement, and other associated hydrologic data were collected. A hydrologic data and analysis report will be prepared for the period 1975-79. The subsidence data-collection program for 1981 will be continued at approximately the same level as the 1980 program.

### Ground-Water Resources of Rusk County, Texas

The purpose of this study, which is in cooperation with the Texas Department of Water Resources, is to evaluate the ground-water resources of Rusk County. Emphasis will be placed on the source, occurrence, quantity, and quality of the ground water suitable for municipal, industrial, and irrigation use.

This program, which began in the 1979 fiscal year, was suspended during the 1980 fiscal year and reinstated in the 1981 fiscal year. Plans for the 1981 fiscal year consist of completing the data collection and beginning the preparation of the final report.

## Ground-Water Resources of Limestone County, Texas

The purpose of this study, which is in cooperation with the Texas Department of Water Resources, is to evaluate the ground-water resources of Limestone County. Emphasis will be placed on the sources, occurrence, quantity, and quality of ground water suitable for municipal, industrial, and irrigation use, and on evaluating the effects of lignite mining.

The study will begin in the 1981 fiscal year and will include: (1) A determination of the freshwater-bearing units and the quality of water contained in them; (2) any changes in ground-water conditions that have occurred in the area where earlier comparable data are available; (3) the quantity of water being pumped and the effects of these withdrawals on water levels; (4) the hydraulic characteristics of the important water-bearing units; and (5) an estimate of the quantity of ground water available from each of the important water-bearing units.

### High Plains Regional Aquifer-System Analysis--Texas

The Ogallala Formation is the principal aquifer underlying the High Plains of Texas. The economic future of the High Plains is dependent upon the capacity of the aquifer to sustain withdrawals of water; however, water is being withdrawn for irrigation in excess of the rate of natural replenishment. The purpose of this 5-year federally funded study covering eight states will be to develop a regional geohydrologic data base for the High Plains, and to develop computer models of the ground-water flow system for use in evaluating the response of the aquifer system to ground-water management alternatives. Much of the work is being performed under contract by the Texas Department of Water Resources.

Plans for fiscal year 1981 for the Texas part of the regional study include: Completing the data collection from a test-drilling and well-inventory program that will be used to prepare the saturated thickness, water-table, and lithologic maps of the Ogallala Formation; continuing the collection of historical pumpage data; and planning for the digital model.

### Edwards (Balcones Fault Zone) Aquifer in Travis, Bell, and Williamson Counties, Texas

This study began during the 1978 fiscal year and is jointly being conducted by the U.S. Geological Survey and the Texas Department of Water Resources. The objectives of the study are to appraise quantitatively the ground-water resources of the Edwards aquifer system and to provide the data and methodology necessary for present and long-range planning for water use and management.

The 1981 program will consist of continuing to collect and analyze the geologic and hydrologic data and to refine previous evaluations. Items of work will include measuring the network of observation wells on a monthly basis and collection of additional water-quality samples for inorganic, chemical, biological, nutrient, pesticide, and minor-element analyses. The activities will also include the preparation of a jointly authored progress report.

### Texas Water-Use Data Program

This program began during the 1978 fiscal year in cooperation with the Texas Department of Water Resources. The program will provide water-use information for the optimum utilization and management of the State's water resources for the overall benefit of the people of Texas and of the United States. Inherent in the program will be the collection, storage, and dissemination of water-use data to compliment data on the availability and quality of the State's water resources and to develop and operate a system to process the data. Most of the work on this program is being performed by the Texas Department of Water Resources, with funds from the Geological Survey being used to supplement the program to conform to the National program needs.

During the 1980 fiscal year, the State will continue to: (1) Collect and compile water-use data; (2) store, maintain, and provide water-use data to local users; (3) develop procedures and methodology for entering water-use data on the National Water-Use Data System, and (4) begin entering data to the National system on a test basis for selected basins.

Work during the 1981 fiscal year will also include preparing and publishing a 1979-80 Statewide irrigation-inventory data report. The development and testing of a new computerized accounting procedure to process the total surveyed municipal and industrial use by county and river basin will continue.

### Salinity Control, Brazos and Red River Basins

The U.S. Army Corps of Engineers has proposed the construction of brine-detention reservoirs on tributaries of the Upper Brazos River and Wichita River (Red River basin of Texas) for use in salinity-control projects in these basins. The U.S. Geological Survey is studying the effects of these proposed reservoirs on ground-water conditions in the vicinity of each reservoir.

During fiscal year 1979, water levels in approximately 90 wells were measured quarterly, and most of these wells were sampled twice for chemical analyses. Part of the compilation and analysis of collected and published information was completed.



Plans for fiscal year 1981 include continuing the data-collection and analysis programs, constructing and calibrating hydrologic models for the purpose of simulating and projecting the effects of the proposed reservoirs, and preparing an interpretive report.

#### Sources of Saline Water in the Upper Colorado River Basin

The segment of the Colorado River between Colorado City and Lake J. B. Thomas has long been known to contain high concentrations of salt. Recent investigations suggest that controls on disposal of oil-field brine, diversions of saline water, and other remedial measures are improving the quality of water in the Colorado River. The purposes of this study, in cooperation with the U.S. Army Corps of Engineers, are to delineate the areas of saline inflow and to determine if the quantities of salt reaching the upper Colorado River are decreasing.

The report summarizing the results of the study has been prepared and will be published during fiscal year 1981.

#### Hydrology of Lignite Mining, Camp Swift, Texas

A detailed study of the hydrology in the Camp Swift area near Bastrop is being conducted in anticipation of lignite mining on the largely unused military reservation. This study is one of several studies in a nationwide U.S. Geological Survey coal-hydrology program.

The lignite in the study area is found in a seam generally less than 10 feet thick. The expected mining is to be at depths up to 200 feet and in a strip about 5-miles wide.

The objectives of the study, which began in 1979, are to quantitatively appraise the existing ground-water and surface-water resources of the area, and to determine the availability of water supplies for lignite development. The seasonal variations in the organic, inorganic, and sediment characteristics of surface-water runoff, and the areal variations in the quality of ground water will also be determined.

Future plans include a study to determine or predict the hydrologic effects of a lignite mining operation. This will involve chemical and physical tests of overburden and lignite samples, and the development of digital models to simulate the ground-water system and the expected stresses.

REPORTS IN PREPARATION, RELEASED, OR PUBLISHED

DURING FISCAL YEAR 1981 1/

Hydrologic-Data Reports

Water Resources Data for Texas

Water resources data for Texas, water year 1979 (October 1978-September 1979), volumes 1-3. Published as U.S. Geological Survey Water-Data Report TX 79-1, TX 79-2, TX 79-3.

Water resources data for Texas, water year 1980 (October 1979-September 1980), volumes 1-3. To be published as U.S. Geological Survey Water-Data Report TX 80-1, TX 80-2, TX 80-3.

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Urban-Hydrology Studies

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Lind, W. B., Chemical and physical characteristics of water in estuaries in Texas, October 1974-September 1975. This report was published as Texas Department of Water Resources report 245.

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