

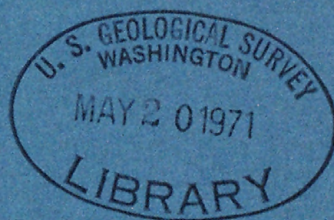
Annual Compilation and Analysis of Hydrologic Data for Pin Oak Creek, Trinity River Basin Texas 1969

By B.B. Hampton and D.R. Myers

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY-WATER RESOURCES DIVISION

Texas District

Trigg Twichell, District Chief



Prepared in Cooperation with the Texas Water Development Board

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ANNUAL COMPILATION AND ANALYSIS OF HYDROLOGIC DATA FOR PIN OAK CREEK,
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INTRODUCTION

History of Small Watershed Projects in Texas

The U.S. Soil Conservation Service is actively engaged in the installation of flood and soil erosion reducing measures in Texas under the authority of "The Flood Control Act of 1936 and 1944" and "Watershed Protection and Flood Prevention Act" (Public Law 566), as amended. The Soil Conservation Service has found a total of approximately 3,500 floodwater-retarding structures to be physically and economically feasible in Texas. As of September 30, 1969, 1,355 of these structures had been built.

This watershed-development program will have varying but important effects on the natural surface- and ground-water resources of river basins, especially where a large number of the floodwater-retarding structures are built. Basic hydrologic data under natural and developed conditions are needed to appraise the effects of the structures on the yield and mode of occurrence of runoff.

Hydrologic investigations of these small watersheds were begun by the U.S. Geological Survey in 1951 and are now being made in 12 areas (fig. 1). These studies are being made in cooperation with the Texas Water Development Board, the Soil Conservation Service, the San Antonio River Authority, the city of Dallas, and the Tarrant County Water Control and Improvement District No. 1. The 12 study areas were chosen to sample watersheds having different rainfall, topography, geology, and soils. In five of the study areas (North, Little Elm, Mukewater, North Elm-Little Pond, and Pin Oak Creeks), streamflow and rainfall records were collected prior to construction of the floodwater-retarding structures, thus affording the opportunity for analyses of the conditions "before and after" development. Structures have now been built in three of these study areas. A summary of the development of the floodwater-retarding structures on each study area as of September 30, 1969, is shown in table 1.

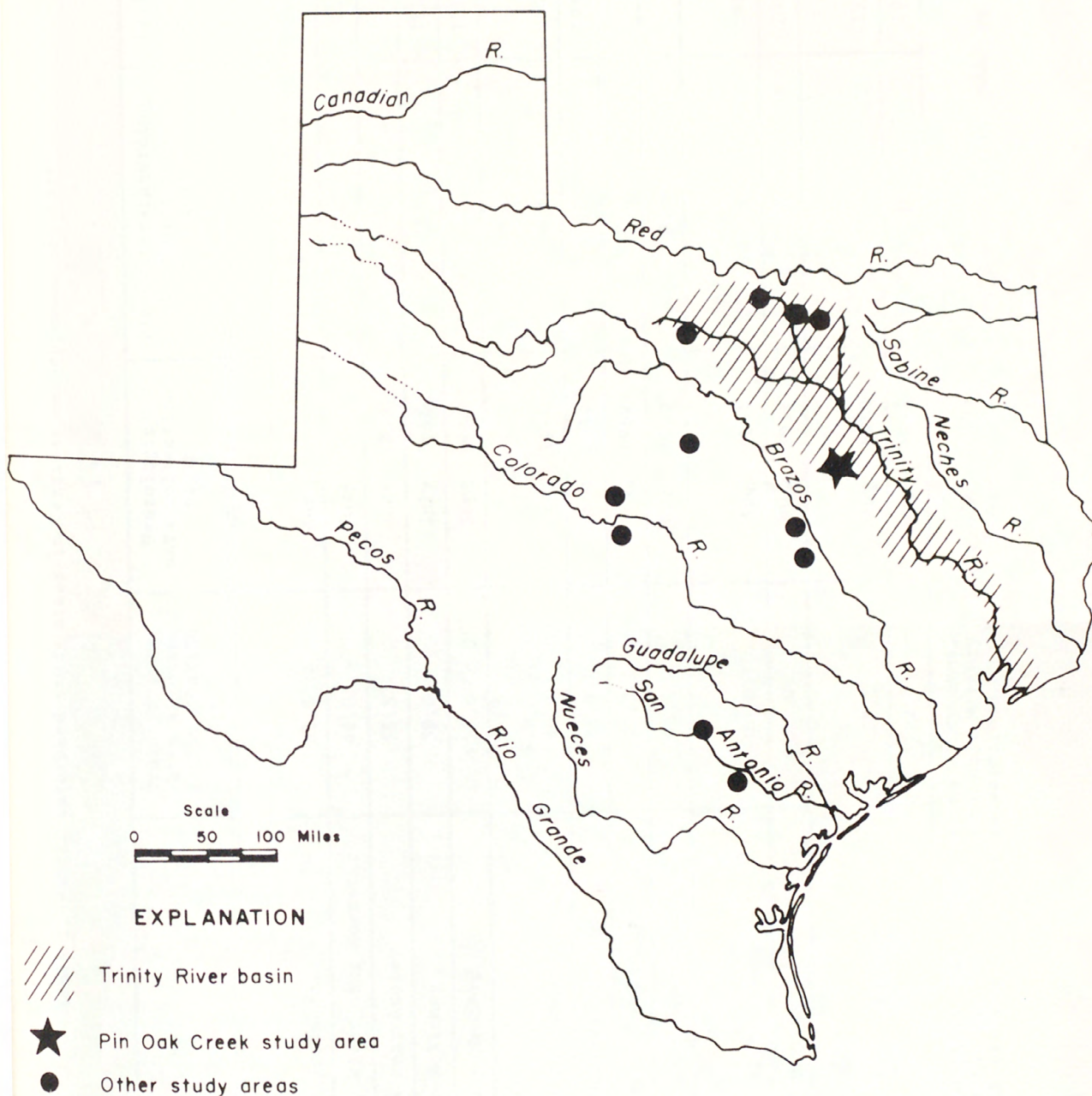


FIGURE 1.-Location of the Pin Oak Creek study area

Table 1.--Small watershed study areas in Texas as of September 30, 1969

Watershed	Drainage area above stream- gaging station (sq mi)	Hydrologic data collection began	Floodwater-retarding structures above stream-gaging station	Period the structures were built
<u>Trinity River basin:</u>				
North Creek near Jacksboro	21.6	Aug. 1956	None	-
Elm Fork Trinity River near Muenster	46.0	July 1956	14	1954-57, 63
Little Elm Creek near Aubrey	75.5	June 1956	8	1966
Honey Creek near McKinney	39.0	July 1951	13	1951-57, 69
Pin Oak Creek near Hubbard	17.6	Sept. 1956	6	1962-63, 65
<u>Brazos River basin:</u>				
Green Creek near Alexander	46.1	Oct. 1954	8	1954-56
Cow Bayou near Mooreville	85.0	Sept. 1954	26	1955-58, 64-65
1/Little Pond Creek at Burlington	22.2	Oct. 1962	None	-
1/North Elm Creek near Cameron	48.6	Oct. 1962	None	-
<u>Colorado River basin:</u>				
Mukewater Creek at Trickham	70.0	Aug. 1951	6	1961-62, 65
Deep Creek near Mercury	a/43.9	June 1951	5	1951-53
<u>San Antonio River basin:</u>				
Calaveras Creek near Elmendorf	77.2	Aug. 1954	7	1954-58
Escondido Creek at Kenedy	b/72.4	July 1954	10	1954-58

1/ Adjacent watersheds; considered as one study area.

a/ 8.31 sq mi above Dry Prong Deep Creek near Mercury not included in this total.

b/ 8.43 sq mi above Escondido Creek subwatershed No. 11 (Dry Escondido Creek) near Kenedy not included in this total.

Objectives of the Texas Small Watersheds Project

The purpose of these investigations is to collect sufficient data to meet the following objectives:

1. To determine the net effect of floodwater-retarding structures on the regimen of streamflow at downstream points.
2. To determine the effectiveness of the structures as ground-water recharge facilities.
3. To determine the effect of the structures on the sediment yield at downstream points.
4. To develop relationships between maximum rates and/or volumes of runoff with rainfall in small natural watersheds.
5. To develop a stream-system model for basins with floodwater-retarding structures.
6. To determine the minimum instrumentation necessary for estimating the flood hydrographs below a system of structures, as needed for downstream water-management operation.

Purpose and Scope of this Basic-Data Report

This report, which is the tenth in a series of basic-data reports published annually for the Pin Oak Creek study area, contains the rainfall and runoff data collected during the 1969 water year for the 17.6-square-mile area above the stream-gaging station Pin Oak Creek near Hubbard, Texas. The locations of floodwater-retarding structures (ungaged) and hydrologic instruments in the area are shown on figure 2.

The investigation is scheduled to continue through a period of both above- and below-normal precipitation to define the various factors used in the analyses of rainfall-runoff relationships before and after floodwater-retarding structures were built.

To facilitate the publication and distribution of this report at the earliest feasible time, certain material contained herein does not conform to the formal publication standards of the U.S. Geological Survey.

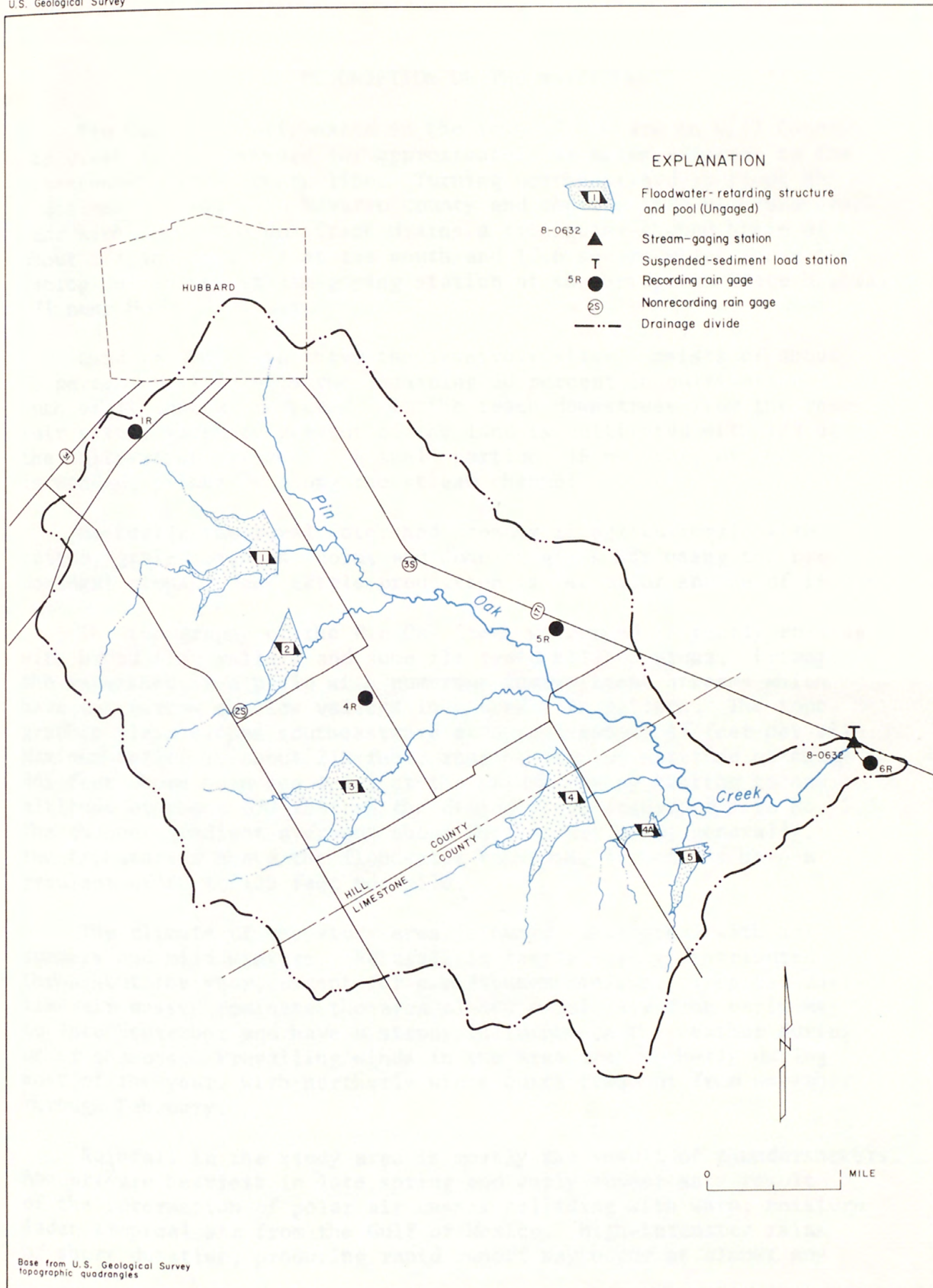


FIGURE 2.—Locations of floodwater-retarding structures and hydrologic-instrument installations in the Pin Oak Creek study area

DESCRIPTION OF THE WATERSHED

Pin Oak Creek originates in the town of Hubbard in Hill County. The creek flows eastward for approximately 14 miles adjacent to the Limestone-Navarro County line. Turning northeastward it flows an additional 14 miles in Navarro County and empties into Richland Creek near Richland. Pin Oak Creek drains a triangular-shaped basin of about 171 square miles at the mouth and 17.6 square miles above the Geological Survey stream-gaging station at the bridge on State Highway 171 near Hubbard, Texas.

Land in the basin above the reservoir sites consists of about 70 percent pasture with the remaining 30 percent in cultivation, much of it contour terraced. In the reach downstream from the reservoir sites, about 80 percent of the land is cultivated with 1/2 of the cultivation terraced. A small portion, 15 percent, of the land is wooded, primarily along the stream channel.

Basically the rural watershed economy is agricultural, with cotton, grain sorghums, corn, and Johnson grass hay being the predominant crops. Beef cattle production is the major source of income.

The topography of the Pin Oak Creek watershed is gently rolling with broad flat valleys and some flattened hilltop areas. Primarily the watershed is a plain with numerous intermittent streams which have cut narrow shallow valleys in a dendritic pattern. The topographic plain slopes southeastward at approximately 17 feet per mile. Maximum relief is about 210 feet, ranging from an altitude of about 465 feet above mean sea level at the stream-gaging station to an altitude of about 670 feet on the divide above reservoir site No. 1. The channel gradient averages about 20 feet per mile; generally, the tributaries above the floodwater-retarding structures have a gradient of 60 to 100 feet per mile.

The climate of the study area is humid subtropical with hot summers and mild winters. Rainfall is fairly evenly distributed throughout the year, except for a midsummer minimum. Tropical maritime air masses dominate the area almost completely from early May to late September and have a strong influence on the weather during other seasons. Prevailing winds in the area are southerly during most of the year, with northerly winds quite frequent from November through February.

Rainfall in the study area is mostly the result of thundershowers. Amounts are heaviest in late spring and early summer as a result of the interaction of polar air masses colliding with warm, moisture laden tropical air from the Gulf of Mexico. High-intensity rains of short duration, producing rapid runoff may occur at almost any

time during the year, but are most frequent in the spring and early summer. Considerable variation in rainfall may occur from month to month and from year to year. The normal annual rainfall for the 30-year base period (1931-60) at the U.S. Weather Bureau station at Corsicana (28 miles northeast of the study area) is 37.06 inches. The wettest year of record at Corsicana (28 miles northeast of the study area) was 1957, when a total of 61.50 inches fell. In 1917, the driest year of record, only 19.36 inches occurred. The average annual rainfall in the study area for the 12-year (1957-69) period was 35.30 inches, compared to the 12-year (1957-69) average annual rainfall of 38.89 inches at the U.S. Weather Bureau at Corsicana.

FLOODWATER-RETARDING STRUCTURES

Five floodwater-retarding structures in the study area were built during the 1963 water year, and one was completed in the 1965 water year. These six structures (sites 1, 2, 3, 4, 4A, and 5) have a combined capacity of 3,480 acre-feet at the emergency spillway crests and partly control runoff from 9.68 square miles of the 17.6-square-mile area above the stream-gaging station. Pertinent information relating to each structure is given in table 2.

HYDROLOGIC INSTRUMENTS

Instruments to collect rainfall, runoff, and sediment data consist of a network of rain gages and a stream-gaging station downstream from the floodwater-retarding structures to measure the stage, from which the integrated flow from the study area can be computed. No instrumentation has been installed on the pool sites, and none is anticipated. Location of instruments presently in operation is shown on figure 2.

Four recording and two nonrecording rain gages are located in the study area to determine the amount and intensity of rainfall. The rain gages were located to give the best geometric coverage of the study area. Basin rainfall is computed as the arithmetic average of the six gages. Daily rainfall observed at the nonrecording gages is distributed to storm periods on the basis of the recorded rainfall.

The stream-gaging station, Pin Oak Creek near Hubbard, continuously records the stage, which together with measurements of streamflow allows the computation of the total runoff from the study area. Streamflow records at this gage began September 1, 1956.

Table 2.--Floodwater-retarding structures in Pin Oak Creek study area, 1969 water year

Site number	Drainage area (sq mi)	Date dam completed	Capacity, in acre-feet		
			Total	Floodwater-retarding pool	Sediment pool
1	2.66	April 1963	836	769	67
2	0.99	April 1963	354	303	51
3	2.13	April 1963	791	641	150
4	2.39	November 1964	943	744	199
4A	0.51	December 1962	165	111	54
5	1.00	December 1962	391	283	108

Suspended-sediment load is computed from daily or more frequent sediment samples collected at the gaging station. The collection of sediment data began in October 1956 and continued until September 1960 when the sediment station was discontinued. The sediment station was re-established in September 1962, and data have been collected to the present time.

SUMMARY OF DATA FOR THE 1969 WATER YEAR

Rainfall and Runoff

The average rainfall over the study area during the 1969 water year was 28.42 inches, or 81 percent of the 12-year (1957-69) average of 35.30 inches. Rainfall was scattered throughout the year with every month receiving some rainfall. The monthly rainfall totals ranged from 0.09 inch in July to 5.46 inches in April. The mean daily discharge at the stream-gaging station Pin Oak Creek near Hubbard was 7.53 cfs (cubic feet per second), compared with the 13-year (1956-69) average of 11.8 cfs. The annual runoff at the stream-gaging station was 5,450 acre-feet, or 5.81 inches which represents 20 percent of the total rainfall.

A storm event is defined as a period of rainfall separated by at least 6 hours from other rainfall. Storms are selected for detailed rainfall-runoff computations on the basis of rainfall totals and distribution, the peak discharge produced from the rainfall at the stream-gaging station, and the assurance of good rainfall and runoff records for the storm periods selected.

During the 1969 water year, three storm periods were selected for detailed computations and analyses. These computations include detailed time breakdown of rainfall and discharge, hydrograph, and mass curves. The storms selected occurred on April 4, 1969; May 5, 1969; and May 6-7, 1969. A summary of rainfall-runoff data for these storms is shown in table 3. Computations along with hydrograph and mass curves for each storm are shown in the compilation and analysis of data.

Chemical Quality

During the 1969 water year, two chemical-quality samples were collected for analysis at the stream-gaging station Pin Oak Creek near Hubbard. The results of the chemical analyses are given in table 4. The water contained calcium and bicarbonate as the predominant ions. No samples were collected at the reservoir sites during the year.

ANNUAL STORM RAINFALL—RUNOFF SUMMARY DATA

Table 3.--Storm rainfall-runoff data, 1969 water year.

[illegible]

Table 4.--Chemical analyses of surface water, Pin Oak Creek study area, 1969 water year.

DATE	DIS- CHARGE (CFS)	SILICA (SiO ₂) (MG/L)	CAL- CIUM (CA) (MG/L)	MAG- NES- IUM (MG) (MG/L)	SODIUM (NA) (MG/L)	BICAR- BONATE (HCO ₃) (MG/L)	CAR- BONATE (CO ₃) (MG/L)	SULFATE (SO ₄) (MG/L)	CHLO- RIDE (CL) (MG/L)	FLUO- RIDE (F) (MG/L)	NITRATE NO ₃ (MG/L)	DIS- SOLVED SOLIDS (SUM OF CONSTITU- ENTS) (MG/L)	DIS- SOLVED SOLIDS (TONS PER AC-FT)	DIS- SOLVED SOLIDS (TONS PER DAY)	HARD- NESS (CA, MG) (MG/L)	NON- CAR- BONATE HARD- NESS (MG/L)	SODIUM AD- SORP- TION RATIO	SPECI- FIC CON- DUCTANCE (MICRO- MHOS)	PH (UNITS)	TEMP- ERATURE (DEG C)
FEB. 14...	64	8.8	30	2.0	29	112	0	24	17	1.1	3.2	170	.23	29.4	83	0	1.4	286	7.0	8
MAR. 24...	56	7.8	36	3.9	16	114	0	30	8.9	.7	1.2	160	.22	24.2	106	13	.7	266	7.5	14

Suspended-sediment load for the 1969 water year were not available for publication with this report. These data will be published with the 1970 basic-data report for this study area.

COMPI LATION AND ANALYSIS OF DATA

TRINITY RIVER BASIN

8-0632. Pin Oak Creek near Hubbard, Tex.

LOCATION.--Lat 31°48'01", long 96°43'02", Hill County, on right bank 85 ft downstream from bridge on State Highway 171, 5.8 miles southeast of Hubbard, and 11 miles upstream from Elm Creek.

DRAINAGE AREA.--17.6 sq mi.

PERIOD OF RECORD.--September 1956 to current year.

GAGE.--Water-stage recorder. Datum of gage is 463.08 ft above mean sea level.

AVERAGE DISCHARGE.--13 years, 11.8 cfs (9.10 inches per year, 8,550 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 828 cfs Apr. 4 (gage height, 10.33 ft); no flow for many days.

Period of record: Maximum discharge, 4,340 cfs Aug. 24, 1958 (gage height, 13.86 ft); no flow at times each year.

Maximum stage since at least 1900, about 17 ft in August 1919, from information by local resident.

REMARKS.--Records good. Since 1966, flow from 9.68 sq mi above this station has been partly controlled by 6 floodwater-retarding structures with a total combined capacity of 3,480 acre-ft below the flood-spillway crests, of which 2,850 acre-ft is floodwater-retarding capacity and 630 acre-ft is sediment-pool capacity. The capacity in these pools allocated to sediment storage will be used for conservation storage until eliminated by sedimentation. Three recording and two standard rain gages are located in the basin above the station, and one recording rain gage is located at the station. Records of suspended-sediment loads and water temperatures for the water year 1969 are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	38	0	.10	.27	.79	2.0	.17	0	0	0
2	0	0	1.2	0	.08	.33	2.9	1.5	.10	0	0	0
3	0	0	.13	0	.06	1.3	8.4	4.6	.06	0	0	0
4	0	0	.04	0	.02	.47	193	3.8	.17	0	0	0
5	0	0	.01	0	.01	3.1	107	258	.27	0	0	0
6	0	0	0	0	.01	16	70	93	.08	0	0	0
7	0	0	0	0	.01	5.4	50	247	.03	0	0	0
8	0	0	0	0	.01	9.6	32	96	.02	0	0	0
9	0	0	0	0	.01	4.0	21	70	.02	0	0	0
10	0	0	0	0	.01	2.0	12	59	.01	0	0	0
11	0	0	0	0	.01	.94	6.3	37	.01	0	0	0
12	0	0	0	0	.01	.55	161	25	.01	0	0	0
13	0	0	0	0	.01	.27	97	15	.01	0	0	0
14	0	0	0	0	28	.17	49	7.5	.01	0	0	0
15	0	0	0	0	23	58	32	5.4	0	0	0	0
16	0	0	0	.04	4.2	43	20	3.5	0	0	0	0
17	0	0	0	.94	1.1	19	16	3.1	0	0	0	0
18	0	0	0	.13	.33	43	12	1.5	0	0	0	0
19	0	0	0	.03	.08	16	8.1	.79	0	0	0	0
20	0	0	0	.01	.08	6.6	6.3	.68	0	0	0	0
21	0	0	0	.01	59	3.1	8.4	.68	0	0	0	0
22	0	0	0	.01	40	1.8	11	.40	0	0	0	0
23	0	0	0	.02	17	142	9.0	.40	0	0	0	0
24	0	0	0	.02	6.9	54	24	.33	0	0	0	0
25	0	0	0	.01	2.9	35	19	.13	0	0	0	0
26	0	0	0	.01	1.7	18	12	.13	0	0	0	0
27	0	.10	0	.01	.94	9.9	36	.13	0	0	0	0
28	0	3.8	0	.01	.47	4.4	19	.13	0	0	0	0
29	0	.13	0	.03	-----	2.4	7.5	.17	0	0	0	0
30	0	23	0	.06	-----	1.4	4.2	.17	0	0	0	0
31	0	-----	0	.13	-----	.94	-----	.27	-----	0	0	-----
TOTAL	0	27.03	39.38	1.47	186.05	502.94	1,054.89	937.31	0.97	0	0	0
MEAN	0	.90	1.27	.047	6.64	16.2	35.2	30.2	.032	0	0	0
MAX	0	23	38	.94	59	142	193	258	.27	0	0	0
MIN	0	0	0	0	.01	.17	.79	.13	0	0	0	0
CFSM	0	.05	.07	.003	.38	.92	2.00	1.72	.002	0	0	0
IN.	0	.06	.08	.003	.39	1.06	2.23	1.98	.002	0	0	0
AC-FT	0	54	78	2.9	369	998	2,090	1,860	1.9	0	0	0

CAL YR 1968	TOTAL 9,294.21	MEAN 25.4	MAX 1,050	MIN 0	CFSM 1.44	IN 19.64	AC-FT 18,430
WTR YR 1969	TOTAL 2,750.04	MEAN 7.53	MAX 258	MIN 0	CFSM .43	IN 5.81	AC-FT 5,450

of Pin Oak Creek ~~River~~^{est} near Hubbard, Texas
[Drainage area, 17.6 square miles]

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PRECIPITATION DATA SUMMARY

STUDY AREA		PIN OAK CREEK		RAIN GAGES					1969	WATER YEAR
Date of storm		1-R	2-S	3-S	4-R	5-R	6-R	Average		
Oct.	5, 1968	0.11	0	0.05	0.05	0.05	0.03	-		
	9	(1.50)	.98	1.15	(.85)	.95	.86	-		
	12	0	0	.03	.03	0	0	-		
	23	(.13)	0	0	.25	.20	.18	-		
Oct. Totals		1.74	.98	1.23	1.18	1.20	1.07	1.23		
Nov.	2, 1968	(0.27)	0.61	0.61	(0.20)	(0.15)	0.43	-		
	8	.98	1.00	1.02	.95	1.02	.86	-		
	15	.40	.41	.60	.69	.72	.72	-		
	23	0	.09	0	0	0	0	-		
	26-27	1.75	1.94	1.69	1.72	1.75	1.71	-		
	30	(1.75)	1.48	1.50	1.48	(1.45)	1.29	-		
Nov. Totals		5.15	5.53	5.42	5.04	5.09	5.01	5.21		
Dec.	9, 1968	0	0	0	0.05	0	0.05	-		
	12	(.25)	.28	.24	(.15)	.25	.18	-		
	20-21	(.25)	.25	.23	.23	(.20)	.14	-		
	21-22	(.30)	.26	.22	.25	(.25)	.18	-		
	27	0	0	0	.10	0	.10	-		
	Dec. Totals		.8	.79	.69	.78	.7	.65	0.74	
Calendar Year Total										44.76
Jan	16, 1969	0.55	0.76	0.77	(0.40)	0.35	0.31	-		
	29	.08	.05	.07	.05	.07	.40	-		
	30	.35	.28	.36	.35	.30	.20	-		
	31	.28	.20	.27	.25	.25	.33	-		
Jan Totals		1.26	1.29	1.47	1.05	.97	1.24	1.21		

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PRECIPITATION DATA SUMMARY

STUDY AREA		PIN OAK CREEK		RAIN GAGES					1969	WATER YEAR
Date of storm		1-R	2-S	3-S	4-R	5-R	6-R	Average		
Feb. 13-14, 1969		1.30	1.35	1.22	1.24	1.25	1.18			
14		.30	.40	.30	.36	.35	.30			-
20		.20	.36	.24	.29	.26	.23			-
21		.93	.56	.81	.71	.54	.64			-
Feb. Totals		2.73	2.67	2.57	2.60	2.40	2.35			2.55
Mar. 2, 1969		0.53	0.41	0.53	0.50	0.48	0.44			-
5		.40	.46	.50	.46	.50	.36			-
7		.30	.26	.25	.30	.26	.27			-
14-15		(1.25)	.66	1.15	.97	1.00	1.17			-
17-18		(.30)	.42	.37	.32	.31	.34			-
22		.07	.07	.08	.07	.06	.11			-
23		1.18	1.30	1.34	1.23	1.09	1.36			-
Mar. Totals		4.03	3.58	4.22	3.85	3.70	4.05			3.90
Apr. 4, 1969		(1.90)	2.18	2.11	2.25	2.00	1.23			-
12		(1.47)	2.82	2.10	1.95	1.85	1.69			-
17		.55	.41	.40	.42	.35	.34			-
27		(.95)	1.10	1.40	1.26	(1.00)	1.00			-
Apr. Totals		4.87	6.51	6.01	5.88	5.20	4.26			5.46
May 3, 1969		0	0	0	0	0.10	0.13			-
4		.55	.46	.59	.75	.45	.50			-
5		1.35	1.56	1.42	1.85	1.38	1.35			-
6-7		.85	1.16	1.26	1.10	1.20	1.87			-
8		(.10)	.19	.14	.12	.13	.16			-
14		0	.57	.29	0	0	.03			-
15		.37	.11	0	.31	(.25)	.32			-
17		.12	0	0	0	0	0			-
30		0	.35	0	.23	0	0			-
May Totals		3.34	4.40	3.70	4.36	3.51	4.36			3.94

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PRECIPITATION DATA SUMMARY

STUDY AREA		PIN OAK CREEK		RAIN GAGES					1969	WATER YEAR
Date of storm		1-R	2-S	3-S	4-R	5-R	6-R	Average		
June 3, 1969		0.30	0.26	0.42	0.23	0.20	0.17	-	-	
16		.05	.15	.20	0	0	0	-	-	
June Totals		.35	.41	.62	.23	.20	.17	0.33		
July 16, 1969		0.10	0	0.03	0.05	0.05	0.28	-	-	
20		0	0	0	0	0	.05	-	-	
July Totals		.10	0	.03	.05	.05	.33	0.09		
Aug. 4, 1969		(0.10)	0.05	0.07	0.06	0.06	0.02	-	-	
5		(1.10)	.55	.71	.62	.55	.35	-	-	
14		(.75)	.73	.63	.83	(.50)	.12	-	-	
15		(.10)	0	.11	.07	(.10)	.15	-	-	
16		.05	0	0	.03	.10	0	-	-	
22		.05	.27	.05	.35	.05	0	-	-	
26		1.16	.74	1.23	1.25	1.00	.69	-	-	
28		0	.90	0	0	0	.05	-	-	
Aug. Totals		3.31	3.24	2.80	3.21	2.36	1.38	2.72		
Sept. 2, 1969		0.05	0	0.03	0.02	0.13	0.68	-	-	
5		.12	0	.03	.10	.24	.23	-	-	
17		.55	.55	.75	.25	.24	.07	-	-	
23		.60	.42	.30	.40	.25	.25	-	-	
Sept. Totals		1.32	.97	1.11	.77	.86	1.23	1.04		
Water Year Total								28.42		

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY-TEXAS DISTRICT

RUNOFF COMPUTATIONS

Station 8-632 Pin Oak Creek near Hubbard, Tex.

Period of Record April 4-5, 1969

Drainage Area 17.6

Time	G. Ht. Feet	Sh. Adj.	Discharge			Runoff	
			c.f.s.	Inc.	In/hr.	Inches	Acc. In.
			April 4				
0000	2.00	0	7.86	.5	0.0007	0.0046	0.0046
1300	1.98		7.27	.5	.0006	.0042	.0088
1400	2.02		8.4	.75	.0007	.0005	.0093
1430	2.18		13	.5	.0011	.0006	.0099
1500	3.08		63	.5	.0055	.0028	.0127
30	5.00		170	.5	.0149	.0074	.0201
1600	6.95		248	.5	.0218	.0109	.0310
30	7.52		276	.5	.0243	.0122	.0432
1700	8.35		335	.5	.0295	.0148	.0580
30	9.02		423	.5	.0372	.0186	.0766
1800	9.41		488	.75	.0429	.0322	.1088
1900	10.07		718	1	.0631	.0631	.1719
2000	10.31		820	.625	.0721	.0451	.2170
15	10.33		828	.25	.0728	.0182	.2352
30	10.31		820	.375	.0721	.0210	.2622
2100	10.23		784	.75	.0689	.0517	.3139
2200	9.69		572	1	.0503	.0503	.3642
2300	8.57		357	1	.0314	.0314	.3956
2400	7.20	0	260	.5	.0229	.0114	.4070
			429.4	.24			
			193				
Comp. by			BBH				
checked by			RRP			DRM	

Time	G. Ht. Feet	Sh. Adj.	Discharge			Runoff	
			c.f.s.	Inc.	In/hr.	Inches	Acc. In.
			April 5				
0000	7.20	0	266	.25	.0029	.00057	0.4127
30	6.50		226	.5	.0199	.0100	.4227
0100	5.82		199	.5	.0175	.0088	.4315
30	5.28		179	.5	.0157	.0078	.4393
0200	4.80		163	.75	.0143	.0107	.4500
0300	4.37		142	1	.0125	.0125	.4625
0400	4.14		130	.5	.0114	.0171	.4796
0600	3.86		114	3	.0100	.0300	.5096
1000	3.59		97	3	.0085	.0255	.5351
1200	3.51		93	4	.0082	.0328	.5679
1800	3.37		83	6	.0073	.0438	.6117
2400	3.28	0	76	3	.0067	.0201	.6318
			2557.25	.27			
			107				
Total Runoff in acre-feet 595							
Comp. by			BBH				
checked by			RRP			DRM	

Computed by _____ Date _____ Checked by _____ Date _____

Sheet 1 of 1

Comp. by: B.B.H.

Date: 4/16/70

Check by: DRM

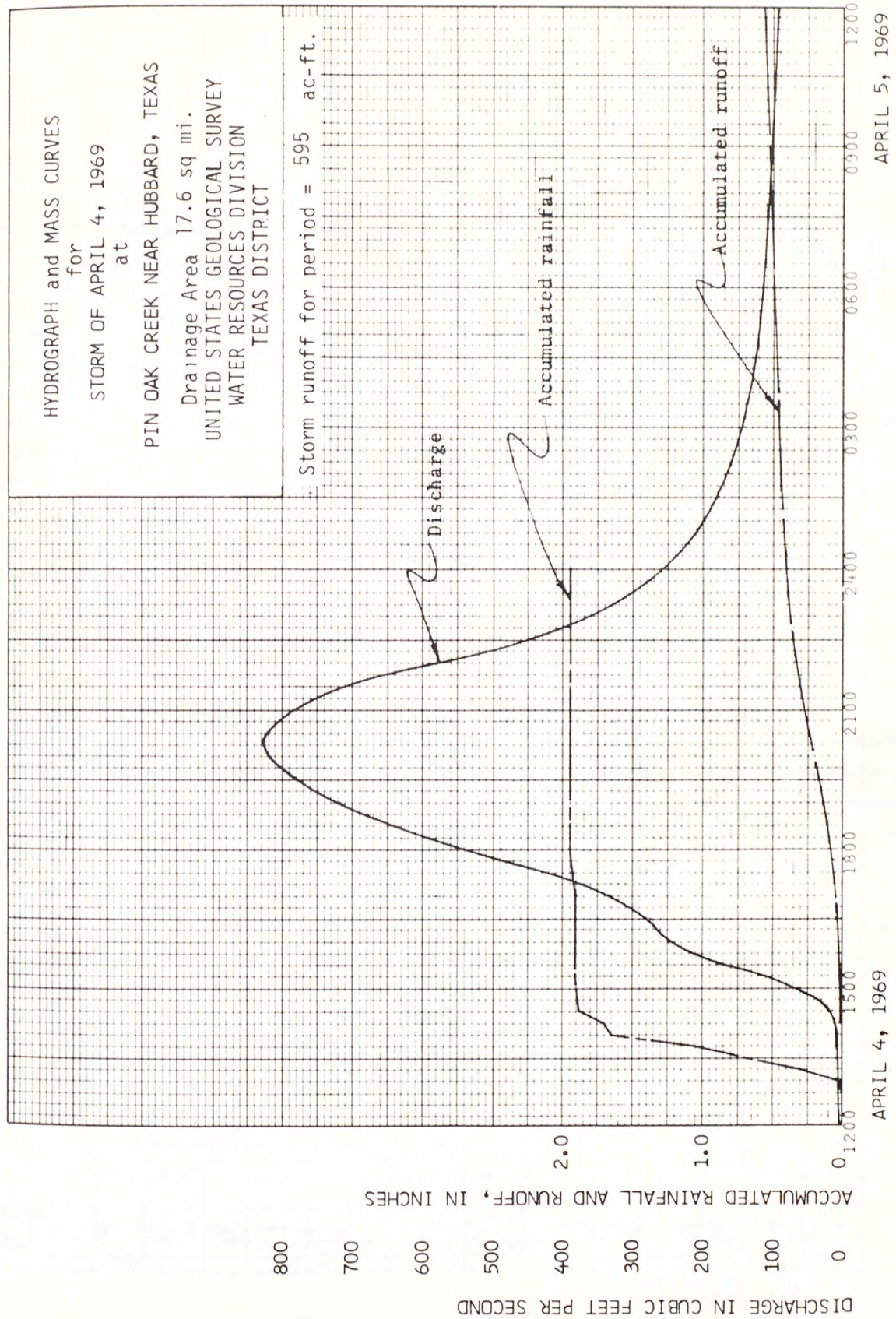
Date: 5/4/70

UNITED STATES DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY, SURFACE WATER BRANCH
AUSTIN DISTRICT

WEIGHTED PRECIPITATION RECORD

Area: Pin Oak Creek near Hubbard, Tex. Date of storm April 4, 1969

[illegible]



UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY-TEXAS DISTRICT

RUNOFF COMPUTATIONS

Station 8-632 Pin Oak Creek near Hubbard, Tex.
Period of Record May 5-6, 1969 Drainage Area 17.6 sq. mi.

Time	G. Ht. Feet	Sh. Adj.	Discharge			Runoff	
			c.f.s.	Inc.	In/hr.	Inches	Acc. In.
			May 5				
0000	1.84	0	3.52	.5	.00003	.00008	.00008
0500	1.82		3.12	.75	.0003	.0008	.0016
30	2.21		14	.5	.0012	.0006	.0022
0600	3.20		71	.5	.0062	.0031	.0053
30	4.60		154	.5	.0135	.0068	.0121
0700	5.75		196	.5	.0172	.0086	.0207
30	5.97		205	.5	.0180	.0090	.0297
0800	6.05		208	.5	.0183	.0092	.0389
30	6.88		244	.5	.0215	.0108	.0497
0900	8.00		304	.5	.0267	.0134	.0631
30	8.72		378	.5	.0332	.0166	.0797
1000	9.27		461	.75	.0405	.0304	.1101
1100	10.00		690	1	.0607	.0607	.1708
1200	10.23		784	1	.0689	.0689	.2397
1300	10.00		690	1	.0607	.0607	.3004
1400	9.64		554	1	.0487	.0487	.3491
1500	9.18		447	1	.0393	.0393	.3884
1600	8.58		358	1	.0315	.0315	.4199
1700	7.82		293	1	.0258	.0258	.4457
1800	6.97		248	1	.0218	.0218	.4675
1900	5.92		203	1	.0178	.0178	.4853
2000	5.18		175	1	.0154	.0154	.5007
2100	4.65		156	1.5	.0137	.0206	.5213
2300	4.14		130	1.5	.0114	.0171	.5384
2400	4.00	0	122	.5	.0107	.0054	.5438
			6182	.025	24		
			258				
Computed by			BBH				
Checked by		RRP			DRM		

Time	G. Ht. Feet	Sh. Adj.	Discharge			Runoff	
			c.f.s.	Inc.	In/hr.	Inches	Acc. In.
			May 6				
0000	4.00	0	122	3	.00107	.0321	.5759
0600	3.58		97	6	.0085	.0510	.6269
1200	3.45		88	8	.0077	.0616	.6885
2200	3.31		79	6	.0069	.0414	.7299
2400	3.67	0	102	1	.0090	.0090	.7389
			2228	24			
			93				
Total Runoff			696 acre-feet				
Comp. by			BBH				
Checked by		RRP			DRM		

Computed by _____ Date _____ Checked by _____ Date _____

Sheet 1 of 1
 Comp. by: B B H
 Date: 4/16/70
 Check by: DRM
 Date: 5/4/70

UNITED STATES DEPARTMENT OF INTERIOR
 GEOLOGICAL SURVEY, SURFACE WATER BRANCH
 AUSTIN DISTRICT

F-4411.4
 WEIGHTED PRECIPITATION RECORD

Area: Pin Oak Creek near Hubbard, Tex.

Date of storm May 5, 1969

Area: Pin Oak Creek near Hubbard, Tex.											
Date of storm May 3, 1961											
Accumulated Precipitation in Inches for Recording Gages											
Weight Factor		Gages 1-R		Gages 4-R		Gages 5-R		Gages 6-R			
Recorded		x Factor		Recorded		x Factor		Recorded		x Factor	
Date & Time		Gage		Gage		Gage		Gage		Gage	
May 5, 1969		Recorded		Recorded		Recorded		Recorded		Recorded	
0000		0.00		0.00		0.00		0.00		0.00	
0500		0		0		0		0		0	
15		.03		.03		.03		.03		.03	
30		.76		.76		.76		.76		.76	
45		1.18		1.18		1.18		1.18		1.18	
0600		1.30		1.30		1.30		1.30		1.30	
15		1.35		1.35		1.35		1.35		1.35	
30		1.37		1.37		1.37		1.37		1.37	
45		1.40		1.40		1.40		1.40		1.40	
0700		1.40		1.40		1.40		1.40		1.40	
0900		1.40		1.40		1.40		1.40		1.40	
30		1.40		1.40		1.40		1.40		1.40	
45		1.40		1.40		1.40		1.40		1.40	
1000		1.73		1.73		1.73		1.73		1.73	
15		1.78		1.78		1.78		1.78		1.78	
30		1.81		1.81		1.81		1.81		1.81	
45		1.84		1.84		1.84		1.84		1.84	
1100		1.85		1.85		1.85		1.85		1.85	
1200		1.85		1.85		1.85		1.85		1.85	
1500		1.85		1.85		1.85		1.85		1.85	
2400		1.85		1.85		1.85		1.85		1.85	

HYDROGRAPH and MASS CURVES for

STORM OF MAY 5, 1969
at

PIN OAK CREEK NEAR HUBBARD, TEXAS

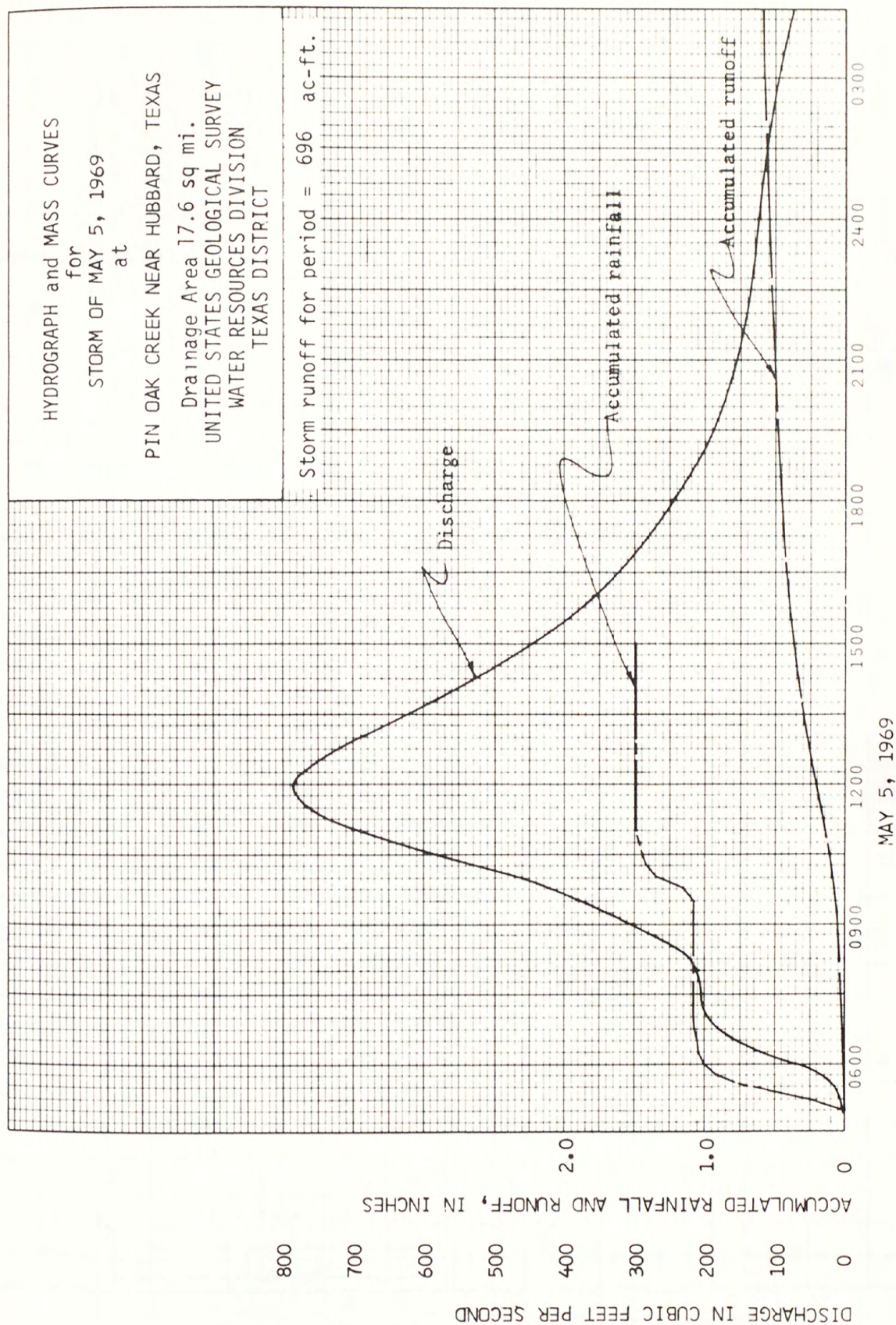
Drainage Area 17.6 sq mi.

UNITED STATES GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

TEXAS DISTRICT

Storm runoff for period = 696 ac-ft.



UNITED STATES DEPARTMENT OF THE INTERIOR
 GEOLOGICAL SURVEY - TEXAS DISTRICT

RUNOFF COMPUTATIONS

Station Pin Oak Creek near Hubbard, Tex.Period of Record May 7, 1969Drainage Area 17.6

Time	G. Ht. Feet	Sh. Adj.	Discharge			Runoff	
			C. f. s.	Inc.	In/Hr.	Inches	Acc. In.
			May 7				
0000	3.67	0	102.5	.00090	.00045	.00045	
0100	3.80		110.75	.0097	.0073	.0118	
30	4.50		149.5	.0131	.0066	.0184	
0200	7.00		250.5	.0220	.0110	.0294	
30	8.17		318.5	.0280	.0140	.0434	
0300	8.42		342.75	.0301	.0226	.0660	
0400	8.50		350.125	.0308	.0385	.1045	
0530	8.88		402.1	.0353	.0353	.1397	
0600	8.93		410.5	.0360	.0180	.1577	
30	8.90		405.1	.0356	.0356	.1933	
0800	8.61		362.125	.0318	.0398	.2331	
0900	9.05		428.1	.0376	.0376	.2707	
1000	8.66		369.1	.0324	.0324	.3031	
1100	7.95		300.1	.0264	.0264	.3295	
1200	7.32		266.1	.0234	.0234	.3529	
1300	6.78		239.1	.0210	.0210	.3739	
1400	6.27		217.15	.0191	.0286	.4025	
1600	5.34		180.2	.0158	.0316	.4341	
1800	4.70		159.2	.0140	.0280	.4621	
2000	4.33		140.3	.0123	.0369	.4990	
2400	3.98	0	121.2	.0106	.0212	.5202	
			5,918	.24			
			247				
Total runoff =			490	ac-ft.			
Computed by			BBH				
checked by			DRM				

Computed by _____ Date _____ Checked by _____ Date _____

UNITED STATES DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY, SURFACE WATER BRANCH
AUSTIN DISTRICT

WEIGHTED PRECIPITATION RECORD

Area: Pin Oak Creek near Hubbard, Tex. Date of storm May 6-7, 1969

Area: <u>Pin Oak Creek near Hubbard, Ia.</u>									
Accumulated Precipitation in Inches for Recording Gages									
Date & Time	Gage 1-R		Gage 4-R		Gage 5-R		Gage 6-R		Accumulated Weighted Precipitation (Rec. Gages x K) All Gages
	Recorded	x Factor	Recorded	x Factor	Recorded	x Factor	Recorded	x Factor	
May 6 1969									
2100	0.00		0.00		0.00		0.00		0.00
45	.00		.00		.00		.00		.00
2200	.05		.27		.30		.30		.23
2400	.05		.27		.30		.30		.23
May 7									
0015	.11		.27		.30		.30		.24
30	.19		.29		.30		.32		.28
45	.41		.34		.42		.32		.36
0100	.54		.48		.65		.52		.54
15	.55		.68		.89		1.02		.77
30	.56		.78		.92		1.24		.88
0200	.56		.80		.92		1.24		.87
0700	.56		.80		.92		1.27		.88
0715	.56		.80		.92		1.27		.89
0730	(.60)		(.87)		(.98)		1.62		1.02
0745	(.70)		(.95)		1.10		1.82		1.14
0800	(.75)		1.00		1.14		1.82		1.18
1100	(.75)		1.00		1.15		1.82		1.16
1200	(.80)		1.03		1.18		1.87		1.22
1300	(.80)		1.03		1.18		1.87		1.22
1630	(.80)		1.05		1.18		1.87		1.22
45	(.80)		1.05		1.18		1.87		1.22
1700	.85		1.10		1.20		1.87		1.26
2400	.85		1.10		1.20		1.87		1.24
Rain Gage Weight Factor Precipitation Precipitation x Weight factor Rain Gage Weight Factor Precipitation Weight Factor Precipitation x Weight Factor									
1-R									
2-5			.85		6-R		1.87		
3-5			1.16				7.44		
4-R			1.26				1.24		
5-R			1.20						
Total Average 6-R 1.87 7.44 1.24									
Sum of Precipitation x Weight Factor K = 1.24 Total Recording Gages Weighted Precipitation = 1.24 / 1.26 = 0.984									

