TEXAS WATER DEVELOPMENT BOARD

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QUANTITY AND QUALITY OF LOW FLOW IN THE PECOS RIVER BELOW GIRVIN, TEXAS, FEBRUARY 6-9, 1968

By

V. L. Spiers and H. R. Hejl, Jr.
United States Geological Survey

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QUANTITY AND QUALITY OF LOW FLOW IN THE PECOS RIVER BELOW GIRVIN, TEXAS, FEBRUARY 6-9, 1968

ABSTRACT

During the period February 6-9, 1968, water discharge in the Pecos River increased from 25.9 cfs (cubic feet per second) near Girvin to 134 cfs near the mouth. The discharge measurements show four major gains, three major losses, and numerous smaller gains and losses between individual sites. The quality of water improved progressively downstream, with dissolved solids decreasing from 15,600 mg/l (milligrams per liter) to 1,720 mg/l. The chloride concentration decreased from 6,480 mg/l to 650 mg/l.

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PURPOSE AND SCOPE OF THE STUDY

This investigation was made to determine the changes in quantity and quality of low flow in a 193.6-mile reach of the Pecos River from the U.S. Geological Survey stream-gaging and chemical-quality station Pecos River near Girvin to the International Boundary and Water Commission, United States and Mexico stream-gaging station Pecos River at mouth near Comstock.

Discharge measurements were made and water samples were collected at 21 sites on the Pecos River and at six sites on tributaries to the Pecos River. In addition, nine observations of no flow were made on tributaries.

The first reach, from mile 194.6 (distance in river miles measured upstream from the mouth) to mile 125.9, was studied during the period February 6-7; the second reach, from mile 125.9 to mile 61.5, was studied during the period February 6-8; and the third reach, from mile 61.5 to mile 1.0, was studied during the period February 6-9. Measurements and samples were obtained in a downstream order with overlapping at the beginning and end of the middle reach.

Low-flow and water-delivery studies of the Pecos River from Red Bluff Reservoir to Girvin were made in 1964, 1965, and 1967 (Grozier and others, 1966 and 1968). Results of miscellaneous stream flow measurements and chemical analyses made in the reach from Girvin to Sheffield have been published by the Geological Survey (Collins and Riffenburg, 1927).

DESCRIPTION OF THE BASIN

The reach of the Pecos River investigated during this study is in the Pecos Valley and Edwards-Stockton Plateau region of west Texas (Figure 2). Altitudes along the river range from 2,269 feet above sea level at the stream-gaging station near Girvin to 1,031 feet above sea level at the gaging station near Comstock.

From Girvin to about midway between Girvin and Iraan, the river flows through an area of Quaternary alluvium, composed of gravel, sand, silt, clay, and caliche. From this point to its mouth, the river is deeply incised in Cretaceous rocks, chiefly limestones.

CONDITIONS OF FLOW

During this study, conditions were generally favorable for determining gains and losses in streamflow. There were no releases of water from Red Bluff Reservoir (188.4 miles upstream from Girvin), and no water was being diverted from the Pecos River by any irrigation district. No appreciable precipitation had occurred for 15 days prior to this study, and most of the streamflow was ground-water effluent. A small rise occurred at the stream-gaging station Pecos River near Girvin on January 31 as the result of rainfall near Pecos, Texas, on January 20. This rise did not affect the relative magnitude of downstream measurements. During the period January 25-February 10, daily mean discharge at the station Pecos River near Girvin ranged from 23 to 36 cfs (cubic feet per second); and daily mean discharge at the station Pecos River near Comstock ranged from 135 to 149 cfs.

CHEMICAL QUALITY OF THE WATER

The water of the Pecos River at the station near Girvin, the initial point of the investigation, contained 15,600 mg/l (milligrams per liter) dissolved solids and 6,480 mg/l chloride. Past records for this station and earlier analyses for this reach of the Pecos River (Collins and Riffenburg, 1927) show that these concentrations are typical during low-flow periods. There had been no release from Red Bluff Reservoir during the period immediately preceding the investigation, so the high concentrations of dissolved constituents were due to the poor quality of the ground-water inflow above the station.

The quality of the river water improved progressively downstream, with dissolved solids decreasing to 1,720 mg/l and chloride to 650 mg/l. The water in the tributary streams contained lower concentrations of dissolved solids and chloride than the water in the main stem. Chemical quality and discharge data are shown in Figure 1. Chemical analyses are given in Table 2.

GAINS AND LOSSES IN FLOW

During this investigation there was an overall gain in flow throughout the total reach of 193.6 miles (Table

1). Between individual sites, however, the measurements show four major gains, three major losses, and numerous smaller gains and losses. These gains and losses are summarized in Table 3.

Losses in streamflow are attributable generally to losses of water into the alluvium of the river bed. Gains in streamflow are attributable to effluent ground water, springflow, and tributary inflow. A distinct change in chemical quality without a corresponding change in discharge indicates an interchange of surface water and ground water.

The effluent ground water is derived chiefly from aquifers in the Cretaceous rocks in the Edwards and Stockton Plateaus. Ground-water discharge during this investigation should not necessarily be considered typical because data concerning the stage of the water table and hydraulic gradients in the Cretaceous aquifers were not available. Changes in stage and gradient would cause changes in discharge.

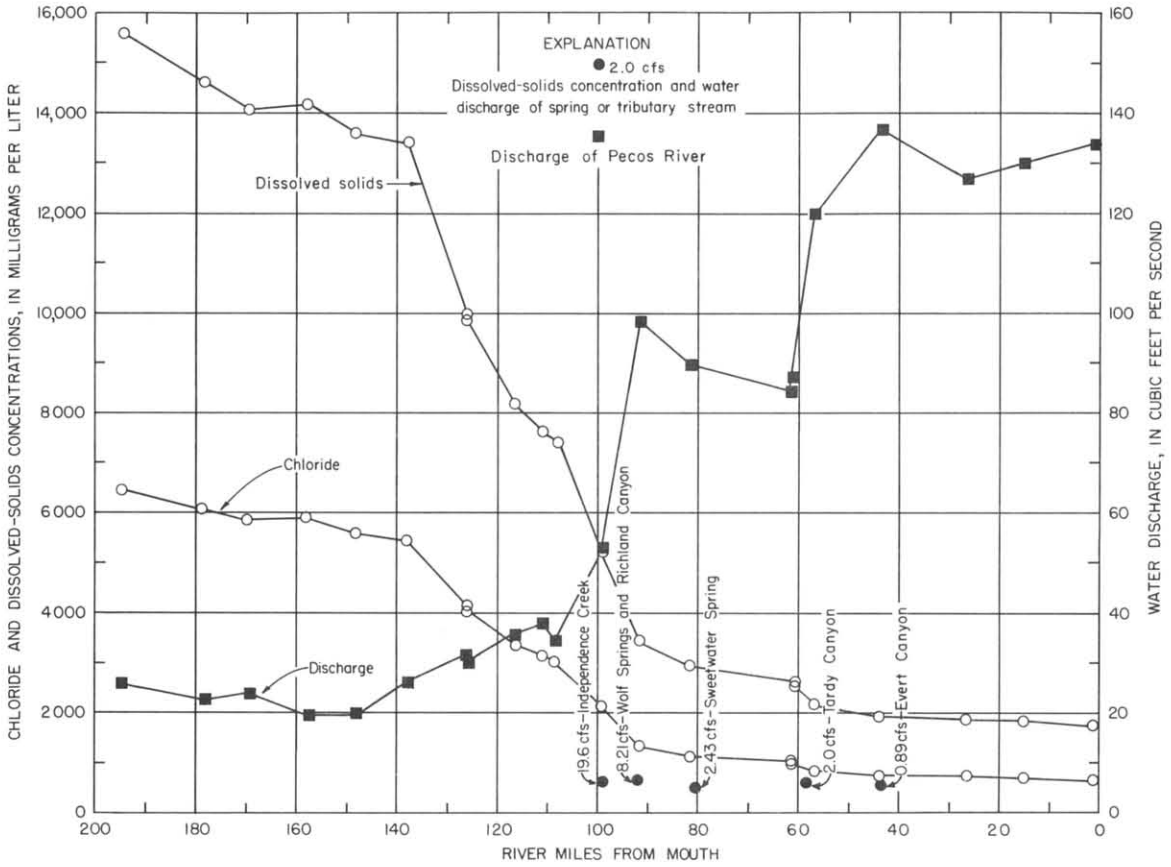

Figure 1.—Chloride and Dissolved-Solids Concentrations and Water Discharge, Pecos River, Tributaries, and Springs, February 6-9, 1968

REFERENCES CITED

Collins, W. D., and Riffenburg, H. B., 1927, Quality of water of Pecos River in Texas: U.S. Geol. Survey Water-Supply Paper 596-D, 22 p., 4 figs., 1 pl.

Grozier, R. U., Albert, H. W., Blakey, J. F., and Hembree, C. H., 1966, Water-delivery and low-flow studies, Pecos River, Texas, quantity and quality, 1964 and 1965: Texas Water Devel. Board Rept. 22, 21 p., 6 figs., 2 pls.

Grozier, R. U., Hejl, H. R., Jr., and Hembree, C. H., 1968, Water-delivery study, Pecos River, Texas, quantity and quality, 1967: Texas Water Devel. Board Rept. 76, 16 p., 6 figs.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
1	Feb. 6	Pecos River	Lat 31°06'35", long 102°25'00", at stream-gaging station, Pecos River near Girvin.	194.6	9	25.9	--	Measured in flume 60 ft below station. Heavy moss on crest of flume.
2	Feb. 6	Tunis Creek	Lat 31°00'50", long 102°15'05", at Farm Road 1901, 8.8 miles south of McCamey.	179.0a/	--	--	0	Observation made at low-water crossing.
3	Feb. 6	Pecos River	Lat 31°02'05", long 102°13'15", at Farm Road 1901, 7.0 miles south of McCamey.	178.4	11	22.8	--	Channel is sandy silt with some gravel. Medium growth of saltcedars on sandy silt banks.
4	Feb. 6	do	Lat 31°00'05", long 102°07'40", at Farm Road 305, 11.0 miles southeast of McCamey	169.5	13	24.1	--	Banks caliche and sandy silt. Medium growth of saltcedars. Channel is clay and sandy silt.
5	Feb. 6	Five mile Creek	Lat 31°00'15", long 102°01'00", near mouth, 9.5 miles northwest of Iraan.	161.8a/	--	--	0	Channel has caliche bottom.
6	Feb. 6	Pecos River	Lat 30°58'45", long 101°58'25", at State Highway 349, 6.5 miles northwest of Iraan.	157.9	13	19.6	--	Channel is gravel and caliche. Heavy growth of saltcedars.

See footnote at end of table.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs--Continued

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
7	Feb. 6	Pecos River	Lat 30°54'15", long 101°52'50", at Farm Road 1980, 1.1 miles east of Iraan.	148.2	16	19.6	--	Banks are sandy silt. Channel is gravel. Light growth of saltcedars.
8	Feb. 7	do	Lat 30°47'20", long 101°50'05", at third county road crossing, 6.9 miles north of Sheffield.	137.6	12	26.6	--	Banks are caliche and gravel. Channel is mostly gravel. Light growth of saltcedars.
9	Feb. 7	Four mile Draw	Lat 30°45'00", long 101°49'55", at State Highway 349, 4.2 miles north of Sheffield.	133.9a/	--	--	0	Wide channel is gravel and caliche.
10	Feb. 7	Sheffield Draw	Lat 30°41'05", long 101°48'40", at US Highway 290, 0.8 mile southeast of Sheffield.	128.6a/	--	--	0	Channel is gravel and caliche.
11	Feb. 6	Pecos River	Lat 30°39'35", long 101°46'10", at former gaging station Pecos River near Sheffield.	125.9	14	30.7	--	Banks and bed are sandy silt. Saltcedars and grass on both banks.
11	Feb. 7	do	do	125.9	12	32.0	--	Do.

See footnote at end of table.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs--Continued

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
12	Feb. 6	Live Oak Creek	Lat 30°39'40", long 101°42'20", on US Highway 290, 0.8 mile above mouth, 7.4 miles east of Sheffield.	121.0a/	--	--	0	Banks are sandy silt, with saltcedars and grass. Channel is gravel.
13	Feb. 6	Pecos River	Lat 30°37'05", long 101°39'20", at road crossing, 11.3 miles southeast of Sheffield.	116.5	14	36.0	--	Silt banks with strata of gravel showing. Channel is large cobblestones. Saltcedars on banks.
14	Feb. 6	do	Lat 30°32'50", long 101°39'05", at road crossing south of US Highway 290, 14.4 miles southeast of Sheffield.	110.8	17	38.0	--	Channel is gravel. Banks lined with saltcedars and mesquite.
15	Feb. 6	do	Lat 30°31'30", long 101°40'15", at natural ford, 14.7 miles southeast of Sheffield.	108.8	15	34.9	--	Low, silty banks lined with saltcedars. Channel is about 80 ft wide with gravel bottom.
16	Feb. 7	do	Lat 30°26'50", long 101°43'20", above mouth of Independence Creek, 18.0 miles south of Sheffield.	99.1	13	52.7	--	Left bank 200 ft rock and soil cliff, with saltcedars and mesquite. Channel is gravel.

See footnote at end of table.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs--Continued

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
17	Feb. 7	Independence Creek	Lat 30°26'45", long 101°43'30", at mouth, 18.0 miles south of Sheffield.	99.0a/	12	--	19.6	Bed consists of sandy gravel. Mesquite on left bank, live oaks on right. Limestone outcrop on right overbank.
18	Feb. 7	Wolf Spring	Lat 30°22'30", long 101°41'50", on right bank Pecos River, 16.4 miles northwest of Pandale.	92.2a/	22	--	6.28	9.5 ft wide channel with 5 ft vertical sides of sandy silt and gravel. Both banks have large amount of underbrush.
19	Feb. 7	Richland Canyon	Lat 30°22'30", long 101°41'55", at mouth, 16.1 miles northwest of Pandale.	92.1a/	20	--	1.93	Streambed about 200 ft wide with thick liver oak trees on 6 ft high overflow banks. Channel is gravel.
20	Feb. 7	Pecos River	Lat 30°22'30", long 101°41'25", below Richland Canyon, at low-water crossing, 15.8 miles northwest of Pandale.	91.7	20	98.7	--	Two channels flowing over conglomerate with sandy silt overbanks. Mesquite and some saltcedars lining both banks.
21	Feb. 7	Geddis Canyon	Lat 30°18'20", long 101°44'50", at mouth, 14.5 miles northwest of Pandale.	81.6a/	--	--	0	Channel is gravel. Mesquite on banks.

See footnote at end of table.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs--Continued

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
22	Feb. 7	Pecos River	Lat 30°18'00", long 101°44'40", below Geddis Canyon, 14.2 miles northwest of Pandale.	81.5	16	90.0	--	Left bank sheer limestone cliff. Right bank is silt and gravel with mesquite and saltcedars.
23	Feb. 7	Sweetwater Spring	Lat 30°17'20", long 101°45'30", 14.6 miles northwest of Pandale.	80.4a/	20	--	2.43	Measurement at source near Banner Ranch House.
24	Feb. 8	Howards Creek	Lat 30°09'35", long 101°33'55", ½ mile above mouth, 1.8 miles south of Pandale.	63.8a/	--	--	0	Channel is gravel, about 100 ft wide with low overflow banks covered with mixed vegetation.
25	Feb. 8	Big Fielders Creek	Lat 30°07'50", long 101°34'50", ½ mile above mouth, 4.2 miles south of Pandale.	61.6a/	--	--	0	Narrow channel about 40 ft made up of gravel with steep bluff on right and low overflow on left bank with sparse mesquite and saltcedars.
26	Feb. 6	Pecos River	Lat 30°07'50", long 101°34'20", 150 ft above crossing, 4.0 miles south of Pandale.	61.5	14	87.3	--	Channel is bedrock. Banks lined with mesquite.

See footnote at end of table.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs--Continued

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
26	Feb. 8	Pecos River	Lat 30°07'50", long 101°34'20", 150 ft above crossing, 4.0 miles south of Pandale.	61.5	13	84.7	--	Channel is bedrock. Banks lines with mesquite.
27	Feb. 6	Tardy Canyon	Lat 30°07'35", long 101°31'40", 100 ft above mouth, 4.3 miles south of Pandale.	58.5a/	22	--	2.0	Channel is gravel.
28	Feb. 6	Pecos River	Lat 30°07'30", long 101°30'25", ¼ mile below mouth of Spring Creek, 4.8 miles south of Pandale.	56.8	16	120	--	Channel rocky.
29	Feb. 7	do	Lat 30°00'15", long 101°30'30", 800 ft above mouth of Evert Canyon, 12.8 miles south of Pandale.	43.8	17	137	--	Channel smooth limestone. Large spring bubbling up in river near right bank about 300 ft upstream.
30	Feb. 7	Evert Canyon	Lat 30°00'10", long 101°30'20", at mouth, 13.0 miles south of Pandale.	43.7a/	18	--	.89	Channel smooth limestone.

See footnote at end of table.

Table 1.--Discharge Measurements, Pecos River, Tributaries, and Springs--Continued

SITE	DATE (1968)	STREAM	LOCATION	RIVER MILE	WATER TEMP. (°C)	DISCHARGE IN CFS MAIN STREAM	DISCHARGE IN CFS TRIBUTARY	REMARKS
31	Feb. 8	Pecos River	Lat 29°53'20", long 101°27'05", 3/4 mile above Still Canyon, 8.6 miles northeast of Langtry.	26.5	13	127	--	Channel rocky.
32	Feb. 7	Lewis Canyon	Lat 29°51'50", long 101°24'15", at mouth, 10.2 miles east of Langtry.	22.9a/	--	--	0	
33	Feb. 8	Pecos River	Lat 29°48'10", long 101°26'40", at International Boundary and Water Commission stream-gaging station near Langtry.	15.0	13	130	--	Measurement in concrete flume.
34	Feb. 9	do	Lat 29°42'20", long 101°21'35", at mouth at International Boundary and Water Commission stream-gaging station near Comstock.	1.0	11	134	--	Channel rocky.

a/ River milage shown for each stream is that of the main stem at the mouth of the tributary.

Table 2.--Chemical Analyses of Water From the Pecos River, Tributaries, and Springs

(Results in Milligrams Per Liter Except as Indicated)

SITE	STREAM	DATE OF COLLECTION (1968)	DISCHARGE (CFS)	SILICA (SiO_2)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS (CALCULATED)	HARDNESS AS $CaCO_3$		SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C)	pH
																CALCIUM, MAGNESIUM	NONCARBONATE			
1	Pecos River	Feb. 6	25.9	2.6	838	506	4,000	42	196	3,620	6,480	--	--	--	15,600	4,170	4,010	27	22,100	7.0
3	do	Feb. 6	22.8	--	--	--	--	--	164	3,510	6,050	--	--	--	14,700	4,700	4,570	--	21,000	7.3
4	do	Feb. 6	24.1	--	--	--	--	--	151	3,470	5,880	--	--	--	14,100	4,450	4,330	--	20,300	7.1
6	do	Feb. 6	19.6	--	--	--	--	--	152	3,570	5,900	--	--	--	14,200	4,800	4,680	--	20,400	7.2
7	do	Feb. 6	19.6	--	--	--	--	--	152	3,380	5,600	--	--	--	13,600	4,250	4,130	--	19,700	7.4
8	do	Feb. 7	26.6	1.0	748	440	3,470	38	186	3,110	5,550	--	--	--	13,400	3,680	3,520	25	19,400	7.4
11	do	Feb. 6	30.7	--	--	--	--	--	204	2,400	4,100	--	--	--	9,950	2,940	2,770	--	14,800	7.4
11	do	Feb. 7	32.0	4.4	545	320	2,520	29	200	2,320	4,050	--	--	0.90	9,890	2,680	2,510	21	14,700	7.3
13	do	Feb. 6	36.0	--	--	--	--	--	206	1,840	3,400	--	--	--	8,200	2,440	2,270	--	12,300	7.4
14	do	Feb. 6	38.0	--	--	--	--	--	202	1,700	3,150	--	--	--	7,650	2,300	2,130	--	11,500	7.5
15	do	Feb. 6	34.9	--	--	--	--	--	206	1,650	3,050	--	--	--	7,450	2,280	2,110	--	11,200	7.6
16	do	Feb. 7	52.7	7.7	335	176	1,280	16	214	1,150	2,140	--	--	--	5,210	1,560	1,380	14	7,950	7.5
17	Independence Creek	Feb. 7	19.6	16	86	27	82	4.2	218	171	111	0.9	3.2	.13	608	326	147	2.0	986	7.8
18	Wolf Spring	Feb. 7	6.28	18	96	28	87	4.7	234	177	118	1.0	4.8	--	650	354	162	2.0	1,050	7.6
19	Richland Canyon	Feb. 7	1.93	--	--	--	--	--	234	176	122	--	--	--	650	366	174	--	1,050	7.6
20	Pecos River	Feb. 7	98.7	12	241	116	816	11	218	780	1,360	--	1.5	--	3,440	1,080	900	11	5,400	7.5
22	do	Feb. 7	90.0	--	--	--	--	--	216	676	1,140	--	--	--	2,940	990	813	--	4,660	7.5
23	Sweetwater Spring	Feb. 7	2.43	18	93	20	52	3.2	250	111	74	.7	6.9	--	502	314	110	1.3	821	7.6
26	Pecos River	Feb. 6	87.3	--	--	--	--	--	192	580	1,000	--	--	--	2,560	890	732	--	4,110	7.5
26	do	Feb. 8	84.7	8.4	191	90	608	8.2	178	600	1,020	--	1.2	--	2,610	846	700	9.1	4,190	7.5
27	Tardy Canyon	Feb. 6	2.0	19	81	20	111	1.8	226	45	206	.3	13	--	608	284	100	2.9	1,100	7.5
28	Pecos River	Feb. 6	120	--	--	--	--	--	214	476	850	--	--	--	2,170	775	600	--	3,520	7.5
29	do	Feb. 7	137	12	160	66	428	6.3	200	408	740	--	5.2	--	1,920	670	506	7.2	3,160	7.6
30	Evert Canyon	Feb. 7	.89	14	79	25	96	2.0	212	97	163	.5	1.8	--	582	300	126	2.4	1.020	7.8
31	Pecos River	Feb. 8	127	--	--	--	--	--	184	404	730	--	--	--	1,870	675	524	--	3,090	7.5
33	do	Feb. 8	130	9.9	150	64	418	6.1	182	404	710	--	4.1	--	1,860	637	488	7.2	3,080	7.4
34	do	Feb. 9	134	9.3	144	61	387	5.7	186	371	650	.7	4.5	.19	1,720	610	458	6.8	2,890	7.5

Table 3.--Gains and Losses in Seven Subreaches of the Pecos River

SUBREACH	RIVER MILES	CHANGE IN DISCHARGE	NUMBER OF MILES IN SUBREACH	REMARKS
Site 1 to site 7	194.6 to 148.2	6.3 cfs loss	46.4	There is a general loss throughout subreach. Dissolved solids decreased from 15,600 mg/l at mile 194.6 (site 1) to 13,600 mg/l at mile 148.2 (site 7). The decrease in dissolved solids indicates that an interchange of surface water and ground water was occurring.
Site 7 to site 14	148.2 to 110.8	18.4 cfs gain	37.4	This gain probably results from the Cretaceous aquifers contributing water in this subreach. Dissolved solids decreased from 13,600 mg/l at site 7 to 9,890 mg/l at site 11, and to 7,650 mg/l at site 14.
Site 14 to site 20	110.8 to 91.7	60.7 cfs gain	19.1	Tributary flow contributed 27.8 cfs of the total flow in this subreach. The rest was from seeps and springs along the main channel. Dissolved solids decreased from 7,650 mg/l at site 14 to 3,440 mg/l at site 20.
Site 20 to site 26	91.7 to 61.5	14.0 cfs loss	30.2	Loss in this subreach was to porous limestone and numerous gravel deposits in the channel.
Site 26 to site 29	61.5 to 43.8	52.3 cfs gain	17.7	Between sites 26 and 28, there are six springs and numerous seeps along the left bank. Dissolved solids decreased from 2,560 mg/l at site 26 to 2,170 mg/l at site 28.
Site 29 to site 31	43.8 to 26.5	10.0 cfs loss	17.3	In this subreach, water is probably lost to porous limestone.
Site 31 to site 34	26.5 to 1.0	7.0 cfs gain	25.5	This gain is probably from springs and tributary inflow. Dissolved solids decreased from 2,170 mg/l at site 28 to 1,720 mg/l at site 34.