# ANNUAL REPORT TO THE PECOS RIVER COMMISSION

*on investigations being made in New Mexico and Texas by the United States Geological Survey in Cooperation with the Pecos River Commission*

CALENDAR YEAR 1976

PREPARED BY THE U.S. GEOLOGICAL SURVEY

Distribution list for USGS 1976 Annual Report to the Pecos River Commission
(Meeting scheduled Feb. 17-~~18~~, in Albuquerque, Airport Marina Hotel)

address corrections

Mr. Horace M. Babcock, Chairman
and Commissioner representing the US
Pecos River Commission
~~P. O. Box 4070~~ USGS, Fed. Bldg.
Tucson, AZ 85717 301 W. Congress

Mr. J. Lee Cathey
Commissioner representing New Mexico
Pecos River Commission
308 ~~109~~ North Canal Street (P.O. Box 37)
Carlsbad, NM 88220

Mr. R. B. McGowen
Commissioner representing Texas
Pecos River Commission
P. O. Box 2104
Pecos, Texas 79772

Mrs. Wilma Sandford
Assistant Secretary-Manager
Pecos River Commission
P. O. Box 123
Carlsbad, NM 88220

Mr. S. E. Reynolds
Engineer Advisor for New Mexico
Pecos River Commission
Bataan Memorial Building
Santa Fe, NM 87503

Mr. David P. Hale
Engineer Advisor for New Mexico
Pecos River Commission
Bataan Memorial Building
Santa Fe, NM 87503

Mr. Carl Slingerland
Engineer Advisor for New Mexico
Bataan Memorial Building
Santa Fe. NM 87503

Mr. John Hayes
Engineer Advisor for Texas
Red Bluff Water Power Control District
111 Second Street
Pecos, Tx 79772

Mr. Robert M. Whitenton
Engineer Advisor for Texas
Pecos River Commission
Texas Water Rights Commission
P. O. Box 13207, Capitol Station
Austin, TX 78711

Mr. Zack Dean
Engineer Advisor for Texas
Pecos River Commission
Texas Water Rights Commission
P. O. Box 13207, Capitol Station
Austin, TX 78711

Mr. Morris Stagner
Legal Advisor for New Mexico
Pecos River Commission
P. O. Box 1513
Roswell, NM 88201

Mr. Douglas A. Caroom
Legal Advisor for Texas
Pecos River Commission
P. O. Box 12548, Capitol Station
Austin, TX 78711

Mr. Pat Mann
Pecos River Watermaster
P. O. Box 1717
Roswell, NM 88201

Regional Hydrologist, CR
WRD, USGS, Lakewood, CO

District Chief, WRD
USGS, Austin, TX

Chief, Subdistrict Office, WRD
USGS, San Angelo, TX

New Mexico WRD
Subdistrict Offices:
Albuquerque
Santa Fe
Carlsbad - 3 copies
District Office:
Hale
Soule M. E. Breen
Welder
Denis
Lepp
Funderburg
Elsie
Bobbie

CONTENTS

FIGURES



TABLES

# ANNUAL REPORT TO THE PECOS RIVER COMMISSION

# ON INVESTIGATIONS BEING MADE IN NEW MEXICO AND TEXAS

by the

UNITED STATES GEOLOGICAL SURVEY

in cooperation with the

PECOS RIVER COMMISSION

Calendar Year 1976

## INTRODUCTION

This report describes investigations in New Mexico and Texas made by the Water Resources Division of the U.S. Geological Survey in cooperation with the Pecos River Commission during the 1976 calendar year and provides a summary of costs for the fiscal year ending June 30, 1976.

## STREAMFLOW

### Gaging Stations

Table 1 is a listing of gaging stations operated in cooperation with the Pecos River Commission; table 2 is a listing of regular gaging stations; table 3 of low-flow stations; table 4 of flood-hydrograph stations; and table 5 of crest-stage gages operated in cooperation with other agencies or by USGS funds in the Pecos River basin. Figure 1 shows the locations of regular, low-flow, and reservoir stations; and figure 2 shows the locations of flood-hydrograph and crest-stage gages.

Four discharge measurements were made of the overflow from Lea Lake at Bottomless Lakes State Park near Roswell, N. Mex. Water from Lea Lake is spreading out on the flood plain east of the Pecos River, no surface flow to the Pecos.

Eight measurements were made on Blue Springs above diversion near White City; four measurements were made on Castle Springs above mouth at Black River Village.

Twenty-seven measurements or observations of no flow were made on springs in the Pecos River drainage in New Mexico.

Nine measurements were made at Pecos River at Fishing Rock Crossing and eight measurements at Pecos River at First Ford to assist in the continued evaluation of the Malaga Bend salinity alleviation project.

The maintenance funds were used for painting, brush control, and minor repairs at the gaging stations.

Table 1.--Stations operated in cooperation with the PRC

| | Station No. | Station Name |
|---|---|---|
| 1. | 08 3830 00 | Pecos R. at Santa Rosa, N. Mex. |
| 2. | 08 3835 00 | Pecos R. near Puerto de Luna, N. Mex. |
| 3. | 08 3840 00 | Lake Sumner, N. Mex. |
| 4. | 08 3845 00 | Pecos R. below Sumner Dam, N. Mex. |
| 5. | 08 3860 00 | Pecos R. near Acme, N. Mex. |
| 6. | 08 3941 00 | Pecos R. near Hagerman, N. Mex. (low-flow only) |
| 7. | 08 3945 00 | Rio Felix near Hagerman, N. Mex. |
| 8. | 08 3965 00 | Pecos R. near Artesia, N. Mex. |
| 9. | 08 3995 00 | Pecos R. (Kaiser Channel) near Lakewood, N. Mex. |
| 10. | 08 4005 00 | Lake McMillan, N. Mex. |
| 11. | 08 4010 00 | Pecos R. below McMillan Dam, N. Mex. |
| 12. | 08 4011 00 | Pecos R. above Seven Rivers, near Lakewood, N. Mex. (low-flow and releases) |
| 13. | 08 4012 00 | South Seven Rivers near Lakewood, N. Mex. |
| 14. | 08 4015 00 | Pecos R. below Major Johnson Springs, near Carlsbad, N. Mex. (low-flow only) |
| 15. | 08 4019 00 | Rocky Arroyo near Carlsbad, N. Mex. |
| 16. | 08 4020 00 | Pecos R. at Damsite 3, near Carlsbad, N. Mex. |
| 17. | 08 4038 00 | Lake Avalon, N. Mex. |
| 18. | 08 4052 00 | Pecos R. below Dark Canyon, at Carlsbad, N. Mex. |
| 19. | 08 4055 00 | Black R. above Malaga, N. Mex. |
| 20. | 08 4065 00 | Pecos R. near Malaga, N. Mex. |
| 21. | 08 4070 00 | Pecos R. at Pierce Canyon Crossing, near Malaga, N. Mex. |
| 22. | 08 4075 00 | Pecos R. at Red Bluff, N. Mex. |
| 23. | 08 4085 00 | Delaware R. near Red Bluff, N. Mex. |
| 24. | 08 4125 00 | Pecos R. near Orla, Tex. |
| 25. | 08 4145 00 | Reeves County Water Improvement District No. 2 canal near Mentone, Tex. |
| 26. | 08 4150 00 | Ward County Water Improvement District No. 3 canal near Barstow, Tex. |
| 27. | 08 4180 00 | Ward County Irrigation District No. 1 canal near Barstow, Tex. |
| 28. | 08 4350 00 | Grandfalls-Big Valley Canal near Barstow, Tex. (Discontinued 6/30/76) |
| 29. | 08 4365 00 | Pecos County Water Improvement District No. 2 canal (Upper Diversion) near Grandfalls, Tex. |
| 30. | 08 4375 00 | Pecos County Water Improvement District No. 2 canal near Imperial, Tex. |
| 31. | 08 4376 00 | Pecos County Water Improvement District No. 3 canal near Imperial, Tex. |
| 32. | 08 4377 00 | Ward County Water Improvement District No. 2 canal near Grandfalls, Tex. |
| 33. | 08 4465 00 | Pecos R. near Girvin, Tex. |

Table 2.--Regular stations operated in cooperation with other agencies or with USGS funds

| | Station No. | Station Name | Cooperator |
|---|---|---|---|
| 1. | 08 3779 00 | Rio Mora near Terrero, NM | USGS |
| 2. | 08 3785 00 | Pecos R. near Pecos, NM | USGS |
| 3. | 08 3795 00 | Pecos R. near Anton Chico, NM | NMSE-ISC |
| 4. | 08 3805 00 | Gallinas Cr. near Montezuma, NM | NMSE-ISC |
| 5. | 08 3825 00 | Gallinas R. near Colonias, NM | USGS |
| 6. | 08 3826 00 | Pecos R. ab. Cannon del Uta nr. Colonias, NM | CE |
| 7. | 08 3826 50 | Pecos R. ab. Los Esteros Reservoir, NM | CE |
| 8. | 08 3827 30 | Los Esteros Cr. ab. Los Esteros Reservoir, NM | CE |
| 9. | 08 3827 60 | Los Esteros Cr. Tributary above Los Esteros Reservoir, NM | CE |
| 10. | 08 3850 00 | Ft. Sumner main canal nr. Ft. Sumner, NM | NMSE-ISC |
| 11. | 08 3869 00 | F. Herrera Ditch - S. at Hollywood, NM | NMSE-ISC |
| 12. | 08 3870 00 | Rio Ruidoso at Hollywood, NM | NMSE-ISC |
| 13. | 08 3876 00 | Eagle Cr. below South Fork nr. Alto, NM | ECA |
| 14. | 08 3878 00 | Eagle Cr. near Alto, N. Mex. | ECA |
| 15. | 08 3905 00 | Rio Hondo at Diamond A Ranch, nr. Roswell, NM | CE |
| 16. | 08 3906 00 | Two Rivers Reservoir, nr. Roswell, NM | CE |
| 17. | 08 3908 00 | Rio Hondo bl. Diamond A Dam, nr. Roswell, NM | CE |
| 18. | 08 3932 00 | Rocky Arroyo above Two Rivers Reservoir near Roswell, NM | CE |
| 19. | 08 3933 00 | Rocky Arroyo below Rocky Dam, NM | CE |
| 20. | 08 3936 00 | North Spring River at Roswell, NM | CE |
| 21. | 08 3955 00 | Pecos River near Lake Arthur, NM | NMSE-ISC |
| 22. | 08 3985 00 | Rio Penasco at Dayton, NM | USGS |
| 23. | 08 4000 00 | Fourmile Draw near Lakewood, NM | USGS |
| 24. | 08 4035 00 | Carlsbad main canal at head, nr. Carlsbad, NM | USGS |
| 25. | 08 4040 00 | Pecos River below Avalon Dam, NM | USGS |
| 26. | 08 4051 50 | Dark Canyon at Carlsbad, NM | CE |
| 27. | 08 4100 00 | Red Bluff Reservoir near Orla, TX | TWDB |
| 28. | 08 4317 00 | Limpia Creek above Fort Davis, TX | USGS |
| 29. | 08 4318 00 | Limpia Creek below Fort Davis, TX | TWDB |
| 30. | 08 4330 00 | Barrilla Draw nr. Saragosa, TX | TWDB |
| 31. | 08 4356 00 | Toronto Creek nr. Alpine, TX (Disc. 12/31/76) | CE |
| 32. | 08 4356 20 | Alpine Creek at Alpine, TX (Disc. 12/31/76) | CE |
| 33. | 08 4356 60 | Moss Creek near Alpine, TX (Disc. 12/31/76) | CE |
| 34. | 08 4357 00 | Sunny Glenn Canyon near Alpine, TX | TWDB |
| 35. | 08 4358 00 | Cayanosa Draw near Fort Stockton, TX | TWDB |
| 36. | 08 4470 20 | Independence Creek nr. Sheffield, TX | TWDB |

CE ---------- Corps of Engineers
ECA --------- Eagle Creek Association
NMSE-ISC ---- New Mexico State Engineer & Interstate Stream Commission
TWDB -------- Texas Water Development Board
USGS -------- U. S. Geological Survey

Table 3.--Low-flow and partial-record stations operated in cooperation with other agencies

| | Station No. | Station Name | Cooperator |
|---|---|---|---|
| 1. | 08 3827 00 | Pecos R. near Colonias, N. Mex. (discontinued 12/31/76) | NMSE-ISC |
| 2. | 08 3828 00 | Pecos R. above Los Esteros damsite, near Santa Rosa, N. Mex. | NMSE-ISC |
| 3. | 08 3865 00 | Rio Ruidoso near Ruidoso, N. Mex. | NMSE-ISC |
| 4. | 08 3866 00 | Carrizo Creek at Ruidoso, N. Mex. | NMSE-ISC |
| 5. | 08 4052 60 | Pecos River below Six Mile Dam, near Carlsbad, N. Mex. | EPA |
| 6. | 08 4076 00 | Smith Spring in Guadalupe Mountain National Park near Salt Flat, Tex. | NPS |
| 7. | 08 4140 00 | Pecos River near Mentone, Tex. | TWDB |
| 8. | 08 4255 00 | Phantom Lake Spring near Toyahvale, Tex. | TWDB |
| 9. | 08 4270 00 | Giffin Springs at Toyahvale, Tex. | TWDB |
| 10. | 08 4275 00 | San Solomon Springs at Toyahvale, Tex. | RCWID |
| 11. | 08 4445 00 | Comanche Springs at Fort Stockton, Tex. | TWDB |
| 12. | 08 4470 00 | Pecos River near Sheffield, Tex. | TWDB |

EPA --------- Environmental Protection Agency
NMSE-ISC ---- New Mexico State Engineer & Interstate Stream Commission
NPS --------- National Park Service
RCWID ------- Reeves County Water Improvement District No. 1
TWDB -------- Texas Water Development Board

Table 4.--Flood-hydrograph stations

| | Station No. | Station Name |
|---|---|---|
| 1. | 08 3791 00 | Pecos River tributary near Sena, N. Mex. |
| 2. | 08 3795 50 | Canon Blanco near Leyba, N. Mex. |
| 3. | 08 3817 00 | Canon Piedra Lumbre near Las Vegas, N. Mex. |
| 4. | 08 3833 70 | Pecos River tributary near Puerto de Luna, N. Mex. |
| 5. | 08 3900 50 | Rio Hondo tributary at Tinnie, N. Mex. |
| 6. | 08 3943 00 | Twin Butte Canyon tributary near Roswell, N. Mex. |
| 7. | 08 3974 00 | Hyatt Canyon near Cloudcroft, N. Mex. |
| 8. | 08 4046 00 | Pecos River tributary at Carlsbad, N. Mex. |

Note.--All listed flood-hydrograph stations operated in cooperation with the New Mexico State Highway Department.

Table 5.--Crest-stage gages

| | Station No. | Station Name |
|---|---|---|
| 1. | 08 3793 00 | Tecolote Cr. at Tecolote, N. Mex. |
| 2. | 08 3796 00 | Pecos R. tributary near Dilia, N. Mex. |
| 3. | 08 3803 00 | Sandoval Canyon at Gallinas, N. Mex. |
| 4. | 08 3829 00 | Pecos R. tributary near Pintada, N. Mex. |
| 5. | 08 3832 00 | Pintada Arroyo tributary near Clines Corners, N. Mex. |
| 6. | 08 3832 10 | Pintada Arroyo tributary near Encino, N. Mex. |
| 7. | 08 3833 00 | Pintada Arroyo near Santa Rosa, N. Mex. |
| 8. | 08 3855 30 | Alamosa Cr. tributary near Jordan, N. Mex. |
| 9. | 08 3856 00 | Yeso Cr. near Fort Sumner, N. Mex. |
| 10. | 08 3856 70 | Aragon Cr. tributary near Encinoso, N. Mex. |
| 11. | 08 3856 90 | Bonito Canyon tributary near Corona, N. Mex. |
| 12. | 08 3857 00 | Cloud Canyon near Gallinas, N. Mex. |
| 13. | 08 3859 00 | Salt Cr. tributary near Roswell, N. Mex. |
| 14. | 08 3890 00 | Rio Bonito near Fort Stanton, N. Mex. |
| 15. | 08 3890 60 | Rio Bonito tributary near Fort Stanton, N. Mex. |
| 16. | 08 3901 00 | Rio Hondo at Picacho, N. Mex. |
| 17. | 08 3901 50 | Gallo Canyon near Picacho, N. Mex. |
| 18. | 08 3937 00 | Pancho Canyon near Arabela, N. Mex. |
| 19. | 08 3939 00 | Eight Mile Draw near Roswell, N. Mex. |
| 20. | 08 3973 90 | Curtis Canyon near Mayhill, N. Mex. |
| 21. | 08 3976 00 | Rio Penasco near Dunken, N. Mex. |
| 22. | 08 4050 50 | Last Chance Canyon tributary near Carlsbad Caverns, N. Mex. |
| 23. | 08 4051 00 | Mosley Canyon near White City, N. Mex. |
| 24. | 08 4071 00 | Pierce Canyon near Malaga, N. Mex. |

Note.--All listed crest-stage gages operated in cooperation with the New Mexico State Highway Department.

## Streamflow Data

Table 6 is a comparison of the 1976 calendar-year flows with the average for the period of record and the current 20-year average.

Table 7 gives peak flows for selected stations for 1976.

Table 6.--1976 calendar year streamflow and its comparison with average streamflow

| Station | 1976 streamflow in acre-ft | Period of record | | | Current 20 years | |
|---|---|---|---|---|---|---|
| | | Average annual runoff in acre-ft | Years of record | Percent of average | Average annual runoff in acre-ft | Current year percent of average |
| Pecos River near Pecos | 48,770 | 69,990 | 57 | 70 | 66,070 | 74 |
| Pecos River near Anton Chico | 33,810 | 94,180 | 63 | 36 | 79,700 | 42 |
| Gallinas River near Colonias | 5,790 | 12,240 | 26 | 47 | 13,770 | 42 |
| Pecos River at Santa Rosa | 41,390 | 99,260 | 62 | 42 | 77,520 | 53 |
| Pecos River near Puerto de Luna | 98,720 | 152,100 | 38 | 65 | 137,700 | 72 |
| Pecos River below Sumner Dam | 102,900 | 150,700 | 40 | 68 | 129,700 | 79 |
| Fort Sumner main canal | 40,820 | 35,280 | 25 | 116 | 36,300 | 112 |
| Pecos River near Acme | 73,680 | 138,400 | 39 | 53 | 113,700 | 65 |
| Rio Ruidoso at Hollywood | 9,840 | 9,560 | 23 | 103 | 10,290 | 96 |
| Rio Hondo at Diamond A Ranch | 1,090 | 15,940 | 37 | 7 | 9,640 | 11 |
| Rio Felix near Hagerman | 0.04 | 11,230 | 37 | 0 | 7,970 | 0 |
| Pecos River near Lake Arthur | 72,960 | 176,100 | 38 | 41 | 124,600 | 59 |
| Pecos River near Artesia | 71,890 | 188,400 | 40 | 38 | 122,400 | 59 |
| Rio Penasco at Dayton | 0 | 4,390 | 25 | 0 | 4,350 | 0 |
| Fourmile Draw near Lakewood | 0 | 2,980 | 25 | 0 | 3,400 | 0 |
| Pecos River below McMillan Dam | 37,410 | 72,020 | 33 | 52 | 73,170 | 51 |
| South Seven Rivers near Lakewood | 86 | 3,960 | 13 | 2 | - | - |
| Rocky Arroyo at highway bridge, near Carlsbad | 0 | 7,110 | 13 | 0 | - | - |
| Pecos River at damsite 3 | 51,540 | 118,800 | 33 | 43 | 109,400 | 47 |
| Carlsbad main canal at head | 35,700 | 77,520 | 37 | 46 | 68,760 | 52 |
| Pecos River below Avalon Dam | 0 | 27,020 | 25 | 0 | 24,490 | 0 |
| Dark Canyon at Carlsbad | 0 | - | - | - | - | - |
| Pecos River below Dark Canyon at Carlsbad | 7,610 | 40,930 | 7 | 19 | - | - |
| Black River above Malaga | 5,130 | 9,850 | 30 | 52 | 9,780 | 52 |
| Pecos River near Malaga | 14,900 | 138,400 | 40 | 11 | 61,800 | 24 |
| Pecos River at Red Bluff | 17,790 | 131,900 | 39 | 13 | 65,280 | 27 |
| Delaware River near Red Bluff | 3,380 | 9,710 | 39 | 35 | 8,330 | 41 |
| Pecos River near Orla | 68,930 | 128,600 | 39 | 54 | 59,360 | 116 |
| Pecos River near Girvin | 20,420 | 67,960 | 37 | 30 | 22,110 | 92 |

Table 7.--1976 peak flows at selected stations

| Station | Date | Peak, in cfs |
|---|---|---|
| Pecos River near Pecos | June 9 | 334 |
| Pecos River near Anton Chico | Aug. 2 | 5,480 |
| Gallinas River near Colonias | July 4 | 3,600 |
| Pecos River at Santa Rosa | July 24 | 8,030 |
| Pecos River near Puerto de Luna | July 24 | 6,370 |
| Pecos River below Lake Sumner | Mar. 13 | 1,190 (daily) |
| Pecos River near Acme | July 14 | 2,150 |
| Rio Ruidoso at Hollywood | May 13 | 88 |
| Eagle Creek below South Fork near Alto | Aug. 18 | 17 |
| Rio Hondo at Diamond A Ranch | July 21 | 236 |
| Rio Felix near Hagerman | May 6 | 0.32 |
| Pecos River near Lake Arthur | Aug. 4 | 962 |
| Pecos River near Artesia | Aug. 5 | 931 |
| Rio Penasco at Dayton | | No flow during year |
| Fourmile Draw near Lakewood | | No flow during year |
| South Seven Rivers near Lakewood | Sept. 24 | 242 |
| Rocky Arroyo near Carlsbad | | No flow during year |
| Pecos River at damsite 3 | Aug. 4 | 715 |
| Pecos River below Avalon Dam | | No flow during year |
| Dark Canyon at Carlsbad | | No flow during year |
| Pecos River below Dark Canyon | Sept. 9 | 181 |
| Black River above Malaga | Sept. 9 | 534 |
| Pecos River near Malaga | Sept. 9 | 157 |
| Pecos River at Red Bluff | Sept. 9 | 491 |
| Delaware River near Red Bluff | July 12 | 876 |
| Pecos River near Orla | Sept. 9 | 3,070 |
| Pecos River near Girvin | Jan. 27 | 160 |

## RESERVOIR STORAGE

Table 8 shows storage and extremes of storage in Pecos River basin reservoirs for calendar year 1976.

Table 8.--Reservoir storage in Pecos River basin reservoirs, in acre-feet

| Reservoir | Reservoir capacity | 12/31/75 storage | 1976 max. and date | 1976 min. and date | 12/31/76 storage |
|---|---|---|---|---|---|
| Lake Sumner | 110,700 | 32,180 | 39,900<br>Feb. 28, 29 | 3,440<br>Aug. 22 | 24,270 |
| Lake McMillan | 33,620 | 4,120 | 21,840<br>Mar. 30 | 0<br>June 12 to July 21<br>July 24 to Aug. 2<br>Sept. 25 to Nov. 2 | 2,570 |
| Lake Avalon | 4,970 | 2,510 | 3,940<br>Apr. 1 | 686<br>Jul. 26-30 | 3,450 |
| Red Bluff | 310,000 | 115,600 | 116,200<br>Jan. 13-16 | 59,300<br>Sept. 8 | 68,700 |

# WATER QUALITY

## Chemical Qaulity

Table 9 is a list of Pecos River basin stations at which chemical-quality data are collected in New Mexico and Texas. The table also shows the types of analyses, the frequency of collection, and the cooperating or funding agency.

Table 10 shows the constituents analyzed for the Central Laboratory Schedules (CLS) shown in table 9. Where two types of CLS's are listed, the latter is a more complete analysis performed quarterly or semiannually. Total values are for constituents analyzed on a whole water sample. A whole water sample contains dissolved plus suspended material. Dissolved values are for constituents analyzed on water that has been filtered through a 0.45 micron pore diameter membrane. Dissolved values were analyzed on Central Laboratory Schedules 72, 74, 76, and 304. Central Laboratory Schedules 10 and 305 include dissolved and total values. Field measurements are streamflow, air temperature, water temperature, specific conductance, pH, dissolved oxygen, fecal coliform, bacteria, and fecal streptococci bacteria. Chemical analyses of samples collected daily are run on composits of the daily samples. Composite periods were determined from changes in the specific conductances of the daily samples and from changes in discharge. The samples were composited by discharge weighting the sample volumes.

Table 11 shows annual dissolved solids values for the most recent eight years at Pecos River stations between Carlsbad and Red Bluff, N. Mex. The 1969 through 1972 figures are water year values and the 1973 through 1976 figures are calendar year values.

Table 9.--Chemical-quality stations operated in the Pecos River basin during 1976

| Station | Analysis type | Sample collection frequency | Cooperator |
|---|---|---|---|
| Rio Mora nr. Terrero, N. Mex. | CLS304, field meas. | Bimonthly | USGS |
| | CLS305 | Semiannually | USGS |
| | Pesticides & radiochemical | Annually | USGS |
| Pecos R. nr. Anton Chico, N. Mex. | CLS76, field | Monthly | NMISC |
| | CLS10 | Quarterly | NMISC |
| Pecos R. nr. Puerto de Luna, N. Mex. | CLS76, field | Monthly | NMISC |
| Pecos R. nr. Acme, N. Mex. | CLS72 or CLS74 | Monthly | NMISC |
| Pecos R. nr. Artesia, N. Mex. | CLS72 | Daily | NMISC |
| | CLS76, field | Monthly | NMISC |
| | CLS10 | Quarterly | NMISC |
| Pecos R. at Carlsbad, N. Mex. | CLS72 or CLS74 | Daily | PRC |
| Pecos R. bl. Six-Mile Dam, nr. Carlsbad, N. Mex. | CLS76, field | Monthly | NMISC |
| | CLS10 | Quarterly | NMISC |
| Pecos R. nr. Malaga, N. Mex. | CLS72 | Daily | PRC |
| Pecos R. at Pierce Canyon Crossing, N. Mex. | CLS72 or CLS74 | Daily | PRC |
| Pecos R. at Red Bluff, N. Mex. | Specific conductance | Daily | USGS |
| | CLS76, field meas. | Monthly | USGS |
| | CLS10, aquatic biology | Quarterly | USGS |
| | Pesticides | Quarterly | EPA |
| | Radiochemical | Annually | USGS |

Table 9.--Chemical-quality stations operated in the Pecos River basin during 1976 - concluded

| Station | Analysis type | Sample collection frequency | Cooperator |
|---|---|---|---|
| Pecos R. nr. Orla, Tex. | Specific conductance | Daily | RBWPCD |
| | CLS72 less ($NO_2$ + $NO_3$) | Monthly | RBWPCD |
| Pecos R. nr. Mentone, Tex. | CLS72 | Monthly | TWDB |
| Limpia Cr. ab. Ft. Davis, Tex. | CLS72 | Intermittently when flowing | USGS |
| * Alpine Cr. at Alpine, Tex. | CLS72 | Intermittently when flowing | CE |
| * Moss Cr. nr. Alpine, Tex. (formerly published as West Moss Cr.) | CLS72 | Intermittently when flowing | CE |
| * Toronto Cr. nr. Alpine, Tex. (formerly published as Paisano Cr.) | CLS72 | Intermittently when flowing | CE |
| Pecos R. nr. Girvin, Tex. | Specific conductance | Daily | USGS |
| | CLS72 less ($NO_2$ + $NO_3$) | Monthly | USGS |
| Pecos R. nr. Sheffield, Tex. | CLS72 | Monthly | TWDB |
| Pecos R. nr. Langtry, Tex. | CLS76, field meas. | Monthly | USGS |
| | CLS10, aquatic biology | Quarterly | USGS |

USGS -------- U. S. Geological Survey
NMISC ------- New Mexico Interstate Stream Commission
PRC --------- Pecos River Commission
EPA --------- Environmental Protection Agency
RBWPCD ------ Red Bluff Water Power Control District
CE ---------- Corps of Engineers
TWDB -------- Texas Water Development Board

* Discontinued after Sept. 30, 1976

Table 10.--Central Laboratory Schedules (CLS)

| Constituents | Central Laboratory Schedules (CLS) | | | | | |
|---|---|---|---|---|---|---|
| | 10[1/] | 72 | 74 | 76 | 304 | 305[2/] |
| Dissolved solids (determined) | - | - | X | X | X | - |
| Dissolved solids (calculated) | - | X | X | X | - | - |
| Silicia ($SiO_2$) | - | X | X | X | X | - |
| Iron (Fe) | X | - | X | X | - | X |
| Manganese (Mn) | X | - | - | - | - | X |
| Calcium (Ca) | - | X | X | X | X | - |
| Magnesium (Mg) | - | X | X | X | X | - |
| Hardness, as $CaCO_3$ | - | X | X | X | X | - |
| Sodium (Na) | - | X | X | X | X | - |
| Potassium (K) | - | X | X | X | X | - |
| Bicarbonate ($HCO_3$) | - | X | X | X | X | - |
| Carbonate ($CO_3$) | - | X | X | X | X | - |
| Sulfate ($SO_4$) | - | X | X | X | X | - |
| Chloride (Cl) | - | X | X | X | X | - |
| Fluoride (F) | - | X | X | X | X | - |
| Nitrite ($NO_2$) + Nitrate ($NO_3$) as N | - | X | X | X | - | - |
| Nitrite ($NO_2$) + Nitrate ($NO_3$) as N total | - | - | - | - | X | - |
| Amonia as N | - | - | - | X | - | - |
| Total nitrogen as N | - | - | - | X | - | - |
| Boron (B) | - | - | X | X | - | - |
| Phosphate dissolved as P | - | - | X | X | - | - |
| Total phosphorus as P | - | - | - | X | X | - |
| Specific conductance | - | X | X | X | X | - |
| pH | - | X | X | X | X | - |
| Arsenic (As) | X | - | - | - | - | X |
| Barium (Ba) | - | - | - | - | - | X |
| Cadmium (Cd) | X | - | - | - | - | X |
| Chromium (Cr) | X | - | - | - | - | X |
| Cobalt (Co) | X | - | - | - | - | - |
| Copper (Cu) | X | - | - | - | - | X |
| Selenium (Se) | X | - | - | - | - | X |
| Silver (Ag) | - | - | - | - | - | X |
| Zinc (Zn) | X | - | - | - | - | X |
| Mercury (Hg) | X | - | - | - | - | X |
| Lead (Pb) | X | - | - | - | - | X |
| Chemical oxygen demand (COD) | - | - | - | X | - | - |
| Turbidity (Jackson units) | - | - | - | X | - | - |
| Cyanide (CN) | - | - | - | - | - | X |
| Organic carbon (suspended & dissolved) | - | - | - | X | - | - |

1/ Both dissolved and total values of constituents indicated
2/ Total values only of the constituents indicated

Table 11.--Annual dissolved-solids values (1969-76)

| Year | Total flow, acre-feet | Dissolved-solids concentrations, mg/l: Composite maximum | Composite minimum | Discharge-weighted average | Time-weighted average | Annual dissolved-solids load, tons |
|---|---|---|---|---|---|---|
| **Pecos River at Carlsbad, NM** | | | | | | |
| 1969 wy | 11,790 | 3,850 | 1,800 | 2,490 | 2,620 | 39,800 |
| 1970 wy | 38,420 | 3,270 | 335 | 1,720 | 2,680 | 89,100 |
| 1971 wy | 10,040 | 3,560 | 1,650 | 2,540 | 2,730 | 35,000 |
| 1972 wy | 27,310 | 3,020 | 1,190 | 1,590 | 2,390 | 59,000 |
| 1973 cy | 58,760 | 3,140 | 1,600 | 2,200 | 2,580 | 176,000 |
| 1974 cy | 138,500 | 4,680 | 395 | 856 | 2,860 | 161,000 |
| 1975 cy | 26,850 | 3,080 | 2,430 | 2,860 | 2,780 | 96,000 |
| 1976 cy | 7,610 | 3,530 | 2,150 | 2,470 | 2,540 | 25,500 |
| **Pecos River near Malaga, NM** | | | | | | |
| 1969 wy | 24,480 | 6,720 | 1,770 | 4,820 | 5,680 | 160,000 |
| 1970 wy | 61,800 | 6,900 | 344 | 2,670 | 4,990 | 224,000 |
| 1971 wy | 19,990 | 7,700 | 3,020 | 5,360 | 5,850 | 146,000 |
| 1972 wy | 37,620 | 6,590 | 1,020 | 3,190 | 5,580 | 164,000 |
| 1973 cy | 78,620 | 5,120 | 1,720 | 3,080 | 4,390 | 330,000 |
| 1974 cy | 157,100 | 6,360 | 414 | 1,350 | 4,690 | 287,000 |
| 1975 cy | 40,110 | 5,470 | 3,620 | 4,330 | 4,360 | 236,000 |
| 1976 cy | 14,900 | 7,350 | 2,930 | 5,000 | 5,560 | 101,000 |
| **Pecos River at Pierce Canyon Crossing, NM** | | | | | | |
| 1969 wy | 24,100 | 32,900 | 1,300 | 10,900 | 13,600 | 356,000 |
| 1970 wy | 55,180 | 40,700 | 740 | 5,190 | 10,900 | 420,000 |
| 1971 wy | 19,740 | 27,800 | 4,990 | 10,300 | 13,500 | 286,000 |
| 1972 wy | 37,120 | 37,500 | 1,330 | 6,350 | 14,800 | 321,000 |
| 1973 cy | 80,030 | 21,000 | 1,870 | 4,880 | 8,110 | 530,000 |
| 1974 cy | 158,800 | 26,400 | 538 | 2,330 | 11,200 | 503,000 |
| 1975 cy | 41,440 | 12,500 | 4,690 | 7,430 | 7,730 | 418,000 |
| 1976 cy | 16,620 | 38,800 | 7,070 | 11,900 | 14,700 | 271,000 |

Table 11.--Annual dissolved-solids values - cont.

| Year | Total flow, acre-feet | Dissolved-solids concentrations, mg/l: Composite maximum | Composite minimum | Discharge-weighted average | Time-weighted average | Annual dissolved-solids load, tons |
|---|---|---|---|---|---|---|
| Pecos River at Red Bluff, NM | | | | | | |
| 1969 wy | 22,980 | 27,800 | 1,890 | 10,400 | 13,700 | 324,000 |
| 1970 wy | 66,710 | 19,200 | 570 | 4,610 | 9,040 | 558,000 |
| 1971 wy | 23,230 | a33,200 | a952 | a9,650 | a13,600 | a305,000 |
| 1972 wy | 38,930 | a35,700 | a1,690 | a6,360 | a15,100 | a337,000 |
| 1973 cy | 77,890 | a14,600 | a1,550 | a5,240 | a8,380 | a555,000 |
| 1974 cy | 165,700 | a31,500 | a438 | a3,060 | a12,100 | a689,000 |
| 1975 cy | 43,620 | a11,100 | a5,940 | a8,270 | a9,100 | a491,000 |
| 1976 cy | 17,790 | a25,100 | a5,030 | a12,300 | a15,100 | a298,000 |

a - Estimated from daily specific conductances
cy - Calendar year
wy - Water year, October 1 through Sept. 30

## Suspended Sediment

Table 12 is a listing of stations where suspended-sediment data were collected during 1976. All samples collected were analyzed for sediment concentrations and a few samples for each station were analyzed for particle size. Samples selected for size analysis were selected on the basis of stage or discharge in an attempt to cover a range in discharge. Selection was also made to define seasonal changes in size distribution and concentration.

Table 13 shows the maximum and minimum observed concentrations in the Pecos River basin for 1976. Observed concentrations at the time of sampling ranged considerably during the 1976 calendar year for the stations at Santa Rosa and Artesia. Very low concentrations were observed at the stations at Terrero and Red Bluff.

Table 12.--Suspended-sediment stations operated during 1976 in the Pecos River basin

| Station | Frequency of measurement | Cooperator |
|---|---|---|
| Rio Mora nr. Terrero | Monthly, plus significant runoff events | USGS |
| Pecos R. at Santa Rosa | Daily | USGS |
| Pecos R. nr. Artesia | Daily | USGS |
| Pecos R. at Red Bluff | Monthly | EPA |

USGS - U. S. Geological Survey
EPA - Environmental Protection Agency

Table 13.--Extreme suspended-sediment concentrations observed for Pecos River basin stations in 1976, in milligrams per liter

| Station | Maximum | Minimum |
|---|---|---|
| Rio Mora nr. Terrero | 21 | 0 |
| Pecos R. at Santa Rosa | 38,300 | 6 |
| Pecos R. nr. Artesia | 16,500 | 4 |
| Pecos R. at Red Bluff | 27 | 8 |

## Stream Temperatures

Water temperatures were generally obtained wherever water samples were collected and when discharge measurements were made.

Following are maximum, mean, and minimum observed water temperatures for selected streamflow stations. The means were computed as the average for all observations made during the month.

Table 14.--Monthly observed water-temperature averages and extremes, in degrees centigrade, for selected streamflow stations during 1976

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pecos River at Carlsbad, NM** | | | | | | | | | | | | |
| Max. | 12.0 | 17.5 | 18.0 | 23.0 | 27.0 | 29.0 | 29.0 | 28.0 | 25.0 | 23.0 | 15.0 | 9.0 |
| Mean | 10.0 | 13.5 | 14.5 | 19.0 | 22.5 | 24.5 | 26.0 | 24.5 | 23.5 | 16.5 | 11.0 | 7.5 |
| Min. | 8.0 | 10.5 | 12.5 | 15.0 | 18.0 | 22.5 | 24.0 | 22.5 | 19.0 | 11.0 | 5.5 | 6.0 |
| **Pecos River near Malaga, NM** | | | | | | | | | | | | |
| Max. | 12.0 | 16.0 | 17.0 | 24.5 | 27.0 | 30.0 | 30.5 | 31.0 | 29.0 | 24.0 | 16.0 | 12.0 |
| Mean | 8.0 | 12.0 | 13.5 | 19.5 | 22.0 | 26.0 | 27.5 | 27.5 | 24.5 | 17.0 | 11.0 | 7.5 |
| Min. | 5.5 | 8.5 | 11.0 | 14.0 | 17.0 | 22.0 | 23.0 | 22.0 | 19.0 | 11.0 | 5.0 | 5.5 |
| **Pecos River at Pierce Canyon Crossing, NM** | | | | | | | | | | | | |
| Max. | 11.5 | 17.0 | 16.5 | 25.0 | 27.0 | 32.0 | 32.0 | 32.0 | 31.0 | 28.5 | 13.0 | 9.0 |
| Mean | 7.0 | 11.5 | 13.0 | 18.5 | 22.0 | 26.5 | 28.0 | 28.0 | 25.0 | 17.0 | 10.0 | 6.5 |
| Min. | 4.0 | 7.5 | 9.0 | 12.0 | 16.0 | 23.0 | 24.0 | 22.0 | 19.5 | 10.0 | 3.5 | 4.0 |
| **Pecos River at Red Bluff, NM** | | | | | | | | | | | | |
| Max. | 10.0 | 17.5 | 19.0 | 24.0 | 26.0 | 29.0 | 30.0 | 32.0 | 29.0 | 23.5 | 15.5 | 7.5 |
| Mean | 8.0 | 13.0 | 15.5 | 20.0 | 23.0 | 27.0 | 29.0 | 28.5 | 25.0 | 17.5 | 10.5 | 6.0 |
| Min. | 5.5 | 9.0 | 12.0 | 16.5 | 17.5 | 25.0 | 26.5 | 26.0 | 19.0 | 11.0 | 5.0 | 4.0 |

## OTHER ACTIVITIES

### Malaga Bend Salinity-Alleviation Project

Routine collection of hydrologic data for monitoring of the project ended October 29, 1976. At present the stage of Anderson Lake is read monthly, and a recorder still operates on well USGS 11. There has been no pumping of brine from well USGS 8 since May 1976.

A report by J. L. Kunkler describing the methods of calculating evaporation and leakage from Anderson Lake has been revised and sent to reviewers outside the New Mexico district.

A second amd more comprehensive report by John S. Havens will be condensed, edited, and revised to describe the present effect of leakage from Anderson Lake on the quality of water in the Pecos River.

A monthly tabulation of pumpage, evaporation, and precipitation is shown below.

| Month | Brine pumped, in acre-feet | Gross evaporation, in feet | Precipitation in inches |
|---|---|---|---|
| January | 47 | *0.301 | 0.06 |
| February | 20 | *.648 | .10 |
| March | 21 | .914 | .36 |
| April | 50 | .887 | 2.19 |
| May | 31 | .946 | 1.42 |
| June | 0 | 1.137 | .06 |
| July | 0 | 1.060 | 2.75 |
| August | 0 | 1.188 | .51 |
| September | 0 | .811 | 4.51 |
| October | 0 | .524 | 1.25 |
| November - | Discontinued | | |
| Total | 169 | 8.416 | 13.21 |

* - Ice on pan at times.

| | Dec. 31, 1975 to Jan. 2, 1977 | July 1963 through Dec. 1976 |
|---|---|---|
| Weight of sodium-potassium chloride pumped (tons, at 318 tons per acre-feet) | 54,000 | 3,424,000 |
| Weight of total dissolved solids pumped (tons, at 340 tons per acre-feet) | 57,000 | 3,622,000 |

## Phreatophyte Eradication and Control Program Evaluation

The purpose of this program is to evaluate, in the Acme to Artesia reach, the effects on the water table and streamflow of the Bureau of Reclamation's phreatophyte control program along the Pecos River.

Activities during 1976 included the computation of the 1975 gain in base flow between the Acme and Artesia gaging stations. The base flow of 20,550 acre-feet for 1975 was somewhat less than the 1974 base flow of 22,090 acre-feet. The monthly measuring of water levels in 19 observation wells was continued.

A conventional-type water budget analysis of the Acme-Artesia reach was stopped after it was determined that water-table gradients to the west were generally correlative with changes in base flow. Full effort was then directed to the design of the Roswell Basin digital model with particular emphasis on the Acme-Artesia reach and the shallow aquifer. Preparation of the input data for the model is about 85 percent complete. These data include water-level maps, distribution of ground-water pumpage, aquifer characteristics, base flow of the Pecos River, return flow from irrigation, and a number of other components. Data relating leakage to artesian head and the effects of the Hagerman Canal remain to be assembled. All of the data will then be coded for use in the model's computer program.

## Other Miscellaneous Pecos River Studies

Other miscellaneous Pecos River studies that were in progress in 1976 include the evaluation of gains and losses from Artesia to Carlsbad and the compilation of all miscellaneous streamflow data.

Full effort on the evaluation of gains and losses from Artesia to Carlsbad has been postponed until the compilation of miscellaneous and seepage run measurements is completed.

A detailee from the Arizona District to the New Mexico District spent 2.5 months working on the compilation. The collecting and tabulation of data is now approximately 90 percent complete. Data for the Rio Hondo and tributaries is in the process of being key punched for input to the computer at this time.

## SUMMARY OF COSTS

Following is a summary of costs for the 1976 fiscal year for the cooperative agreement of the U. S. Geological Survey with the Pecos River Commission.

| | USGS share | PRC share | Total |
|---|---|---|---|
| Basic-data program | | | |
| Stream-gaging stations | | | |
| Operation | | | |
| New Mexico | $30,470 | $30,470 | $60,940 |
| Texas | 10,730 | 10,730 | 21,460 |
| Maintenance | 1,000 | 1,000 | 2,000 |
| Chemical-quality records | 7,500 | 7,500 | 15,000 |
| Subtotal | $49,700 | $49,700 | $99,400 |
| Special studies | | | |
| Malaga Bend salinity-alleviation project | $4,000 | $4,000 | $8,000 |
| Miscellaneous reach studies | 12,935 | 12,935 | 25,870 |
| Subtotal | $16,935 | $16,935 | $33,870 |
| PRC office rent (unmatched) | | $1,853 | $1,853 |
| TOTAL | $66,635 | $68,488 | $135,123 |

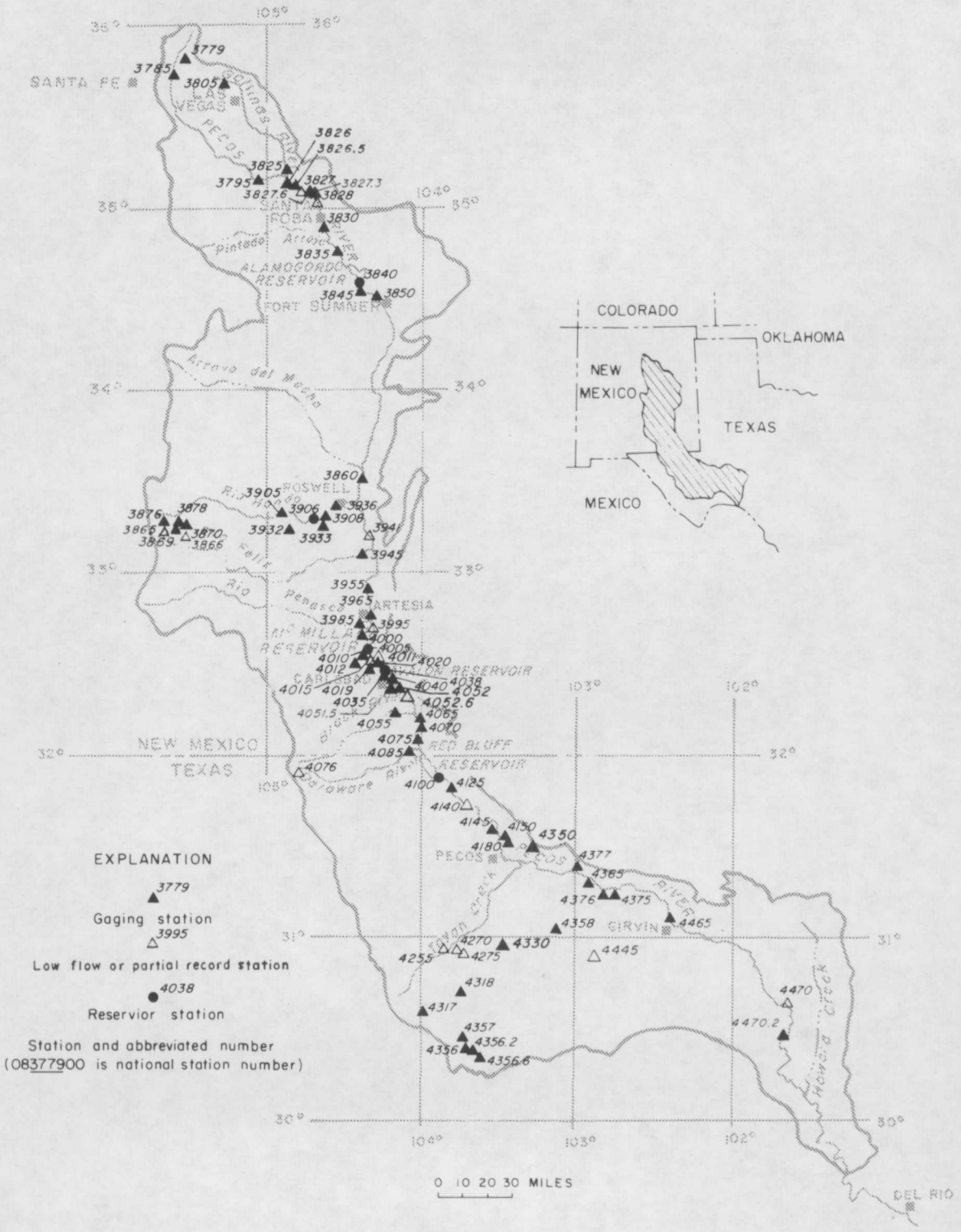


Figure 1.--Location of regular, low-flow, and reservoir gaging stations in the Pecos River basin

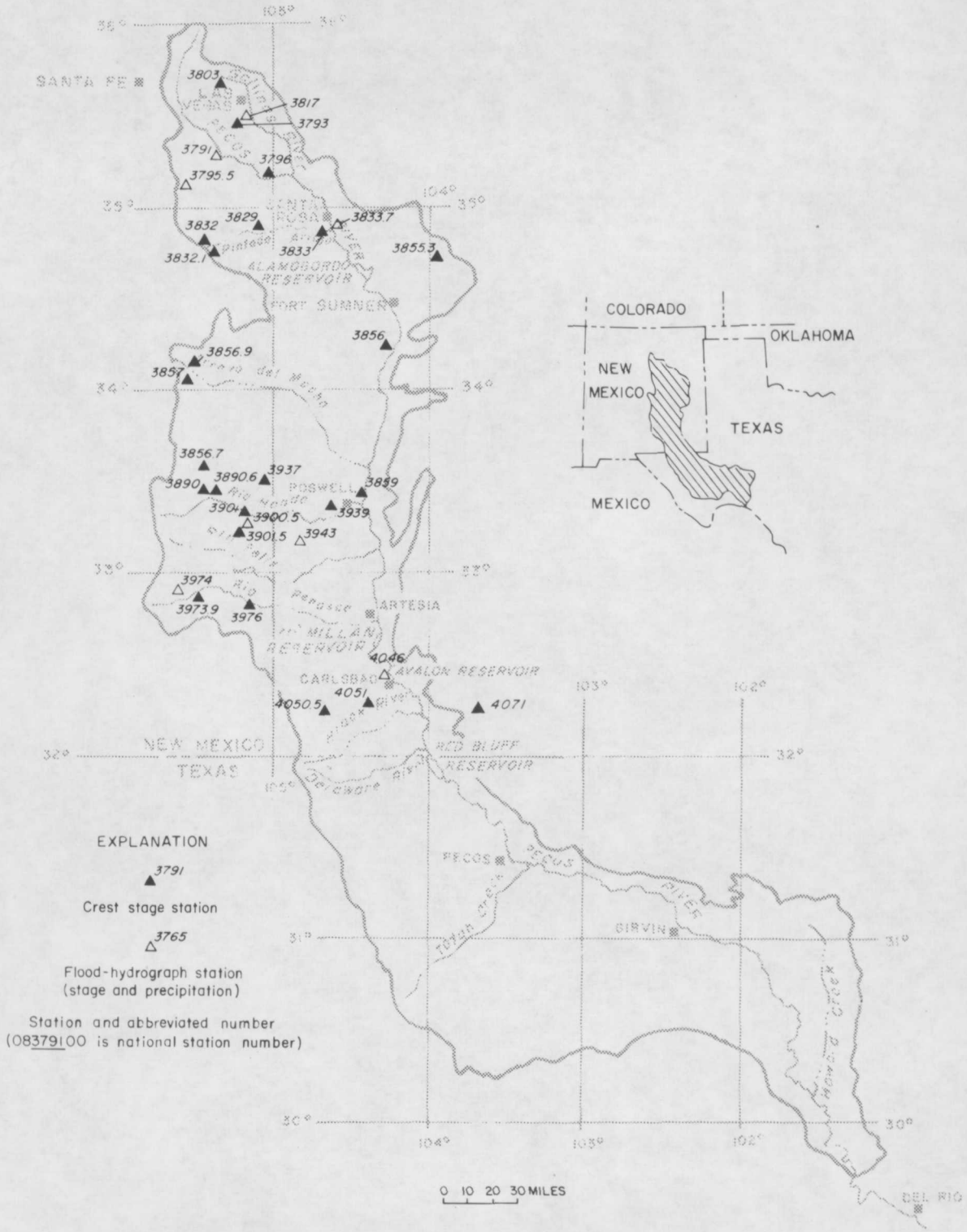


Figure 2.-- Location of crest-stage and flood-hydrograph stations in the Pecos River basin.