HYDROLOGIC INVESTIGATIONS AND DATA-COLLECTION NETWORK IN STRIPPABLE COAL AREAS IN NORTHWESTERN NEW MEXICO

By H. R. Hejl, Jr.

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CONTENTS

ILLUSTRATIONS

TABLES

HYDROLOGIC INVESTIGATIONS AND DATA-COLLECTION NETWORK IN STRIPPABLE COAL AREAS IN NORTHWESTERN NEW MEXICO

BY H. R. HEJL, JR.

ABSTRACT

Expansion of coal mining to help meet the nation's needs in becoming energy self-sufficient has resulted in the need for hydrologic information for coal development and environmental protection. The Surface Mining Control and Reclamation Act (SMCRA) of 1977, Public Law 95-87, provides comprehensive regulations to protect the environment from the impacts of surface mining for coal. The purpose of this report is to inform State and Federal agencies, private companies, and the public of the hydrologic investigations and hydrologic data collection conducted by the U.S. Geological Survey in the strippable coal areas of northwestern New Mexico. The coal deposit that currently is of greatest interest is the strippable coal found in the Fruitland Formation in the San Juan structural basin.

INTRODUCTION

Expansion of coal mining to help meet the nation's needs in becoming energy self-sufficient has resulted in the need for hydrologic information for coal development and environmental protection. The Surface Mining Control and Reclamation Act (SMCRA) of 1977, Public Law 95-87, provides comprehensive regulations to protect the environment from the impacts of surface mining for coal. Assessment of the water-resource characteristics and the impacts on the prevailing hydrologic balance are part of the evaluation required by SMCRA.

Purpose and scope

The purpose of this report is to inform State and Federal agencies, private companies, and the public of the hydrologic investigations and hydrologic data collection being conducted by the U.S. Geological Survey in the strippable coal areas of northwestern New Mexico. Streamflow, groundwater, and quality-of-water data in the strippable coal areas are being collected to provide information about baseline or prevailing hydrologic conditions. The data are needed for writing stipulations to minimize adverse impacts to water resources and for determining appropriate water-quality standards for mining and reclamation operations.

The network of hydrologic data-collection sites in the strippable coal areas of the Fruitland Formation was designed to meet the need of detailed investigations, including site-specific studies, and to provide hydrologic data in support of the expanding mining activity. Prior to 1974, the U.S. Geological Survey's hydrologic data-collection network in the coal-lease areas was limited to 9 continuous-record streamflow-gaging stations (6 included water-quality sampling) and 21 annual maximum discharge stations. The hydrologic data-collection network was expanded; in 1981 the network consisted of 34 continuous-record streamflow-gaging stations (32 included water-quality sampling), 20 miscellaneous water quality of streamflow stations, 12 annual maximum discharge stations, 27 observation wells completed in strata associated with the strippable coal seams, and 24 observation wells completed in channel alluvium downstream from strippable coal areas. Subsequent sections of this report detail the information available from the hydrologic investigations and the data-collection network.

Study area

The coal deposit that currently is of greatest interest in New Mexico is the strippable coal found in the Fruitland Formation. This strippable coal lies within 250 feet of the land surface and is located along the western and southern margins of the San Juan Basin in northwestern New Mexico (fig. 1). The Fruitland Formation is composed of shale, sandstone, siltstone, and coal, with occasional thin beds of limestone interspersed throughout the lower part of the formation. The lower part of the Fruitland Formation contains thicker and more numerous coal beds than the upper part. Surface mining in the Fruitland Formation to furnish coal for power-generating plants in the vicinity of Farmington has been taking place for several years. Several new surface coal mines are proposed along the Fruitland strippable coal band. Surface mining for coal in the Menefee Formation of the Mesaverde Group is taking place in the vicinity of Gallup (fig. 1).

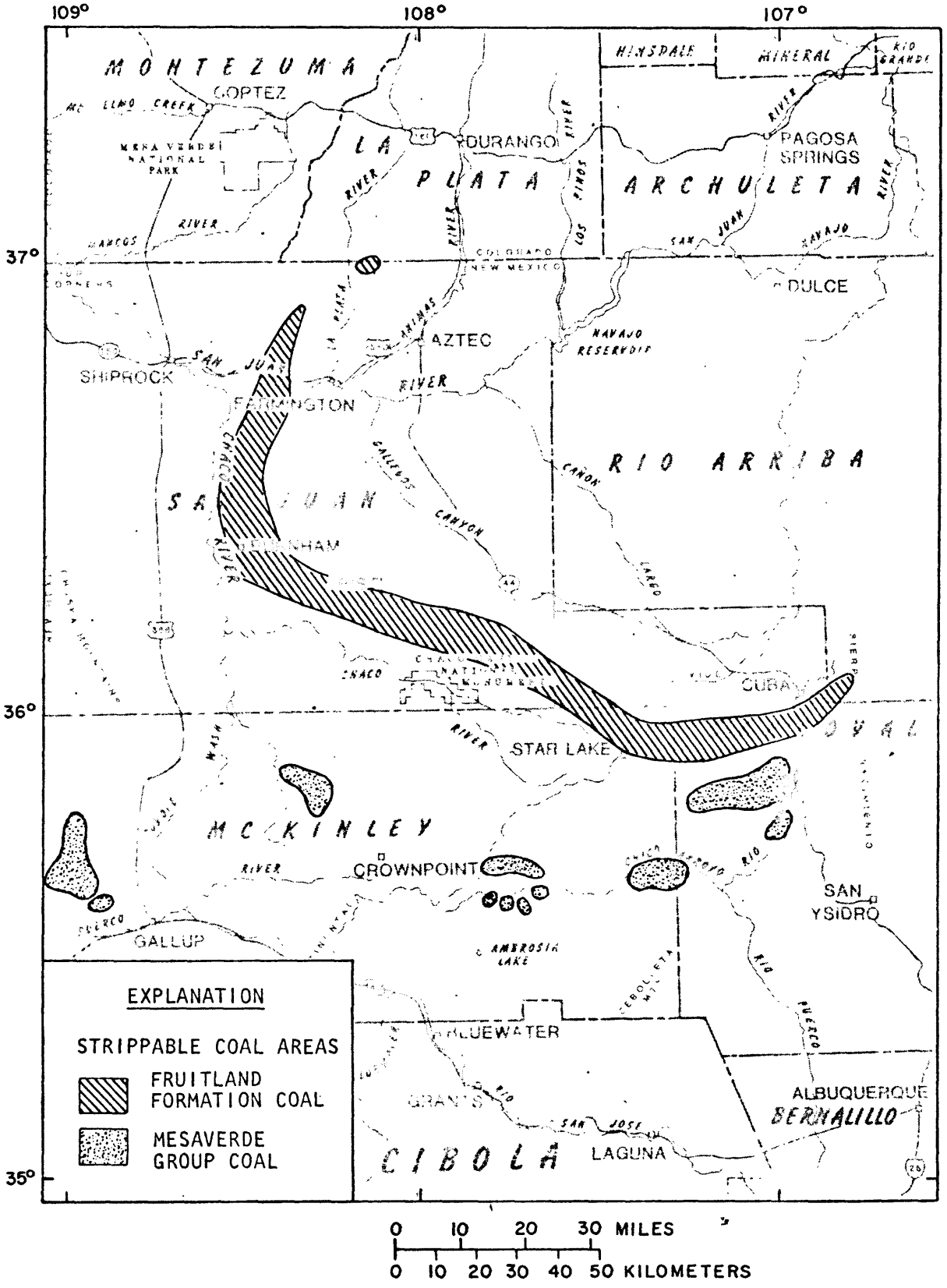

Figure 1.--Location of strippable coal in northwestern New Mexico.

HYDROLOGIC INVESTIGATIONS

The hydrologic investigations in the coal-resource areas of northwestern New Mexico are directed towards: (1) Monitoring and documenting baseline hydrologic characteristics of streamflow and ground-water quantity and quality prior to and during surface mining and subsequent to reclamation; (2) developing transfer techniques to estimate water-resources characteristics at ungaged areas by obtaining a knowledge of the principles and processes affecting the local and regional flow systems; and (3) developing methods to predict the effects of surface mining and associated development of water resources on the local and regional flow systems.

Geohydrology of northwestern New Mexico and its relationship to energy-resources development

Project number: NM 75-221 (terminated September 1980)

Cooperating agencies: New Mexico Bureau of Mines and Mineral Resources, New Mexico State Engineer Office, and Bureau of Indian Affairs San Juan Regional Uranium Study

Project chief: Peter F. Frenzel

Problem: Large reserves of minerals currently are being developed in the San Juan Basin of New Mexico. Expanded exploration and production of these minerals will be accompanied by an increasing need for large supplies of water. Production and disposal of waste water in a rather fragile environment are also anticipated. The Bureau of Indian Affairs and numerous communities are concerned with the effects of development on ground water in the area. The well records that are available in the area indicate that there are usable ground-water supplies available locally; however, these probably are somewhat limited.

Objectives: Objectives of the study included: (1) Evaluation of the aquifers within the project area; (2) determination of ground-water levels for the various aquifers; (3) estimation of the effects of various degrees of withdrawals upon the water levels; and (4) determination of the chemical and radiochemical quality of the ground water.

Approach: All geohydrologic data collected from the area during previous studies were incorporated in this study, but emphasis was placed on recent developments and on those areas where mineral exploration and development were most likely to occur. Ground-water quality was determined.

Reports published or in press:

Lyford, F. P., 1979, Ground water in the San Juan Basin, New Mexico and Colorado: U.S. Geological Survey Water-Resources Investigations 79-73, 22 p.

Lyford, F. P., Frenzel, P. F., and Stone, W. J., 1980, Preliminary estimates of effects of uranium-mine dewatering on water levels, San Juan Basin: New Mexico Bureau of Mines and Mineral Resources, Memoir 38, p. 320-333.

Stone, W. J., Lyford, F. P., Frenzel, P. F., Mizell, N. H., and Padgett, E. T., 1982, Hydrogeology and water resources of the San Juan Basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 6, [in press].

Hydrologic surveillance of coal-lease areas in northwestern New Mexico

Project number: NM 75-321

Cooperating agency: Bureau of Land Management

Project chief: Henry R. Hejl, Jr.

Problem: Certain areas of the San Juan Basin in northwestern New Mexico are undergoing water- and land-use changes, most of which are related to energy development. Among these developments are strip mining of coal, oil and gas exploration, electric power generation, coal gasification, and agriculture. These developments may affect the condition of the water resources by changing drainage patterns, increasing sediment yield, and altering the chemical quality of water.

Objectives: The objectives of this project are to document variabilities in quantity and quality of streamflow and ground water associated with the coal seams, obtain a knowledge of the flow-systems and the principles and processes in effect, and determine the effects of coal extraction and associated development on the quantity and quality of water resources in the coal-lease areas of northwestern New Mexico.

Approach: Streamflow, ground-water, and water-quality data are being collected prior to surface extraction of coal and related activities to establish baseline conditions of the quantity and quality of water resources. All water-resources data being collected in and near the coal-resource areas in northwestern New Mexico are being used to develop transfer techniques to estimate streamflow characteristics at ungaged basins and to develop predictive capabilities to estimate changes in quantity and quality during surface mining for coal and after spoil piles are reclaimed.

Reports published:

Hejl, H. R. Jr., 1980, Preliminary appraisal of ephemeral-streamflow characteristics as related to drainage area, active-channel width, and soils in northwestern New Mexico: U.S. Geological Survey Open-File Report 81-64, 15 p.

U.S. Department of the Interior, 1976, Resource and potential reclamation evaluation, Bisti West study site -- Bisti coal field: Bureau of Land Management EMRIA Report 5-1976, p. 69-80, F1-F16.

_____1981, Resource and potential reclamation evaluation, Kimbeto study area: Bureau of Land Management EMRIA Report 17-1977, p. J1-J7, L13-L18, Q1-Q19.

_____1981, Resource and potential reclamation evaluation, Ojo Encino study area: Bureau of Land Management Technical Investigations Report 19-78, p. C17-C20, J1-J9, Q1-Q-12.

Quality-of-water monitoring in the Chaco River basin in northwestern New Mexico's energy-development area

Project number: NM 75-325 (terminated April 1980)

Cooperating agency: U.S. Environmental Protection Agency

Project chief: Kim Ong

Problem: The demand to develop energy mineral resources in the Chaco River basin and the concern to protect the environment surrounding these resources have created the need to study the associated hydrologic system. The flow in the Chaco River and the ground water in the channel alluvium may be impacted by these developments. There is concern that water quality may be impaired downstream in the San Juan River and ultimately in the Colorado River. In

the past, the water resources of the Chaco River basin were not studied because the basin is sparsely populated, the natural flow in the Chaco River is ephemeral and unpredictable, the Chaco River's contribution to the total flow in the San Juan River is thought to be small, and the quality of the water resources in the basin is considered to be poor. Consequently, insufficient water-resource data existed to define adequately the natural conditions and to assess effects of energy developments.

Objective: The objective of this project was to collect water-resources data from selected sites along the Chaco River system that might be impacted by energy developments, particularly uranium mining and coal mining.

Approach: A network of 12 water quality of streamflow sites equipped with single-stage samplers was established. In addition, one of the sites was equipped to collect continuous streamflow data and another site was equipped with an automatic pump sampler. Water samples from shallow alluvial wells were collected and analyzed. Emphasis was placed on collecting water-quality data. The data collected under this project, combined with the data collected from other studies, may be used to define natural or present water-resources conditions, to assist in resolving Chaco River water-supply concerns at energy developments, and to help predict impacts on the Chaco River by these energy developments.

Precipitation-runoff modeling of watershed systems in northwestern New Mexico

Project number: NM 79-333

Cooperating agency: Bureau of Land Management

Project chief: Henry R. Hejl, Jr.

Problem: The effects of surface mining for coal on surface runoff and sediment yield in strippable coal-lease areas in the San Juan Basin during the period of mining and post-mining reclamation are unknown. The Bureau of Land Management needs a method to predict these effects in order to determine whether or not to lease the coal-bearing areas of the public domain.

Objectives: The objectives of this project are to develop, test, and verify precipitation-runoff models for predicting surface runoff and sediment yield under various land-use conditions in the coal-lease areas in northwestern New Mexico. The model will be developed from intensive data collection on a typical basin in a strippable coal area for use in similar ungaged basins; however, data collection at the ungaged basins will be limited only to basin physical characteristics, soil and overburden characteristics, and vegetation data.

Approach: Ah-shi-sle-pah Wash basin was selected as being representative of typical strippable coal-lease areas in northwestern New Mexico. The basin, which has a drainage area of 8.21 square miles, is equipped with instruments for collecting data on streamflow, water quality, precipitation, temperature, solar intensity, wind, relative humidity, and soil moisture. The basic model being developed by a cooperative effort between the Geological Survey and the Bureau of Land Management is a modular package using a distributed-parameter approach. The model uses mathematical relationships to represent the hydrologic system. To aid in model development and refinement of data-collection procedures, the basic model is recalibrated as additional data become available. The long-term rainfall required as one of the variables for the model will be simulated by a statistical rainfall generator using rainfall data being collected throughout the coal-resource region of the San Juan Basin in New Mexico.

Water-resources monitoring of coal development in the San Juan Basin, New Mexico

Project number: NM 77-406

Project chief: Henry R. Hejl, Jr.

Problem: Coal mining and associated developments in the San Juan Basin may have an adverse effect on the water resources of the area. Mine dewatering, changes in land use, water disposal, stream-channel realignment, and water withdrawals for industries and municipalities may alter streamflow and ground-water systems, interfere with traditional water uses, and may cause deterioration of remaining water resources.

Objectives: The objectives of the program are to monitor surface and ground water in the coal area, to detect and document changes in water quantity or quality that may result from coal mining and associated activities, and to obtain knowledge of the regional flow system and the principles and processes in effect.

Approach: The existing water-resources monitoring program was evaluated for its regional surveillance value, and hydrologic data-collection sites were added to upgrade the existing network. The hydrologic data-collection network is continuously being modified to meet data needs for documenting changes that may be caused by the expanding surface coal-mining activities and for refinements in understanding the regional surface-flow and ground-water systems in coal areas of northwestern New Mexico.

Exploration of techniques for separation and quantification of individual coal mine effects from cumulative effects data

Project number: NM 80-411

Project chief: Carole L. Goetz

Problem: Legal requirements of regulatory agencies have created a need to evaluate the hydrologic effects of proposed and actual coal mining activities. The situation on the San Juan River in northwest New Mexico offers a promising set of circumstances to determine whether the effects of a single coal mine are large enough to be measured and separated from other natural and cultural effects using the cumulative hydrologic data collected at stream sites.

Objectives: The objective of the study is to investigate various data-analysis techniques that can be used to quantify and separate individual coal mine effects on streamflow, water quality, and sedimentation from cumulative natural and cultural effects.

Approach: The major project work element will be the analysis of existing streamflow, water-quality, and sediment data. The analysis will include the use of trilinear plots, hydrographs, isogram maps, Stiff and Collins diagrams, mass diagrams, and low flow frequency curves. Statistical techniques will include regression analyses; frequency-distribution analyses; and calculation of ratios, minimum, maximum, mean, and standard deviation. Geochemical techniques will be applied to determine mineral equilibrium.

Reports published:

Goetz, C. L., 1981, Preliminary analysis of historical streamflow and water-quality records for the San Juan River Basin, New Mexico and Colorado, in Environmental geology and hydrology in New Mexico: New Mexico Geological Society Special Publication No. 10, p. 21-25.

HYDROLOGIC DATA-COLLECTION NETWORK

The types of hydrologic data being collected in the coal areas of northwestern New Mexico include information on discharge of ephemeral and perennial streams, ground-water data on alluvial and coal-associated water-bearing strata, and water quality of streamflow and ground water. Sources from which the hydrologic data may be obtained are described in the "Sources of Hydrologic Data" section of this report.

Cooperating agencies

The hydrologic data-collection network in the strippable coal areas in northwestern New Mexico is or was funded by various Federal and State agencies under cooperative agreements with the U.S. Geological Survey, Water Resources Division. Part of this work is sponsored entirely by the U.S. Geological Survey from funds allocated to coal hydrology. The agencies that fund or funded the station operations are indicated in the tables in this report and are abbreviated as follows:

Agency name	Abbreviation
Bureau of Land Management	BLM
Colorado State Engineer Office	CO
National Park Service	NPS
New Mexico Environmental Improvement Division	EID
New Mexico State Engineer Office/ Interstate Stream Commission	SEO/ISC
New Mexico State Highway Department	SHD
U.S. Environmental Protection Agency	EPA
U.S. Geological Survey	USGS

Streamflow and water-quality station network

The network of streamflow and water-quality stations is shown in figure 2 and listed in table 1. The first column in table 1 contains the numbers given to station locations in figure 2, and the second column contains the station-identification numbers needed to obtain data from published reports and computer-storage systems. The third and fourth columns contain the station name (stream name and nearby city, town, or major feature) and the drainage area of the basin. The fifth through eighth columns contain the period of record for discharge, chemical-quality, sediment, and biological data.

Daily values of streamflow discharge are available at all streamflow-gaging stations in table 1. The frequency of water-quality analysis is dependent upon the needs of the funding agency. In general, the water-quality information includes temperature, specific conductance, pH, dissolved oxygen, major and minor constituents, nutrients, radiochemical level, suspended-sediment concentration, particle-size distribution of sediment, and biological data.

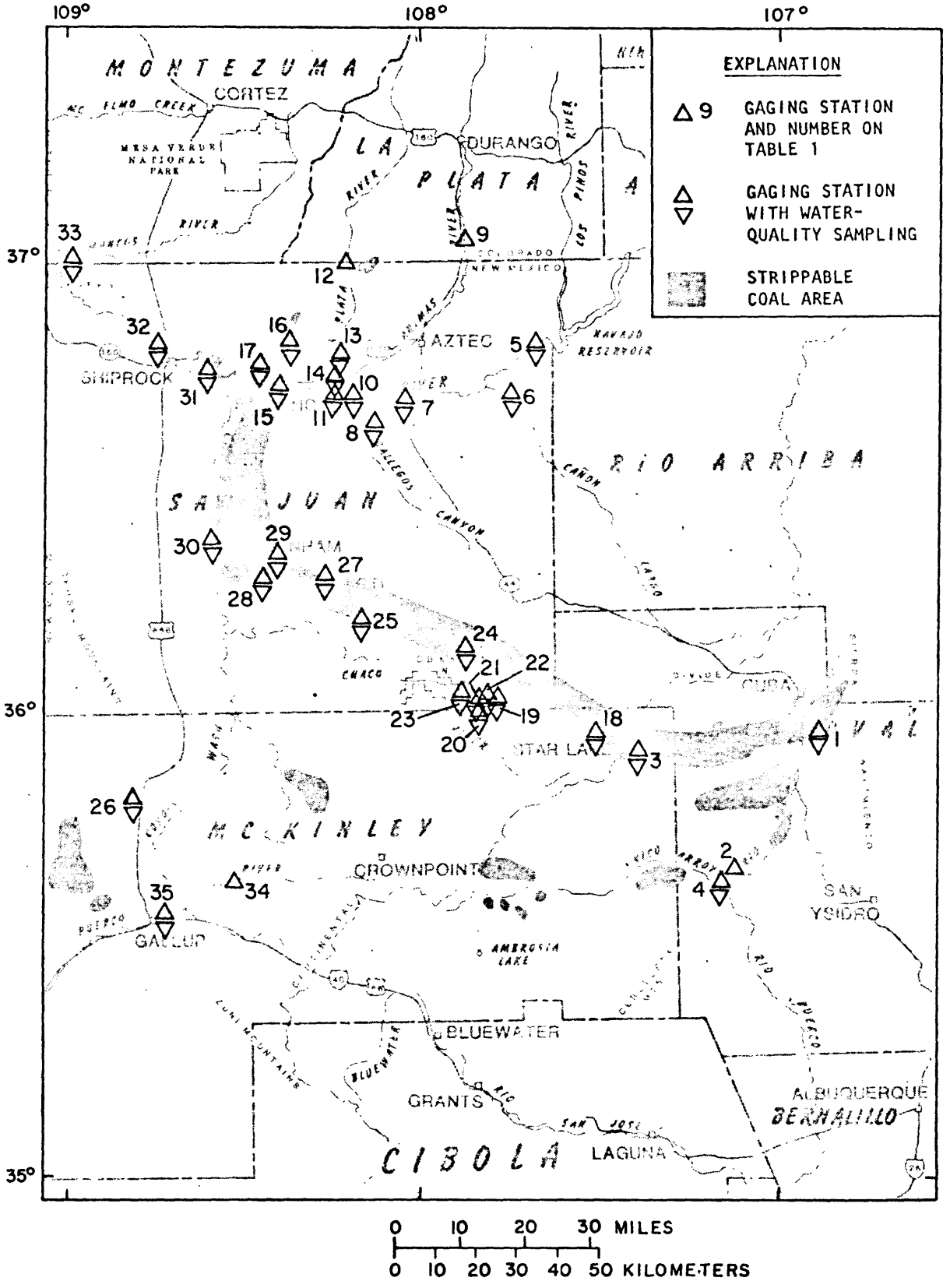

Figure 2.--Location of streamflow and water-quality stations.

Table 1. Streamflow and water-quality stations

[A dash (-) after a date indicates data are currently being collected. Funding agencies are: USGS, United States Geological Survey; SEO, New Mexico State Engineer Office; ISC, Interstate Stream Commission; BLM, Bureau of Land Management; CO, Colorado State Engineer Office; NPS, National Park Service; EID, New Mexico Environmental Improvement Division]

Number in figure 2	Station identification number	Station name	Drainage area (square miles)	Type and period of record				Funding agencies
				Discharge	Chemical quality	Sediment	Biological	
1	08332700	San Pablo Creek near Cuba, NM	12.8	1979-	1979-	1979-	-	USGS
2	08334000	Rio Puerco above Arroyo Chico, near Guadalupe, NM	420	1951-	-	1981	-	SEO/ISC
3	08334300	Papers Wash near Star Lake Trading Post, NM	20.3	1978-	1978-	1978-	1979-80	USGS
4	08340500	Arroyo Chico near Guadalupe, NM	1,390	1944-	1948-56 1978-	1979-81	-	BLM
5	09355500	San Juan River near Archuleta, NM	3,260	1955-	1955-81	-	-	SEO/ISC
6	09356565	Canon Largo Wash near Blanco, NM	1,700	1978-81	1978-81	1978-81	1978-80	USGS
7	09357100	San Juan River at Hammond Bridge near Bloomfield, NM	5,540	1978-81	1978-81	1978-81	1978-80	USGS
8	09357250	Gallegos Canyon Wash near Farmington, NM	290	1978-81	1978-81	1978-81	1978-80	USGS
9	09363500	Animas River near Cedar Hill, NM	1,090	1934-	-	-	-	SEO/ISC
10	09364500	Animas River at Farmington, NM	1,360	1904-	1940-	1950-	1970-	SEO/ISC
11	09365000	San Juan River at Farmington, NM	7,240	1913-	1962-	-	1970-78	SEO/ISC

12	09366500	La Plata River at Colorado-New Mexico State line	331	1920-	-	-	-	CO
13	09367400	La Plata River Tributary near Farmington, NM	1.03	1979-	1979-	1979-	-	USGS
14	09367500	La Plata River near Farmington, NM	583	1938-	1970-73 1978-	1978-81	1978-80	SEO/ISC
15	09367540	San Juan River near Fruitland, NM	8,010	1978-80	1978-81	1978-81	1978-80	USGS
16	09367555	Shumway Arroyo near Fruitland, NM	62.8	1975-	1976-	1976-	-	BLM
17	09367561	Shumway Arroyo near Waterflow, NM	73.8	1975-	1975-	1975-	1975-80	BLM
18	09367660	Chaco Wash near Star Lake Trading Post, NM	59.0	1978-	1978-	1978-	1978-80	USGS
19	09367676	Chaco Wash at East Boundary at Chaco National Monument, NM	-	1980-	1980-	1980-	-	NPS
20	09367678	Fajada Wash at Chaco Canyon, NM	-	1980-	1980-	1980-	-	NPS
21	09367680	Chaco Wash at Chaco Canyon National Monument, NM	578	1976-	1976-	1976-	-	USGS
22	09367682	Gallo Wash at Chaco Canyon National Monument, NM	36.2	1978-81	1979-81	1979-81	-	USGS
23	09367683	Chaco Wash at Pueblo Bonito at Chaco Canyon, NM	-	1980-	1980-	1980-	-	NPS
24	09367685	Ah-shi-sle-pah Wash near Kimbeto, NM	8.21	1977-	1977-	1977-	-	BLM
25	09367710	De-na-zin Wash near Bisti Trading Post, NM	184	1976-	1976-	1976-	-	BLM

Table 1. Streamflow and water-quality stations - Concluded

Number in figure 2	Station identification number	Station name	Drainage area (square miles)	Type and period of record				Funding agencies
				Discharge	Chemical quality	Sediment	Biological	
26	09367900	Black Springs Wash near Mexican Springs, NM	7.05	1979-	1979-	1979-	-	USGS
27	09367930	Hunter Wash at Bisti Trading Post, NM	45.6	1975-	1975-	1975-	-	BLM
28	09367934	Teec-ni-di-tso Wash near Burnham, NM	7.2	1978-	1978-	1978-	1979-80	USGS
29	09367936	Burnham Wash near Burnham, NM	8.6	1978-	1978-	1978-	1978-80	USGS
30	09367938	Chaco River near Burnham, NM	3,640	1978-	1978-	1978-	1978-80	USGS
31	09367950	Chaco River near Waterflow, NM	4,350	1976-	1976-	1976-	1977-80	USGS
32	09368000	San Juan River at Shiprock, NM	12,900	1927-	1941-45 1951-	1951-	1977-	SEO/ISC & USGS
33	09371010	San Juan River at Four Corners, NM	14,600	1978-	1978-	1978-	1979-80	SEO/ISC & USGS
34	09395350	Puerco River near Church Rock, NM	193	1978-	-	-	-	EID
35	09395500	Puerco River at Gallup, NM	558	1978-	1975-	-	-	EID & SEO/ISC

Miscellaneous water quality of streamflow data-collection network

The network of miscellaneous water quality of streamflow data-collection stations is shown in figure 3 and listed in table 2. The first column in table 2 contains the numbers given to station locations in figure 3, and the second column contains the station-identification numbers needed to obtain data from published reports and computer-storage systems. Also included in table 2 are the station name, drainage area (if determined), period and type of record, and funding agencies.

The frequency of water-quality analysis is dependent upon the needs of the funding agency. In general, the information available includes specific conductance, pH, major and minor constituents, nutrients, and suspended-sediment concentration.

Table 2. Miscellaneous water quality of streamflow data-collection stations

[A dash (-) after a date indicates data are currently being collected. Funding agencies: BLM, Bureau of Land Management; USGS, U.S. Geological Survey; EPA, Environmental Protection Agency]

Number in figure 3	Station identification number	Station name	Drainage area (square miles)	Type and period of record		Funding agency
				Chemical quality	Sediment	
1	09367700	Alamo Wash near Tanner Lake, NM	-	1976-81	1976-81	BLM
2	09367932	Hunter Wash tributary near Bisti Trading Post, NM	8.47	1976-81	1976-81	BLM
3	355841108081810	Kim-me-ni-oli Wash near Phillips Mine near Crownpoint, NM	-	1978-	1978-	USGS
4	360641108103810	Kim-me-ni-oli Wash near Lake Valley, NM	-	1978-	1978-	USGS
5	360614107572010	Escavado Wash at Highway 56 Bridge near Chaco Canyon Trading Post, NM	-	1976-81	1976-81	USGS
6	360743107571410	Tsosie Swale near Kimbeto, NM	-	1978-81	1978-81	BLM
7	360809108323410	Coyote Wash near Naschitti, NM	-	1976-81	1976-81	USGS
8	361137108202110	Chaco River below De-na-zin Wash near Bisti Trading Post, NM	-	1975-80	1975-80	EPA
9	361404108074710	Coal Creek above Tanner Lake near Bisti Trading Post, NM	-	1976-81	1976-81	BLM
10	361445108071510	De-na-zin Wash 1.5 miles northeast and above Tanner Lake, NM	-	1976-81	1976-81	BLM

11	362813108344110	Sanostee Wash near Sanostee, NM	-	1976-81	1976-81	USGS
12	363417108334910	Chaco Wash above Four Corners Power-plant near Fruitland, NM	-	1976-81	1976-81	USGS
13	364042108271410	Navajo Mine 1973 reclamation plot near Fruitland, NM	-	1979-	1979-	BLM
14	364158108260710	Navajo Mine 1976 reclamation plot near Fruitland, NM	-	1979-	1979-	BLM
15	364348108251310	Navajo Mine 1978 reclamation plot near Fruitland, NM	-	1979-	1979-	BLM
16	364621108250710	San Juan Mine 1978 reclamation plot near Fruitland, NM	-	1979-	1979-	BLM
17	364631108250810	San Juan Mine 1977 graded pile near Fruitland, NM	-	1979-	1979-	BLM
18	364631108261010	Shumway Arroyo above Dunlap Farm near Waterflow, NM	-	1976-81	-	USGS
19	364637108251010	San Juan Mine 1974 reclamation plot near Fruitland, NM	-	1979-	1979-	BLM
20	364706108262610	Powerplant Arroyo below San Juan Powerplant Reservoir, NM	-	1976-	-	USGS
21	364737108254710	Westwater Arroyo at San Juan Powerplant, NM	-	1976-	-	USGS

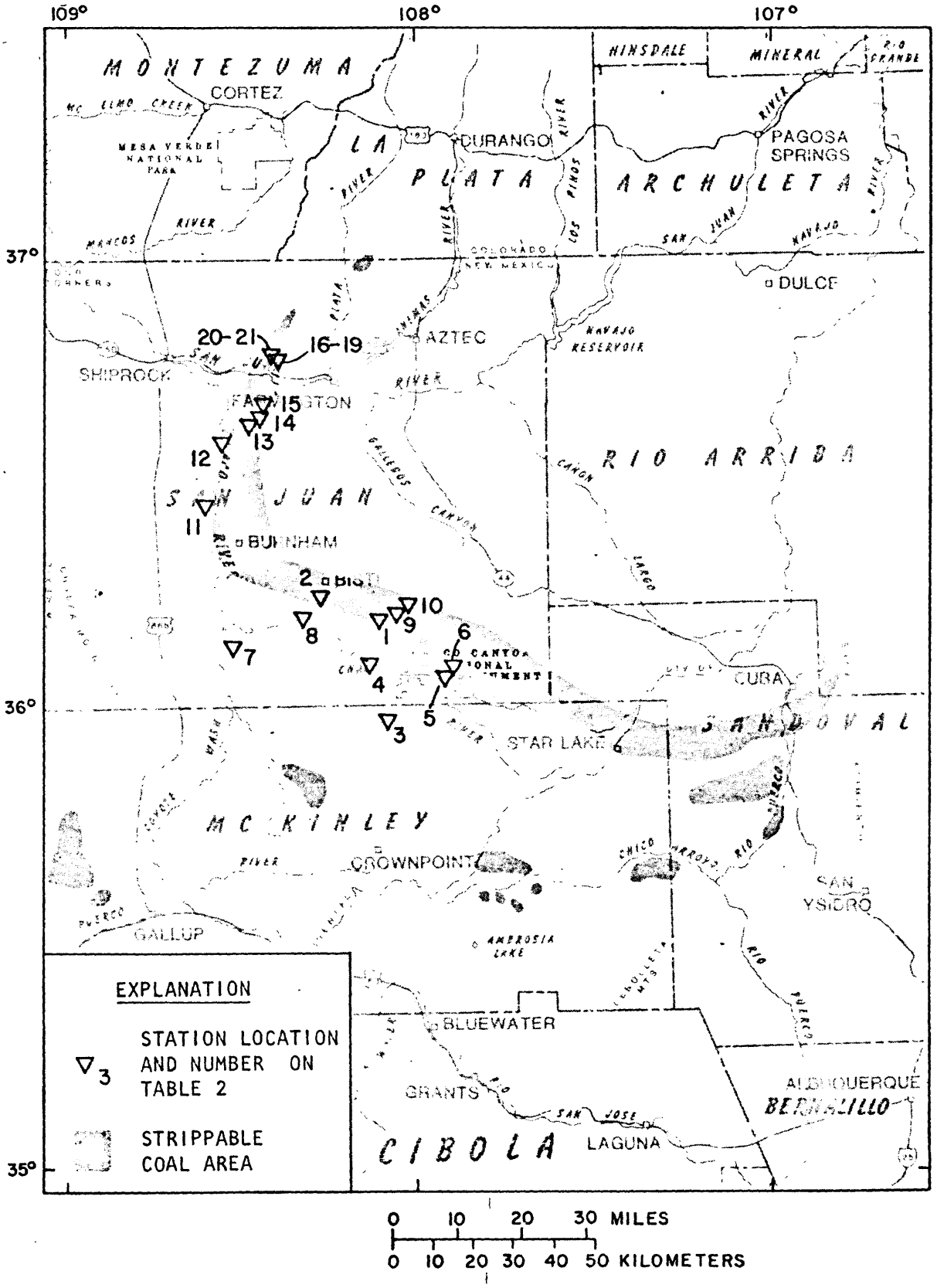

Figure 3.--Location of miscellaneous water quality of streamflow data-collection stations.

Annual maximum discharge gaging-station network

The network of annual maximum discharge gaging stations is shown in figure 4 and listed in table 3. The first column in table 3 contains numbers given to station locations in figure 4, and the second column contains the station-identification numbers needed to obtain data from published reports and computer-storage systems. Table 3 also contains the station name, drainage area of the basin, and the period of record.

The data available from this network includes the annual maximum discharges during the period of record, corresponding maximum stage relative to gage datum, and estimate of date of occurrence.

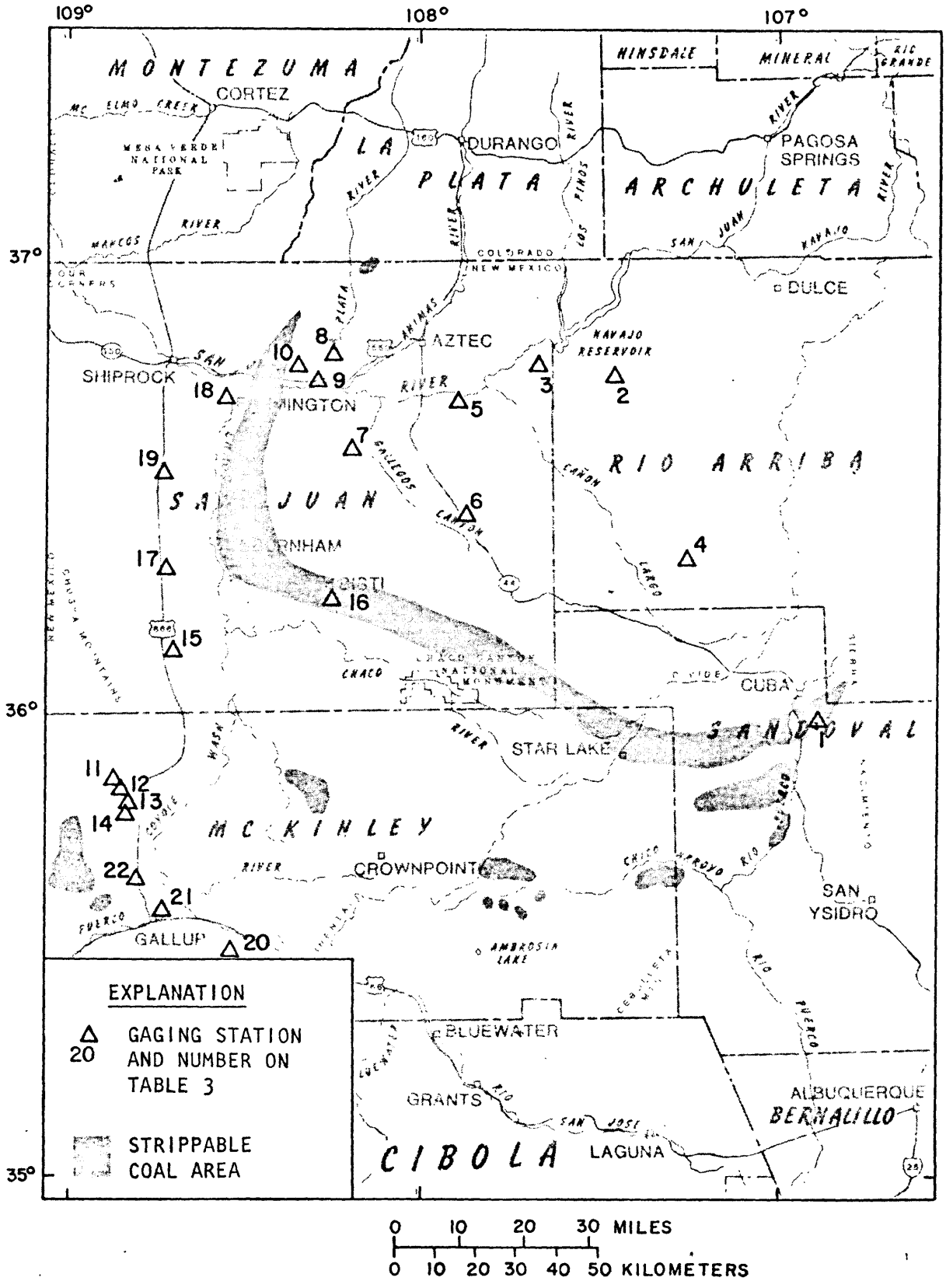

Figure 4.--Location of annual maximum discharge stations.

Table 3. Annual maximum discharge stations

[All stations funded in cooperation with New Mexico State Highway Department. A dash (-) after a date indicates data are currently being collected.]

Number in figure 4	Station identification number	Station name	Drainage area (square miles)	Period of record
1	08332700	San Pablo Creek near Cuba, NM	12.8	1970-79*
2	09355700	Gobernador Canyon near Gobernador, NM	19.8	1956-
3	09356400	Manzanares Canyon near Turley, NM	3.20	1956-
4	09356520	Burro Canyon near Lindrith, NM	9.11	1970-
5	09356750	Valdez Draw near Bloomfield, NM	1.3	1956-67
6	09357200	Gallegos Canyon tributary near Nageezi, NM	.20	1952-
7	09357230	West Draw near Farmington, NM	.32	1975-
8	09367400	La Plata River tributary near Farmington, NM	1.03	1970-79*
9	09367530	Locke Arroyo near Kirtland, NM	2.96	1951-
10	09367550	Stevens Arroyo near Kirtland, NM	4.52	1970-
11	09367840	Yazzie Wash near Mexican Springs, NM	2.1 (approx)	1938-42, 1953-54, 1956-
12	09367860	Chusca Wash near Mexican Springs, NM	8.70	1937-42, 1953-76
13	09367880	Catron Wash near Mexican Springs, NM	26.9	1937-42, 1954, 1956-67
14	09367900	Black Springs Wash near Mexican Springs, NM	7.05	1954-79*
15	09367920	Coyote Wash tributary near Naschitti, NM	12.0	1967-

Table 3. Annual maximum discharge stations - Concluded

Number in figure 4	Station identification number	Station name	Drainage area (square miles)	Period of record
16	09367932	Hunter Wash tributary near Bisti Trading Post, NM	8.47	1975-
17	09367940	Peña Blanca Arroyo near Newcomb, NM	46.8	1967-80
18	09367950	Chaco River near Waterflow, NM	4350	1959-69, 1975*
19	09367960	Pajarito Creek near Shiprock, NM	80	1953-58
20	09395400	Milk Ranch Canyon near Fort Wingate, NM	14.0	1949, 1953-
21	09395500	Puerco River at Gallup, NM	558	1940-45, 1956-76*
22	09395600	Wagon Trail Wash near Gamerco, NM	.38	1951-74

*Converted to continuous-record station.

Observation-well network

The observation-well network is shown in figure 5 and listed in table 4. The first column in table 4 contains the numbers given to well locations in figure 5, and the second column contains the well-identification numbers needed to obtain data from published reports and computer-storage systems. The third column contains the well location; the fourth column contains the geologic formation in which the well is completed. The fifth column contains the period of record, and the sixth column contains the funding agencies.

The network includes observation wells completed in the Menefee Formation, Pictured Cliffs Sandstone, Fruitland coal seam, Fruitland overburden, and channel alluvium. The frequency of water-level measurement and water-quality analysis is dependent upon the needs of the funding agency. Water levels and comprehensive water-quality analyses are available except when an observation well was found dry or produced insufficient water for an analysis.

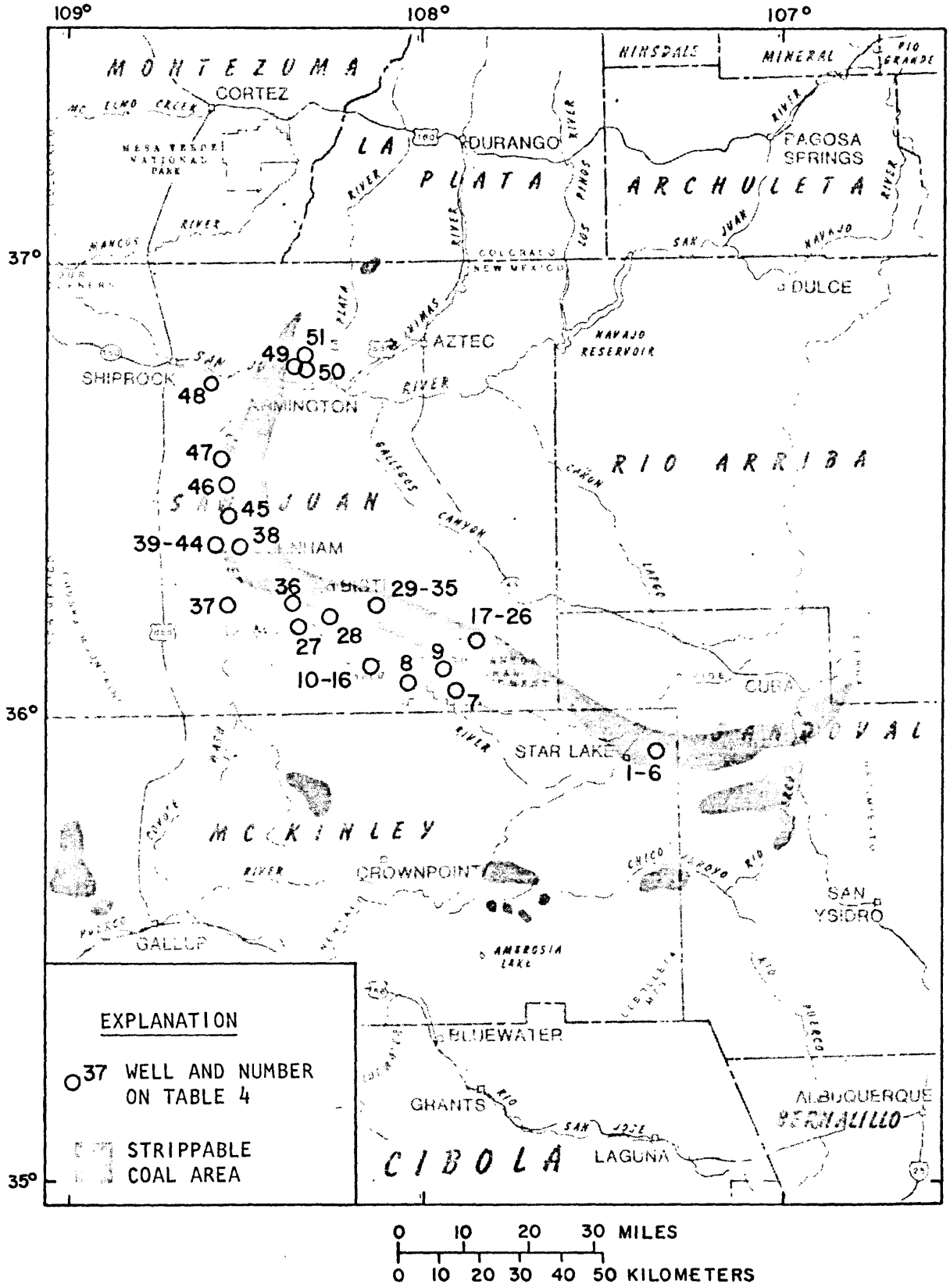

Figure 5.--Location of observation wells.

Table 4. Observation wells

[Data from year given to present. Funding agencies: BLM, Bureau of Land Management; USGS, United States Geological Survey]

Number in figure 5	Well identification number	Well location	Geologic formation	Period of record	Funding agency
1	355351107244401	Ojo Encino EMRIA study area	Pictured Cliffs Sandstone	1979-	BLM
2	355353107244501	do.	Fruitland overburden	1979-	BLM
3	355400107224201	do.	Pictured Cliffs Sandstone	1979-	BLM
4	355446107204801	do.	Fruitland coal seam	1979-	BLM
5	355447107224301	do.	do.	1979-	BLM
6	355448107212801	do.	Fruitland overburden	1979-	BLM
7	360134107550401	Chaco Wash at Chaco Canyon National Monument, NM	Alluvium	1978-	USGS
8	360415108022201	Chaco River below Chaco Canyon National Monument, NM	do.	1978-	USGS
9	360621107582301	Escavado Wash near Chaco Canyon National Monument, NM	do.	1978-	USGS
10	360717108102301	Chaco River near Lake Valley, NM	do.	1977-	USGS
11	360721108103201	do.	Menefee Formation	1979-	USGS
12	360725108102701	do.	Alluvium	1977-	USGS

Table 4. Observation wells - Continued

Number in figure 5	Well identification number	Well location	Geologic formation	Period of record	Funding agency
13	360726108102801	Chaco River near Lake Valley, NM	Alluvium	1977-	USGS
14	360729108102901	do.	do.	1977-	USGS
15	360733108103201	do. 1/	do.	1978-	USGS
16	360734108103201	do.	do.	1977-	USGS
17	360731107494701	Kimbeto EMRIA study area	Pictured Cliffs Sandstone	1977-	BLM
18	360734107523101	do.	Fruitland coal seam	1977-	BLM
19	360754107505201	do.	Fruitland overburden	1977-	BLM
20	360822107561601	do.	Pictured Cliffs Sandstone	1977-	BLM
21	360823107544001	do.	Fruitland coal seam	1977-	BLM
22	360849107561801	do.	do.	1977-	BLM
23	360857107531001	do.	Fruitland overburden	1977-	BLM
24	360916107543901	do.	Pictured Cliffs Sandstone	1977-	BLM
25	360941107561601	do.	Fruitland overburden	1977-	BLM
26	361008107543901	do.	Fruitland coal seam	1977-	BLM

27	361142108220401	Chaco River below De-na-zin Wash near Bisti Trading Post, NM	Alluvium	1977-	USGS
28	361318108151401	De-na-zin Wash near Bisti Trading Post, NM	do.	1978-	USGS
29	361407108081901	Bisti West EMRIA study area	Pictured Cliffs Sandstone	1975-	BLM
30	361435108093001	do.	do.	1975-	BLM
31	361446108083701	do.	Fruitland overburden	1976-	BLM
32	361446108090801	do.	Fruitland coal seam	1976-	BLM
33	361447108090901	do.	Fruitland overburden	1977-	BLM
34	361457108081901	do.	Pictured Cliffs Sandstone	1975-	BLM
35	361513108090701	do.	Fruitland coal seam	1977-	BLM
36	361503108243801	Hunter Wash near Burnham Trading Post, NM	Alluvium	1978-	USGS
37	361554108333201	Chaco River above Hunter Wash near Burnham Trading Post, NM	do.	1978-	USGS
38	362145108310901	Brimhall Wash near Burnham Trading Post, NM	do.	1978-	USGS
39	362208108341201	Chaco River near Burnham Trading Post, NM	Alluvium	1979-	USGS
40	362210108341001	do.	do.	1979-	USGS
41	362211108340601	do.	do.	1979-	USGS

Table 4. Observation wells - Concluded

Number in figure 5	Well identification number	Well location	Geologic formation	Period of record	Funding agency
42	362212108340701	Chaco River near Burnham Trading Post, NM	do.	1979-	USGS
43	362213108340501	do. 1/	do.	1978-	USGS
44	362217108335701	do.	do.	1979-	USGS
45	362902108334801	Pinabete Arroyo near Burnham Trading Post, NM	do.	1977-	USGS
46	363113108333501	Cottonwood Arroyo near Burnham Trading Post, NM	do.	1978-	USGS
47	363503108342101	Chaco River above Hogback, NM	do.	1978-	USGS
48	364325108353001	Chaco Well below Hogback near Waterflow, NM 1/	do.	1978-	USGS
49	364744108225001	Western Coal Company Mine	Pictured Cliffs Sandstone	1977-	BLM
50	364750108214701	do.	Fruitland overburden	1977-	BLM
51	364845108214201	do.	Fruitland coal seam	1977-	BLM

1/Well equipped with continuous recorder.

SOURCES OF HYDROLOGIC INFORMATION

This section briefly describes sources of hydrologic information about the coal-resource areas in northwestern New Mexico. Additional information about any of these sources may be obtained by contacting the District Chief, U.S. Geological Survey, Water Resources Division, 505 Marquette N.W., Room 720, Albuquerque, New Mexico 87102, telephone: (505) 766-2246.

Reports of interpretive hydrologic investigations

Published reports of interpretive hydrologic investigations are generally available to the public from the agency sponsoring the investigation or the U.S. Geological Survey. Hydrologic data collected for these investigations are published in the annual compilation report and stored in WATSTORE. Both the annual compilation report and WATSTORE are described in sections that follow.

Annual compilation report

"U.S. Geological Survey Water Resources Data for New Mexico" is an annual compilation of water-resources information collected on a systematic basis and published for each water year (October 1 to September 30). Included are data collected in the strippable coal areas for hydrologic investigations in the northwestern part of the State. The bulk of the data consists of streamflow discharge and water-quality records. The report also includes ground-water levels and water-quality data. This report may be obtained from the U.S. Geological Survey.

National Water Data Storage and Retrieval System (WATSTORE)

Water-resources information collected at sites shown in this report is accessible through WATSTORE, the central computerized repository of water data collected by the U.S. Geological Survey. The information available includes data on quantity and quality of both surface and ground water. Information for a specific site included in this report may be retrieved from WATSTORE by furnishing the unique identifier given in the second column in tables 1-4, or sites within a stream reach may be obtained by furnishing the unique identifier of the upstream and downstream stations. All streamflow, ground-water, and associated water-quality information stored within an area may be obtained by specifying latitude and longitude coordinates that bound the area of interest. The computer cost incurred in obtaining the information is passed on to the requester.

Other sources of water data

The Office of Water Data Coordination (OWDC) of the U.S. Geological Survey coordinates water-data acquisition of Federal agencies. This office maintains a catalogue of information on water data.

The National Water Data Exchange (NAWDEX) is a confederation of water-oriented organizations. NAWDEX is centrally managed by a Program Office within the U.S. Geological Survey, Water Resources Division in Reston, Virginia. This office serves as a focal point to help those in need of water data by determining what information is available and referring the requester to the organization that retains the data required.