Oklahoma, A Summary of Activities of the U.S. Geological Survey, Water Resources Division, in Fiscal Years 1991–92

Compiled by JOHN S. HAVENS

U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 94–38

Oklahoma City, Oklahoma
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Oklahoma, A Summary of Activities of the U.S. Geological Survey, Water Resources Division, in Fiscal Years 1991–92

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Abstract

This report summarizes the activities of the Oklahoma District, Water Resources Division, U.S. Geological Survey, for fiscal years 1991–92. Included are summary statements of current and recently completed projects in the State of Oklahoma.

A MESSAGE FROM THE DISTRICT CHIEF

The U.S. Geological Survey historically has worked to fulfill its principal mission of appraising the nation's water resources through scientifically designed data-collection and investigative programs managed at the District level. This provides ready access by State and local governments to valuable information on national water issues, but also allows Districts to concentrate on relevant State and local needs.

Past reports on topics such as ground water in the High Plains, flood frequency of Oklahoma streams, water quality of the Garber-Wellington aquifer, and potential water supplies from the alluvial and terrace aquifers of the North Canadian River have provided information beneficial both to the Nation and residents of Oklahoma. The focus of water-resources studies has changed as awareness of the vulnerability of water resources to contamination has joined continuing concern for long-term water supplies for all needs and prediction of and protection from catastrophic flooding.

Data-collection activities and investigative projects will enable the Oklahoma District of the U.S. Geological Survey to meet the challenge and opportunity of providing needed water-resources information in the future.

Kathy D. Peter
District Chief
U.S. Geological Survey
Oklahoma City, Oklahoma

U.S. GEOLOGICAL SURVEY ORIGIN

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879 to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public land, and examination of the geological structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and dissemination of the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian map-making agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

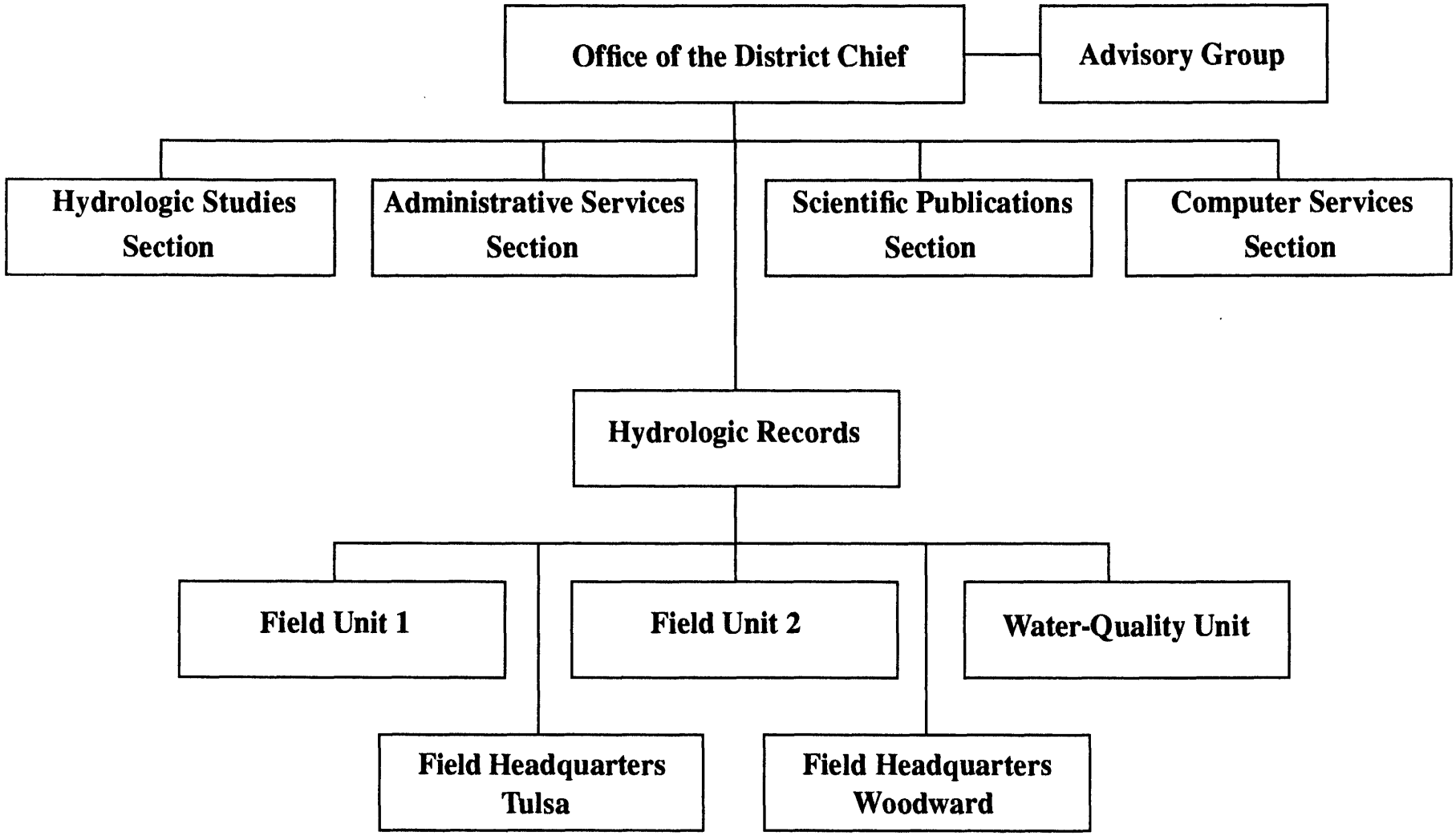
- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warning of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resource appraisals in order to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation—providing "Earth Science in the Public Service."

WATER RESOURCES MISSION OF THE U.S. GEOLOGICAL SURVEY

The water resources mission of the U.S. Geological Survey is to provide the hydrologic information needed by others to help manage the Nation's water resources. To accomplish its mission, the Survey, in cooperation with State and local governments and other Federal agencies:

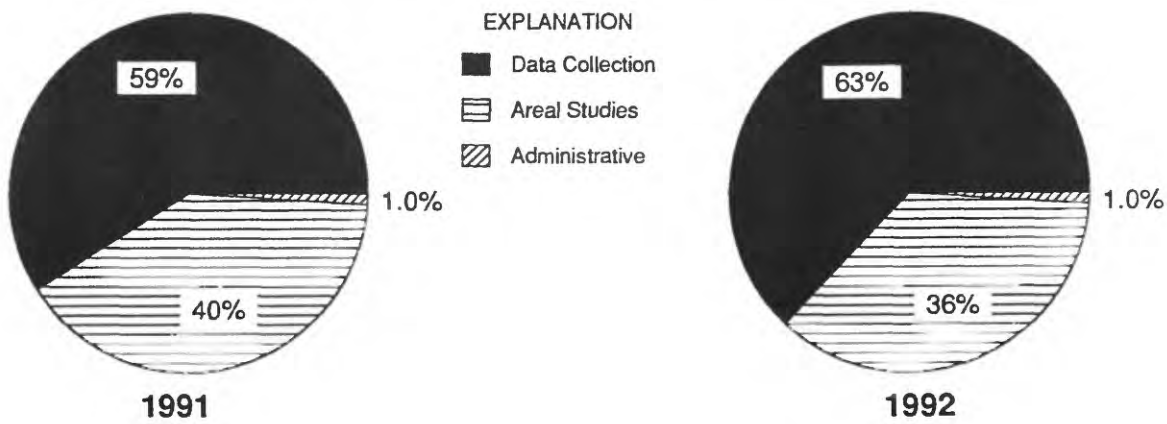
- Collects data on a systematic basis to determine the quantity, quality, and use of surface and ground water, and the quality of precipitation.
- Conducts water-resources investigations and assessments at national, State, and local scales, characterizes water-resources conditions, and provides the capability to predict the impact on the resource of managerial actions, proposed development plans, and natural phenomena.
- Conducts basic and problem-oriented hydrologic and water-related research that is likely to produce knowledge useful for the resolution of water-resources problems facing the State, regions, and Nation.
- Acquires information useful in predicting and delineating water-related natural hazards from flooding, volcanoes, mudflows, and land subsidence.
- Coordinates the activities of all Federal agencies in the acquisition of water data, and operates water information centers.
- Disseminates data and the results of investigations through reports, maps, and other forms of public release.
- Provides scientific and technical assistance in hydrology to other Federal agencies, to State and local agencies, to licensees of the Federal Energy Regulatory Commission , and, on behalf of the U.S. Department of State, to international agencies.
- Administers the provisions of the Water Resources Research Act of 1984, which include the State Water Resources Research Institute Program (Section 104) and the Water Resources Research Grant Program (Section 105).



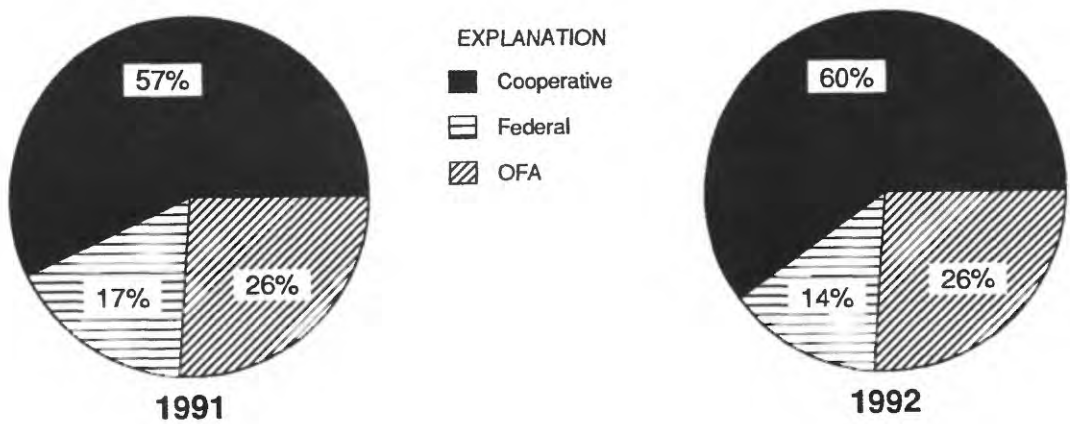
OKLAHOMA DISTRICT ORGANIZATION CHART

TYPES OF INVESTIGATIONS AND SOURCES OF FUNDING FOR OKLAHOMA IN 1991–92

Three broad categories of investigations are conducted in Oklahoma to obtain the information needed by managers and planners for the solution or alleviation of water problems in the State. These categories are: (1) Areal studies involving the appraisal of ground-water resources and river basins, (2) hydrologic data collection involving the statewide surface-water, ground-water, and quality-of-water monitoring programs, and (3) administration of programs involving the collection of data for national programs. The diagrams below show these investigations, expressed as a percentage of the District's total work for fiscal years 1991–92.



The investigations shown above are supported by services and funds from three basic programs: (1) Cooperative programs with 50 percent of the funds provided by State and local agencies and the remaining 50 percent by Federal funds, (2) Federal programs with funds appropriated directly to the U.S. Geological Survey, and (3) other Federal agency programs (OFA) supported entirely by other Federal agencies. In fiscal year 1991, the financial support for these three programs in Oklahoma was about $3,946,432 and in 1992, about $3,887,813. The distribution is shown below.



LIST OF COOPERATORS

The following table lists State, local, and other Federal agencies that supported water-resources investigations in cooperation with the U.S. Geological Survey in Oklahoma during fiscal years 1991–92:

State Agencies

Oklahoma Conservation Commission
Oklahoma Department of Agriculture
Oklahoma Geological Survey
Oklahoma Pollution Control Coordinating Board
Oklahoma State Department of Health
Oklahoma Water Resources Board

Local Agencies

City of Ada
City of Altus
City of Lawton
City of Norman
City of Oklahoma City
City of Tulsa
Central Oklahoma Master Conservancy District
Ft. Cobb Reservoir Master Conservancy District
Foss Reservoir Master Conservancy District
Grand River Dam Authority
Lugert-Altus Irrigation District
Mountain Park Master Conservancy District

Federal Agencies

U.S. Air Force
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation

Indian Tribes

Sac and Fox Nation
Cheyenne/Arapaho Tribes

OTHER DISTRICT ACTIVITIES IN SUPPORT OF THE STATE'S WATER PROGRAMS

As part of the Geological Survey's responsibility to provide hydrologic information to all water users, the Survey participates in numerous other activities in addition to the regular Federal and State cooperative programs of hydrologic data collection and analysis. These other activities include involvement in various water-related committees and task forces, the review of technical reports on hydrology prepared by other agencies and universities, answering requests for hydrologic data and related information, and presenting information to schools, civic groups, and other interested groups on the water resources of Oklahoma and the Nation. Some of the current special activities are:

Committee Activities---Members of the Oklahoma District staff participate in various technical committees, task forces, and professional societies dealing with water problems. Included are: (1) The Governor's Coordinating Committee on Water Resources Research; (2) the Illinois River Task Force; (3) the board of the Oklahoma Clean Lakes Association; (4) and the board of the Oklahoma Society of Environmental Professionals. The District provides technical support to four interstate river compact commissions.

Special Activities---Beginning in 1984, the Geological Survey published the first of an annual series of Water-Supply Papers, "National Water Summary", describing the conditions, trends, availability, quality, and use of the Nations's water resources. Each of these reports contains a chapter devoted to Oklahoma. In addition to yearly hydrologic events, the reports address: Water issues (1983), selected water-quality trends and ground-water resources (1984), surface-water resources (1985), ground-water quality (1986), water supply and demand (1987), hydrologic events and floods and droughts (1988-89), and stream water quality (1990-91, unpublished).

SUMMARY OF PROJECTS

Project title: SURFACE-WATER STATIONS

Project number: OK001

Leader: Blazs, Robert L.

Problem: Surface-water information is needed for purposes of surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. An appropriate data base is necessary to provide this information.

Objectives: (1) Collect surface-water data for: (a) Assessment of water resources, (b) operation of reservoirs or industries, (c) forecasting, (d) pollution controls and disposal of wastes, (e) discharge data to accompany water-quality measurements, (f) compact and legal requirements, and (g) research or special studies, and (2) collect data necessary for analytical studies to define for any location the statistical properties of, and trends in, the occurrence of water in streams, lakes, estuaries, and other water bodies for use in planning and design.

Progress: Surface-water data were collected at 216 active sites (fig. 1 and 2): 156 stream-gaging stations (continuous-discharge records), 21 lake and reservoir gages, 6 dual-digital gages (synchronous stage-rainfall with discharge hydrographs only), 9 continuous river stage-only gages, and 9 miscellaneous discharge data sites; 15 tables of reservoir-stage data were published as requested by the U.S. Army Corps of Engineers.

Cooperators: Various Federal, State, and local agencies

Reports:

Blazs, R.L., Walters, D.M., Coffey, T.E., White, D.K., and Boyle, D.L., 1991, Water resources data for Oklahoma, water year 1990: U.S. Geological Survey Water-Data Report OK–90–1, 517 p.

Blazs, R.L., Walters, D.M., Coffey, T.E., White, D.K., Boyle, D.L., and Kerestes, J.F., 1992, Water resources data for Oklahoma, water year 1991: U.S. Geological Survey Water-Data Report OK–91–1, 449 p.

Project title: GROUND-WATER STATIONS

Project number: OK002

Leader: Blazs, Robert L.

Problem: Long-term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from the ground-water systems (fig. 3), to provide a data base

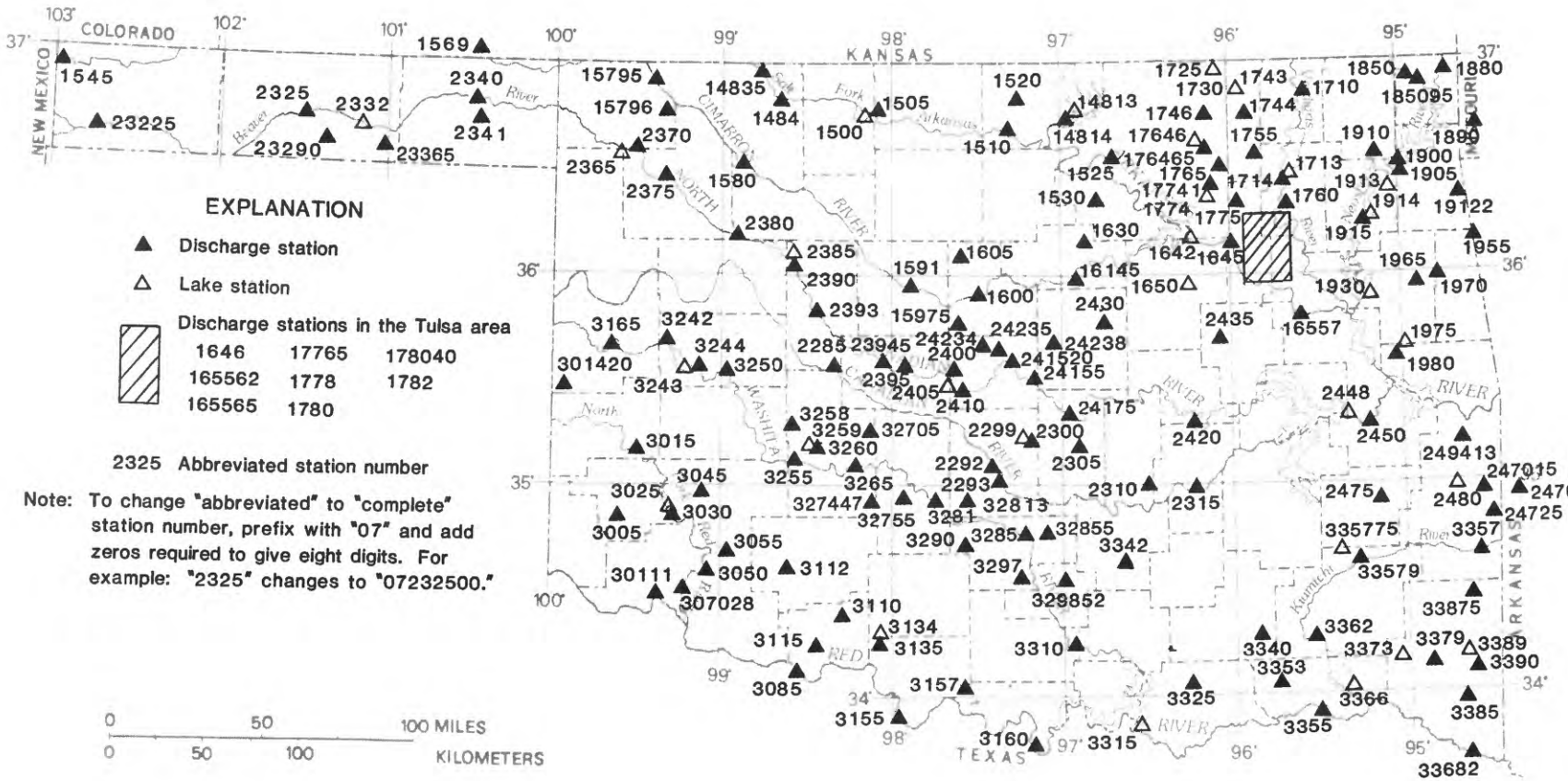


Figure 1. Location of continuous-record surface-water stations, water year 1992.

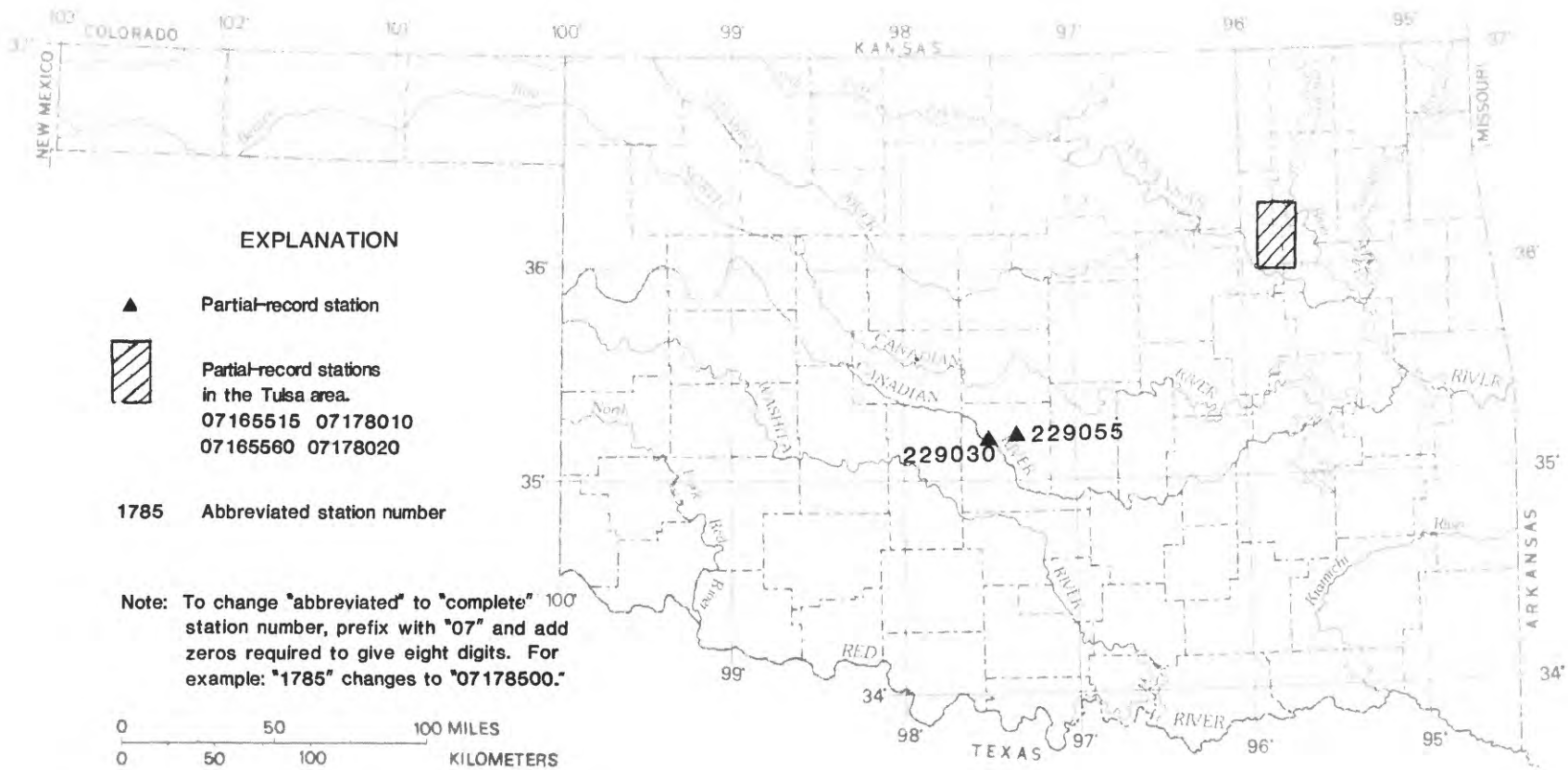


Figure 2. Location of partial-record surface-water stations, water year 1992.

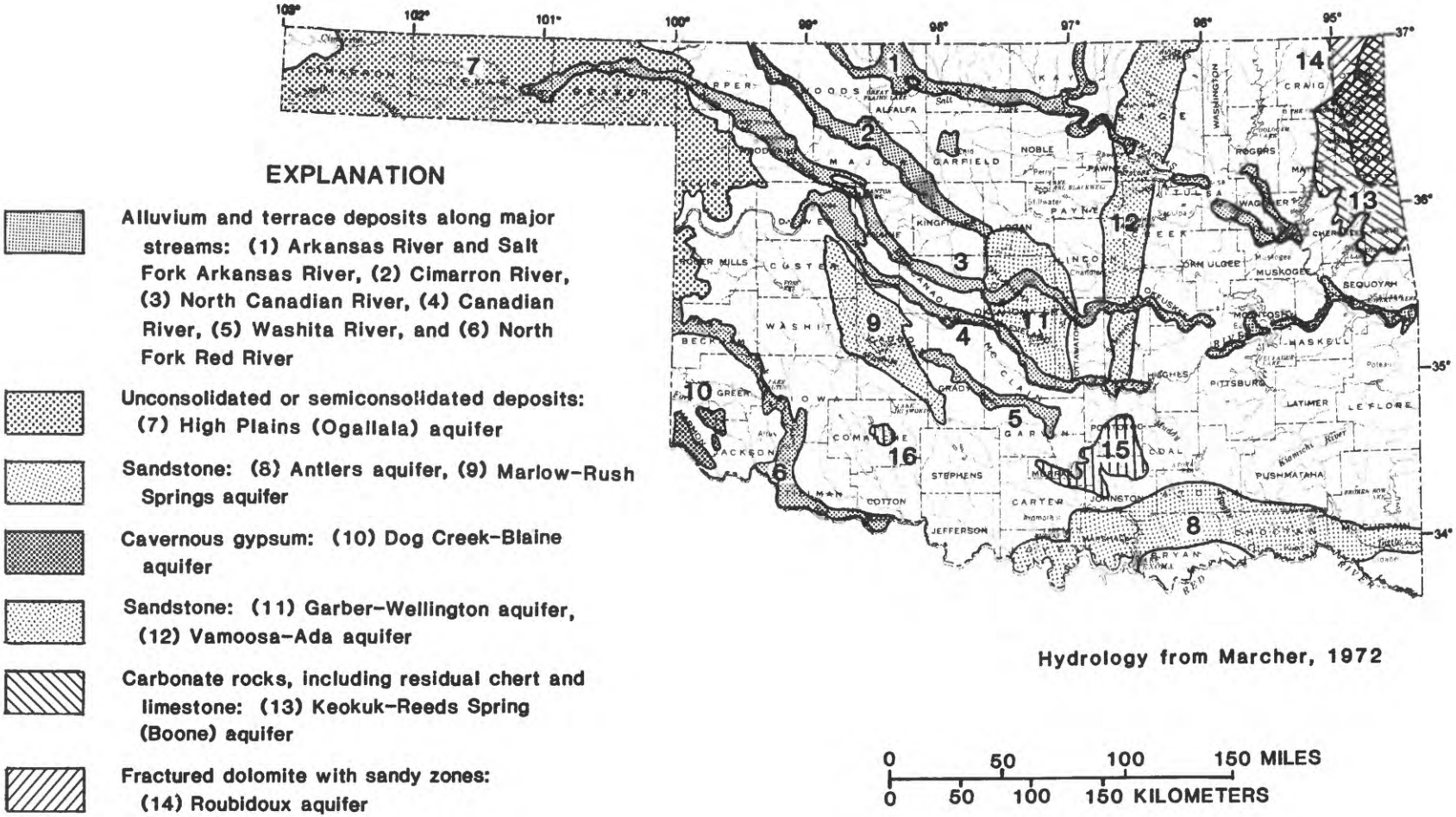


Figure 3. Location of principal aquifers in Oklahoma.

from which to measure the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resource.

Objectives: (1) Collect water-level data to provide long-term records of the general response of the hydrologic system to natural climatic variations and induced stresses, and (2) provide a data base against which the short-term records acquired in areal studies can be analyzed.

Progress: Water levels were measured in 32 wells (fig. 4): Continuous water levels were monitored at 30 sites and yearly, monthly, or quarterly measurements were made at 2 other sites.

Reports: Data for these sites are included in the annual Water-Data Report.

Cooperator: Oklahoma Water Resources Board

Project title: QUALITY-OF-WATER STATIONS

Project number: OK003

Leader: Kurklin, Joanne K.

Problem: Water-resource planning and water-quality assessment require a nationwide base level of relatively standardized information. For intelligent planning and realistic assessment of the water resource, the chemical and physical quality of the rivers and streams must be defined and monitored.

Objectives: (1) Provide a national bank of water-quality data for broad federal planning and action programs, and (2) provide data for federal management of interstate waters.

Progress: Water-quality data were collected at 46 active sites: 11 continuous and 35 other (fig. 5). Water-quality techniques, laboratory services and techniques, quality assurance plans, field-techniques manual, and overall water-quality operations were evaluated during a wter-quality technical review. Quality-assurance samples were analyzed by District personnel as part of the District's ongoing quality-assurance program.

Reports: Data for these sites are included in the annual Water-Data Report.

Cooperators: Various federal, state, and local agencies

Project title: SEDIMENT STATIONS

Project number: OK004

Leaders: Blazs, Robert L. and Kurklin, Joanne K.

Problem: Water-resource planning and water-quality assessment require a nationwide base level of relatively standardized information. Sediment concentrations and discharges in rivers and streams must be defined and monitored to provide a data base for present and future studies.

Objectives: (1) Provide a national bank of sediment data for use in broad federal and state planning and action programs, and (2) provide data for federal management of interstate waters.

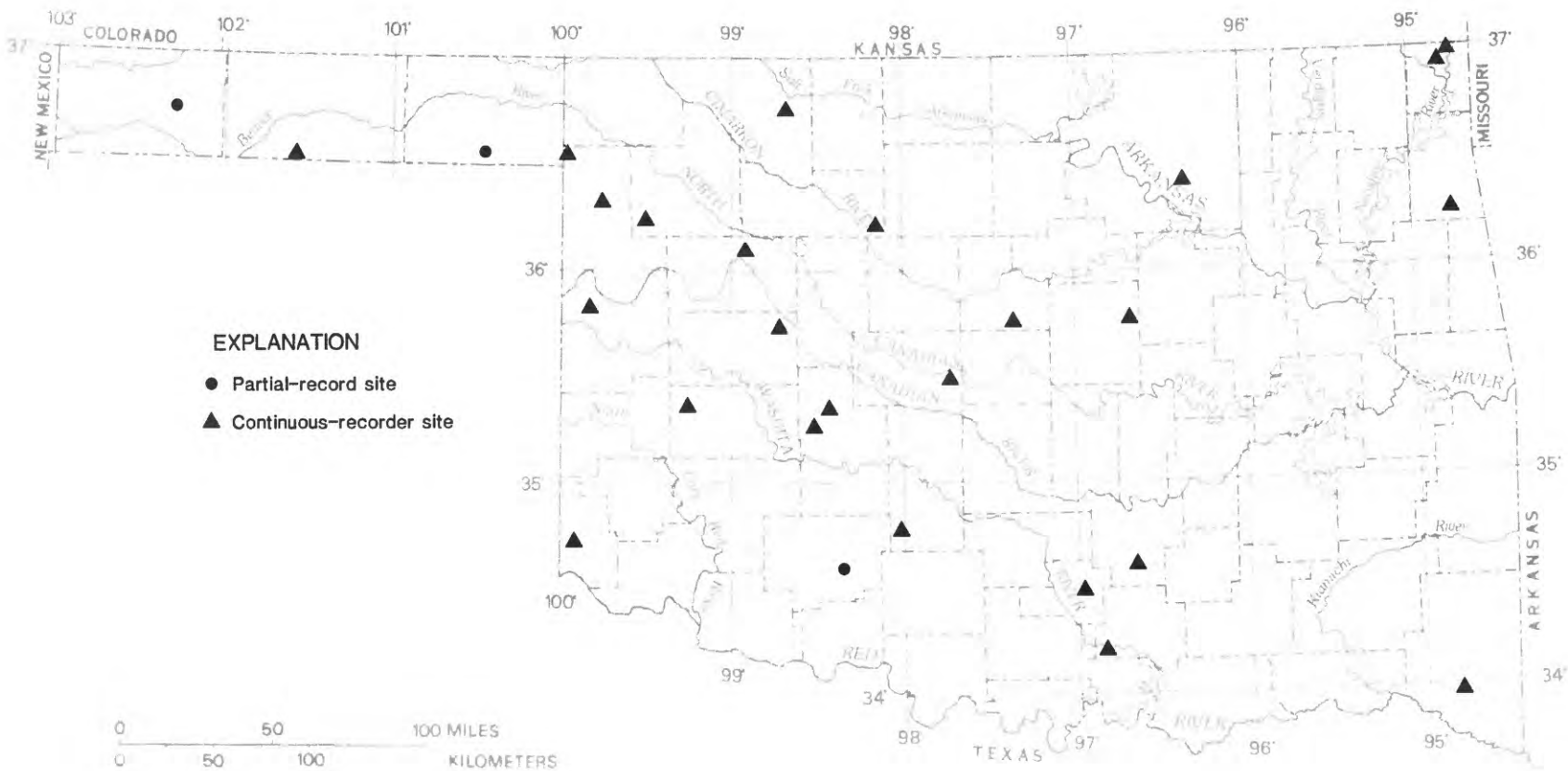


Figure 4. Locations of network ground-water wells, water year 1992.

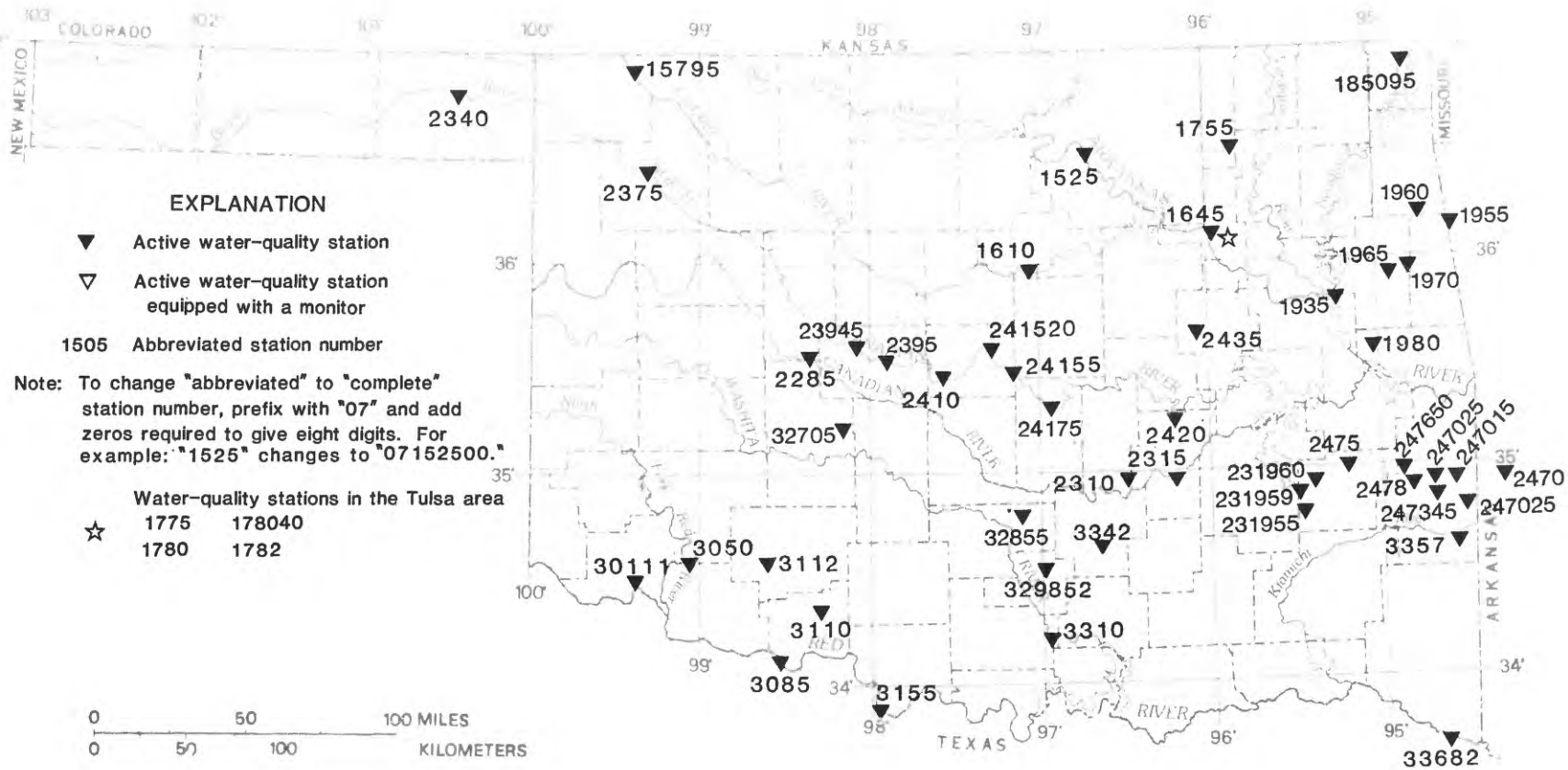


Figure 5. Locations of water-quality stations, water year 1992.

Progress: A team from the U.S. Geological Survey reviewed the operations of and evaluated analyses from the District Sediment Laboratory in Oklahoma. The Oklahoma District Sediment Laboratory and personnel successfully completed all necessary steps for certification.

Sediment data are collected presently at 48 sites.

Reports: Data for these sites are included in the annual Water-Data Report.

Cooperators: U.S. Army Corps of Engineers, Oklahoma Department of Pollution Control

Project title: NATIONAL TRENDS NETWORK (NTN) FOR MONITORING

Project number: OK005

Leader: Kurklin, Joanne K.

Problem: Long-term monitoring stations to detect and measure levels of atmospheric deposition are needed to provide a data base for present and future studies.

Objectives: (1) Determine variations in atmospheric depositions that occur on a week-to-week basis, and (2) collect wet and dry deposition products for analysis of elements and compounds that can contribute to chemical composition of surface waters.

Progress: Two sites operated in District.

Reports: Data for these sites are included in the annual Water-Data Report.

Project title: WATER USE

Project number: OK007

Leader: Tortorelli, Robert L.

Problem: Water-use data that have been collected for the State of Oklahoma are presently distributed throughout many Federal, State, and local agencies. The data are in different formats and contain different bits of information that may make the data from one agency unusable by another agency. In addition, future data collection is presently based on different agency needs that can render the data to be collected by one agency incompatible with another agency's needs. There is a need to develop a comprehensive water-use data-collection and management system for the State of Oklahoma.

Objectives: A planning meeting, under the lead of the Oklahoma Water Resources Board, will be held among all interested Federal, State, and local agencies. The result of this meeting will be the development of a comprehensive water-use data system.

Progress: The Oklahoma part of the water-use compilation report, "Estimated use of water in the United States for 1990," (EUOWITUS) was begun during the first quarter of fiscal year 1992 and completed during the second quarter of fiscal year 1992. The Oklahoma Water Resources Board was the major contributor of withdrawal data. A project proposal for "Reported water used in Oklahoma, 1990" data report has been approved for fiscal year 1993. The data used in EUOWITUS for

1990 are the basis of tabular and graphic statewide and countywide summaries by use category and source.

Reports:

Solley, W.B., Pierce, R.R., Perlman, H.A., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p. These reports are published every 5 years.

Cooperator: Oklahoma Water Resources Board

Project title: AN INVENTORY OF OKLAHOMA SPRINGS

Project number: OK069

Leader: Funkhouser, Ronald A.

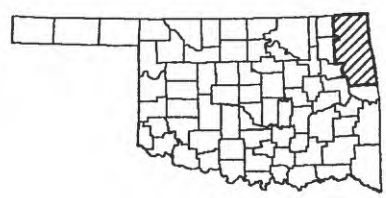
Problem: Nearly every stream flowing out of the State of Oklahoma is augmented in part by springflow. State agencies interested in water rights, ground-water contribution to base flows, or streamflow accountability require knowledge of the location, quality and quantity of flow—particularly in areas where large springflows occur. An annotated statewide springs report does not exist.

Objectives: (1) Locate and inventory Oklahoma springs; (2) make field measurements of their discharge, pH, temperature, alkalinity, and specific conductance; and to collect water-quality samples for analysis of anions, cations, alkalinity, and nutrients; (3) make a site record of environmental, geological, and hydrologic conditions influencing the rate of discharge, point of discharge, and water quality; and (4) provide the State of Oklahoma with the resulting annotated report.

Progress: A search for landowners was conducted at the county courthouses in nine counties in south-central Oklahoma. Permission was obtained from the landowners to inventory their springs. Field visits to 74 sites in Pontotoc, Johnston, Coal, Love, Carter, Ellis, and Atoka Counties were made during seven weeks in August and September 1992, and 42 water-quality samples were collected. The samples were analyzed by the Oklahoma Geological Survey laboratory.

Planned reports: County or area map reports are proposed.

Cooperator: Oklahoma Geological Survey



Project title: DIGITAL MODEL ANALYSIS OF THE ROUBIDOUX AQUIFER IN NORTHEASTERN OKLAHOMA

Project number: OK070

Leader: Christenson, Scott C.

Problem: Water from the Roubidoux aquifer is used for public supplies and industrial purposes. The water users in the area are concerned about lowering water levels as a result of withdrawal of

water from the aquifer and the possibility of contamination of the water supply from abandoned lead and zinc mines in the northern part of the area. The possibility exists for downward migration of the toxic mine water through existing or abandoned leaky well casings or through fractures in rocks that overlie the Roubidoux aquifer.

Objectives: The hydraulic properties of the formations above and below the Roubidoux aquifer are unknown. Information about the hydraulic properties of the rocks in the deep formations is needed for a better understanding of the functioning of the hydrologic system.

Progress: Project is completed.

Reports:

Christenson, S.C., Parkhurst, D.L., and Fairchild, R.W., 1990, Geohydrology and water quality of the Roubidoux aquifer, northeastern Oklahoma: U.S. Geological Survey Open-File Report 90–570, 109 p., 1 plate.

Cooperator: Oklahoma Geological Survey

Project title: GEOHYDROLOGY OF ALLUVIUM AND TERRACE DEPOSITS OF THE CIMARRON RIVER FROM NEAR THE KANSAS STATE LINE TO GUTHRIE, OKLAHOMA

Project number: OK072

Leader: Adams, Gregory P.

Problem: Ground water in the alluvial and terrace deposits along the Cimarron River in northwestern Oklahoma is used extensively for irrigation, municipal, stock, and domestic supplies. Increasing demands for water within the State makes it necessary to have a quantitative knowledge of the hydrologic system for formulation of effective management plans. The area of study extends about 115 miles from Freedom, Oklahoma in T.26N., R.17W., downstream to Guthrie, Oklahoma in T.17N., R.3W. This area includes the Cimarron Terrace and associated aquifers.

Objectives: (1) Describe the geologic setting of the alluvial and terrace deposits along the Cimarron River from Freedom, Oklahoma to Guthrie, Oklahoma; (2) estimate the quantity of water in storage, the annual recharge and the annual discharge from the alluvium and terrace deposits and associated aquifers to the Cimarron River; (3) provide estimates of the effects of future withdrawals from the aquifer by means of a digital model of the aquifer-river system; and (4) document sources of existing and potential natural saline pollution.

Progress: The open-file data report, "Hydrologic data for the terrace and alluvial aquifer of the Cimarron River from Freedom to Guthrie, Oklahoma," by G.P. Adams, D.L. Bergman, and D.J. Pruitt is in review. The final report, "Geohydrology of the terrace and alluvial aquifer of the Cimarron River from Freedom to Guthrie, Oklahoma," by G.P. Adams and D.L. Bergman, is near completion.

Planned reports: Basic data report for Cimarron Terrace geohydrology; final report on Cimarron Terrace geohydrology

Cooperator: Oklahoma Geological Survey

Project title: NUMERICAL SIMULATION OF SATURATED THICKNESS AND STORAGE CHANGES RESULTING FROM PROJECTED PUMPING FROM THE MARLOW-RUSH SPRINGS AQUIFER, SOUTHWESTERN OKLAHOMA

Project number: OK073

Leader: Becker, Mark F.

Problem: Beginning in about 1950, the drilling of irrigation wells in the Marlow-Rush Springs area increased to an estimated 1,500 large-capacity wells in an area of about 1,500 square miles. Well density in the more heavily drilled areas is four to five wells per square mile. The future economy of the area is dependent upon the sensible use and management of the water resources that are derived mostly from the Marlow-Rush Springs aquifer.

Objectives: (1) Provide a better understanding of the hydrologic system than is presently known; (2) predict the effect of future pumping on the aquifer; and (3) provide data that will aid in the management and use of the Marlow-Rush Springs aquifer.

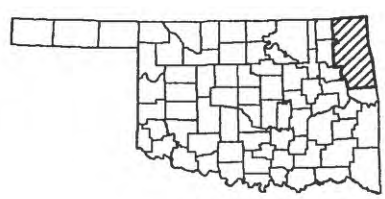
Progress: Digital maps showing the elevation of the base of the Rush Springs aquifer and the pre-pumping potentiometric surface have been completed. Pump test data from drillers' logs have been entered into the data base and hydraulic conductivities have been estimated for these wells. Recharge has been estimated from 1989–90 baseflow measurements.

Reports:

Johnson, K.S., Runkle, D.L., and Becker, M.F., 1990, Hydrogeology of the Rush Springs-Marlow aquifer in the Anadarko Basin, west-central Oklahoma, U.S.A.: Proceedings of the International Association of Hydrologists, Conference on Groundwater in Large Sedimentary Basins, Perth, Western Australia, July 9–10, 1990.

Cooperators: Oklahoma Water Resources Board, Oklahoma Geological Survey

Project title: HYDROGEOLOGICAL AND GEOCHEMICAL STUDY OF THE ROUBIDOUX AQUIFER IN THE VICINITY OF THE PICHER MINING FIELD, NORTHEASTERN OKLAHOMA



Project number: OK074

Leader: Christenson, Scott C

Problem: Most of the water supply for extreme northeastern Oklahoma is obtained from fractured sandstone and dolomite units in the Roubidoux and associated formations of Cambrian and Ordovician ages. It is anticipated that the demand for water from the principal aquifer, the Roubidoux, will increase in proportion to the population growth of the area. There is concern that the Roubidoux, which averages 150 feet thick and lies between 800 and 1,000 feet below land sur-

face, may be subject to contamination from abandoned mines of the Picher mining field. Water in the underground lead-zinc mines contains high concentrations of iron, zinc, cadmium, and lead. The contaminated water may migrate from the mines to the Roubidoux through abandoned water wells. A multi-agency effort to locate and plug all such wells began in late 1984. Participation in this effort will provide information in support of other ongoing investigations of the hydrogeology of the Roubidoux aquifer and of the geochemical mechanisms involved in the contamination of surface and ground waters in the vicinity of the Picher mining field.

Objectives: Determine the geologic, hydraulic, and chemical characteristics of the Roubidoux and of the overlying formations that separate the Roubidoux from the mined interval. Specific objectives are to: (1) Obtain a suite of geophysical logs for each well prior to plugging; (2) construct a production well and several observation wells within the abandoned wells; (3) perform aquifer tests to determine the hydraulic properties and leakage characteristics of the Roubidoux; and (4) collect chemical and isotope samples to determine the geochemical evolution and age of water in the Roubidoux.

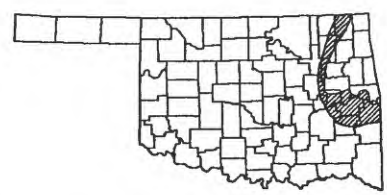
Progress: Project is completed.

Reports:

Christenson, S.C., Thomas, T.B., Overton, M.D., Goemaat, R.L., and Havens, J.S., 1991, Geophysical logs for selected wells in the Picher Field, northeast Oklahoma and southeast Kansas: U.S. Geological Survey Open-File Report 91–213, 95 p.

Cooperator: Oklahoma Water Resources Board

Project title: LIMNOLOGY OF SELECTED COAL-MINE PONDS IN THE COAL-MINING REGION OF EASTERN OKLAHOMA



Project number: OK075

Leader: Parkhurst, Renee S.

Problem: No information was available on the limnological characteristics of mine ponds and non-mine ponds in the coal-mining region of eastern Oklahoma. Limnological information is needed to manage the water resource created by strip mining, and to further understand the limnological processes occurring in mine ponds.

Objectives: (1) Describe the limnological characteristics of the strip-mine ponds and other ponds in the area not associated with coal mining; (2) determine if the limnological characteristics of strip-mine ponds are significantly different from those of other ponds; (3) to determine if the limnological characteristics of strip-mine ponds are significantly different among (a) those associated with different coal seams, (b) those associated with different mining and reclamation practices and (c) those of different ages; and (4) intensively study selected strip-mine ponds and non-strip-mine ponds to develop an understanding of hydrologic, chemical, and biological processes occurring within the ponds as well as the interrelationships among these processes.

Progress: Project is terminated.

Reports:

Parkhurst, R.S., 1994, Water chemistry and biota of ponds formed by strip mining in eastern Oklahoma: U.S. Geological Survey Open-File Report 94–xxx, xx p.

Parkhurst, R.S., 1994, Suitability of ponds formed by strip mining in eastern Oklahoma for domestic water supply, aquatic life, waterfowl habitat, livestock watering, irrigation, and recreation: U.S. Geological Survey Open-File Report 94–xxx, xx p.

Cooperator: Oklahoma Geological Survey

Project title: HYDROGEOLOGIC CHARACTERISTICS OF SELECTED SHALEY FORMATIONS IN OKLAHOMA, WITH PARTICULAR EMPHASIS ON THEIR SUITABILITY FOR CONTAINMENT OF HAZARDOUS WASTES

Project number: OK080PG

Leader: Adams, Gregory P.

Problem: American industry produces millions of tons of potentially hazardous waste each year. In Oklahoma, industrial wastes are disposed of by near-surface burial and subsurface injection. Only one burial site currently is licensed in Oklahoma, but pressure is mounting for the selection and approval of other sites. In a recent reconnaissance study of the geology of rocks in Oklahoma that may be suitable for the disposal of hazardous waste, it was concluded that thick shales would be most favorable for near-surface burial of wastes. Few data are available, however, on the hydraulic properties of shales and little is known of the role of shales in ground-water flow systems.

Objectives: (1) Conduct literature search to determine the current state of knowledge regarding the hydrology of shales; (2) assemble any unpublished data that may have been collected by the energy industry or research institutions regarding the physical properties of Oklahoma shales; (3) determine, from soil mechanics theory, which measurable physical properties of shale may be used as a relative index of permeability and fracture tendency; (4) select as many as four "representative" shales for study, map the outcrop areas, and examine and describe the detailed mineralogy, lithology, and stratigraphy of rocks at the test sites; (5) evaluate the hydraulic and selected physical (mechanical) properties of the shales through field and laboratory testing and geophysical-log analysis; (6) evaluate the fracture tendency of the shales and the effect that the fracturing may have on the flow of ground water; (7) determine the significant differences between the weathered zone and the unweathered zone in the shale and whether they are distinct hydrologic units.

Progress: Laboratory tests for hydraulic conductivity of five shale samples have been completed. Project is complete except for report.

Planned reports: Physical and Hydrologic Characterizations of Selected Oklahoma Shales; Hydrology of Selected Shaley Formations in Oklahoma

Cooperator: Oklahoma Geological Survey

Project title: HYDROGEOLOGY OF THE BLAINE AQUIFER AND ASSOCIATED UNITS IN SOUTHWESTERN OKLAHOMA AND ADJACENT PARTS OF TEXAS

Project number: OK081

Leader: Runkle, Donna L.

Problem: The Blaine aquifer consists of cavernous gypsum and dolomite beds interlayered with shales in the Permian Blaine Formation in Harmon, Jackson, and Greer Counties in southwestern Oklahoma and Childress, Collingsworth, and Hardeman Counties in Texas. Ground water from the Blaine supports a local agriculture based mainly on irrigated cotton, corn, and wheat. Declining water levels in parts of the Blaine aquifer are evidence that water is being withdrawn at rates greater than it is being replenished. The Blaine aquifer has been artificially recharged since about 1961, although much of the effort was abandoned after 1975. The aquifer was recharged at more than 60 different locations by diverting streamflow and storm runoff into sinkholes and wells. Water in the Blaine aquifer is not used for human consumption because of large dissolved-solids concentrations, but the calcium sulfate-type water in the Blaine is acceptable for irrigation of salt-tolerant crops.

Objectives: (1) Evaluate and map the stratigraphy and structure of all geologic units in the study area adjacent to the Blaine Formation; (2) evaluate the hydrology of the Blaine Formation and adjacent units; (3) determine the distribution of major and selected trace and organic (agriculturally applied) chemical constituents in the aquifers; (4) analyze the effects that extensive irrigation development and the artificial recharge program have had on the Blaine and associated aquifers and to project their effect on the quantity and quality of water in the aquifer; and (5) determine if opportunities exist for additional artificial recharge.

Progress: Project is complete except reports.

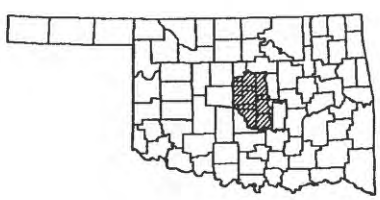
Planned reports: Hydrogeology of the Blaine aquifer and associated units in southwestern Oklahoma; data report for the Blaine aquifer and associated units in southwestern Oklahoma

Reports:

Runkle, D.L., and Johnson, K.S., 1988, Hydrologic study of a gypsum-dolomite karst aquifer in southwestern Oklahoma and adjacent parts of Texas, U.S.A.: Proceedings of the International Association of Hydrogeologists 21st Congress, Karst hydrogeology and karst environmental protection, October 10–15, 1988, Guilin City, Peoples Republic of China, v. 21, part 1, p. 400–405.

Cooperators: Oklahoma Water Resources Board, Oklahoma Geological Survey

Project title: GROUND-WATER-QUALITY ASSESSMENT OF THE CENTRAL OKLAHOMA (GARBER-WELLINGTON) AQUIFER



Project number: OK082

Leader: Christenson, Scott C.

Problem: The Central Oklahoma aquifer underlies about 3,000 square miles of central Oklahoma, where the aquifer is used extensively for municipal, industrial, commercial, and domestic water supplies. Most of the usable ground water is in the Garber Sandstone and the Wellington Formation. Substantial quantities of usable ground water also are in the Chase, Council Grove, and Admire Groups, and in alluvium and terrace deposits. The Central Oklahoma aquifer was selected for study in the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program because it is a major source for water supplies in central Oklahoma and because it has several known or suspected water-quality problems. These problems include arsenic, chromium, and selenium concentrations in excess of public drinking-water standards; large gross alpha particle activity; contamination by synthetic organic compounds; and contamination by oil-field brines and drilling fluids. The aquifer also was chosen because it underlies large urban areas, and the effects of an urban environment on regional ground-water quality have not been studied extensively.

Objectives: (1) Investigate regional ground-water quality throughout the aquifer, emphasizing the occurrence and distribution of potentially toxic substances in ground water, including trace elements, organic compounds, and radioactive constituents; (2) describe the relation of ground-water quality to hydrogeologic and other pertinent factors; and (3) provide a general description of the location, nature, and causes of selected water-quality problems within the study unit.

Progress: The data-collection phase of the project has been completed, and data and interpretive reports are being published.

Reports:

Breit, G.N., 1992, Mineralogy and petrography of Permian rocks in the Central Oklahoma aquifer: Implications for ground-water quality [abs.]: in Christenson, Scott, and Carpenter, Lyn, 1992, eds., Ground-water quality of the Central Oklahoma (Garber-Wellington) aquifer conference: Proceedings, February 20, 1992: U.S. Geological Survey Open-File Report 92–116, p. 12–13

Breit, G.N., Cast, M.E., and Stanton, M.R., 1992, Chromium redistribution within continental red beds: A function of pore-water chemistry: Proceedings of the 7th International Symposium on Water-Rock Interaction, Park City, Utah, 13–19 July 1992, Rotterdam, A.A. Balkema.

Breit, G.N., Mosier, E.L., Schlottmann, J.L., and Papp, C.S.E., 1990, Rock/water interactions and ground-water contamination in Permian rocks, Central Oklahoma aquifer [abs.]: in Gough, L.P., ed., 1990, Environmental forum 1990: Geoscience investigations that emphasize chemical, physical, and biological ecosystem processes: U.S. Geological Survey Open-File Report 90–288, p. 14.

Breit, G.N., Rice, Cyndi, Esposito, Ken, and Schlottmann, J.L., 1990, Mineralogy and petrography of Permian rocks in the Central Oklahoma aquifer: U.S. Geological Survey Open-File Report 90–678, 50 p.

Christenson, Scott, 1992, Geohydrology and ground-water flow simulation of the Central Oklahoma aquifer [abs.]: in Christenson, Scott, and Carpenter, Lyn, 1992, eds., Ground-water quality of the Central Oklahoma (Garber-Wellington) aquifer conference: Proceedings, February 20, 1992: U.S. Geological Survey Open-File Report 92–116, p. 12–13.

Christenson, Scott, and Carpenter, Lyn, 1992, eds., Ground-water quality of the Central Oklahoma (Garber-Wellington) aquifer conference: Proceedings, February 20, 1992: U.S. Geological Survey Open-File Report 92–116, 24 p.

Christenson S.C., Morton, R.B., and Mesander, B.A., 1992, Hydrogeologic maps of the Central Oklahoma aquifer, Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA–724, 3 sheets.

Christenson, S.C., and Parkhurst, D.L., 1987, Ground-Water-Quality Assessment of the Central Oklahoma Aquifer, Oklahoma: Project Description: U.S. Geological Survey Open-File Report 87–235, 30 p.

Christenson, S.C., and Rea, A.H., 1991, Factors related to pesticide occurrence in ground water in the Oklahoma City urban area [abs.]: American Water Resources Association, 27th annual conference and symposium, New Orleans, 1991, Proceedings: Water management of river systems, p. 343–344.

Christenson, Scott, and Rea, Alan, 1993, Ground-water quality in the Oklahoma City urban area: in Alley, W.M., ed., 1993, Regional ground-water quality: New York, Van Nostrand Reinhold, p. 589–611.

Ferree, D.M., Christenson, Scott, Rea, A.H., and Mesander, B.A., 1992, Ground-water quality assessment of the Central Oklahoma aquifer, Oklahoma: Hydrologic, water-quality, and quality-assurance data 1987–90: U.S. Geological Survey Open-File Report 92–641.

Hamilton, P.A., Welch, A.H., Christenson, S.C., and Alley, W.M., 1993, Uses and limitations of existing ground-water quality data: in Alley, W.M., ed., 1993, Regional ground-water quality: New York, Van Nostrand Reinhold, p. 613–622.

Mosier, E.L., Breit, G.N., Schlottmann, J.L., and Papp, C.S.E., 1990, Processes responsible for large concentrations of As, Cr, Se, U, and V in water produced from the Central Oklahoma aquifer [abs.]: Geological Society of America, Abstracts with Programs, v. 22, no. 7, p. A61.

Mosier, E.L., Breit, G.N., Schlottmann, J.L., and Papp, C.S.E., 1992, Processes responsible for large concentrations of As, Cr, Se, U, and V in water produced from the Central Oklahoma aquifer [abs.]: Oklahoma Geological Survey Oklahoma Geology Notes, v. 52, no. 1., p. 39–40.

Mosier, E.L., Briggs, P.H., Crock, J.G., Kennedy, K.R., McKown, D.M., Vaughn, R.B., and Welsch, E.P., 1990, Analyses of subsurface Permian rock samples from the Central Oklahoma aquifer: U.S. Geological Survey Open-File Report 90–456, 65 p.

Mosier, E.L., and Bullock, J.H., Jr., 1988, Review of the general geology and solid-phase geochemical studies in the vicinity of the Central Oklahoma aquifer: U.S. Geological Survey Circular 1019, 18 p.

Mosier, E.L., Bullock, J.H., Jr., Fey, D.L., Kennedy, K.R., McKown, D.M., Vaughn, R.B., and Welsch, E.P., 1991, Elemental composition of surficial materials from central Oklahoma: U.S. Geological Survey Open-File Report 91–442, 62 p.

Mosier, E.L., Papp, C.S.E., Motooka, J.M., Kennedy, K.R., and Riddle, G.O., 1991, Sequential extraction analyses of drill core samples, Central Oklahoma aquifer: U.S. Geological Survey Open-File Report 91–347, 42 p.

Mosier, E.L., and Schlottmann, J.L., 1992, Geochemical studies of solid-phase materials in the Central Oklahoma aquifer—relation to water quality [abs.]: in Christenson, Scott, and Carpenter, Lyn, 1992, eds., Ground-water quality of the Central Oklahoma (Garber-Wellington) aquifer conference: Proceedings, February 20, 1992: U.S. Geological Survey Open-File Report 92–116, p. 10–11.

Parkhurst, D.L., 1992, The geochemical evolution of ground waters in the Central Oklahoma aquifer [abs.]: in Christenson, Scott, and Carpenter, Lyn, 1992, eds., Ground-water quality of the Central Oklahoma (Garber-Wellington) aquifer conference: Proceedings, February 20, 1992: U.S. Geological Survey Open-File Report 92–116, p. 7–9.

Parkhurst, D.L., Christenson, S.C., and Schlottmann, J.L., 1989, Ground-water-quality assessment of the Central Oklahoma aquifer, Oklahoma: Analysis of available water-quality data through 1987, U.S. Geological Survey Open-File Report 88–728, 80 p.

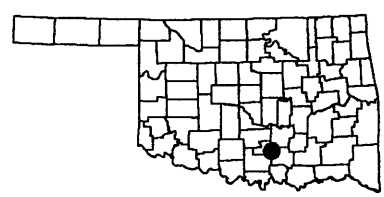
Parkhurst, D.L., Christenson, Scott, and Breit, G.N., 1992, Ground-water-quality assessment of the Central Oklahoma aquifer, Oklahoma: Geochemical and geohydrologic investigations: U.S. Geological Survey Open-File Report 92–642.

Rea, Alan, and Christenson, Scott, 1992, Factors related to ground-water quality in the Oklahoma City urban area [abs.]: in Christenson, Scott, and Carpenter, Lyn, 1992, eds., Ground-water quality of the Central Oklahoma (Garber-Wellington) aquifer conference: Proceedings, February 20, 1992: U.S. Geological Survey Open-File Report 92–116, p. 21–22.

Rea, A.H., and Scott, J.C., 1990, A computer program to determine map coordinates from public land-survey coordinates [abs.]: in Balthrop, B.H., and Baker, E.G., 1990, U.S. Geological Survey national computer technology meeting: Program and abstracts, May 7–11, 1990: U.S. Geological Survey Open-File Report 90–161, p. 33.

Schlottmann, J.L. and Breit G.N., 1992, Mobilization of As and U in the Central Oklahoma Aquifer: Proceedings of the 7th International Symposium on Water-Rock Interaction, Park City Utah, 13–19 July 1992, Rotterdam, A.A. Balkema.

Schlottmann, J.L., and Funkhouser, R.A., 1991, Chemical analyses of water samples and geophysical logs from cored test holes drilled in the Central Oklahoma aquifer, Oklahoma: U.S. Geological Survey Open-File Report 91–464, 58 p.



Project title: PRELIMINARY INVESTIGATION OF THE HYDROGEOLOGY OF THE CHICKASAW NATIONAL RECREATION AREA

Project number: OK084

Leader: Hanson, Ronald L.

Problem: The Chickasaw National Recreational Area, located in south-central Oklahoma, is experiencing significant reduction in spring and stream discharges. In 1906, the Park had 33 flowing springs but presently only 5 have sustained flow. Reduced discharge from these springs and periodic cessation of flow in the two streams flowing through the Park have been attributed to increased pumping from the Arbuckle-Simpson aquifer that underlies the Park. Recorded ground-

water-level declines in the area suggest that two major springs are expected to dry up within 10 years and that all remaining springs in the Park will cease to flow within 40 years. Increased stresses on the system are anticipated when eight new wells upgradient from the Park become operational.

Objectives: (1) Collate the hydrogeologic data presently available for the Arbuckle-Simpson aquifer and overlying surface waters in the Park, and (2) evaluate the adequacy of these data for fully describing the surface-water/ground-water system associated with the area. If this evaluation shows that a more comprehensive study is warranted, a detailed study plan will be prepared describing the approach necessary to obtain a complete understanding of the system and the projected impacts of changes on the system as a result of potential hydrologic stresses imposed on the system.

Progress: Verification of streamflow and spring-flow data by the District Data Base Managers has been completed. Some water-quality data remain to be verified. The report has been submitted to the District Chief for review. Project is complete except for report.

Planned reports:

Hanson, R.L., and Cates, S.W., 1994, Appraisal of the hydrogeology of the Chickasaw National Recreation Area, Murray County, Oklahoma, 1902–87: U.S. Geological Survey Open-File Report 93–xxx, xx p.

Cooperator: National Park Service

Project title: FACILITATING THE ANALYSIS OF GROUND-WATER SYSTEMS USING A GEOGRAPHIC INFORMATION SYSTEM

Project number: OK085

Leader: Scott, Jonathon C.

Problem: Ground-water hydrologists need sophisticated computer software to aid them in the analysis of ground-water systems. Geographic Information Systems (GIS) provide powerful map-making and analysis capability; however, system integration programming is needed to transform this software into a productive tool.

Objectives: (1) Develop software to transport water-quality and ground-water site inventory data into the Geographic Information System (GIS). (2) Develop software to randomly choose a set of areally distributed sampling locations from a stratified set of polygons describing the study area. (3) Develop software to assist with visualizing the results of finite-difference numerical simulations performed with the Modular Ground-Water Flow Model. (4) Develop software to aid in the establishment of relationships between land use and ground-water quality using statistical methods.

Progress: Project is completed.

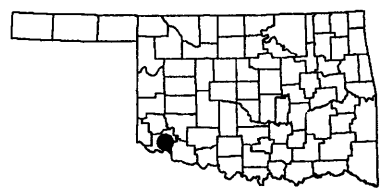
Reports:

Scott, J.C., 1989, A computerized data-base system for land-use and land-cover data collected at ground-water sampling sites in the pilot National Water-Quality Assessment program: U.S. Geological Survey Water-Resources Investigations Report 89–4172, 139 p

——— 1990a, A statistical processor for analyzing simulations made using the modular finite-difference ground-water flow model: U.S. Geological Survey Water-Resources Investigations Report 89–4159, 218 p.

——— 1990b, Computerized stratified random site-selection approaches for design of a ground-water-quality sampling network: U.S. Geological Survey Water-Resources Investigations Report 90–4101, 109 p.

——— 1991, Computer software for converting ground-water and water-quality data from the National Water Information System for use in a geographic information system: U.S. Geological Survey Water-Resources Investigations Report 90–4200, 55 p.



Project title: ALTUS AFB IRP STUDY: CONFIRMATION/QUANTIFICATION PHASE

Project number: OK086

Leader: Runkle, Donna L.

Problem: Altus Air Force Base (AFB) was established as a flight-training facility in 1942. An investigation of historical waste-disposal practices on the 2,525–acre Base identified nine former disposal sites that may pose a continued hazard to humans and the environment. The sites include fire-protection training areas, landfills, and liquid-waste disposal sites. A gas station presumed to have a leaking tank is the tenth site that will be investigated as part of the Altus Installation Restoration Program (IRP) Study. No major aquifers underlie the area.

Objectives: (1) Identify and fully evaluate any areas suspected to be contaminated with hazardous materials caused by past U.S. Air Force operations, and (2) eliminate or control any hazards to the public health, welfare, or the environment. A records search and initial investigation of ten sites was completed in the Phase I work. Phase II work includes: Further data collection at five of the original ten sites to establish the extent of any contamination; further data collection at three of the ten sites for long-term monitoring and trend analysis; installation of and data collection from three monitoring wells near the southern boundary of the base; and water-level measurements in all monitoring wells. The U.S. Army Corps of Engineers is responsible for directing and coordinating the Phase II work.

Progress: Phase II work has begun; field investigations are in progress.

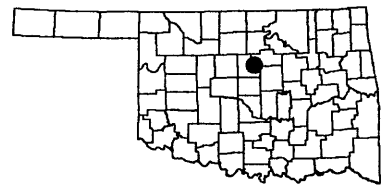
Reports: Technical Data Report, Altus AFB IRP

Cooperator: U.S. Army Corps of Engineers

Project title: LANGSTON UNIVERSITY

Project number: OK089

Leader: Steele, Karen S.



Problem: Langston University, a Historically Black University located at Langston, in central Oklahoma, has a computing and information science program within the University's Division of Business. Since 1984, Langston University has participated in the U.S. Department of Interior's Historically Black College and University program, which provides education, training, and funding to the University through a combined earth-science and computer-technology program that is administered by the U.S. Geological Survey.

Objectives: (1) Promote student use of the Earth Science Computer Laboratory, (2) support the hiring of part-time students, and (3) support the guest-lecture series to (a) assist the University in offering state-of-the-art education in the computer sciences, (b) provide students with an opportunity to learn from and interact with skilled computer-science professionals in the Survey, and (c) create a pool of potential future employees for part-time and full-time employment.

Progress: Continue hiring Langston students during the school year; continue with the guest-lecture series.

Reports:

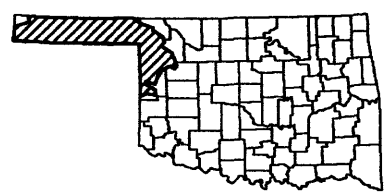
Hall, A.E., and Scott, J.C., 1991, Cooperative activities of the U.S. Geological Survey with historically black colleges and universities, fiscal year 1983–90: U.S. Geological Survey Open-File Report 91–90, 19 p.

Cooperator: Langston University

Project title: WATER-LEVEL MONITORING IN THE HIGH PLAINS AQUIFER

Project number: OK090

Leader: Goemaat, Robert L.



Problem: Most of the land surface overlying the High Plains aquifer is intensively developed for agriculture. Because the High Plains region is semi-arid and subject to frequent droughts, the crop water demands are met largely with irrigation water drawn from the High Plains aquifer. Extensive long-term pumpage from the aquifer has resulted in large water-level declines and depletion of storage in many areas.

Objectives: (1) Evaluate the adequacy of the current water-level monitoring network, and (2) effect additions and deletions of annually measured observation wells and recorder wells as needed to improve the cost and informational effectiveness of the network.

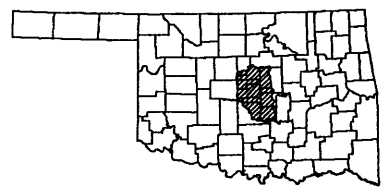
Progress: All ground-water sites in the Oklahoma Panhandle and Harper County previously entered into GWSI have been screened to verify location and appropriateness of information. Most of the ground-water sites in the remaining High Plains counties of western Oklahoma

(Harper, Ellis, Woodward, and Roger Mills) have been screened also. The Oklahoma Water Resources Board has entered over 6,000 wells sites into their computer system including drillers' log information. Preparations have been made to slug test wells at all continuous recorder and quarterly measurement sites. This will determine if the wells are actively connected to the aquifer.

Reports: A data report is planned.

Cooperator: Oklahoma Water Resources Board

Project title: SOURCE AND MOVEMENT OF NATURALLY OCCURRING TOXIC SUBSTANCES IN THE CENTRAL OKLAHOMA AQUIFER



Project number: OK091

Leader: Schlottmann, Jamie L.

Problem: The Central Oklahoma aquifer is the primary water supply for many communities and farms in central Oklahoma and supplements surface-water supplies in other communities. In some wells in the aquifer, arsenic, chromium, gross-alpha radioactivity, and selenium exceed the Environmental Protection Agency's primary drinking-water standards and uranium concentrations commonly are greater than 10 picoCuries per liter. Some wells have been abandoned due to these large concentrations.

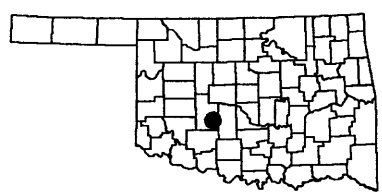
Objectives: (1) Determine the locations of large concentrations of the regulated elements in the ground water; (2) determine the solid-phase sources of the regulated elements in the aquifer; and (3) determine the geochemical causes for the large concentrations of the elements in the ground water.

Progress: Project is completed.

Reports: See reports under project OK082

Cooperator: Association of Central Oklahoma Governments

Project title: EVALUATION OF THE IMPACT OF OIL REFINERY PRODUCTS AND WASTES ON GROUND- AND SURFACE-WATER RESOURCES NEAR CYRIL IN SOUTHEASTERN CADDO COUNTY, OKLAHOMA



Project number: OK092

Leader: Stoner, Jerry D.

Problem: Water from the Rush Springs Sandstone, a major aquifer in southwestern Oklahoma, is used for irrigation, public, domestic, and livestock supplies. Beginning in the early 1920's, refin-

ing of crude oil was been carried on in this area near Cyril, Oklahoma in Caddo County. Even though refinery operations have now been suspended, the past operations are potential sources of contamination of the water in the Rush Springs aquifer and in the local surface-water drainages. Four potential sources of contamination of the water resources of the area, resulting from past refinery operations at Cyril, have been identified and are: (1) Spillage and leakage of crude petroleum and finished products, (2) acid sludges buried on site, (3) buried lime and caustic waste sites, and (4) an API Separator and a soil farm.

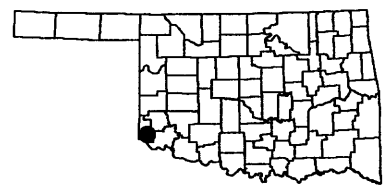
Objectives: Evaluate the impacts of oil refinery products and wastes on the ground- and surface-water quality in southeastern Caddo County near Cyril, Oklahoma.

Progress: Project is terminated.

Reports: No report is planned.

Cooperator: Oklahoma Geological Survey

Project title: BLAINE GYPSUM GROUND-WATER RECHARGE DEMONSTRATION PROJECT IN SOUTHWESTERN OKLAHOMA



Project number: OK094

Leader: Hanson, Ronald L.

Problem: The U.S. Bureau of Reclamation, pursuant to the Act of September 28, 1984, (98 Stat. 1967, P.L. 98–434) is authorized to administer the High Plains States Groundwater Demonstration Program Act of 1983. The Blaine Gypsum aquifer, located near Hollis in southwestern Oklahoma, is one of 21 demonstration projects in the High Plains States selected for study under this Act. The overall purpose of the study is to advance the state of the art of groundwater recharge utilizing an existing recharge project in the Blaine Gypsum aquifer. The U.S. Geological Survey (WRD) role in this program is to provide technical support and review of the study as it relates to the planning, surface- and ground-water monitoring, and report preparation.

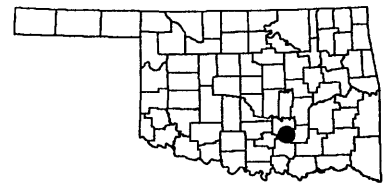
Objectives: Expand, monitor, and evaluate the recharge potential of an existing recharge project that diverts surface runoff from precipitation and irrigation tail-water to recharge wells completed in fracture or solution zones in the Blaine Gypsum aquifer near Hollis in southwestern Oklahoma. The surface water will be impounded by two diversion structures. Recharge and monitoring wells will be established within the impoundment area.

Progress: The U.S. Geological Survey reviews quarterly progress reports by the Oklahoma Water Resources Board and provides technical assistance as requested.

Planned reports: Quarterly reports prepared by Oklahoma Water Resources Board; final report prepared by U.S. Bureau of Reclamation.

Cooperators: Oklahoma Water Resources Board, U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service

Project title: HYDROLOGY OF BYRDS MILL SPRING



Project number: OK096

Leader: Savoca, Mark E.

Problem: Local water-level declines may be the result of ground-water withdrawals by the City of Ada.

Objectives: (1) Delineate the ground-water divides of the aquifer in the study area and describe the associated ground-water flow paths, and (2) document the effect that pumping from the Arbuckle-Simpson aquifer by the City of Ada wells may have on the local water-levels and discharge from nearby springs and streams.

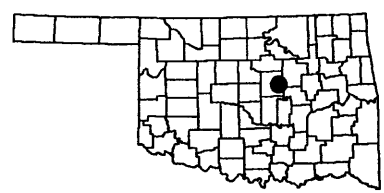
Progress: A 63.5–hour aquifer test (City Well 2), and a 241–hour stress test (City Wells 2 and 3) were conducted. Data collected during these tests include: Discharge from the pumped wells; discharge from Byrds Mill Spring and other nearby springs; discharge along a 5–mile reach of Blue River; water levels in selected wells throughout the study area; and precipitation in the vicinity of Byrds Mill Spring. Project is complete except report.

Report:

Savoca, M.E., and Bergman, D.L.,199?, Effects of municipal ground-water withdrawals on the Arbuckle-Simpson aquifer, Pontotoc County, Oklahoma: U.S. Geological Survey Water-Resources Investigations Report 94–xxxx.

Cooperators: City of Ada, Oklahoma Water Resources Board

Project title: HYDROLOGIC STUDY OF TRIBAL RESERVE LANDS OF THE SAC AND FOX NATION OF OKLAHOMA, LINCOLN COUNTY, OKLAHOMA



Project number: OK097

Leader: Abbott, Marvin M.

Problem: Beginning in the 1950's and 1960's, numerous complaints were made of poor-quality ground water in the area. Water from some wells on the tribal land has become impotable and it is believed that the Ada-Vamoosa aquifer beneath these lands has been contaminated by high-chloride waters from oil-production activities. The Justice Department is evaluating the reason for the contamination and its effect on the resources of the Sac and Fox Nation of Oklahoma. Hydrologic and water-quality data were needed for the evaluation.

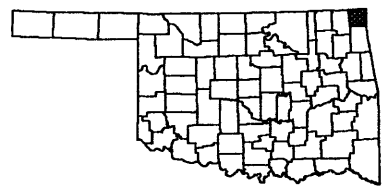
Objectives: (1) Determine the elevations and gradients of the piezometric surfaces, (2) determine ground-water quality and quantity within and adjacent to the 960 acres owned by the Tribe, (3) locate a source of water capable of supplying present and future needs of the Tribe, and (4) assess the potential for contamination of the new water supply.

Progress: Thirty-four existing domestic wells were sampled in and near the study area. Three cluster wells were constructed, logged, and sampled on the Tribe's land. Six water samples from producing oil wells and four surface-water samples were taken. Borehole geophysical logs and cores were used to correlate the regional geology. A regional map of the base of the fresh ground water beneath tribal land is abnormally shallow for the region. Water samples from below the base of the fresh water indicate that brine found at a shallow depth is a mixture of fresh water and oil-field brine.

Planned reports: Administrative report

Cooperator: Sac and Fox Nation

Project title: GROUND-WATER QUALITY OF THE ROUBIDOUX AQUIFER IN THE VICINITY OF THE TAR CREEK SUPERFUND SITE, OTTAWA COUNTY, OKLAHOMA



Project number: OK099

Leader: Christenson, Scott C.

Problem: Lead and zinc sulfides were mined from the Boone Formation in Ottawa County from about 1900 until about 1970. The mines were dewatered during mining operations by extensive pumping, but later filled with water when pumping ceased. Water-quality analyses have detected large concentrations of cadmium, copper, fluoride, lead, manganese, and nickel in some mine water. Because the hydraulic head in the Boone Formation is higher than the head in the Roubidoux aquifer, water will tend to move from the mine workings in the Boone Formation downward through pores and fractures in the rock units toward the Roubidoux aquifer.

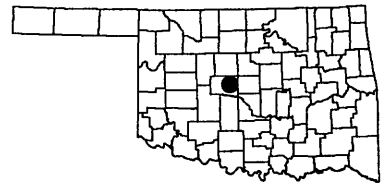
Objectives: (1) Determine if the Roubidoux aquifer in the Picher mining area has become contaminated by water in the Boone Formation that has been degraded by abandoned lead and zinc mines, (2) determine if wells completed in the Roubidoux aquifer in the mining area have become contaminated by water in the Boone Formation that has been degraded by abandoned lead and zinc mines, and (3) determine if the quality of the produced water from wells completed in the Roubidoux aquifer in the mining area is related to the wells' construction and casing integrity.

Progress: Municipal wells completed in the Roubidoux aquifer in the mining area have been sampled monthly for six months. Additional wells completed in the Roubidoux aquifer outside the mining area were sampled once. Water levels were measured in wells completed in the Roubidoux aquifer throughout Ottawa County so a potentiometric-surface map could be constructed.

Planned reports: A data and interpretive report will be prepared. The report will present the hydrologic, water-quality, and quality-assurance data collected as part of the project, and will present the results of statistical analyses of the water-quality data.

Cooperator: Oklahoma Water Resources Board

Project title: VULNERABILITY OF WATER WELLS AND SPRINGS IN THE CHEYENNE AND ARAPAHO TRIBAL LANDS OF WESTERN OKLAHOMA TO CONTAMINATION



Project number: OK100

Leader: Bergman, DeRoy L.

Problem: Knowledge of the ground-water hydrology and vulnerability to contamination of ground water beneath Cheyenne and Arapaho Tribal lands is needed by Tribal managers to establish a well-head protection plan for the Tribal water supply.

Objectives: Conduct a study to determine the vulnerability to contamination of springs and ground water beneath the Tribal land within the 3,981–acre Concho Reserve.

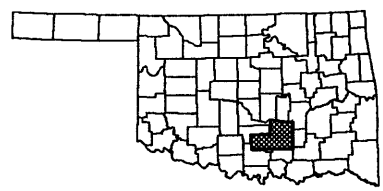
Progress: The project was completed in 1993.

Report:

Bergman, D.L., and Savoca, M.E., 1993, Land-use and ground-water data, Cheyenne-Arapaho Tribes, Concho Reserve, Canadian County, Oklahoma: U.S. Geologcial Survey Open-File Report 93–110, 2 sheets, scale 1:24,000.

Cooperator: Cheyenne and Arapaho Tribes

Project title: HYDROLOGY OF THE ARBUCKLE-SIMPSON AQUIFER, SOUTH-CENTRAL OKLAHOMA



Project number: OK101

Leader: Savoca, Mark E.

Problem: The Arbuckle-Simpson aquifer consists of limestone, dolomite, sandstone, and shale of the Late Cambrian- to Middle Ordovician-aged Arbuckle and Simpson Groups. These broadly folded and extensively faulted and jointed units contain karst features. The Arbuckle-Simpson is an EPA-designated sole-source aquifer, and the principal source of water for the Cities of Ada, Sulphur, Mill Creek, and Roff, and supplies domestic users, ranches, and farms throughout the area. To comply with Oklahoma ground-water law, the Oklahoma Water Resources Board is required to conduct hydrologic surveys and investigations of the Arbuckle-Simpson aquifer and determine the aquifer's maximum annual yield of fresh water.

Objectives: (1) Determine the areal extent and approximate base of the Arbuckle-Simpson aquifer, and potential amount of fresh ground water stored in the aquifer, (2) define the rate of recharge to the aquifer, and the total discharge from the aquifer, and (3) determine aquifer constants (hydraulic conductivity, transmissivity, and storage coefficient), and document their spatial variability.

Progress: The project is unfunded.

Reports: None.

Cooperator: Oklahoma Water Resources Board

WATER CONDITIONS IN OKLAHOMA

Large variations in streamflow characterize hydrologic conditions in Oklahoma. In the extreme southeastern part of the State, mean annual precipitation exceeds 52 inches and mean annual runoff exceeds 20 inches. In the southeast, stream channels are deeply incised in mountainous terrain, and streamflow generally is perennial. In the extreme northwestern part of the Oklahoma Panhandle, mean annual precipitation is less than 16 inches (fig. 6) and mean annual runoff is less than 0.1 inch (fig. 7). In northwestern Oklahoma, streams generally have shallow, poorly defined channels, and ephemeral flow.

Water Year 1991

Precipitation data from monthly reports of the Oklahoma Climatological Survey, averaged over the State, indicated that monthly precipitation was below normal during October, February, March, July, and August of the water year. Totals were above normal during June and September. November, December, January, April, and May totals were about average.

Precipitation was not uniform across the State, however. Western Oklahoma was particularly hard-hit by dry conditions. During February, the western third of the State averaged only 0.1 inch of precipitation, and it was the fourth driest year on record for the whole State. In June, heavy rains fell across southern Oklahoma and eased parched conditions in northwest Oklahoma, but near-drought conditions persisted in northeast Oklahoma. During September above-average precipitation fell over the entire State.

A comparison of daily, monthly, and annual streamflow for the 1991 water year with the period of record at selected stations reflected unusually dry conditions for the entire year in western and northern Oklahoma. Streamflow was average for the year in southwestern, central, southern, and southeastern Oklahoma, because of high flows in June and September.

Drought effects during the 1991 water year varied throughout the State. Streamflow was far below normal in all streams during the year in the western and north-central areas, and in large streams in northeastern Oklahoma. In central Oklahoma, streamflow was below normal during April with above-normal flows in September. In smaller streams in northeastern Oklahoma, streamflow was below normal in February, March, and the summer months of June through August. Two medium-flow periods in December through January and in April were the only outstanding wet periods in the otherwise dry year. In southwestern Oklahoma, streamflow was above normal in June. Streamflow was above normal in June and September in the south-central part of the State and in June in the southeast. Overall the streamflow, on an annual basis, reflected dry conditions in the northern third of the State with all annual peak flows in the low-flow range. In the rest of the State, streamflow was about normal with all annual peak flows in the medium-flow range.

The worst flooding occurred during June across large parts of southwest and south-central Oklahoma. Daily rainfall totals greater than 5 inches were reported in Altus, Snyder, and Sedan in the southwest, causing flash floods. The Kingston-Madill area in south-central Oklahoma received more than 10 inches in 3 days, causing street flooding; low-lying areas near Lake Murray in Love County were flooded.

Conservation storage in six selected reservoirs in the State, with a combined conservation storage capacity of 8,014,000 acre-feet, remained about the same. Conservation storage decreased slightly, from 97 percent at the start of the water year to 95 percent at the end of the water year.

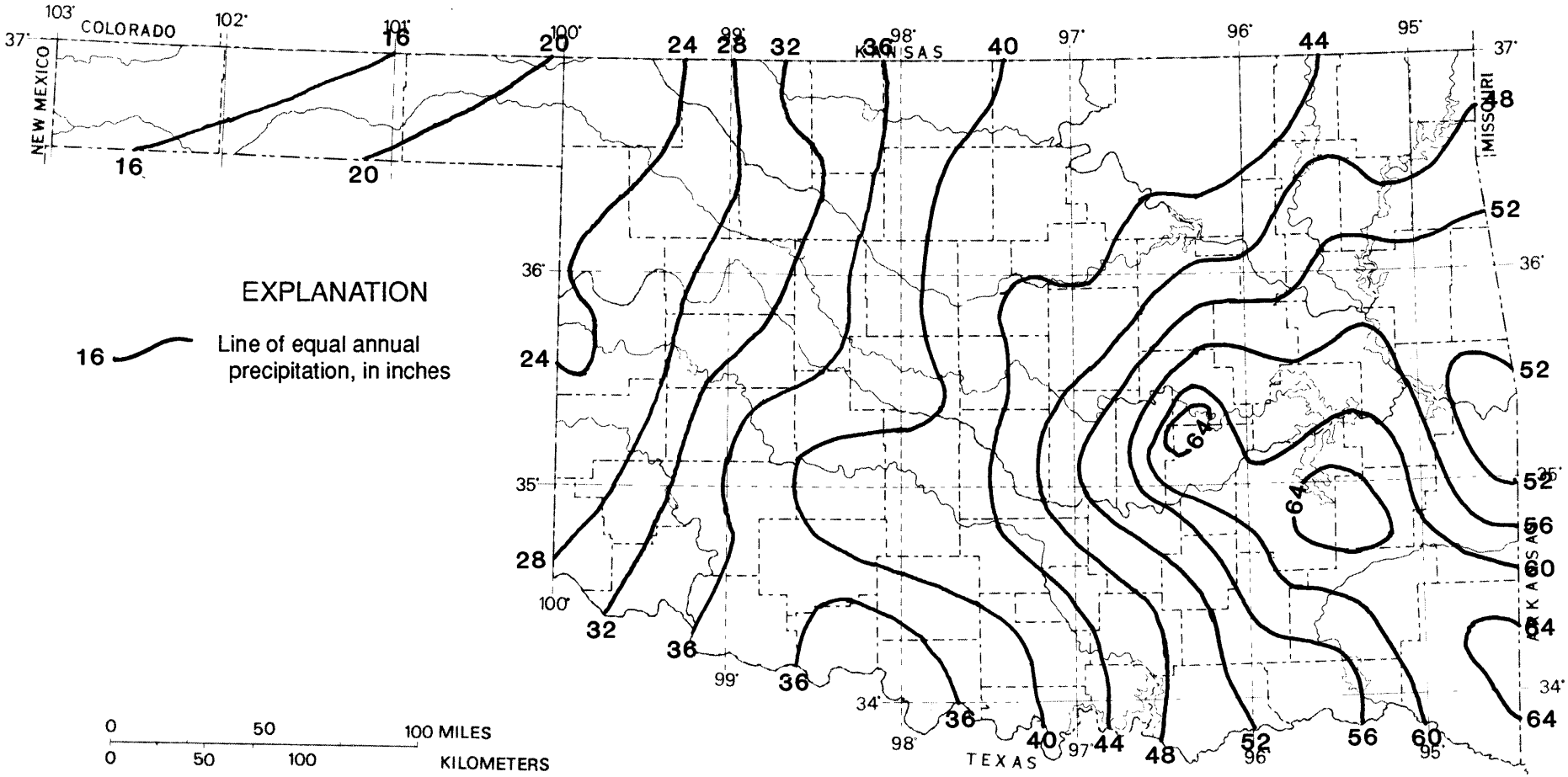
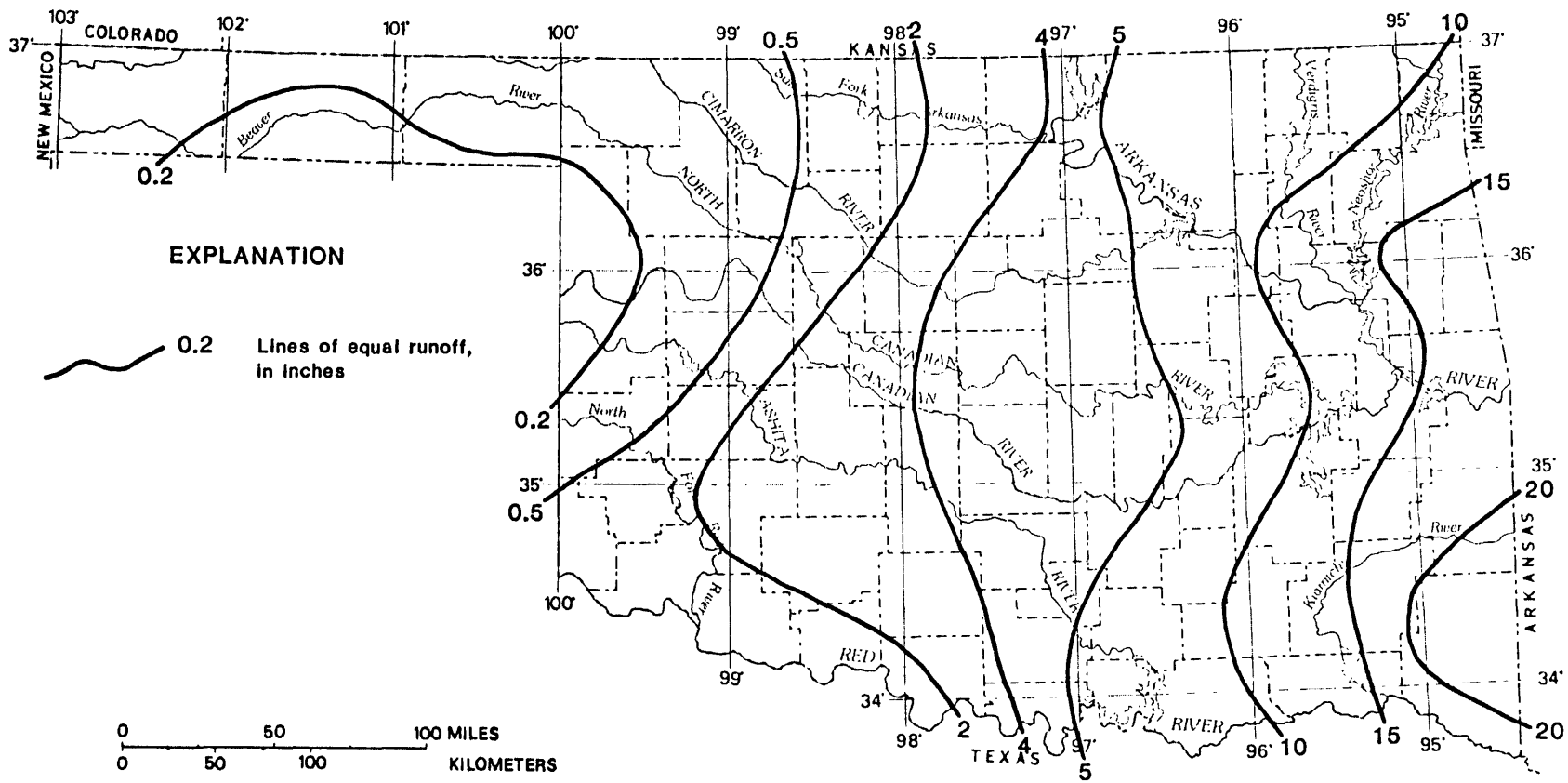


Figure 6. Total precipitation, 1992 (modified from Oklahoma Climatological Survey, 1992 Oklahoma Annual Summary).



From Pettyjohn, W. A., and others, 1983, Water Atlas of Oklahoma: University Center for Water Research, Oklahoma State University, Stillwater, Oklahoma, 72 p.

Figure 7. Average annual runoff in Oklahoma, 1970–79.

Water Year 1992

Precipitation data from monthly reports of the Oklahoma Climatological Survey, averaged over the State, indicated that monthly precipitation was below normal during February and March of the water year. Totals were above normal during October, December, June, July, and August. December was the 3rd wettest and the summer total (June-August) was the 5th wettest in the last 100 years. November, January, April, May, and September totals were about average.

However, precipitation was not spread uniformly across the State. Western Oklahoma had dry conditions during September; the panhandle of the State averaged only 0.14 inch of precipitation. In October, heavy rains fell across southeastern Oklahoma with three times normal rainfall being reported. The entire state had a very wet December with over five times normal precipitation reported in southwestern Oklahoma. Although April had normal rainfall, locally heavy rains caused flooding which took the lives of three children, two in Oklahoma City and one in Lawton. During the summer months significantly above-average precipitation fell over the entire State.

A comparison of daily, monthly, and annual streamflow for the 1992 water year with the period of record at eight selected representative stations reflected unusually dry conditions for the entire year in western Oklahoma; average streamflow for the year in north-central and northeastern Oklahoma; and above-average streamflow for the year in southwestern, central, southern and southeastern Oklahoma caused by high flows in December, and June through September.

Drought effects during the 1992 water year varied throughout the State. Streamflow was below normal in streams during the water year in northwesten Oklahoma and about normal in streams during the year in north-central and in northeastern Oklahoma with high flows in December and the summer months. In central Oklahoma, streamflow was far above normal during December and April through August. In southwestern Oklahoma, streamflow was above normal throughout the water year, with the most significant rises occurring in December and June through September. Streamflow was above normal throughout the year with the highest peaks in December, June and July in the south-central part of the State and in October, December, and September in the southeast. Overall the streamflow on an annual basis was dry in the northwest; about normal in the north-central and northeast; and above normal in central, southwestern, south-central, and southeastern Oklahoma, with all annual peak flows in the medium to high flow range.

The worst flooding occurred during December across the entire State and during June through August in large parts of the State except northwestern Oklahoma. For several days in late December, rainfall totals over 2 inches were reported at several locations, with 3.20 inches at Anadarko and 3.47 inches at Bartlesville. Thunderstorms buffeted Oklahoma throughout June. Rainfall totals in excess of 3 inches were reported in Oneta, Boynton, and Tahlequah in early June; Muskogee reported 6.03 inches. Flooding caused by heavy rains stopped the wheat harvest in many parts of the State. Flash flooding hit Carter, Bryan, and Creek Counties at the end of June.

Conservation storage in six selected reservoirs in the State, with a combined conservation storage capacity of 8,014,000 acre-feet, remained about the same. Conservation storage increased slightly from 95 percent at the start of the water year to 98 percent at the end of the water year.

RECONNAISSANCE HYDROLOGIC STUDIES OF THE STATE OF OKLAHOMA

Maps showing the geology and hydrology of the State of Oklahoma (fig. 8) include the following hydrologic atlases. These reports, here cited for the convenience of readers of this report, were prepared in cooperation with the Oklahoma Water Resources Board and the Oklahoma Geological Survey, and show the latest geologic and hydrologic maps of the State.

Bingham, R.H., and Bergman, D.L., 1980, Reconnaissance of the water resources of the **Enid** quadrangle, north-central Oklahoma: Oklahoma Geological Survey Hydrologic Atlas HA–7, 4 sheets, scale 1:250,000.

Bingham, R.H., and Moore, R.L., 1975, Reconnaissance of the water resources of the **Oklahoma City** quadrangle, central Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 4, scale 1:250,000, 4 sheets.

Carr, J.E., and Bergman, D.L., 1976, Reconnaissance of the water resources of the **Clinton** quadrangle, west-central Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 5, scale 1:250,000, 4 sheets.

Hart, D.L., Jr., 1974, Reconnaissance of the water resources of the **Ardmore and Sherman** quadrangles, southern Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 3, scale 1:250,000, 4 sheets.

Havens, J.S., 1977, Reconnaissance of the water resources of the **Lawton** quadrangle, southwestern Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 6, scale 1:250,000, 4 sheets.

Marcher, M.V., 1969, Reconnaissance of the water resources of the **Fort Smith** quadrangle, east-central Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 1, scale 1:250,000, 4 sheets.

Marcher, M.V., and Bergman, D.L., 1983, Reconnaissance of the water resources of the **McAlester and Texarkana** quadrangles, southeastern Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 9, scale 1:250,000, 4 sheets.

Marcher, M.V., and Bingham, R.H., 1971, Reconnaissance of the water resources of the **Tulsa** quadrangle, northeastern Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 2, scale 1:250,000, 4 sheets.

Morton, R.B., 1980, Reconnaissance of the water resources of the **Woodward** quadrangle, northwest Oklahoma: Oklahoma Geological Survey Hydrologic Atlas 8, scale 1:250,000, 4 sheets.

Morton, R.B., and Goemaat, R.L., 1972, Reconnaissance of the water resources of **Beaver** County, Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA–450, scale 1:125,000, 3 sheets.

Sapik, D.B., and Goemaat, R.L., 1972, Reconnaissance of the ground-water resources of **Cimarron** County, Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA–373, scale 1:125,000, 3 sheets.

Wood, P.R., and Hart, D.L., Jr., 1967, Availability of ground water in **Texas** County, Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA–250, scale 1:125,000, 3 sheets.

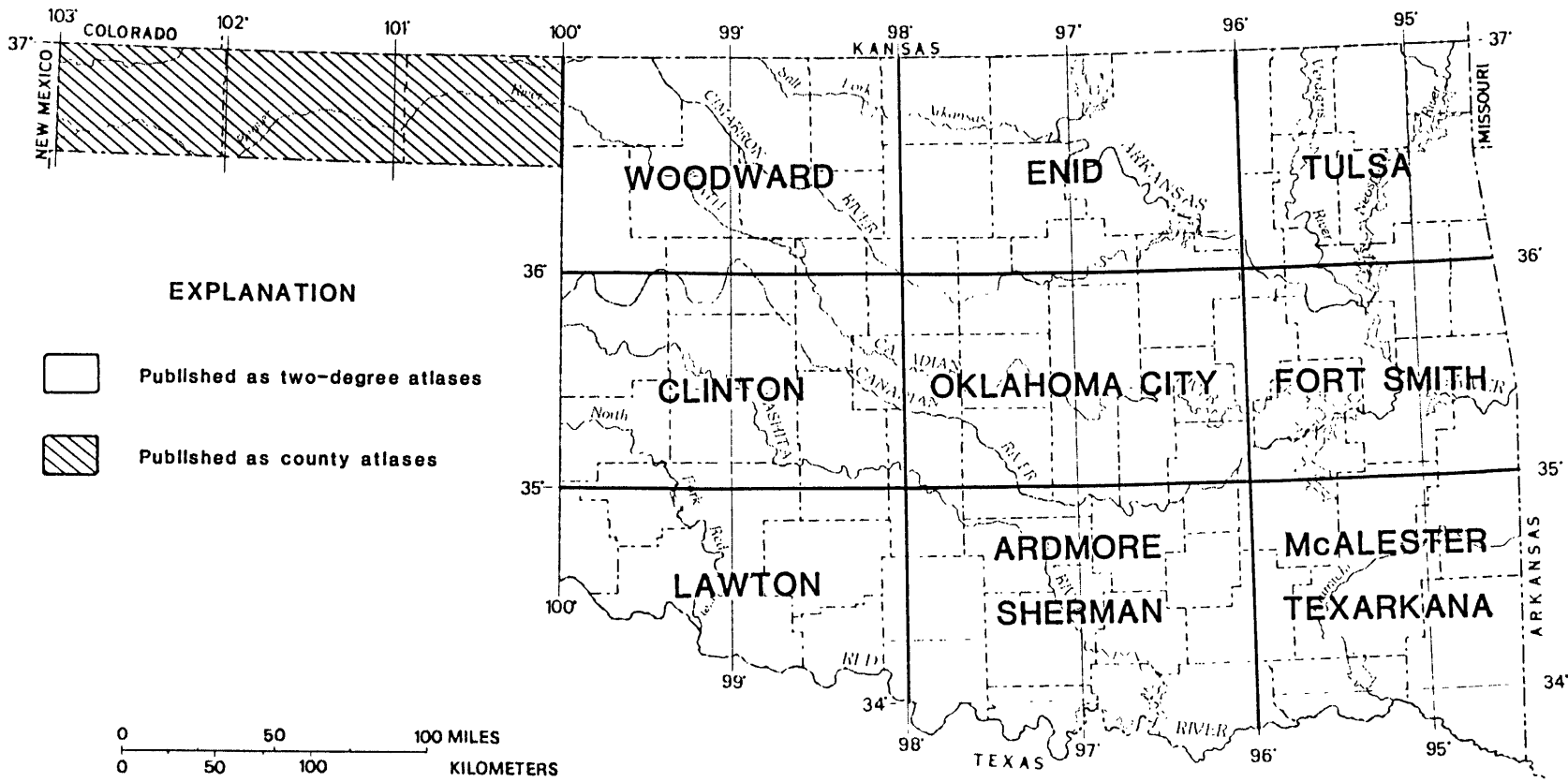


Figure 8. Areas for which reconnaissance hydrologic studies have been made.