WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN UTAH, OCTOBER 1, 1996, TO SEPTEMBER 30, 1997

Compiled by Ellen E. Hardy and Stefanie L. Dragos

U.S. GEOLOGICAL SURVEY

Open-File Report 98-277

Salt Lake City, Utah
1998

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Thomas J. Casadevall, Acting Director

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District Chief
U.S. Geological Survey
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver Federal Center
Denver, Colorado 80225

Message from the District Chief

The U.S. Geological Survey, Water Resources Division, is entering its 108th year of activity in Utah. As Utah's economy and population continue to expand, so has the demand for water and the need for quantitative, unbiased water-resources data and interpretive studies. The Utah District program is designed to provide this information and help the Water Resources Division fulfill its mission of assessing the quantity and quality of the Nation's water resources.

The following report describes the many data-collection activities and interpretive investigations in which the Utah District is involved. Although all these activities are providing important data and information, I would like to take this opportunity to briefly discuss two in particular. These are "Assessment of brine shrimp population and nutrients in Great Salt Lake" and "Field demonstration of in-situ chemical barriers to control uranium contamination in ground water." Although these investigations are quite different in technical direction and scope, I believe they provide an insight into how the Water Resources Division and the Utah District provide relevant information to help assess and manage water resources.

The harvesting of brine shrimp from Great Salt Lake has, during the past decade, become a high-tech, multi-million dollar industry. Spotter aircraft and high-powered boats are used to maximize harvest, and competition between individual companies is intense. However, no one understands the population dynamics of the shrimp nor the amount that can be annually harvested without threatening the resource. The Utah District, in cooperation with the Utah Division of Wildlife Resources and Utah State University, is helping provide answers to these questions. Information provided from this work is being used by Wildlife Resources to manage the harvest on an almost real-time basis. For those of you with additional interest in this work and in the ecology of brine shrimp, please visit our Great Salt Lake web site at wwwdutslc.wr.usgs.gov/greatsaltlake/saltlake.html

Uranium has been mined throughout large areas of the Colorado Plateau in southeastern Utah since about the time of the Second World War. A legacy of this effort is the hundreds of abandoned mines, upgrading facilities, and mills. Many of these sites have contaminated the underlying ground water with uranium and other metals that are hazardous to health. Traditionally, contaminated ground water has been mitigated by the so-called "pump-and-treat" method, which is costly and maintenance intensive. For this reason, only large and highly contaminated sites could be mitigated; smaller or less contaminated sites were simply abandoned and forgotten. At Fry Canyon, the Utah District, in cooperation with the U.S. Environmental Protection Agency, the U.S. Department of Energy, and the Bureau of Land Management, is experimenting with new and less costly technologies for the mitigation of uranium-contaminated ground water. Several reactive barriers have been installed within a plume of contaminated ground water. The barriers contain materials that react with the uranium and remove it from solution. Although these removal reactions have been known for many years and can be demonstrated in the laboratory, the performance and longevity of the barriers in actual field settings are unknown. Results from this work may provide a cheaper and minimal-maintenance technology to help clean up uranium-contaminated sites throughout the United States. For those with additional interest in this work, please visit our Fry Canyon web site at wwwdutslc.wr.usgs.gov/fry/fry.html

The future promises the continued challenge of helping local, State, and Federal agencies meet their water-resources needs. I look forward to another active year in which the U.S. Geological Survey helps meet these needs.

Kimball E. Goddard
District Chief
U.S. Geological Survey, Water Resources Division
Salt Lake City, Utah 84104
kgoddard@usgs.gov

Utah District Web Page:
http://wwwdutslc.wr.usgs.gov

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WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN UTAH, OCTOBER 1, 1996, TO SEPTEMBER 30, 1997

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INTRODUCTION

This report contains summaries of the progress of water-resources activities of the U.S. Geological Survey (USGS), Water Resources Division, Utah District, from October 1, 1996, to September 30, 1997. The water-resources program in Utah during this period consisted of 25 projects, and a discussion of each project is presented.

The following sections outline the origin of the USGS, the mission of the Water Resources Division, the organizational structure of the Utah District, office addresses of the Utah District, the distribution of program funding as source of funds and type of activity funded in Federal Fiscal Year 1997 (FY97) (October 1, 1996, to September 30, 1997), and the agencies with which the District cooperates. The last part of the introduction is a list of reports produced by the District from October 1996 to September 1997.

Origin of the U.S. Geological Survey

The 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 lands, and examination of the geologic structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and disseminating 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 factfinding 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 mapmaking 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 warnings 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 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 publication 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 "Science for a changing world."

Mission of the U.S. Geological Survey, Water Resources Division

The mission of the Water Resources Division, which supports the overall mission of the U.S. Department of the Interior and the USGS, is to provide the hydrologic information and understanding needed for the best use and management of the Nation's water resources for the benefit of the people of the United States.

To accomplish its mission, the Water Resources Division, in cooperation with State and local governments and other Federal agencies:

- Systematically collects data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducts analytical and interpretive water-resources appraisals to describe the occurrence, availability, and physical, chemical, and biological characteristics of surface and ground water and their interrelation.
- Conducts supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science and engineering to improve the basis for field investigations and measurement techniques and to understand hydrologic systems sufficiently well to predict quantitatively their response to stress, either natural or manmade.
- Disseminates water data and the results of investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinates the activities of all Federal agencies in the acquisition of certain water data.
- Provides scientific and technical assistance in hydrologic fields to State, local, and other Federal agencies, to licensees of the Federal Energy Regulatory Commission, and, on behalf of the U.S. Department of State, to international agencies.
- Acquires, develops, and disseminates information on water-related natural hazards such as droughts, floods, landslides, land subsidence, mudflows, and volcanoes.
- Administers the provisions of the Water Resources Research Act of 1984 that include the programs of the State Water Resources Research Institutes and the Research Grants and Contracts.
- Supports the provisions of the National Environmental Policy Act of 1969 and manages USGS conduct of natural-resources surveys in response to the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Act) of 1980.

Authority for carrying out this mission is derived from legislation of 1879 that created the USGS and legislation of 1888 and 1894 that provided for stream gaging and determining the Nation's water supply. Congressional appropriations have been made annually since 1894 for stream gaging and performing other functions related to water resources. In 1964, the USGS's mission was broadened to include the role of lead agency in the coordination of the activities of all Federal agencies in the acquisition of certain water data. This responsibility was assigned to the Department of the Interior in Office of Management and Budget Circular A-67.

Organization of the Utah District

The Utah District consists of the District Office in Salt Lake City and Field Offices in Salt Lake City, Moab, and Cedar City. The locations of these offices and their areas of responsibility are shown in figure 1. The District is organized into three groups under the District Chief and management staff (fig. 2). Water-resources projects are done by the Hydrologic Investigations Section (primarily interpretive studies) and the Hydrologic Surveillance Section (primarily collection of hydrologic data). Responsibility for each project is assigned to a project chief. Support for project work is supplied by the Administrative Section and the Scientific Information Management Section (SIM). The SIM section consists of four units—Publications, Computer, Data Management, and Geographic Information Systems.

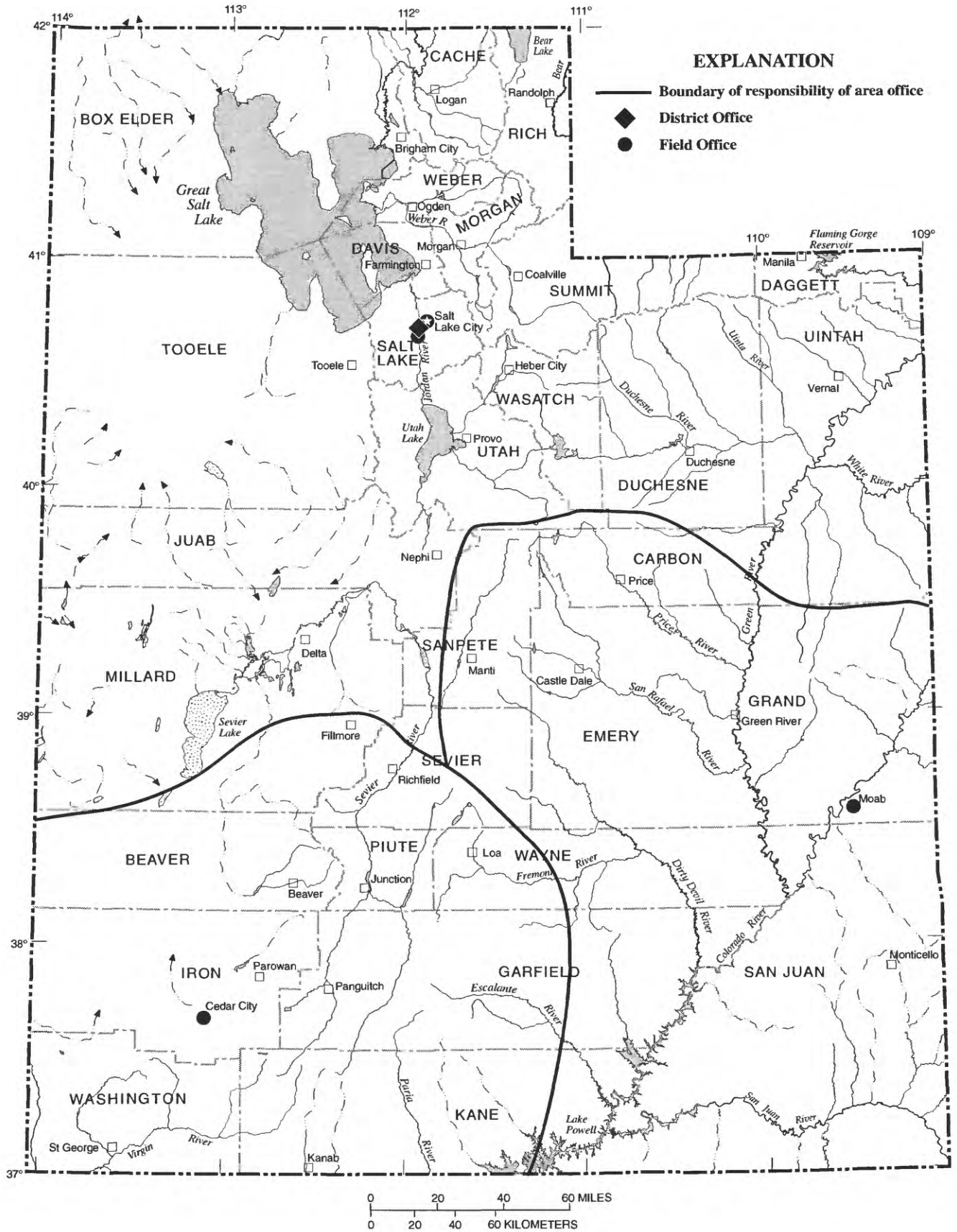


Figure 1. Location of U.S. Geological Survey, Water Resources Division, offices and general areas of responsibility.

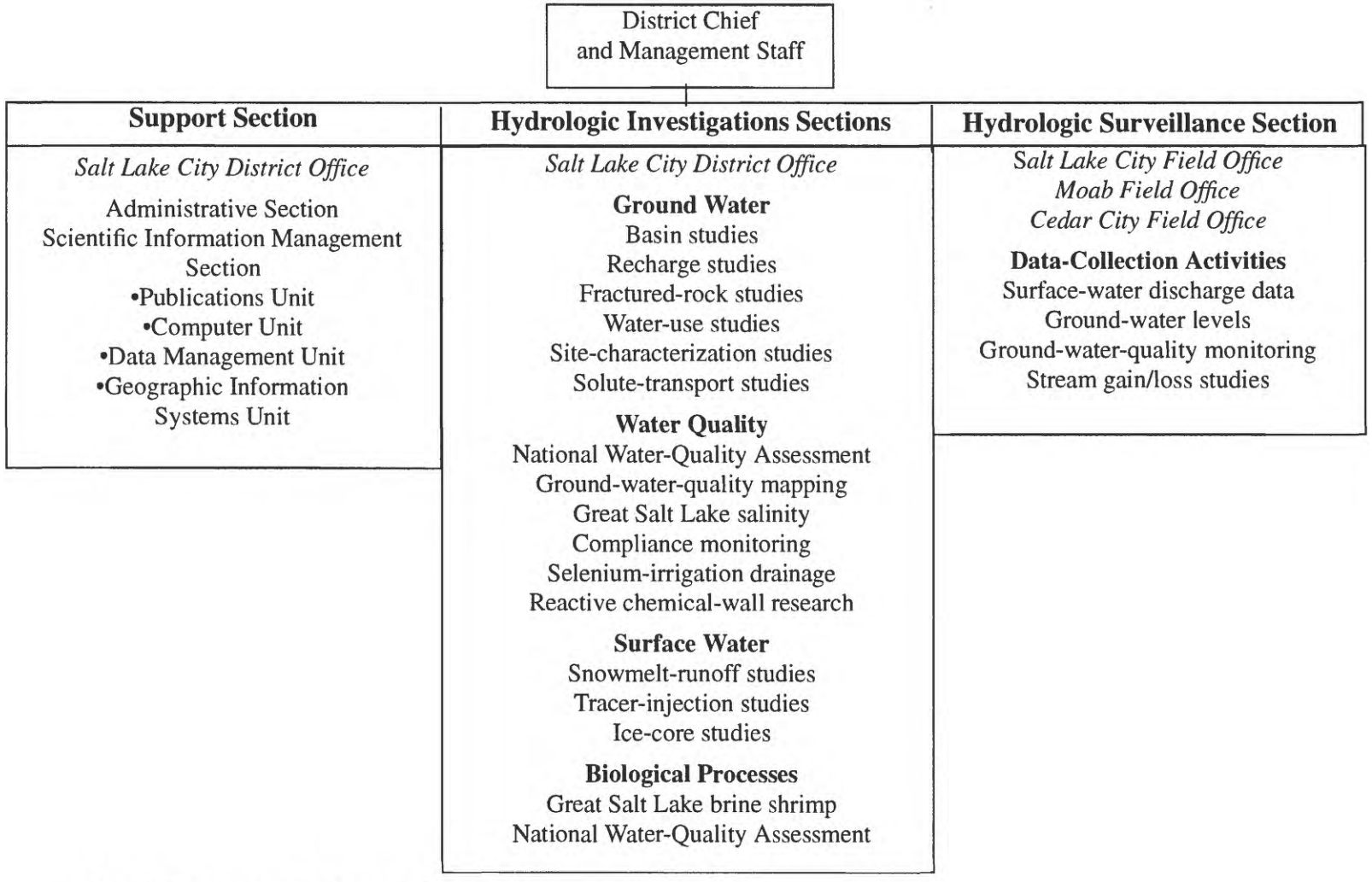


Figure 2. Organization of the Utah District.

Office Addresses of the Utah District

Inquiries regarding projects may be directed to the District Office or to the office in which the work originated.

District Office and Salt Lake City Field Office
(801) 975-3350

U.S. Geological Survey
Water Resources Division
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

Cedar City Field Office
(435) 586-4543

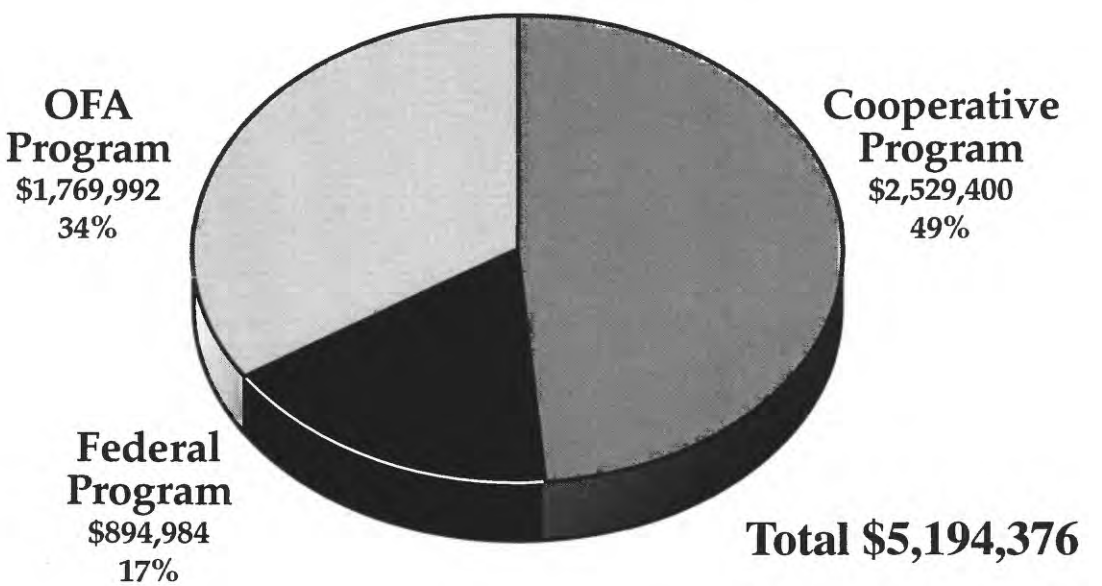
U.S. Geological Survey
Water Resources Division
2390 West Highway 56
Suite 8
Cedar City, Utah 84720

Moab Field Office
(435) 259-5495

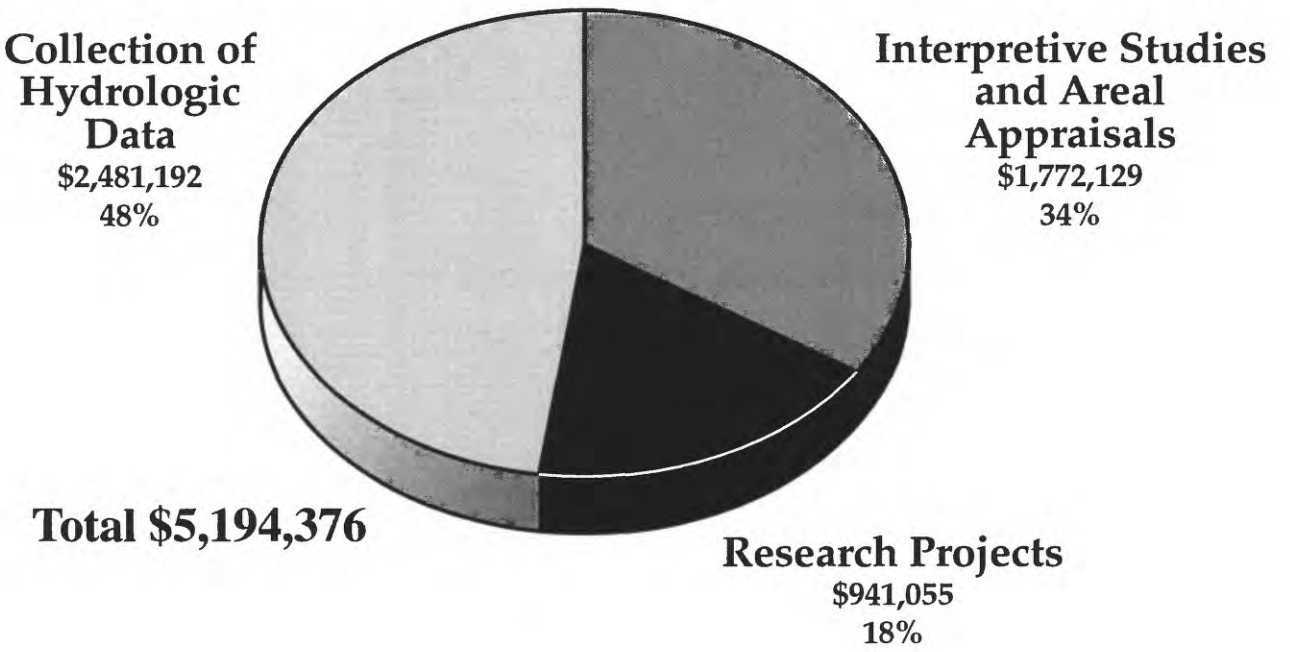
U.S. Geological Survey
Water Resources Division
121 West 200 South
P.O. Box 490
Moab, Utah 84532

Program Funding and Cooperating Agencies

Funds to support water-resources work done by the Utah District come from three sources. Cooperative-Program funds and services are provided by State and local government agencies and generally are matched by Federal funds on a 50-50 basis. Funds transferred from other Federal agencies (OFA) are part of the OFA Program, and funds appropriated directly to the USGS by Congress are part of the Federal Program. In FY97, total financial support from these programs for the Utah District was about $5.2 million. The amount of funding received from each of the three sources is:



In FY97, the Utah District pursued three broad categories of studies: (1) collection of hydrologic data, (2) interpretive studies and areal appraisals, and (3) research projects. About 48 percent of the program was for collection of hydrologic data, 34 percent was for interpretive studies and areal appraisals, and 18 percent was for research projects. These studies provide water managers and planners with information about the availability and quality of Utah's water resources. The distribution of funds among the three categories is represented graphically as:



From October 1, 1996, to September 30, 1997, the cooperating agencies for District projects were:

State Agencies

Utah Department of Natural Resources
- Division of Oil, Gas, and Mining
- Division of Water Resources
- Division of Water Rights

Local Agencies

Bear River Commission
Central Iron County Water Conservancy District
Central Utah Water Conservancy District
City of Grantsville
City of Moab
City of Park City
City of Tooele
Grand County
Navajo Nation Department of Water Resources
Ogden River Water Users Association
Salt Lake County Division of Flood Control and Water Quality

Summit County
Tooele County
Washington County Water Conservancy District
Weber Basin Water Conservancy District
Weber River Water Users Association

Federal Agencies

U.S. Department of Agriculture
  Natural Resources Conservation Service
U.S. Department of the Interior
  Bureau of Land Management
  Bureau of Reclamation, Denver
U.S. Department of Defense
  U.S. Air Force
  U.S. Army
U.S. Department of Energy
U.S. Environmental Protection Agency

Reports Released or Published

The following reports were released or published from October 1, 1996, to September 30, 1997:

Downhour, P.A., and Brooks, L.E., Selected hydrologic data for Snyderville Basin, Park City, and adjacent areas, Summit County, Utah, 1967-95: U.S. Geological Survey Open-File Report 96-494, 52 p.

Enright, Michael, Selected hydrologic data for the Beaver Dam Wash area, Washington County, Utah, Lincoln County, Nevada, and Mohave County, Arizona, 1991-95: U.S. Geological Survey Open-File Report 96-493, 36 p.

Hardy, E.E., and Dragos, S.L., Water-resources activities of the U.S. Geological Survey in Utah, October 1, 1994, to September 30, 1995: U.S. Geological Survey Open-File Report 97-577, 38 p.

Herbert, L.R., and others, Water resources data for Utah, water year 1996: U.S. Geological Survey Water-Data Report UT-96-1, 300 p.

Kimball, B.A., Use of tracer injections and synoptic sampling to measure metal loading from acid mine drainage: U.S. Geological Survey Fact Sheet FS-245-96, 4 p.

Lambert, P.M., Numerical simulation of the movement of sulfate in ground water in southwestern Salt Lake Valley, Utah: Utah Department of Natural Resources Technical Publication No. 110-D, 44 p.

Spangler, L.E., Naftz, D.L., and Peterman, Z.E., Hydrology, chemical quality, and characterization of salinity in the Navajo aquifer in and near the Greater Aneth Oil Field, San Juan County, Utah: U.S. Geological Survey Water-Resources Investigations Report 96-4155, 90 p.

Steiger, J.I., Gerner, S.J., and others, Ground-water conditions in Utah, Spring of 1996: Utah Department of Natural Resources Cooperative Investigations Report No. 36, 89 p.

Steiger, J.I., and Lowe, M., Recharge and discharge areas and quality of ground water in Tooele Valley, Tooele County, Utah: U.S. Geological Survey Water-Resources Investigations Report 97-4005, 4 pls.

Stephens, D.W., Waddell, Bruce, DuBois, Kristi, and Peterson, Elise, Field screening of water quality, bottom sediment, and biota associated with the Emery and Scofield Project areas, central Utah, 1994: Water-Resources Investigations Report 96-4298, 39 p.

U.S. Geological Survey, U.S. Geological Survey programs in Utah: U.S. Geological Survey Fact Sheet FS-044-96, 4 p.

Reports prepared by or in cooperation with the Utah District can be obtained or inspected at the following locations:

U.S. Geological Survey **Utah District Office** **Room 1016 Administration Building** **1745 West 1700 South** **Salt Lake City, Utah 84104** **(801) 975-3350**	U.S. Geological Survey Open-File Reports, Water-Resources Investigations Reports, Hydrologic-Data Reports, and Water-Data Reports; Utah Department of Natural Resources Technical Publications and Cooperative Investigations Reports.
U.S. Geological Survey **Earth Science Information Center** **2222 West 2300 South, 2nd Floor** **Salt Lake City, Utah 84119** **(801) 975-3742**	U.S. Geological Survey Water-Supply Papers, Professional Papers, Circulars, and Hydrologic Investigations Atlases.
Utah Department of Natural Resources **1594 West North Temple** **Salt Lake City, Utah 84116** **(801) 538-7240**	Utah Department of Natural Resources Technical Publications and Cooperative Investigations Reports; and U.S. Geological Survey Water Circulars, Hydrologic-Data Reports, and Water-Use Reports.

CURRENT PROJECTS BY NUMBER AND TITLE

Collection of Hydrologic Data

Surface-Water Data

Number: UT-00-001

Cooperating Agencies: Bureau of Reclamation; Utah Division of Water Rights; Utah Division of Water Resources; Central Utah Water Conservancy District; Bear River Commission; Weber Basin Water Conservancy District; Salt Lake County Division of Flood Control and Water Quality; Weber River Water Users Association; Ogden River Water Users Association; and other local water agencies

Staff: J.R. Kolva, Supervisory Hydrologist, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Information on surface water is needed for management of the resource and for warning of related hazards. This information is used to better manage and plan for water supply, hydroelectric power generation, irrigation, flood control, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. To provide this information, an appropriate data base on discharge of streams and contents and stages of reservoirs and lakes is necessary.

Objective: To obtain data on stream discharge, and reservoir and lake contents and stages at selected sites throughout Utah.

Approach: Standard methods will be used for the operation and maintenance of streamflow-gaging stations and for the computation, computer storage, and publication of data.

Progress: Data collection and computation necessary for the publication of discharge records for 154 streamflow-gaging stations and contents and stage records for 14 reservoir- and lake-stage stations continued during the year. In addition, streamflow data were collected at seven partial-record sites. The locations of the stations and station numbers are shown in figure 3. Data collected at these stations, as well as larger-scale maps showing station locations, are presented in the series of reports entitled "Water resources data for Utah," USGS Water-Data Reports. The stations are classified as follows:

	Number of stations
Discharge	
Current use	123
Hydrologic data	30
Benchmark	1
Contents of reservoirs and lakes	11
Stage of Great Salt Lake	3

One streamflow-gaging station was discontinued as of September 30, 1997. This was:

10224100 Oak Creek above Little Creek, near Oak City

Plans for Next Year: Continue operation of network. Prepare 1997 water-year records for publication.

Report:

Herbert, L.R., and others, 1997, Water resources data for Utah, water year 1996: U.S. Geological Survey Water–Data Report UT-96-1.

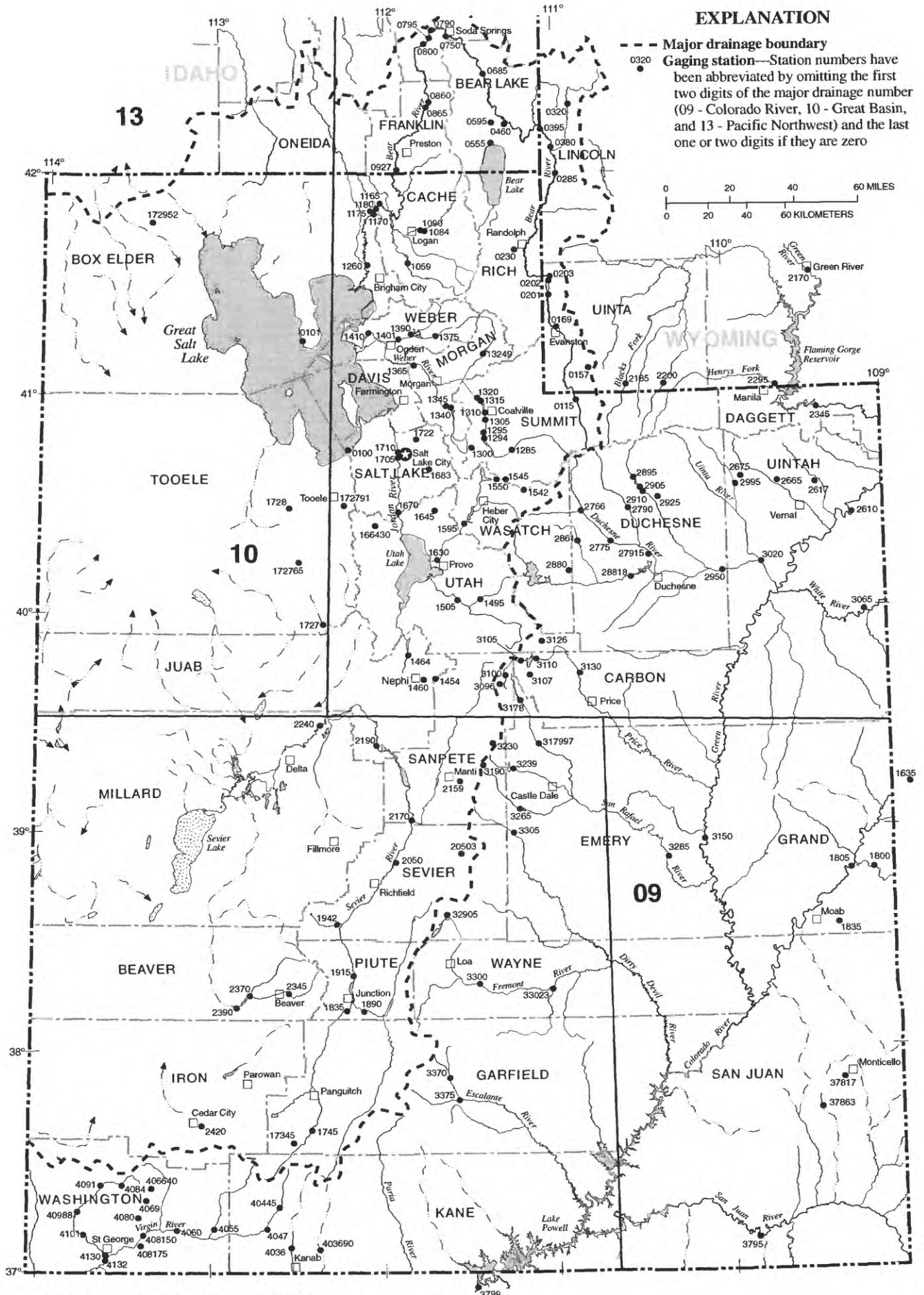


Figure 3. Location of gaging stations.

Ground-Water Data and Ground-Water Conditions in Utah

Number: UT-00-002

Cooperating Agencies: Utah Division of Water Rights; Utah Division of Water Resources; Central Utah Water Conservancy District

Staff: J.R. Kolva, Supervisory Hydrologist, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Long-term records of water level and ground-water withdrawal are needed to evaluate the effects of climatic variations, to determine the effect of withdrawal from aquifers on water level, to assist in the prediction of future conditions of aquifers, and to provide data for management of ground-water resources.

Objectives: (1) To obtain long-term records of ground-water level for determination of water-level changes for yearly or other periods, (2) to determine withdrawal from aquifers in the State, and (3) to make an annual evaluation of ground-water conditions in Utah and publish the information in a report.

Approach: Measure water level annually (normally during February and March) and operate continuous water-level recorders on selected observation wells (fig. 4). Measure discharge or obtain amounts of discharge from irrigation wells in 17 selected valleys; determine the ratio of water produced to energy consumed, and use the ratio along with energy-consumption data to help compute total annual withdrawal from irrigation wells. Measure discharge from selected flowing wells. Obtain estimates of ground water withdrawn from wells for public supply and industrial use from the Utah Division of Water Rights. Obtain additional estimates of ground water withdrawn from wells for public supply or industrial use by interviewing users. Determine the number and diameter of new wells drilled annually from well drillers' reports filed with the Utah Division of Water Rights. Prepare an annual report on ground-water conditions in Utah that includes data, graphs, and maps showing water-level changes, withdrawals from wells, number of wells drilled in defined ground-water basins or areas, changes in ground-water quality, and a discussion of ground-water conditions in each basin or area that has substantial withdrawal. Store water-level data in computer files and publish selected data in the annual USGS report, "Water resources data for Utah."

Progress: Water levels were measured in about 1,000 wells in February and March. In addition, the water level in 25 of these wells was measured monthly, and continuous water-level records were maintained on 27 of these wells. During the irrigation season, about 500 discharging irrigation wells were observed; discharge was measured at about one-half of the wells, and the ratio of water production to energy consumption was determined. Natural flow was measured at about 30 flowing wells during the irrigation season. The number and diameter of wells drilled during the past year were compiled. The 34th in the series of annual reports on ground-water conditions in Utah was completed. The continuous water-level records were published in the annual USGS report "Water resources data for Utah."

Plans for Next Year: Continue collecting, recording, and publishing data on water level, ground-water withdrawal, and wells drilled. The 35th in the series of annual reports on ground-water conditions will be compiled.

Reports:

Steiger, J.I., Gerner, S.J., and others, 1996, Ground-water conditions in Utah, spring of 1996: Utah Department of Natural Resources Cooperative Investigations Report No. 36, 89 p.

Herbert, L.R., and others, 1997, Water resources data for Utah, water year 1996: U.S. Geological Survey Water–Data Report UT-96-1.

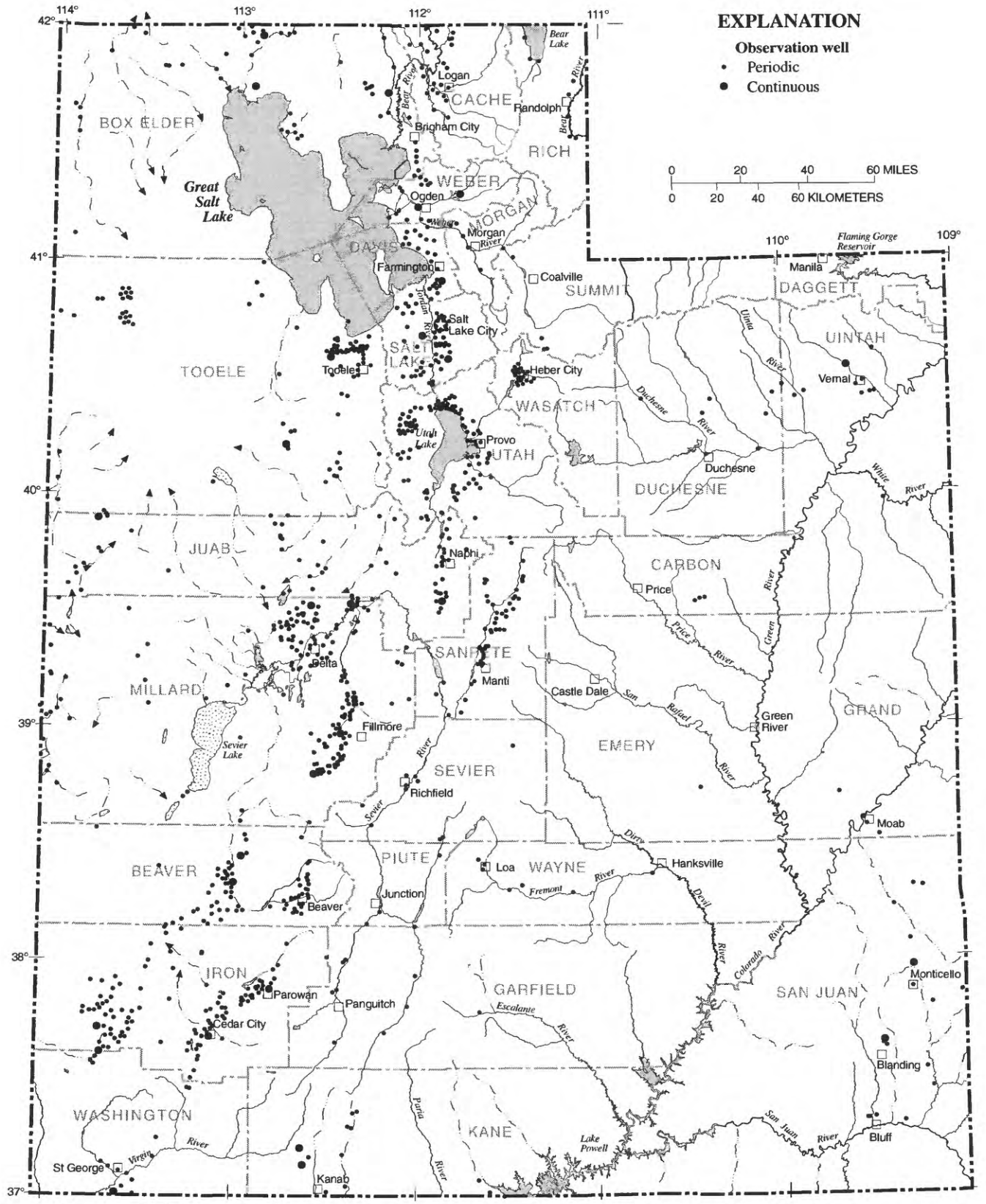


Figure 4. Location of observation wells in which water levels were measured.

Water-Quality, Fluvial-Sediment, and Precipitation Data

Number: UT–00–003; UT–00–004; UT-00-005

Cooperating Agencies: Utah Division of Water Resources; Utah Division of Water Rights; Utah Division of Oil, Gas, and Mining; Bureau of Reclamation

Staff: J.R. Kolva, Supervisory Hydrologist, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Data on the quality of surface and ground water and the sediment load in selected rivers are needed for the management of water resources. Water-quality problems can affect industries, water-treatment facilities, irrigators, and individuals. Sediment reduces storage in reservoirs, contaminates water supplies, and harms fisheries. Sediment and precipitation data are needed for erosion studies, reservoir design, water-resources management, and water-quality evaluation. Data bases are needed to store and provide the appropriate water-quality, sediment, and precipitation information.

Objective: To obtain records of water quality, sediment, and precipitation at selected sites throughout Utah.

Approach: Standard methods will be used for the collection and analysis of water-quality samples, fluvial-sediment samples, biological samples, and precipitation data, and for the computer storage and publication of data.

Progress: Water samples for chemical analysis were obtained periodically at 12 stream sites (fig. 5) using the USGS parts per billion inorganic sampling protocol. In addition, continuous or daily temperature and/or specific-conductance data were obtained at eight of these stream sites. About 200 wells are in the ground-water-quality monitoring program (fig. 6), of which complete chemical analyses were obtained from about 70 wells. Water from about 20 surface-water sites in Utah, Uintah, and Duchesne Counties was sampled using the USGS parts per billion inorganic sampling protocol. All water-quality data for streams and wells are listed in the annual water-resources data reports. Sediment data were obtained during snowmelt at one site and periodically at three additional sites. Supervision of the acid-rain network site near Green River continued.

Plans for Next Year: Continue collecting water-quality data from selected surface-water sites by using the inorganic sampling protocol. Continue processing data and preparing records for publication. Continue collecting water-quality data from the State ground-water network and from selected wells in the brine-injection area of the Uinta Basin. Continue collecting precipitation data. Continue supervision of acid-rain network site near Green River.

Report:

Herbert, L.R., and others, 1997, Water resources data for Utah, water year 1996: U.S. Geological Survey Water-Data Report UT–96–1.

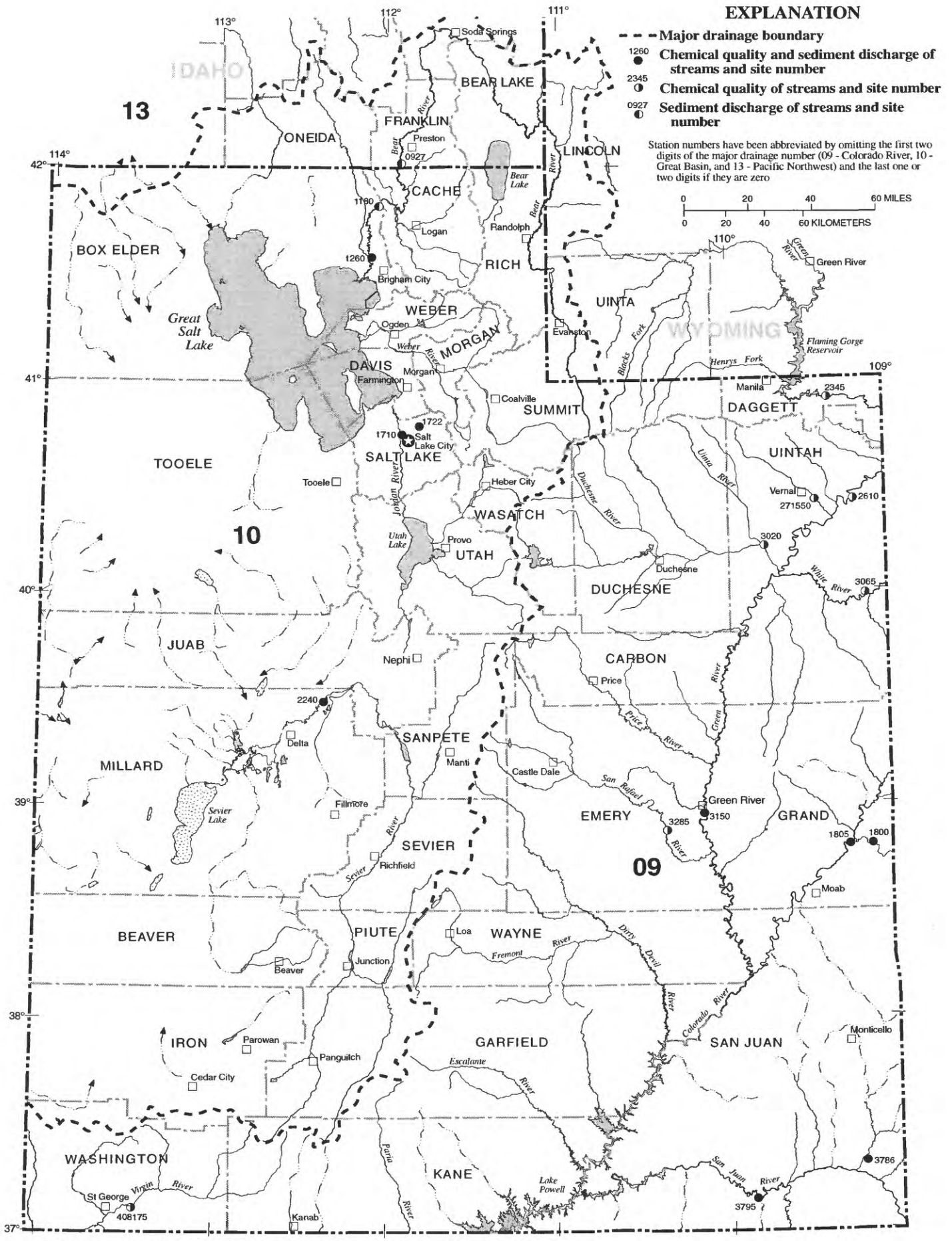


Figure 5. Location of surface-water-quality stations.

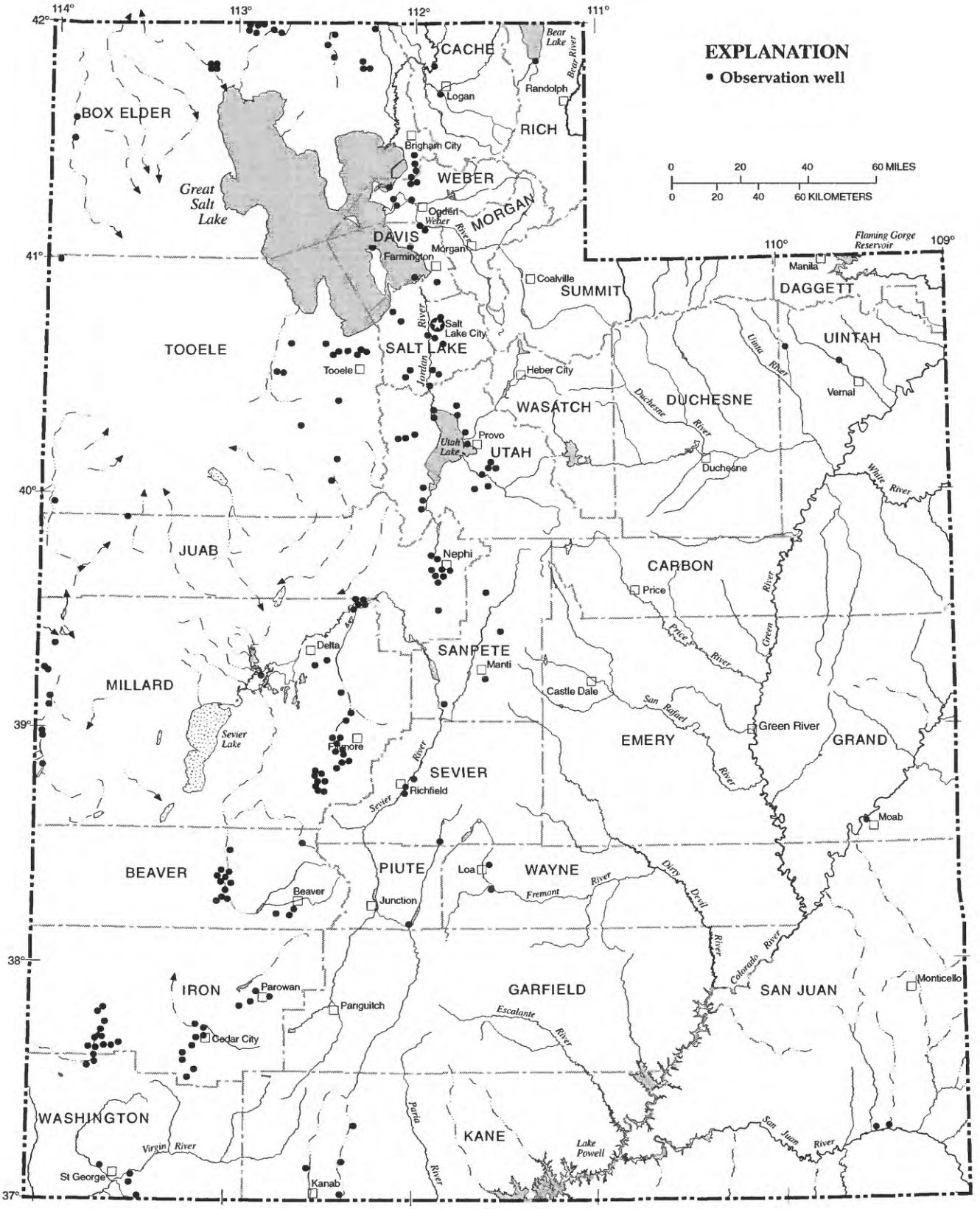


Figure 6. Location of observation wells from which water samples were collected for monitoring water quality.

Interpretive Studies

The location of each interpretive study discussed in this section is shown in figure 7.

Statewide Water Use

Number: UT–00–007

Cooperating Agencies: Utah Division of Water Rights; Utah Division of Water Resources

Staff: H.K. Hadley, Hydrologist, Project Chief (part time)
K.K. Wilson, Hydrologic Technician (part time)

Period of Project: July 1977—Continuing

Problem: In 1977, the U.S. Congress recognized the need for consistent, current, and reliable water-use information on water for the entire United States and directed the USGS to establish a program to collect, compile, and publish such data. These data are needed to document trends in total water use and in the different categories of use, and to aid in the management of the Nation's water resources.

Objective: To obtain information about the withdrawal and return flow of water for different uses, and the consumptive use of water for each use category.

Approach: Determine total amount of water diversion and consumptive use by verification of user measurements and records and, where possible, by field inventory and measurement of surface-water diversions and selected types of ground-water diversions. Use acreage and crop surveys to estimate consumptive use by irrigation. State personnel are collecting data on public-supply and industrial use; USGS personnel are collecting data on irrigation use.

Progress: Mail surveys were done by the Utah Division of Water Rights to determine water use by about 390 public-water suppliers and about 120 major self-supplied and public-supply industries. Water-use data that were collected and compiled for the Utah section of the "1995 Estimated Use of Water in the United States" report were checked and sent to be compiled with data from the other States. Aquifer data were calculated, compiled, and checked. Major water-use categories include public supply, domestic, commercial, industrial, mining, fossil fuel, hydroelectric power, livestock, animal specialities, irrigation, wastewater, and reservoir evaporation.

Plans for Next Year: A fact sheet will be created for comparison of 1985, 1990, and 1995 water-use data in Utah.

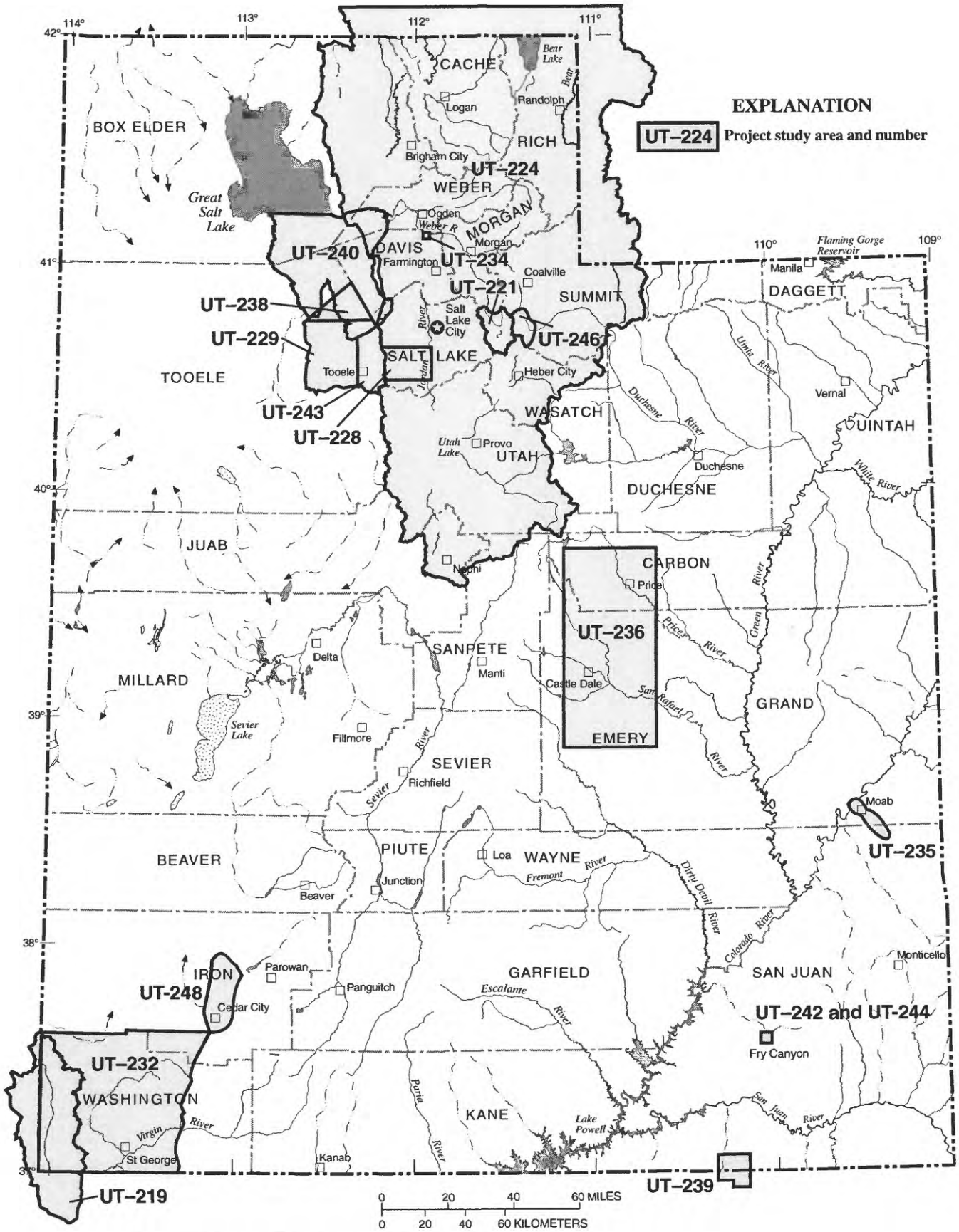


Figure 7. Location of interpretive studies done in the State of Utah.

Mechanisms of Stream Recovery from Metal Contamination

Number: UT-97-208

Cooperating Agencies: None

Staff: B.A. Kimball, Hydrologist, Project Chief
L.J. Gerner, Hydrologist (part time)

Period of Project: February 1986 to September 2001

Problem: Past mining of ore deposits in the Western United States has yielded metals with significant economic value. Water flowing through abandoned tailings and from draining mine adits contributes cadmium, copper, iron, lead, manganese, nickel, and zinc to hundreds of streams. Reactive solute-transport processes affecting these metals are not well quantified. An interdisciplinary study of controls on trace-element concentration in streams throughout the West will allow a better understanding of the transport and removal mechanisms involved.

Objectives: The objectives of this study are to (1) characterize the in-stream chemical processes that control the transport and distribution of trace elements in streams; (2) characterize the chemistry of sediment and sediment coatings that are active in controlling the dissolved concentration of trace elements; and (3) quantify the time and length scales for chemical and hydrologic processes that affect the metals, and determine the extent to which chemical equilibrium has been attained.

Approach: Spatial profiles of pH, metal concentrations, and major solutes in streams affected by acid mine drainage are the result of the interaction of hydrologic and geochemical processes. One of the most useful ways to study these processes and to gain understanding of the many contributions to metal loading in streams is with tracer-injection studies. Tracers are used to calculate discharge throughout a stream reach. Samples of water and colloids are collected to study geochemical processes in the context of hydrologic transport. This also results in characterization of a watershed with a detailed profile of metal loading to the stream so that all the sources can be considered.

Progress: The Abandoned Mine Lands Initiative began in FY97. Studies were done in Cataract Creek, Montana, and in the Animas River, Colorado. Results will support biologic and geologic work to assess the watershed and individual sites.

Two tracer-injection studies were requested by the U.S. Environmental Protection Agency and one by the Bureau of Land Management. Most of the year was occupied with planning, conducting, and analyzing results from these injections. A paper published in Environmental Science & Technology culminated 6 years of work on the development and application of a reactive solute-transport model. Simulations of the data set from a 1988 experiment provided important interpretations of the amount of pH control by atmospheric carbon dioxide, by precipitation of aluminum and iron hydroxides, and by exchange of hydrogen ion with the streambed iron. A special publication of the Society of Economic Geology presented much of the information about the interaction of metals and wetlands. An open-file report was written as the initial publication that brought together the Geologic and Water Resources Divisions for the study of interaction among water, colloids, and bed sediments.

Plans for Next Year: Analysis of data from five tracer-injection studies done last summer will occupy much of FY98. As chemical results become available, reports of the results and simulations will be compiled. Papers will be prepared for data from 1993, 1994, and 1995 from St. Kevin Gulch, Colorado. Two tracer experiments are planned for the summer as part of the Abandoned Mine Lands Initiative.

Water Resources of Snyderville Basin, Park City, and Surrounding Communities, Summit County, Utah

Number: UT-93-221

Cooperating Agencies: Utah Division of Water Rights; Park City; Summit County; Weber Basin Water Conservancy District

Staff: J.L. Mason, Hydrologist, Project Chief
L.E. Brooks, Hydrologist (part time)
P.A. Downhour, Hydrologic Technician (part time)

Period of Project: July 1993 to September 1997

Problem: The Snyderville Basin and Park City study area is defined as the southwestern corner of Summit County, including the valley generally south of and straddling Interstate 80 through which East Canyon Creek flows (Snyderville Basin); the area around Park City, including Prospector Square and Deer Valley; and the area from Richardson Flat to Tollgate Canyon. Population in this area has increased substantially from 1980 through 1993, and much of this increase has occurred since 1987.

Increasing demands on the ground- and surface-water resources in the area are being caused by residential, industrial, and commercial development, and by ski areas planning to increase snow-making operations. Water supply is one of the major constraints on development of additional residential areas and commercial activities. Surface water in the area is part of the Weber River drainage basin and is considered to be fully appropriated. There are concerns about the effect of increased ground-water withdrawal on springs, surface-water flow, and ground-water levels.

Water quality in the Park City area is suitable for domestic purposes but could deteriorate with industrial development or if centralized sewage treatment cannot accommodate the increase in housing developments. At least two public-water suppliers have indicated that sulfate concentration is increasing. The cause of increased concentration of certain dissolved constituents is not known but could be related to changes that have occurred in the hydrologic system as a result of development.

Objectives: The purpose of the study is to provide water-resources planners and managers with quantitative information on water resources in the Snyderville Basin and Park City area. Specific objectives of the study are to (1) define and describe the lateral and vertical extent of the principal aquifers in the area; (2) describe the hydrologic system, including hydrologic properties of the aquifer, surface-water discharge and variability, ground-water recharge, rate and direction of movement, discharge, and storage and water use; (3) improve estimates of existing water budgets of the area to give managers a more accurate tool to use for planning additional development; (4) define and describe the interaction of surface and ground water; (5) describe the chemical quality of the surface and ground water and identify potential causes of increasing dissolved-solids concentration; and (6) describe the hydrologic and hydrochemical effects that could be expected to occur as development creates a steadily increasing need for more water.

Approach: (1) Collect hydrologic and geologic data that can be used to define the geometry of the principal aquifers; (2) formulate a conceptual model of the hydrologic system and recharge and discharge using aquifer tests, fracture analysis, precipitation records, water-level data, water-use data, spring and streamflow measurements, and water-quality data; (3) collect surface- and ground-water samples and analyze them for potential causes of increasing dissolved-solids concentration; (4) if possible, develop tools to examine the water-balance relations in the project area; (5) prepare a report documenting the data collected; and (6) prepare a report describing the analysis of the data and results of the study.

Progress: The data report has been published. Snowmelt runoff simulation was completed for 1994 and 1995. The results of the runoff simulation were used to refine the water budgets for six subbasins within the study area. The total-water, surface-water, and ground-water budget was determined for each subbasin and for the entire study area. Interpretation of ground-water flow paths, source areas, and discharge areas was completed. The interpretive report was completed and sent for colleague review.

Plans for Next Year: Colleague review comments for the interpretive report will be addressed and the report will be submitted for approval for publication.

Simulating Climate-Biosphere Interactions Under Changing Climate Conditions

Number: UT-97-223

Cooperating Agency: U.S. Environmental Protection Agency

Staff: D. Marks, Hydrologist, Project Chief (part time)
D.D. Susong, Hydrologist (part time)

Period of Project: October 1993 to September 1997

Problem: Global climate changes affect the terrestrial biosphere through changes in the regional energy balance and associated changes in the regional water balance. Large shifts in vegetation patterns and conditions could occur as the result of climate change. Changes in the regional water balance influence interaction between vegetation and climate by altering the magnitude and timing of surface albedo and radiation balance, soil-moisture storage, and evapotranspiration. New hydrologic models must be developed to simulate the spatial magnitude and extent of hydrospheric processes and properties in response to changing climatic conditions.

Objectives: (1) Develop a coupled energy and water balance (CEWB) model that simulates vegetation-water interaction under any climate conditions in any region or river basin on the globe; (2) develop methodologies to extend sparse, irregularly distributed observations of climate parameters such as precipitation, temperature, humidity, and wind over complex topography to provide the spatially distributed inputs required for models; and (3) modify and implement an energy-balance snowmelt model to simulate patterns of snowmelt and runoff at multiple scales over the simulated boreal-forest region in Canada.

Approach: The strategy is to bridge the gap between the detailed process simulation of the watershed-scale models and the simple land-surface hydrology of the coarse-resolution global climate models. Models will be developed to simulate hydrologic processes over large regions that include complex topography, soils, and vegetation. These models will be extensions of previously developed watershed-scale models and will include coupled vegetation-hydrologic processes. They will provide the foundation for future global-scale models that accurately represent vegetation-water interaction.

The regional-scale models will be used to (1) improve the understanding of the response of critical hydrologic processes (precipitation, evapotranspiration, soil moisture, and runoff) to climate variation over large heterogeneous regions; (2) determine the sensitivity of critical processes to projected climate change; and (3) assess potential effects of climate change on specific regions of interest. The regional models also will be used to (1) develop improved representation of critical hydrologic processes in continental- and global-scale models; (2) determine the minimum data, time-step, and spatial resolution required for global-scale simulations; and (3) calibrate continental- and global-scale models under current and projected conditions.

Progress: Project has been completed.

Plans for Next Year: None.

National Water-Quality Assessment (NAWQA) for Great Salt Lake River Basins, Utah, Idaho, and Wyoming

Number: UT-94-224

Cooperating Agencies: None

Staff: K.M. Waddell, Supervisory Hydrologist, Project Chief
R.L. Baskin, Hydrologist
S.A. Thiros, Hydrologist
D.W. Stephens, Biologist
E.M. Giddings, Biologist
S.J. Gerner, Hydrologic Technician

Period of Project: October 1993—Continuing

Problem: The status and trends of the Nation's water quality have not been evaluated on a consistent basis so that nationwide comparisons can be made.

Objective: To describe the status and trends of water quality in a nationally consistent manner.

Approach: The Great Salt Lake River Basins study unit was initiated as 1 of 60 nationwide study units planned for the NAWQA. The quality of both ground and surface water will be studied by using a nationally consistent approach for design of data collection and methodology for collection and analysis of water samples.

Progress: The Great Salt Lake River Basins study unit was restarted during FY97. A surface-water specialist, ground-water specialist, biologist, and lead technician were selected for the NAWQA staff, who will begin part-time work in FY97. The staff prepared a detailed workplan for FY98, attended water-quality meetings, presented NAWQA plans to a Liaison Committee, continued work on digital coverages of the NAWQA study area, and prepared a data base for a retrospective report. The staff attended a coordination meeting with the Utah Department of Environmental Quality and other State agencies.

Plans for Next Year: A mobile laboratory will be procured and equipped. The surveys for ground water will be initiated. Bed-sediment and tissue sampling will be completed during the late summer of FY98. Streamflow gages and other water-quality monitoring equipment will be installed at basic-fixed sites. Existing water-quality data will be compiled and evaluated, and a draft of the report will be prepared.

Kennecott Utah Copper Plume

Number: UT-94-228

Cooperating Agency: U.S. Environmental Protection Agency

Staff: B.J. Stolp, Hydrologist, Project Chief
J.L. Mason, Hydrologist (part time)
W.F. Holmes, Supervisory Hydrologist (part time)
H.K. Hadley, Hydrologist (part time)

Period of Project: August 1994 to September 1996

Problem: During mining of a sulfide ore deposit to extract valuable minerals and metals, the principal aquifer of the ground-water system of southwestern Salt Lake Valley has been recharged with water of poor quality. Three sources of the poor-quality water are the Large Bingham Creek Reservoir, the South Jordan Evaporation Pond, and runoff from the abandoned mine tunnels and tailings in the Lark area. Low pH values and increased concentrations of sulfate, trace metals, and dissolved solids characterize the contaminated ground-water system. Copper, selenium, and other metals also have been introduced to surface and ground water at the northern end of the Oquirrh Mountains. Kennecott Utah Copper, Inc. (KUC) is the responsible party and principal investigator of this contamination study, which qualifies for the National Priority List but has not been listed.

Objective: The U.S. Environmental Protection Agency (EPA), KUC, and the Utah Department of Environmental Quality (UDEQ) agreed to do a Remedial Investigation/Feasibility Study (RI/FS) to characterize site conditions and evaluate remedial alternatives. At the request of the EPA and with the consensus of members of a technical review committee, the USGS agreed to serve as technical advisor to the EPA and oversee the RI/FS activities done by KUC in their efforts to characterize, delineate the extent of, and remediate the contaminated ground water.

Approach: As part of the RI/FS process, KUC will (1) install monitoring wells, (2) conduct aquifer tests, and (3) collect and analyze ground-water samples. The USGS will periodically observe these activities to ensure adherence to standard operating procedures. Duplicate water samples will be collected for analysis at the USGS National Water Quality Laboratory or at other laboratories. KUC will incorporate the results of their analyses of field data into conceptual and computer models of the contaminated areas and will evaluate remedial alternatives. USGS personnel will critique documents and workplans, oversee the development of computer models, and provide technical assistance as the need arises.

Progress: USGS personnel provided technical reviews of geochemical studies and ground-water flow modeling. The reviewed work is part of the appendices and body of the RI for southwestern Salt Lake Valley. USGS personnel attended all technical review committee meetings held in FY97.

Plans for Next Year: The USGS will continue to provide, as needed, technical review and advice on each phase of the RI/FS. Results of geochemical, ground-water flow, and solute-transport simulations will be reviewed.

Central Virgin River Ground-Water Study, Southwestern Utah

Number: UT-95-232

Cooperating Agencies: Utah Division of Water Rights; Washington County Water Conservancy District

Staff: V.M. Heilweil, Hydrologist, Project Chief
D.E. Wilberg, Hydrologist (part time)
C.D. Wilkowske, Hydrologic Technician (part time)
G.W. Freethey, Supervisory Hydrologist (part time)

Period of Project: April 1995 to September 1999

Problem: The central Virgin River basin and especially the communities of St. George, Washington, Hurricane, Santa Clara, and Ivins are experiencing tremendous growth. The 1990 census indicates that the population of these communities has doubled since 1980. State and local agencies are concerned that the increase in population will cause water shortages unless prudent planning measures are implemented.

Objectives: Additional knowledge gained from studying the ground-water systems of the central Virgin River basin would help State and local water-resource managers plan for growth in ground-water use without jeopardizing the resource. Objectives are to (1) quantify the ground-water resources in the Navajo Sandstone aquifer and New Harmony/Kanarraville alluvial aquifer, and (2) review the potential water-yielding capability of other significant aquifers within the study area.

Approach: Phase 1: Compile, synthesize, and collect appropriate surface-water, ground-water, and water-quality data. Phase 2: Investigate the lithologic character, structure, and stratigraphic relation of the formations that make up the important aquifers of the area. Phase 3: Analyze and interpret the data and conceptualize and describe the hydrologic system. Phase 4: Develop the ground-water flow model and simulate movement of ground water into, within, and from the Navajo Sandstone aquifer and the New Harmony/Kanarraville alluvial aquifer.

Progress: Water-level inventory (about 60 wells) has been completed; 5 aquifer tests (Hurricane Bench, Gunlock well field, Grapevine Pass, Anderson Junction, and New Harmony) were done; Navajo aquifer spring-discharge inventory has been completed; potentiometric maps for the Navajo aquifer were constructed; 35 ground-water samples were collected for laboratory analysis of general chemistry, stable isotopes, and chlorofluorocarbons; ground-water budget data for the Navajo aquifer have been compiled; and the ground-water flow model of the New Harmony/Kanarraville alluvial aquifer and the Gunlock part of the Navajo Sandstone aquifer has been developed. A data report containing water-level, water-chemistry, and discharge data has been prepared.

Plans for Next Year: Develop a ground-water flow model for the Navajo aquifer, analyze and interpret water-chemistry data as related to ground-water flow paths, and prepare an interpretive report on the central Virgin River basin ground-water study, including documentation of the three ground-water flow models.

Hydrogeology of Hill Air Force Base and Adjacent Areas, Utah

Number: UT-95-234

Cooperating Agency: U.S. Air Force, managed by the Hill Air Force Base Environmental Management Restoration (EMR) Division

Staff: S.A. Thiros, Hydrologist, Project Chief

Period of Project: February 1995 to September 1999

Problem: A large quantity of data has been collected to better understand the extent of contamination to the ground-water system at Hill Air Force Base on a site-specific scale. Information on lithology, water level, water chemistry, well completion, and hydrologic properties is available from investigations of eight sites, and much of the information has been entered into a central data base. A better understanding of the ground-water system on a larger scale is necessary to conduct future environmental investigations.

Objectives: (1) To gain a better understanding of the subsurface using lithologic and geophysical information; (2) to better define the ground-water flow system of the area in and around Hill Air Force Base, primarily using existing data; (3) to update the geographic-information-system (GIS) data base with data pertaining to environmental investigations; (4) to develop versatile tools that allow better visualization of the hydrologic data; and (5) to evaluate changes in the extent of contaminants in the subsurface with time.

Approach: (1) Construct generalized cross sections of the subsurface for areas where adequate data are available, (2) study the ground-water flow system of the area in and around Hill Air Force Base, (3) obtain information relevant to environmental investigations at Hill Air Force Base from other sources and compile the information into the EMR-GIS data base, (4) work with the EMR computer section to develop programs that allow better visualization of hydrologic data using the GIS data base, and (5) use the GIS data base to map and contour subsurface contaminant concentration and to show the plume shape.

Progress: Borehole geophysical data from flowmeter, natural gamma, and induction logs were collected for selected wells to better understand ground-water flow. Assistance was provided in the application of an innovative geophysical technique based on electromagnetics to determine ground-water flow paths. Attribute data were linked with map features to create a data-base table for the regulated sites on the base.

Plans for Next Year: Continue to update maps and interpret the data that have been collected. Continue to develop the lease data base and associated maps showing lease information. Provide GIS support to EMR staff.

Baseline Ground-Water-Quality Mapping in the Spanish Valley Area, Grand and San Juan Counties, Utah

Number: UT-95-235

Cooperating Agencies: U.S. Environmental Protection Agency; Utah Division of Water Quality; Grand County; City of Moab

Staff: J.I. Steiger, Hydrologist, Project Chief
D.D. Susong, Hydrologist

Period of Project: October 1995 to September 1996

Problem: The Spanish Valley area is experiencing a rapid increase in development of residential and business property. Some of this development is taking place on the east side of Spanish Valley in the outcrop area of the Navajo Sandstone, which contains the principal drinking-water aquifer for the area. Additional development is occurring in the valley south of Moab where the valley fill makes up a secondary aquifer. Sewage-treatment facilities are currently inadequate to meet the sustained level of growth. Grand County would like to classify the water in the two aquifers according to the State's Groundwater Classification System and develop a pollution prevention plan that would help to protect the ground-water resources of Grand and San Juan Counties.

Objectives: The objectives of this study are to provide Grand County with maps showing (1) recharge areas for the valley-fill and Navajo aquifers, (2) dissolved-solids concentration in water from wells in the valley-fill and Navajo aquifers, and (3) a table showing water-quality data for water from selected wells and springs in Spanish Valley.

Approach: (1) Compile existing water-quality data; (2) collect water samples from 20 wells completed in the valley-fill aquifer and 10 springs or wells completed in the Navajo aquifer; analyze the samples for common ions, inorganic constituents, metals, and nutrients; and analyze samples from 12 of the 30 sites for organic constituents; (3) interpret geologic maps and aerial photographs to delineate recharge areas for the valley-fill and Navajo aquifers; and (4) prepare water-quality and recharge-area maps for publication and write the interpretive report.

Progress: The interpretive report has been completed.

Plans for Next Year: Publish the interpretive report.

Determination of Background Methane Concentrations in Soil Gas and Shallow Ground Water near Price, Utah

Number: UT-95-236

Cooperating Agency: Utah Division of Oil, Gas, and Mining

Staff: D.L. Naftz, Hydrologist, Project Chief
H.K. Hadley, Hydrologist (part time)

Period of Project: July 1995 to September 1996

Problem: Ongoing and future development of coal-bed methane resources in the vicinity of Price, Utah, could cause migration of methane into near-surface environments. After dewatering, the methane can potentially migrate into the shallow subsurface (saturated and unsaturated zones) through abandoned wells, conventional gas wells, coal-bed gas wells, cathodic protection wells, and natural fractures. Pre- and early development baseline methane concentrations in ground water and soil gas are needed to measure the effects of future development of coal-bed methane resources in the vicinity of Price, Utah.

Objectives: The overall objective of the study is to determine the pre- and early development methane concentrations in ground water and soil gas in areas to be affected by development of coal-bed methane in the vicinity of Price, Utah. Specific objectives are to (1) determine methane concentration in water samples from about 30 wells and springs in the study area, (2) determine soil-gas methane concentration in close proximity to about 20 active and plugged gas wells in the study area, and (3) calculate a threshold value for methane in ground water using appropriate statistical techniques.

Approach: Soil-gas samples will be collected from about 30 sites adjacent to active and plugged gas wells. Methane concentration will be determined onsite using a gas chromatograph with a flame ionization detector.

Progress: Twenty sites were sampled for methane concentration in soil gas. The results were tabulated, interpreted, and discussed with the cooperator. A four-page fact sheet discussing data collected over the last 2 1/2 years was prepared and approved for publication.

Plans for Next Year: The fact sheet will be printed and distributed by mid-February of 1998. Continued monitoring at 30 soil-gas sample sites within the study area is planned for May or June 1998.

Conceptual and Computer Models of Ground-Water Flow in Tooele Valley, Utah

Number: UT-95-238

Cooperating Agencies: Tooele County; U.S. Army; Utah Division of Water Resources; City of Tooele; City of Grantsville

Staff: P.M. Lambert, Hydrologist, Project Chief
M. Stanger, Geographer, University of Utah (part time)

Period of Project: August 1995 to March 1998

Problem: The increasing population of Tooele Valley requires additional water supplies for industrial, public supply, and domestic use. Ground water is the most important source of water in Tooele Valley, and increased withdrawal is expected to cause water levels to decline and may require well owners to lower pumps or deepen wells. Lower water levels also could reduce the discharge from flowing wells, the discharge to springs, and the crop yield of subirrigated lands in the lower parts of the valley. Water managers need a tool that is capable of determining the effects of continued ground-water development on the ground-water system in Tooele Valley.

The availability of ground water for public supply is limited by quality. Areas of poor-quality ground water, unsuitable for public use, have been identified in Tooele Valley. High sulfate concentrations in ground water in the Pine Canyon area and in the southern part of the valley are probably a result of recharge from tunnels containing mine-drainage waters. Water from wells in the northern part of the valley contains high sodium chloride concentrations that could be related to dissolution of evaporites deposited in ancient lakes. Industrial wastewater containing organic solvents has contaminated ground water at Tooele Army Depot. Some ground water near Bates Canyon has a nitrate concentration that is greater than State drinking-water standards. Increased ground-water withdrawal and resultant water-level decline in Tooele Valley may induce the movement of poor-quality water into freshwater aquifers. A better understanding of the direction and rate of ground-water flow in Tooele Valley is needed.

Currently allocated water rights are thought to exceed the total annual inflow of good-quality ground water to basin-fill material in the valley. The State of Utah needs to know the effects of additional ground-water development on the hydrologic system and the source area for water withdrawn from proposed wells at several locations within the valley. A better understanding of the flow system would allow water managers and planners to anticipate and prevent migration of poor-quality water to points of withdrawal and better manage development of the principal aquifer.

Objectives: To improve the understanding of the ground-water system in Tooele Valley and to develop computer models that can be used to investigate ground-water flow.

Approach: The approach to achieving the objectives includes (1) compilation and interpretation of available hydrologic and geologic data to develop an improved conceptual model of the ground-water flow system in Tooele Valley, (2) development of a three-dimensional, numerical computer model of ground-water flow in Tooele Valley, and (3) application of the numerical model in conjunction with a regridded, embedded flow model to investigate flow paths and advection processes in the vicinity of Tooele Army Depot.

Progress: During 1997, the conceptual and numerical models of the regional ground-water flow system of Tooele Valley were completed. Calibration of the numerical model was accomplished by simulating steady-state conditions in 1968 and 1992 and transient-state conditions during 1969-94. The interpretive report that describes these models has been written and reviewed by colleagues within the USGS. Response to colleague review comments has been completed. The embedded ground-water flow model of Tooele Army Depot has been constructed and linked to the regional ground-water flow model of Tooele Valley.

Plans for Next Year: Work during 1998 will focus on quantifying the effects of regional processes on the ground-water flow system at Tooele Army Depot. This will include an initial quantification of flow paths and advection processes (using particle-tracking techniques) within the embedded model area and their sensitivity to simulated changes in the regional ground-water system. A report documenting this work will be completed, submitted for editorial and technical review, and published upon approval.

Ground Water in the Monument Valley Area of the Navajo Indian Reservation, Utah and Arizona

Number: UT-95-239

Cooperating Agency: Navajo Nation Department of Water Resources

Staff: L.E. Spangler, Hydrologist, Project Chief
G.W. Freethey, Supervisory Hydrologist (part time)

Period of Project: August 1994 to September 1996

Problem: The Navajo Indian Reservation (the Navajo Nation) in Utah lies within one of the driest parts of the Western United States. Normal annual precipitation is generally less than 8 inches. Water supplies for people living on reservation lands are generally from wells and springs, but in some areas these supplies are small or are slightly to moderately saline and not suitable for domestic purposes. One area where the supply of drinking water is especially scarce is Monument Valley, which is near the center of the Utah part of the Navajo Reservation and extends south into Arizona.

The principal concern of the Navajo Nation Department of Water Resources is maintaining an adequate water supply for the residents of the Monument Valley area. Additional water sources need to be identified to avoid the expense of piping water into the area from the San Juan River. In addition, supplemental water supplies need to be developed to meet the needs of the increasing number of tourists.

Objectives: To (1) determine the feasibility of developing additional water supplies in alluvial deposits along the Oljeto Wash drainage system and characterize the quality of the shallow ground water; (2) describe the stratigraphy, structural character, and water-bearing potential of consolidated rocks in the Monument Valley area and the chemical quality of water contained in the rocks; and (3) analyze the potential for ground-water development from these consolidated rocks on the basis of hydrologic properties, proximity to possible recharge sources, and the feasibility of using conventional drilling techniques.

Approach: Specific work elements for objective 1 are to (1) inventory wells and springs and establish a discharge, water-level, and water-quality monitoring network; (2) install 10 to 20 monitoring wells in areas where data are needed; (3) determine the extent and thickness of the alluvial aquifer; (4) determine the water-transmitting properties of the alluvium; and (5) determine the quantity of ground water in storage and the amount of ground water that can be developed.

Work elements for objective 2 are to (1) inventory oil or gas test holes drilled into consolidated formations in the study area; (2) search geologic literature for additional information on structure and lithology; (3) identify wells and sample and analyze the water for dissolved-solids and major-ion concentrations; and (4) construct maps and cross sections showing the geology of the consolidated rocks and the quality of water in the consolidated-rock aquifers.

Work elements for objective 3 are to (1) identify significant water-bearing formations and estimate water storage and transmitting properties; (2) arrange, design, and conduct aquifer test(s); (3) estimate hydrologic properties from results of specific-capacity tests; (4) construct potentiometric-contour maps; (5) estimate the effects of geologic structure and stratigraphy on the occurrence and movement of ground water in the consolidated rocks of the area; (6) identify areas of ground-water recharge and estimate the rate of recharge; (7) locate and identify areas of ground-water discharge and estimate the rate of discharge; and (8) identify test-hole drill areas to explore ground-water sources below the DeChelly Sandstone.

Progress: In FY97, a 6-day aquifer test was completed and the analysis report was written. Several additional single-well and slug tests were completed. All monitoring wells were surveyed. Surface geophysical surveys (magnetotelluric) were done across two parts of the valley. Archaeological surveys were done along a projected seismic line. Three additional wells were drilled and logged in the eastern part of the study area. Water samples were collected from the new wells and also collected from other wells and springs in the study area. Water levels were measured monthly in an established network of 17 wells. Writing was begun on a map report that summarizes results of the alluvial aquifer study.

Plans for Next Year: The map report for the alluvial aquifer study will be finished and published. The aquifer test package will be submitted to region for final approval and forwarding to the cooperator. Other single well and slug tests done in FY96 will be analyzed. The consolidated-rock aquifer study will begin, which includes collection of water samples from various bedrock units and completion of two aquifer tests. Borehole geophysical logs will be run in two wells that were drilled in alluvium in FY96. A seismic survey may be done. Work will begin on the final interpretive report for the project. A meeting is planned to update the cooperator on progress and plans to discuss potential future work.

Assessment of Brine Shrimp Population and Nutrients in Great Salt Lake, Utah

Number: UT-95-240

Cooperating Agencies: Utah Department of Wildlife Resources; Utah State University

Staff: D.W. Stephens, Hydrologist, Project Chief
K.K. Johnson, Hydrologic Technician
Other District personnel as required

Period of Project: July 1995 to July 1998

Problem: Great Salt Lake supports a $90-million per year brine-shrimp industry. More information is needed about the population, structure, food-resource base, and variables that affect shrimp population dynamics.

Objectives: (1) Determine changes in sex and age-class structure of the shrimp population throughout the year, (2) measure variations in nitrogen and phosphorus concentrations at selected sites throughout the year, (3) measure the quality and quantity of algal resources available to shrimp, and (4) measure standard limnological variables in the water column and correlate them with changes in the algal and shrimp communities.

Approach: Sample brine shrimp, nutrients, and conditions at randomly selected, fixed stations at variable times throughout the year. Use biological, chemical, and physical data as input to a population model being developed at Utah State University.

Progress: Seventeen randomly selected sites were established and sampled about monthly. The usual chlorophyte phytoplankton community was determined to have been replaced by a diatom community. Associated with the initiation of diatom dominance were 2 years of record shrimp cyst production. In 1997, most of the diatoms present were larger than the oral cavity of the shrimp nauplii. As a result, development from nauplius to juvenile stage was severely limited and the shrimp crop declined dramatically. Harvest of the shrimp cysts was stopped after only 3 weeks because the crop was so poor.

Plans for Next Year: Complete analysis of samples and write data report.

Field Demonstration of In-Situ Chemical Barriers to Control Uranium Contamination in Ground Water, Fry Canyon, Utah

Number: UT-96-242

Cooperating Agencies: U.S. Environmental Protection Agency; Bureau of Land Management; U.S. Department of Energy; Utah Department of Environmental Quality

Staff: D.L. Naftz, Hydrologist, Project Chief
G.W. Freethey, Supervisory Hydrologist (part time)
R.C. Rowland, Hydrologic Technician (student)

Period of Project: October 1995 to September 1999

Problem: Potable ground-water supplies worldwide are contaminated or threatened by advancing plumes containing radionuclides and metals. Passive in-situ chemical barriers may offer a cost-effective alternative or supplement to pump-and-treat technologies for controlling ground-water contamination. An in-situ chemical barrier is a permeable zone of reactive materials that are placed in the subsurface to remove ground-water contaminants and results in clean ground water exiting from the treatment zone. Laboratory experiments have indicated the usefulness of chemical barriers; however, field demonstrations of these technologies are needed to test their usefulness for ground-water clean up. Abandoned and unreclaimed tailings from uranium-upgrading and copper-leaching operations adjacent to Fry Creek provide a site for the field demonstration of chemical-barrier technology to remove uranium from ground water. The Fry Canyon site is located on Bureau of Land Management property.

Objectives: (1) Characterize the predemonstration hydrologic and geochemical conditions in the shallow ground-water system at the Fry Canyon site; (2) assess developed technologies for application to the site, including laboratory experiments to obtain site-specific operating parameters; (3) design the field demonstration and obtain necessary permits; (4) perform the field demonstration; and (5) evaluate the performance of the field system and determine cost effectiveness of the process.

Approach: The investigation will be completed in five phases: (1) Characterize the predemonstration hydrology and geochemistry of the shallow ground-water system(s) using standard techniques, (2) use tailings and ground water collected from the site in laboratory experiments to obtain operating parameters for the field demonstration, (3) use laboratory and field data to design the field demonstration, (4) install the chemical barrier and conduct and monitor the field demonstration, and (5) use data collected from the field demonstration to determine method effectiveness and develop cost estimates for commercialization of the technique.

Progress: A multiagency and multidiscipline study team was assembled, and initial organizational meetings were conducted. A project work plan was completed and approved by the study team. Eight monitoring wells were installed and site hydrologic and geochemical conditions in the shallow ground-water system at the Fry Canyon site were determined. Three reactive chemical materials were selected for use in the chemical barrier based on laboratory experiments. Regulatory approval for installation of the chemical barrier was obtained. The chemical barrier and associated monitoring wells and equipment were installed. An abstract describing the initial study results was submitted and accepted for an upcoming scientific meeting.

Plans for Next Year: Publish results of the hydrologic characterization activities at Fry Canyon. Attend a scientific meeting on chemical barriers. Continue monthly and bimonthly field-monitoring activities to assess barrier performance. Produce a USGS Fact Sheet and journal article describing the demonstrations.

Determination of Nitrate Loading to the Basin-Fill Aquifer, Tooele Valley, Tooele County, Utah

Number: UT-97-243

Cooperating Agency: Tooele County

Staff: D.D. Susong, Hydrologist, Project Chief
K.K. Wilson, Hydrologic Technician (part time)
K.M. Hanson, Physical Scientist (part time)

Period of Project: January 1997 to December 1997

Problem: Historical land use in the Tooele Valley area was primarily agricultural with some mining and smelting. Substantial parts of the valley are still farmed today, but agriculture is slowly yielding to development of residential subdivisions. Many of these subdivisions do not have public water-supply systems or community sewage-treatment facilities and rely on individual wells and septic systems. The nitrate concentration of water from some individual wells in the eastern part of Tooele County exceeds the State standard of 10 mg/L. The amount of nitrate entering the ground-water system from septic systems and the effect on drinking-water supplies need to be determined. A compilation of chemical analyses of water from wells sampled since the 1970s shows that nitrate plus nitrite concentrations exceeded the State standards in eight wells and was three times the State standard in two wells east of Erda. All the samples that exceeded State standards were collected within the primary recharge area for the principal basin-fill aquifer that supplies most of the culinary water for Tooele Valley (Steiger and Lowe, 1997). Tooele County planners consider septic systems to be a major source of contamination that must be managed. To continue residential development with individual wells and septic systems, Tooele County planners need to determine which areas are susceptible to nitrate loading from individual septic systems and (or) other sources of nitrogen, and how nitrogen is cycled through the unsaturated zone.

Objectives: Objectives of the proposed study are to (1) assess nitrate loading to the principal aquifer in Tooele Valley and the effects of septic systems on water quality, (2) determine sources of nitrate contamination, and (3) delineate areas that are susceptible to nitrate contamination from septic systems.

Approach: The study will be conducted in two phases. In the first phase, the sources of existing nitrate contamination on the east side of Tooele Valley will be determined. In the second phase, a map will be prepared to show areas susceptible to nitrate contamination on the basis of soil and aquifer characteristics, land use, nitrate sources, unsaturated zone characteristics, ground-water recharge and discharge, and flow velocities.

Progress: The previously surveyed network of water-level measuring points in the Erda area was expanded. Water levels were measured, and an updated potentiometric-surface map was produced. Additional wells for sampling were selected and samples were collected from 10 wells. Samples were collected from two wells while they were being drilled to determine vertical nitrate gradients. Geographic-information-system coverages were compiled for land use, soils, and vegetation.

Plans for Next Year: Collect additional samples from new wells as they are drilled. Delineate nitrate plume and propose monitoring well locations. Redirect project to nitrate plume in place of nonpoint source contamination.

Development and Technology Transfer of the Iron Hydroxide/Phosphate Sandwich: A Reactive Chemical Barrier to Remediate Ground Water with Metal Contaminants

Number: UT-97-244

Cooperating Agencies: None

Staff: D.L. Naftz, Hydrologist, Project Chief

Period of Project: February 1997 to February 2000

Problem: Plumes of contaminated ground water are often managed by operating above-ground pump-and-treat systems. These systems require continuous site management and maintenance, which are generally expensive and not cost effective in removing contaminants that are strongly sorbed to porous media. An alternative technology that is receiving considerable attention is the use of in-situ reactive walls or barriers. In this technology, a ground-water plume flows through a permeable reaction zone within the aquifer where physical, chemical, or biological processes remove contaminants from the ground water. Clean ground water exits from the downgradient side of the reaction zone.

Objectives: The objective of the study is to develop the iron hydroxide/phosphate barrier sandwich and demonstrate its ability to clean up contaminated ground water so that a patentable product from the research can be obtained.

Approach: A combination of laboratory and field demonstrations will be used to produce a patentable product at the end of the project. This product will be used to remediate contaminated ground water in deep aquifers that cannot be treated using classic reactive-wall emplacement techniques.

Progress: Laboratory work on the various barrier materials and combinations was researched. The first prototype of the barrier-deployment package was constructed. The Area 1 site at Fry Canyon was characterized for future field demonstration work. Approval was obtained for initial barrier deployment at an in-situ uranium mine in Wyoming.

Plans for Next Year: Deploy and retrieve initial barrier packages at the Wyoming site. Determine uranium, selenium, arsenic, and vanadium removal efficiencies. Obtain permission to install nonpumping well array at Fry Canyon. Deploy modified barrier packages at Fry Canyon Area 1. Continue laboratory work on the different barrier materials and combinations, including the phosphate diffusion barrier. Apply for multiple patents on barrier-deployment package and barrier material.

Snowmelt Modeling in Mountain Basins

Number: UT-97-245

Cooperating Agencies: Natural Resource Conservation Service (NRCS)

Staff: D. Marks, Hydrologist (part time)
D.D. Susong, Hydrologist (part time)
David Garen, Natural Resource Conservation Service (part time)

Period of Project: May 1997 to September 2001

Problem: In the Western United States, snowmelt is the major source of streamflow. This resource is highly regulated and carefully managed. Streamflow forecasts are crucial to the management of regional water resources and are dependent upon the use of hydrologic models to simulate snowpack accumulation and ablation. Improvements in hydrologic modeling have direct effects in improving streamflow forecasts and management of water resources.

Objective: The objective of this study is to further develop and test a topographically distributed energy-balance snowmelt-runoff model that has been developed by the USGS and U.S. Environmental Protection Agency for use in simulating snowmelt runoff in mountainous basins.

Approach: Radiation, wind, and humidity sensors will be installed at two existing NRCS SNOTEL sites in the Boise River basin in Idaho. Similar instrumentation has been installed at SNOTEL and other data-collection sites in the Wasatch Mountains of Utah. The collected data, in addition to the existing precipitation and temperature measurements, will be input for the energy-balance snow model. Spatial data layers required for model input, including digital elevation, vegetation, soils, watershed boundaries, and measurement site locations will be prepared. Algorithms for estimating spatial fields of hydrometeorological parameters from point measurements will be used to process the data from the observational network into the input fields required by the model. Model testing will begin with data collected since October 1995. The results of model simulations will be verified against observations of streamflow, satellite-derived estimates of snow-covered area, and point measurements of snow-water equivalent and soil moisture. Snow-water equivalent data will be combined with estimates of snow-covered area to obtain spatial fields of snowcover properties so that the snow model can be verified on a grid-cell basis.

Progress: Model runs for the Park City area were completed. Results were presented at two meetings. Draft papers were completed. An analysis of rain-on-snow events in the Cascade Range was completed and a paper describing the results was accepted by the journal "Hydrological Processes." Major revisions to software documentation were completed. Initial simulations with the snowmelt model, including canopy effects, were completed.

Plans for Next Year: Publish results of Park City work in peer-reviewed journals. Publish model documentation in electronic format. Simulate snowmelt conditions in the Boise River basin and publish results.

Hydrology of Kamas Valley and Adjacent Areas, Summit County, Utah

Number: UT-97-246

Cooperating Agencies: Utah Division of Water Rights; Summit County; Weber Basin Water Conservancy District

Staff: J.L. Mason, Hydrologist, Project Chief
L.E. Brooks, Hydrologist
J.I. Steiger, Hydrologist

Period of Project: July 1997 to September 2002

Problem: Kamas Valley is experiencing increasing residential development. The water needed to support this new development will come from ground-water sources. The Utah Division of Water Rights needs to determine how additional ground-water development will affect existing surface- and ground-water appropriations. Existing data and results of past studies are not adequate to allow a thorough understanding of the hydrologic system. Specific needs include a better understanding of direction and rate of ground-water flow, the amount of recharge into, storage within, and discharge from aquifers, the hydrologic connection between surface and ground water, the quality of ground water prior to additional residential development, and the change in chemical composition of ground water as it moves through the ground-water system.

Objectives: The general objectives of the study are to define the geometry and character of the principal aquifers, define how the hydrologic system works and how various components interact, assess the existing quality of the water and its potential for degradation, and provide data, analyses, and tools by which the effects of future development of water on the hydrologic system can be estimated. Specific objectives of the study are to (1) describe the geohydrologic framework of the area, including the geometry of the principal ground-water systems of the area; (2) construct a steady-state ground-water flow model to help determine data needs and to test conceptual ideas; (3) determine or estimate the hydrologic properties of the unconsolidated valley fill and the consolidated rocks at selected locations; (4) determine the direction of ground-water flow in the unconsolidated valley fill in Kamas Valley; (5) refine previous estimates of ground-water recharge and discharge, where feasible; (6) describe ground-water and surface-water interactions in Kamas Valley; and (7) describe the chemical quality of surface water and ground water, including historical trends, extent and movement of nitrate, relation to land use if possible, and potential sources of degradation.

Approach: New and existing geohydrologic data will be collected, compiled, and interpreted to help define the hydrologic system and its interactions. Cross sections across the valley and across the fault on the east side of the valley will be constructed. A preliminary ground-water flow model will be used to determine additional data needs, and the ground-water flow model will be refined as additional data are collected. The steady-state calibration will be limited by the lack of data on natural recharge and discharge, hydraulic properties, and water levels in consolidated rocks. Because of the limited data and the lack of stress on the ground-water system, the model will not be calibrated to transient-state conditions. The steady-state ground-water flow model will be used to assess the general effects of additional ground-water development by comparing water-budget components before and after projected development. Aquifer properties will be determined by estimating transmissivity from specific-capacity values reported on drillers' logs and by completing single- and multiwell aquifer tests. The chemical quality of surface and ground water will be described, including historical trends, maps of water quality, and relation to land use, if possible. Potential sources of present or potential degradation of the water supply will be described on the basis of existing and possible future development.

Progress: The geologic framework part of the study was begun. Wells and springs were inventoried to locate suitable water-level monitoring wells and major springs for discharge measurements. A reconnaissance of streams and canals to determine complexities of the surface-water system was completed. One aquifer test was completed.

Plans for Next Year: Prepare project planning document. Complete inventory of wells. Finalize water-level monitoring network and measure water levels in about 20 wells monthly. Measure discharge from at least two springs and two streams monthly. Install shallow monitoring wells. Begin surface- and ground-water sampling to determine baseline water quality. Complete preliminary ground-water flow model to help determine what data needs to be collected.

Mass Loading of Metals from Historic Mining in Fisher Creek, Montana

Number: UT-97-247

Cooperating Agency: U.S. Environmental Protection Agency

Staff: B.A. Kimball, Hydrologist, Project Chief
L.J. Gerner, Hydrologist (part time)

Period of Project: July 1997 to December 1997

Problem: Abandoned and inactive mines in the Fisher Creek drainage near Cooke City, Montana, contribute metals to the stream. To assess the effects of historic mining activities on the water quality of Fisher Creek, the USGS carried out a tracer-injection study in August 1997.

Objective: The objective of the study is to determine the location and amount of metal loading from multiple sources of surface and ground water in the upper reaches of the Fisher Creek drainage.

Approach: A tracer injection will be used to calculate discharge along Fisher Creek. Water and colloid samples will be collected to study geochemical processes in the context of hydrologic transport. Metal-loading profiles will be produced to characterize the principal sources of metals to the stream, the metal-rich ground-water inflows, and reaches of the stream where metals are present because of chemical reaction.

Progress: The tracer-injection study was completed in August 1997. A sodium chloride tracer was added to the stream for 29.5 hours to provide the hydrologic context for a synoptic sampling of metal chemistry in streamwater and inflows. The detailed profile of stream discharge and metal loading indicated those subreaches of Fisher Creek where most of the metal loading occurred. Results indicate that there are substantial nonpoint-source contributions to metal loading in addition to the obvious point-source flows from adits and seeps from waste-rock piles. This indicates that treatment of large point sources will still leave metal concentrations in Fisher Creek at levels that may adversely affect aquatic life. The report was written and submitted for review.

Plans for Next Year: Publish report upon approval.

Movement and Chemical Composition of Ground Water in the Basin-Fill Aquifer, Cedar Valley, Utah

Number: UT-97-248

Cooperating Agency: Central Iron County Water Conservancy District

Staff: J.L. Mason, Hydrologist, Project Chief
D.E. Wilberg, Hydrologist

Period of Project: July 1997 to September 2003

Problem: Cedar City and the surrounding areas of Cedar Valley in southwestern Utah are experiencing rapid population growth typical of the Western United States. Ground water and surface water historically used for agriculture are being used increasingly for culinary and industrial supplies. Ground-water quality in the basin-fill aquifer is variable, and water suppliers need to know how much water can be pumped in different locations of the valley without causing poor-quality water to influence the public-supply wells.

Objectives: The general objective of the study is to define the hydrologic and hydrochemical systems in the basin-fill aquifer of Cedar Valley. Specific objectives are to (1) define the hydrologic properties of the basin-fill aquifer, (2) determine the direction and rate of ground-water movement, (3) define areal and temporal variations in the chemical composition of the ground water, (4) determine the processes responsible for variations in the chemical quality of the ground water, and (5) ascertain the effects of current and future ground-water withdrawals on the chemical quality.

Approach: The objectives will be achieved by (1) studying and mapping the surface and subsurface geology; (2) inventorying wells and collecting samples of ground water, surface water, and aquifer material to characterize the isotopic signature of end members; (3) using end-member mixing models to determine the source of nitrate in certain wells; (4) sampling and analyzing for inorganic constituents in ground water and using the results to determine reactions occurring along ground-water flow paths; (5) conducting aquifer tests and seepage investigations, studying climatic records, drillers' logs, water-level changes, water-level configurations, pumping variability, land-use patterns, and geologic framework of the aquifer to allow development of ground-water budgets; (6) constructing a qualitative ground-water flow model of the basin-fill aquifer in Cedar Valley to test current conceptual models and guide data collection; (7) constructing a quantitative steady-state model by matching the results from the model to measured hydrologic values; and (8) using the quantitative model to project likely flow paths to wells and likely sources of water to wells under various withdrawal alternatives determined by local water users.

Progress: Well inventory has begun to determine which wells are suitable for inclusion in the monitoring network. Compilation of existing data was initiated.

Plans for Next Year: Complete well inventory, establish water-level and water-quality network, initiate stream gain-loss studies, and develop preliminary ground-water flow model.

REFERENCE

Steiger, J.I., and Lowe, Mike, 1997, Recharge and discharge areas and quality of ground water in Tooele Valley, Tooele County, Utah: U.S. Geological Survey Water-Resources Investigations Report 97-4005, 4 pls.