UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-RESOURCES ACTIVITIES IN UTAH

BY THE U.S. GEOLOGICAL SURVEY,

JULY 1, 1987, TO SEPTEMBER 30, 1988

Compiled by Stefanie L. Dragos and Joseph S. Gates

Open-File Report 89-240

Salt Lake City, Utah

May 1989

DEPARTMENT OF THE INTERIOR

MANUEL J. LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

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WATER-RESOURCES ACTIVITIES IN UTAH

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INTRODUCTION

This report contains summaries of the progress of water-resources studies in Utah by the U.S. Geological Survey, Water Resources Division, Utah District, from July 1, 1987, to September 30, 1988. The program in Utah during this period consisted of 29 projects; a discussion of each project is given in the main body of the report. Short descriptions are given at the end of the report for three projects proposed to be started on or after October 1, 1988.

The following sections outline the basic mission and program of the Water Resources Division, the organizational structure of the Utah District, the distribution of District funding in terms of source of funds and type of activity funded, and the agencies with which the District cooperates. The last part of the introduction is a list of reports produced by the District from July 1987 to September 1988.

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

The U.S. Geological Survey, through its Water Resources Division, investigates the occurrence, quantity, distribution, and movement of the surface and ground water that comprise the Nation's water resources, and coordinates Federal water-data acquisition activities.

The mission of the Division is accomplished through programs supported by the U.S. Geological Survey independent of, or in cooperation with, other Federal and non-Federal agencies. These programs involve:

1. Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.

2. Conducting analytical and interpretive water-resource appraisals of the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water.

3. Conducting basic problem-oriented research in hydrology to improve the scientific basis for investigations and measurement techniques, and to predict quantitatively the response of hydrologic systems to stress.

4. Disseminating water data and the results of investigations and research through reports, maps, computerized information services, and other forms of public releases.

5. Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water.

6. Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies; to licensees of the Federal Power Commission; and to international agencies on behalf of the Department of State.

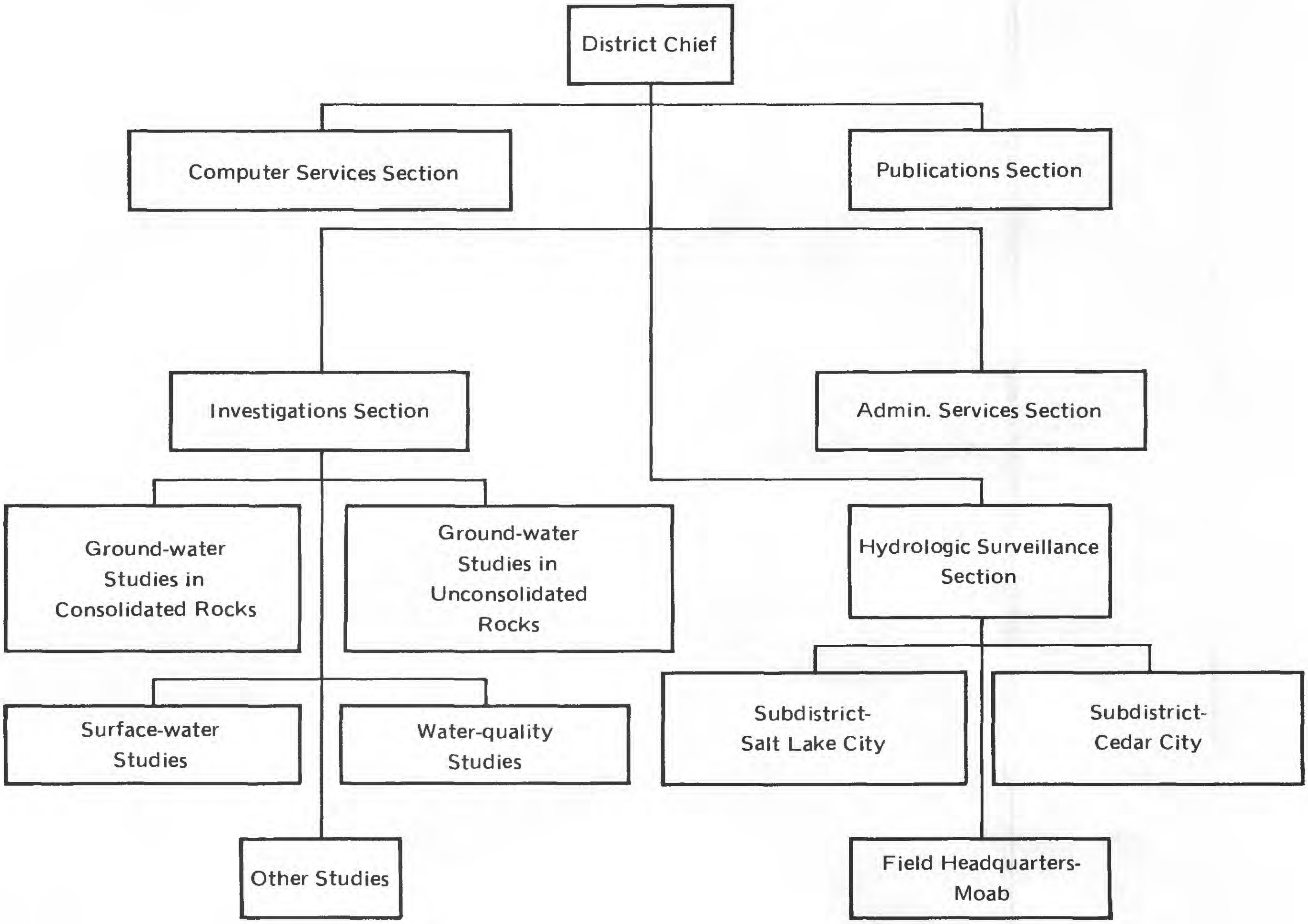
7. Administering the provisions of the Water Resources Research Act of 1984, which includes the State Water Resources Research Institute Program (Section 104) and the National Water Resources Research Grant Program (Section 105).

8. Acquiring information useful in predicting and delineating water-related natural hazards from flooding, volcanoes, mudflows, and land subsidence.

Utah District Organization

The Utah District of the Water Resources Division is organized into five operating sections under the District Chief (see organization chart). Water-resources projects are conducted by the Investigations Section (primarily interpretive studies) and 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 Publications Section, which processes and illustrates reports, and the Computer Services and Administrative Services Sections. The Utah District consists of the District Office in Salt Lake City, Subdistrict Offices in Salt Lake City and Cedar City, and a Field Headquarters in Moab. The location of these offices and their areas of responsibility are shown in figure 1.

UTAH DISTRICT ORGANIZATION



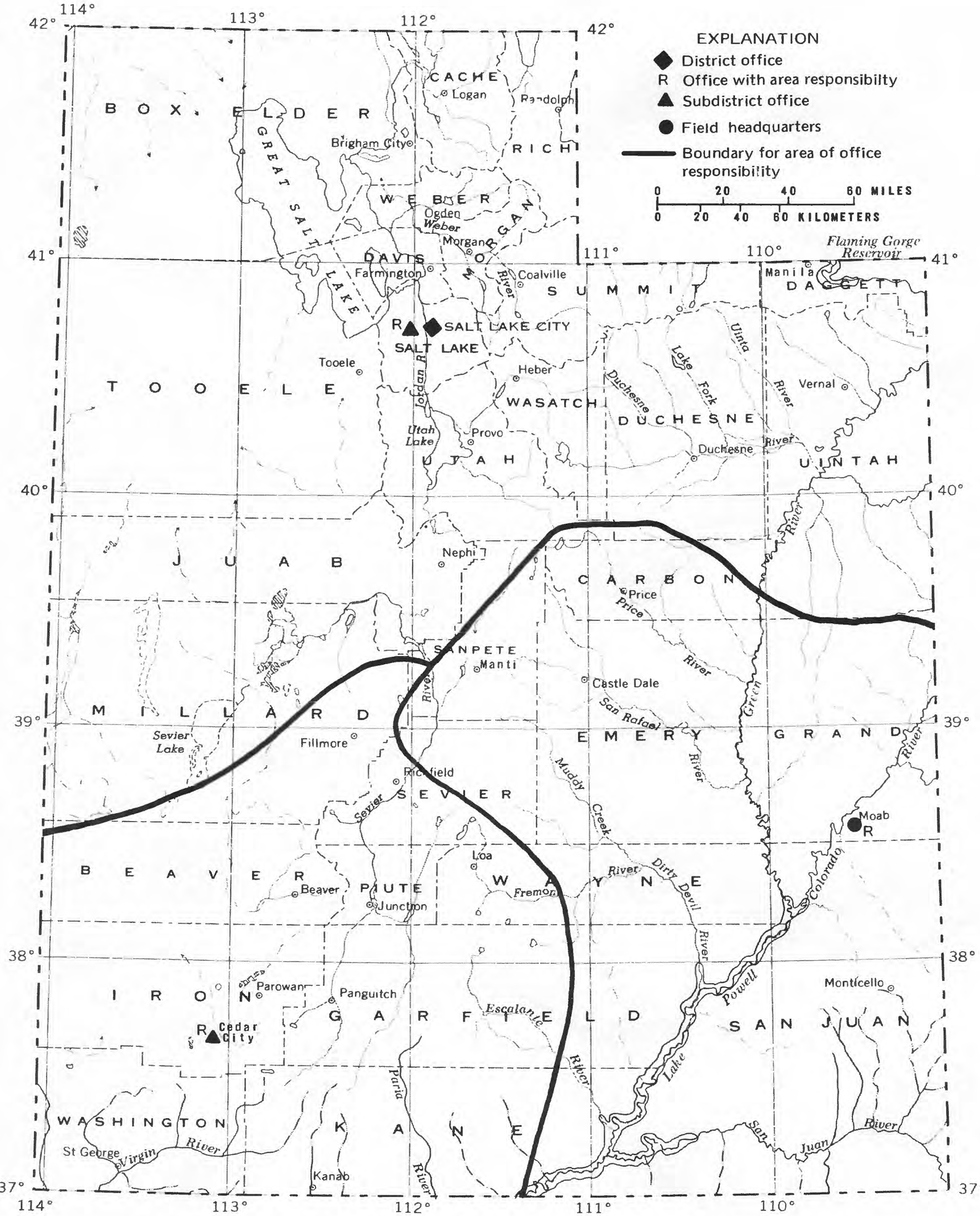
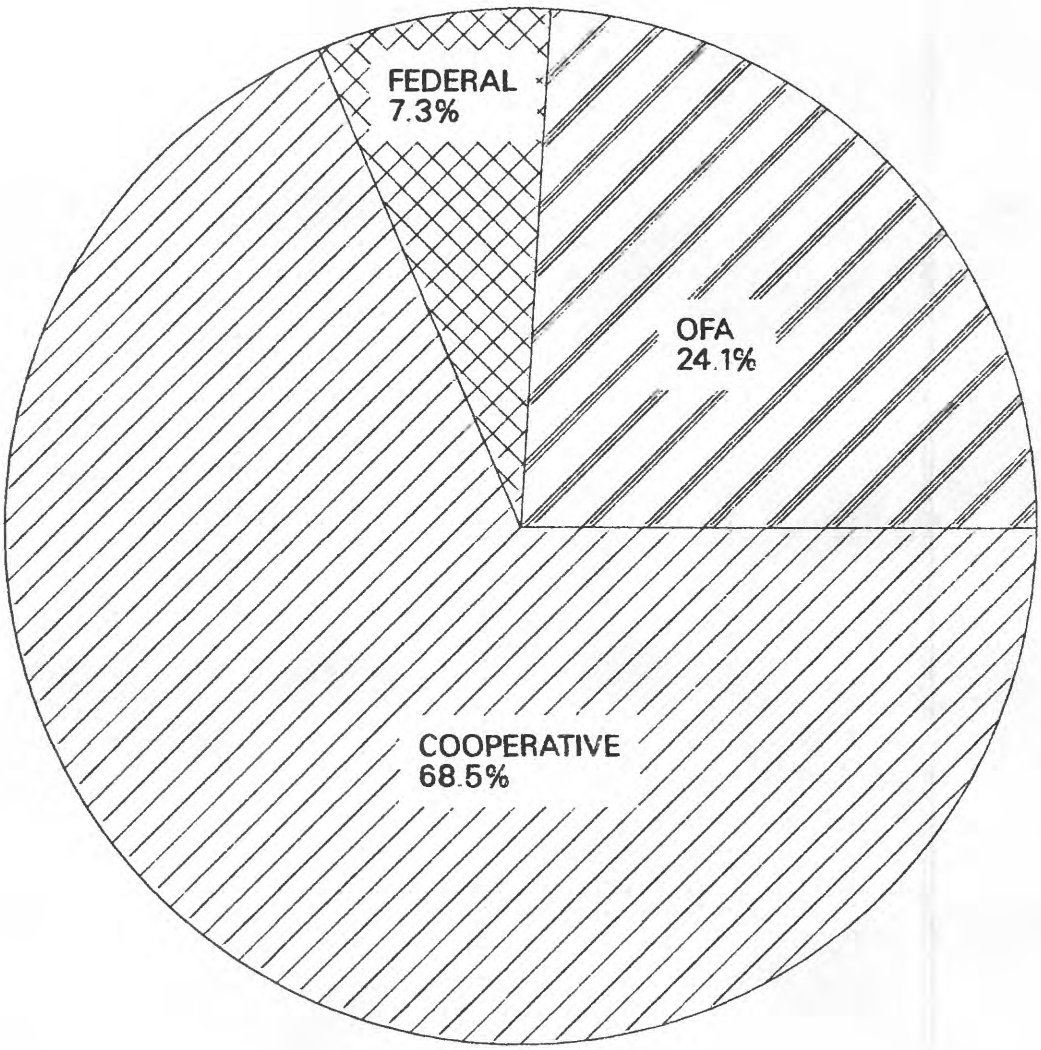


Figure 1.--Location of U.S. Geological Survey, Water Resources Division, offices and general areas of responsibility.

Program Funding and Cooperating Agencies

Funds to support water-resources work done by the Utah District are from three sources. Cooperative-Program funds and services are provided from 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 Geological Survey by the Congress are part of the Federal Program. In fiscal year 1988 the total financial support from these programs for the Utah District was about $3.5 million. The distribution of funds among the three sources is shown below:



In fiscal year 1988, the Utah District pursued two broad categories of studies: (1) hydrologic data collection, and (2) interpretive studies and areal appraisals. Approximately 50 percent of the program was for collection of hydrologic data and 50 percent for interpretive studies and appraisals. These studies provide water managers and planners with information about the availability and quality of Utah's water resources.

From July 1, 1987, to September 30, 1988, the State and local cooperators for District projects were:

Utah Department of Natural Resources
- Division of Water Rights
- Division of Water Resources
- Division of Wildlife Resources
- Division of Oil, Gas, and Mining
- Geological and Mineral Survey

Utah Department of Transportation
Utah Department of Health, Division of Environmental Health
Bear River Commission
Salt Lake County Division of Flood Control and Water Quality
Central Utah Water Conservancy District
Wasatch County
Weber Basin Water Conservancy District
Lower Gunlock Reservoir Corporation
Wasatch County Water Users, Associated
Tooele County
Tooele City

The Federal cooperators were:

U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Department of the Air Force
U.S. Department of the Army
U.S. Soil Conservation Service
Office of the Secretary of the U.S. Department of the Interior
Federal Power Commission (Utah Power and Light)

Reports Released or Published

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

Utah District Office: Open-File Reports; Water-Resources Investigations Reports; Hydrologic-Data Reports; Water-Data Reports; and Utah Department of Natural Resources Technical Publications, Cooperative Investigations Reports, and Water Circulars.

U.S. Geological Survey Public Inquiries Office (125 South State Street, Salt Lake City): U.S. Geological Survey Water-Supply Papers, Professional Papers, Circulars, and Hydrologic Investigations Atlases.

Utah Department of Natural Resources, Division of Water Rights: Technical Publications, Water Circulars, Hydrologic-Data Reports, Water-Use Reports.

Utah Department of Natural Resources, Division of Water Resources: Cooperative Investigations Reports.

The following reports were released to the Open File:

Dragos, S.L., compiler, 1988, Water-resources activities in Utah by the U.S. Geological Survey, July 1, 1986 to June 30, 1987: U.S. Geological Survey Open-File Report 88-302.

Thiros, S.A., 1988, Selected hydrologic data for Pahvant Valley and adjacent areas, Millard County, Utah, 1987: U.S. Geological Survey Open-File Report 88-195. (Duplicated as Utah Hydrologic Data Report 46.)

Weigel, J.F., 1987, Selected water-level data for Mesozoic formations in the Upper Colorado River Basin, Arizona, Colorado, Utah, and Wyoming--excluding the San Juan Basin: U.S. Geological Survey Open-File Report 87-397.

The following reports were published:

Cordy, G. E., and others, Ground-water conditions in Utah, Spring of 1988: Utah Division of Water Resources Cooperative Investigations Report No. 28.

Enright, Michael, 1987, Seepage study of a 15.3-mile section of the Central Utah Canal, Pahvant Valley, Millard County, Utah: Utah Department of Natural Resources Technical Publication No. 91.

Freethey, G. W., 1988, Geohydrology of the Navajo Sandstone in western Kane, southwestern Garfield, and southeastern Iron Counties, Utah: U.S. Geological Survey Water-Resources Investigations Report 88-4040.

Gates, J.S., 1987, Ground water in the Great Basin part of the Basin and Range province, western Utah, in Kopp, R.S., and Cohenour, R.E., eds., Cenozoic geology of western Utah--sites for precious metal and hydrocarbon accumulations: Utah Geological Association Publication 16, p. 75-89.

Holmes, W.F., and Kimball, B.A., 1987, Ground water in the southeastern Uinta Basin, Utah and Colorado: U.S. Geological Survey Water-Supply Paper 2248, 47 p.

Howells, Lewis, Longson, M. S., and Hunt, G. L., 1988, The base of moderately saline water in the Uinta basin, Utah, and methods used in determining its position: Utah Department of Natural Resources Technical Publication 92.

Seiler, R.L., and Baskin, R.L., 1988, Hydrology of Alkali Creek and Castle Valley Ridge coal-lease tracts, central Utah, and potential effects of coal mining: U.S. Geological Survey Water-Resources Investigations Report 87-4186.

Stephens, D.W., and Arnow, Ted, 1987, Fluctuations of water level, water quality, and biota of Great Salt Lake, Utah, 1847-1986 in Kopp, R.S., and Cohenour, R.E., eds., Cenozoic geology of western Utah--sites for precious metal and hydrocarbon accumulations: Utah Geological Association Publication 16, p. 182-194.

Stephens, D.W., Waddell, Bruce, and Miller, J.B., 1988, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the middle Green River basin, Utah: U.S. Geological Survey Water-Resources Investigations Report 88-4011.

Several reports on past projects are not yet released or published but are being completed. The status of these reports, listed by project number, is as follows:

UT-147

Mason, J.L., Simulated alternatives for ground-water withdrawal and their possible effects on the basin-fill aquifer in the Milford area, southwestern Utah: U.S. Geological Survey, written commun., 1987 (in review).

Gates, J.S., and Bedinger, M.S., (in press), Ground-water flow systems of western Utah: American Water Resources Association Monograph Series No. 14.

UT-160

Stephens, D. W., Thompson, K.R., and Wangsgard, J.B., Hydrology and effects of coal mining on water quality of Scofield Reservoir and hydrology of streams in the Pleasant Valley area, central Utah, water years 1983-84: U.S. Geological Survey, written commun., 1987 (in review).

UT-162

Clark, D.W., Appel, C.L., Lambert, P.M., and Puryear, R.L., Ground-water resources and simulated effects of withdrawals in the East Shore area of the Great Salt Lake, Utah: U.S. Geological Survey, written commun., 1987 (in review).

Lambert, P.M., (in press), Continuous seismic-reflection survey of the Great Salt Lake, Utah, east of Antelope and Fremont Islands: U.S. Geological Survey, Water-Resources Investigations Report 88-4157.

Clark, D.W., The ground-water system and simulated effects of ground-water withdrawals in the Bountiful area, Davis County, Utah: U.S. Geological Survey, written commun., 1987 (in review).

UT-167

Avery, Charles, Ground-water hydrology of Ogden Valley and surrounding areas, eastern Weber County, Utah: U.S. Geological Survey, written commun., 1987 (in review).

UT-168

Blanchard, P.J., Ground-water conditions in Grand County and parts of northern San Juan County, Utah, with emphasis on the Entrada, Navajo, and Wingate Sandstones: U.S. Geological Survey, written commun., 1987, (in review).

Blanchard, P.J., (in press), Hydrology of the Navajo Sandstone in southeastern and southern Utah: American Water Resources Association Monograph Series No. 14.

UT-169
Price, Don, Ellis, S. R., and Wilson, J. F., Jr., Water for an oil-shale industry—Summary results of the U.S. Geological Survey's hydrologic-study program for the major oil-shale areas of Colorado, Utah, and Wyoming: U.S. Geological Survey, written commun., 1987 (in review).

UT-170
Stephens, D. W., Sediments and water quality in Decker Lake storm-water retention pond: U.S. Geological Survey, written commun., 1987 (in preparation).

UT-171
Howells, Lewis, The base of moderately saline ground water in San Juan County, Utah: U.S. Geological Survey, written commun., 1987 (in review).

UT-174
Arnow, Ted, and Stephens, D. W., (in press), The Great Salt Lake, Utah: 1847-1986: U.S. Geological Survey Water-Supply Paper 2332.

CURRENT PROJECTS BY NUMBER AND TITLE

COLLECTION OF HYDROLOGIC DATA

SURFACE-WATER DATA, INCLUDING SEEPAGE LOSSES FROM CANALS

Number: UT-00-001

Cooperating Agencies: U.S. Bureau of Reclamation; U.S. Bureau of Land Management; U.S. Soil Conservation Service; U.S. Department of the Army; Federal Power Commission; Utah Division of Water Rights; Utah Division of Water Resources; Utah Division of Wildlife Resources; Utah Geological and Mineral Survey; Bear River Commission; Central Utah Water Conservancy District; Weber Basin Conservancy District; Lower Gunlock Reservoir Corporation; Salt Lake County Division of Flood Control and Water Quality.

Staff: L. R. Herbert, Hydrologic Technician, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Objective: To obtain data on stream discharge, reservoir contents, and lake stage at selected sites throughout Utah (fig. 2).

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

Progress: Data collection and computation necessary for the publication of discharge records for 180 streamflow-gaging stations and contents and stage records for 18 reservoir and 3 lake-stage stations continued during the year. Figure 2 shows the locations of the stations and station numbers. Data collected at these stations, as well as larger-scale maps showing station locations, are given in the series of reports "Water resources data for Utah", U.S. Geological Survey Water-Data Reports. In addition, monthly flow measurements were made of water through the breach in the causeway across Great Salt Lake. The stations are classified as follows:

Discharge	
Current use	114
Hydrologic data for planning and design	54
Benchmark for long-term trends	12
Contents of reservoirs	18
Stage of Great Salt Lake and West Pond	3

Due to funding constraints, 6 gaging stations were discontinued. These stations are:

Summit Creek near Summit
Center Creek above Parowan Creek near Parowan
Parleys Creek above Alexander Creek near Salt Lake City

Smith and Morehouse Creek near Oakley
Ophir Creek near Ophir
Cottonwood Wash near Blanding

Gaging stations established were:

Crouse Creek near Vernal
Big Creek near Randolph
Box Elder Wash near Grantsville.

Seepage-loss studies: Flow measurements in the Southbend and Richfield canals and a section of the Vermillion Canal of the central Sevier River valley were started in May 1987 and finished in August 1987. The report on seepage losses from the canals was completed and is in review.

Flood report: Work on the report of floods in the Great Basin during 1983 and 1984 continues; completion is expected in January 1989.

Virgin River dye study: Results of the Virgin River dye study will be prepared and presented in a scientific report.

West Desert pumping project: Continued to monitor the stage of the West Pond, West Desert pumping project.

Plans for Next Year: Continue operation of network. Prepare 1988 water-year records for publication. Select canals for the next seepage-loss study, and begin flow measurements. Complete report on floods in the Great Basin during 1983-84. Continue monitoring flow through breach in Great Salt Lake causeway and stage of West Pond.

Reports:

Christensen, R.C., Moosburner, O., and Johnson, E.B., High-water runoff conditions during the 1983 and 1984 water years in the Great Basin: U.S. Geological Survey, written commun., 1988 (in preparation).

Herbert, L.R., and Smith, G.J., Seepage study of the Southbend, Richfield, and Vermillion canals, Sevier County, Utah: U.S. Geological Survey, written commun., 1988 (in review).

"Streamflow and reservoir contents in Upper Colorado River Basin" is issued monthly.

ReMillard, M.D., and others, 1988, Water resources data for Utah, water year 1987: U.S. Geological Survey Water-Data Report UT-87-1.

ReMillard, M.D., and others, Water resources data for Utah, water year 1988: U.S. Geological Survey Water-Data Report UT-88-1 (in preparation).

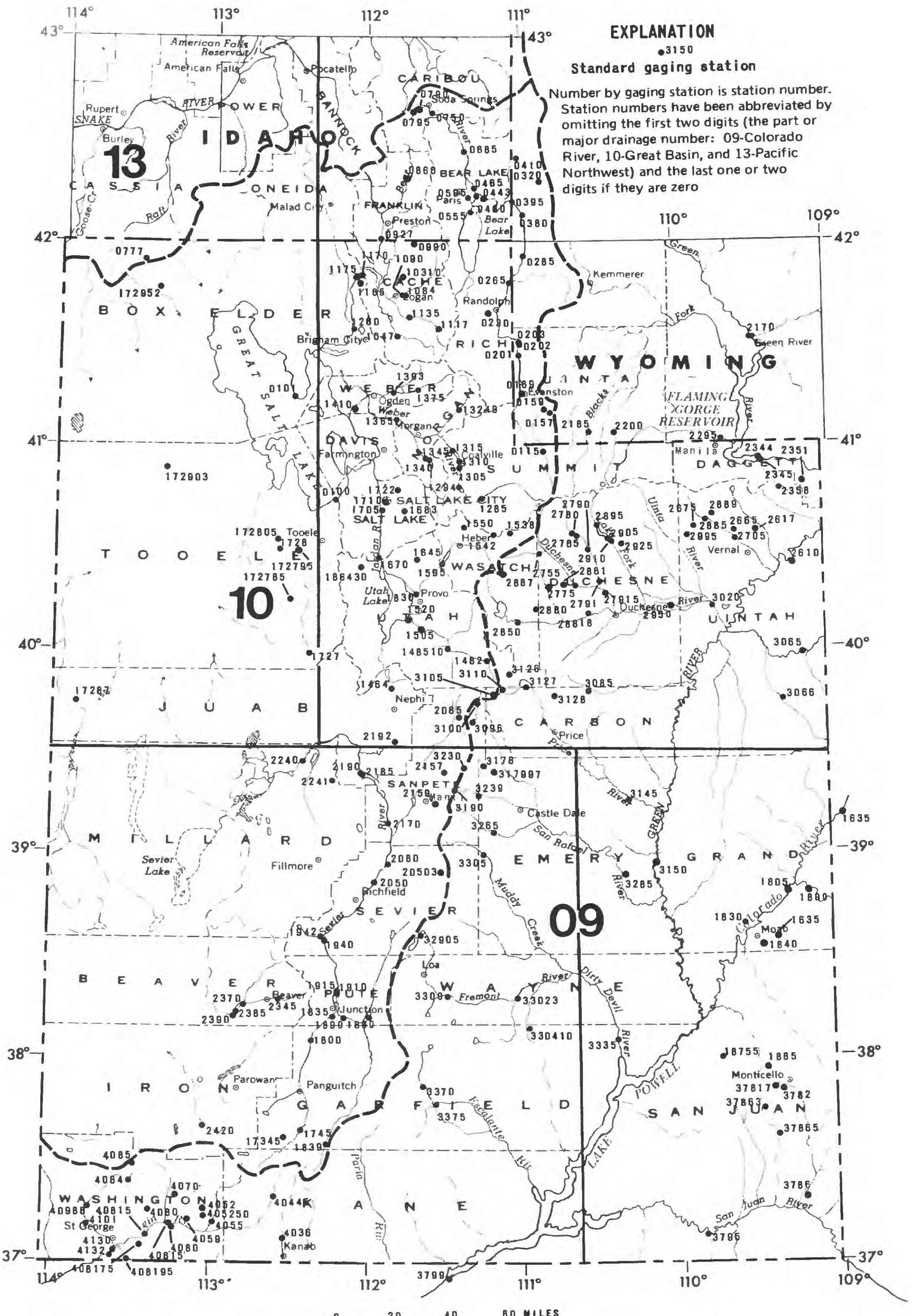


Figure 2.--Location of gaging stations, September 1988.

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; Utah Department of Transportation

Staff: L.R. Herbert, Hydrologic Technician, Project Chief (part time)
C.B. Burden, Hydrologic Technician
G.E. Cordy, Hydrologist, Editor of annual ground-water conditions report (part time)
Other District personnel as assigned

Period of Project: Continuing

Objectives: To obtain long-term records of ground-water levels, to determine water-level changes for yearly or other periods, and to determine withdrawals from and status of development of aquifers in the State. To make an annual evaluation of ground-water conditions in Utah.

Approach: Measure water levels annually or semiannually (normally February-March and September) and operate continuous water-level recorders on selected wells. Visit selected discharging irrigation wells, measure discharge, determine the ratio of water produced to energy consumed, and use the ratio along with energy-consumption data to compute total annual pumpage. Visit selected flowing wells and measure discharge. Obtain estimates of ground water withdrawn from wells for public supply and industrial use from the Utah Division of Water Rights. Obtain additional selected estimates of industrial use of water from wells by interviewing users, or by rating pumps and using the ratio of water produced to energy consumed with energy-consumption records. Determine the number and diameter of new wells drilled annually from well drillers' reports supplied by the Division of Water Rights. Prepare an annual report on ground-water conditions in Utah which includes data, graphs, and maps showing water-level changes; withdrawals from wells; number of wells drilled in defined ground-water basins or areas; and a discussion of ground-water conditions in each basin or area. Store water-level data in computer files and publish selected data in the annual report of water-resources data for Utah.

Progress: Water levels were measured in about 1,100 wells in February and March; in addition, water levels in 600 of these wells were measured in September, and water levels in 40 wells were measured monthly. Continuous water-level recorders were maintained on 33 wells. Locations of the water-level observation wells and recorder wells are shown in figure 3. During the irrigation season, about 500 discharging irrigation wells were visited; 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 for about 50 wells during the irrigation season. Number and diameters of new wells drilled were determined. The twenty-fifth in the series of annual reports on ground-water conditions in Utah was completed.

Plans for Next Year: Collecting, recording, and publishing data on water levels, ground-water withdrawals, and wells drilled will continue. The twenty-sixth in the series of annual ground-water reports will be compiled.

Reports:

Cordy, G.E., and others, 1988, Ground-water conditions in Utah, Spring of 1988: Utah Division of Water Resources Cooperative-Investigations Report 28.

ReMillard, M.D., and others, 1988, Water resources data for Utah, water year 1987: U.S. Geological Survey Water-Data Report UT-87-1.

ReMillard, M.D., and others, Water resources data for Utah, water year 1988: U.S. Geological Survey Water-Data Report UT-88-1, (in preparation).

Water-level-change maps, for the period February or March 1987-February or March 1988, of 15 areas in Utah--Issued April 1 as local press releases and distributed to agencies and interested individuals.

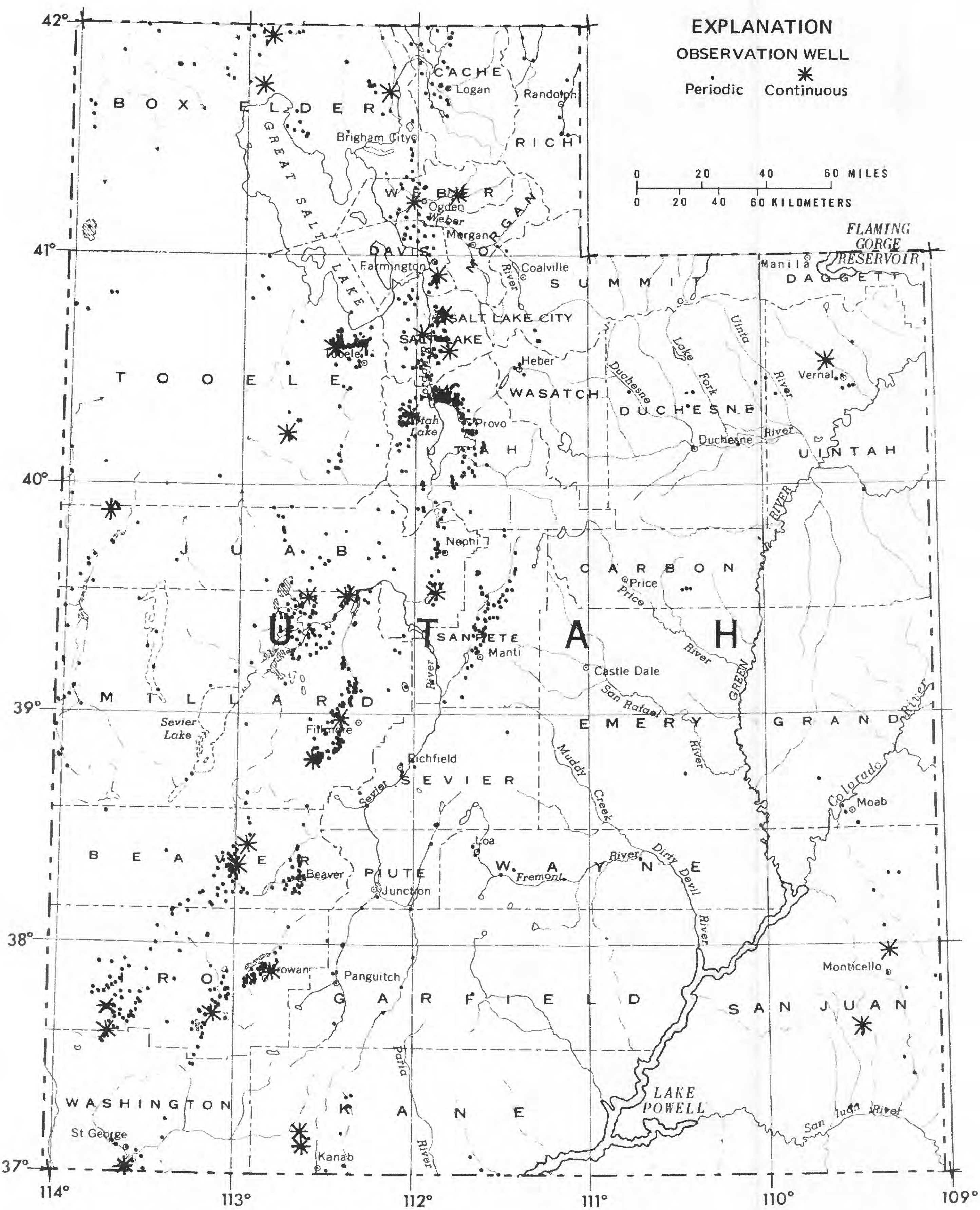


Figure 3.--Location of observation wells where ground-water levels are measured, September 1988.

WATER-QUALITY AND FLUVIAL-SEDIMENT DATA

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

Cooperating Agencies: Utah Division of Water Resources;
Utah Division of Water Rights;
Utah Geological and Mineral Survey;
U.S. Bureau of Land Management;
U.S. Bureau of Reclamation;
U.S. Department of the Army, Corps of Engineers;
U.S. Soil Conservation Service

Staff: L. R. Herbert, Hydrologic Technician, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Objectives: To obtain records of the quality of water at selected stream sites (fig. 4), from wells (fig. 5), and of sediment (fig. 4) at selected sites throughout Utah and at sites on Great Salt Lake.

Approach: Standard methods for the collection and analysis of chemical-quality, fluvial-sediment, biological samples, and computer storage and publication of data were used.

Progress: Samples for chemical analysis were obtained periodically (about eight times per year) at 25 stream sites. In addition, temperature and specific-conductance data were obtained daily at eight of these stream sites. Temperature and specific-conductance data also were obtained periodically at an additional 155 stream sites. Sediment data were obtained daily at four sites and periodically at an additional five sites. Samples for chemical analysis of ground water were obtained from about 225 wells. All water-quality data for streams and wells are listed in the annual water-resources data reports.

Physical and chemical data also were obtained for long-term sites on Great Salt Lake and West Pond of the West Desert pumping project. Temperature and density were measured at the sites at various depths, and selected samples were submitted for chemical and biological analyses. Seasonal and areal variations in quality were defined by sampling three times a year at five sites in the north part of the lake and three sites in the south part. Monthly measurements of temperature, density, and velocity of flow were made along several verticals through cross sections at both the upstream and downstream sides of the causeway at the breach between the south and north parts of the lake. In addition, monthly field measurements of temperature and specific gravity were made of water from 24 observation wells near the dikes of the West Pond of the West Desert pumping project. Samples were taken quarterly from these wells for chemical analysis.

Streamflow and sediment transport in Parleys Creek, above the proposed Little Dell Reservoir site near Salt Lake City, was measured during May to September, 1987. Using this information and regression equations developed in other work that related selected streamflow characteristics to basin and climatic characteristics, total sediment load and streamflow were estimated for selected recurrence intervals. This information will be used by the U.S. Army Corps of Engineers to design a diversion structure in the stream.

Plans for Next Year: Continue collecting and processing data and preparing records for publication. Continue monitoring Great Salt Lake and attempt to collect and count brine-shrimp samples. Continue monitoring stage and salt balance in the West Pond of the West Desert pumping project. Continue monitoring water quality in observation wells near the dikes of the West Pond of the West Desert pumping project.

Reports:

ReMillard, M. D., and others, 1988, Water resources data for Utah, water year 1987: U.S. Geological Survey Water-Data Report UT-87-1.

ReMillard, M. D., and others, Water resources data for Utah, water year 1988: U.S. Geological Survey Water-Data Report UT-88-1, (in press).

Waddell, K.M., and Burden, Carole, Water and salt balance of the West Pond of Great Salt Lake, U.S. Geological Survey, written commun., 1988, (in review).

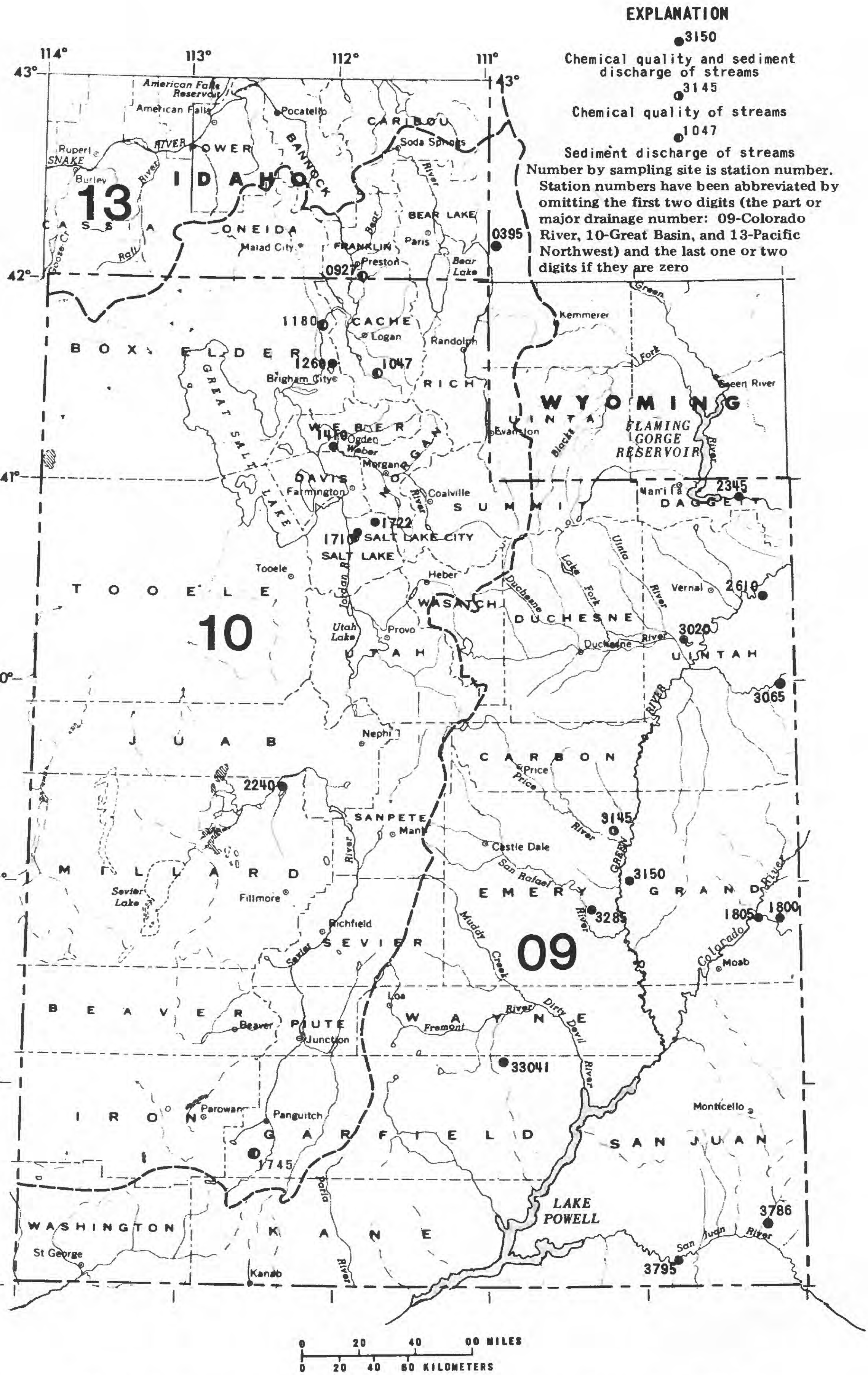


Figure 4.--Location of surface-water-quality stations, September 1988.

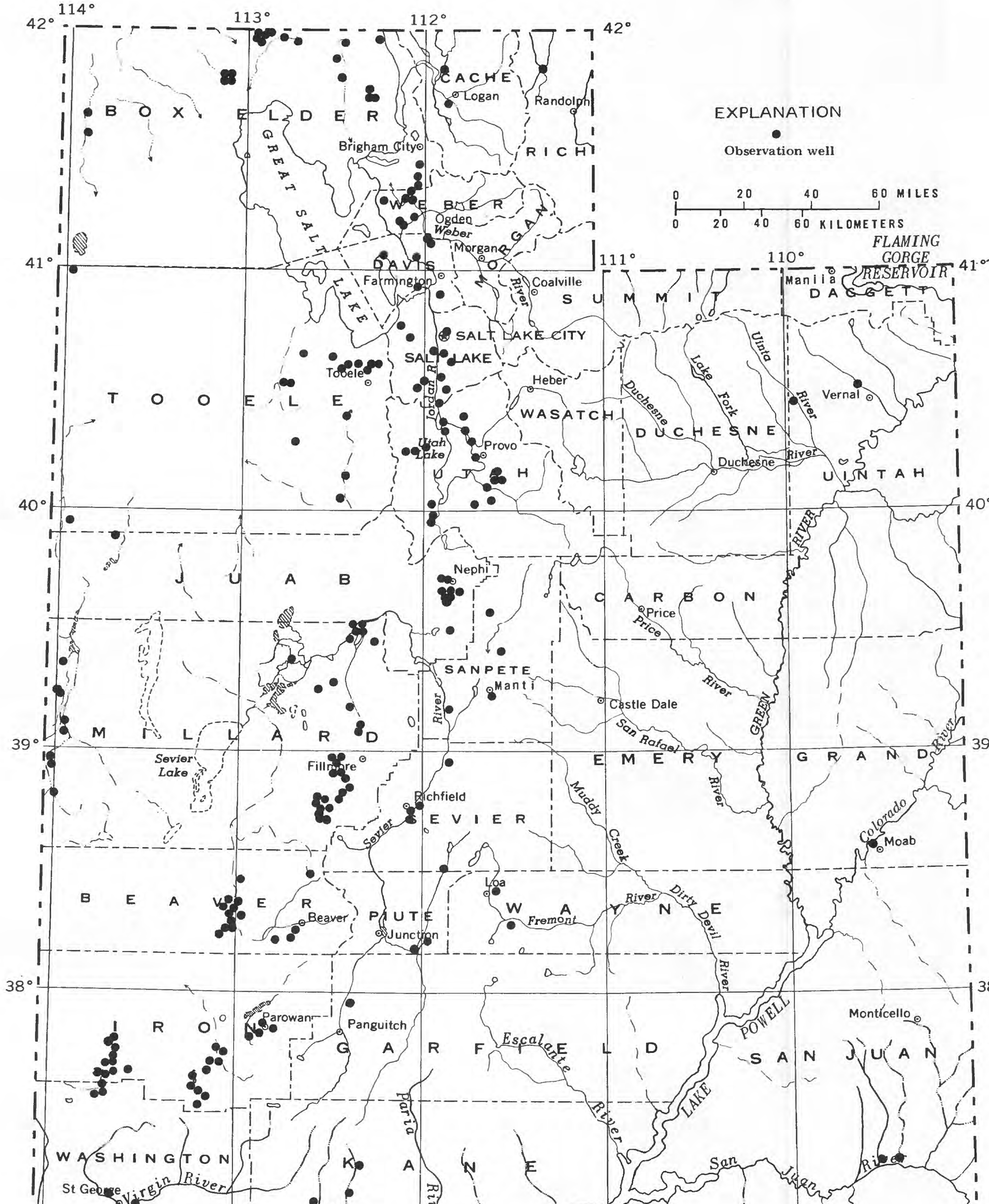


Figure 5.--Location of observation wells where water samples are collected for monitoring ground-water quality, July 1988.

FLOOD MAPPING

Number: UT-00-006

Cooperating Agency: Federal Emergency Management Agency

Staff: R. C. Christensen, Hydrologist,
Project Chief (part time)
E. B. Johnson, Hydrologist (part time)

Period of Project: May 1983 to November 1988

Objectives: To delineate the parts of areas selected by the Federal Emergency Management Agency (FEMA) that are subject to inundation by floods of selected recurrence intervals, primarily the 100-year flood. The information is needed by FEMA to assist State and local agencies in controlling development of flood-plain areas and to determine insurance rates for the flood-insurance program.

Approach: Determine areas subject to inundation by floods of selected magnitude by ground surveys or photogrammetric methods. Determine frequency relationships using local historical information, gaging-station records, and other applicable information. Determine water-surface profiles at flood stage using step-backwater models or by other acceptable methods and present the results in information releases to FEMA, prepared to their specifications.

Progress: For the Tooele City study, 100-year water-surface profiles were determined, areas subject to inundation by 100-year floods were delineated on topographic maps, and results of the study were summarized in a preliminary report and submitted to FEMA on March 31, 1988. Water-surface profiles at the 100-year flood stage were completed for the Morgan County study.

Plans for Next Year: Delineate, on topographic maps, areas subject to inundation by 100-year floods in the Morgan County study area, summarize the results of the Morgan County study in a preliminary report, and submit the results of the study to FEMA about November 30, 1988.

Reports: None.

STATEWIDE WATER USE

Number: UT-00-007

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

Staff: G. E. Pyper, Hydrologic Technician, Project Chief
Brent Johnson, Engineer, Utah Division of Water Rights
Other State and District personnel as assigned

Period of Project: Began July 1977, continuing

Objective: To obtain information about withdrawals and return flows of water for various uses and consumptive use of water in connection with each type of withdrawal.

Approach: Total water diversions and consumptive use will be determined by field inventory and measurement of surface-water diversions and selected types of ground-water diversions, and by verification of user measurements and records. Acreage and crop surveys will be used to aid in estimating consumptive use by irrigation. The results of a pilot study in Tooele Valley will be used to determine an optimum way to estimate water used for irrigation. State personnel are collecting data on public-supply and industrial use; U.S. Geological Survey personnel are collecting data on irrigation use.

Progress: Mail surveys were made by the Division of Water Rights to determine water use by about 350 public suppliers and 130 major self-supplied and public-supplied industries. A total of 95 public suppliers were visited during the year to verify the data. A report on water use during 1984 and 1985 by public suppliers and industry was published. Work continued on determining water use for irrigation in Utah. A report on estimated use of water in Utah, 1985, for twelve categories of water use was written and reviewed.

Plans for Next Year: Data for public supply and industrial use will continue to be collected and verified. The National water-use data base will be updated from the verified State data base. Work will continue on determining irrigated acreage and water used for irrigation. Water use for irrigation will be determined for the Sevier River drainage. A data report for twelve categories of water use by county and hydrologic subregion for the year 1985 will be published.

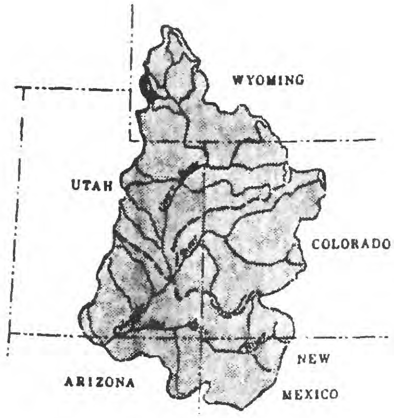
Reports:

Johnson, Brent, 1988, Water-use data for public water suppliers and self-supplied industry in Utah, 1984, 1985: Utah Department of Natural Resources, Utah Water-Use Report No. 6.

Pyper, G. E., and Baskin, R. L., An examination of irrigation water-use data sources for Utah, and a selected alternative approach for estimation of irrigation water use where published data are not available, U.S. Geological Survey, written commun., 1987 (in review).

Pyper, G. E., Estimated use of water in Utah, 1985, U.S. Geological Survey, written commun., 1988 (in review).

REGIONAL AQUIFER-SYSTEM ANALYSIS—MESOZOIC SANDSTONE AQUIFERS IN THE UPPER COLORADO RIVER BASIN



Number: UT 81-154

Staff: G. W. Freethey, Hydrologist, Project Chief
B. E. Thomas, Hydrologist
G. E. Cordy, Hydrologist
J. F. Weigel, Hydrologist

Period of Project: October 1981 to September 1988

Objectives: This study is one of the series of National studies of regional aquifer systems that together will cover much of the United States. In the Upper Colorado River Basin, aquifers that are truly regional in areal extent include the complex of thick sandstones of Jurassic and Triassic age and carbonate and sandstone aquifers of Mississippian and Permian age. This study will target the thick sandstones of the Mesozoic Era and locally related aquifers of lesser extent. The study is intended to (1) provide a basin-wide data base; (2) define and quantify recharge, occurrence, movement, discharge, and quality of ground water; (3) model the system(s) in order (a) to understand the natural (pre-development) flow and geochemical system(s) and (b) to evaluate or predict the effects of future development and differences in these effects due to various management strategies.

Approach: Computer simulation will be the main tool used to analyze the hydrogeologic regimen of the aquifer system of Mesozoic age. The results of prior local, areal, and regional studies will be collected and combined, and basic data from those studies will be updated. Concurrently, subregional-flow models will be constructed in order to test provisional hypotheses and show areas where additional data are needed. Following will be a period of data collection, during which the models will be updated as field data are obtained. Final analyses will incorporate consideration of the effects of development on the ground-water flow regimen and on ground-water storage, on surface-water flow, and on possible water-quality changes that would accompany development. Results of the study will appear as a planning document, data report(s), hydrologic atlases, model documentation, and a final interpretive report.

Progress: Reports detailing the principal findings of the investigation are being written and reviewed for publication.

Plans for Next Year: None.

Reports:

Freethey, G. W., and Cordy, G. E., (in press), Geohydrology of Mesozoic rocks in the Upper Colorado River Basin--excluding the San Juan Basin--in Arizona, Colorado, New Mexico, Utah, and Wyoming: U.S. Geological Survey Professional Paper 1411-C.

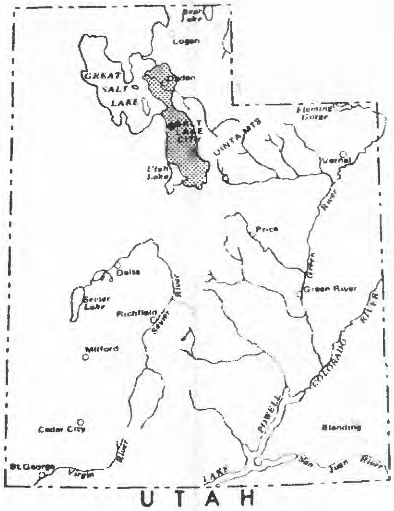
Thomas, B. E., (in press), Simulation analysis of the ground-water system in Mesozoic rocks in the Four Corners area, Utah, Colorado, Arizona, and New Mexico: U.S. Geological Survey Water-Resources Investigations Report 88-4086.

Freethey, G. W., (in press), Upper Colorado River Basin Regional Aquifer-Systems Analysis--the Mesozoic System: American Water Resources Association Monograph Series No. 14.

Freethey, G. W., (in press), Lithologic and hydrologic properties of Mesozoic rocks in the Upper Colorado River Basin: American Water Resources Association Monograph Series No. 14.

Weigel, J. F., (in press), Sources of hydrologic data on Mesozoic formations in the Upper Colorado River Basin and comparison of data-analysis methods: American Water Resources Association Monograph Series No. 14.

FLOOD CHARACTERISTICS OF URBAN WATERSHEDS



Number: UT-84-165

Cooperating Agency: Utah Department of Transportation

Staff: K. L. Lindskov, Hydrologist, Project Chief (part time)
K. R. Thompson, Hydrologist (part time)

Period of Project: July 1984 to September 1987

Objectives: (1) Obtain hydrologic data for 12 representative urban watersheds to define frequency relations of peak flow and volumes of flood flow. The results will be used to determine the impacts of urban development on floods along the Wasatch Front (Salt Lake, Davis, and parts of Utah and Weber Counties). (2) Develop methods for determining peak flow and volumes of flood flow for selected recurrence intervals for ungaged urban watersheds. (3) Document increases or decreases in peak flow between the canyon mouth and the stream mouth for major streams that receive most of their flow from mountain snowmelt, flow through the urban areas, and are tributary to the Jordan River, Utah Lake, and the Great Salt Lake. This will provide methods for estimating snowmelt runoff combined with the thunderstorm runoff contributed by the areas between the canyon mouth and the stream mouth.

Approach: Floodflow and rainfall data will be obtained at sites in 12 representative urban watersheds for 3 years. The data for about 20 storms will be used to calibrate an urban rainfall-runoff model for each site. The model will be used, along with synthetic rainfall data, to compute peak flow of selected frequencies. After the data collection and computation of peak flows are complete, various techniques will be investigated for transferring the information from gaged to ungaged sites. One possible method would be to relate peak flows to basin and climatic characteristics using multiple-regression techniques. Case histories will be compiled by comparing peak flow at canyon mouths with peak flow at points where selected larger streams flow into the Jordan River, Utah Lake, and the Great Salt Lake. This will enable modification of the snowmelt peak flow as measured at the canyon mouth.

Progress: The report has been written and is in review. The Distributed Routing Rainfall-Runoff Model (DR3M) was calibrated for eight urban drainages located along the Wasatch Front, Utah, using data collected during 1983-85. The calibrated models were then used to estimate 36 annual peak flows for the eight urban drainages using rainfall data collected during 1948-83 by the National Weather Service, Salt Lake City airport station. Log-Pearson fits were made to the peak-flow data for each drainage, and peak flows for recurrence intervals of 2, 5, 10, 25, 50, and 100 years were calculated. Multiple-regression techniques were used to develop relations between flow and the basin characteristics of drainage area, basin slope, and effective impervious area. The resulting equations can be used to estimate peak flows for 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals.

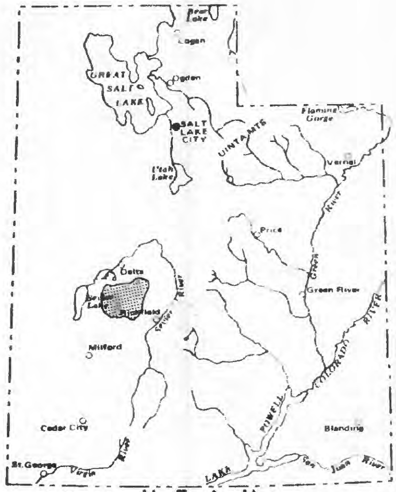
Plans for Next Year: Complete review and revision of report and submit it for approval.

Reports:

Lindskov, K. L., and Thompson, K. R., Peak-flow characteristics of small urban drainages along the Wasatch Front, Utah: U.S. Geological Survey, written commun., 1988 (in review).

GROUND-WATER HYDROLOGY OF PAHVANT VALLEY AND ADJACENT AREAS

Number: UT-85-175



U T A H

Cooperating Agency: Utah Division of Water Rights

Staff: W. F. Holmes, Hydrologist, Project Chief
S. A. Thiros, Hydrologist (part time)

Period of Project: July 1985 to June 1988

Objectives: (1) Improve understanding of the ground-water system of Pahvant Valley and how it functions, including directions of ground-water movement, aquifer coefficients, locations and quantities of recharge and discharge, ground-water quantity, and quantity of water in storage. (2) Provide an assessment of the current state of the ground-water system by determining the changes in water levels and water quality due to increased withdrawals for irrigation, changes in the quantities and locations of recharge and discharge, and recirculation of ground water pumped for irrigation. (3) Project the effects of continued large ground-water withdrawals on water levels and water quality.

Approach: (1) Input existing ground-water data into computer storage. (2) Collect data on discharge of ground water from wells, springs, drains, and to streams, and estimate discharge by phreatophytes and subsurface outflow. (3) Estimate recharge from streams, unconsumed irrigation water, precipitation, and subsurface inflow from consolidated rocks. (4) Determine the relationship between ground-water withdrawals and increasing concentrations of dissolved solids. (5) Conduct aquifer tests and reanalyze data from past tests. (6) Construct a digital model capable of simulating three-dimensional flow to provide a method for evaluating the components of the flow system and their interactions and to simulate past and present ground-water flow conditions. (7) Project the effects of potential changes in recharge and discharge on the various components of the system using the ground-water model. (8) Prepare a basic-data report for release to the open file, an interpretive report for publication by the Utah Department of Natural Resources, and document the ground-water model in an open-file report.

Progress: The project has been completed except for the final report, which is in review. A basic-data report and a report on seepage from and to the Central Utah Canal were published.

Plans for next year: Complete review and revision and publish final report.

Reports:

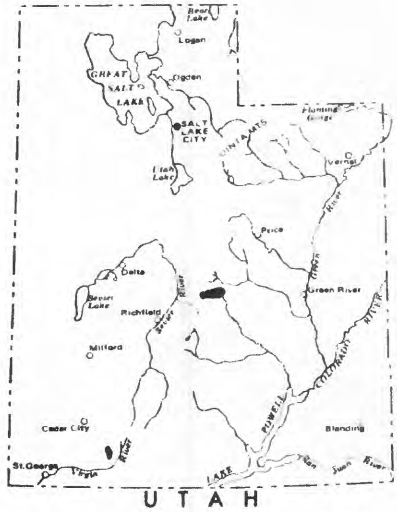
Enright, Michael, 1987, Seepage study of a 15.3-mile section of the Central Utah Canal, Pahvant Valley, Millard County, Utah: Utah Department of Natural Resources Technical Publication No. 91.

Thiros, S.A., 1988, Selected hydrologic data for Pahvant Valley and adjacent areas, Millard County, Utah, 1987: U.S. Geological Survey Open-File Report No. 88-195. (Duplicated as Utah Hydrologic-Data Report No. 46)

Holmes, W.F., and Thiros, S. A., Ground-water hydrology of Pahvant Valley and adjacent areas, Utah: U.S. Geological Survey, written commun., 1988 (in review).

HYDROLOGIC EVALUATION OF THE QUITCHUPAH, PINES, AND L. C. HOLDING COAL-LEASE AREAS

Number: UT-85-176



Cooperating Agency: U.S. Bureau of Land Management

Staff: G. E. Cordy, Hydrologist, Project Chief
S. A. Thiros, Hydrologist (part time)

Period of Project: October 1985 to January 1988

Objectives: Characterize the pre-mining aspects of the local hydrology of two coal-lease areas that have been designated by the Bureau of Land Management as priority areas in their coal-leasing program. Resulting data and evaluations will be used in environmental-impact statements. Aspects of hydrology to be included are: (1) Average streamflow, variability in flow, quality, and fluvial-sediment production. (2) Geologic units and their water-yielding characteristics and identification of geologic structure that may influence hydrology; and, in the L. C. Holding lease, general stability of local geologic units in relation to sediment production, road construction, and mining. (3) Recharge, movement, and discharge of ground water; ground-water quality; and ground water in storage. (4) Potential effects of coal mining on the pre-mining hydrologic system in and near the coal-lease areas. In the L. C. Holding lease area, this will include (a) potential post-mining fluvial-sediment production, (b) stability of geologic units during road construction and of overburden during underground coal mining (to evaluate the potential for land subsidence), (c) potential effects on the downstream surface-water habitat of the Virgin River spindace fish, and (d) potential effects on the hydrology of alluvial valleys and flood plains if they or underlying aquifers are disrupted by mining.

Approach: (1) Measure streamflow in and near the lease areas periodically and correlate flow with that at nearby gaging stations. Estimate average and peak flows using regression relations developed in prior Bureau of Land Management-U.S. Geological Survey studies. Sample streamflow for chemical analysis and periodically for suspended-sediment concentration. (2) Field evaluation of water-yielding characteristics of geologic units and hydrologic effects of geologic structure (supplementing available geologic maps with limited field investigations). Test holes will be drilled and tested in each of the lease areas if funds and suitable test locations are available. Tests will include determining the water level in each hole, taking a water sample, and estimating the hydraulic conductivity of the aquifers. In the L. C. Holding lease area, map the extent of underlying alluvial aquifers. Obtain data on stability of geologic units, especially those above the coal beds. Obtain consulting help from Geologic Division on stability of geologic units. (3) Identify sources of ground-water recharge and points or areas of discharge. Conduct seepage studies on streams to identify areas of ground-water recharge and discharge. Inventory springs and wells in and near the lease areas. Use water-level data from wells to estimate direction of ground-water movement. Obtain hydrologic data from nearby existing coal mines in hydrologically similar areas. Sample water from springs and wells for chemical analysis. Estimate saturated thickness of geologic units and the volume of ground-water in storage. (4) Using hydrologic, mine-plan, mine-production, and mining-method data, qualitatively estimate the potential effects of mining on hydrology of the lease areas.

Progress: Field-data collection in the L. C. Holding area has been completed. Test-hole drilling in the L. C. Holding area was also completed, and data have been analyzed. Literature search, compilation of available data, and collection of field data for the Quitchupah-Pines area have been completed. The final reports for the lease areas have been through colleague review and are currently being prepared for forwarding for Regional and Director's approval.

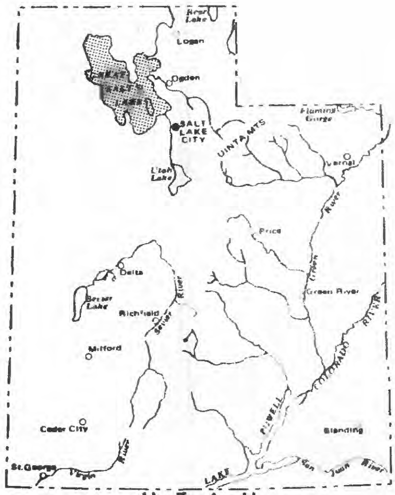
Plans for Next Year: Completion of review and publication of final reports.

Reports:

Thiros, S. A., and Cordy, G. E., Hydrology of the Quitchupah and Pines coal-lease tracts, central Utah, U.S. Geological Survey, written commun., 1988 (in review).

Cordy, G. E., Seiler, R. L., and Stolp, B. J., Hydrology of the L. C. Holding coal-lease tract, southwestern Utah, and potential effects of coal mining, U.S. Geological Survey, written commun., 1988 (in review).

MODEL FOR PREDICTING THE WATER AND SALT BALANCE OF GREAT SALT LAKE FOR SELECTED LAKE LEVELS



U T A H

Number: UT-87-177

Cooperating Agency: Utah Division of State Lands and Forestry

Staff: K. M. Waddell, Hydrologist, Project Chief (part time)
B. E. Thomas, Hydrologist

Period of Project: January 1986 to December 1987

Objectives: To update the existing model (constructed in 1972) of the water and salt balance for Great Salt Lake so that it can be used to predict the water and salt balance between the north and south parts of the lake for variable amounts of freshwater inflow. The existing model is out-of-date in terms of currently higher water levels and modification of the causeway between the north and south parts of the lake since 1972. Variations in stratification in the south part of the lake will be incorporated in the model, if possible.

Approach: Equations used for flow through the causeway breach will be taken from Holley and Waddell (1976) and new equations for stratified flows through the submerged culverts will be developed. The causeway-fill flows are being updated using the two-constituent solute-transport model of Sanford and Konikow (1985). The fill-flow model will be calibrated by indirectly estimating flow through the causeway fill as the unknown variable, and calculating the fill-flow values using equations that describe the water and salt balance for the north and south parts of the lake.

Data collected by the Utah Geological and Mineral Survey indicate the deep stratified layer in the south part of the lake remained relatively stable during 1962-83 but began to change when the causeway was breached in 1984. The effects of different variables on stratification patterns will be determined by plotting time trends of density for each sampling section and then contrasting the trends for other parameters, such as surface inflow and breach width, that affect the water and salt balance of the lake.

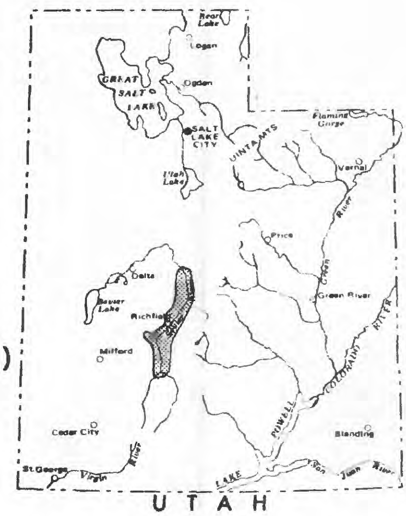
Progress: The solute-transport model for the causeway-fill flows was calibrated and the part of the report dealing with the fill-flow model was written.

Plans for Next Year: Calibrate the overall model, and use it to predict water and salt balance between the north and south parts of the lake for various conditions; attempt to define the variables that govern stratification; and complete the report.

Reports:

Waddell, K.M., and Thomas, B.E., Model for predicting the water and salt balance of Great Salt Lake, Utah, for selected lake levels: U.S. Geological Survey, written commun., 1988 (in preparation).

EFFECTS OF IRRIGATION AND NATURAL SOURCES OF SALT ON SURFACE- AND GROUND-WATER QUALITY IN THE CENTRAL SEVIER VALLEY



Number: UT-86-180

Cooperating Agency: Utah Division of Water Rights

Staff: R. L. Seiler, Hydrologist, Acting Project Chief, succeeded by P. M. Lambert, Hydrologist, Acting Project Chief, and
J. L. Mason, Project Chief
R. W. Puchta, Hydrologist
T. P. Ryan, Hydrologic Technician (part time)

Period of Project: July 1986 to June 1990

Objectives: To assess the current state of the hydrologic system of the Central Sevier Valley, in terms of surface-water flow, ground-water levels, and water quality. To quantify the hydrologic system in terms of surface-water runoff and ground-water recharge, movement and discharge, and to determine the relations between surface and ground water. To determine the factors that result in an increase in dissolved solids in surface and ground water along the valley. To estimate the effects of continued and increased ground-water withdrawals on the hydrologic system, including water quality.

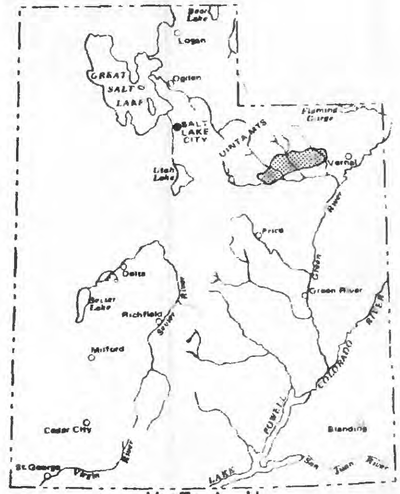
Approach: Update data on streamflow, ground-water levels, and surface- and ground-water quality. Refine previous estimates of ground-water recharge and discharge, especially recharge from irrigation and discharge by seepage to the Sevier River. Sample ground and surface water to define in detail the changes that occur in water quality. Construct a digital model (or models) of the valley's ground- and surface-water system (or a representative part of the system) to define surface-water/ground-water interaction. Install a series of shallow wells near selected river reaches to determine quality of ground-water seepage to the river and to obtain the gradient from the aquifer to the stream. Conduct seepage studies during low flow combined with sampling to better define quality and quantity of inflow to the river. Analyze ground water for isotopes to help determine sources of recharge, and to differentiate recharge by irrigation, precipitation, and inflow from adjacent areas. Apply geochemical models (such as salt-routing models) in an attempt to quantitatively characterize changes in water quality. A solute-transport model of a representative part or cross-section of the valley also may be used to study changes in ground-water quality. Use the analytical techniques to further estimate the effects of continued and increased ground-water withdrawals on the hydrologic system, including water quality.

Progress: Well inventory was completed and an observation-well network was established. Mass measurements of water levels in observation wells were completed in March and September 1988. Monthly water-level measurements are made on the majority of the observation wells in the center of the study area. Ground-water sampling for water quality continued. A seepage study along the Sevier River indicated total gains of 200 cubic feet per second. A seismic-refraction study was completed which determined the cross-sectional area of channel deposits near Brine and Lost Creeks.

Plans for Next Year: Complete a second seepage study on the Sevier River. Continue measurements of water levels and water quality. Drill four shallow wells to obtain additional sites at which to measure water levels and confirm valley-fill thickness derived from seismic data. Compile basic data for final report. Complete ground-water-flow model of the central part of the valley to estimate ground-water/surface-water relationships and effects of additional ground-water development on water levels and streamflows. Analyze water-quality data to determine flow paths of ground water. Begin writing final report.

Reports: None.

PLAN TO DETERMINE EFFECTS OF INJECTING BRINE, UINTA BASIN


U T A H

Number: UT-87-182

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

Staff: G. W. Freethey, Hydrologist, Project Chief (part time)
L. W. Howells, Hydrologist (part time)

Period of Project: October 1986 to September 1987

Objectives: To determine the best method of estimating the effects of injecting brines produced by oil and gas wells on the ground-water system in the Uinta Basin. If digital modeling is determined to be part of the method, define the type of data needed and the availability of that data for developing a model to simulate the hydraulic and chemical effects of injecting the brines.

Approach: (1) Evaluate methods for estimating the effects of brine injection, especially the use of various digital models, (2) determine data requirements for modeling, (3) determine availability, sources, reliability, and distribution of these data, (4) design a data-collection program to obtain these data if they are not available, and (5) begin model development if data are available and time allows.

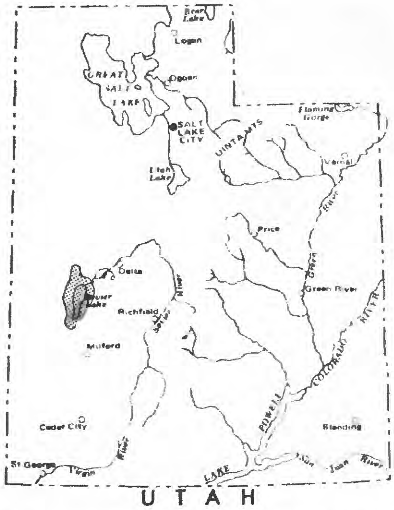
Progress: Available flow and transport models have been reviewed. Data availability has been reviewed and additional data-collection programs outlined and assessed. A report outlining the requirements of the four most-pertinent model codes; the availability and distribution of pressure-head, hydrologic-property, and water-quality data; and a plan for determining the effects of brine injection, has been prepared, reviewed, and approved.

Plans for Next Year: Publish report. If the project is funded for another year, begin assembling data for a digital model. Begin collecting field data as necessary for the modeling effort.

Reports:

Freethey, G. W., (in press), Models, data available, and data requirements for estimating the effects of injecting saltwater into disposal wells in the Greater Altamont-Bluebell oil and gas fields, northern Uinta Basin, Utah, U.S. Geological Survey Open-File Report 88-475.

HYDROLOGIC ASSESSMENT OF THE SEVIER LAKE AREA



Number: UT-87-183

Cooperating Agency: Utah Division of Water Rights

Staff: D. E. Wilberg, Hydrologist, Project Chief

Period of Project: April 1987 to September 1988

Objectives: (1) To define the extent, thickness, and characteristics of the basin fill in the Sevier Lake area. (2) To define the potentiometric surface and ground-water-flow directions. (3) To define a ground-water budget by estimating recharge and discharge within the area. (4) To assess ground-water quality. (5) To estimate surface-water runoff to Sevier Lake.

Approach: (1) Use published geophysical surveys and available geophysical data to derive thickness of basin fill, depth to consolidated rock, and to help determine depositional history of the study area. Use shallow test-hole data obtained from consultants to help define lithology, the potentiometric surface, and ground-water quality. (2) Obtain water-level measurements, both historical and current, to determine potentiometric surface and ground-water-flow directions. (3) Estimate water budget using climatological data for precipitation and evaporation, inflow from adjacent areas estimated from previous studies, and outflow from the area based on potentiometric surfaces and flow directions. (4) Obtain water samples from test-holes and wells, analyze constituents, and determine water types using Piper diagrams, which may help to determine the direction of flow. (5) Use channel-geometry surveys and/or equations based on basin characteristics to estimate surface-water flow and recharge from surface water. (6) Use data from a private test-drilling program to help define basin-fill characteristics. When a production well is drilled and tested, use data to estimate hydraulic characteristics of basin fill. (7) Compile historical data on surface-water inflow to and levels of Sevier Lake.

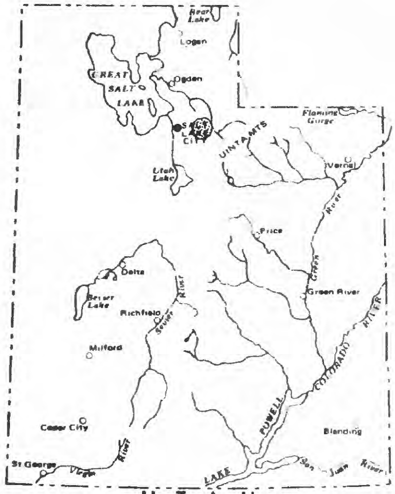
Progress: The report has been written and currently is in review. The findings suggest two separate aquifers, the brine aquifer located near the low points of the lake and the alluvial-fan aquifer located at higher elevations surrounding the lake.

Plans for Next Year: The colleague review comments will be incorporated into the report, which will be submitted for Regional and Headquarters review. Upon approval, the report will be published as a Utah Division of Natural Resources Technical Publication.

Reports:

Wilberg, D.E., Hydrologic system of the Sevier Lake area, west-central Utah, U.S. Geological Survey, written commun., 1988 (in review).

GROUND- AND SURFACE-WATER QUALITY IN THE SILVER CREEK TAILINGS AREA OF PARK CITY, UTAH



U T A H

Number: UT-87-184

Cooperating Agency: Utah Department of Health, Division of Environmental Health

Staff: J. L. Mason, Hydrologist, Project Chief
W. F. Holmes, Hydrologist (part time)
K. R. Thompson, Hydrologist (part time)

Period of Project: July 1987 to September 1988

Objectives: To determine the quality of ground water, surface water, and stream sediment in and adjacent to the Silver Creek tailings site. The data and analyses will be used by the Utah Division of Environmental Health and the U.S. Environmental Protection Agency to determine if contaminants are being released from the tailings to Silver Creek or to the ground water underlying the site.

Approach: Ground-water samples will be obtained from 11 monitoring wells on a quarterly basis, with the exception of the months February through June, when monthly samples may be required due to rapid changes in water levels from increased recharge. Additional ground-water samples will be collected at a spring discharging from the unconsolidated valley fill on the eastern side of the site, and from subsurface drains that are buried in the eastern and northeastern part of the site. Surface-water samples will be collected above and below the tailings site. The data will be used to determine if water from the site is degrading the quality of water in Silver Creek or if sediments may be transporting metals from the site.

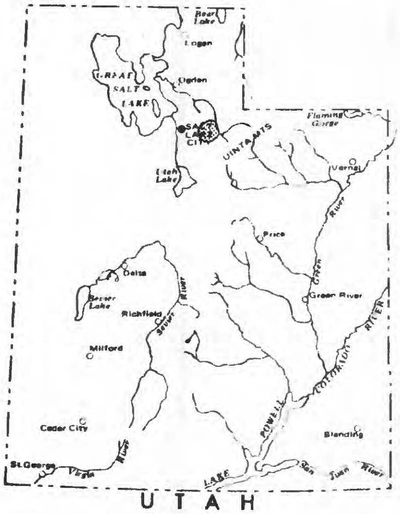
Progress: Field-data collection, test drilling, and water sampling were completed. Data analysis was completed and the report prepared, reviewed and approved.

Plans for Next Year: Publish the report.

Reports:

Mason, J.L., (in press), Hydrology of the Prospector Square area, Summit County, Utah: U.S. Geological Survey Water-Resources Investigations Report 88-4156.

GROUND-WATER HYDROLOGY OF THE PROSPECTOR SQUARE AREA, SUMMIT COUNTY, UTAH



Number: UT 87-185

Cooperating Agency: Utah Department of Health, Division of Environmental Health

Staff: J. L. Mason, Hydrologist, Project Chief
W. F. Holmes, Hydrologist (part time)
K. R. Thompson, Hydrologist (part time)

Period of Project: July 1987 to September 1988

Objectives: (1) To characterize the ground-water hydrology in the area of Prospector Square including water levels, direction of flow, estimates of recharge, discharge, and vertical leakage between unconsolidated valley fill and underlying consolidated-rock aquifers. (2) To prepare a detailed plan of study for a second phase of this project if data from this study or other studies show a need for additional data and analyses.

Approach: The characterization of the ground-water system will include determining depth to water, direction of flow, and seasonal fluctuations in water levels in the unconsolidated valley fill. Data will be obtained from 2 deep and 11 shallow observation wells that will be drilled in the valley fill. Additional data may be obtained from existing wells in the area. Data collected will identify seasonal changes in water levels and in discharge of springs and drains due to changes in recharge and discharge that occur during the year. An aquifer test may be conducted to assess the vertical and horizontal hydraulic properties of the unconsolidated- and consolidated-rock aquifers and the degree of connection that exists between them.

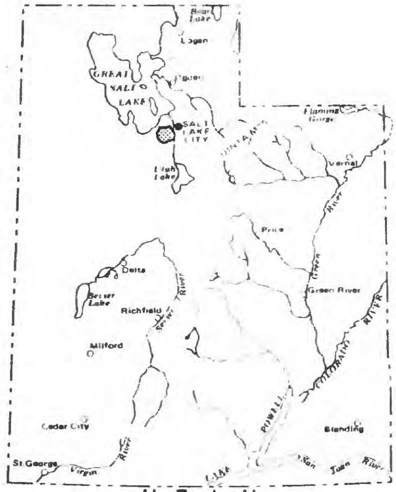
Progress: Field data collection, test drilling, and water sampling were completed. Data analysis was completed and the report prepared, reviewed, and approved.

Plans for Next Year: Publish the report.

Reports:

Mason, J.L., (in press), Hydrology of the Prospector Square area, Summit County, Utah: U.S. Geological Survey Water-Resources Investigations Report 88-4156.

REVIEW OF GROUND-WATER CONTAMINATION, SOUTHWESTERN SALT LAKE VALLEY



U T A H

Number: UT-88-186

Cooperating Agency: Utah Division of Environmental Health

Staff: K. M. Waddell, Hydrologist, Project Chief (part time)
Upmanu Lall, Hydrologist (part time)

Period of Project: July 1987 to September 1988

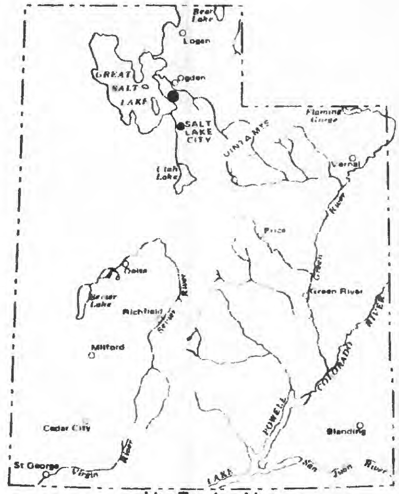
Objectives: At the request of the Utah Division of Environmental Health, the U.S. Geological Survey will review the characterization of the hydrogeologic system in southwestern Salt Lake Valley and the flow and solute-transport models developed for this area to help insure that the models represent the ground-water system within limitations of the data base.

Approach: The data base will be examined to determine if all data pertinent to the study are included and will be spot-checked to determine consistency with original sources of data. Estimates of recharge, discharge, and aquifer properties will be checked for consistency with other reports. Definitions of the extent, thickness, and physical characteristics of the geologic units will be reviewed using the results of test drilling, core samples, and geophysical logging. Water levels and land-surface datums will be reviewed to determine consistency between field data, illustrations, and tables. Chemical analyses will be reviewed to see if analytical balances are within acceptable limits. The conceptual model of the ground-water system will be reviewed to evaluate consistency with the data base and other hydrologic information deemed pertinent to the study area. Representations and assumptions that are made to apply the computer models to the ground-water system will be evaluated. Historical time trends of selected water-quality parameters will be compared with model-computed trends.

Progress: The contractor did not complete any reports until June 1988, about a year behind schedule. Since June, several reports have been received and are now being reviewed.

Plans for Next Year: Prepare progress reports after reviews of designated parts of the study. A summary report evaluating the accuracy and limitations of the model will be prepared at the conclusion of the study.

GROUND-WATER CONTAMINATION AT HILL AIR FORCE BASE LANDFILLS 1 AND 2



U T A H

Number: UT-88-187

Cooperating Agency: U.S. Air Force

Staff: R. L. Seiler, Hydrologist, Project Chief
K. M. Waddell, Hydrologist (part time)
K. A. Kariya, Hydrologist
L. J. Gerner, Hydrologic Technician
Other District and Regional personnel as assigned

Period of Project: October 1987 to September 1988

Objectives: To conduct a remedial investigation/feasibility study at landfills 1 and 2 to identify the existence of hazardous waste and to evaluate the source, extent, and degree of contamination of ground water. To assess the risk to human health and the environment. To define and assess alternative actions that will control or eliminate the risk.

Approach: Determine the hazard level of the site so that the proper safety equipment will be used. Define the source, extent, and degree of contamination by sampling and analyzing soil gas, by drilling test holes and completing them as monitoring wells, and sampling and analyzing cuttings and water. Conduct geophysical surveys and use data from test holes to characterize the local hydrogeologic system. Measure water levels in monitoring wells to determine directions of ground-water movement. The data collected at the site will be used to prepare a risk assessment. A contractor will design and evaluate alternatives for controlling or removing the contaminant source and the contaminated ground water.

Progress: Completed surface-geophysics and soil-gas investigations and drilled eight test holes which were cased to complete them as monitoring wells. A plume of trichloroethylene (TCE) was approximately defined for the area below landfill 1 on Hill AFB. Completed a draft of an interim report for the first year of work.

Plans for next year: Complete field studies, including geophysical and soil-gas surveys and water-quality sampling to refine definition of plume on-base, and extend areal coverage of study downgradient and off-base. Determine the hazard level of the site. Drill additional test holes and complete them as monitoring wells. Collect cuttings and water samples and analyze them, interpret results, and prepare a report on the evaluation of the site.

Reports:

Seiler, R.L., Waddell, K.M., and Kariya, K.A., Installation restoration program remedial investigation draft final report landfills 1 and 2, Hill Air Force Base, Utah: U.S. Geological Survey, written commun., 1988 (in review).

GROUND-WATER HYDROLOGY OF SANPETE VALLEY AND THE SAN PITCH RIVER DRAINAGE BASIN, UTAH

U T A H

Number: UT-88-188

Cooperating Agency: Utah Division of Water Rights

Staff: C. F. Avery, Hydrologist, Project Chief, succeeded by D. E. Wilberg, Hydrologist, Project Chief
E. S. Leibold, Hydrologist (part time)

Period of Project: July 1987 to June 1990

Objectives: (1) To assess current hydrologic conditions in terms of ground-water occurrence, recharge, movement, and discharge; ground-water levels and quality; surface-water flow and quality; and ground- and surface-water interrelations. (2) To improve understanding of the hydrologic system and how it functions, especially the ground-water component. (3) To estimate the effects on the hydrologic system caused by potential redistribution or changes in the amounts and locations of ground-water withdrawals, importation of surface water, and modification of irrigation methods. (4) To determine causes for downstream deterioration in quality of surface water, the lesser deterioration in quality of ground water, and local variations in ground-water quality. (5) To define the relationship between the consolidated-rock aquifer(s), the valley-fill aquifer, and surface water. (6) To locate the ground-water divide between the San Pitch and Spanish Fork surface-water drainage basins and to assess basic ground-water conditions in the Indianola area.

Approach: (1) Compile data on ground water and surface water that has been collected since the last study in the area during 1964-67. (2) Measure or estimate ground-water discharge from wells, springs, drains, to streams, and by evapotranspiration; and estimate recharge from streams, irrigation, and seepage from consolidated rock. Conduct low-flow discharge measurements on the San Pitch River to delineate losing and gaining reaches and to estimate ground-water recharge and discharge, including irrigation return flow. Measure seepage losses on representative tributaries to determine the amount of runoff that contributes to ground-water recharge. (3) Measure water levels in wells to monitor spatial and temporal variations, to define directions of ground-water movement, and to determine ground-water divides. (4) Conduct aquifer tests to obtain hydraulic characteristics of the valley fill. (5) Construct a digital model of the valley-fill aquifer to simulate the three-dimensional ground-water system and to provide a means of estimating the effects of changes in the hydrologic system. (6) Install temporary surface-water gages on major tributaries of the San Pitch River in order to better define surface-water runoff prior to importation of surface water. (7)

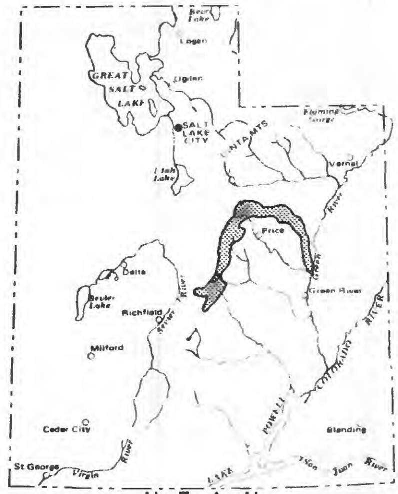
Sample and analyze water from wells, springs, streams, and drains to define variations in ground- and surface-water quality and provide information to use in estimating causes of these variations. Sample selected ground- and surface-water sources having previous chemical analyses to determine if any water-quality deterioration has occurred; and correlate available analyses with geologic cross-sections and drillers' logs to determine possible causes of water-quality variation. (8) Compile drill-stem-test data from the few oil-test wells drilled in the area to help estimate the relations between the consolidated-rock aquifer and the valley-fill aquifer.

Progress: (1) Conducted low-flow seepage measurements on the San Pitch River. (2) Measured water levels in wells. (3) Measured flowing-well discharge. (4) Sampled selected ground- and surface-water sources for chemical analysis, compared with previous analyses, and correlated analytical results with geologic cross-sections and drillers' logs. (5) Collected available drill-stem-test data from oil-test wells in the area.

Plans for Next Year: Compile potentiometric-surface maps based on measured water levels to determine directions of ground-water movement. Construct geologic cross-sections and depth-to-consolidated-rock maps using drillers' logs to determine extent and depth of valley-fill aquifer. Measure discharge on the San Pitch River and representative tributaries to determine both the location of losing and gaining reaches and the magnitude of the resulting recharge or discharge. Measure discharge from selected pumped and flowing wells and springs to determine ground-water discharge. Drill observation wells perpendicular to the San Pitch River to determine the vertical and horizontal components of ground-water flow. Reanalyze the results from previously conducted aquifer tests to determine aquifer characteristics. Determine acreage of various types of vegetation to estimate evapotranspiration rates. Construct and calibrate digital model to simulate the ground-water system and predict the effects of potential changes in water use on that system.

Reports: None.

ROCK FRACTURES AND COAL CLEATS AND THEIR EFFECTS ON GROUND-WATER HYDRAULICS IN COAL FIELDS OF CENTRAL UTAH



U T A H

Number: UT-88-189

Cooperating Agency: U.S. Bureau of Land Management

Staff: G. W. Freethey, Hydrologist, Project Chief
L. W. Howells, Hydrologist (part time)
R. S. Black, Hydrologic Technician (part time)

Period of Project: October 1987 to September 1988

Objectives: The major objectives of this study are to determine, quantitatively where possible, the effects of fractures (both natural and subsidence-induced) and coal cleats on: (1) Hydraulic conductivity and anisotropy, (2) natural movement of ground water, and (3) inflows of water to underground mines.

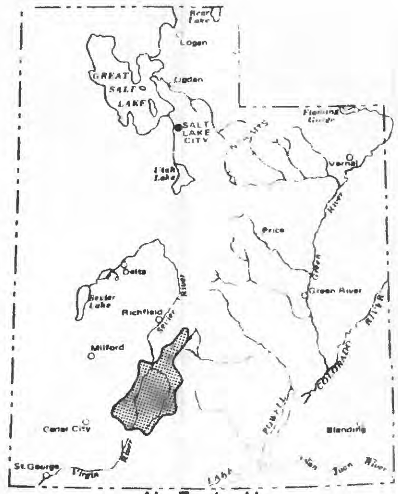
Approach: (1) Search and review literature. (2) Contact government and local agencies and search USGS files for existing aquifer-test data and unpublished geologic and hydrologic data. (3) Prepare project description and detailed planning document by January 1, 1988. (4) Identify surface fractures on low-altitude aerial photographs and Landsat imagery, field check, compare with regional lineaments, and relate to geologic structures. (5) Map fractures and coal cleats in outcrops and selected underground mines to determine continuity, orientation, frequency, aperture, and any relationship to geologic structures, depth of burial, topographic setting, lithology, or subsidence. (6) Document ground-water inflow to selected mines and estimate quantity of water discharging from fractures compared to that from unfractured mine faces. Determine if quantity of inflow is related to orientation of fractures or mine workings. (7) Analyze water samples from fractures to estimate length of time in flow system. (8) Review aquifer-test data and compare with laboratory hydraulic-conductivity values and field measurements of fractures. Participate in aquifer tests conducted by consultants or mining companies when possible. (9) Estimate principal axes of hydraulic conductivity from stereonet plots of fracture orientation and density.

Progress: Mine plans have been collected and digitized. Faults, drainage basins, and mined-area boundaries have been put into ARC/INFO coverages. Approximately 20 fracture surveys have been done and another 10 have been obtained from mine geologists. Five mine-inflow samples were collected for chemical and age-dating analysis.

Plans for Next Year: Identify fractures on aerial photographs and collect data on fractures and joints on the surface and in mines. Compile data on occurrence of water in and inflow to mines. Assemble and simulate aquifer-test and laboratory-permeability data. Enter data sets into ARC-INFO for further analysis. Although the preceding work was begun in October 1988, the project was terminated or suspended by the Bureau of Land Management because of a lack of funds.

Reports: None.

HYDROLOGY OF THE UPPER SEVIER RIVER BASIN, SOUTH-CENTRAL UTAH, AND SIMULATION OF THE GROUND-WATER SYSTEM IN PANGUITCH VALLEY



U T A H

Number: UT-88-190

Cooperating Agency: Utah Division of Water Rights

Staff: S. A. Thiros, Hydrologist, Project Chief
J. D. Olson, Hydrologic Technician (part time)
W. C. Brothers, Hydrologist (part time)

Period of Project: July 1987 to June 1990

Objectives: (1) To define the hydrology of the Upper Sevier River drainage basin and the current state of the hydrogeologic system, including the hydrologic budget, ground-water/surface-water relations, and characterization of the ground-water reservoir. (2) To define the chemical quality of ground and surface water and to describe the mechanisms for quality changes in the downstream direction. (3) To estimate the hydrologic effects of increased ground-water development, changes in irrigation practices, and impoundment of surface water on ground-water levels, streamflow, spring discharge, and evapotranspiration.

Approach: (1) Compile all data on ground water, surface water, and chemical quality of water collected since the last study in the area in 1961-64. (2) Conduct seepage runs and/or install short-term gaging stations along the major streams to define ground-water seepage to or from streams and gaining and losing reaches. Select observation wells to better define periods of ground-water seepage to or from streams. Conduct aquifer tests on suitable wells. (3) Estimate ground-water recharge from streams and irrigation, ground-water inflow from adjacent basins, and discharge by wells, springs, seepage to streams, and evapotranspiration. (4) Sample and analyze water from wells, springs, drains, and streams to define quality of ground and surface water, and use analyses to determine causes of downstream changes in water quality. (5) Construct analytical or digital models for simulating flow in parts of the basin to help estimate hydrologic effects of increased ground-water development, changes in irrigation practices, or surface-water impoundment.

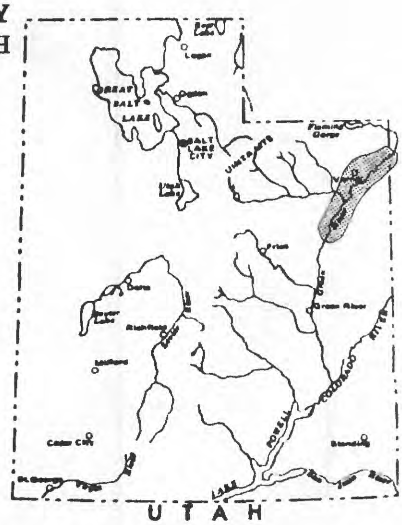
Progress: Historical water-level, well-discharge, water-quality, drillers'-log, and surface-water data available for the area are being compiled. A base map has been constructed. The process of inventorying wells and springs in the field and entering data into the GWSI system has begun. Water levels in selected observation wells are being measured monthly. The collection of water-quality samples from ground- and surface-water sources is in progress.

Data collected from gain-loss studies on selected canals and reaches of the Sevier and East Fork Sevier Rivers are being analyzed.

Plans for Next Year: Continue the inventory of wells and springs in the field and entry of the data collected into the GWSI system. Collect additional water-quality samples from ground- and surface-water sources. Repeat gain-loss studies along selected canals and reaches of the Sevier River under baseflow conditions. Construct and calibrate a finite-difference ground-water flow model of Panguitch Valley. Install and monitor soil-moisture access tubes and observation wells on two test plots in Panguitch Valley in order to quantify recharge from irrigation and to help determine the rate of irrigation return flow.

Reports: None.

DETAILED ASSESSMENT OF EFFECTS OF IRRIGATION DRAINAGE ON WATER QUALITY IN THE MIDDLE GREEN RIVER BASIN, UTAH



Number: UT-88-191

Cooperating Agency: Office of the Secretary, U.S. Department of the Interior

Staff: D. W. Stephens, Hydrologist, Project Chief
L. A. Peltz-Lewis, Hydrologic Technician

Objectives: (1) To define the extent and severity of existing irrigation-induced water-quality problems or the potential for future problems, and (2) to provide the scientific understanding needed for development of alternatives to mitigate or resolve identified problems. The areas that will receive detailed study are: Stewart Lake and associated Marsh 4720, lower Ashley Creek, and Ouray National Wildlife Refuge. Reconnaissance will be extended at Pariette Wetlands to include upstream agricultural areas in Pleasant Valley.

Approach: The relative contribution of each of the drains to chemical loading will be determined by sampling drain water. Once major contributing reaches are identified, soil cores will be collected, analyzed, and sequential extractions used to determine the potential for continued release of selenium if irrigation is continued. Analyses to determine selenium speciation in the drain water will be done and compared to selenium speciation in shallow ground-water samples collected from wells. Shallow ground water in the Jensen area will be investigated by determining vertical and horizontal gradients, direction of flow, and concentration of dissolved constituents in the water at existing and new wells. Shallow wells will be augered north of Stewart Lake and cased to provide piezometers, which will be monitored periodically for water levels and sampled for chemical analysis to determine the concentrations of selenium in the ground water.

The degree to which the water has been concentrated by evaporation will be determined using hydrogen and oxygen isotopes as described by Deveral and Fujii (1987). As the shallow ground water probably is less than 30 years old, age dating will be done using tritium. Water samples will be collected at several locations for analysis of oxygen-18/oxygen-16 ratios, deuterium/protium ratios, and tritium. Processes involved in precipitation of selenium, incorporation by sediments, and uptake by plants will be identified and quantified by transect sampling and analysis of water, sediments, and plants.

Synoptic sampling will be done on Ashley Creek from Vernal to its confluence with the Green River. Samples will be collected from all inflowing water and from existing wells and analyzed to determine quantities of selenium and total salts entering Ashley Creek.

Reconnaissance will be continued on water supplied to marsh 4720 to determine if there are seasonal patterns in selenium content of the irrigation-drainage water. The relation of water delivery in the Ruppe drain, Naples drain, and the oilfield canal to selenium entering the marsh will be determined.

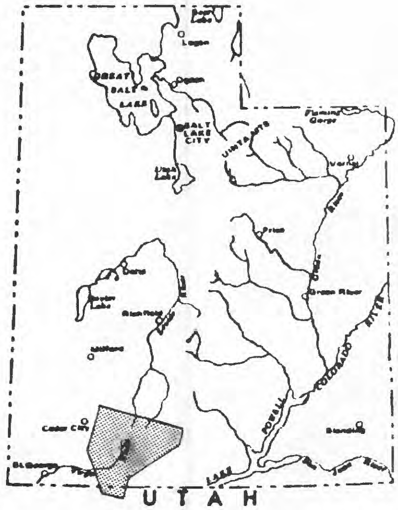
The outflow from Pelican Lake and Ouray Park Irrigation Company drainage, which provide inflow to the Ouray National Wildlife Refuge, will be monitored at the refuge three times during the summer for selenium and major ions. A more complete search of well records will be made prior to test-well drilling to determine if existing wells could be used for monitoring. Synoptic sampling will be done to identify stream reaches where the selenium input in ground water is greatest. The distribution of selenium will be determined in the sediments in the Roadside ponds and in Sheppard Pond S5.

Progress: Monitoring of water quality has continued from Project UT-179 at Stewart Lake, Ashley Valley, and Ouray NWR. Water from shallow wells at Ouray contained 3,200 µg/L of selenium. Tributary and drain inflow into Ashley Creek contained 8,900 µg/L of selenium. Sources of large concentrations of selenium in water are natural springs and irrigation return flow from Bureau of Reclamation drains. Shallow wells and three deeper wells (to 42 feet) were installed at Ouray. Additional reconnaissance in Pleasant Valley and Pariette Wetlands was completed. Incremental sampling of the drains at Stewart Lake has identified sites of large concentrations of selenium.

Plans for Next Year: Complete well monitoring, core-desorption studies, and selenium-volatilization studies. Most fieldwork will be completed during FY 1989.

Reports: None.

EXAMINATION OF THE GROUND-WATER HYDROLOGY OF SOUTHWESTERN UTAH AND NORTHWESTERN ARIZONA USING COMPUTER SIMULATION TO ESTIMATE EFFECTS OF PUMPING FROM THE NAVAJO SANDSTONE



Number: UT-88-192

Cooperating Agency: U.S. National Park Service

Staff: G. W. Freethey, Hydrologist, Project Chief (part time)
V. M. Heilweil, Hydrologist

Period of Project: May 1988 to September 1989

Objectives: The objective of the study is to improve understanding of the hydrologic system of the Navajo Sandstone without the collection of additional extensive and costly field data. This involves using computer simulation to test various alternative concepts of the system or system parameters to determine the range of possible effects if pumping of ground water from wells in the Navajo increases.

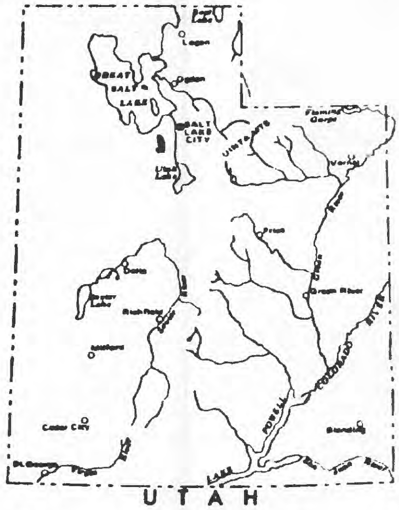
Approach: The first step will be to compile all data that can be used to describe the ground-water budget of the area. These data will include estimates of recharge from infiltrating precipitation, underflow from adjacent areas, and stream losses, and estimates of discharge from springs, wells, and evapotranspiration, and seepage to streams, made by previous investigators. The second step will be to describe the direction and rate of ground-water flow based on water-level measurements in wells and the altitudes of springs that are part of the regional ground-water flow system in the Navajo Sandstone, and on hydrologic properties of the Navajo aquifer. The third step will be to define hydrologic boundaries of the system that are far enough removed so as not to be affected by any projected development of ground-water supplies. The fourth step will be to develop and test several of the most plausible hydrologic conceptualizations in a numerical model to determine if they are mathematically plausible. The final step will be to use several of the most plausible steady-state simulations to determine the effects of pumping from wells in the Navajo on the direction and rate of flow in the aquifer and subsequently on springs in Zion National Park and Pipe Spring National Monument.

Progess: Compilation of all hydrologic and geologic information has been completed, and a 3-D digital model has been constructed. Development of alternative conceptualizations of the hydrologic system is in progress.

Plans for next year: Development of the several concepts of the system will be completed and pumping stress on the Navajo aquifer will be simulated in transient runs of the model. A report discussing model conceptualization, development, and predictive simulations will be written and published.

Reports: None.

HYDROLOGY AND WATER AVAILABILITY IN SOUTHEASTERN TOOELE VALLEY, NORTHEASTERN RUSH VALLEY, AND ADJACENT AREAS IN THE OQUIRRH MOUNTAINS, TOOELE COUNTY, UTAH



U T A H

Number: UT-88-193

Cooperating Agencies: Tooele County
City of Tooele

Staff: B. J. Stolp, Hydrologist, Project Chief
W. F. Holmes, Hydrologist (part time)

Period of Project: May 1988 to August 1990

Objectives: (1) To determine the saturated thickness and hydraulic characteristics of the basin fill in southeastern Tooele Valley. (2) To quantify the amount of water moving out of the Oquirrh Mountains via underflow in the channel alluvium of Soldier, Settlement, and Middle Canyons. (3) To determine the occurrence of ground water in and hydraulic properties of the consolidated rock of the Oquirrh Mountains. (4) To determine the average annual streamflow in Soldier, Settlement, and Middle Canyons.

Approach: Inventory and measure water levels of wells located in southeastern Tooele Valley. Determine the depth to consolidated rock from drillers' logs and seismic surveys. Monitor water levels in and determine quality of water from selected wells. Perform aquifer tests to determine hydraulic parameters.

Obtain all water-level data, pumping records, and drillers' logs for municipal wells located at the mouths of Settlement and Middle Canyons, and continuously monitor water levels in selected wells. Inventory all wells and monitor water levels of selected wells at the mouth of Soldier Canyon. Perform aquifer tests on wells at canyon mouths to determine hydraulic properties. If possible, conduct an aquifer test on two wells above the mouth of Middle Canyon. Collect water samples at selected sites for chemical analysis.

Find all water sources (springs and tunnels) in the mountain areas, and monitor discharge at selected sites. Identify several candidate sites along the mountain front for possible test drilling into the consolidated rock. If test drilling is feasible, and water is found in the test hole, conduct a slug or aquifer test to estimate hydraulic properties of the rock. Collect water samples from selected mountain sites for chemical analysis.

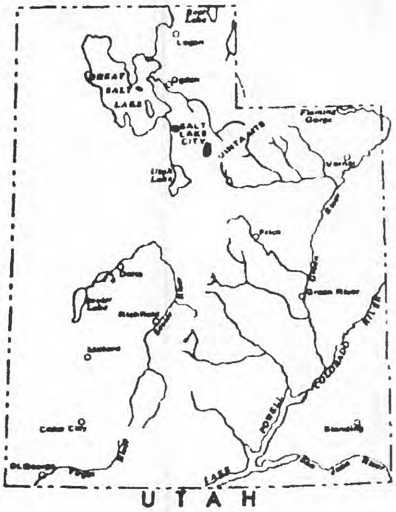
Based on studies in adjacent areas, historical records, and streamflow monitoring during this study, estimate average annual streamflow for Soldier, Settlement, and Middle Canyons.

Progress: Began site and water-quality inventory of mountain water sources, and visited 21 sites. Conducted seismic-refraction survey in the Middle Canyon area and at the mouth of Silcox Canyon. Installed a continuous water-level monitoring instrument in a well at the mouth of Middle Canyon. Began monitoring water levels in wells in southeastern Tooele Valley, along the mountain front, and at the mouth of Settlement Canyon. Began monitoring the discharge of selected mountain water sources. Restored control structure for making surface-water discharge measurements in Settlement Canyon. Began monitoring discharge of both Middle and Settlement Canyon streams. Measured seepage losses from Middle Canyon Creek between Angel Grove and diversions. Completed survey of information on the hydrology and geology of the area from previous studies. Compiled the base map and a project planning document.

Plans for Next Year: Continue inventorying and monitoring wells in southeastern Tooele Valley and conduct aquifer tests on selected wells. Compile pumping data and perform aquifer tests on wells at the mouths of Settlement and Middle Canyons. Maintain continous recording of water levels in the well at the mouth of Middle Canyon. Conduct an aquifer test of channel fill in Middle Canyon using two wells below Left Hand Fork. Install a continuous recording device on a well at the mouth of Settlement Canyon. Inventory and begin to monitor water levels in wells at the mouth of Soldier Canyon. Continue inventory and monitoring of water sources in the mountain areas. If feasible, drill a test hole in the consolidated rock. Compile historic streamflow data for streams and begin estimation of average annual streamflow. Continue streamflow measurements of Soldier, Settlement, and Middle Canyons. Install surface-water gaging station on Settlement Creek to continuously record streamflow.

Reports: None.

HYDROLOGY OF HEBER AND ROUND VALLEYS, WASATCH COUNTY, UTAH, WITH EMPHASIS ON GROUND WATER



Number: UT-88-194

Cooperating Agencies: Utah Division of Water Resources
Utah Division of Water Rights
Wasatch County
Central Utah Water Conservancy District
Wasatch County Water Users, Associated

Staff: W. F. Holmes, Hydrologist, Project Chief
D. M. Roark, Hydrologist
H. K. Schatmeier, Hydrologic Technician (part time)

Period of Project: May 1988 to June 1990

Objectives: (1) Define and quantify recharge, movement, and discharge of the ground-water systems of Heber and Round Valleys. (2) Define ground-water quality in the two valleys and its spatial and temporal variations. (3) Provide a method for assessing the effects on the hydrologic system of changes in surface-water flows, irrigation methods, and ground-water recharge in Heber Valley, and increased ground-water withdrawals in Round Valley. (4) In a written report, discuss the hydrologic systems of Heber and Round Valleys and how the components interact.

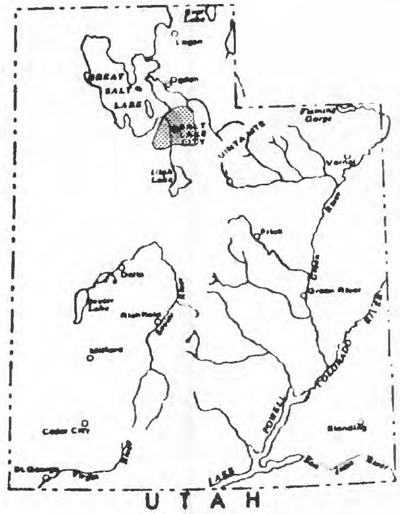
Approach: (1) Update the hydrologic data base. (2) Inventory all large-diameter wells drilled since 1968 and all wells in areas where data were lacking in the previous study, and drill observation wells where needed. (3) Assess the quality of ground water by collecting samples for laboratory analysis. (4) Conduct seepage studies, check diversion and streamflow records, and estimate recharge from irrigated fields and direct precipitation. (5) Estimate discharge from wells, springs, evapotranspiration, and seepage to Deer Creek Reservoir. (6) Compile water budgets for Heber and Round Valleys. (7) Construct a three-dimensional ground-water flow model of each valley to improve understanding of the hydrologic systems and estimate water-level changes and changes in natural discharge related to potential changes in surface-water flows and irrigation practices.

Progress: Observation wells have been located and water levels are being measured monthly. A planning document has been completed. Seepage studies have been conducted on several of the major canals and the Provo River.

Plans for Next Year: Store data in GWSI and QWDATA databases. Inventory existing wells, conduct seepage studies, and collect streamflow information. Collect samples for water-quality analysis. Begin construction of digital ground-water flow models. Drill observation wells in areas where data are lacking.

Reports: None.

RECHARGE AREAS AND CONTAMINATION
POTENTIAL OF THE PRINCIPAL AQUIFER,
SALT LAKE VALLEY, UTAH



Number: UT-88-195

Cooperating Agency: Utah Division of Environmental Health

Staff: K. M. Waddell, Hydrologist, Project Chief (part time)
P. D. Fikstad, Computer Programmer (part time)
R. L. Baskin, Hydrologist (part time)
Other district personnel as assigned

Period of Project: February 1988 to January 1989

Objectives: (1) To define the natural and potential recharge areas of the principal aquifer of Salt Lake Valley, including areas where water can readily infiltrate directly to the deep unconfined part of the principal aquifer. (2) To determine areas where additional development of ground water from the confined part of the principal aquifer may cause a reversal of hydraulic gradient and allow percolation of potentially contaminated water from the shallow unconfined aquifer into the principal aquifer.

Approach: (1) Using information from prior USGS studies, select the approximate boundaries of natural and potential recharge areas. For these areas, develop a data base from existing data. (2) Many wells in the Salt Lake Valley have been logged by drillers, and some have been geophysically logged. If time permits, these logs will be used to assist in evaluating the lithology and hydraulic properties of the subsurface both in the saturated and unsaturated zones of the recharge areas. (3) Obtain Digital Line Graph (DLG) data on transportation and hydrography in the Salt Lake Valley from USGS, National Mapping Division, for inclusion in the base map. (4) Obtain digitized political boundaries and reference information from the State of Utah, Automated Geographic Reference (AGR) group for inclusion in the base map. (5) Place DLG, AGR, extent-of-aquifer maps, and model-generated data into ARC/INFO-compatible data bases. (6) Simulate hydraulic gradients resulting from potential future ground-water withdrawals using the digital model of the Salt Lake Valley's ground-water flow system described in Waddell and others (1987). (7) Show areas where hydraulic gradients may be reversed or changed due to pumping by comparing current and future gradients derived from the model. (8) Obtain and place into an ARC/INFO coverage general land-use data for the Salt Lake Valley from the University of Utah, Center for Remote Sensing and Cartography. Define land uses in the catagories of residential, rural, and commercial/industrial. (9) Obtain locations of hazardous-waste sites and public-supply wells from the Utah Division of Environmental Health and USGS files and place into an ARC/INFO coverage. (10) Identify areas of potential contamination by assessing vertical hydraulic assessing vertical hydraulic gradient and conductivity, quality of ground water, extent of shallow and principal aquifer, and thickness of the confining clay-lens zone separating the principal and shallow aquifers.

Progress: Computer-compatible map coverages have been obtained for all the planned report illustrations. Land-use categories are being separated from the base maps and all Digital Line Graphs have been processed. Maps have been generated for the study area and many of the interpretive illustrations are complete. The text is ready for colleague review and the rest of the illustrations are being finalized.

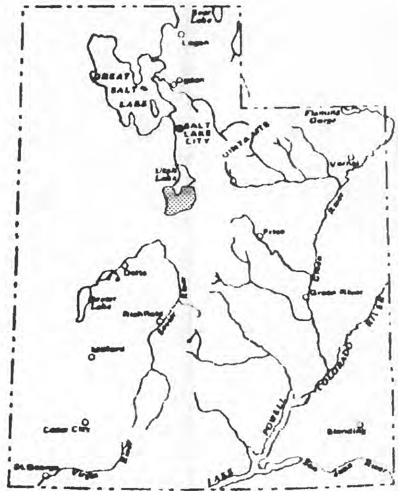
Plans for Next Year: The report will be completed and published.

Reports:

Baskin, R. L., Geohydrology of recharge areas and contamination potential of the principal aquifer, Salt Lake Valley, Utah: U.S. Geological Survey, written commun., 1988 (in review).

PROJECTS BEGINNING ON JULY 1, 1988

GROUND WATER IN SOUTHERN UTAH AND GOSHEN VALLEYS, UTAH COUNTY



U T A H

Number: UT-88-196

Cooperating Agency: Utah Division of Water Rights

Staff: L. E. Brooks, Hydrologist, Project Chief
H. K. Schatmeier, Hydrologic Technician, part-time

Period of Project: July 1988 to June 1991

Problem: Southern Utah and Goshen Valleys are at the southern end of the Wasatch Front, where most of Utah's population is located and where population growth is rapid. Thick basin-fill deposits contain large volumes of ground water of good quality which has been developed for irrigation and municipal and industrial use. Further development, most of which is proposed for municipal use, has been limited because of the probable effects on surface water draining to Utah Lake and the lake itself, which is a source of water for irrigation downstream in the Salt Lake Valley. In addition, many wells flow under artesian pressure, and additional ground-water development would likely cause some wells to stop flowing.

The Central Utah Project will make more surface water available in the Utah and Goshen Valleys, and some of this water could be traded for surface water lost as a result of additional ground-water withdrawals. The State of Utah would like to know what effects additional ground-water development would have on water levels, surface water, and water quality, and the effects on the ground-water system of importing additional surface water.

Objectives: (1) To assess current hydrologic conditions in terms of recharge, movement, and discharge of ground water, water levels, ground-water quality, and volumes of ground water of various qualities in storage. (2) To better define the ground-water system and how its components interact. (3) To estimate the effects of additional ground-water withdrawals on water levels, water quality, and surface water; and the effects of importation of additional surface water on the ground-water system.

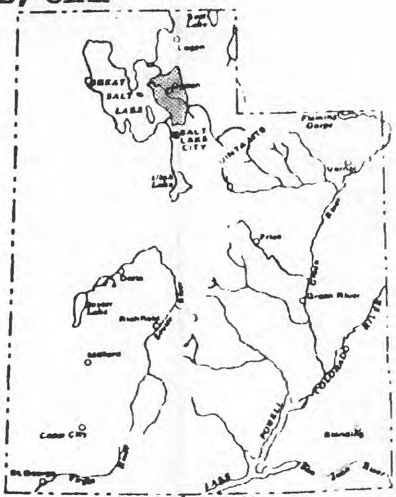
Approach: (1) Compile data on wells, springs, water levels, ground-water quality, and surface-water flow. (2) Inventory ground-water discharge by wells and springs, to drains and streams, by evapotranspiration, and by seepage to Utah Lake. (3) Estimate recharge, where feasible, from streams, irrigation, precipitation, and subsurface flow from consolidated rock. (4) Conduct aquifer tests to improve knowledge of hydraulic characteristics of the basin fill. (5) Construct a three-dimensional digital model of the ground-water system to simulate ground-water flow and predict effects of proposed changes in water use on the system. (6) Prepare a basic-data report and an interpretive report of the study for publication by the Utah Department of Natural Resources.

Progress: A project proposal was prepared, and a start was made in assembling data collected since the previous study of the area.

Plans for Next Year: Obtain drillers' reports and logs of wells drilled since the last study in 1964-67. Inventory all new large-discharge wells and wells in areas where data are lacking. Compile pumpage data, by well, back to 1963. Design an observation-well network. Compile data on stream, spring, drain, and flowing-well discharge and on water quality; and plan for obtaining additional data on these elements of the hydrologic system. Identify wells that could be used to conduct aquifer tests. Begin design of the digital model.

Reports: None.

DEFINITION OF RECHARGE AREAS, AQUIFERS, AND CONFINING BEDS, AND CLASSIFICATION OF AQUIFERS BASED ON WATER QUALITY IN THE EAST SHORE AREA OF GREAT SALT LAKE; BOX ELDER, WEBER, AND DAVIS COUNTIES, UTAH



UTAH

Number: UT-88-199

Cooperating Agency: Utah Division of Environmental Health

Staff: K.R. Thompson, Hydrologist, Project Chief
Vacancy, Hydrologist
R. L. Baskin, Hydrologist (part time)

Period of Project: October 1988 to December 1989

Problem: The Utah Division of Environmental Health needs information on the location and extent of the main recharge areas for the principal aquifers from which water is withdrawn for municipal and industrial use in parts of Utah having the major part of and potential for growth in population. The East Shore area of Great Salt Lake is a major populated area in which substantial growth has occurred over the past 10 years. Industry, urban population centers, military installations, and agriculture coexist within the area. As part of the State's ground-water protection strategy, information on recharge areas is needed so that activities and land uses that could result in migration of contaminants from the land surface to the water table can be regulated or modified to minimize contamination. In addition, the State needs improved information on aquifers and confining beds, both laterally and vertically, and needs to classify the aquifers and parts of aquifers in terms of water quality.

Objectives: (1) Define areas in which major recharge occurs to the principal water-yielding aquifers of the East Shore area. (2) Define areas in which recharge could occur if land-use practices resulted in infiltration of water. (3) Define areas in which downward migration of water from the shallow water-table aquifer could occur if withdrawals of ground-water from the confined principal aquifer resulted in a downward hydraulic gradient. These are areas in which the hydraulic gradient currently is upward and, thus, there currently is little potential for contamination. (4) Estimate ground-water velocities in recharge areas to define subareas where potential contamination could spread rapidly. (5) Define the thickness, lateral extent, and other relevant characteristics of aquifers and confining beds in the East Shore area. (6) Improve knowledge of ground-water quality and define areas of the principal aquifers in terms of the State's aquifer-classification system, in which aquifers are classified on the basis of water quality.

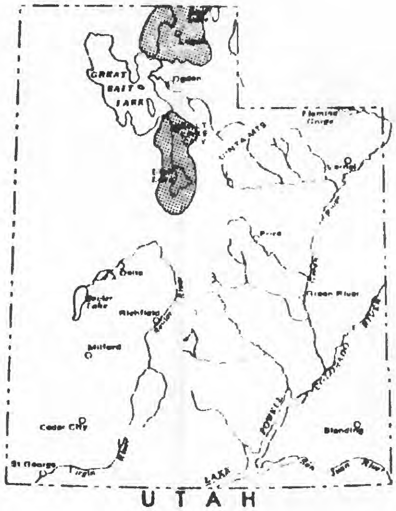
Approach: (1) Compile all drillers', formation, and geophysical logs from likely recharge areas to identify where confining layers are absent. Run borehole geophysical logs in any open wells to verify drillers' or formation logs. (2) Use data on losing reaches of streams or canals or conduct seepage runs to identify areas where recharge currently occurs. (3) Use log and water-level data to identify areas where confining layers exist and the vertical hydraulic gradient is downward. (4) Compile information on horizontal and vertical hydraulic conductivity values used to construct the digital-computer models and values generated by models of the East Shore area. Use these data, as well as hydraulic gradients, to estimate ground-water-flow velocities. (5) Use the digital-computer model to identify areas where withdrawals of water might cause a downward hydraulic gradient and result in movement of water from the shallow water table to the principal artesian aquifer. (6) Use geographic-information-system techniques to define areas of various aquifer and recharge-area characteristics and how they overlap, coincide, or relate to each other. (7) Use drillers', formation, and geophysical logs to define the thickness and lateral extent of the confining bed or beds and principal aquifer or aquifers. Prepare maps showing contours of the top and bottom of the main confining bed and the base of the principal artesian-aquifer system. (8) Select wells in various areas of the valley--on the basis of obtaining representative data from recharge areas near mountain fronts (both near and distant from losing reaches of streams), areas where confining beds exist but the vertical gradient is downward, areas where water is confined and the gradient is upward, and in areas of major ground-water discharge--for sampling and analysis of selected major constituents, trace metals, organic chemicals (including pesticides), and radionuclides. Most sampling sites will be wells in the principal artesian-aquifer system, as few wells are completed in the shallow water-table aquifer. (9) Compile existing data on ground-water quality and prepare contour maps of dissolved solids in water of the principal artesian-aquifer system at concentrations of 500, 1,000, 3,000, and 10,000 mg/L. Identify areas where ground-water-quality standards are exceeded (data on trace metals, organic chemicals, and radionuclides are limited, so data may be mostly that collected for this project). (10) Prepare a report consisting of a map or series of maps, in hydrologic-atlas format, portraying the recharge areas, extent of confining beds and aquifers, and water quality.

Progress: Prepared project proposal and began assembling available data.

Plans for Next Year: Collect all well logs in and near the recharge areas and use them to refine the location of recharge-area boundaries and the extent of aquifers and confining beds. Locate any unused wells that could be logged, and run borehole geophysical logs in them. Make seepage runs on the Ogden River to help identify losing reaches in the recharge area. Use the digital models of the East Shore area to help identify areas of the mountain front that contribute substantial recharge, to define transmissivity and vertical hydraulic conductivity of the basin fill, to indicate areas where hydraulic gradients are upward and downward, and to define hydraulic gradients. Use these data to identify recharge areas for the principal aquifer in the basin fill and areas where ground water in the fill is vulnerable to contamination because of large hydraulic gradients and transmissivity. Use model to delineate areas where upward hydraulic gradients could be reversed by pumping wells. Sample water from selected wells and analyze for selected constituents listed in the State's ground-water-quality standards.

Reports: None.

DEFINITION OF AQUIFERS AND CONFINING BEDS AND CLASSIFICATION OF AQUIFERS IN TERMS OF WATER QUALITY—WASATCH FRONT, CACHE VALLEY, AND LOWER BEAR RIVER VALLEY IN CACHE, BOX ELDER, SALT LAKE, AND UTAH COUNTIES, UTAH



Number: UT-88-200

Cooperating Agency: Utah Division of Environmental Health

Staff: K.R. Thompson, Hydrologist, Project Chief
Vacancy, Hydrologist
R.L. Baskin, Hydrologist (part time)

Period of Project: October 1988 to December 1989

Problem: The State of Utah needs to protect ground-water quality in areas where the potential for contamination of ground water exists and where contamination would have a serious impact on public water supplies. These areas generally are the heavily urbanized and industrialized parts of Utah. The main urbanized area in Utah is the Wasatch Front, stretching north-south along the western front of the Wasatch Range. The most urbanized part of the Wasatch Front extends from Santaquin in southern Utah Valley to Brigham City, just north of the East Shore area. Cache Valley, just northeast of the Wasatch Front, and the lower Bear River valley north of Brigham City, also are populated areas that depend on ground water for public supplies. In order to plan a program of ground-water protection, the State needs information on the lateral and vertical extent of aquifers and confining beds and a classification of aquifers on the basis of water quality. This information will be used to design a program to prevent contamination of potable water by regulating the discharge of contaminants in recharge areas. This project will include the Wasatch Front from Brigham City to southern Utah Valley (except for the East Shore area, which will be included in a separate project), Cache Valley, and the lower Bear River valley.

Objectives: (1) To define the thickness, lateral extent, and other relevant characteristics of aquifers and confining beds in valleys along the Wasatch Front (excluding the East Shore area). This work would supplement existing studies of the recharge areas in Salt Lake Valley in cooperation with the Utah Division of Environmental Health and a study of ground water in southern Utah Valley in cooperation with the Utah Division of Water Rights. (2) To improve knowledge of ground-water quality in these areas by sampling water from selected wells and springs for analysis of constituents listed in the State's ground-water quality standards. (3) To define areas of the principal aquifers in terms of the State's aquifer-classification system, in which aquifers are classified on the basis of water quality.

Approach: (1) Compile available drillers', formation, and geophysical logs for each valley and use them to define the thickness and lateral extent of the confining bed or beds and principal aquifer or aquifers. Prepare maps showing contours of the top and bottom of the main confining bed and the base of the principal artesian-aquifer system. (2) Select wells in various areas of each valley—on the basis of obtaining representative data from recharge areas near mountain fronts (both near and distant from losing reaches of streams), areas where confining beds exist but the vertical gradient is downward, areas where water is confined and the gradient is upward, and in areas of major ground-water discharge--for sampling and analysis of selected major constituents, trace metals, organic chemicals (including pesticides), and radionuclides. Most sampling sites will be wells in the principal artesian-aquifer system, as few wells are completed in the shallow water-table aquifer. (3) Compile existing data on ground-water quality for each valley and prepare contour maps of dissolved solids in water for the principal artesian-aquifer system at concentrations of 500, 1,000, 3,000, and 10,000 mg/L. Identify areas where ground-water-quality standards are exceeded (data on trace metals, organic chemicals, and radionuclides are limited, so data may be largely that collected for this project). (4) Prepare a report that will consist of a map or series of maps, possibly in hydrologic-atlas format, portraying the extent of the aquifer(s) and confining bed(s) and water quality in all areas except the lower Bear River valley. Results of chemical analyses of water from wells in the lower Bear River valley will be stored in U.S. Geological Survey computer files and will be provided to the Division of Environmental Health in hard-copy and machine-readable formats. If additional funding is provided, the interpretive report also will include aquifer and confining-bed delineation and classification of ground water for the lower Bear River valley.

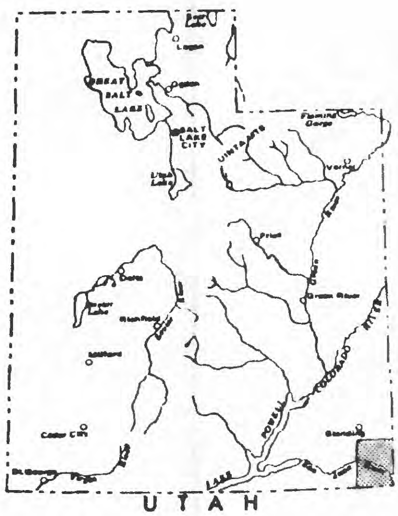
Progress: Prepared project proposal and began assembling data.

Plans for Next Year: Assemble all well and geophysical logs. Identify unused wells that could be logged and run borehole geophysical logs in them. Compile all ground-water-quality analyses, specifically those that include analysis of constituents designated for use in classifying aquifers. Select wells in hydrologically different areas of each basin and sample water for analysis of constituents designated for classifying aquifers. Use data to define lateral and vertical extent of aquifers and confining beds and to determine preliminary classification of aquifers based on water quality.

Reports: None.

PROPOSED PROJECTS

A. INVESTIGATION OF INCREASING SALINITY OF WATER IN THE NAVAJO SANDSTONE AQUIFER IN THE ANETH AREA, SAN JUAN COUNTY, UTAH



U T A H

Cooperating Agencies: Utah Division of Oil, Gas, and Mining
U.S. Bureau of Land Management

Staff: G. W. Freethey, Hydrologist, Acting Project Chief
L. E. Spangler, Hydrologist
R. S. Black, Hydrologic Technician (part time)

Period of Project: October 1988 to September 1993

Problem: During a study of aquifers in strata overlying the Paradox Formation in eastern San Juan County, Avery (1986) found that, over the last 25 years, the salinity of water from some wells near Aneth that tap the Navajo Sandstone has increased as much as 10-fold, to more than 60,000 milligrams per liter dissolved solids. Water wells known to be affected are in and adjacent to the southeastern part of the greater Aneth petroleum field. The maximum increase in salinity appears to be in and near the town of Aneth, and has affected at least one well belonging to the Navajo Tribe. From evidence presented by Kimball (in press), the most likely cause of the salinity increases north of Aneth is injection of oil-field brines into Mesozoic sandstones or into formations closely associated with these sandstones. However, in and around the Aneth field, other possible causes might include (1) leakage of brine upward through natural fractures, the movement induced by decreasing hydraulic head in the Navajo and related hydrologic units because of withdrawal of water for domestic, stock and other uses; (2) leakage upward through natural fractures of production water injected into older formations; (3) leakage from oil wells and/or injection wells through defective and corroded well casings; (4) leakage upward from aquifers containing very saline or briny water through annuli between the well casings and the borehole walls, particularily in older oil wells where only a hundred feet or less of surface casing was cemented in place; (5) upward leakage through the bores of poorly plugged or unplugged abandoned wells and test holes; and (6) some combination of the above.

Objectives: The objectives of the proposed study are to determine the following: (1) The extent of the area affected, (2) the cause of the salinity increase, (3) the direction and rate of movement of the contamination, (4) the character of the source of contamination (single point, multiple points, or a uniformly distributed source).

Approach: Considerably more geochemical, hydrochemical, geological, and hydrological information will be needed to determine the source of the saline contamination, its direction and rate of movement, and its areal extent. An investigation of the problem will be pursued in four phases: (1) Collection of new and compilation of existing geological, geochemical, and hydrological information. (2) Collection and compilation of hydrochemical data. (3) Analysis of all data and preliminary development of a variable-density model to calculate possible flow directions for variably-saline fluids. (4) Development and testing of final varible-density-flow and solute-transport models.

Plans for Next Year: Inventory water wells in the study area in order to locate the largest number of wells suitable for sampling. Collect 20 samples for analysis. Collect geological and geophysical logs and existing laboratory analyses of drill-core samples. Review well records in order to extract production and injection information and dates when wells were plugged or otherwise abandoned. Construction and pressure-test data on the injection wells will be recorded and analyzed to determine the integrity of the well casing and seal behind the casing. If possible, the quantity of oil and water produced and injected will be compiled and used to do fluid-balance calculations.

B. HYDROLOGIC RESPONSE TO LAND SUBSIDENCE CAUSED BY UNDERGROUND COAL MINING, MILLER CREEK DRAINAGE, CARBON COUNTY, CENTRAL UTAH

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

Staff: C. B. Slaughter, Hydrologist, Project Chief
G. W. Freethey, Hydrologist (part time)

Period of Project: October 1988 to September 1993

Problem: Land subsidence caused by underground coal mining usually is accompanied by vertical fracturing and bed separation in overlying rocks. The Utah Division of Oil, Gas, and Mining is concerned about the various impacts that subsidence, caused by underground mining, could have on ground water and surface water above mines in Utah. The Division particularly must look at mining in areas where the thickness of overburden is less than 500 feet. Specific impacts on streamflow, ground-water levels, and the quality of surface and ground water are not known. Thus, the Division must consider where mining companies can recover all the coal in a seam by longwall mining methods and where they must leave pillars of coal to prevent subsidence. This investigation will provide hydrologic data that will enable the Division to more accurately determine the effects of subsidence from underground mining on nearby streamflow, spring flow, water quality, and potentiometric levels in aquifers in the coal fields of central Utah.

Objectives: The objectives of the proposed study are: (1) to determine the effect of longwall mining on overlying ground water and surface water in an area where the thickness of overburden is less than 500 feet, and (2) to develop methods of determining the hydrologic effects of mining-related land subsidence.

Approach: The approach will consist of (1) an initial monitoring-well-installation, data-collection, and data-analysis phase (first year), (2) a less intense monitoring phase after removal of the Wattis seam (second year), (3) a more intense monitoring and data-collection phase as the "Third" seam is being mined, and (4) a final monitoring phase to observe how the hydrologic systems recover from the impact, and whether they attain a new state of equilibrium. The effects of certain geologic properties will be included in the study. These properties include the variable thickness, strength, stratigraphy, and lithologic character of overlying rocks, the orientation and density of pre-existing joints, and the proximity and principal strike direction of faults. Documenting the impact on specific hydrologic features, such as water levels in perched aquifers, water-level gradient in regional aquifers, chemical quality of ground water in these aquifers, streamflow quantity and quality, and spring discharge quantity and quality, also will be included in the study.

Plans for Next Year: Baseline information will be obtained. Mining of the panel under the study area will begin about January 1989 and continue through August 1989. The area with the least overburden thickness will be mined in March and April 1989. Two to four new wells will be drilled to measure pre-mining water levels and water quality in two aquifers above the mined seam. One borehole will be drilled for time-domain reflectometry to measure progression of the caving above the longwall area. Water levels in these wells will be measured and remotely recorded once a day from November 1988 through February 1989, every four hours during March and April 1989, and then daily from June through September 1989, using pressure transducers and data recorders. Water-quality analyses will be examined to determine if ground water from different formations and from the stream can be identified by one or more dissolved chemical constituents.

Daily fluctuations in stream discharge immediately downstream from the mined area will be monitored with a continuous-recording gage at the contact of the Blackhawk Formation and the Star Point Sandstone. Discharge from springs that provide the stream's baseflow will be measured periodically to see if discharge changes during or immediately after mining.

Vertical changes in land surface will be monitored by the mining company using a series of vertical control points located along the stream course. A single vertical-control point will be surveyed more frequently to help determine the time sequence between mining and surface subsidence.

Joint systems will be mapped and photographed at various points along the stream channel to document pre- and post-mining conditions. Cores of the various types of rock extracted from the boreholes will be sent to a laboratory for analysis of tensile and shear strength (possibly a U.S. Bureau of Mines lab). An initial survey of the riparian growth along the stream channel will be made by the Utah Division of Oil, Gas, and Mining.

C. METHODS TO PREDICT SCOUR AT BRIDGE CROSSINGS ON STREAMS IN UTAH

Cooperating Agency: Utah Department of Transportation

Staff: D. D. Carlson, Hydrologist,
Project Chief, (part time)
Other Utah District personnel as
assigned

Period of Project: January 1989 to June 1993

Problem: Exposure or undermining of bridge piers and bridge abutment foundations by the erosive action of flowing water can result in structural failure of the bridge. This erosion of streambed material around bridge structures is often referred to as "scour". Although equations have been developed to predict scour at bridges, these equations have been found to provide a wide range of scour depths for the same set of conditions.

More reliable methods are needed to predict bridge scour. Most bridge-scour equations are based entirely on scale-model measurements of scour, and have not been validated because of the scarcity of onsite measurements. Lack of onsite measurements of scour results from the difficulty in collecting data during high flows, especially high flows caused by storms. In an arid state such as Utah, additional problems in measuring and predicting scour exist because very rapid changes in streamflow and sediment transport result from some storms.

Objectives: The objectives of the project are: (1) to obtain flow and scour data during high flow at selected sites, (2) to evaluate formulas presently being used to predict scour, and (3) possibly develop new formulas that apply to streams in Utah.

Approach: (1) A thorough review of current research, journal articles, and other technical publications related to bridge scour will be conducted. Special emphasis will be given to equations currently being used or recommended for estimating scour depths. (2) About 20 potential sites will be selected using data that have has been compiled and assessed by the USGS. Three to five sites will be selected from the 20 potential sites identified above during the first year of the study. These sites will be reviewed with personnel of the Utah Department of Transportation for study. After final site selection, site preparation will begin.

Data at each of the selected sites will be collected over a three- to five-year period. Conditions permitting, at least two onsite measurements will be made at each site during high flow caused by storms. In addition, one onsite measurement will be made at each site during high flow caused by spring runoff. Annual data analysis will consist of examination of scour data collected at each site. Local scour depths will be estimated using the existing scour-predicting equations. These computed local scour depths will be compared to measured local scour depths, and an assessment will be made as to which equation(s) best predict the scour depths measured in the field.

Site selection will be reviewed annually. Alternate sites may be used for sites that did not meet expectations. In addition, new sites may be added to the data-collection network once data-collection methods are producing desired results.

Final data collection at each site will include surveying all elevation reference marks, approach sections, and the bridge sections. Bed-material samples will be collected in scour holes and along the upstream side of the bridges for bed-material statistical-size distributions. The final data analysis will consist of an examination of the data collected to determine what type(s) of scour have occurred at the sampled bridge sites.

Regression analysis and(or) other curve-fitting techniques will be used in an attempt to develop improved scour-prediction equations. Data to be analyzed will not necessarily be restricted to that collected in this study, if similar data can be obtained from compatible scour studies being conducted elsewhere. Similar studies are being conducted in Arkansas and Ohio. Studies may begin in New York, Kansas, Missouri, Washington, Oregon, and California.

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