ACTIVITIES OF THE WATER RESOURCES DIVISION, CALIFORNIA DISTRICT, IN THE 1987 FISCAL YEAR

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U.S. GEOLOGICAL SURVEY

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Sacramento, California
1988

DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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MESSAGE FROM THE DISTRICT CHIEF

After almost a century of activity and publication of approximately 2,100 water-resources related reports for the State of California, one needs to ask: Have we as an agency improved the level of understanding of the hydrologic environment in the State? Have we provided sufficient data and interpretive products that are necessary for sound decisionmaking to the water-management community?

A century of existence certainly demonstrates an historical role for the U.S. Geological Survey in the hydrologic community. The resulting 2,100 reports continue to serve as the foundation of hydrologic knowledge for the State of California. Additionally, hydrologic historians will note: (1) The evolution and sophistication of the investigative and interpretive tools used to collect and transfer hydrologic data and knowledge to the water user community, and (2) a strong and steadfast adherence to the essence of science and the maintenance of our unbiased and nonregulatory stance in the midst of highly controversial and political issues. The justification for this stance is simple--the need has existed and will continue to exist for an unbiased entity such as the U.S. Geological Survey to produce scientific, credible information.

The major national water issues for the Water Resources Division in 1988 correspond well to water issues in the State of California. These issues are (1) Water availability and competition for this water; (2) quality of water; and (3) management of water and land resources. Studies being conducted by the U.S. Geological Survey and described in this publication are, for the most part, in support of providing data and interpretation to address these issues.

As an agency, we are aware of and dedicated to the premise that credible data are obtained only when subjected to consistent, discipline related, quality-assurance programs. Throughout the Water Resources Division, continuous quality-assurance programs are conducted of all the activities that influence and ensure the quality of our products and services. These documented and proven quality-assurance programs provide to the hydrologic community necessary confidence that our products and services will meet the most stringent criteria.

Several of the most relevant and visible studies being conducted by the California District deal with selenium toxicity in the western San Joaquin Valley; ground-water export from the Owens Valley, coupled with vegetation survivability studies; hydrodynamics variability in San Francisco Bay; reclaimed water use; seawater intrusion in the Santa Barbara area; and involvement in the water-quality standard/water-rights hearing for the San Francisco Bay/Delta. These studies and the others described herein are providing valuable data and methods development that continue to contribute significantly to the science of hydrology and the water-management community within the State.

John M. Klein
District Chief
U.S. Geological Survey
Sacramento, California

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U.S. GEOLOGICAL SURVEY ORIGIN

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

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

°Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.

°Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.

°Conducting research on the geologic structure of the Nation.

°Studying the geologic features, structure, processes, and history of the other planets of our solar system.

°Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.

°Developing and producing digital cartographic data bases and products.

°Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.

°Conducting water-resource appraisals in order to describe the consequences of alternative plans for developing land and water resources.

°Conducting research in hydraulics and hydrology and coordinating all Federal water-data acquisition.

°Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural-resources planning and management.

°Providing earth-science information through an extensive publications program and a network of public-access points.

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

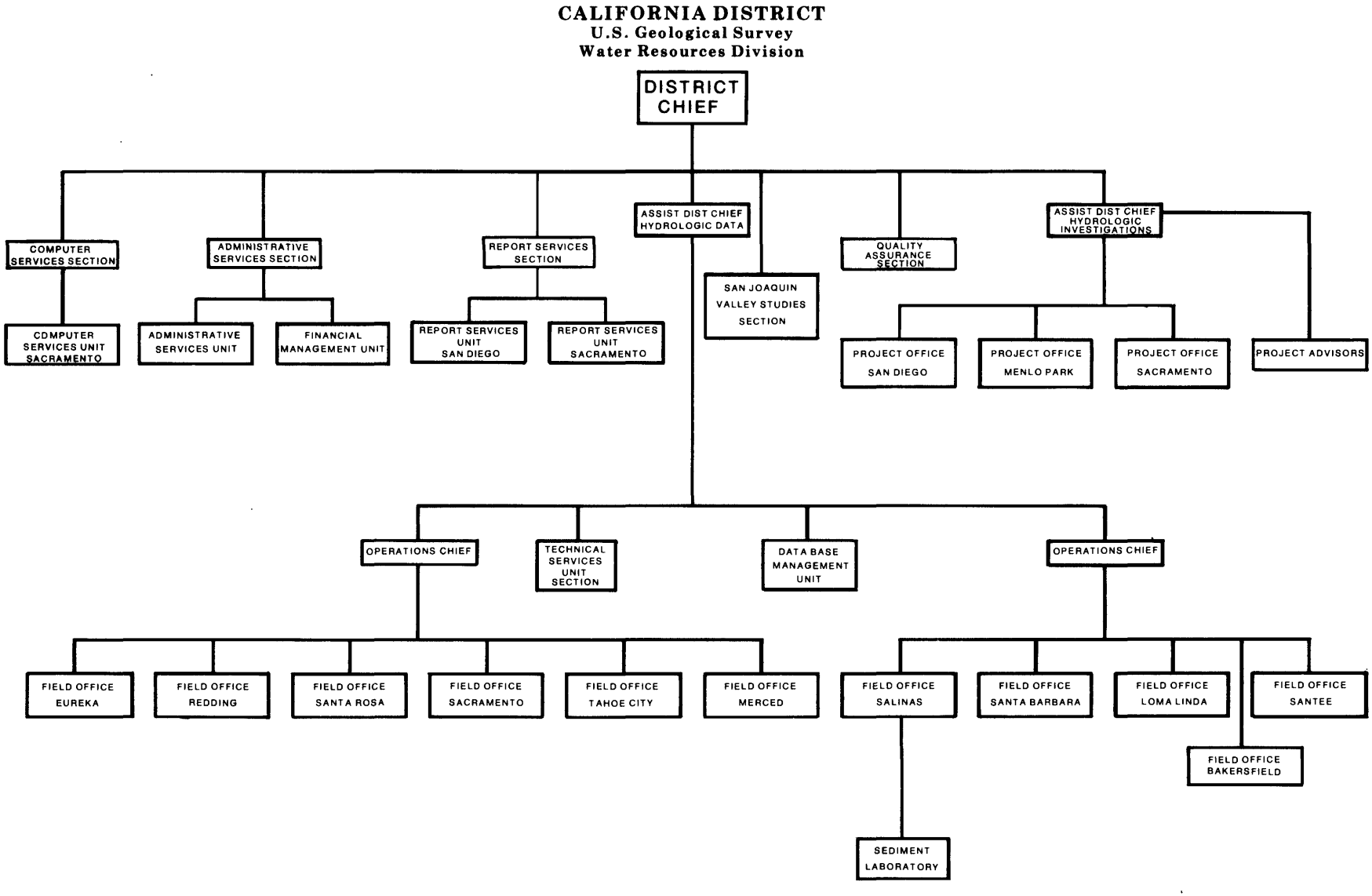


FIGURE 1. — Organization chart for the California District, 1988.

WATER RESOURCES DIVISION BASIC MISSION AND PROGRAM

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

°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.

°Conducting analytical and interpretive water-resources appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface and ground water.

°Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.

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

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

°Providing scientific and technical assistance in hydrology fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the Department of State.

CALIFORNIA DISTRICT ORGANIZATION

The headquarters for the California District is located in Sacramento. Hydrologic investigations and data collection are conducted from 10 field offices and 3 project offices. These offices and supporting units of the District are shown in the organization chart (fig. 1).

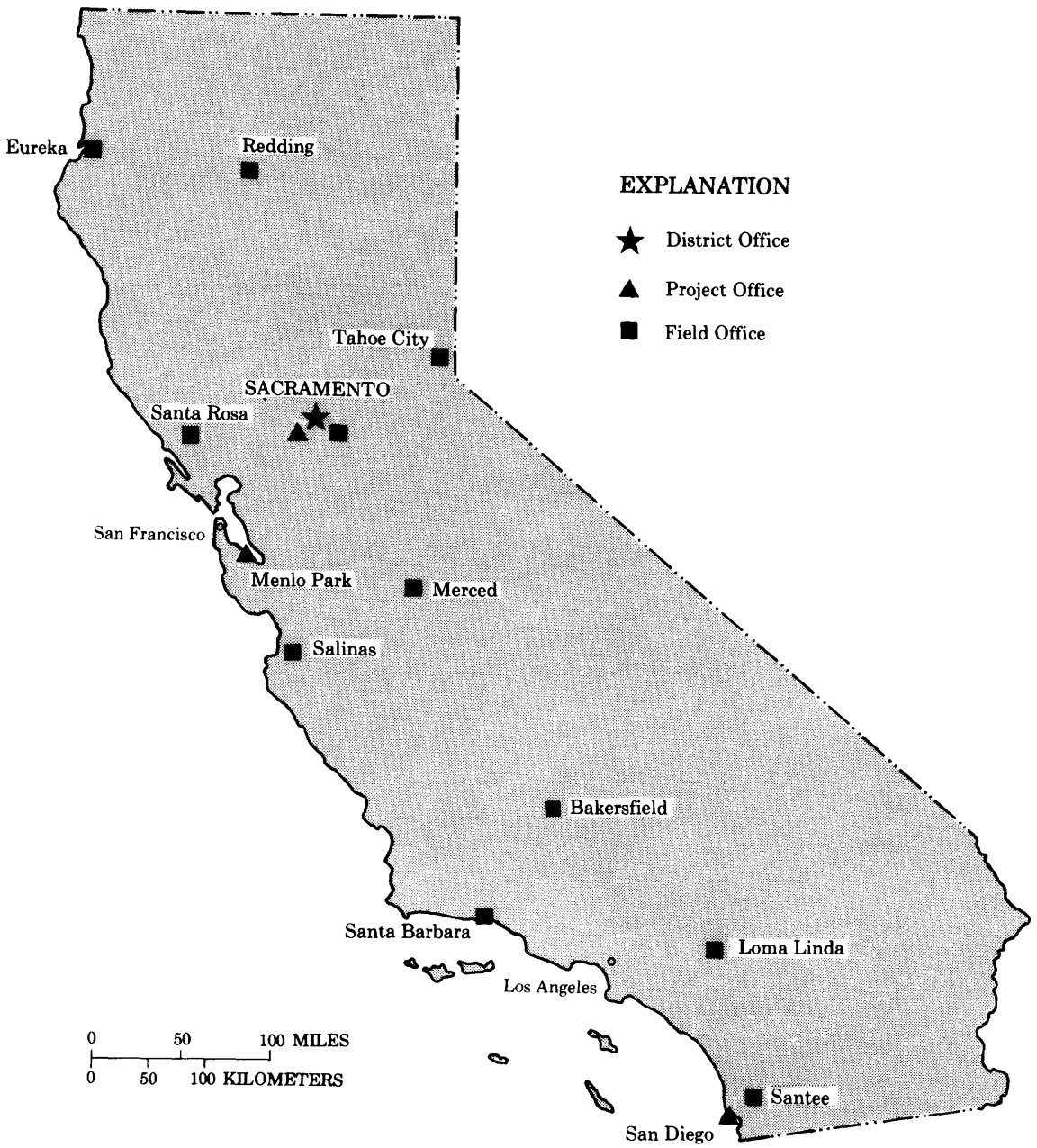


FIGURE 2. — Location of offices in the California District.

CALIFORNIA DISTRICT ADDRESSES

Inquiries regarding projects described in this report may be directed to the District Office. Addresses for the District Office and project and field offices are listed below. Location of offices are shown in figure 2.

DISTRICT OFFICE	(916) 978-4633	U.S. Geological Survey 2800 Cottage Way, Rm. W-2234 Sacramento, CA 95825
PROJECT OFFICES		
Menlo Park, MS 439	(415) 329-4418	345 Middlefield Rd., Menlo Park, CA 94025
Sacramento	(916) 978-4648	2800 Cottage Way, Rm. W-2234 Sacramento, CA 95825
San Diego	(619) 557-6700	Suite F, COC Annex 5201 Ruffin Rd. San Diego, CA 92123
FIELD OFFICES		
Bakersfield		Future Office Address not established
Eureka	(707) 443-2028	1105 6th St. Eureka, CA 95501
Merced	(209) 383-9067	1547 Yosemite Parkway Merced, CA 95340
Redding	(916) 246-5282	11075 Black Marble Way Redding, CA 96003
Sacramento	(916) 978-4665 (916) 978-4658	2800 Cottage Way, Rm. W-2234 Sacramento, CA 95825
Salinas	(408) 443-2245	P.O. Box 5027 Salinas, CA 93915
Loma Linda	(714) 383-5617	10421 Corporate Drive, Suite A Loma Linda Redlands, CA 92374
Santa Barbara	(805) 962-8114	126 West Figueroa St. Santa Barbara, CA 93101
Santa Rosa	(707) 576-1832	5 West 9th St., #2 Santa Rosa, CA 94502
Santee	(619) 293-5155	10130 Mission Gorge Rd. Santee, CA 92071
Tahoe City	(916) 583-4823	605 Westlake Blvd. Tahoe City, CA 95730

CALIFORNIA DISTRICT FUNDING

Programs of the Water Resources Division in California are funded as follows: (1) the Federal program, which is specifically identified in annual Geological Survey appropriations made by Congress; (2) the Federal-State cooperative program, where the Water Resources Division represents National interest, the cooperating agencies represent State and local interest, and the funding generally is shared equally (the Federal share comes from direct Congressional appropriations); (3) the Other-Federal-Agencies (OFA) Program, which is funded by the Federal agencies that request the work. Total funds for fiscal years 1986 and 1987, and the sources of those funds, are shown in figure 3. [The fiscal year (FY) is from October 1 to September 30, and is designated by the calendar year in which it ends.]

The percentage of investigations, by funding, for fiscal year 1987 in each of the broad categories of hydrologic-data collection, areal appraisals and interpretive studies, and research projects are shown in figure 4.

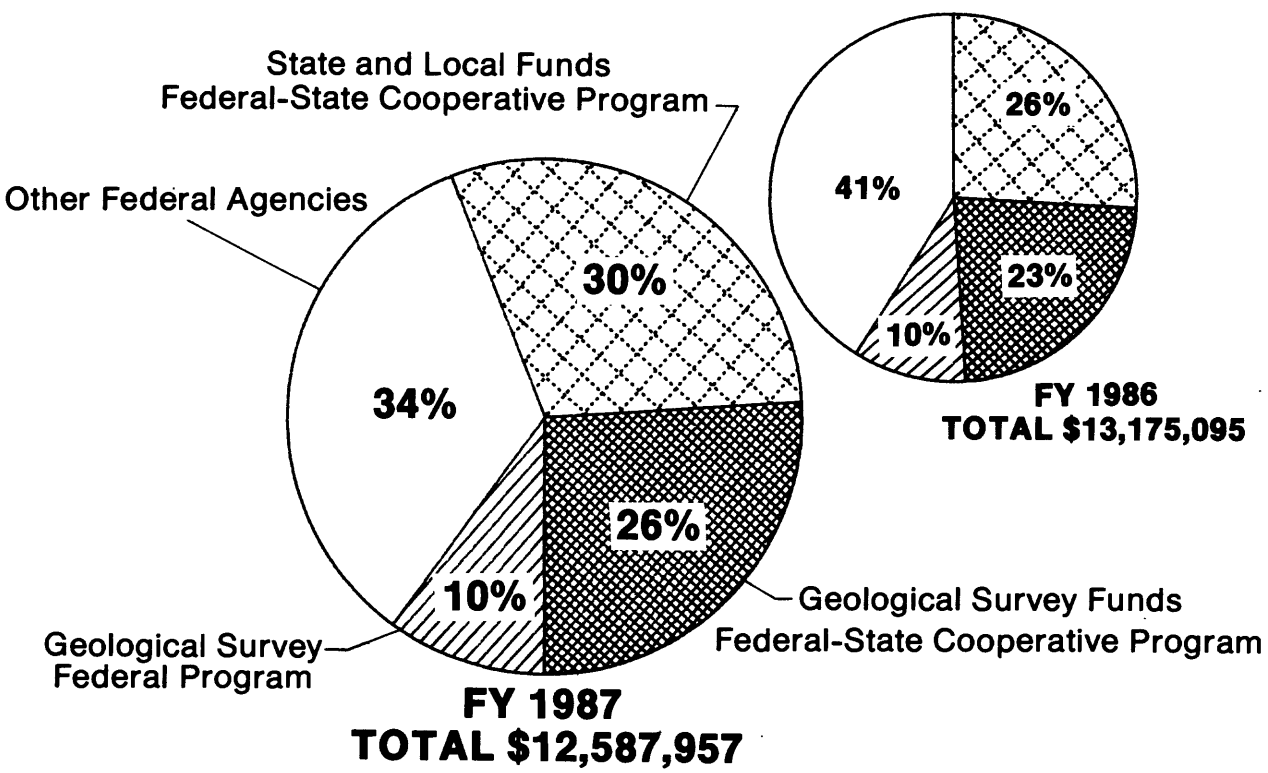


FIGURE 3. — Sources of California District funds in fiscal years 1986 and 1987.

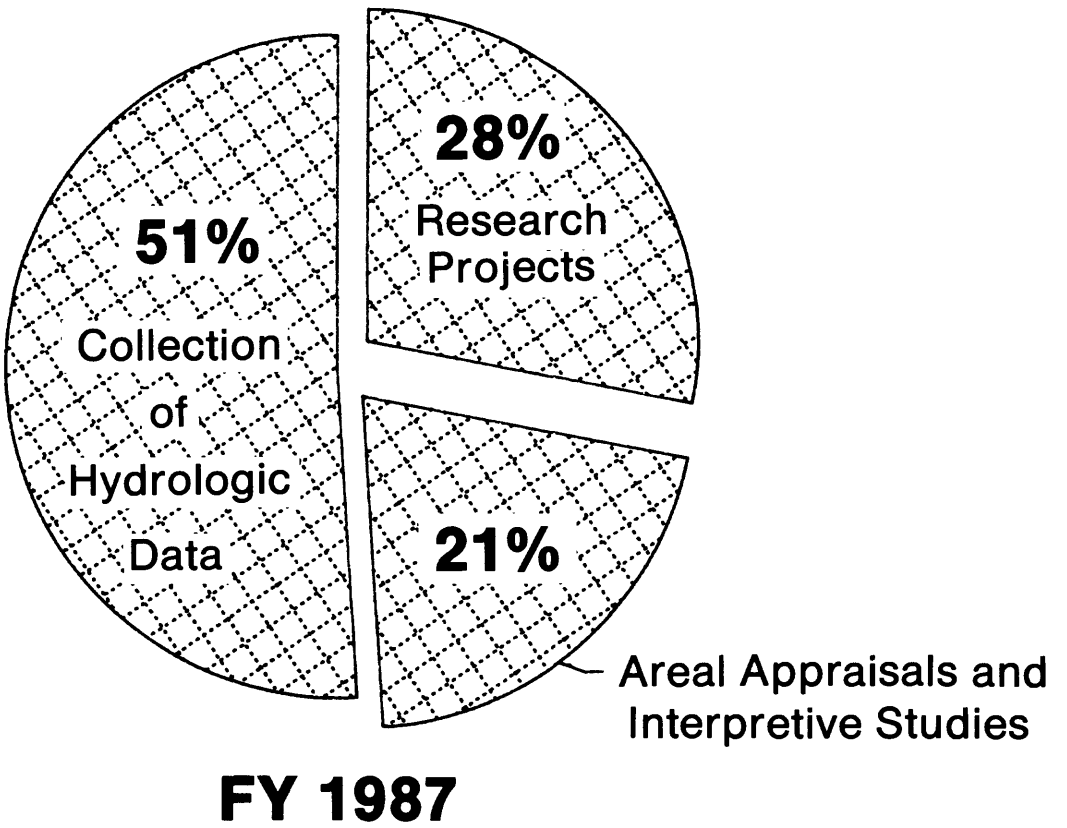


FIGURE 4. — Categories of investigations in the California District, by funding, fiscal year 1987.

In fiscal year 1987, the following State, local, and Federal agencies contributed funds and/or services in cooperative programs with the California District:

State Agencies

California Department of Boating and Waterways
California Department of Fish and Game
California Department of Parks and Recreation
California Department of Water Resources
California State Water Resources Control Board
California Regional Water Quality Control Board
    Lahontan Region
    San Diego Region
    San Francisco Bay Region

Local Agencies

Alameda County Flood Control and Water Conservation District
Alameda County Water District
Antelope Valley-East Kern Water Agency
Calaveras County Water District
Carpinteria County Water District
Casitas Municipal Water District

Local Agencies--Continued

Coachella Valley Water District
Contra Costa County
Crestline-Lake Arrowhead Water Agency
Desert Water Agency
East Bay Municipal Utilities District
Fresno Metropolitan Flood Control District
Georgetown Divide Public Utility District
Goleta County Water District
Humboldt Bay Municipal Water District
Imperial County Department of Public Works
Imperial Irrigation District
Indian Wells Valley Water District
Inyo County, Department of Water
Kings River Conservation District
Los Angeles, city of, Department of Water and Power
Los Penasquitas Lagoon Foundation
Madera Irrigation District
Marin Municipal Water District
Merced Irrigation District
Merced, city of
Mojave Water Agency
Montecito County Water District
Monterey County Flood Control and Water Conservation District
Monterey Peninsula Water Management District
Nevada Irrigation District
Oakdale-South San Joaquin Irrigation District
Orange County Environmental Management Agency
Orange County Water District
Oroville-Wyandotte Irrigation District
Pacific Gas & Electric Company
Pacific Power and Light
Placer County Water Agency
Rancho California Water District
Riverside County Flood Control and Water Conservation District
Rock Creek Limited Partnership
Sacramento Municipal Utility District
Sacramento County Regional Sanitation District
San Benito County Water Conservation and Flood Control District
San Bernardino County Environmental Public Works Agency--Flood Control District
San Bernardino Valley Municipal Water District
San Diego County Department of Planning and Land Use
San Diego County Department of Public Works
San Diego County Department of Sanitation/Flood Control
San Diego, city of
San Francisco, City and County, Hetch Hetchy
San Francisco Water Department
San Luis Obispo County Engineering Department
San Mateo County
Santa Barbara County Flood Control and Water Conservation District
Santa Barbara County Water Agency
Santa Barbara, city of
Santa Clara Valley Water District

Local Agencies--Continued

Santa Cruz County Flood Control and Water Conservation District
Santa Cruz, city of
Santa Maria Valley Water Conservation District
Santa Ynez River Water Conservation District
Scotts Valley County Water District
Siskiyou County Flood Control and Water Conservation District
Sonoma County
Sonoma County Water Agency
Southern California Edison Company
Tahoe Regional Planning Agency
Terra Bella Irrigation District
Tulare County Flood Control District
Tuolumne County
Turlock Irrigation District
United Water Conservation District
Ventura County Flood Control District
Western Municipal Water District
Westlands Water District
Woodbridge Irrigation District
Yolo County Flood Control and Water Conservation District
Yuba County Water Agency

Federal Agencies

U.S. Department of Agriculture
- Forest Service

U.S. Department of the Air Force
- Vandenberg Air Force Base

U.S. Department of the Army
- Corps of Engineers
  - Los Angeles District
  - Sacramento District
  - San Francisco District

U.S. Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Fish and Wildlife Service
- National Park Service

U.S. Department of Justice
- U.S. Penitentiary, Lompoc

U.S. Department of the Navy
- Marine Corps Air Ground Combat Center, Twentynine Palms
- Marine Corps Base, Camp Pendleton
- Naval Weapons Center, China Lake

WATER CONDITIONS

Below-normal precipitation and runoff in California dominated the water picture throughout the 1987 water year. Statewide precipitation was only 65 percent of the long-term average (California Department of Water Resources, 1987); in the Lake Tahoe area, precipitation was only 46 percent of the average (table 1). Runoff measured at stream-gaging stations at the Salmon River at Somes Bar in north-coastal California was 57 percent of the long-term average; at the Pit River near Canby, 35 percent; and at North Fork American River, 30 percent. Comparisons of long-term mean and minimum monthly flows with 1977 and 1987 water-year monthly mean flows for these stations are shown in figure 5.

Snowmelt in the Sierra Nevada was only 30 to 40 percent of average, and unusually warm temperatures in early May caused the snowmelt to peak about a month earlier than normal. In the Sacramento River basin, the 1987 water year was the ninth driest of this century (California Department of Water Resources, 1987). It was not surprising that by early spring, people were comparing the 1987 water year with the memorable 1976 and 1977 drought years.

TABLE 1.--Comparison of 1987 monthly precipitation with average monthly precipitation, historic minimum monthly precipitation, and 1977 monthly precipitation at Tahoe City

[Values in inches]

Month	Average 1951-80	Minimum 1951-80	Average monthly precipitation 1977	Average monthly precipitation 1987	1987 percent of average
October	1.81	0.00	1.05	0.11	6
November	3.70	.00	.67	.63	17
December	5.62	.23	.29	.48	9
January	6.03	.35	1.07	3.34	55
February	5.12	.00	2.96	4.82	94
March	3.92	.11	.62	2.78	71
April	2.16	.06	.08	.61	28
May	1.11	.00	1.50	.28	25
June	.66	.00	.41	.94	142
July	.27	.00	.06	.38	141
August	.29	.00	.04	.10	34
September	.60	.00	.15	.00	0
October-September	31.29	.00	8.90	14.47	46

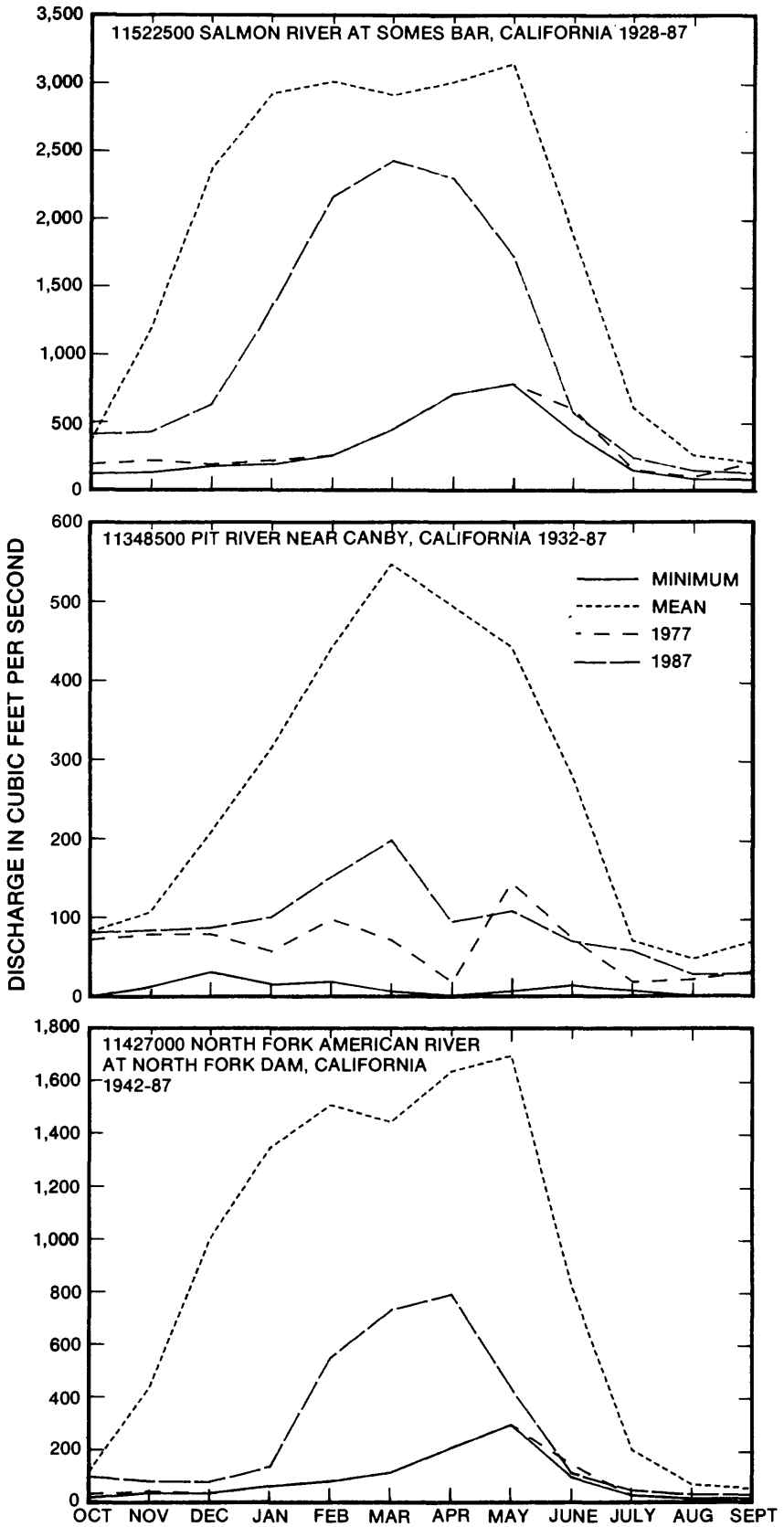


FIGURE 5. — Comparison of long-term mean and minimum monthly flows, with 1977 and 1987 water-year monthly mean flows.

The natural concern is what could happen if 1988 should be another dry year? There is only about a 10-percent chance that 1988 will be a drier year than 1987 (California Department of Water Resources, 1987); if it is, the impact probably would not be as severe as that of the 1976-77 drought. At the end of the 1987 water year, storage in 150 major reservoirs in California was 4.7 million acre-feet greater than at the end of the 1976 water year; storage in the Colorado River system was greater by 7.5 million acre-feet. This is not to say that there would be no major impacts. Population and water demand have increased since 1977. Water-conservation measures, changes in irrigation practices, and increased ground-water pumpage certainly will be necessary if runoff is deficient in 1988. Ground-water levels throughout California are generally equal to or higher than in 1976 because of the many exceptionally wet years (1978, 1980, 1982, 1983, and 1986) following the 1976-77 drought. The ground-water resources of California could significantly offset temporary shortages in river runoff and reservoir storage.

REFERENCES CITED

California Department of Water Resources, 1987, Water conditions in California--Special dry year report; October 1987: California Cooperative Snow Surveys, Bulletin 120-87, 16 p.

PROJECT DESCRIPTIONS

SURFACE-WATER STATIONS

Number: *CA001*

Location: *Statewide (See accompanying map)*

Project Chief: *Kenneth W. Lee*

Period of Project: *Continuing*

Problem: Surface water accounts for about 60 percent of the freshwater withdrawals in California--more than 22.5 billion gallons per day in 1985. About 31 percent of the population, 8 million people, use surface water for domestic supplies. Significantly, over 20 billion gallons per day were withdrawn for irrigation (1985). The distribution of surface water is highly variable both seasonally and areally; close monitoring of runoff is essential to the optimum management and development of this resource.

Objectives: Collect and publish surface-water data to meet needs for (1) assessing quantity and distribution of surface-water resources; (2) operating reservoirs for power, flood control, and irrigation; (3) flow forecasting; (4) monitoring of flow for instream use requirements; (5) determining discharge to support water-quality sampling and assessment programs; (6) determining safe releases of treated reclaimed water to streams and rivers; (7) defining the statistical streamflow characteristics needed for research and planning, and design of dams, bridges, culverts, canals, flood-management projects, and ground-water recharge facilities.

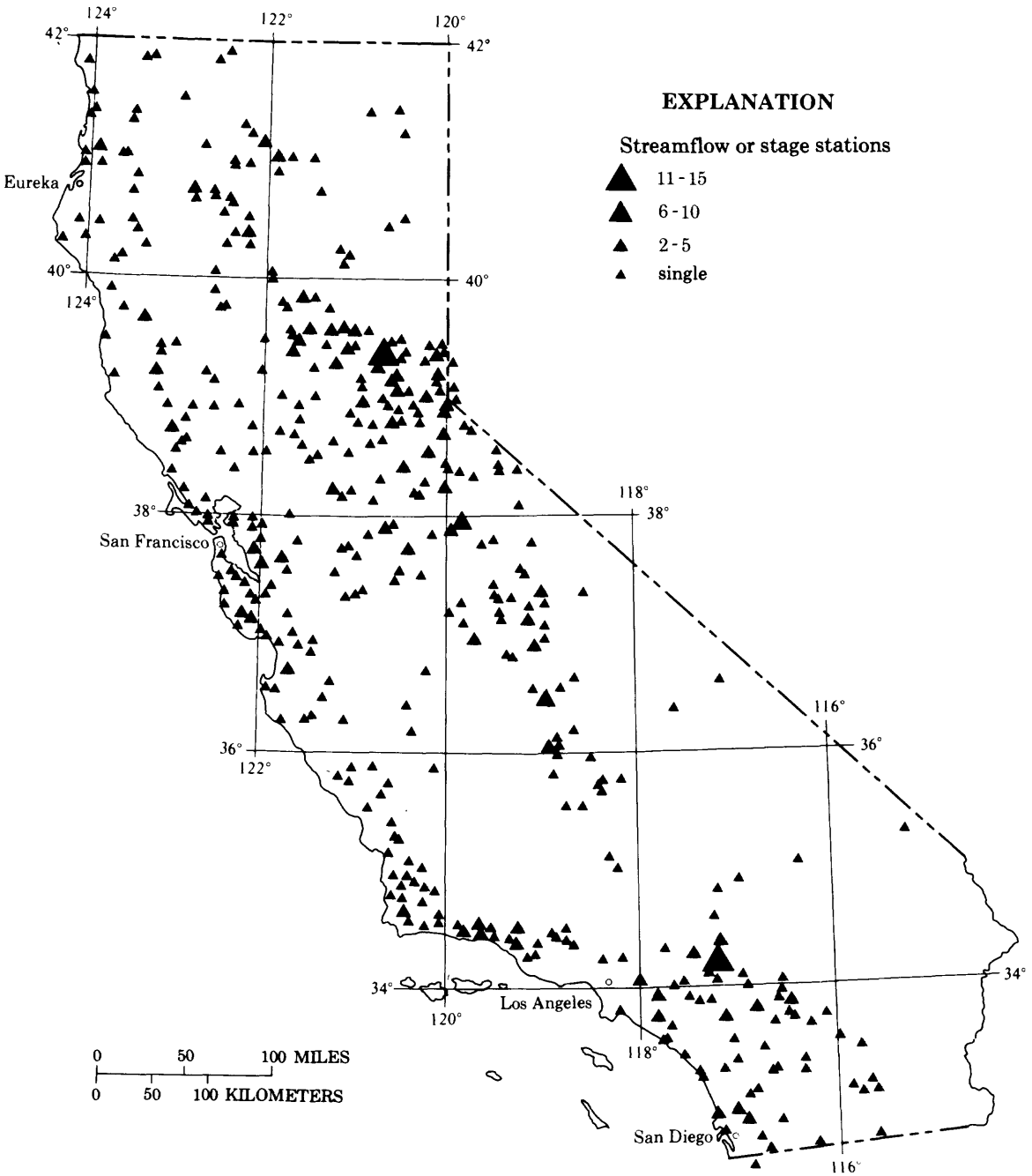
Approach: Stage and discharge of streams and stage and contents of lakes and reservoirs will be measured and recorded. Standard methods of data collection will be used as described in the series "U.S. Geological Survey Techniques of Water-Resources Investigations." Partial-record data collection will be used instead of continuous-record data collection where it serves the required purpose.

Progress: Surface-water data for 459 continuous streamflow stations were collected and compiled for publication. Records for 145 streamflow stations provided by other agencies and FERC (Federal Energy Regulatory Commission) licensees were reviewed for publication. Data were collected and compiled for publication of 38 records of reservoir contents, and 65 additional reservoir records provided by cooperators were reviewed. Data were collected and compiled for publication of 44 partial-record sites providing peak flow, low flow, seasonal flow, limited range of discharge, or stage information. There are, in addition, 202 unpublished records consisting mainly of records provided by FERC licensees.

Plans for Next Year: Statewide data collection and review will continue. Fifteen stations are presently equipped with satellite-relay data in transmitters installed by the U.S. Geological Survey. Installation of 15 additional satellite data-collection platforms is planned for real-time transmission of streamflow information from selected remote stations.

Reports:

U.S. Geological Survey, 1987, Water resources data for California, water year 1985: U.S. Geological Survey Water-Data Report CA-85-1 to CA-85-4.



Location of streamflow-measuring stations.

GROUND-WATER STATIONS

Number: *CA002*

Location: *Statewide (See accompanying map)*

Project Chief: *Charles E. Lamb*

Period of Project: *Continuing*

Problem: Ground water accounts for about 40 percent of freshwater withdrawals in California--about 15 billion gallons per day (1985). Over 18 million people, 69 percent of the population, are served by ground-water supplies. Over 10 billion gallons per day were withdrawn for irrigation (1985). The occurrence of ground water is highly variable, related to geology, natural, and manmade stresses. Monitoring of ground-water levels is essential to the prudent management and development of the resource.

Objectives: Collect ground-water-level data to meet the needs for assessment of quantity and occurrence of ground water. These data will serve as a management tool for National, State, and local water planners.

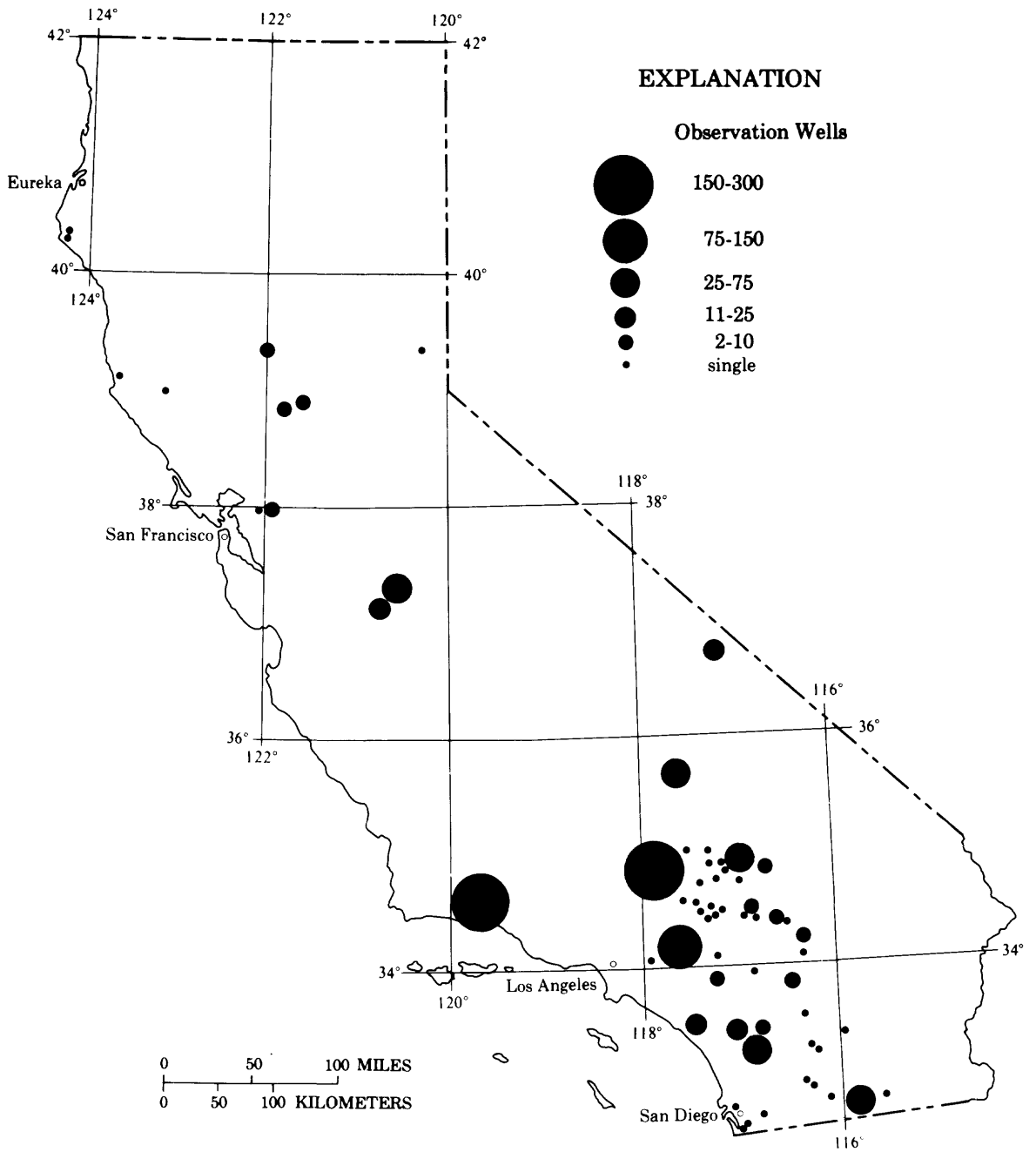
Approach: Water levels including continuous, monthly, semiannual, and annual will be measured, recorded, and computerized. Standard methods of data collection are used as described in "National Handbook of Recommended Methods for Water-Data Acquisition" and Water Resources Division manuals and memorandums.

Progress: Collection and compilation of ground-water level data continued at 960 long-term sites and at 19 continuous-recorder wells. Data were published in a separate volume of the annual data-report series.

Plans for Next Year: Data collection and record processing will continue. All processed data will be published in a separate volume of the annual data-report series.

Reports:

U.S. Geological Survey, 1987, Water resources data for California, water year 1985: U.S. Geological Survey Water-Data Report CA-85-5.



Location of selected observation wells.

WATER-QUALITY STATIONS

Number: *CA003*

Location: *Statewide (See accompanying map. Also see map of selected observation wells, page 17)*

Project Chief: *Kenneth W. Lee*

Period of Project: *Continuing*

Problem: In order to properly manage the water resources of the State, the quality of surface and ground water must be defined and monitored.

Objectives: Collect and publish long- and short-term records of water-quality data at selected stream, well, spring, reservoir, and precipitation sites located throughout California. The data will be used by Federal, State, and local agencies in the assessment, management, development, and protection of the State's water resources.

Approach: A network of water-quality stations will be established and operated to provide physical, chemical, and biological data for the objectives stated above. Standard methods are used to collect, process, and analyze the water samples as described in "National Handbook of Recommended Methods for Water-Data Aquisition" and Water Resources Division manuals and memorandums.

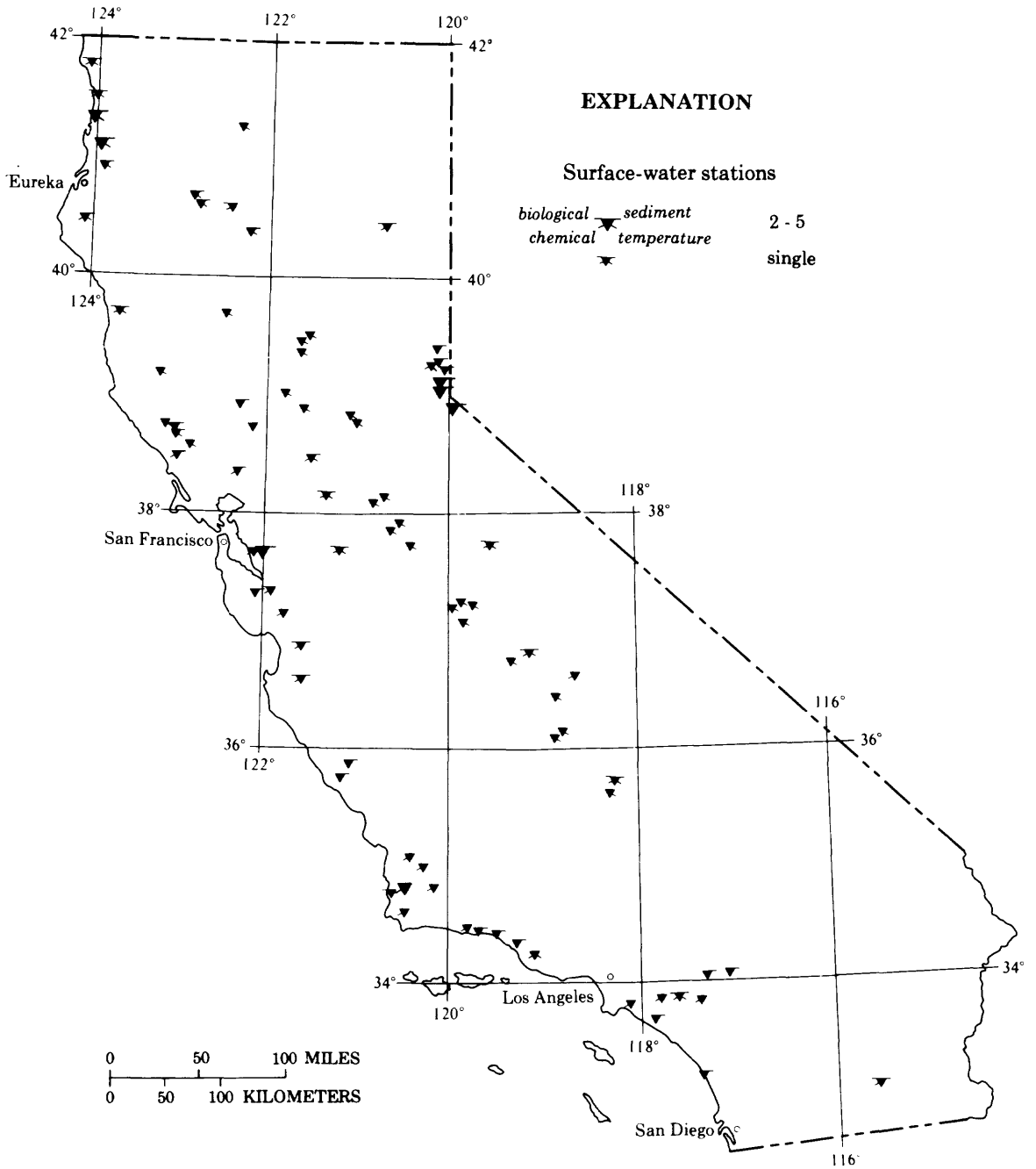
Progress: Water-quality data were gathered periodically at many sites throughout California. Water-quality samples were collected bimonthly at 12 and quarterly at 7 NASQAN (National Stream Quality Accounting Network) stations, and quarterly at 3 Hydrologic Benchmark stations. Water temperature and specific conductance were measured continuously at 36 and 5 sites, respectively. Precipitation samples were collected weekly at the National Trends Network stations located in the Los Padres National Forest and at Yreka. In addition to these stations, water-quality data were collected at 44 stream and reservoir sites. Chemical analyses were completed for ground-water samples collected from 323 long-term monitoring wells and 90 short-term monitoring wells. Data for water year 1985 were published in the annual data-report series.

Plans for Next Year: Collection of water-quality data will continue.

Reports:

Berenbrock, Charles, (in press), Ground-water quality in the Lompoc plain, Santa Barbara County, California, 1983: U.S. Geological Survey Water-Resources Investigations Report 87-4101.

U.S. Geological Survey, 1987, Water resources data for California, water year 1985: U.S. Geological Survey Water-Data Report CA-85-1 to CA-85-5.



Location of surface-water-quality monitoring stations.

SEDIMENT STATIONS

Number: *CA004*

Location: *Statewide (See accompanying map for water-quality stations, page 19)*

Project Chief: *James M. Knott*

Period of Project: *Continuing*

Problem: The effects of erosion, movement, and deposition of sediment can be devastating. Knowledge of sediment transported by streams is essential in the development and management of water and land resources. Wide variations in drainage basin and precipitation characteristics in California result in significant differences in the quantity and composition of fluvial sediment. Close monitoring of sediment within the State is needed to define variations.

Objectives: Provide sediment data that can be used to (1) develop land-management practices that will reduce erosion rates; (2) evaluate the effects of timber harvesting on fisheries; (3) determine the effects of debris basins and drop structures on sediment transport; (4) monitor reservoir-capacity losses for flood control and water-supply purposes; (5) determine the relation of sediment to lake algae growth; (6) evaluate changes in coastal morphology caused by coastal river sediment; (7) determine the effects of urbanization on channel morphology; and (8) estimate channel changes that may result from proposed damsites.

Approach: Suspended-sediment and bed-material samples will be collected at specific sites on streams within the State. Bedload samples will be collected at those stream sites that are total-load stations if the stream characteristics warrant use of a bedload sampler. Daily concentration and suspended-sediment discharge will be computed for all daily sediment stations. Monthly bedload discharge will be estimated for all daily total-load stations. Particle-size distribution and selected suspended-sediment, bedload, and bed-material samples will be analyzed. Standard methods of data collection will be used as described in the series "U.S. Geological Survey Techniques of Water-Resources Investigations." Partial-record data collection will be used instead of continuous-record data collection where it serves the required purpose.

Progress: Sediment data collected during water year 1985 were published in the California annual data-report series. Sediment data collected at 27 daily, 28 periodic, 20 NASQAN, and 3 Hydrologic Benchmark stations during water year 1986 are being compiled and reviewed. Daily suspended-sediment samples were collected at 20 daily sediment stations during water year 1987; bedload samples and/or indirect bedload computations were made for 15 of these sites. Monthly and storm-related suspended-sediment samples were collected at 19 periodic sediment stations. Bedload samples and/or indirect bedload computations were made for 16 of the periodic sites. Suspended-sediment samples were collected on a bimonthly or quarterly basis at 19 NASQAN and 3 Hydrologic Benchmark stations.

Plans for Next Year: Compilation and review procedures will be completed for all 1987 sediment records. Sediment data at 20 daily, 19 periodic, and 22 NASQAN/Benchmark stations will be collected in water year 1988.

Reports:

U.S. Geological Survey, 1987, Water resources data for California, water year 1985: U.S. Geological Survey Water-Data Report CA-85-1 to CA-85-4.

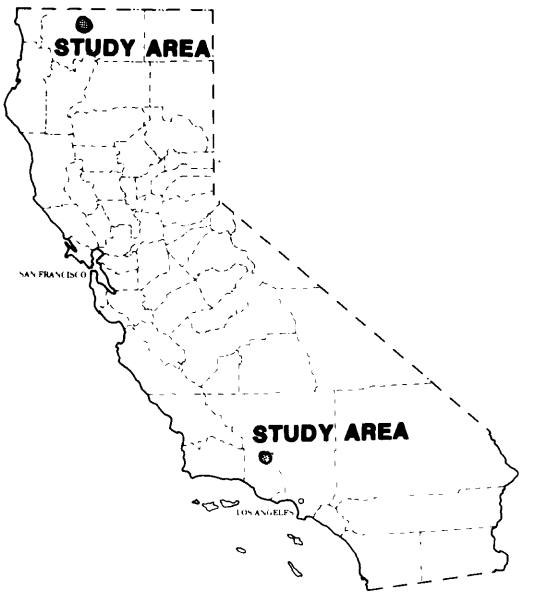
NATIONAL TRENDS NETWORK FOR MONITORING ATMOSPHERIC DEPOSITION

Number: *CA005*

Cooperating Agency: *None. (U.S. Geological Survey Federal Program)*

Project Chief: *Keith G. Polinoski*

Period of Project: *Continuing*



Problem: Acid rain has become a worldwide environmental concern in recent years. Lakes in the United States are becoming more acidic, aquatic life is being irreparably damaged, and the pH of precipitation is as low as 4.0. One question being asked is "What is the areal and temporal variation of the quality of wet atmospheric deposition in the United States?"

Objectives: Sample and analyze the quality of wet-atmospheric deposition. Sampling sites in California are part of a National network.

Approach: One atmospheric-deposition sampler will be operated at Chuchupate Ranger Station in Los Padres National Forest in Ventura County. The California District's function at this station is to collect and ship the samples to the laboratory. Weekly samples will be collected for chemical analysis. A second station located in Yreka is operated by Siskiyou County under the direction of the National program. The California District inspects this station annually.

Progress: Operation of atmospheric-deposition sampler and rain gage at Chuchupate was continued. The station at Yreka was inspected.

Plans For Next Year: Collection of atmospheric-deposition samples will continue at Chuchupate. Also, an annual field inspection of the Yreka site will continue.

Reports: None

WATER-USE INFORMATION PROGRAM

Number: *CA007*

Cooperating Agency: *California Department of Water Resources*

Project Chief: *William E. Templin*

Period of Project: *Continuing*

Problem: Nationwide estimates of water use are needed by those involved in establishing water-resources policies. These estimates must be consistent in water-use categories and methods of determination to allow valid comparisons of statewide totals. California has the largest water-use volume of any State in the nation. California's multiagency water-management organization structure has created a complex water-use information environment. The problem is to meet these present and future National water-use information needs in the most efficient and cost-effective manner possible.

Objective: (1) Determine how much fresh and saline surface and ground water is withdrawn and for what purposes, how much of this water is consumed during use, and how much water is returned to the source after use; (2) maintain and refine a computerized system to store and retrieve water-use information; (3) devise and apply new methods and techniques to improve the collection, analysis, and dissemination of water-use information; and (4) explain the values and applications of water-use information, and make this information available.

Approach: Water-use information will be developed for each of the following 12 National water-use categories: irrigation; industrial; commercial; domestic; water supply; sewage treatment; mining; agricultural, nonirrigation; hydroelectric power; and three thermoelectric power categories--nuclear, fossil fuel, and geothermal. Site-specific information will be entered into the State Water Use Data System. Methods and techniques for the collection, storage, and dissemination of water-use information will be improved.

Progress: California's water use during 1985 was estimated and entered in the U.S. Geological Survey's National Water Use Data System (NWUDS). Information provided for the U.S. Geological Survey's 1987 National Water Summary included (1) estimates of water use in each of California's 58 counties during 1985, (2) an article titled, "California Water Supply and Demand," (3) a reservoir storage data base including normal storage for all California reservoirs exceeding 5,000 acre-ft capacity, (4) economic data on water supply and sewer rate schedules for 22 of California's communities, (5) estimates of ground-water depletion in each of California's hydrologic subregions, and (6) interbasin transfers throughout California. A California water-use "Fact Sheet" and presentation was prepared for

the Western U.S. Water Use Conference in Minden, Nevada, February 9-13, 1987. A water-use session was organized and chaired at the Spring Meeting of the American Institute of Hydrology in San Francisco, California, March 26-27, 1987. A prototype five-component District Water Use Program was designed for California, and a multiple year applied-irrigation water-use project was begun for the San Joaquin Valley Drainage Program.

Plans for Next Year: The water-use information tables and methods of estimation compiled for 1985 will be published. The first of three water-use and crop-information reports for the San Joaquin Valley Drainage Program will be published. The statewide water-use information compiled for 1985 will be improved as additional information becomes available. Statewide water-use information will be compiled for 1986. Water-use information from hydrologic projects in California will be added to the water-use data bases. Information from the water-use program will be available for use by other investigators. Ground-water withdrawals will be estimated for Kings and Tulare Counties and for the Westlands Water District.

Reports: None

GROUND-WATER APPRAISAL, U.S. MARINE CORPS BASE, TWENTYNINE PALMS

Number: *CA027*

Cooperating Agency: *U.S. Marine Corps, Air Ground Combat Center, Twentynine Palms*

Project Chief: *Clark J. Londquist*

Period of Project: *September 1981 to September 1988*

Problem: The Marine Base water supply is from wells in Surprise Spring Basin. Although the basin has water of good quality, the quantity is limited because of barrier faults that restrict ground-water flow and because of low ground-water recharge in the arid environment. Water levels are declining because of increased pumping. Other ground-water basins may be used as potential sources of water. However, water quality, particularly fluoride, may be a problem.

Objectives: Determine the quantity and quality of ground water and maintain a water-level and water-quality monitoring network in the western part of the base.

Approach: U.S. Geological Survey personnel will locate and determine status of all wells in project area. Water levels will be measured and compared with past data to determine water-level changes. Samples of water from pertinent wells will be collected and analyzed. A gravity survey will determine the thickness of aquifers and basin configuration. Previously estimated specific yields and gravity data will be used to refine storage estimates. A digital model of the ground-water system will be developed to assess the effect of future ground-water pumping.

Progress: Three test wells were drilled, two in Surprise Spring basin and one east of Surprise Spring fault in Deadman Basin. The water levels in these wells indicated that there is about a 400-foot head difference across this fault. Analysis of water-quality data indicate that water probably enters the basin as underflow both north and south of Artillery Hill rather than just north of the hill as previously thought. Water levels were measured in all existing wells in the basin, and altitude of land surface was surveyed for all wells which had not been surveyed previously. The ground-water flow model was recalibrated, incorporating all new data gathered, and used to calculate the effects of proposed pumpage increases through the year 2035. The model indicated that there was adequate water in the basin to meet the projected demand at least through 2035. A report has been written and is currently undergoing revision after advisor review.

Plans for Next Year: Complete and publish report and continue ground-water monitoring.

Reports: None

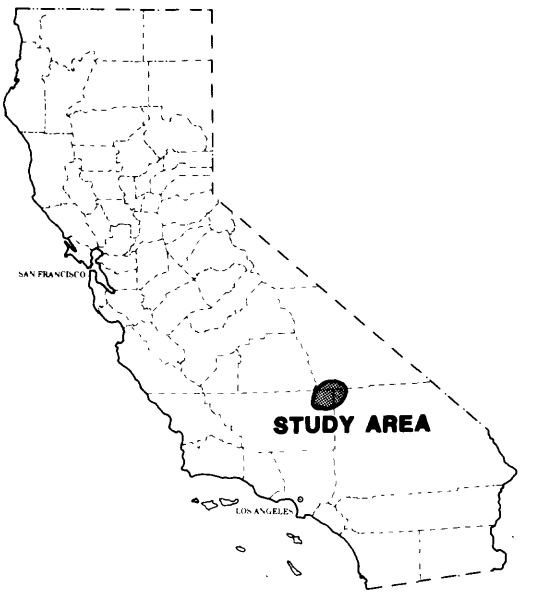
APPRAISAL OF GROUND WATER, INDIAN WELLS VALLEY

Number: *CA030*

Cooperating Agencies: *Indian Wells Valley Water District; U.S. Navy, Naval Weapons Center, China Lake*

Project Chief: *Charles E. Berenbrock*

Period of Project: *Continuing*



Problem: Indian Wells Valley is undergoing rapid population growth, ground-water levels are declining throughout the valley, and ground-water quality has deteriorated in the Ridgecrest area. Thus, there is a need to develop a better understanding of the ground-water system and to apply analytical techniques, such as models, to facilitate management of the ground-water system.

Objectives: (1) Define current ground-water conditions in the valley using a water-level and water-quality monitoring network, and (2) develop management tools (computer models) that can be used to predict response to future ground-water pumpage.

Approach: Maintain monitoring of ground-water levels and quality in the valley. An earlier ground-water flow model will be refined in order to develop a three-dimensional computer model of the basin ground-water system. The new model will be updated with hydrologic data collected during 1976-87 and will be used to predict ground-water levels resulting from a number of possible future pumpage patterns in the valley. In addition, water quality of the ground water will be assessed and the solute-transport model will be developed.

Progress: A water-level and water-quality monitoring network operated during the year consisted of semiannual water-level measurements (22 wells) and annual chemical analysis of major dissolved ions (13 wells), with three samples analyzed for concentrations of volatile organics and trace metals. Three samples in the western part of the valley were analyzed for alpha radiation levels. Assistance was given to China Lake Naval Weapons Center with construction of test holes to be used as monitoring wells drilled during 1986. The calibration of the three-dimensional ground-water flow model has been completed, and a report describing the model and the geohydrology of the basin is in review. A new well drilled to a depth of 1,010 feet in the southwestern part of the valley showed that the unconsolidated deposits were coarser and thicker than originally thought. This new information allowed for refinement of the model. Work began on a valleywide assessment of ground-water quality, and 30 wells were sampled for chemical analyses.

Plans for Next Year: The hydrologic monitoring will consist of semiannual water-level measurements at 22 wells and annual chemical analyses for major dissolved ions in water from 13 wells. Three samples will be analyzed for concentrations of volatile organics and selected trace metals. The valleywide ground-water quality study will continue. During fiscal year 1988 existing geohydrologic and water-quality data will be evaluated, and an additional 30 wells will be sampled for chemical analyses. The ground-water quality study, which is scheduled to be completed by September 30, 1989, ultimately will lead to the development and calibration of a solute-transport model.

Reports: None

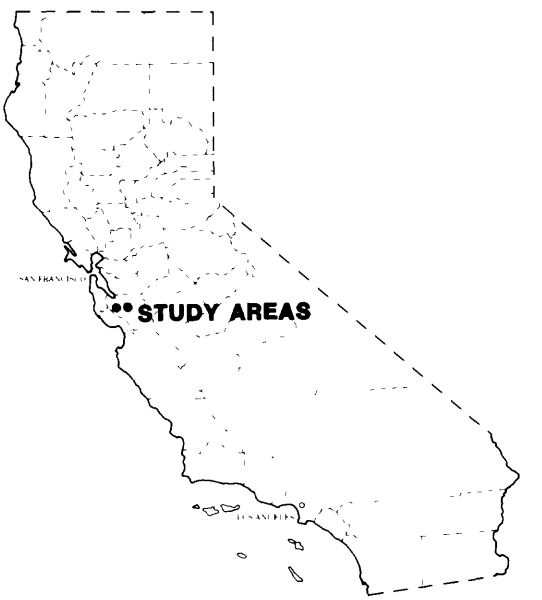
CHARACTERISTICS OF SELECTED LAKES AND RESERVOIRS

Number: *CA184*

Cooperating Agency: *Santa Clara Valley Water District*

Project Chief: *Patricia A. Showalter*

Period of Project: *Continuing*



Problem: During the past 40 years, the Santa Clara Valley Water District has constructed a network of reservoirs, percolation ponds for ground-water recharge, imported water systems, and water-treatment plants to provide water for municipal, agricultural, industrial, and recreational uses. Because reservoirs store most ground-water recharge water, assessments of water-quality conditions of the Santa Clara Valley reservoirs are necessary for water-resources management.

Objectives: Describe present water-quality conditions of Santa Clara Valley reservoirs including (1) estimation of primary productivity at reservoir center, (2) comparison of water-quality conditions and water-quality objectives, (3) evaluation of present reservoir monitoring to determine if Santa Clara Valley Water District's monitoring objectives are being met, and (4) definition of baseline water quality before water imported by the San Felipe Project is introduced.

Approach: Data will be collected four times per year or as required by changes in hydrologic conditions. Physical, chemical, and biological characteristics of the reservoirs and major tributaries will be described using graphical and tabular summaries. Areal and seasonal variations will be delineated. Water-quality conditions that do not comply with water-quality objectives established and/or proposed by the San Francisco Bay Regional Water Quality Control Board will be documented.

Progress: Monitoring continued on Lexington Reservoir and was started on Lake Anderson. Lexington Reservoir and Los Gatos Creek above and below the reservoir were monitored four times this year. The conditions at Lexington Reservoir have been atypical because of low rainfall and because the reservoir is being drained to allow for more dam repairs. A report evaluating the first 5 years of data collection has been submitted for Director's approval. Lake Anderson, the largest reservoir in Santa Clara County, was monitored twice this year. The character of this reservoir is distinct from Lexington, because it has 4.5 times more capacity and drains an area that receives less than half the rainfall. The reservoir itself was monitored near the dam at approximately the deepest point. Coyote Creek, which flows into the south arm of the reservoir, was monitored from downstream of Coyote Dam approximately 4 miles from Lake Anderson. Inflow from Coyote Creek is the reservoir's main source of water. Los Animas Creek, which flows into the north arm of the lake, also was monitored.

Plans for Next Year: The reservoir water quality program will continue into 1988. Lake Anderson and Lexington Reservoir are being drained, so the hydrologic conditions on those lakes will be atypical this year. Monitoring will be suspended on those lakes until conditions become more typical. San Felipe project water is being delivered to Calero Reservoir, so monitoring will be resumed at the reservoir to document how the imported water affects the water quality. The reservoir and the Almaden-Calero Canal will be monitored four times per year. Samplings will be coordinated with seasonal changes. Almaden, Guadalupe, and Coyote Reservoirs will be monitored twice in 1988 to establish a water-quality data base.

Reports:

Iwatsubo, R.T., Sylvester, M.A., and Gloege, I.S., (in press), Water quality of the Lexington Reservoir, Santa Clara County, California, 1978-80: U.S. Geological Survey Water-Resources Investigations Report 87-4253.

CHARACTERISTICS OF FLOODING AND CHANNEL CHANGES OF THE SACRAMENTO RIVER BETWEEN BUTTE CITY AND CHICO

Number: *CA271*

Cooperating Agencies: *California Department of Water Resources*

Project Chief: *Jerry G. Harmon*

Period of Project: *Continuing*

Problem: Flooding and channel changes of the Sacramento River are causing changes in the magnitude and duration of overbank flows to Butte Basin and increased amounts of lateral erosion. There is concern that continued lateral migration of the channel may cause the Sacramento River to change course and enter Butte Basin or greatly alter the division of flows between the main channel and overflow area.

Objectives: (1) Evaluate the magnitude and duration of historic floods, rates of lateral migration through scour and deposition, and changes in geomorphic features of the channel; and (2) indicate, by tracing past changes in the channel capacity and location, the distribution of flow between the main channel and overbank areas.

Approach: Flood data (part of the ongoing data-collection program, CA001) will be collected. Aerial photos of the study area will be obtained, and existing streamflow, bank-erosion, and deposition data will be evaluated. A report will be prepared giving the results of data evaluations.

Progress: A network of recording gages and crest-stage gages in Butte Basin and the Sacramento River was installed and operated during 1986-87. Construction to add crest-stage gages and to repair a recording gage was completed. Level surveys to document 1986 flood data were conducted. Monumented cross sections at eight sites on the Sacramento River were resurveyed in August. No floods occurred in the study area in 1987. Previous flood data (1980-86) were assembled, reviewed, and checked for publication in a future report.

Plans for Next Year: Recording gages and crest-stage gages will be prepared and operated for the 1987-88 flood season. Floodflow measurements and surveys of high-water marks along the Sacramento River and in Butte Basin will be recorded to document changes in floodflow characteristics. Changes in division of floodflows between the river and the overflow basin is a continuing concern, because changes may cause the channel capacity of the river to be exceeded in leveed reaches downstream from the overflow areas. Monumented cross sections of the river will be surveyed. Aerial photographs will be obtained, and lateral migration of the river will be measured and included in an interpretive report to follow the 1980-87 flood report.

Reports: None

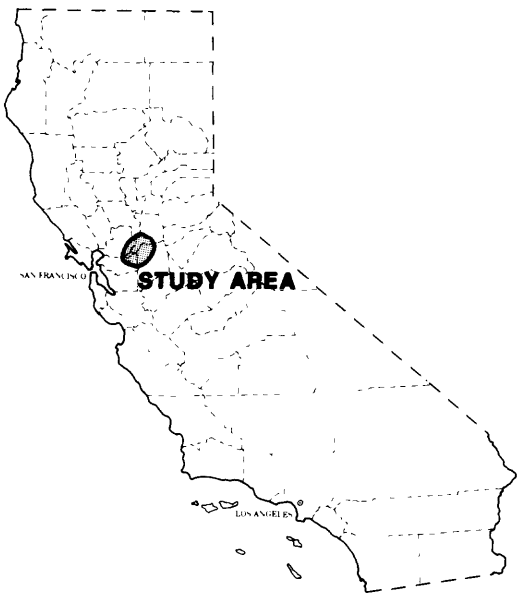
COMPUTER MODELS FOR COMPUTATION OF TIDAL RIVER DISCHARGE

Number: *CA324*

Cooperating Agency: *California Department of Water Resources*

Project Chief: *Richard N. Oltmann*

Period of Project: *July 1975 to September 1989*



Problem: Water quality and sediment are being studied by many different organizations within the Sacramento-San Joaquin River Delta. However, data on instantaneous flows and flow distribution in the many channels that make up the delta area are not available. Because the transport medium of sediment and water-quality constituents is water, the need for a flow record in this area is apparent.

Objectives: Evaluate the feasibility of applying the U.S. Geological Survey's implicit finite-difference branch-network flow-simulation computer model (BRANCH) to a part of the Sacramento-San Joaquin Delta.

Approach: Synchronized stage data will be collected at existing State and Federal gages throughout the study area and used as boundary condition data for the model. Channel cross-section data will be obtained from other agencies or field collected to simulate channel geometry. Model calibration will be made comparing simulated and measured stage and discharge data. Model verification also will be made using Survey collected stage and discharge data. A report will be prepared documenting the results of the study.

Progress: Two acoustic velocity meters (AVM) on the Old and Middle Rivers in the San Joaquin River Delta began providing line-velocity data November 1986. Channel area surveys made January 6, 1987, were used to determine channel cross-sectional area versus water-level relations and line-velocity coefficients for both sites. Collection of synchronized water-level data for use as boundary-condition data for the model began in April 1987. Processed data have been stored in a data base used in conjunction with the model, BRANCH. Modeled area has been reschematized (33 branches, 25 nodes), and channel cross-sectional data have been collected, processed, and entered into the model in addition to the remaining necessary input data. Sensitivity testing of the model with respect to datum and water-level recording errors has begun.

Plans for Next Year: Testing of the Doppler measuring system will begin. When the system is operational, it will be used to provide measured flow data to calibrate and verify the two AVMs and the flow model. AVM flow data also will be used to calibrate and verify the flow model. Collection of synchronized water-level data will continue at the five boundary locations for the model. A report will be prepared covering the first year's operation of the AVM's, and a report documenting the results of the modeling effort will be started.

Reports: None

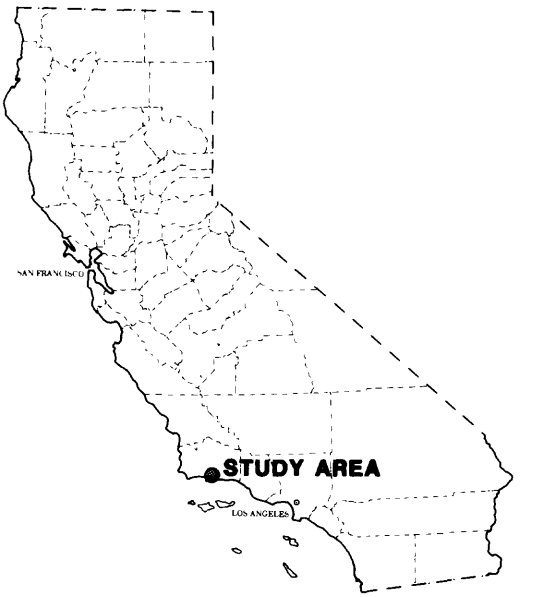
GROUND-WATER RESOURCES OF THE SANTA BARBARA AREA

Number: *CA342*

Cooperating Agency: *Santa Barbara, city of*

Project Chief: *John Freckleton*

Period of Project: *July 1977 to September 1988*



Problem: The reduced efficiency of surface reservoirs due to siltation will place increasing pressure on the ground-water supply in the Santa Barbara ground-water basin. In light of anticipated pumpage in the basin and the possibility of saltwater intrusion into the freshwater aquifer, the development and implementation of a ground-water program capable of evaluating the effects of anticipated stresses on the ground-water basin has become necessary.

Objectives: Design a comprehensive program to regularly monitor water levels and water quality in the ground-water basin to measure the effects of increased pumping and the movement of saltwater into the ground-water reservoir. Results of the monitoring program will be used to develop a computer model of the ground-water basin that will help define the hydrogeology and aid in the management of water resources of the basin.

Approach: Previous investigations will be reviewed. Historic water-level and water-quality data will be collected and analyzed. Water-level and water-quality differences across faults may indicate a possible subbasin boundary. Rainfall and streamflow records will be collected and analyzed when available. These factors may be valuable in determining recharge and discharge. Additional data will be collected, and estimates will be made of transmissivity and storage coefficients. A finite-difference flow model based on measured or estimated hydraulic properties and known or estimated values of recharge and discharge will be constructed for the Foothill basin (formerly the Goleta-East subbasin). The mathematical model will be used to investigate various pumping alternatives which may lessen the effects of increasing subbasin pumping.

Progress: A calibrated ground-water flow model has been developed for the Foothill basin. The basin has been redefined as a result of analysis of hydrologic data. A three-dimensional finite-difference mathematical model of the basin has been constructed. Steady-state and transient-state simulations have been calibrated and show acceptable match to historic data.

Analysis of water-level and water-quality data, as well as model calibration, indicate that the basin covers a greater area than previously assumed. A report of the findings of the investigation, including a description of the mathematical model of the basin, is in review.

Plans for Next Year: Computer simulations of basin operation will be done. These computer simulations will include the examination of basin response to pumpage during simulated drought conditions as well as normal and greater than normal recharge conditions. These simulations may provide guides to a more efficient basin management scheme. A report will be completed and published.

Reports: None

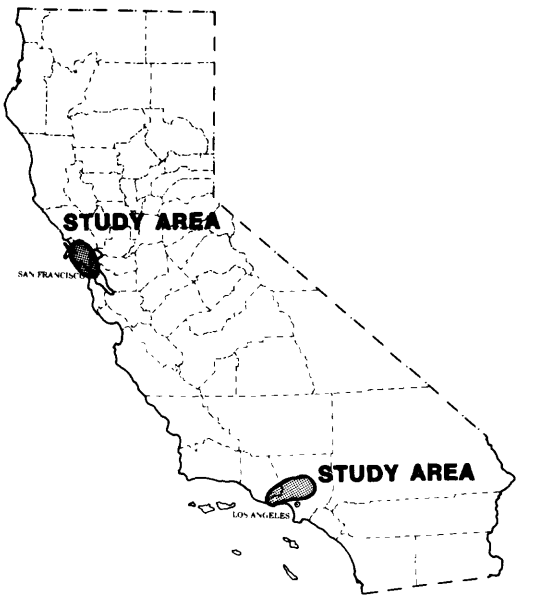
WATER QUALITY IN NATIONAL PARK SERVICE LANDS

Number: *CA355*

Cooperating Agency: *U.S. Department of the Interior, National Park Service*

Project Chief: *Michael V. Shulters*

Period of Project: *Continuing*



Problem: Studies of water quality in National Park Service lands in California need to be designed and operated in support of the continuing planning process under Sections 208 and 303 of Public Law 92-500. The National Park Service has requested the assistance of the U.S. Geological Survey in designing and conducting these studies.

Objectives: Design and implement a program of water-quality studies in selected National Parks in California.

Approach: The U.S. Geological Survey and Park Service personnel will (1) identify areas suitable for or requiring study; (2) reconnoiter the areas, select sampling sites, and observe water-quality conditions; (3) specify information needed to carry out the studies; (4) schedule water-sample collection and measurement in a field-studies program; and (5) identify personnel needs and program costs.

Progress: A 3-year water-quality sampling program was continued in the Golden Gate National Recreation Area (GGNRA), north of San Francisco. Eight surface-water sites in the recreation area were sampled during the winter-storm period and summer low-flow period. Sampling continued in the Santa Monica Mountains National Recreation Area (SMMNRA), northwest of central Los Angeles. All samples were analyzed for major ions, nutrients, indicator bacteria, and selected pesticides. Results from GGNRA indicate that the water is of generally good chemical quality. Specific conductance during low flow ranged from 118 microsiemens per centimeter in Redwood Creek at Muir Beach to 518 microsiemens per centimeter in Green Gulch near Muir Beach. Fecal coliform and fecal streptococci bacteria were present in all samples collected during both sampling periods, with maximum values occurring during the winter. In Redwood Creek at Muir Beach, the fecal coliform count was 8,000 colonies per 100 milliliters, and in Tennessee Valley Creek fecal streptococci count was 23,000 colonies per 100 milliliters. Lowest bacteria counts during the winter were detected in samples from Redwood Creek below Muir Woods with fecal coliform of 5 colonies per 100 milliliters and fecal streptococci of 8 colonies per 100 milliliters.

Owing to below-average precipitation and resulting low-flow conditions, only four sites were sampled during the year in the SMMNRA; during base-flow conditions, specific conductance ranged from 1,120 microsiemens per centimeter in Malibu Creek near Cornell, to 2,000 microsiemens per centimeter downstream near Crater Camp. In Malibu Creek near Cornell, the largest values for fecal coliform and fecal streptococci were 670 and 4,100 colonies per 100 milliliters, respectively. In Topanga Creek near Topanga, the lowest values were <1 and 150 colonies per 100 milliliters, respectively.

Plans for Next Year: Sampling will continue during summer low-flow and winter-storm periods in both study areas. Sampling modifications based on 1987 results will be discussed with each of the National Recreation Area staffs and implemented.

Reports: None

MOVING BOAT DISCHARGE MEASUREMENTS

Number: *CA382*

Cooperating Agency: *None. (U.S. Geological Survey Federal Program)*

Project Chief: *Michael R. Simpson*

Period of Project: *January 1987 to September 1988*

Problem: Accurate discharge measurements of large and/or tide-affected rivers cannot be made using conventional boat discharge-measurement techniques. In large rivers (over 800 feet wide), the bank-to-bank tagline used for boat stationing becomes unwieldy and unsafe. In tide-affected rivers, the duration of a conventional discharge measurement (1 hour or longer) does not permit accurate measurement of fast-changing discharges. Existing moving-boat discharge-measurement techniques developed by the Survey in an attempt to solve these problems have major deficiencies when used under these conditions.

Objective: (1) Develop and test a moving-boat discharge measuring system using a vessel-mounted acoustic Doppler current profiler (ADCP). Tests have shown that an ADCP system is capable of measuring water velocities from a moving vessel and of calculating discharge if controlled by the proper software. (2) Write and debug software which computes river discharge from data provided by the ADCP. (3) Install the software on the ADCP system and field test.

Approach: The discharge-measurement software will be written in the Pascal language using generic Pascal tools and compiler directives so that the final source code will be transportable to other computers. The program structure and documentation will conform to programming standards as set forth by the Survey's Hydrologic Instrumentation Facility. Field tests of the ADCP system will be done under steady-state and nonsteady-state flow conditions using an ADCP system mounted on the Research Vessel Saul E. Rantz at two locations on the Sacramento River. After being tested and debugged, the final source code and documentation will be available as a magnetic file or in hard copy.

Progress: Coding of the preliminary discharge-measurement computer program began during June 1987 and was completed in September 1987. The program source code, written in the Pascal language, was documented extensively to provide a clear history of program development and modification. The acoustic velocity meter at Freeport, California, was calibrated so that accurate river discharges would be available for comparison with river discharges measured by the moving-boat discharge-measuring system. Tests that were to be done on the Sacramento River near Verona, California, under steady-state conditions were cancelled because of inadequate river flows.

Plans for Next Year: Initial test data will be collected during the third week of October on the Sacramento River at Freeport. The Research Vessel Saul E. Rantz will be used for the moving-boat discharge-measurement test. After the Freeport tests, the discharge-measurement computer program will be debugged and rewritten as necessary. Final testing of the moving-boat system will be done during the first part of November, again at Freeport. Following these tests, the computer program will be finalized, and a report will be prepared for publication in the U.S. Geological Survey Techniques of Water-Resources Investigations series. The completed computer program and documentation will be presented to the Hydrologic Instrumentation Facility and the Office of Surface Water, Water Resources Division, for review and possible Divisionwide distribution.

Reports: None

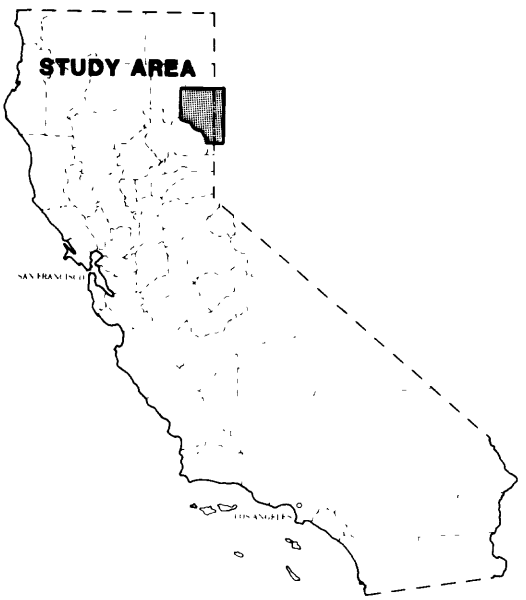
REAPPRAISAL OF THE GROUND-WATER BUDGET AT HONEY LAKE VALLEY, WASHOE COUNTY, NEVADA, AND LASSEN COUNTY, CALIFORNIA

Number: *CA397*

Cooperating Agency: *California Department of Water Resources*

Project Chief: *Clark J. Londquist*

Period of Project: *October 1986 to September 1989*



Problem: Development of the Reno-Sparks, Nevada, area is increasing, nearly all economically available surface water has been allocated, and the demand for ground water continues to grow. Use of water from the Honey Lake aquifer is under consideration, but decisions concerning development of the aquifer are complicated by the institutional constraints of withdrawal from an interstate source as well as the physical limitations of ground-water availability in semiarid areas. Therefore, a detailed appraisal of the ground-water budget is needed.

Objective: (1) Determine the components of ground-water flow and the hydraulic characteristics of the aquifer. (2) Develop a digital model of the flow system and use it to evaluate and quantify the ground-water budget. (3) Produce a report to disseminate the results of the study in a format and with language appropriate for understanding and use by water managers, water users, and elected officials.

Approach: Phase 1 will include assembly and evaluation of existing data, reconnaissance-level data collection, planning for additional detailed data collection, and flow-model development. Phase 2 will involve collection of additional field data to fill needs indentified in Phase 1, interpretation of data, and revision of the model. Phase 3 will include completion of the model, calibration and sensitivity analysis, and preparation of the final report.

Progress: Wells were inventoried and stream sites selected for monthly discharge measurements. Gravity and magnetic surveys and bathymetric study of the Honey Lake were completed. Three high-altitude precipitation-storage gages were installed and additional data collection planned. A conceptual model and preliminary digital flow model were developed, and an annotated outline of a report was prepared.

Plans for Next Year: Collect additional data; process, analyze, and interpret the data; and develop basinwide flow model.

Reports: None

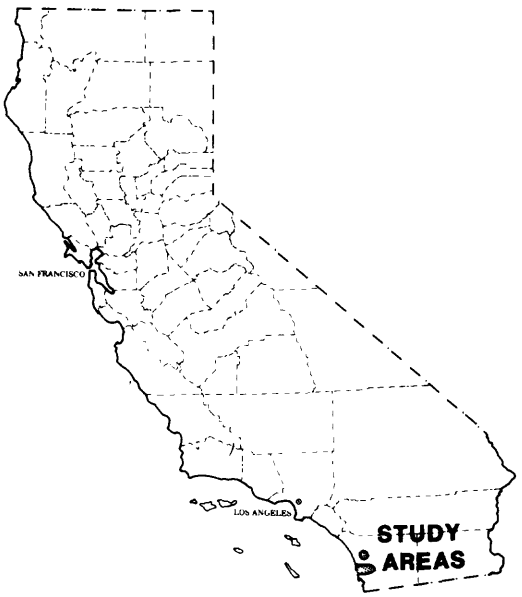
RECLAIMED WATER USE, SAN DIEGO COUNTY

Number: *CA399*

Cooperating Agency: *California Regional Water Quality Control Board, San Diego Region*

Project Chief: *Linda R. Woolfenden*

Period of Project: *July 1981 to December 1987*



Problem: Most of San Diego County's water is imported. When the Central Arizona Project is completed, a major source of water will be reduced. To compensate for this loss, the San Diego Regional Water Quality Control Board wants to evaluate selected ground-water basins as sites for reclaimed water use. Many problems are associated with using reclaimed water, such as ambient quality of ground water, storage capacity of aquifers, quality of reclaimed water, and soil suitability.

Objectives: (1) Evaluate the ground-water and surface-water quantity and quality for each subarea; (2) define past, present, and future beneficial water uses; (3) determine future plans of water purveyors, public agencies, and other water users concerning the use of reclaimed water; and (4) assess the environmental impact of the use of reclaimed water on each subarea.

Approach: Background information and available ground-water data will be compiled. Wells will be inventoried to determine sampling locations. Data required to define ground-water quality and quantity will be collected. Existing surface-water records will be compiled. Data required to determine present and future water use and information on reclaimed water will be collected. The effect of reclaimed water recharge on ground-water quality will be assessed, and the percentage of water supply it might replace will be determined. Potential uses of reclaimed water also will be assessed.

Progress: The report describing ground- and surface-water quality in the Poway, Soledad, and Moosa hydrologic subareas in San Diego County is in review. The geology, soils, and cultural features of each subarea are described in the report, and the potential use of reclaimed water and its effects on exisiting water quality are evaluated.

A study of water quality in the Escondido hydrologic unit in north-central San Diego County was started in May. This study is the fourth in the series of water-quality studies conducted for this project. Fieldwork was completed for the study. Historic hydrologic data were obtained, a map showing the areal distribution of dissolved solids has been constructed, and Stiff diagrams drawn. Maps showing well locations, geology, and water levels have been completed.

Plans for Next Year: Review, approval, and publication of the report on Poway, Soledad, and Moosa hydrologic subareas will be completed. Final data analysis and a report on the Escondido hydrologic unit will be completed.

Reports:

Evenson, K.D., (in press) Water resources of Soledad, Poway, and Moosa basins, San Diego County, California: U.S. Geological Survey Water-Resources Investigations Report 88-4030.

LAND SUBSIDENCE IN THE SACRAMENTO-SAN JOAQUIN DELTA

Number: *CA403*

Cooperating Agency: *California Department of Water Resources*

Project Chief: *Stuart A. Rojstaczer*

Period of Project: *October 1987 to September 1993*

Problem: Land subsidence in the Sacramento-San Joaquin Delta threatens the use of delta lands for agricultural purposes. This study is necessary to identify the causes and quantify the rates of land subsidence in the delta.

Objective: (1) Quantify subsidence rates at selected sites within the delta and (2) identify the role that the surficial peat layer plays in the subsidence process.

Approach: Borehole extensometry and geodetic positioning satellites will be used to monitor subsidence in the delta. In-situ measurement of soil moisture, temperature, and respiration rate will be used to relate subsidence to the physical and biological state of the soil.

Progress: A 430-feet deep extensometer and two piezometers were installed on Bacon Island. One piezometer extends to a depth of 11.25 feet and is intended to measure the water level in the peat layer; the other extends to a depth of 25.75 feet and is intended to measure the water level below the peat layer to reflect changes due to ground-water pumpage in the area. An 8- x 12-foot steel recording shelter was installed and equipped with compaction and water-level recorders. Level lines were run to establish a datum referenced to bench marks outside the influence of the delta that were established using Global Positioning System techniques.

Plans for Next Year: Two sites for subsidence monitoring and one site for soil monitoring will be installed. An experiment to determine the in-situ compressibility of peat will be established.

Reports: None

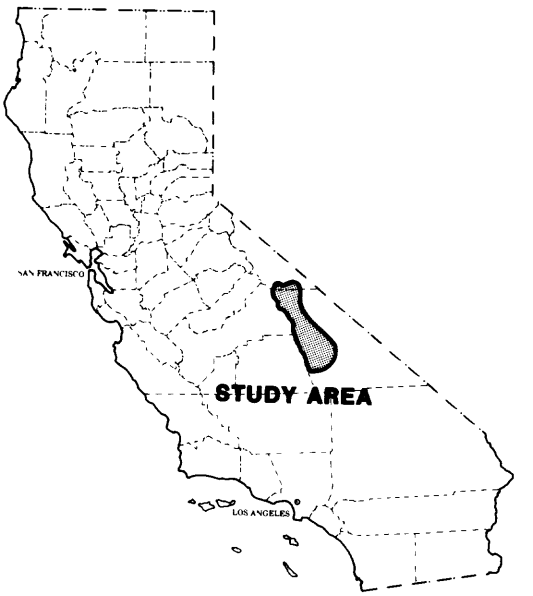
VEGETATION SURVIVABILITY STUDIES IN OWENS VALLEY

Number: *CA413*

Cooperating Agencies: *Inyo County, Department of Water; Los Angeles, city of, Department of Water and Power*

Project Chief: *Stephen K. Sorenson*

Period of Project: *April 1983 to September 1987*



Problem: Much of the valley floor in Owens Valley is covered by phreatophytic shrub and grass communities which are dependent on the shallow water table (2 to 10 feet) for survival. During the past 15 years, large areas of these plant communities have been adversely affected by declines in the water table and the resultant depletion of soil moisture. These adverse effects are thought to be caused, in part, by increased pumping and export of ground water from the basin. A quantitative understanding of the relation of plant survivability and ground-water levels is essential in order to manage the water resources in the valley.

Objectives: (1) Define those factors which control the ability of native phreatophytic vegetation to survive and to adapt to lowering water tables, and (2) quantitatively link physiological responses in plants, such as internal water stress, growth, and leaf area, with hydrologic parameters, such as water-table depth, the rate at which the water table is drawn down, and soil moisture content and stress. These results will be linked to a ground-water optimization model that will help to evaluate alternative strategies for mitigating effects of ground-water pumping on the phreatophytic vegetation communities.

Approach: Wells will be installed and pumped in order to draw down the shallow water table in a controlled manner under several test vegetation plots. A range of induced plant stress, from little or no stress to high stress, which will cause death to the phreatophytic plants, will be created by controlled pumping. Soil-moisture content and soil-moisture stress will be determined along with internal plant stress, growth rates, vegetation cover, and transpiration rates. These determinations will be used to relate the plants responses to the lowered water table and decreased soil moisture.

Progress: Two of the four water-table drawdown sites established for this project were shut down in October 1986. Pumping at the remaining two slow drawdown sites continued throughout the year. Inyo County personnel collected plant and soils data at these sites, but no fieldwork was done by the U.S. Geological Survey. Further evaluation of the soil water characteristics model proved successful. A report on estimating soil matric potential, and a report on osomotic potential and projected drought tolerances of four phreatophytic shrub species with a section on plant-water relations were completed and approved. A report on tolerance of western plants to drought and salinity was completed and is in review, and an annotated outline of a report on vegetation responses to ground-water depth changes was completed and reviewed.

Plans for Next Year: The final report of this project will be completed and submitted for review and Director's approval.

Reports:

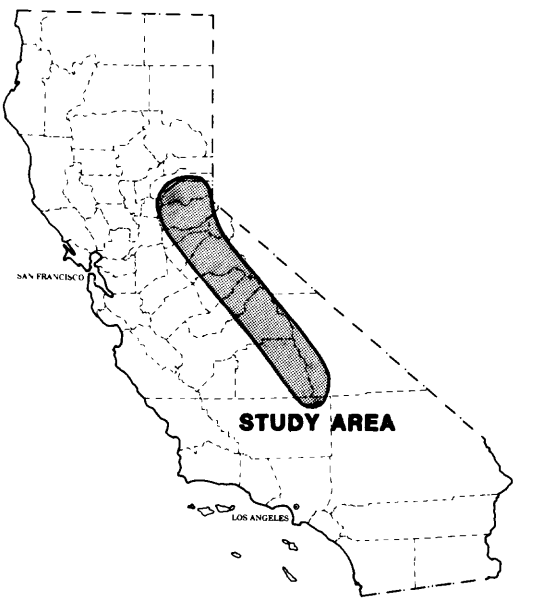
Sorenson, S.K., and Miller, R.F., 1987, Estimating soil matric potential in Owens Valley, California [abs.]: EOS Transactions, American Geophysical Union, 1987 Fall Meeting, v. 68, no. 44, San Francisco, December 7-11, 1987, p. 1299.

GIARDIA IN THE SIERRA NEVADA

Number: *CA414*

Project Chief: *Stephen K. Sorenson*

Period of Project: *October 1982 to September 1987*



Problem: Giardiasis, an abdominal disorder caused by the presence of the protozoan Giardia lamblia, is one of the most common intestinal disorders worldwide. Outbreaks of giardiasis in this country, believed to have been of waterborne origin, have occurred in many states including California. Recently this disease has been linked with greater frequency to drinking native water in wilderness areas of the United States. Although Giardia are now known to occur in the wilderness environment, little is known about the magnitude of the health problem, the organism's persistence in the hydrologic environment, and host classification.

Objectives: (1) Develop a usable field technique to determine the presence of Giardia, (2) evaluate the persistence and mobility of Giardia cysts in the hydrologic environment in the Alpine and sub-Alpine regions of the Sierra Nevada, and (3) establish the relation between Giardia in water and the occurrence of giardiasis in wilderness visitors.

Approach: The California Department of Health Services has successfully tested a laboratory procedure for detection of Giardia using immunofluorescence. This procedure will be evaluated and refined to improve its precision. Field and laboratory procedures will be developed to use the immunofluorescence technique to identify and enumerate Giardia cysts in water. The immunofluorescence technique also will be adapted for use in identifying Giardia cysts in animal stools. These techniques will be used to evaluate the occurrence and sources of Giardia cysts in selected drainage basins in the Sierra Nevada.

Progress: A study to determine the specificity and the sensitivity of the monoclonal immunofluorescent stain compared with other established methods of detecting Giardia cysts was started in collaboration with the University of Nevada, Reno. The study used the monoclonal stain to evaluate 100 fecal smear slides, 50 of which were positive using the current laboratory standard method, and 50 of which were negative for Giardia. The results agreed 100 percent with the conventional method. An article summarizing these data will be submitted to a medical journal. A report published in the the Journal of Freshwater Ecology was the result of work done on this project in 1985 and 1986.

Plans for Next Year: Continue Giardia research as funding permits.

Reports:

Suk, T.J., Sorenson, S.K., and Dileanis, P.D., 1987, The relation between human presence and occurrence of Giardia cysts in streams in the Sierra Nevada, California: Journal of Freshwater Ecology, v. 4, no. 1, June 1987, p. 71-75.

ESTIMATING TIDAL AND RESIDUAL CIRCULATION IN SAN FRANCISCO BAY

Number: *CA419*

Cooperating Agencies: *California Department of Water Resources; California State Water Resources Control Board*

Project Chief: *Peter E. Smith*

Period of Project: *October 1985 to September 1990*

Problem: California State and Federal water projects regulate the quantity of fresh water flowing into San Francisco Bay from the Sacramento-San Joaquin River Delta. The regulation has caused a decrease in the annual inflow of fresh water to the bay and has altered the time sequences of inflows during the year. The effect of decreased inflow may be altering the mixing characteristics of the bay and adversely affecting fish and shrimp populations.

Objectives: Determine the magnitude and location of variations in hydrodynamics (water currents and salinity) within San Francisco Bay which result from changes in freshwater inflows from the Sacramento-San Joaquin River Delta.

Approach: Two- and three-dimensional mathematical models will be used to project the effects of variations in delta flows on water currents and salinity in the bay. In addition, currents and salinities in the bay will be measured during a wide range of delta-flow conditions. A new prototype of a ship-mounted acoustic Doppler current profiling system will be tested and used to measure vertical profiles of currents. A high resolution onsite conductivity-temperature-depth system will be used to measure vertical salinity profiles. Collected field data will be used to calibrate and validate mathematical models.

Progress: Numerical modeling and field studies were continued. The two-dimensional spectral model was expanded to cover all of San Francisco Bay with a very fine computational grid. The three-dimensional model of San Pablo Bay was validated using field measurements of currents and salinity collected during October 1986. The two-dimensional model of Suisun Bay was used for numerical experiments aimed at quantifying mixing rates and exchange ratios between shallow and deep water areas in Suisun Bay. A data base and data-management system for all current meter and stage data in the bay was completed. More than 1,500 salinity profiles and 500 velocity profiles were collected in a large field study in South San Francisco Bay during the spring of 1987. Three continuous monitoring sites for water level and one site for water level and salinity were operated and maintained throughout the year. A series of presentations reporting on various aspects of the hydrodynamic program was given at a Workshop on the Hydrodynamics of San Francisco Bay/Delta held in Sausalito, California, during May 1987. A descriptive report reviewing circulation and mixing studies in San Francisco Bay was written, approved, and published.

Plans for Next Year: Two reports on the spectral model will be prepared. Further validation of the three-dimensional model will be done with field data. Calculations of the gravitational circulation will be attempted in San Pablo Bay. Three complete tidal cycle measurements of freshwater inflow to San Francisco Bay at Chipps Island will be done. A data report will be completed on the 1987 South Bay field experiments. South Bay field experiments will be repeated during the spring of 1988. An upward-looking acoustic Doppler current profiler will be deployed in Carquinez Strait. A report will be prepared on mixing and exchange ratios in shallow areas of Suisun Bay, and the operation of water-level and salinity stations will be continued. The current-meter data-management system will be expanded to include velocity and salinity profile data.

Reports:

Smith, L.H., 1987, A review of circulation and mixing studies of San Francisco Bay, California: U.S. Geological Survey Circular 1015, 38 p.

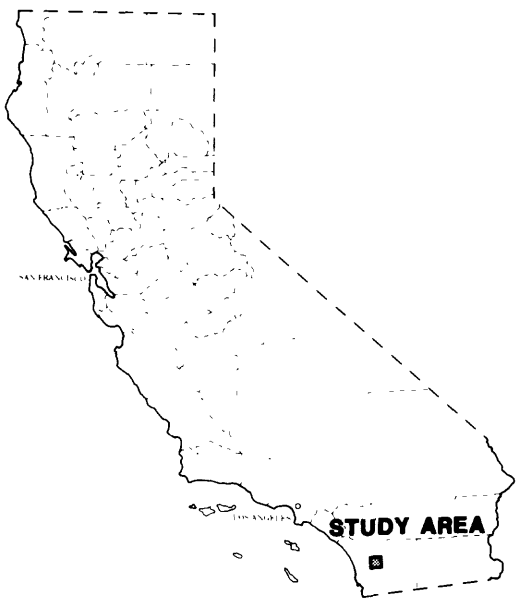
GROUND-WATER HYDRAULICS IN FRACTURED AND WEATHERED GRANITIC ROCKS, LEE VALLEY, SAN DIEGO COUNTY

Number: *CA425*

Cooperating Agency: *San Diego County, Department of Planning and Land Use*

Project Chief: *Charles A. Kaehler*

Period of Project: *October 1984 to September 1988*



Problem: The rapid population growth in San Diego County is extending eastward into the rural consolidated-rock terrains of the Peninsular Ranges. The San Diego County Department of Planning and Land Use is responsible for issuing building permits for new developments, but they have little geohydrologic data to determine the safe long-term rate of ground-water availability. Quantitative knowledge of fractured-rock hydrology is minimal. Better data collection and analytical techniques are needed. Lee Valley is a good area for studying a ground-water budget and the flow of water through fractured and weathered granitic rocks.

Objective: To define the ground-water hydraulics in the bedrock-residuum system in Lee Valley, concentrating specifically on (1) the sources and quantities of ground-water recharge and discharge; (2) the permeability and storage characteristics of the ground-water system,both areally and with depth; and (3) the hydraulic connection between the shallow residuum and deeper fractured bedrock.

Approach: Monitoring of ground-water levels, rainfall, and streamflow, which began in 1983, will be continued. Surface-water data will be used to define recharge and to calculate a basinwide estimate of aquifer diffusivity. The permeability of both the residuum and the fractured bedrock and their hydraulic connection will be determined from aquifer tests that use packers to isolate zones of interest. A suite of geophysical logs will be run on all tested bedrock wells prior to the tests. Water samples will be collected from specific zones and analyzed to provide information on ground-water circulation and movement.

Progress: Meetings were held with San Diego County Department of Planning and Land Use hydrology personnel in the office and in the field to become familiarized with, and to participate in, ongoing data-collection efforts. Existing information was compiled on well locations, well construction, and land ownership. Ten wells suitable for aquifer tests were chosen. Permission was obtained to test existing wells and to drill observation wells; geophysical logging (including acoustic televiewer logs) of test wells were arranged. Five deep (greater than 100 feet into bedrock) and seven shallow observation wells were drilled near existing test wells. Geophysical logging of the deep observation wells was arranged. A first round of

aquifer tests was conducted using four test wells and their nearby observation wells; preliminary analysis of data was done. Wells were added to Survey computer files, and 1984-87 water-level data were entered for all monitored wells (approximately 50). Fracture orientation, dip, and aperture measurements were begun on acoustic televiewer logs. Analysis of the relation between rainfall and streamflow was started. Collection of rainfall data, streamflow data, and water-level measurements from wells was continued.

Acoustic televiewer and caliper logs have been found to be the most useful borehole geophysical logs for determining the location and configuration of subsurface fractures in Lee Valley. Preliminary results from the aquifer tests have shown that fracture zones separated by as little as 12 feet vertically can be hydraulically separate and respond differently to pumping from a nearby test well. Saturated residuum, from which some of the pumped water is drawn, occurs in isolated pockets rather than as a laterally continuous aquifer.

Plans for Next Year: Aquifer tests and water-quality sampling of specific zones in test wells will be done using packers. Collection of rainfall and streamflow data and water-level measurements will continue. Data will be analyzed, and a report will be written.

Reports: None

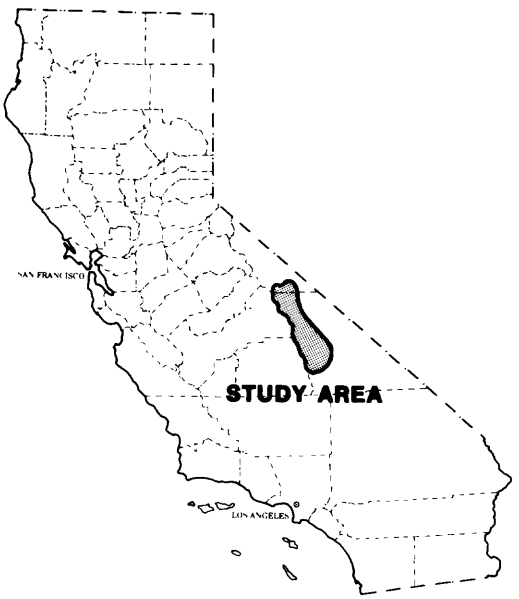
GROUND-WATER INVESTIGATIONS IN OWENS VALLEY

Number: *CA426*

Cooperating Agencies: *Inyo County, Department of Water; Los Angeles, city of, Department of Water and Power*

Project Chief: *Kenneth J. Hollett*

Period of Project: *October 1982 to September 1988*



Problem: The amount of the Owens Valley floor covered by phreatophytes has declined in the last decade. Because these plants provide attractive ground cover, forage for cattle, and protection against soil erosion, their loss is of public concern. Increased ground-water pumping and export by Los Angeles during the 1970's are thought to have had a detrimental effect on the valley phreatophytes. The quantity of water required to keep these plants alive and their sensitivity to changes in the water table or to the moisture content of the unsaturated zone are unknown.

Objectives: (1) Develop quantitative computer models that can be used to evaluate alternative strategies for mitigating the effects of ground-water pumpage on phreatophytes, and (2) develop and calibrate the models by using measurements of evapotranspiration, soil moisture, water-level fluctuations, plant cover, and relation of plant stress to ground-water fluctuations.

Approach: The project is arranged in four consecutive and overlapping phases. The phases are (1) intensive site investigations to develop a one-dimensional model of soil-moisture changes coupled with microclimate and phreatophyte water use; (2) preliminary three-dimensional model and a two-dimensional, probabalistic-deterministic model to evaluate initial and boundary conditions; (3) detailed two-dimensional, cross-sectional models; and (4) valleywide, three-dimensional, predictive and optimization models that could help develop pumping strategies with the minimum effect on valley vegetation.

Progress: Steady- and transient-state flow models of the ground-water system in Owens Valley have been developed as a means of evaluating the conceptualized flow system. The background information for the models (hydrogeologic, water resources, and micrometeorological measurement of evapotranspiration) has been documented in several reports which are in review. Constrained optimization algorithms are being coupled to the flow model to help evaluate alternative strategies to mitigate the effects of ground-water withdrawal on native phreatophytes.

Plans for Next Year: Calibration of the ground-water flow and optimization models will be completed. The project has been extended through fiscal year 1988 to allow transfer of data and model code to the cooperators, to verify models, and to evaluate the management alternatives. The extension also provides funds for color in three of the eight final reports. The summary and system analysis-simulation reports will be completed. Target date for these reports to enter review is early 1988.

Reports:

Danskin, W.R., 1987, Water management in Owens Valley, California, using ground-water models, constrained optimization and monitoring of field sites [abs.]: EOS Transactions, American Geophysical Union, v. 68, no. 44, 1987 Fall Meeting, San Francisco, December 7-11, 1987, p. 1298.

Danskin, W.R., (in press) Preliminary evaluation of the hydrogeologic system in Owens Valley, California: U.S. Geological Survey Water-Resources Investigations Report 88-4003.

Duell, L.F.W., Jr., 1987, Transport resistance adjustments to the Penman Combination Method using estimates of actual evapotranspiration [abs.]: EOS Transactions, American Geophysical Union, v. 68, no. 44, 1987 Fall Meeting, San Francisco, December 7-11, 1987, p. 1294.

McCaffrey, W.F., and Hollett, K.J., 1987, Structure and depositional history of Owens Valley, California [abs.]: Geological Society of America, Las Vegas, Nevada, 1988, v. 19, no. 6, 1 p.

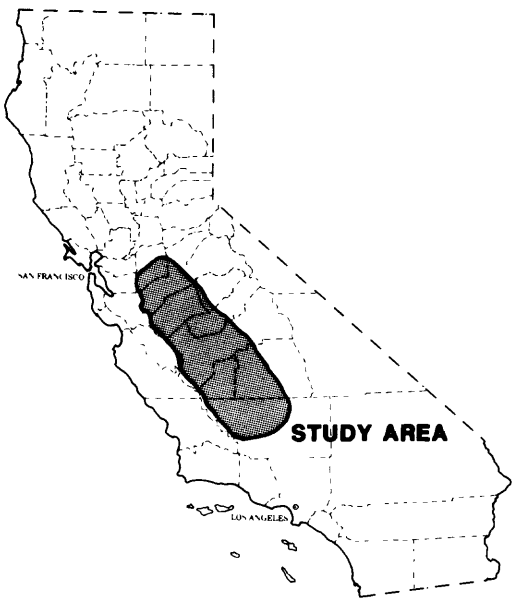
CENTRAL VALLEY REGIONAL AQUIFER-SYSTEM ANALYSIS

Number: *CA428*

Cooperating Agency: *None. (U.S. Geological Survey Federal Program)*

Project Chief: *Neil M. Dubrovsky*

Period of Project: *Continuing*



Problem: Selenium and other elements in the western San Joaquin Valley have been measured in concentrations that exceed recommended levels in agricultural drainage water. Regional aquifers of the western valley and other parts of the San Joaquin Valley may have high trace-element concentrations. High pesticide use may have caused contamination of some parts of the regional aquifers.

Objective: (1) Assess the distribution of major ions, trace elements, and pesticides in zones of fresh water in the regional aquifers; (2) evaluate historical changes in ground-water chemistry due to increased recharge to irrigation and overdrafts caused by pumping for irrigation; (3) determine the regionally important geochemical processes that control trace-element concentrations in ground water, thus explaining their present distribution; and (4) evaluate the key hydrologic and pesticide-use factors that affect the degree of contamination of water-table aquifers.

Approach: The general approach is to inventory and sample existing wells throughout the valley and selectively install new, multiple-depth sampling wells. Trace elements and major ions will be assessed throughout, and pesticides will be assessed in the water-table aquifer.

Progress: During 1987 the eastern side of the San Joaquin Valley was inventoried and sampled. Samples were collected from 112 wells in 65 townships; pesticide samples were collected from approximately half of these wells. This sampling completes the areal reconnaissance.

On the west side of the valley, additional cluster wells were installed. At the Mendota Airport, the shallow part of the aquifer was cored, and pore waters were obtained at close intervals in order to obtain detail on a zone where selenium concentration changes rapidly. Four two-dimensional profiles of the ground-water chemistry along flow lines on the east side of the valley using existing wells have been planned; however, the wells have not been inventoried. Planning for the installation of a two-dimensional profile of piezometers in the vicinity of the Lost Hills in the southwest part of the valley is complete, and three sites have been permitted.

Plans for Next Year: During 1988 the wells required for the two-dimensional cross sections along flow lines on the east side will be inventoried and sampled. Two additional piezometer clusters will be installed on the Panoche fan, and approximately four more wells will be installed at existing sites where necessary. An additional site will be selected where selenium concentrations change rapidly at shallow depths in the regional aquifer. A detailed geochemical profile will be obtained at this site by collecting pore waters at close intervals. Nine wells will be installed at three sites approximately along a flow line in the southwest part of the valley in the vicinity of Lost Hills.

Reports:

Belitz, Kenneth, 1988, Character and evolution of the ground-water flow system in the central part of the western San Joaquin Valley, California: U.S. Geological Survey Open-File Report 87-573, 36 p.

Deverel, S.J., and Fujii, Roger, 1987, Processes affecting the distribution of selenium in shallow ground water of agricultural areas, western San Joaquin Valley, California: U.S. Geological Survey Open-File Report 87-220, 14 p.

Dubrovsky, N.M., and Neil, J.M., (in press), Processes that control selenium distribution in ground water, western San Joaquin Valley, California [abs.]: EOS Transactions, American Geophysical Union, Spring Meeting, Baltimore, Maryland, May 16-20, 1988.

Fujii, Roger, and Deverel, S.J., (in press), Mobility and distribution of selenium and salinity in ground water and soil of drained agricultural fields, western San Joaquin Valley, California in Jacobs, L.W., and others, eds., Selenium in Agriculture and the Environment: American Society of Agronomy, Madison, Wisconsin, Speical Publication.

Fujii, Roger, Deverel, S.J., and Hatfield, D.B., 1987, Distribution of selenium in soils of agricultural fields, western San Joaquin Valley, California: U.S. Geological Survey Open-File Report 87-467, 16 p.

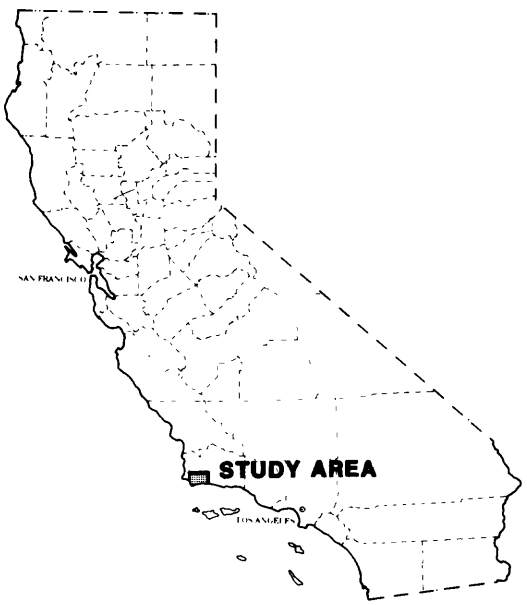
SALTWATER INTRUSION AT SANTA BARBARA

Number: *CA429*

Cooperating Agency: *Santa Barbara, city of*

Project Chief: *Peter Martin*

Period of Project: *October 1985 to December 1988*



Problem: Saltwater intrusion into freshwater aquifers is a major problem in the coastal basins of southern California. Many wells in the coastal basins have been abandoned because of intrusion. Extensive intrusion in some basins has led to the use of injection wells to create freshwater barriers to retard further intrusion. Effective management of the water resources of the region requires greater understanding of the ground-water hydraulics, and the usefulness of computer solute-transport models on saltwater-intrusion problems needs to be evaluated.

Objective: Determine the extent of saltwater intrusion into Storage Unit 1 of the Santa Barbara ground-water basin and develop a model to simulate the movement of saltwater into the freshwater aquifer.

Approach: A series of wells will be drilled and constructed at varying depths perpendicular to the coastline to determine the lateral and vertical distribution of saltwater in the freshwater aquifer and aquifer hydraulic characteristics. Chloride concentrations and water levels will be monitored monthly at the test wells during the first 2 years of the study in order to track the intrusion during major summer pumping periods. A cross-sectional solute-transport model will be calibrated and used to simulate the movement of saltwater into the freshwater aquifer.

Progress: Chloride concentrations and water levels were monitored monthly in 15 test wells completed at varying depths along the coastline. Chloride concentrations were as high as 15,000 milligrams per liter in a well 500 feet inland of the coastline and perforated opposite the lower producing zone (about 700 feet deep). Water from test well, 1,200 feet inland of the coastline and perforated opposite the lower producing zone, had a chloride concentration of 3,000 milligrams per liter. The municipal supply well nearest to the degraded water is about 3,500 feet inland from the coastline; no deep wells were present between it and the degraded water. Two additional monitor sites were installed in September 1987 about 2,400 feet inland of the coastline to determine the inland extent of the saltwater intrusion. Chloride concentrations in these wells were less than 100 milligrams per liter, indicating that saltwater intrusion had not reached these wells. Therefore, the inland extent of saltwater intrusion lies somewhere between the degraded well (1,200 feet inland of the coastline) and the recently installed wells (2,400 feet inland of the coastline).

Plans for Next Year: Monitoring of water levels and chloride concentrations in test wells will continue. A solute-transport model will be used to simulate the observed movement of saltwater into the freshwater aquifer. A report describing the results of water-level and water-quality monitoring and calibration of the solute-transport model will be prepared.

Reports: None

HYDROLOGIC STUDIES RELATED TO VOLCANIC ACTIVITY IN LONG VALLEY

Number: *CA431*

Cooperating Agency: *None. (U.S. Geological Survey Federal Program)*

Project Chief: *Christopher D. Farrar*

Period of Project: *July 1982 to September 1989*

Problem: Long Valley along the eastern Sierra Nevada frontal fault is part of a large volcanic depression called the Long Valley caldera. Since 1978, earthquake activity has increased in the caldera. This earthquake activity and a total uplift of 31 centimeters probably are a result of rising magma. On May 26, 1982, the U.S. Geological Survey issued a notice of potential volcanic hazard in the Long Valley area. In response to this notice, the Survey has taken the lead in studies that include monitoring, assessment of potential hazards, and research for methods of prediction.

Objectives: The project is divided into three phases. Phase 1--monitor ground water and surface water in order to detect any changes in the hydrologic system caused by geologic processes and phenomena associated with volcanism or with magma at depth in the Long Valley Caldera. Phase 2--determine flood discharge at selected locations, depth of flow, extent of inundation, and time of travel of the flood wave following hypothetical failure of Long Valley Dam (Lake Crowley) on the Owens River. Phase 3--delineate the type and magnitude of changes that would be expected in the ground-water system of the Long Valley Caldera prior to volcanic eruption.

Approach: Phase 1--a network will be operated to monitor surface-water quality, ground-water levels, water temperature, and ground-water quality. Data will be related to geologic events. Phase 2--a General Purpose Dam-Break Flood Simulation Model (K-634) will be applied for a hypothetical dam failure. Also, application of other models or development of a new diffusion model will be considered. Phase 3--quantitative models capable of analyzing pressure response in water saturated rock from magmatic intrusions will be developed.

Progress: Hydrologic data were collected from a monitoring network that includes triannual ground-water level measurements (40 wells), continuous recording of water levels (6 wells), springflows (5 sites), streamflow (1 site), continuous temperature and specific conductance (2 sites), and annual chemical and isotopic samples (15 sites). The 1985 data with interpretation have been released. The 1986 data have been processed and will be published.

Continuous water-level records are used to detect rock strain. This analysis is discussed in three papers now in colleague review. Seismicity and geodetic deformation have been at very low levels in the Long Valley area during 1987. As a consequence, the response of the hydrologic system to strain has been minimal. Continued dilatation is detected by one well in the western moat of the caldera. Temperature and geophysical logs were run in a 1,300-foot deep core hole, after which the blank casing was perforated and water samples were collected with a downhole sampler. A summation of the hydrologic data and the relevance to detection of possible shallow magma bodies was given at the "Long Valley Symposium," held at Lawrence Berkeley Laboratory, March 17-18, 1987.

Plans for Next Year: The hydrologic monitoring will be continued. If seismicity and geodetic deformation continue to diminish, the number of sites and frequency of data collection will be reduced. Chemical and isotopic data will be analyzed to better define the ground-water-flow regime. Ground-water-level fluctuations in three wells will be used to detect strain using the analytical techniques already developed. Methods of quantifying vapor-phase discharge from subboiling temperature steam vents will be devised. The quantity of vapor discharged will be correlated with subsurface vent temperature and may provide a means of obtaining a continuous record of vapor-phase discharge at observation sites.

Reports:

Farrar, C.D., Sorey, M.L., and Rojstaczer, S.A., 1987, Hydrologic and geochemical monitoring in Long Valley caldera, California: Proceedings of the Symposium on Long Valley, Lawrence Berkeley Laboratory, March 17-18, 1987, 4 p.

Farrar, C.D., Sorey, M.L., Rojstaczer, S.A., Janik, C.J., Wennett, T.L., and Clark, M.D., 1987, Hydrologic and geochemical monitoring in Long Valley caldera, Mono County, California, 1985: U.S. Geological Survey Water-Resources Investigations Report 87-4090, 71 p.

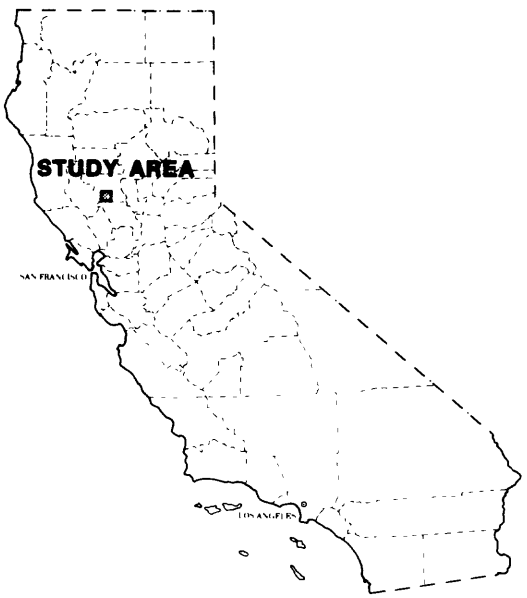
WATER-QUALITY CONDITIONS ON THE CORTINA RANCHERIA INDIAN RESERVATION

Number: *CA435*

Cooperating Agency: *None. (U.S. Geological Survey Federal Program)*

Project Chief: *Eugene B. Yates*

Period of Project: *October 1985 to September 1987*



Problem: The water-supply wells for Cortina Rancheria yield water that fails to meet drinking-water standards because of excessively high concentrations of chloride and dissolved solids. Alternative sources of water that meet the standards are not readily available. The Bureau of Indian Affairs has determined that economic and residential development of the Rancheria cannot proceed without first obtaining an accurate assessment of the quality of available ground- and surface-water supplies.

Objective: (1) Appraise water-quality conditions to assist the Bureau of Indian Affairs in formulating economic and residential development plans for the Rancheria, and (2) prepare a work plan to provide guidelines for future collection of additional geohydrologic and water-quality data for the Rancheria.

Approach: A literature search will be done for all available information regarding the geology, hydrology, and water quality of the Cortina Rancheria area. Available data from Federal, State, local, and private agencies will be obtained and evaluated with respect to accuracy, completeness, and specificity for the Rancheria area. Standard data-analysis methods will be used for the water-quality appraisal. The work plan for further data collection will be based on a subjective evaluation of the limitations of existing data.

Progress: Water-quality samples from two wells and two springs on the Rancheria were analyzed for major ions and selected constituents regulated under the Safe Drinking Water Act. Three of the samples failed to meet drinking-water standards because of high concentrations of chloride, iron, manganese, lead, barium, and/or total dissolved solids. The fourth sample almost failed to meet the standard for chloride. Boron concentrations at three sites would limit use of the water for agriculture. A comparison of water-quality data among the four sites and with data collected at some of the sites during previous investigations demonstrated a high degree of spatial and temporal variability in water quality. A data-collection plan that would define the variability and explore opportunities for developing water supplies from local or seasonal occurrences of high-quality surface or ground water was developed. A final report that described regional and local water resources and the proposed data collection plan was written.

Plans for Next Year: Following approval by the Director of the U.S. Geological Survey, the final report will be published as a Water-Resources Investigation Report.

Reports: None

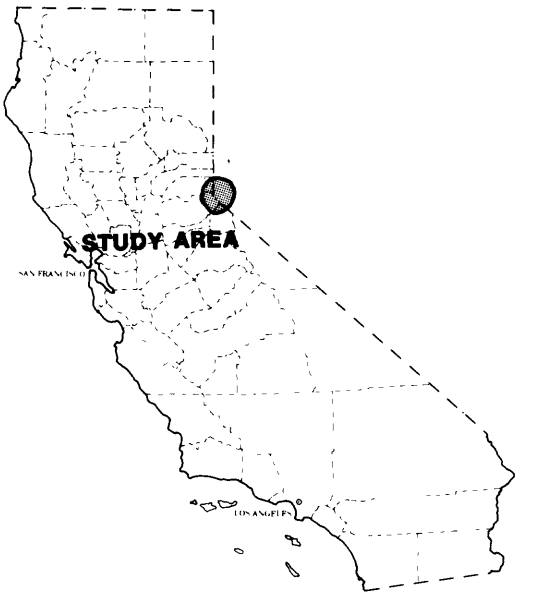
EROSIONAL PROCESSES IN THE LAKE TAHOE BASIN

Number: *CA446*

Cooperating Agency: *Tahoe Regional Planning Agency*

Project Chief: *K. Michael Nolan*

Period of Project: *October 1983 to September 1989*



Problem: The input of nutrients to Lake Tahoe has increased markedly during the past 10 to 15 years. This rise in nutrient input has been tied to cultural development, which disturbs soils and accelerates erosion in tributary drainage basins. To date, most studies of the role of tributaries in the eutrophication of Lake Tahoe have measured quantities of nutrients and sediments supplied to the lake but have not systematically documented erosional processes supplying sediments and associated nutrients to tributary streams.

Objectives: (1) Quantify rates at which sediment is supplied to Lake Tahoe by tributary streams, (2) identify and quantify processes that contribute sediment to tributaries, (3) quantify processes that affect the storage of sediment within tributary channels and those responsible for transport of sediment out of tributary channels and into Lake Tahoe, and (4) where possible, compare processes in undeveloped areas to those operating in developed areas.

Approach: Magnitude and frequency of sediment transport in tributaries will be assessed. Rates of erosional processes will be measured in drainage basins which have been selected to include geology, land use, and physiography representative of significant areas of the Tahoe basin. Hillslope erosion will be quantified by mapping erosional landforms from aerial photographs and field observations and by installing erosion plots. Sediment removed from and stored in stream channels will be quantified by repetitively surveying monumented channel cross profiles and by strip mapping channel conditions using field observations.

Progress: A preliminary sediment budget for the Blackwood Creek basin has located major sources of sediment within the basin. Results of that budget work are helping guide watershed rehabilitation work by the U.S. Forest Service and were included in an abstract which was presented at the spring meeting of the American Geophysical Union. By documenting the long-lasting impacts of a major storm in 1964 on channel geometries and sediment availability in the basin, the data illustrated the delicate nature of this subalpine terrain.

Stream-channel cross profiles established in all four study basins were resurveyed. In addition, 25 samples were collected at erosion boxes in the Blackwood and Edgewood Creek basins, 62 samples were taken for grain size and bulk-density analyses of streambeds and streambanks, and channel mapping was completed for the Edgewood and Logan House Creek basins.

Multiple-regression analyses of sediment data from nine Lake Tahoe tributaries indicate that variations in suspended-sediment yield are strongly controlled by land-use activities, mean annual precipitation, and drainage density.

Plans for Next Year: Fieldwork will be limited to resurveying stream-channel cross profiles at sites that have been characterized by extremely slow rates of change and to collecting samples at hillslope erosion boxes. These data will be used to verify data collected during the previous 4 years. Remaining work will focus on preparing initial drafts of two reports describing sediment budgets from the four study basins. Results from the multiple-regression analyses will be used to estimate sediment input to Lake Tahoe from all tributaries.

Reports:

Nolan, K.M., and Hill, B.R., 1987, Sediment budget and storm effects in a drainage basin tributary to Lake Tahoe [abs.]: EOS Transactions, American Geophysical Union, v. 68, no. 16, 1987 Spring Meeting, Baltimore, Maryland, May 18-22, 1987, p. 305.

GEOHYDROLOGY OF THE LOS OSOS GROUND-WATER BASIN, SAN LUIS OBISPO COUNTY

Number: *CA448*

Cooperating Agencies: *California Department of Water Resources; San Luis Obispo County Engineering Department*

Project Chief: *Eugene B. Yates*

Period of Project: *October 1984 to September 1987*

Problem: Increased percolation of discharge reclaimed water, potential seawater intrusion, and increased demand for potable water within a limited sole-source aquifer system has prompted San Luis Obispo County to develop and implement plans to alleviate existing water-quality problems and manage future water development. The county has requested that the California Department of Water Resources design various alternative plans using a calibrated ground-water flow model to be developed by the U.S. Geological Survey.

Objectives: Develop a ground-water flow model for Los Osos ground-water basin. The model will be used to simulate the hydrologic effects of alternative management plans concerned with ground-water withdrawals, seawater intrusion, and reclaimed water disposal.

Approach: Design of the ground-water model will require collection and evaluation of field data. Fieldwork will include test-hole drilling and logging, installation of piezometers, electromagnetic profiling and resistivity soundings, aquifer tests, water-level monitoring, seepage runs on stream channels, and collection of pumpage data. Office work will include literature review, interpretation of existing well-log information and water-level data, and construction and testing of a digital simulation model.

Progress: A three-dimensional ground-water flow model of the ground-water basin was calibrated for the 1970-77 and 1985-86 periods. Statistical analysis of water-level trends indicated that the basin was not in a steady-state condition during either period, so transient simulations were used for calibration. In simulated basinwide water budgets, infiltration of rainfall contributed about 80 percent of total recharge to the basin. Although there was net outflow of ground water to the ocean, seawater intrusion may have occurred locally and seasonally in recent years. Ground-water levels and water-quality changes at wells on the Morro Bay sandspit support this hypothesis. Sensitivity analysis of the model indicated that simulation results are generally not sensitive to small errors in model input variables. The largest sources of model error probably stem from uncertainties in aquifer storage

properties and agricultural water use. Seven water-resources-management alternatives were simulated under normal, wet, and dry climatic conditions, assuming projected water demand for the year 2010. Specifications for the alternatives were provided by the California Department of Water Resources. Results of the simulations indicated that use of local ground water to meet all municipal demand in 2010 will not result in seawater intrusion, provided that a centralized reclaimed water recharge program is implemented. An interpretive report describing all aspects of basin hydrogeology, model development, and simulation results was written and is presently in review.

Plans for Next Year: The interpretive report will be revised in response to review comments and submitted for Director's approval. An additional report describing technical aspects of model development and use will be prepared. Questions from cooperators relating to basinwide salt balance and local effects of proposed ground-water recharge ponds will be considered.

Reports: None

EROSION AND SEDIMENT TRANSPORT IN THE PERMANENTE CREEK DRAINAGE BASIN

Number: *CA449*

Cooperating Agency: *Santa Clara Valley Water District*

Project Chief: *K. Michael Nolan*

Period of Project: *October 1984 to September 1988*

Problem: Large quantities of sediment, deposited in the channel of Permanente Creek during recent years, have reduced channel capacity and caused localized flooding. If this channel fill resulted from natural processes, the Santa Clara Valley Water District probably will have to plan for channel dredging on a regular basis. If channel filling resulted from land disturbance associated with limestone quarrying in the upper drainage basin, the problem may be mitigated by initiating erosion-control measures.

Objectives: (1) Quantify rates of sediment transport and identify major sources of sediment within the Permanente Creek drainage basin, and (2) compare rates of sediment transport in the main Permanente Creek channel to transport rates in a nearby undisturbed drainage basin.

Approach: Sediment transport in Permanente Creek and a nearby undisturbed drainage basin will be quantified by establishing total-load sediment stations. Major sediment sources in both drainage basins will be identified using ground and aerial-photograph mapping. Rates of sediment discharge from stream channels will be quantified by repetitively surveying selected stream channel cross profiles.

Progress: Data describing sediment discharge during the 1986 water year were reduced and tabulated to produce estimates of sediment discharge. Total sediment load was sampled at both study sites. The isotopic composition of streamflow was sampled during two storms in an effort to fingerprint sources of runoff. Data describing rainfall, water discharge, and sediment discharge during 1986 were entered into the watershed data management system and used to calibrate PRMS (Precipitation-Runoff Modeling System).

Plans for Next Year: Data describing sediment discharge during the 1987 water year will be reduced and tabulated to produce estimates of sediment discharge. PRMS will be run using 1987 data. Drafts of two reports, one describing stormflow generation in the Permanente Creek basin and the other describing variations in sediment yields between the two study basins, will be produced.

Reports: None

IMPLEMENTATION OF REGIONAL-EFFECTS MONITORING IN SAN FRANCISCO BAY

Number: *CA452*

Cooperating Agency: *California State Water Resources Control Board*

Project Chief: *Laurence E. Schemel*

Period of Project: *Continuing*

Problem: Waste discharges, urban runoff, and other anthropogenic factors along with variable natural factors, such as delta outflow, meteorological forces, and ocean currents, can stress the biological inhabitants of San Francisco Bay and affect their abundance, distribution, and composition. These changes may not be either apparent or discernible for several years. Detection and assessment of regional-scale ecological effects from numerous and varied waste discharges will require a long-term monitoring program of key biological components.

Objective: Document and characterize long-term trends in the abundance and composition of key biological components of San Francisco Bay during the next 10 to 20 years.

Approach: The study will use long-term monitoring of selected biological components of the bay ecosystem to identify and evaluate environmental stress. The biological components are plankton, benthic fauna, and macroalgae. Concurrent monitoring of selected chemical and physical properties will support the biological work. Selected special studies will be conducted to pursue issues raised during the course of monitoring.

Progress: Emphasis was placed on selecting methods and sampling locations and collecting consistent and reliable data for (1) intertidal macroalgae (species identification and abundance), (2) benthic infauna (species identification and abundance) and sediment (particle size), and (3) chemical and physical properties of the water column (salinity, temperature, dissolved oxygen, and others) necessary for interpretation of the biological data. Selection of sampling locations and collection of data for intertidal macroalgae were contracted to Romberg Tiburon Center for Environmental Studies. Six sampling locations for intertidal macroalgae were established during fall and winter; these were sampled monthly during appropriate low tides from April through September. Eight locations for benthic infauna and sediment sampling were selected from the locations investigated during September 1986. Regular sampling at 2-month intervals began in March and continued through September 1987. Chemical and physical properties of the water column were measured at these stations and also at about seven additional stations, so that the environment of the bay could be adequately characterized.

Plans for Next Year: Results will be evaluated during autumn, and appropriate changes in methods, sampling locations, and numbers of replicates will be recommended. Intertidal macroalgae will be sampled at 2-month intervals during autumn and winter and monthly during spring and summer. Sampling for benthic fauna, sediment, and water-column properties will continue at 2-month intervals.

Reports: None

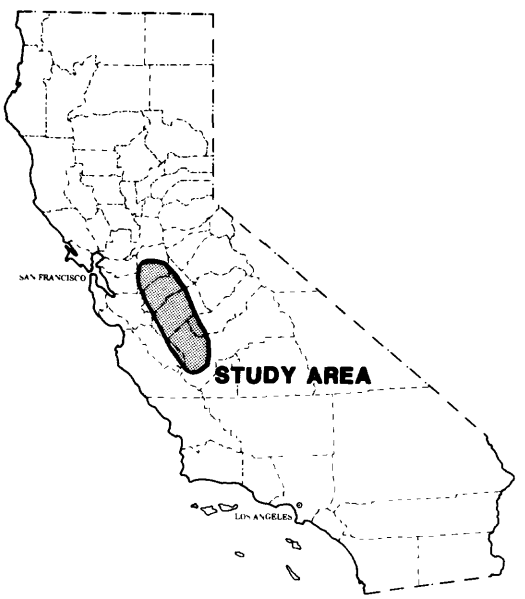
WESTERN SAN JOAQUIN VALLEY HYDROLOGIC STUDIES

Number: *CA456*

Cooperating Agency: *U.S. Department of the Interior, Bureau of Reclamation*

Project Chief: *Robert J. Gilliom*

Period of Project: *October 1984 to September 1989*



Problem: Shallow ground water in the highly productive agricultural area of the western San Joaquin Valley contains high concentrations of several potentially toxic trace elements, particularly selenium. Some of this water has been artificially drained to surface water, where adverse effects on waterfowl have been observed. The area of contaminated ground water is extensive, and the potential effects on surface- and ground-water quality by continued irrigation and drainage discharge is considerable.

Objectives: Conduct a comprehensive hydrogeologic and geochemical study to determine the sources, distribution, movement, and fate of selenium and other trace elements in the hydrologic system of the western San Joaquin Valley.

Approach: An integrated series of laboratory and field studies will be conducted including extensive sampling of soils, ground water, and the San Joaquin River system; laboratory studies of trace-element geochemistry; and ground-water flow and solute-transport monitoring.

Progress: Selected fieldwork and laboratory analyses were continued. Numerous reports have been published. Results from the study of the distribution of selenium in soils and ground water reveal that, on a regional scale, leaching by irrigation, the natural distribution of soil salinity, and evaporation from a shallow water are the most important process that have affected the present-day distribution. At a local farm drainage scale, displacement of evaporated water towards drain laterals is the most important process affecting the distribution. Considerable progress has been made in the study of geochemical processes in characterizing total soluble and phosphate-extractable selenium concentrations in a variety of near-surface soils from the Panoche alluvial fan area.

The primary tool of analysis used to understand the ground-water flow system of the study area is a quasi-three-dimensional flow model. Steady-state calibration of the model for transmissivity and leakance basically was complete. Hydraulic properties of the system were quantified from slug tests at approximately 200 wells.

Preliminary results from the transport study of the San Joaquin River show the San Joaquin River delivers 2 to 3 times the selenium load to the delta in comparison to the Sacramento River. Selenate is the predominant form of selenium in both rivers.

Plans for Next Year: Efforts will focus on data analysis, final data collection, and planning for completion of all studies in 2 years.

Reports:

Beard, Sherrill, and Laudon, Julie, 1988, Data from ground-water test holes in Fresno County, western San Joaquin Valley, California, June to August 1985: U.S. Geological Survey Open-File Report 88-78, 39 p.

Belitz, Kenneth, 1988, Character and evolution of the ground-water flow system in the central part of the western San Joaquin Valley, California: U.S. Open-File Report 87-573, 36 p.

Deverel, S.J., 1988, Hydrologic processes affecting the distribution and mobility of selenium in shallow ground water, western San Joaquin Valley, California [abs.]: 1988 California Plant and Soil Conference, American Society of Agronomy, Fresno, Proceedings, p. 1-3.

Clifton, D.G., and Gilliom, R.J., 1987, Selenium in the San Joaquin River, California, during low flow, June 1985 to January 1986 [abs.]: Lake and Reservoir Management, 7th Annual International Symposium, Orlando, Florida, November 3-7, 1987, North American Lake Management Society, 1 p.

Deverel, S.J., and Fujii, Roger, 1987, Processes affecting the distribution of selenium in shallow ground water of agricultural areas, western San Joaquin Valley, California: U.S. Geological Survey Open-File Report 87-220, 14 p.

Fujii, Roger, and Deverel, S.J., (in press), Mobility and distribution of selenium and salinity in ground water and soil of drained agricultural fields, western San Joaquin Valley, California, in Jacobs, L.W., and others, eds., Selenium in Agriculture and the Environment: American Society of Agronomy, Madison, Wisconsin, Special Publication.

Fujii, Roger, Deverel, S.J., and Hatfield, D.B., 1987, Distribution of selenium in soils of agricultural fields, western San Joaquin Valley, California: U.S. Geological Survey Open-File Report 87-467, 16 p.

Gilliom, R.J., 1987, Determining the natural baseline--importance and approaches [abs.]: IAHS Workshop 8--Estimation of natural baseline conditions as a basis of detecting changes in water quality, Vancouver, Canada, August 19-20, 1987, 1 p.

Gilliom, R.J., (in press), Sources and distribution of selenium in ground water, San Joaquin Valley, California [abs.]: EOS Transactions, American Geophysical Union, Spring Meeting, Baltimore, Maryland, May 16-20, 1988.

Gilliom, R.J., and Clifton, D.G., 1987, Organochlorine pesticide residues in bed sediments of the San Joaquin River and its tributary streams, California: U.S. Geological Survey Open-File Report 87-531, 15 p.

Neil, J.M., 1987, Data for selected pesticides and volatile organic compounds for wells in the western San Joaquin Valley, California, February to July 1985: U.S. Geological Survey Open-File Report 87-48, 10 p.

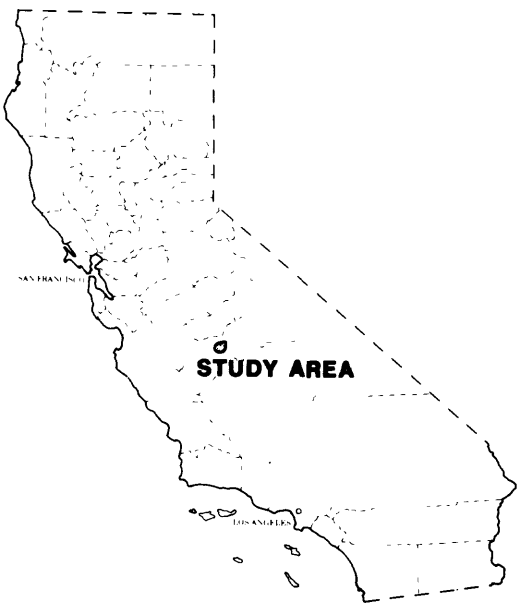
FRESNO SOIL AND GROUND WATER

Number: *CA458*

Cooperating Agency: *Fresno Metropolitan Flood Control District*

Project Chief: *Roy A. Schroeder*

Period of Project: *October 1985 to September 1988*



Problem: During a National Urban Runoff Program study, high concentrations of several trace metals and common pesticides were identified in urban runoff that flows into a ground-water recharge basin in an industrial part of Fresno. There is concern that downward movement of these chemicals could contaminate the ground water.

Objectives: (1) Determine whether contamination of ground water near the recharge basin has occurred, and (2) determine the likelihood of future ground-water contamination by downward movement of contaminants present in recharge-basin sediment.

Approach: Two monitoring wells will be installed near the recharge basin. Chemical analyses of water samples from these wells will be compared to historical regional water-quality data available from local agencies. Subbottom sediments in the basin will be analyzed to establish concentrations to a depth of about 2 meters. Uncontaminated soil representative of the unsaturated zone beneath the basin (obtained from coring during installation of the monitor wells) will be reequilibrated with contaminated water in a laboratory exercise designed to determine the soil's potential to sorb contaminants.

Progress: Soil cores taken from two test holes adjacent to an industrial-runoff basin in Fresno indicate that material below the surface is predominantly fine-grained sand. However, downward percolation of water from the pond is restricted by an impermeable clay-rich layer 2 centimeters thick that has accumulated on its subbottom since excavation in 1981. Water samples were collected from monitor wells, the ponds, and bottom sediment for analysis of major ions, toxic trace elements, macronutrients, organochlorine and organophosphorous insecticides, and volatile organic compounds. Results indicate that little or no transport of toxics from the pond to ground water has occurred. Potassium, which has a much higher concentration in the recharge pond than in the shallow ground water, was found to be a useful indicator of trace metal migration. In a laboratory model experiment designed to assess the potential for contaminant migration in the subsoils, water from the pond was stirred with contaminated mud from the pond, then reequilibrated with clean native soil from the test holes. Chemical analyses of water before and after the clean soil equilibration demonstrated the potential for attenuation of contaminants in the unsaturated zone. Surficial subbottom mud (0 to 1 centimeter depths from six

locations in the recharge zone) was analyzed for toxic trace elements, radiochemcial isotopes, and organic chemicals. Several soil samples from a profile to a subbottom depth of 1.5 meters also were analyzed to evaluate the relation between toxics attenuation and depth in the unsaturated zone beneath the pond. Results indicate that contaminants are absorbed in the top 16 centimeters of sediment.

Plans for Next Year: A final report will be written and submitted for colleague review.

Reports: None

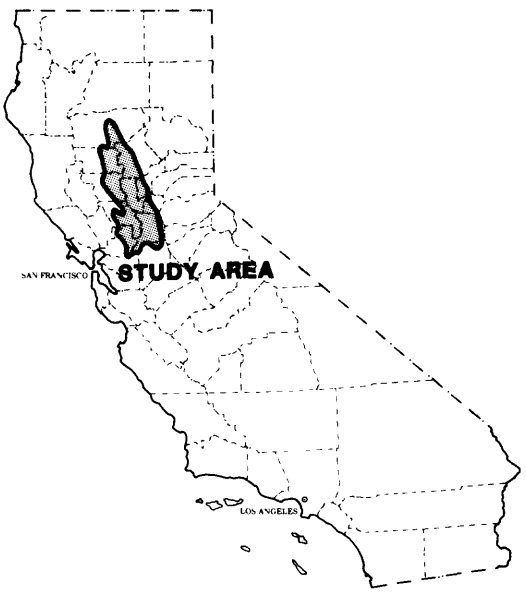
INVESTIGATION OF LAND SUBSIDENCE, SACRAMENTO VALLEY; APPLICATION OF A NEW TECHNIQUE FOR INVESTIGATION OF LAND SUBSIDENCE

Number: *CA459*

Cooperating Agency: *California Department of Water Resources*

Project Chief: *James C. Blodgett*

Period of Project: *October 1985 to September 1989*



Problem: Land subsidence of more than 4 feet has been estimated in parts of the Sacramento Valley as a result of increased ground-water pumpage since 1960. The effectiveness of many floodways, levees, and drains has been impaired by this subsidence. In the Sacramento Valley, many bench marks used to measure subsidence have questionable elevations. Furthermore, the aquifer mechanics responsible for land subsidence in the Sacramento Valley are not understood.

Objectives: (1) Evaluate and implement a new surveying procedure called Global Positioning System that could provide a rapid and relatively inexpensive method of repeat leveling, (2) document existing land subsidence, (3) describe the aquifer mechanics involved in subsidence, and (4) establish a monitoring program to detect any continuing subsidence.

Approach: Initially, a pilot study will be done to evaluate the Global Positioning System survey capabilities. If the Global Positioning System is considered suitable, the methods will be used to survey a primary network of stable bench marks and a secondary network in areas of possible subsidence. Also, a field inventory will be made of unused or abandoned wells in areas of suspected subsidence that are suitable for extensometer, piezometer, and possibly strain meter installation. If a suitable existing well cannot be located, a new well will be drilled. This completed installation will be used to monitor the overall rate of subsidence.

Progress: Results of Global Positioning System surveys of the Sacramento Valley conducted by the U.S. Geological Survey National Mapping Division became available in late 1987. Processing of these data and combining results from Global Positioning System surveys of 21 points surveyed in 1985 is underway. This evaluation includes studies of Global Positioning System survey repeatability, accuracy, measurements of subsidence, and the inconsistency of published bench-mark elevations.

High-precision gravity measurements were conducted at 22 of 38 sites included in the 1986 Global Positioning System surveys. Gravity surveys were made in selected areas to identify large changes in observed gravity based on comparison with older data, to determine merits of repeat observations, and to provide guidelines for deciphering topographic, geologic, and hydrologic effects of ground subsidence in the study area. Processing of these data is scheduled for completion by spring 1988.

Plans for Next Year: Water-level-decline maps prepared by the California Department of Water Resources will be evaluated to determine areas (in addition to Zamora-Knights Landing) in which land subsidence may be occurring. Resurvey of selected Global Positioning System sites is planned where results of earlier surveys provided questionable data; new sites are needed to provide more complete areal coverage and subsidence-monitoring stations. Leveling surveys will be conducted at selected sites to provide data for comparison of published and Global Positioning System survey-derived elevations. A progress report will be written on performance and applicability of Global Positioning System survey procedures to define areal extent, magnitude, and rate of land subsidence in the Sacramento Valley. An evaluation of abandoned wells in the study area for use as subsidence-monitoring stations resulted in a decision to drill two new wells near Zamora. These wells are scheduled for completion in spring 1988.

Reports: None

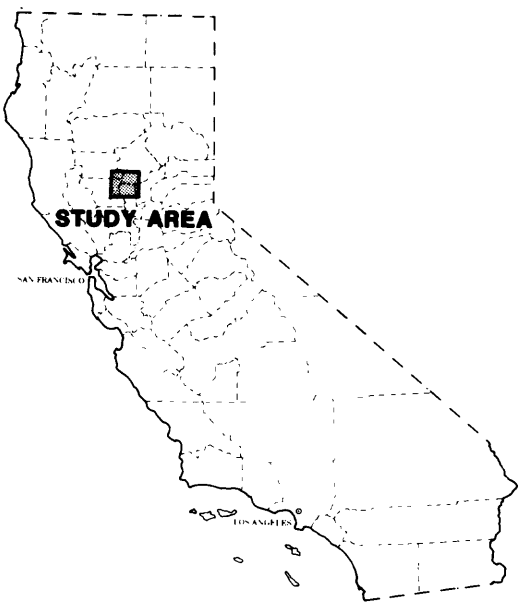
GEOHYDROLOGIC INVESTIGATION OF THE SACRAMENTO VALLEY AREA

Number: *CA461*

Cooperating Agency: *California Department of Water Resources*

Project Chief: *James W. Borchers*

Period fo Project: *October 1985 to September 1991*



Problem: Ground-water-level declines of more than 60 feet, land subsidence of more than 4 feet, and the potential for upward migration of deeper saline water have prompted the California Department of Water Resources and the U.S. Geological Survey to cooperatively investigate the geohydrology of the Sacramento Valley and the Redding Basin. Previous studies have revealed difficulties in characterization of aquifer properties, quantification of stream-aquifer interaction, and estimation of ground-water pumpage.

Objectives: (1) Describe and analyze the ground-water flow system in the Sacramento Valley and the Redding Basin to aid the decisionmaking process of water-resource managers; (2) quantify the hydrologic and geologic characteristics of the ground-water flow system, and the relation between streamflow and the system, and (3) create a Geographic-Information System (GIS) controlled data base that will be easily accessible for future project work in the Sacramento Valley and the Redding Basin.

Approach: A GIS controlled data base will be created in order to manage data compiled from drillers'/electric logs, geologic maps, soil surveys, water-use records, and existing topographic, geologic, and hydrologic data. Stream-aquifer interactions will be quantified within selected streams reaches by analysis of ground-water level, streamflow, and water-quality data. Alluvial texture distribution will be defined by analysis of drillers' logs and borehole electric logs. Aquifer characteristics will be estimated from the alluvial texture distribution. The GIS data base will be used to construct a ground-water flow model that will indicate weaknesses in the data base, and the data base will be expanded and improved as needed.

Progress: The locations of 1,218 test wells from which electric logs have been collected were digitized from 7.5 minute topographic maps. A digital data base containing test-well construction and location information was completed. Digital data files compiled during the Central Valley Aquifer Project (CVAP) were retrieved from the Amdahl computer in Reston, Virginia. GIS coverages were created from data used to construct CVAP's ground-water flow model. These coverages include the model grid, annual recharge and discharge data for 529 nodes for the years 1961-77, and hydraulic properties and geometry of the four aquifer layers. A GIS data dictionary was constructed for the CVAP model coverages. A study of stream/aquifer interaction was begun in the Cottonwood Creek drainage basin.

Plans for Next Year: The area between Putah and Cache Creeks, Yolo County, will serve as the test area for analysis of the distribution of alluvial texture using data compiled from water-well E-logs. This analysis will be compared to an independent analysis of alluvial texture data derived from geologic logs submitted to the California Department of Water Resources by water-well drilling contractors; the comparison will indicate the feasibility of using drillers' logs for a description of alluvial texture in areas where no E-logs are available. An analysis of stream/aquifer interaction in the Cottonwood Creek basin will be completed. Digital files of hydrography, transportation, and elevation data will be acquired from the National Mapping Division. These files will be converted to GIS coverages of the Sacramento Valley and the Redding Basin.

Reports: None

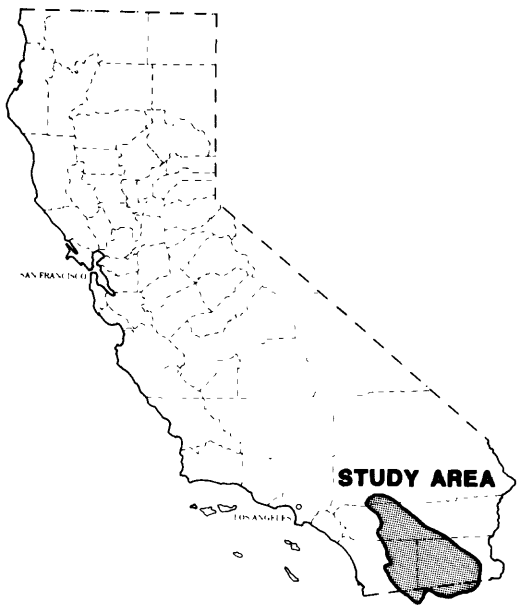
IRRIGATION DRAINAGE, SALTON SEA AREA

Number: *CA462*

Cooperating Agency: *U.S. Department of the Interior, Fish and Wildlife Service and Bureau of Reclamation*

Project Chief: *James G. Setmire*

Period of Project: *May 1986 to September 1987*



Problem: The Department of Interior began this study in the Salton Sea area in response to toxics problems related to irrigation drainage at Kesterson National Wildlife Refuge. Preliminary data indicate the possibility of toxics problems in the Salton Sea area, including the Salton Sea National Wildlife Refuge.

Objective: Obtain reconnaissance-level chemical data from water, bottom sediments, and biota in order to determine whether additional detailed study and remedial action is needed.

Approach: Water from 12 sites and bottom sediment from 16 sites in the Salton Sea area will be collected and analyzed for toxic trace elements and commonly used pesticides. Concurrently, the U.S. Fish and Wildlife Service will collect fish, birds, invertebrates, and plants for similar analyses. Results will be compared to those obtained at other study sites and to regulatory (or advisory) standards.

Progress: Field-screening results from samples collected in Coachella and Imperial Valleys during August 1986 indicate selenium concentrations in 7 of 12 water samples collected exceed the 10-µg/L (micrograms per liter) standard established by the U.S. Environmental Protection Agency and U.S. Public Health Service for human consumption and for protection of aquatic organisms. Selenium concentrations ranged from 1 (Salton Sea composite) to 300 (tile drain sample No. 6), with a median of 25 µg/L. Selenium in bottom sediments ranged from 0.1 (Whitewater River above Highway 111) to 3.3 (Salton Sea composite), with a median of 0.7 g/kg (gram per kilogram). Although no enforceable standards exist for selenium in bottom material, recommended maximum concentration for protection of aquatic life is 2.0 g/kg. Boron concentrations in water exceeded the 750-µg/L criterion for long-term irrigation of sensitive crops (U.S. Environmental Protection Agency, 1986, Quality criteria for water, 1986: EPA 440/5-86-001, 452 p.). The maximum of 10,999 µg/L was detected in the Salton Sea composite; the minimum was 1,000 µg/L. Manganese concentrations exceeding various criteria were detected during field-screening. Tile drain sample No. 1 had 2,900 µg/L, greater than the 50-µg/L criterion for domestic water supplies. Outlet sites on the New and Alamo Rivers had 10 and >10 µg/L manganese, respectively. Study area maximum concentrations of chromium, nickel, vanadium, and zinc were detected at Whitewater River at outlet to the Salton Sea. Organochlorine residues DDD and DDE were detected in bottom material at concentrations approaching those detected in 1978. Biological data are not available.

Plans for Next Year: A report will be completed. A detailed investigation of irrigation drainage in the Salton Sea area is scheduled for fiscal years 1988 and 1989. The scope of this study will include selenium speciation in delta area sediments, deuterium/hydrogen ratios, tritium dating, and selenium loading.

Reports: None

IRRIGATION DRAINAGE, TULARE LAKE

Number: *CA463*

Cooperating Agency: *U.S. Department of the Interior, Fish and Wildlife Service and Bureau of Reclamation*

Project Chief: *Roy A. Schroeder*

Period of Project: *May 1986 to September 1987*

Problem: The Department of Interior began this study in Tulare Lake basin in response to toxics problems related to irrigation drainage at Kesterson National Wildlife Refuge. Preliminary data indicate the possibility of toxics problems in the Tulare Lake basin, including the Kern National Wildlife Refuge.

Objective: Obtain reconnaissance-level chemical data from water, bottom sediments, and biota in order to determine whether additional detailed study and remedial action is needed.

Approach: Water and bottom sediment will be collected from nine sites in or near Kern National Wildlife Refuge and analyzed for toxic trace elements and commonly used pesticides. Concurrently, the U.S. Fish and Wildlife Service will collect fish, birds, invertebrates, and plants for similar analyses. Results will be compared to those obtained at other study sites and to regulatory (or advisory) standards.

Progress: The U.S. Geological Survey and the U.S. Fish and Wildlife Service received results of all chemical analyses from four evaporation ponds that receive agricultural return flow from subsurface drains, two marshlands on Kern National Wildlife Refuge, a canal and a stream (adjacent to Kern National Wildlife Refuge) that convey mostly fresh water (but may at times contain small quantities of irrigation drainage water), and a background (control) stream on Pixley National Wildlife Refuge. Water, bottom material, and biota were analyzed for pesticides, toxic trace elements (including selenium), and the common alpha-emitting radionuclides. High levels of selenium were found at the ponds but not on the refuges. Observed data indicate biological impacts exist at the ponds.

Plans for Next Year: Colleague review comments from a comprehensive final report will be addressed, and a short summary manuscript, based on an oral presentation at the Selenium IV Conference in Berkeley, California, will be prepared.

Reports:

Schroeder, R.A., Palawski, D.U., and Skorupa, J.P., 1988, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Tulare Lake bed area, southern San Joaquin Valley, California, 1986-87: U.S. Geological Survey Water-Resources Investigations Report 88-4001, 86 p.

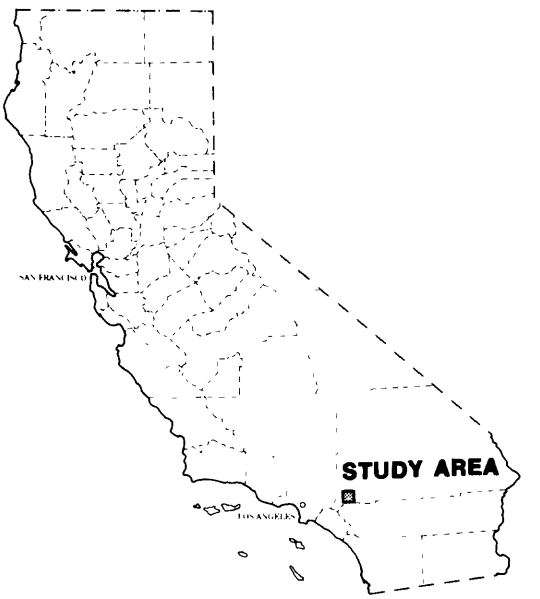
GROUND-WATER QUALITY IN THE SAN BERNARDINO VALLEY

Number: *CA464*

Cooperating Agency: *San Bernardino Valley Municipal Water District*

Project Chief: *Lowell F.W. Duell, Jr.*

Period of Project: *October 1985 to September 1987*



Problem: A basinwide assessment of ground-water quality is needed in order to identify water-quality problems that may affect the use and management of ground water in the Bunker Hill basin in San Bernardino Valley. Current and previous land use had caused increased nitrate-nitrogen concentrations in some areas and localized contamination of municipal wells by trichlorethylene (TCE) and tetrachloroethylene (PCE). Ground-water levels are rising in the former swampland of the basin, and this may hasten or actually cause movement of chemicals now in the unsaturated zone.

Objectives: (1) Identify water-quality conditions affecting the current and future uses of ground water, (2) where possible, identify the effects of current artificial-recharge and pumping practices on ground-water quality in order to allow future basin-management practices to mitigate and avoid water-quality problems; and (3) design a network of observation wells to monitor ground-water quality in suspected areas of contamination.

Approach: Ground-water-quality data will be collected, collated, and reviewed. Water-quality problem areas will be identified. The basin's historic and existing land use will be categorized. An initial network will be designed and sampled. Water-quality data by land-use category will be statistically analyzed. Monitoring network and sampling frequency will be redesigned, and location and construction for new wells will be suggested in areas of contamination.

Progress: A comprehensive interpretive report has been prepared and submitted for colleague review. For the study, 47 wells were sampled in the Bunker Hill basin of San Bernardino Valley for analyses of major inorganic ions, nitrogen species, and volatile organic priority pollutants. Data were supplemented with additional analyses of nitrate, tetrachloroethylene, and trichloroethylene made by other agencies. The quality of ground water is generally good; however, concentrations exceeded California public drinking-water standards for fluoride, nitrate, tetrachloroethylene, and trichloroethylene in some wells. Fluoride exceeded the standard of 1.4 mg/L (milligrams per liter) in 5 of 47 wells; the highest value measured was 3 mg/L. Generally, high concentrations seem to be near faults in the basin. Nitrate (as nitrogen) concentrations exceeded the standard of 10 mg/L in 32 of 167 wells and were generally higher in shallow wells than in deep wells. No basinwide change in nitrate concentrations since 1955 was detected. A total of 24

volatile organic priority pollutants were detected. Tetrachloroethylene and trichloroethylene, commonly used as industrial solvents and degreasers, were among the more frequently found contaminants. The concentration of tetrachloroethylene exceeded California's interim standard of 4 micrograms per liter (µg/L) in 36 of 134 wells; the highest measured concentration was 600 µg/L. The concentration of trichloroethylene exceeded the interim standard of 5 µg/L in 49 of 138 wells; the highest measured concentration was 86 µg/L. These contaminants were found, in both deep and shallow wells, throughout the basin, but the contaminants were found more frequently in wells in central Redlands and in northwest San Bernardino. To monitor changes in ground-water quality in the basin, a network of 11 wells to be sampled twice yearly is proposed.

Plans for Next Year: The reviews, approval process, and printing of the interpretive report will be completed. Monitoring of water quality in the proposed network will be conducted under project CA003.

Reports: None

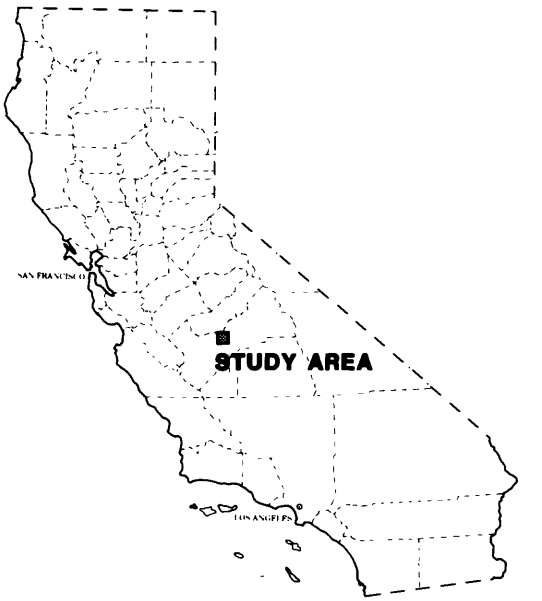
EFFECTS OF URBAN STORMWATER RUNOFF ON THE SAN JOAQUIN RIVER NEAR FRESNO

Number: *CA465*

Cooperating Agency: *Fresno Metropolitan Flood Control District*

Project Chief: *Joel R. Guay*

Period of Project: *October 1986 to September 1989*



Problem: Although the Fresno Metropolitan Flood Control District (FMFCD) routes most urban stormwater runoff into retention/recharge basins, 5 to 10 percent of stormwater is discharged directly into the San Joaquin River from some agricultural and low- to medium-density residential areas. Runoff from these areas could affect agricultural irrigation, fishery and wildlife habitat, and various recreational activities near the San Joaquin-Sacramento River Delta. The final report of the 1981-84 Fresno National Urban Runoff Project by FMFCD recommended the effects of urban runoff into the San Joaquin River be evaluated.

Objective: To determine the effects of urban stormwater runoff on the quality of the San Joaquin River near three urban stormwater outfalls in Fresno, California.

Approach: Probability distributions will be assessed for storm event loads, river flows, and river loads using regression analyses, log-Pearson distributions, and river water-quality data. Results will be used to compare various combinations of storm event loads and San Joaquin River loads. A Monte Carlo simulation will generate random monthly river concentrations by simple mixing of synthesized runoff loads and background river loads. A probability distribution, by month, of river concentrations can be compared with measured background river concentrations to evaluate the effect of urban runoff on the quality of the San Joaquin River near Fresno.

Progress: Tasks completed include general planning and retrieval of water quality and discharge data for San Joaquin River below Kerckhoff Powerhouse, near Prather, for Friant-Kern Canal at Friant, for Millerton Lake at Friant (three sites), and for San Joaquin River below Friant. Whole water samples were collected on the San Joaquin River near the Highway 41 bridge, and just upstream from the outlet for basin DG near the San Joaquin Country Club. Bottom samples were collected at the Highway 41 bridge site and approximately 150 feet downstream from the outlet for basin DF. Discharge measurements were taken at the Highway 41 site and at the most downstream whole-water collection site.

Plans for Next Year: Three additional whole-water samples will be collected during the rainy season to determine background constituent loading of the San Joaquin River. Immediately after the rainy season the sampling schedule used in 1987 will be repeated. Work will begin on retrieving the necessary input data for the four models and calibrating and verifying them.

Reports: None

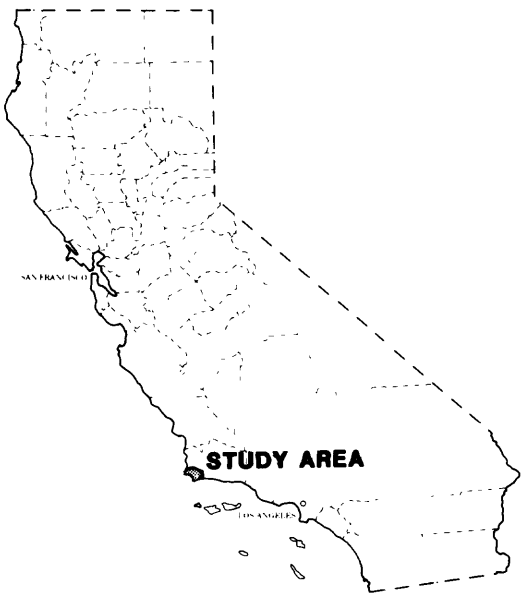
EVALUATION OF GROUND-WATER CONTAMINATION FROM NONPOINT SOURCES USING SOLUTE-TRANSPORT TECHNIQUES

Number: *CA466*

Cooperating Agency: *Santa Ynez River Water Conservation District*

Project Chief: *Peter Martin*

Period of Project: *October 1986 to September 1989*



Problem: Several studies have documented the deterioration of ground-water quality in the Lompoc subarea of the Santa Ynez River basin. These studies indicate that recharge of irrigation water is probably the principal cause of the observed deterioration. Ground water in the Lompoc subarea, especially in the Lompoc plain, is only marginally acceptable for most uses. Dissolved-solids concentrations currently exceed 2,000 milligrams per liter in several areas of the basin. If the ground-water quality continues to deteriorate, the ground water will be unusable for almost all uses without some treatment.

Objectives: (1) Define the geohydrologic framework of the Lompoc subarea of the Santa Ynez River basin. (2) Define, quantitatively where possible, the effects of irrigation on the quality of ground water. (3) Apply and test the usefulness of a cross-sectional solute-transport modeling technique as a means of verifying the regionalization of site-specific hydraulic and chemical information and to simulate and predict the transport of contaminants from irrigation.

Approach: Existing hydrologic data will be used to define the geohydrologic and geochemical framework of the study area. Observation wells and suction cup lysimeters will be installed on two study plots typical of the agricultural and geohydrologic conditions in the areas. Water levels will be monitored monthly, and the wells will be sampled on a bimonthly schedule. A three-dimensional finite-difference ground-water flow model will be developed to simulate flow through unconsolidated deposits that fill the basin. The vertical movement of solutes will be simulated using a two-dimensional solute-transport cross-sectional model.

Progress: Fourteen observation wells and three suction cup lysimeters were installed at four sites on the Lompoc plain during March 1987. Thirteen wells and two lysimeters were sampled on a bimonthly schedule from March through September 1987 for major ion and nutrient analyses. Limited trace-metal and pesticide samples also were collected. Throughout the Lompoc plain where data were lacking, additional private wells were sampled for specific-conductance measurements and analyses of major ions and nutrients. Water-level measurements also were made on all 13 observation wells during each sampling period (March, May, June, and September). Continuous water-level recorders were installed in wells at two study plots on the Lompoc plain, and additional water-level measurements were made in the Lompoc upland area. Geologic

sections through parts of the Lompoc plain and upland areas were constructed. Geologic sections and water-quality data were used to delineate the main water-bearing zones to be modeled. The grid and boundary conditions for the computer flow model, initial parameter values, and a water budget are being developed. New and existing data are being collected, collated, and interpreted.

Plans for Next Year: Bimonthy water-quality samples and water-level measurements will continue to be collected from U.S. Geological Survey observation wells and lysimeters. Approximately six additional observation wells will be installed on the Lompoc plain. Previously collected data will be used as input into a three-dimensional, finite-difference, ground-water flow model which will be calibrated for both steady-state and transient conditions.

Reports: None

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New reports are announced monthly in "New Publications of the Geological Survey," subscriptions to which are available upon request from the U.S. Geological Survey, 582 National Center, Reston, VA 22092.

Water-Data Program:--Water-data stations at selected locations throughout the Nation are used by the Geological Survey to obtain records on stream discharge (flow) and stage (height), reservoir and lake storage, ground-water levels, well and spring discharge, and the quality of surface and ground water. These data provide a continuing record of the quantity and quality of the Nation's surface- and ground-water resources, and thus provide the hydrologic information needed by Federal, State, and local agencies and the private sector for the development and management of land and water resources. All data collected are stored in the Survey's National Water Data Storage and Retrieval System (WATSTORE) and also are published by water year for each State in a publications series entitled "U.S. Geological Survey Water-Data Report." Information about the Water-Data Program can be obtained from the California District Chief.

NAWDEX:--The National Water Data Exchange was established to assist users of water data to identify, locate, and acquire needed data. It provides a nationwide service for indexing and describing the characteristics of data available from the entire spectrum of data-collection activities throughout the Federal and non-Federal water-data community.

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