ACTIVITIES OF THE WATER RESOURCES DIVISION, CALIFORNIA DISTRICT, IN THE 1986 FISCAL YEAR

Compiled by Carol A. Griner and Peter W. Anttila

U.S. GEOLOGICAL SURVEY

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1987

DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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MESSAGE FROM THE DISTRICT CHIEF

The U.S. Geological Survey has been studying water resources in the State of California since 1889. In the early years, many studies were related to availability of water for agriculture. Historical water-supply papers by pioneer hydrologists, such as Mendenhall (1908) and Bryan (1923) did much to explain where and how water occurred and who was using it in California. During World War II and into the 1950's, agricultural and industrial expansion throughout the State gave great impetus to the need for more knowledge about ground-water availability and aquifer properties. During the 1960's, in cooperation with the California Department of Water Resources and many local agencies, the Survey made virtually hundreds of general reconnaissance studies sometimes called "County Studies," and published about 500 reports. In the 1970's, with the completion of most of the California Water Project and the U.S. Bureau of Reclamation's Central Valley Project, a need grew for more definitive quantitative information so that conjunctive use of ground and surface water could be implemented efficiently. Again, in cooperation with State and local agencies, the Survey pioneered simulation modeling of aquifers for large areas of the State. With advances in chemical technology for agricultural and industrial uses, water-quality problems loom as the hydrologic focus of the 1980's.

Although the focus of our efforts has changed with time, several elements of these efforts have not--systematic data collection and analysis, the adherence to the essence of science, and the maintenance of an unbiased, nonregulatory stance in the midst of highly controversial issues. The justification for this stance is simple--the need exists, and will continue to exist, for a nonaligned entity, such as the U.S. Geological Survey, to produce scientifically credible information for the water-resource community in the State of California.

Hydrologic data are the cornerstone of the U.S. Geological Survey's Water Resources Division. Our charge to collect systematic data on an ongoing basis will not change; however, the tools that we use have made significant advances. Data can now be provided in a more timely fashion in a variety of forms: A nationwide link of computers now allows instant communication and ready access to data files for rapid dissemination, satellite telemetry allows data transmission from remote locations to our district computer for real-time processing and reporting, and new automated data-processing systems allow a degree of data manipulation and examination previously not realized.

Selenium toxicity in the western San Joaquin Valley, ground-water export from the Owens Valley coupled with vegetation survivability studies, and the pending water-quality standards/water-rights hearing for the San Francisco Bay/Delta are just a few of the controversial and important efforts with which we are involved. All these studies are providing valuable data and methods development that contribute significantly to the science of hydrology.

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

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ILLUSTRATIONS

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."

U.S.Geological Survey
Water Resources Division
CALIFORNIA DISTRICT

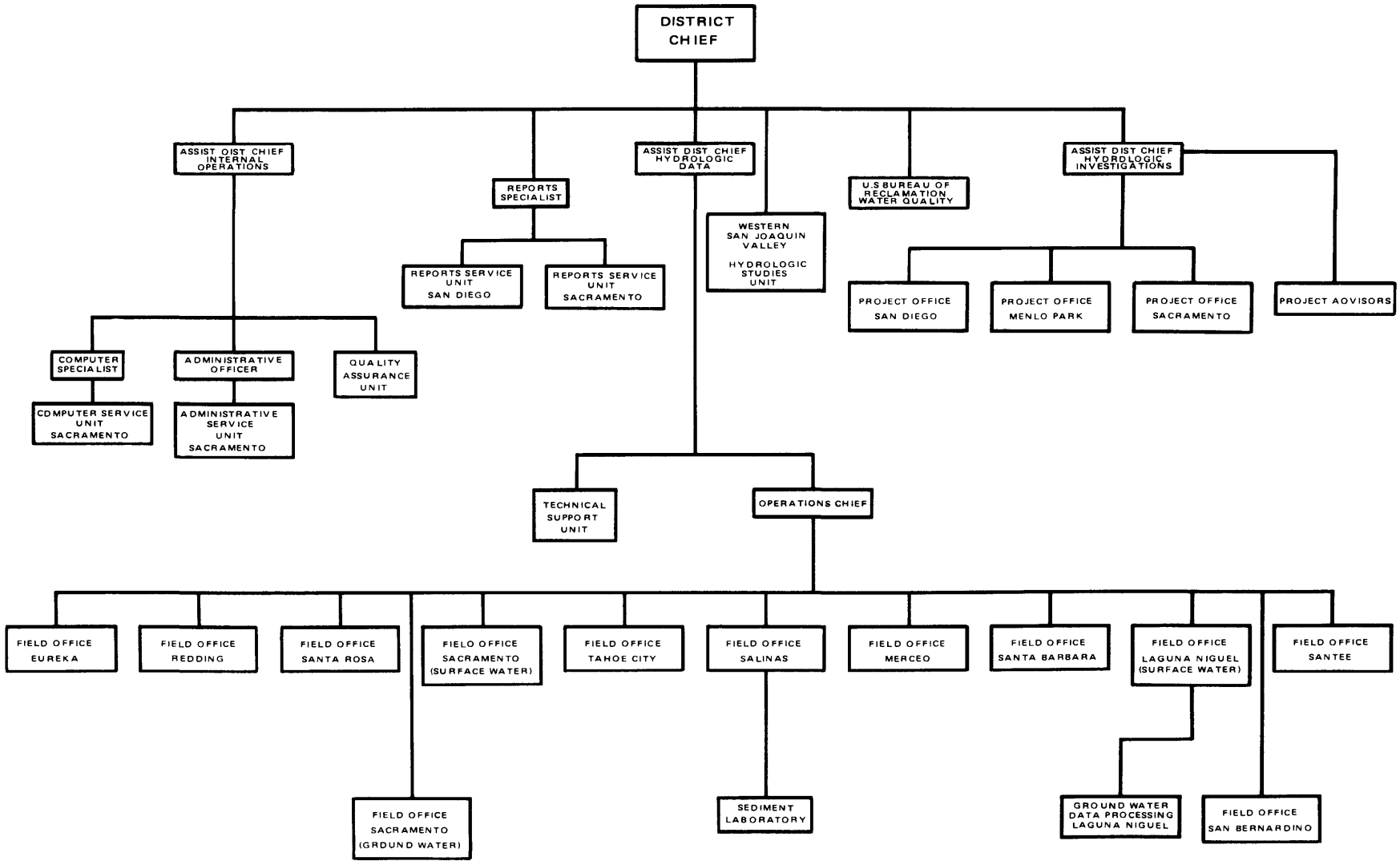


FIGURE 1. Organization chart for the California District, 1986.

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-resource 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 13 field offices and 3 project offices. These offices and supporting units of the District are shown in the organization chart (fig. 1).

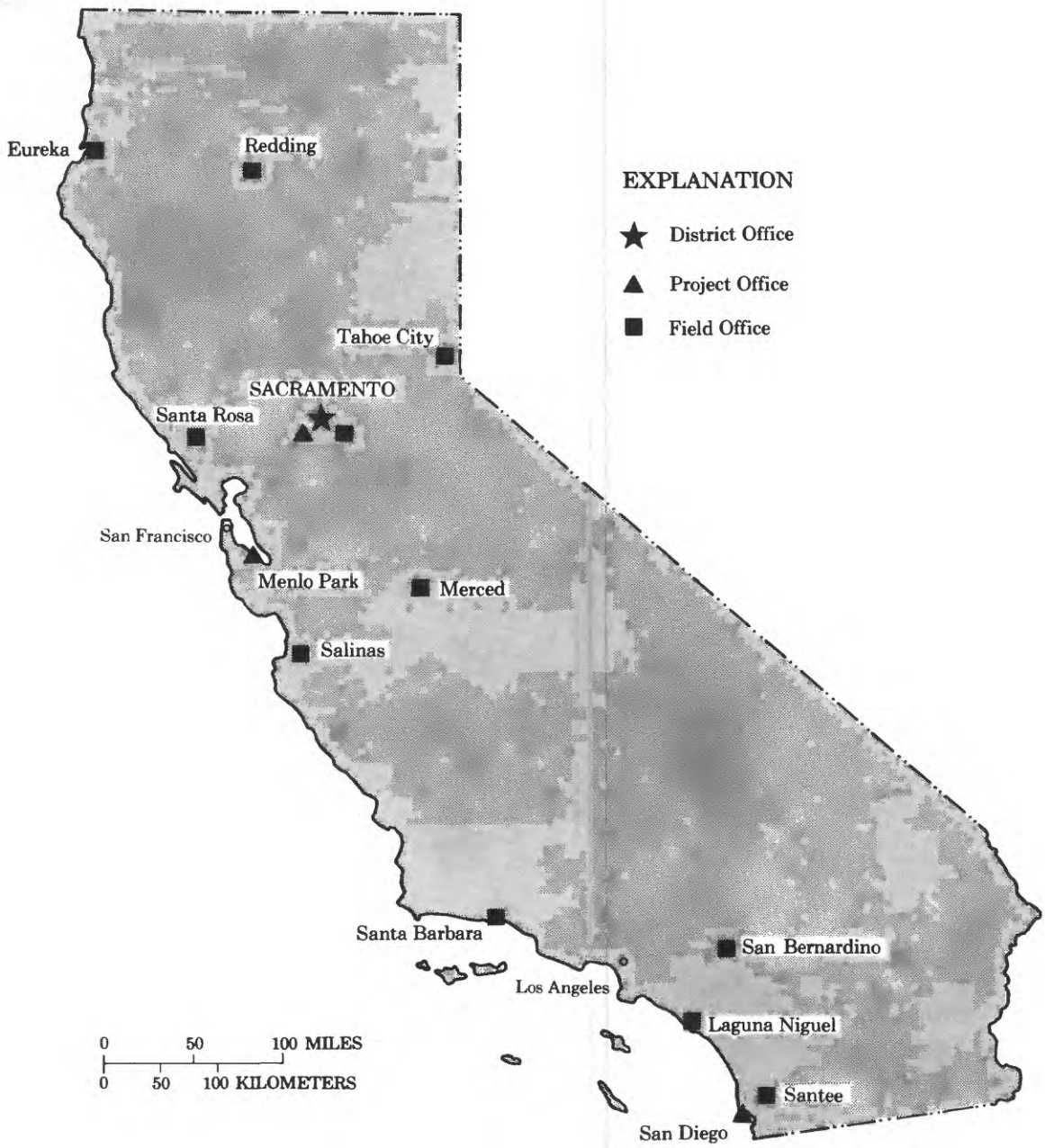


FIGURE 2. Location of offices in the California District.

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 MS 496	(415) 329-4419 (415) 354-3370	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		
Eureka	(707) 443-2028	1105 6th St. Eureka, CA 95501
Laguna Niguel	(714) 643-4232	24000 Avila Rd., 5th Floor Laguna Niguel, CA 92677
Merced	(209) 383-9067	1547 Yosemite Parkway Merced, CA 95340
Redding	(916) 246-5282	640 Twin View Blvd. 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
San Bernardino	(714) 383-5617	1350 South "E" St. San Bernardino, CA 92410
Santa Barbara	(805) 962-8114	126 West Figueroa St. Santa Barbara, CA 93101
Santa Rosa	(707) 525-4265	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 1985 and 1986, 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.]

Figure 4 shows the percentage of investigations, by funding, for fiscal year 1986 in each of the broad categories of hydrologic-data collection, areal appraisals and interpretive studies, and research projects.

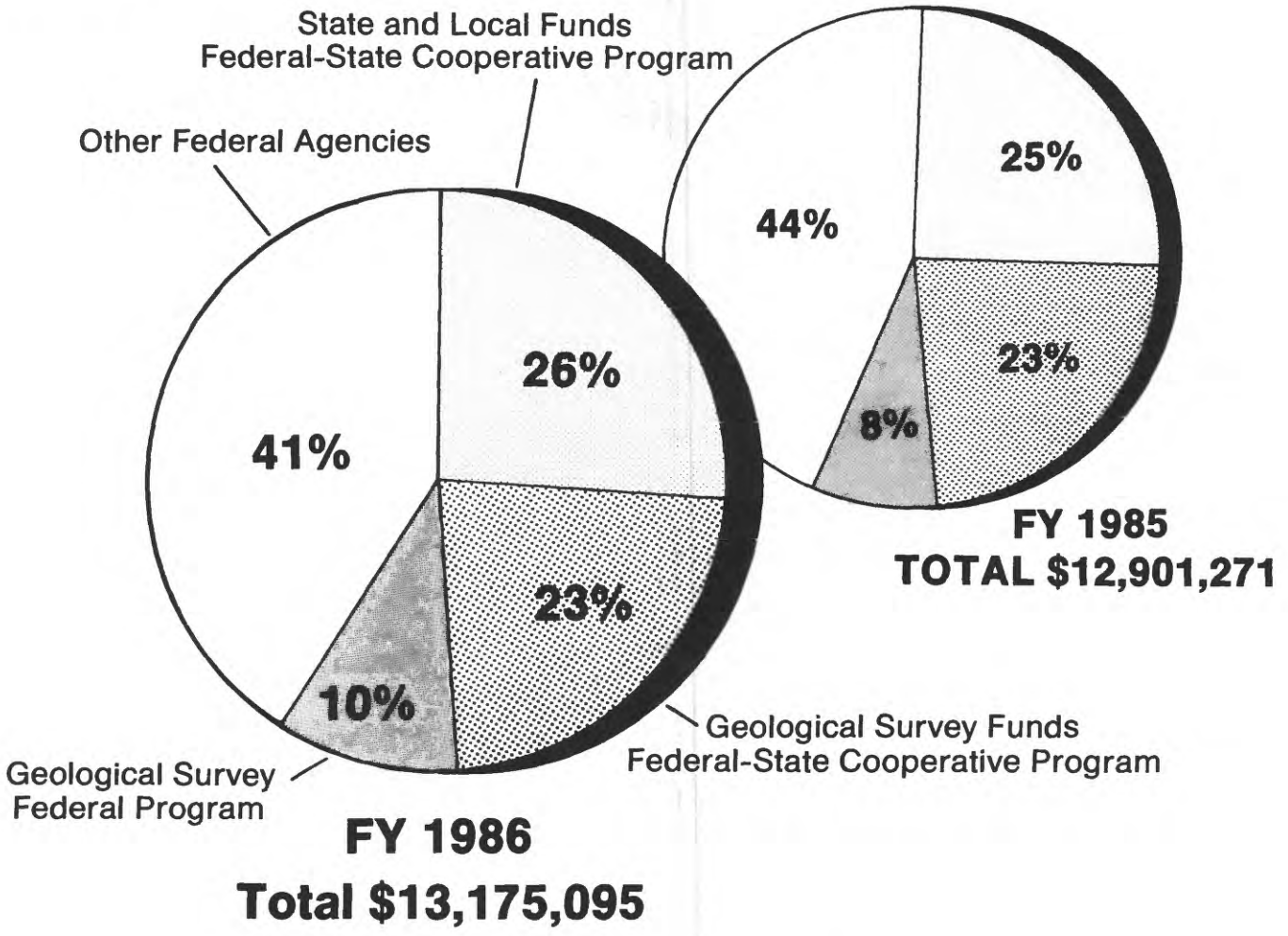


FIGURE 3. — Sources of California District funds in fiscal years 1985 and 1986.

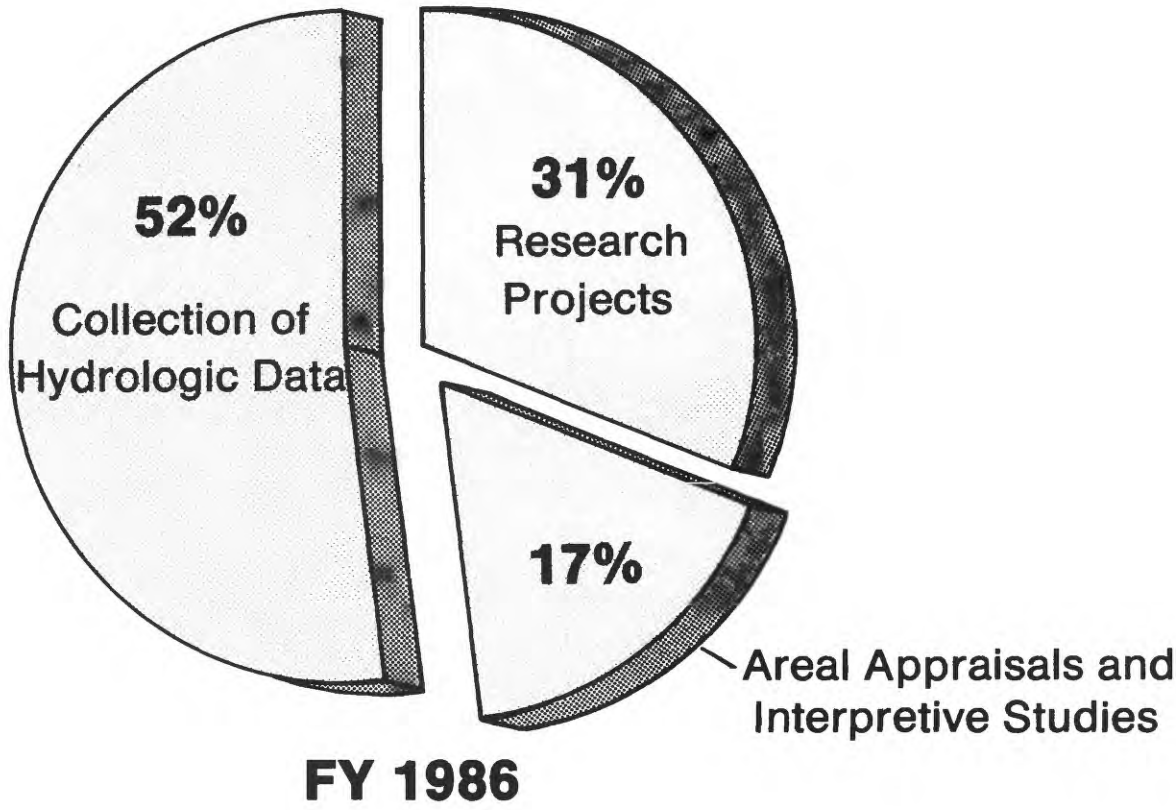


FIGURE 4. — Categories of investigations in the California District, by funding, fiscal year 1986.

In fiscal year 1986, 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 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
Water Resources Center; University of California, Davis

Local Agencies

Alameda County Flood Control and Water Conservation District
Alameda County Flood Control and Water Conservation District, Zone 7
Alameda County Water District
Antelope Valley-East Kern Water Agency
Carpinteria County Water District
Casitas Municipal Water District
Coachella Valley Water District

Local Agencies--Continued

Contra Costa County
Crestline-Lake Arrowhead Water Agency
Desert Water Agency
East Bay Municipal Utilities District
East San Bernardino County Water District
El Dorado County
Fresno Metropolitan Flood Control District
Georgetown Divide Public Utility District
Goleta County Water District
Humboldt Bay Water District
Imperial County Department of Public Works
Imperial Irrigation District
Indian Wells Valley Water District
Inyo County, Department of Water
Jurupa Community Service District
Kern County Water Agency
Kings River Conservation District
Los Angeles, city of, Department of Water and Power
Madera Irrigation District
Marin County Department of Public Works
Marin Municipal Water District
Merced Irrigation District
Merced, city of
Modoc County Department of Public Works
Mojave Water Agency
Montecito County Water District
Monterey County Flood Control and Water Conservation District
Nevada Irrigation District
Oakdale-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
Paradise Irrigation District
Placer County Water Agency
Rainbow Municipal Water District
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 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

Local Agencies--Continued

Santa Barbara County Water Agency
Santa Barbara, city of
Santa Clara Valley Water District
Santa Cruz County Flood Control and Water Conservation District
Santa Maria Valley Water Conservation District
Scotts Valley County Water District
Shupe Energy Development Company
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
Turlock Irrigation District
United Water Conservation District
University of California, Davis
Ventura County Flood Control District
Western Municipal 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
- Soil Conservation 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
- Naval Weapons Station, Seal Beach

WATER CONDITIONS

In the 1986 water year (October 1, 1985, to September 30, 1986), precipitation and river discharge were above the long-term averages throughout California (see figs. 5 and 6 for annual averages). Precipitation was 104 percent of the 1951-80 averages in Eureka, 142 percent in Santa Rosa, and 165 percent in Los Angeles. Discharge at the Smith River near Crescent City gaging station was 109 percent of the 1951-80 mean, whereas discharge at the gaging stations Napa River near St. Helena was 177 percent and Arroyo Seco near Pasadena was 169 percent.

The major climatic and hydrologic events of the 1986 water year were unquestionably the storms and floods which occurred from February 11 to 22 in northern California. Rain and snow fell in many areas of northern California for 12 consecutive days as a series of storms came in from the southwest Pacific. The principal track of the storms passed northeasterly over Santa Rosa, Sacramento, and Yuba City into the Feather, Yuba, and American River basins of the Sierra Nevada. The highest total rainfall for the period was 49.60 inches, recorded at Bucks Lake in the Feather River basin. Runoff was generally well controlled by careful reservoir management and releases and by operation of bypass weirs and channels along the Sacramento River system. Some serious levee failures did occur, however, contributing to 13 deaths, 67 injuries, and 50,000 evacuations. Damages were estimated to be $378 million to private and public property. Peaks of record were recorded at several gaging stations with long-term records and approached the 100-year recurrence interval in some areas.

As a result of the heavy runoff from the February storms, yearend water levels in all major California reservoirs were generally at or above the long-term average. Shasta Lake, the largest reservoir in the State, held 99 percent of the median yearend contents on September 30. Lake Oroville, the second largest reservoir, held 102 percent; and Pine Flat Reservoir, in the Tulare Lake basin, held 145 percent of the average yearend contents.

Water-quality degradation related to irrigation-return water continued to be a major concern in 1986. At the request of the U.S. Department of Interior, reconnaissance-level investigations were started in the Tulare Lake basin and Salton Sea area (Imperial and Coachella Valleys). Investigations in the western San Joaquin Valley continue as a result of the selenium problem in the Kesterson National Wildlife Refuge. As of June 1986, all irrigation-return water was eliminated from the San Luis Drain and the Kesterson National Wildlife Refuge.

Ground-water contamination may be the most serious statewide water-quality problem. Sampling of over 50 percent of large public-supply systems (200 or more connections) as mandated by California Health and Welfare Agency, and California Department of Health Services Assembly Bill 1803 (1986, p. 132) is complete. Of 2,947 wells sampled, 538 tested positive for organic chemicals, excluding the pesticide dibromochloropropane (DBCP). In other sampling through 1984, DBCP was found in 2,522 wells, mainly in the San Joaquin Valley (Cohen and Bowes, 1984, p. 71). Saltwater intrusion continues to threaten coastal basins in the Monterey Bay, Morro Bay, Ventura, and Santa Barbara areas.

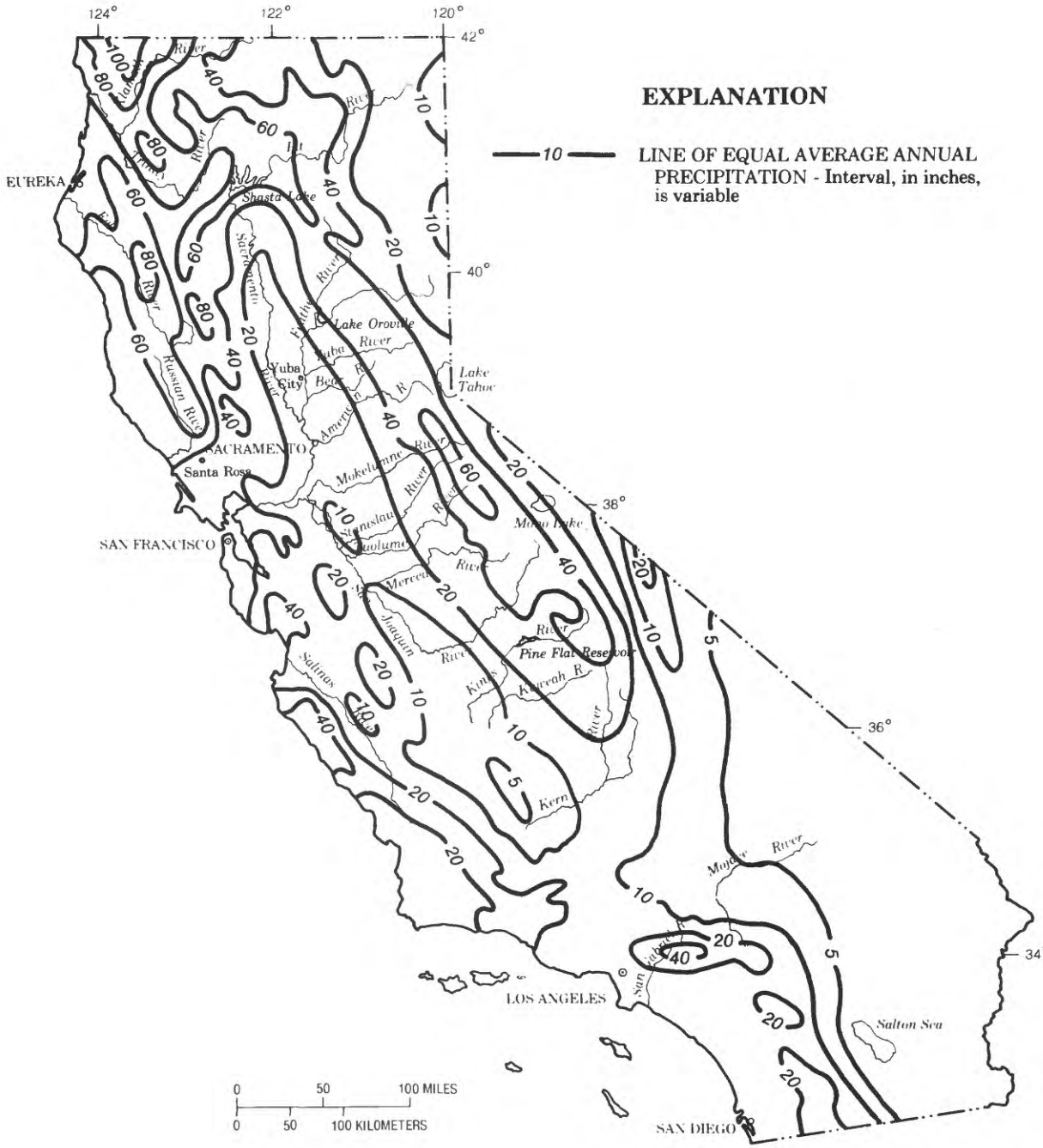


FIGURE 5. Average annual precipitation, 1951-80.

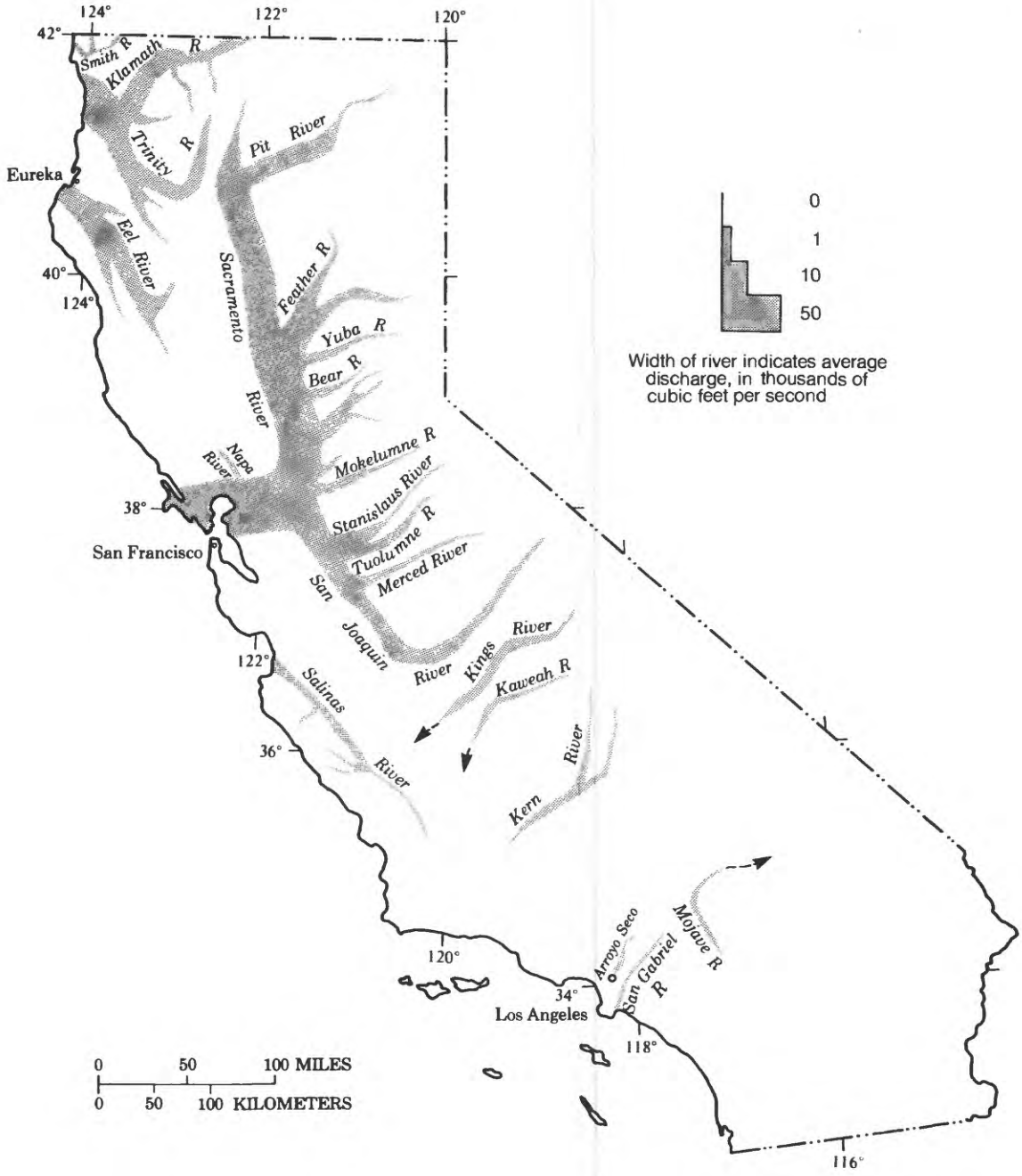


FIGURE 6. Average annual discharge of principal rivers in California, 1951-80.

An indication of the magnitude of the ground-water concern is the number of agencies actively involved in sampling and attempting to define the extent and severity of contamination. The State Water Resources Control Board estimates, on the basis of a partial inventory, 5 Federal, 15 State, 45 county, 350 city, and 1,200 special district water agencies are involved in ground-water quality sampling and studies.

REFERENCES CITED

Bryan, Kirk, 1923, Geology and ground-water resources of Sacramento Valley, California: U.S. Geological Survey Water-Supply Paper 495, 285 p.

California Health and Welfare Agency, and Department of Health Services, 1986, Organic chemical contamination of large public water systems in California: California Assembly Bill 1803, p. 132.

Cohen, D.B., and Bowes, G.W., 1984, Water quality and pesticides: A California risk assessment program: State Water Resources Control Board, Toxic Substances Control Program, Sacramento, California, Special Projects Report No. 84-6SP, v. 1, p. 71.

Mendenhall, W.C., 1908, Ground water and irrigation enterprises in the Foothill Belt, southern California: U.S. Geological Survey Water-Supply Paper 219, 180 p.

page 15 follows

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 52 percent of the freshwater withdrawals in California--more than 23 billion gallons per day in 1980. About 58 percent of the population, 14 million people, use surface water for domestic supplies. 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.

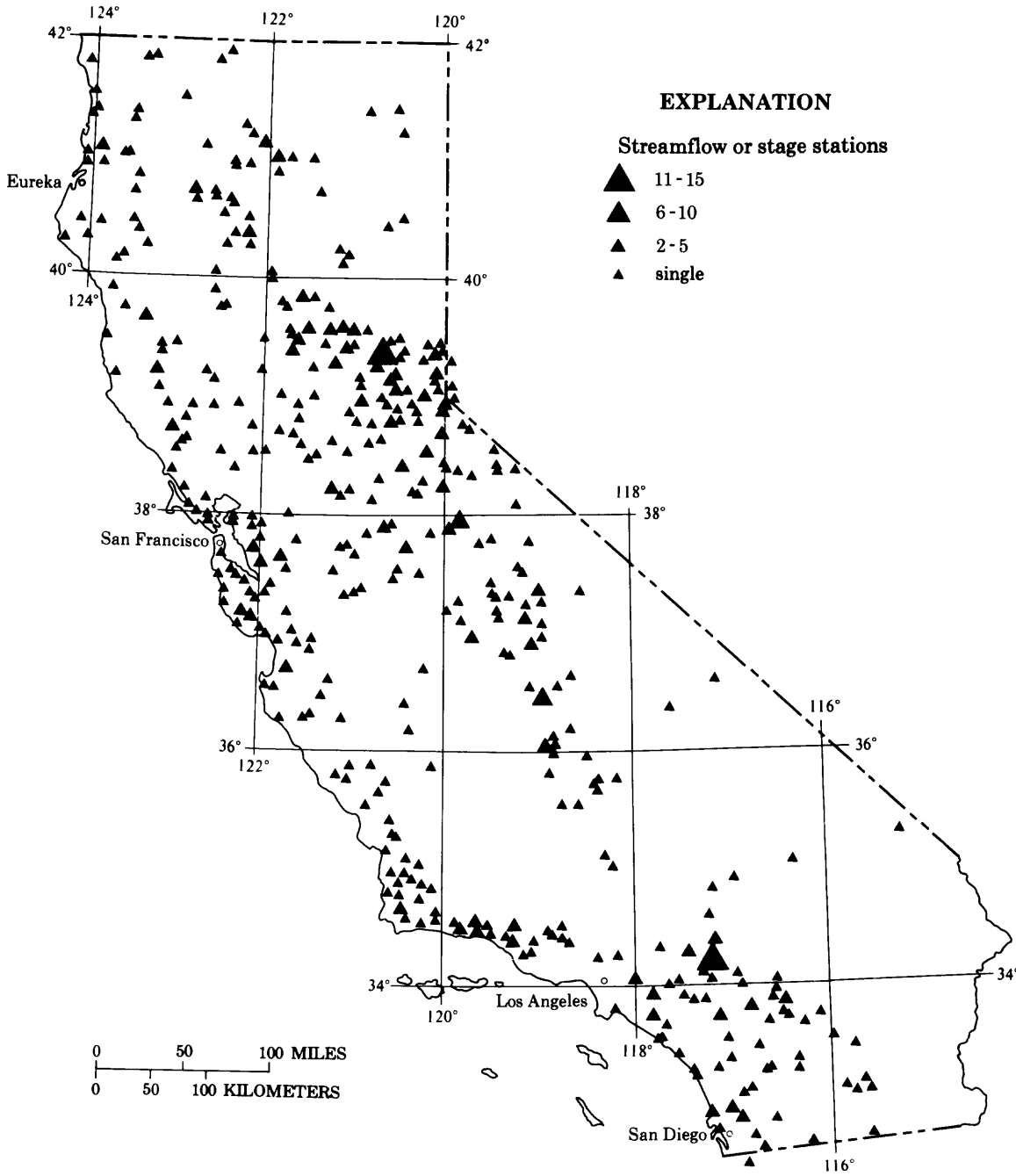
Objectives: Collect and publish surface-water data to meet the needs for (1) assessing quantity and distribution of surface-water resources; (2) operating reservoirs for power, flood control, and irrigation; (3) flow forecasting; (4) monitoring of flow for instream use requirements; (5) determining discharge to support water-quality sampling and assessment programs; (6) determining safe releases of treated wastewater 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 "Techniques of Water Resources Investigations of the United States Geological Survey." Partial-record data collection will be used instead of continuous-record data collection where it serves the required purpose.

Progress: Surface-water data for 478 continuous streamflow stations were collected and compiled for publication. Records for 124 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 47 records of reservoir contents, and 78 additional reservoir records provided by cooperators were reviewed. Data were collected and compiled for publication of 39 partial record sites providing peak flow, low flow, seasonal flow, limited range of discharge or stage information. Unpublished data for an additional 52 partial-record sites were collected for contemplated future hydrologic studies, and 166 unpublished records provided by FERC licensees were reviewed.

Plans for Next Year: Statewide data collection and review will continue. Installation of 16 satellite data-collection platforms is planned for real-time transmission of streamflow information from selected remote stations. Eight stations are presently equipped with satellite-relay data in transmitters installed by the U.S. Geological Survey.

Reports:
Water resources data for California, water year 1984: U.S. Geological Survey Water-Data Report CA-84-1 to CA-84-4.



Locations of streamflow-measuring stations.

GROUND-WATER STATIONS

Number: CA002

Project Chief: Charles E. Lamb

Location: Statewide (See accompanying map)

Period of Project: Continuing

Problem: Ground water accounts for about 48 percent of freshwater withdrawals in California--about 21 billion gallons per day (1980). Nearly 10 million people are served by ground-water supplies. Significantly, 18 billion gallons per day were withdrawn for irrigation (1980). The distribution of ground water is highly variable, related to geology, natural, and manmade stresses. Monitoring of ground-water levels is essential to the management and development of the resource.

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

Approach: Water-level data on varying frequencies, 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.

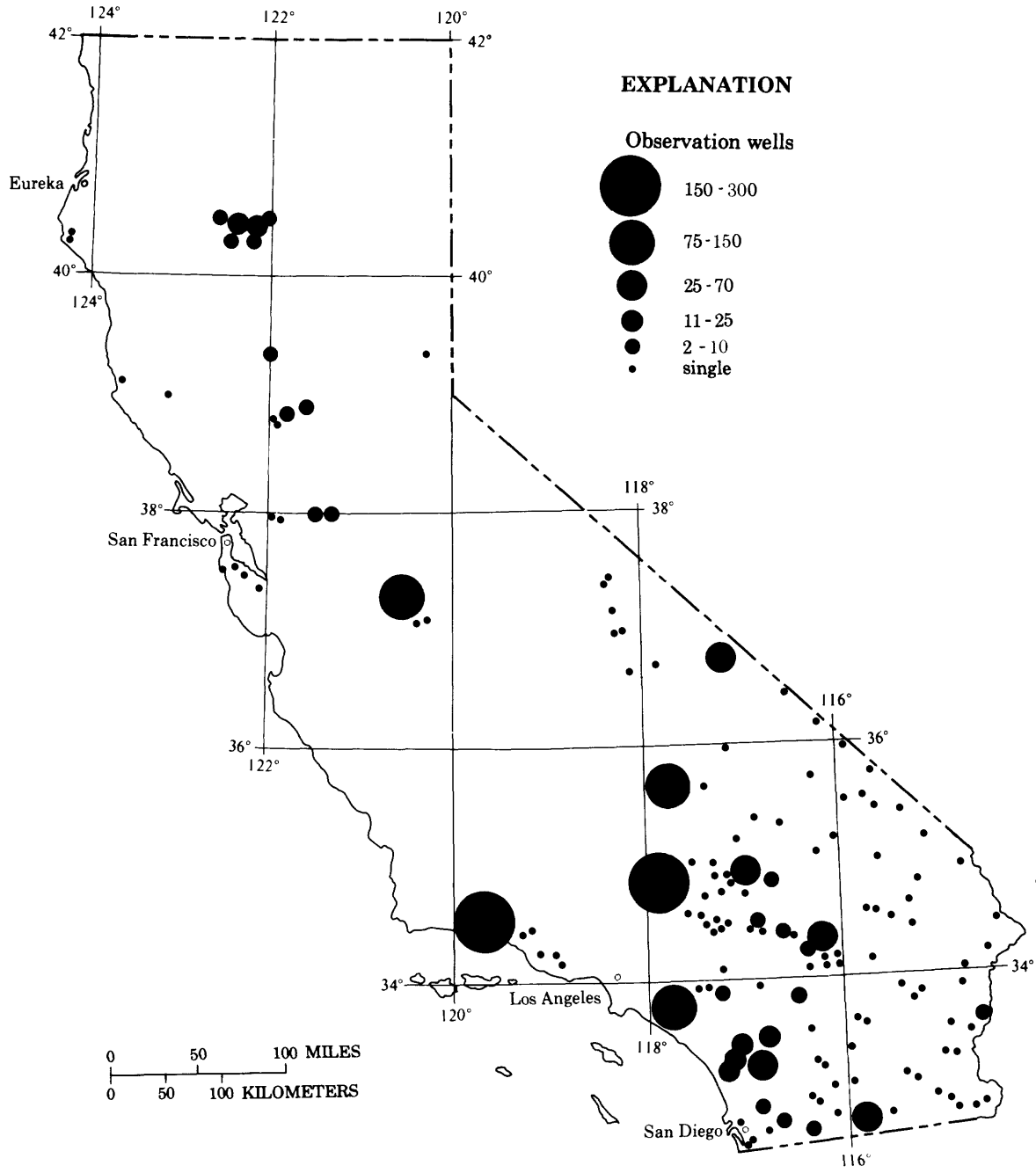
Progress: Collection and compilation of ground-water level data continued at 1,035 long-term sites and at 20 continuous recorder wells. Data for water year 1985 will be published in a separate volume of the annual data report.

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:

Johnson, K.L., and Pierce, M.J., 1986, Ground-water and surface-water level data at Rindge Tract on the Stockton deep water ship channel, San Joaquin County, California, 1983-84: U.S. Geological Survey Open-File Report 85-573, 1 sheet.

Water resources data for California, water year 1984: U.S. Geological Survey Water-Data Report CA-84-1 to CA-84-4.



Locations of selected observation wells.

WATER-QUALITY STATIONS

Number: CA003

Location: Statewide (See accompanying map. Also see map of selected observation wells, page 19)

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 delineated 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 a multitude of sites located throughout California. Water-quality samples were collected bimonthly at 12 and quarterly at 8 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 station located in the Los Padres National Forest. In addition to these stations, water-quality data were collected at 44 stream and reservoir sites. Ground-water samples were collected and analyzed for 323 long-term monitoring wells and 90 short-term monitoring wells. Data for water year 1984 were published in the annual report series.

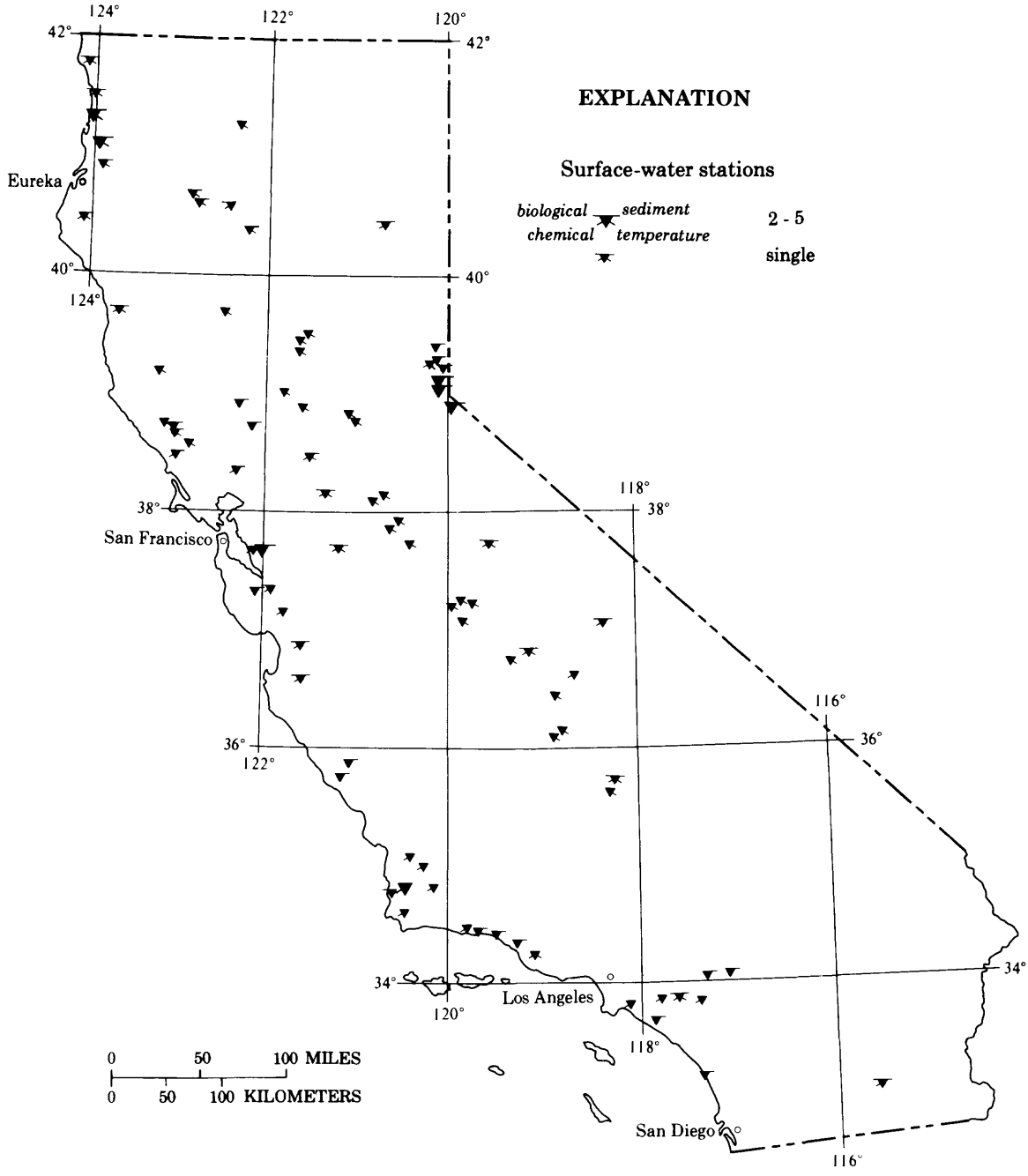
Plans for Next Year: Collection of water-quality data will continue. All activities at Owens River below Tinemaha Reservoir near Big Pine will be discontinued.

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.

Sylvester, M.A., 1986, Water quality and flow of streams in Santa Clara Valley, Santa Clara County, California, 1979-81: U.S. Geological Survey Water-Resources Investigations Report 84-4196, 80 p.

Water resources data for California, water year 1984: U.S. Geological Survey Water-Data Report CA-84-1 to CA-84-4.



Locations of surface-water quality monitoring stations.

SEDIMENT STATIONS

Number: CA004

Location: Statewide (See accompanying map for water-quality stations, page 21)

Project Chief: Larry F. Trujillo

Period of Project: Continuing

Problem: The effects of erosion, movement, and deposition of sediment on the environment 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. These variations require close monitoring of sediment at numerous locations within the State.

Objectives: Provide sediment data that can be used (1) to develop land-management practices that will reduce erosion rates; (2) to evaluate the effects of timber harvesting on fisheries; (3) to determine the effects of debris basins and drop structures on sediment transport; (4) to monitor reservoir capacity losses for flood control and water-supply purposes; (5) to determine the relation of sediment to lake algae growth; (6) to evaluate changes in coastal morphology caused by coastal river sediment; (7) to determine the effects of urbanization on channel morphology; and (8) to 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 "Techniques of Water Resources Investigations of the U.S. Geological Survey." 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 1984 were published in the annual report series. Sediment data collected at 35 daily, 30 periodic, 16 NASQAN, and 2 Hydrologic Benchmark stations during water year 1985 were compiled and reviewed. Daily suspended-sediment samples were collected at 27 daily sediment stations during water year 1986. Bedload samples and/or indirect bedload computations were made at 17 of these sites. Monthly and storm-related suspended-sediment samples were collected at 28 periodic sediment stations. Bedload samples and/or indirect bedload computations were made at 23 of these periodic stations. Suspended-sediment samples were collected on a bimonthly or quarterly basis only at 15 NASQAN and 3 Hydrologic Benchmark stations.

Plans for Next Year: Compilation and review procedures will be completed for all 1986 sediment records. Sediment data at 24 daily, 22 periodic, and 17 NASQAN/Benchmark stations will be collected in water year 1987.

Reports:

Water resources data for California, water year 1984: U.S. Geological Survey Water-Data Report CA-84-1 to CA-84-4.

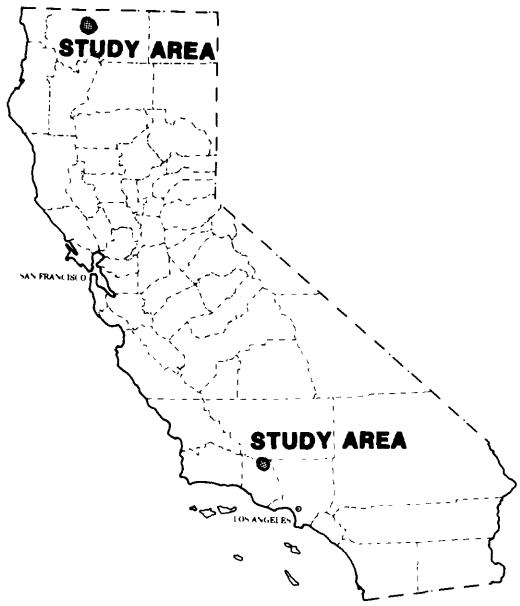
NATIONAL TRENDS NETWORK FOR MONITORING ATMOSPHERIC DEPOSITION

Number: CA005

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

Project Chief: Keith G. Polinoski

Period of Project: Continuing



Problem: Some lakes in the United States are becoming more acidic, fish are no longer found in them, 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, California. 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 in order to be used 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: Water use in each of California's 16 Hydrologic Subregions was determined for inclusion in the report, "The Estimated Use of Water in the United States, 1985." Water use in each of California's 58 counties also was determined for inclusion in the U.S. Geological Survey's 1987 National Water Summary. Progress was made on determining water use in each of the 149 Hydrologic Cataloging Units in California, as required for the National Water Use Data System.

The importance of water-use information was explained in a presentation at the Spring Conference of the Association of California Water Agencies and in a pamphlet prepared for public distribution.

Water-use information on 1,084 industrial and municipal water users in the industrial and sewage treatment categories was entered into the State Water Use Information System for California.

A mock-up of the report, "Water Use in California, 1980 and 1985," was prepared to document water-use computation methods and results for fiscal year 1986.

Plans for Next Year: Information will be compiled by county, hydrologic subregion, and hydrologic cataloging unit, and the State Water Use Data System data base will be improved. This information will be entered into the National Water Use Data System. The California contribution to the Survey's National Water Summary, 1987 will be written and a report on "Water-use in California, 1980 and 1985" will be completed.

Reports:

Templin, W.E., 1986, Water-use information for California: U.S. Geological Survey Open-File Report 86-483, 8 p.

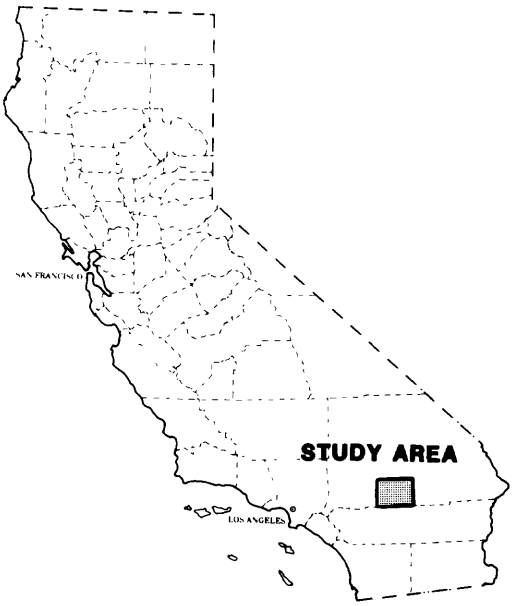
GROUND-WATER APPRAISAL, U.S. MARINE CORPS BASE, TWENTYNINE PALMS

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 1987



Problem: The Marine Base water supply is from wells in Surprise Spring subbasin. Although this area has water of good quality, the quantity is limited because of barrier faults that restrict ground-water flow to wells 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: 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 change. 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: Eleven new observation wells were drilled. Borehole logs were run for each of the new wells. Water-quality samples were collected from these new wells and from several existing wells in the area. These new wells were incorporated into the ongoing water-level monitoring program for the Marine Base. A seismic survey and a short resistivity profile were completed in the area of Surprise Spring. These measurements indicated the presence of several faults within the Surprise Spring subbasin.

A finite-difference model of the aquifer system in Surprise Spring subbasin was constructed and calibrated for the 1953 to 1985 period. The results of this modeling effort indicate that all recharge to the subbasin occurs as underflow in the area of Pipes Wash and Artillery Hill, and all discharge from the subbasin is either pumpage from the Marine Base water-supply wells or underflow across Surprise Spring Fault. For 1985, the model indicates that the underflow to the basin was about 127 acre-feet, and the underflow out of the subbasin was about 30 acre-feet. Pumpage from the water-supply wells in 1985 was about 2,900 acre-feet. The model also indicates that the faulting within the subbasin has divided the area into several smaller zones with large head differences between adjacent zones.

Plans for Next Year: The model will be used to test several water-use scenarios proposed by the cooperator. Reports describing the model and the data collected during the project will be completed. Several additional observation wells will be drilled and logged. The water-level monitoring program will continue.

Reports:

Akers, J.P., 1986, Geohydrology and potential for artificial recharge in the western part of the U.S. Marine Corps Base, Twentynine Palms, California, 1982-83: U.S. Geological Survey Water-Resources Investigations Report 84-4119, 18 p.

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 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 enable 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 a management tool (computer model) that can be used to predict response to future ground-water pumpage.

Approach: Maintain a ground-water level and quality monitoring network 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 1976-86 and will be used to predict ground-water levels resulting from a number of possible future pumpage patterns in the valley.

Progress: A comprehensive water-level and water-quality monitoring network was operated during the year. Monitoring consisted of semiannual water-level measurements (16 wells), continuous water-level recorders (4 wells), annual chemical analyses of major dissolved ions (10 wells), with four of the samples analyzed for volatile organics and trace metals; and chemical analyses of deuterium (20 wells). A report of hydrologic and geochemical monitoring in Indian Wells Valley from 1977-84 was approved for publication.

The ground-water model developed in 1971 and updated in 1979 was converted to the U.S. Geological Survey "modular" model. The new model could not be adequately calibrated using the distribution of transmissivity and storage used in the original model; therefore, the model had to be recalibrated with measured and estimated values of these parameters. A two-dimensional model of the main water-bearing zone in Indian Wells Valley has been completed. This model will be expanded into a quasi three-dimensional model next year.

Plans for Next Year: The hydrologic monitoring will consist of semiannual water-level measurements (22 wells) and annual chemical analysis for major dissolved ions (13 wells). Three of the samples will be analyzed for concentrations of volatile organics and selected trace metals. Three of the samples from wells in the western part of the valley will be analyzed for alpha radiation levels. Calibration of the three-dimensional ground-water flow model will be completed, and a report describing the model and the geohydrology of the basin will be prepared for review.

Reports:

Berenbrock, Charles, 1986, Ground-water data for Indian Wells Valley, Kern, Inyo, and San Bernardino Counties, California, 1977-84: U.S. Geological Survey Open-File Report 86-315, 56 p.

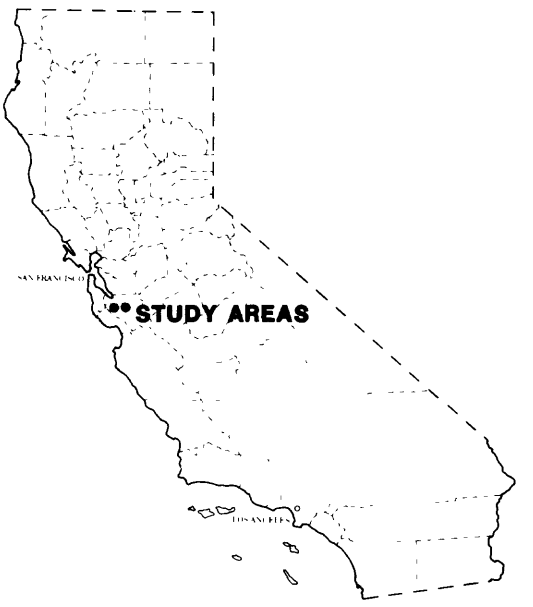
CHARACTERISTICS OF SELECTED LAKES AND RESERVOIRS

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 the majority of 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 was continued on Calero and Lexington Reservoirs. Calero Reservoir and the stream and canal that flow into it were sampled four times. The 6 years of data collected on Calero have provided a representative data base of water-quality conditions. Consequently, data collection will not be continued in 1987. A report interpreting data collected on Calero Reservoir from 1981 to 1983 was approved and prepared for printing. Lexington Reservoir and its major tributary, Los Gatos Creek, were sampled eight times in 1986. Sampling frequency was increased to document reservoir reestablishment. In 1985, the reservoir was drained to repair the dam. In addition, most of the drainage area was burned in 1985 by a forest fire which significantly changed limnological conditions. A week-long storm in February 1986 filled the reservoir to spilling. Two samplings taken before the storm probably reflect effects of the burn. Samplings after the storm reflect the reestablishment of the reservoir. A report interpreting data collected on Lexington Reservoir from 1978 to 1982 is in review.

Plans for Next Year: Lexington Reservoir will be sampled four times in 1987. The data collected in 1986 will be evaluated and presented in a special meeting with the cooperator. Monitoring will be started on Anderson Reservoir, which is the largest reservoir (91,300 acre-foot capacity) in Santa Clara Valley Water District's system. The 1987 collection at Anderson Reservoir will provide one season of data before water is imported from the U.S. Bureau of Reclamation San Felipe Project.

Reports:

Clifton, D.G., and Gloege, I.S., 1986, Water quality of Calero Reservoir, Santa Clara County, California, 1981-83: U.S. Geological Survey Water-Resources Investigations Report 86-4105, 41 p.

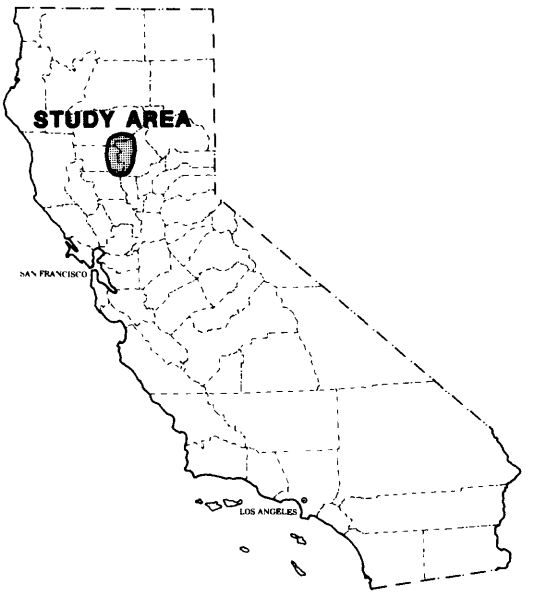
CHARACTERISTICS OF FLOODING AND CHANNEL CHANGES OF THE SACRAMENTO RIVER BETWEEN BUTTE CITY AND CHICO

Number: CA271

Cooperating Agencies: California Department of Water Resources; U.S. Army Corps of Engineers

Project Chief: James C. Blodgett

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 for future floods.

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 and bank erosion and deposition data will be evaluated. A report will be prepared giving the results of data evaluations.

Progress: Cross sections and high water profiles were surveyed as a result of the February 1986 flood. These data are currently being processed. Preparation of a data report has been delayed to allow incorporation of the 1986 flood data.

Plans for Next Year: The processing, review, and evaluation of flood data collected for the Sacramento River and Butte Basin for 1980-86 will be completed; a data report will be started. On the basis of this review, the flood data-collection program will be evaluated.

Reports: None.

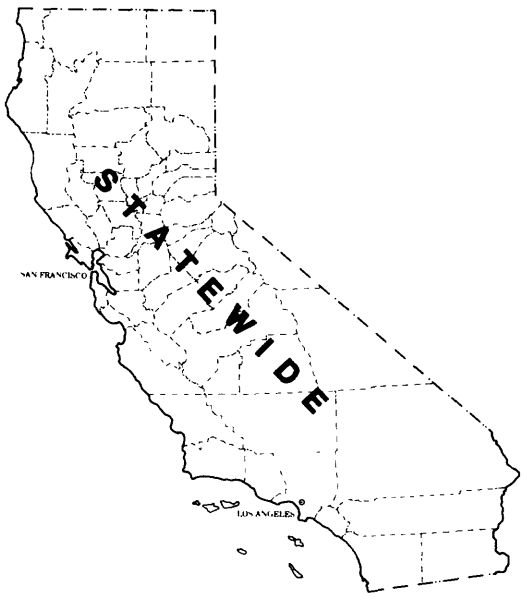
WATER RESOURCES OF INDIAN RESERVATIONS IN CALIFORNIA

Number: CA289

Cooperating Agency: U.S. Department of Interior, Bureau of Indian Affairs

Project Chief: Gregory C. Lines

Period of Project: Continuing



Problem: Approximately 40 Indian reservations in California are under the jurisdiction of the Bureau of Indian Affairs who commonly request the assistance of the U.S. Geological Survey to assess the water resources of selected reservations. This assistance may involve a reconnaissance-level hydrologic study or simply locating a well.

Objectives: Provide the Bureau of Indian Affairs with hydrologic appraisals of selected Indian reservations. Inasmuch as the reservations are generally small (some having only tens of people), the work on each reservation usually is limited to reconnaissance-level qualitative hydrology and well-site selection. Where present or future water needs are large, areas adjacent to the reservations also may be evaluated.

Approach: The work usually includes a well inventory, chemical analyses of water, and the drilling and testing of shallow wells.

Progress: A report describing ground-water conditions on the Cahuilla Indian Reservation has been prepared. The study documents changes in ground-water levels and chemical quality that occurred in the area during 1973-86, and the adequacy of the existing ground-water monitoring network is evaluated. Review began on a report describing water resources of the Twenty-Nine Palms Indian Reservation.

Plans for Next Year: Reviews will be completed on reports for the Cahuilla and Twenty-Nine Palms Indian Reservations, and the two reports will be published.

Reports: None.

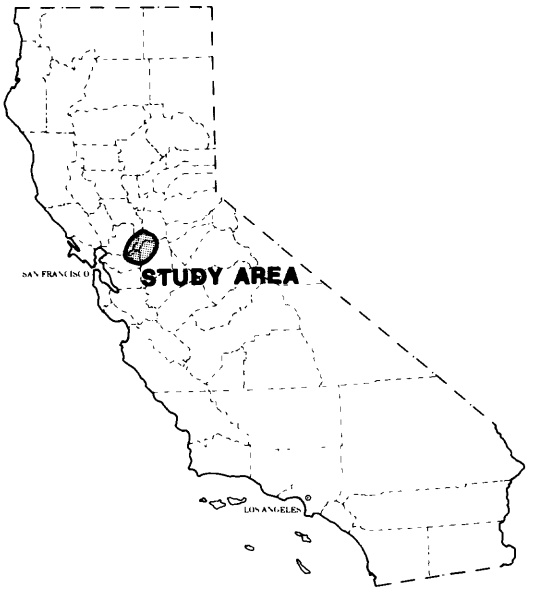
COMPUTER MODELS FOR COMPUTATION OF TIDAL RIVER DISCHARGE

Number: CA324

Cooperating Agency: California Department of Water Resources

Project Chief: Richard N. Oltmann

Period of Project: July 1975 to September 1987



Problem: Work is being done with respect to water quality and sediment 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 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) were installed on Old and Middle Rivers in the San Joaquin River Delta, and the application of the U.S. Geological Survey one-dimensional implicit finite difference BRANCH network flow model was shifted from the Sacramento River delta to a network of channels adjacent to the two AVM locations.

Progress on the modeling effort was slowed due to numerous delays in obtaining permits required to install the AVMs. The AVMs provide stage data for use as boundary-condition data for the model and flow data for calibrating and verifying the model. The modeling work included the schematization of the model area, determination of reach lengths, and assembling the model input and code. Also, channel cross-section data were collected using field surveys and fathometer traverses. These data were digitized to create a relation between depth and channel cross-sectional area in order to simulate channel geometry for each reach of the model.

The last required permit for the installation of the AVMs was received June 1, 1986. On June 23, the piles to support the AVM transducers were driven and the transducers and the remainder of the AVM instrumentation were installed. Assorted transducer alignment problems were overcome using generator power. Electrical power hookup with PG&E was completed.

Plans for Next Year: AC power is now available at the AVM sites, and the stations will be operating in early October. Flow measurements using the hull-mounted acoustic Doppler profiler on the Survey's research vessel, *Saul E. Rantz*, will be used to calibrate and verify the AVMs. The collection of synchronized stage data will begin at three other model boundary locations in addition to the two AVM sites. The acoustic Doppler profiler will again be used to make flow measurements in the various channels included in the model for use in calibrating and verifying the model. A data report will be prepared covering the first year's operation of the AVM's. A report documenting the results of the modeling effort will be started.

Reports: None.

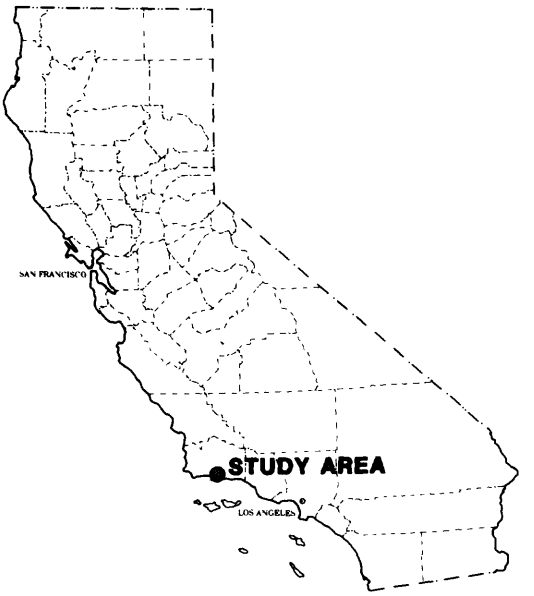
GROUND-WATER RESOURCES OF THE SANTA BARBARA AREA

Number: CA342

Cooperating Agency: Santa Barbara, city of

Project Chief: Peter Martin

Period of Project: July 1977 to September 1987



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 that is 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 hydraulic data, such as storage coefficient and transmissivity estimates, will be collected. 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 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 was developed for the Goleta-East subbasin. The subbasin boundaries were redefined as a result of analysis of hydrologic data. A two-dimensional finite-difference mathematical model of the subbasin was constructed. Steady-state and transient-state simulations were calibrated and show acceptable match to historic data. Analysis of available data indicates that the subbasin covers a greater area than previously assumed. This conclusion was reached on the basis of water-level and water-quality data as well as model calibration. A report of the findings of the investigation, including a description of the mathematical model of the subbasin, is being prepared.

Plans for Next Year: Computer simulations of subbasin operation will be made. The simulations will include examination of subbasin response to pumpage during simulated drought conditions, as well as normal and greater-than-normal recharge conditions. These simulations may lead to a more efficient subbasin management scheme. The report on the Goleta-East subbasin will be submitted for review and subsequent publication and approval.

Reports:

Martin, Peter, and Berenbrock, Charles, 1986, Ground-water monitoring at Santa Barbara, California: Phase 3--Development of a three-dimensional digital ground-water flow model for Storage Unit I of the Santa Barbara ground-water basin: U.S. Geological Survey Water-Resources Investigations Report 86-4103, 58 p.

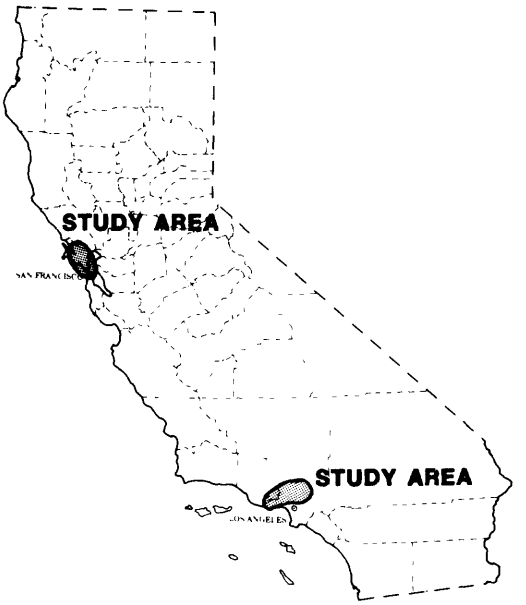
WATER QUALITY IN NATIONAL PARK SERVICE LANDS

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 program of 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 begun 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 was resumed in the Santa Monica Mountain National Recreation area (SMMNRA), east of Los Angeles. All samples were analyzed for major ions, nutrients, indicator bacteria, and selected pesticides. Results from the GGNRA indicate that the water is of generally good chemical quality. Specific conductance ranged from 136 microsiemens per centimeter in Redwood Creek to 320 in Table Rock Creek during low flow. Fecal coliform and fecal streptococci bacteria were present in all samples collected during both winter and summer sampling periods with maximum values occurring during the winter. In Gerbode Valley Creek, fecal coliform was 1,200 colonies per 100 milliliters and fecal streptococci was 2,300 colonies per 100 milliliters. The lowest bacteria counts during the winter were on Redwood Creek below Muir Woods with fecal coliform of 77 colonies per 100 milliliters and fecal streptococci of 82 colonies per 100 milliliters. Fifteen common pesticides analyzed at each site were less than the detection levels.

Results of the SMMNRA sampling were quite different from those in the GGNRA. During base-flow conditions in the SMMNRA, specific conductance ranged from 295 microsiemens per centimeter in Arroyo Sequit to 2,270 in Latigo Creek. The mean of all samples was 1,270 microsiemens per centimeter. In Zuma Creek, the largest values for fecal coliform and fecal streptococci were 39,000 and 92,000 colonies per 100 milliliters. In Latigo Creek, the lowest values were 43 and 210 colonies per 100 milliliters. In Malibu Creek, the pesticide simazine was detected at 1.2 micrograms per liter and atrazine was detected at 0.4 microgram per liter. Simazine and atrazine were also detected in small concentrations in Zuma Creek. Other common pesticides analyzed were less than the detection levels.

Plans for Next Year: Sampling will continue during summer low-flow and winter storm periods in both National recreation areas. Sampling modifications based on 1986 results will be discussed with each of the staffs and implemented.

Reports:

Akers, J.P., 1986, Ground water in the Long Meadow area and its relation with that in the General Sherman Tree area, Sequoia National Park, California: U.S. Geological Survey Water-Resources Investigations Report 85-4178, 15 p.

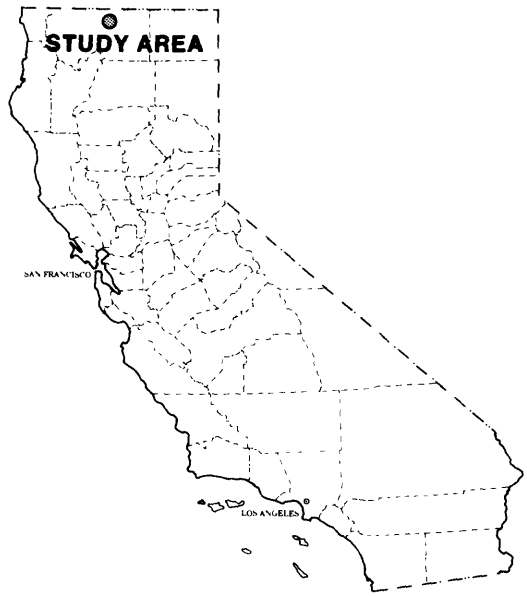
HYDROLOGIC HAZARD ASSESSMENT FOR MOUNT SHASTA AREA

Number: CA392

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

Project Chief: James C. Blodgett

Period of Project: January 1981 to September 1986



Problem: Mount Shasta has erupted with a frequency equivalent to that of Holocene eruptions of Mount St. Helens. Future events such as mudflows and pyroclastic flows could endanger people or property near Mount Shasta including the communities of Weed, Mount Shasta, and McCloud. Damages may occur when water supplies are altered and channel capacities are rendered inadequate. Recent mudflows, caused by rapid melting of glaciers and snow during summer months, pose additional hazards. Future floods and water-quality problems, related to volcanic activity, could extend to the Klamath River or Shasta Lake.

Objectives: Provide information on the character and location of abnormal hydrologic events that might follow an eruption or mudflow, and information on streamflow, water quality of aquifers, springs, streams, and lakes that could be affected by mudflows or volcanic activity. Other programs will assess flood and mudflow hazards, and document existing cultural and hydrologic features.

Approach: Various eruptive events will be theorized and associated hazards will be assessed. Cultural features such as municipalities, reservoirs, water supplies, sewage facilities, highways, and railroads will be identified for probable hazard impact. Flood hazards will be assessed using data from photogrammetry and field measurements of channels, cultural features, and by flow models. The magnitude, frequency, and other characteristics of floods and mudflows will be evaluated. Stream and channel data will be collected for some streams recently affected by mudflows. Available water-quality data will be evaluated.

Progress: Study results show that many springs serve as primary sources of water for various cities around Mount Shasta. Most streams are ephemeral and do not have surface flow at distances greater than 6 miles from the summit. All glacial-meltwater streams on Mount Shasta have had repeated debris-flow activity during the last 500 years. The smaller debris flows pose little hazard to human life or property whereas larger out-of-channel flows could cause damage. Debris flows have been dated and their magnitude measured using dendrogeomorphic techniques. A report describing the origin and behavior of debris flows on Mount Shasta was begun. Field surveys of the Whitney Creek debris flow during July 1985 were completed and data processing and analysis are underway.

Plans for Next Year: Reports currently in review will be completed.

Reports:

Hupp, C.R., Osterkamp, W.R., and Thornton, J.L., (in press), Dendrogeomorphic evidence and dating of recent debris flows on Mount Shasta, northern California: U.S. Geological Survey Professional Paper 1396-B.

Osterkamp, W.R., Hupp, C.R., and Blodgett, J.C., 1986, Magnitude and frequency of debris flows, and areas of hazard on Mount Shasta, northern California: U.S. Geological Survey Prefessional Paper 1396-C, p. C1-C21.

Poeschel, K.P., Rowe, T.G., and Blodgett, J.C., 1986, Water-resources data for the Mount Shasta area, northern California: U.S. Geological Survey Open-File Report 86-65, 73 p.

WASTEWATER REUSE, SAN DIEGO COUNTY

Number: CA399

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

Project Chief: Kristen D. Evenson

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 wastewater reuse. Many problems are associated with using reclaimed wastewater, such as ambient quality of ground water, storage capacity of the aquifer, quality of reclaimed water, and soil suitability.

Objectives: (1) Evaluate the ground-water and surface-water quantity and quality for each subarea, (2) collect samples and provide measurements in order to make a current data base, (3) evaluate the ability of each basin to accept reclaimed water, (4) define past, present, and future beneficial uses, (5) determine future plans of water purveyors, public agencies, and other water users concerning the use of reclaimed water, and (6) 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. Ground-water quality will be assessed and basin yield will be determined. 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: A report describing ground- and surface-water quality in the Poway, Soledad, and Moosa hydrologic subareas in San Diego County was prepared and is in review. Geology, soil, and cultural features of each subarea are described in the report and the potential use of reclaimed water and its affects on existing water quality are evaluated.

Plans for Next Year: A 15-month study of water quality will begin in the Escondido hydrologic subunit in northwestern San Diego County. This new study will be the fourth in a series of studies conducted for this project.

Reports: None.

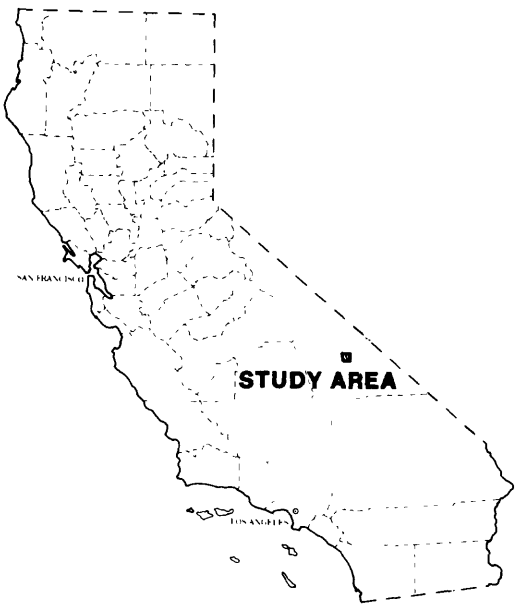
STOVEPIPE WELLS AQUIFER TEST, DEATH VALLEY NATIONAL MONUMENT

Number: CA405

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

Project Chief: Linda R. Woolfenden

Period of Project: April 1986 to September 1986



Problem: The National Park Service currently uses reverse-osmosis treated water only for potable needs at Stovepipe Wells. They have proposed using reverse-osmosis treated water for both potable and non-potable needs. This would require an increase in pumpage of 37,000 gallons per day for the peak tourist season. There is concern that the increased pumpage would cause significant water-level declines in the Stovepipe Wells Hotel area, particularly near phreatophytes located about 2 miles east of the Stovepipe Wells Hotel. Because of the potential adverse effects, there is a need to evaluate the effects of increased pumpage on water levels in the Stovepipe Wells Hotel area.

Objective: Evaluate potential water-level declines that would result from additional pumpage in the Stovepipe Wells Hotel area.

Approach: The transmissivity and storage coefficient of the alluvial aquifer will be determined from two aquifer tests performed at Stovepipe Wells Hotel. For the first test, the saline production well will be used for the pumping well. Two observation wells will be constructed to monitor drawdown and recovery at two distances from the pumping well. For the second test, only the reverse-osmosis production well will be used. Estimates of transmissivity and storage coefficient, obtained from analyses of the aquifer tests data, will be used to quantitatively estimate water-level declines that would occur after 1, 10, and 50 years of increased pumpage in the area.

Progress: Aquifer tests were conducted using the two production wells at Stovepipe Wells Hotel. Two observation wells were constructed near the existing saline production well to monitor drawdown and recovery at two distances (25 and 100 feet) from the pumped well. Two aquifer tests were conducted on May 19 and 20, 1986. The first aquifer test involved monitoring pumpage from the saline production well and water levels on the two observation wells. The second test involved monitoring of pumpage and water-level recovery in the reverse-osmosis production well. The data from these two tests were analyzed to estimate the transmissivity and storage coefficient for the aquifer. Three methods (Theis, Jacob-Cooper and Hantush-Jacob) were used to analyze the pumping-phase and recovery-phase data. Analysis of the data using the Theis and Jacob-Cooper methods was made in the field, and preliminary results were presented to the National Park Service. Transmissivity, storage coefficient, and specific yield were used to quantitatively estimate water-level declines that would occur after 1, 10, and 50 years of increased pumpage at Stovepipe Wells Hotel. Preparation of a report on the results of the tests was started.

Plans for Next Year: The report on the results of the tests will receive colleague and cooperator review. The report subsequently will be forwarded for publication approval and printing.

Reports: None.

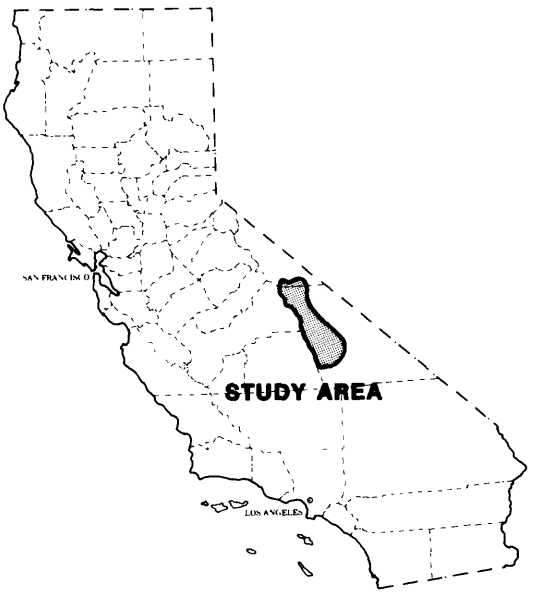
VEGETATION SURVIVABILITY STUDIES IN OWENS VALLEY

Number: CA413

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

Project Chief: Stephen K. Sorenson

Period of Project: April 1983 to October 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 (2-10 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 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 drawdown 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: The controlled drawdown sites continued to function throughout 1986. In October 1985, the pumping rate was increased at the slow drawdown sites to induce additional drawdowns of 5 feet. Water levels at the Independence slow site were drawn down an additional 3 feet, and at the Warm Springs slow site, they were drawn down an additional 1 foot. The drawdown of 5 feet was not attainable because of existing pumping limitations. Data were collected on the same schedule as in the 1985 season. Results of the data collection indicate that the pumping at the Warm Springs slow site had a detrimental effect on the vegetation. These effects include the death of about 80 percent of the rabbitbrush plants, a reduction in the amount of saltgrass, and a reduction in the growth rate of Nevada saltbush and greasewood. At the Independence slow site, pumping has not caused plant mortality, but growth rates and seed production were reduced on plants near the center of the study compound. Measurable effects on the plants at either of the two drawdown sites were not attributed to the controlled water-table drawdown. The soil-moisture model developed in 1985 was unable to reliably convert neutron probe derived moisture content data to soil-moisture potential.

Plans for Next Year: Evaluation of the soil-moisture model will continue. The model will probably require extensive modification to be useful with soils in Owens Valley. Preparation of three water-supply papers for the plant-survivability study is scheduled, and a water-resources investigations report will be completed.

Reports: None.

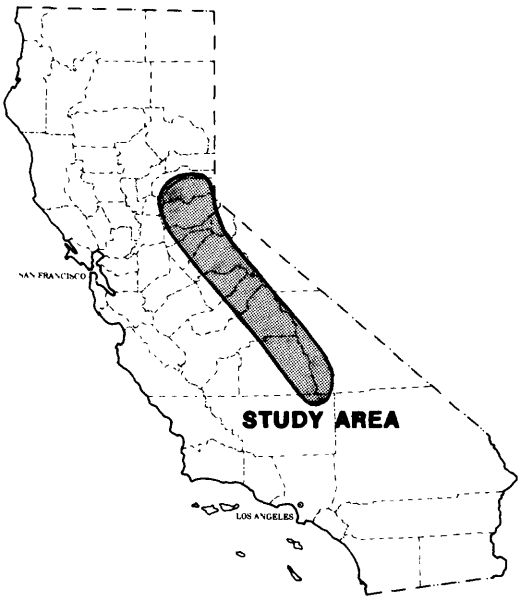
GIARDIA IN THE SIERRA NEVADA

Number: CA414

Cooperating Agency: University of California, Davis

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 organisms 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: In conjunction with the University of California, Davis, and the California Department of Health Services, the laboratory processing method for isolation of *Giardia* cysts was evaluated to determine which steps were responsible for the loss of cysts during processing. This included an evaluation of the Balston filter to determine where and how firmly the cysts are retained so that more effective back-flushing procedures can be devised. Once the processing method is better understood and optimized, the method can be considered quantitative with a known percentage of cyst recovery. Several locations within a drainage basin near Desolation Wilderness that are known to be contaminated with *Giardia* were sampled to evaluate the seasonal fluctuation of cysts. Five publications resulting from previous work on this project were published or accepted for publication during the year.

Plans for Next Year: The District laboratory will continue to be operated to provide analytical services for other agencies or districts. The project with the University of California, Davis, will be completed and the results jointly published. A project will be done with the University of Nevada, Reno, to compare the results of *Giardia* analysis using the monoclonal immunofluorescent stain developed by the California Department of Health Services with established laboratory *Giardia* analysis. Results from this project will be published in a medical journal.

Reports:

Sorenson, S.K., Dileanis, P.D., Nelson, B.C., and Suk, T.J., 1986, Occurrence of *Giardia* in water and animals in Yosemite and Sequoia-Kings Canyon National Parks, California [abs]: Conference on Science in the National Parks, Ft. Collins, Colorado, July 14-18, 1986, Program and Abstracts, p. 247. Poster session also was presented.

Sorenson, S.K., Dileanis, P.D., and Riggs, J.R., 1986, Occurrence of *Giardia* cysts in streams in the Sierra Nevada, California: International Conference on Water and Human Health, Session E of the Water Related Health Issues Symposium, Atlanta, November 9-14, 1986, proceedings, 17 p.

Sorenson, S.K., Riggs, J.L., Dileanis, P.S., and Suk, T.J., 1986, Isolation and detection of *Giardia* cysts from water using direct immunofluorescence: Water Resources Bulletin, v. 22, no. 5, p. 843-845.

Suk, T.J., Sorenson, S.K., and Dileanis, P.D., 1986, Map showing the number of *Giardia* cysts in water samples for 69 streams sites in the Sierra Nevada, California: U.S. Geological Survey Open-File Report 86-404-W, 1 sheet.

-----(in press), The relation between human presence and occurrence of *Giardia* cysts in streams in the Sierra Nevada, California: Journal of Freshwater Ecology.

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 effect 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: Several computer models were programmed and applied to subembayments within San Francisco Bay. The results of a two-dimensional model study in Suisun Bay were prepared and accepted for publication in Water Resources Research. This work also was presented in New Orleans at a meeting of the Ocean Sciences Section of the American Geophysical Union. A three-dimensional model was applied to San Pablo Bay and used to simulate tidal velocity and salinity profiles. A two-dimensional spectral model was programmed and applied to South San Francisco Bay. Regression models also were developed to compare freshwater inflows to salinities in the bay. New graphics software and equipment were purchased and used to produce three-dimensional color images of San Francisco Bay. In addition to model studies, a large data-collection program was begun. Survey and Bureau of Reclamation boats made a series of salinity profiling runs through the northern reach of the bay during late March and early April. Salinity profiles were collected every 2 kilometers at stations along the ship channel. In addition, the Survey boat collected velocity profiles using a vessel-mounted acoustic Doppler current profiling system. During March and September, eight current meters were deployed in shallow-water areas of the north bay. During June and September, three long-term continuous monitoring sites for water levels and one site for water levels and salinity were established at locations in the north bay.

Plans for Next Year: Two-dimensional computer models will be expanded to include the entire bay. An attempt will be made to verify the three-dimensional model with field data. The salinity and velocity profile measurement program will be conducted during low, medium, and high freshwater inflow conditions. Operation of continuous water level and salinity stations will continue, and an upward-looking acoustic Doppler current profiler will be deployed. If funding is secured, a comprehensive hydrodynamic data-management system for the bay will be developed.

Reports:

Smith, L.H., and Cheng, R.T., 1987, Tidal and tidally average circulation characteristics of Suisun Bay, California: Water Resources Research, v. 23, no. 1, p. 143-155.

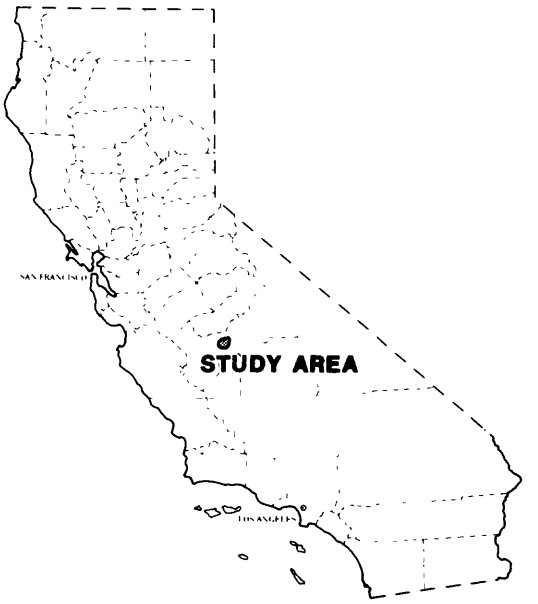
APPLICATION OF URBAN RAINFALL-RUNOFF AND RUNOFF-QUALITY MODELS TO THREE CATCHMENTS IN FRESNO

Number: CA422

Cooperating Agency: Fresno Metropolitan Flood Control District

Project Chief: Joel R. Guay

Period of Project: October 1985 to September 1986



Problem: The Fresno Metropolitan Flood Control District is responsible for designing storm-drain systems for Fresno and developing a master plan for detection and management of urban pollution associated with storm-drain runoff. In order to adequately meet those responsibilities the Fresno Metropolitan Flood Control District needs (1) a method that goes beyond the currently used rational-formula method for determining storm-drain design, and (2) a computer system (hardware and software) that can be used economically, in terms of money and time, to determine management solutions to urban pollution.

Objective: (1) To demonstrate the capabilities of the U.S. Geological Survey Distributed Routing Rainfall-Runoff Model (DR3M--II) and U.S. Geological Survey multi-event urban runoff quality model (DR3M-qual) for use in designing storm drains and retention basins, estimating the frequency of storm loads, and evaluating the effectiveness of street sweeping; and (2) to determine the simulation accuracies of these models.

Approach: A calibrated and verified deterministic rainfall-runoff model will be used to determine the design capacity of the storm drain system at three catchments previously studied in a National Urban runoff program. This method will then be compared to the rational formula method to test the advantages of each method in terms of accuracy. A calibrated and verified runoff-quality model will be used to produce a long-term simulation of loads from hourly rainfall data and to evaluate the potential effectiveness of streetsweeping.

Progress: The distributed routing rainfall-runoff model (DR3M) was applied to single dwelling residential, multiple dwelling residential, and commercial catchments. Model development included schematizing the physical attributes of the catchments and applying daily and/or instantaneous values for rainfall, discharge, and evaporation. The model was calibrated and verified by comparing measured and simulated values for storm-runoff volumes, storm peaks, and hydrograph timing. The runoff-quality model (DR3M-qual) was calibrated and verified for the commercial catchment only using measured constituent storm-load data to determine accumulation and washoff coefficients. These coefficients were input to the quality model to simulate suspended sediments; dissolved solids, sum of constituents; total lead; and dissolved nitrogen, as nitrate and nitrite. Hourly rainfall for 1948-82 was input to the DR3M-qual model to produce a long-term record of the four constituents. Return periods for these annual loads were produced using a log-Pearson type III distribution. The theoretical effectiveness of streetsweeping was evaluated using DR3M-qual by varying time, area, and efficiency parameters for streetsweeping.

Plans for Next Year: A report will be submitted for review.

Reports: None.

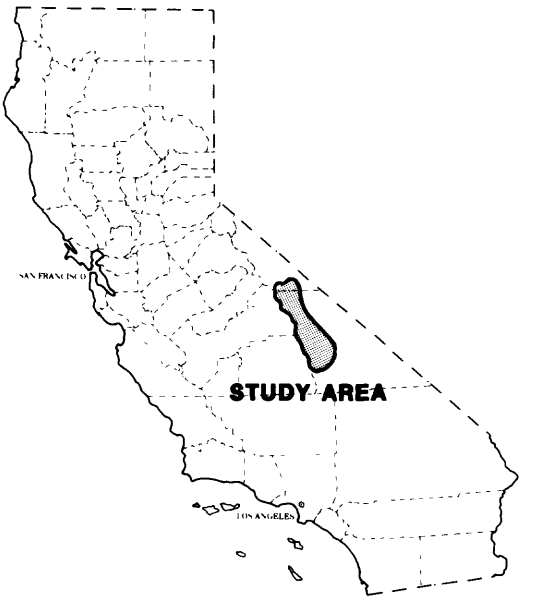
GROUND-WATER INVESTIGATIONS IN OWENS VALLEY

Number: CA426

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

Project Chief: Kenneth J. Hollett

Period of Project: October 1982 to September 1987



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 has caused public outcry. 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: An extensive amount of hydrogeologic, soil-moisture, evapotranspiration, aquifer-characteristics, and vegetation data were collected during the first 4 years of the study. These data were used to define the boundary and initial conditions of a detailed numerical analysis and simulation of the aquifer system. A series of reports consisting of eight Water-Supply Papers were initiated; one is in review and the remainder are in preparation. A number of journal articles and presentations for scientific meetings were prepared and many are in review or in press.

Plans for Next Year: Work will continue on the steady- and transient-state analysis of the aquifer system and will culminate in an optimization analysis designed to test alternative strategies for mitigating the effects of ground-water withdrawal on native phreatophytes. All reports will be completed in manuscript form suitable for technical review.

Reports: None.

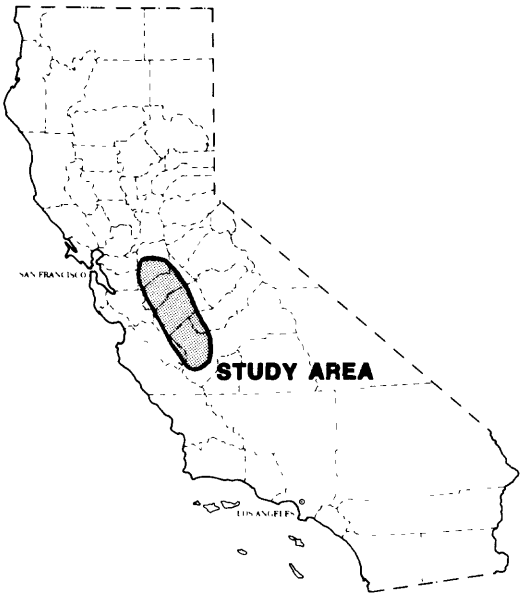
CENTRAL VALLEY REGIONAL AQUIFER-SYSTEM ANALYSIS

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 have been measured in concentrations which exceed recommended levels in agricultural drainage water from the western San Joaquin Valley. 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 freshwater 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: Over 150 wells have been sampled so far. Results for selenium and pesticides were published in open-file reports. A draft of an interpretive report on trace-element distribution in regional ground water of the western San Joaquin Valley is in progress.

Plans for Next Year: In fiscal year 1987, the northeastern one-third of the valley will be inventoried and existing production wells sampled.

Reports:

Deverel, S.J., and Fujii, Roger, (in press), 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. To be submitted for publication in the Journal of Water Resources Research.

Deverel, S.J., and Millard, S.P., 1986, Distribution and mobility of selenium and other trace elements in shallow ground water of the western San Joaquin valley, California: U.S. Geological Survey Open-File Report 86-538, 12 p. To be submitted for publication in the journal of Environmental Science and Technology.

Evenson, K.D., and Neil, J.M., 1986, Map of California showing distribution of selenium concentrations in wells sampled by the U.S. Geological Survey, 1975-85: U.S. Geological Survey Open-File Data Report 86-72, 1 map.

Mandle, R.J., and Kontis, A.L., 1986, Directions and rates of ground-water movement in the vicinity of Kesterson Reservoir, San Joaquin Valley, California: U.S. Geological Survey Water-Resources Investigations Report 86-4196, 57 p.

Neil, J.M., 1986, Dissolved-selenium data for wells in the western San Joaquin Valley, California, February to July 1985: U.S. Geological Survey Open-File Report 86-73, 10 p.

-----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 87-28, 16 p.

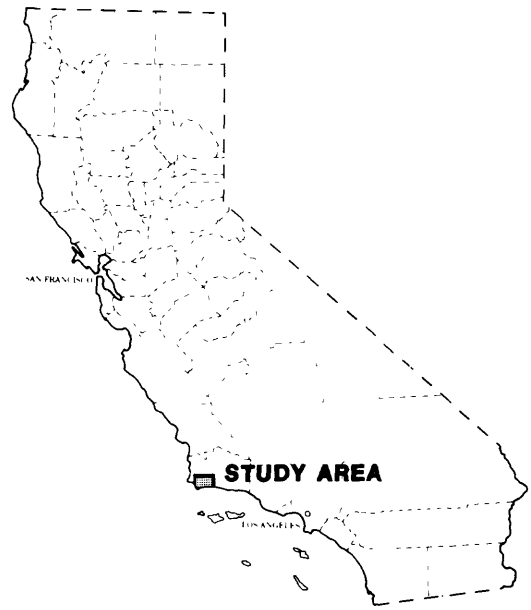
SALTWATER INTRUSION AT SANTA BARBARA

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: Nine test wells were completed at varying depths along a line perpendicular to the coastline. Chloride concentrations and water levels were monitored monthly in these wells and in an additional six wells along the coast. The deepest wells (about 800 feet deep) closest to the coast were found to have chloride concentrations as high as 11,000 milligrams per liter.

Plans for Next Year: Water levels and chloride concentrations in test wells will continue to be monitored. A report describing test drilling and results of water-level and water-quality monitoring will be prepared, and work will begin on the cross-sectional solute-transport model.

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 in order 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 (7 sites); streamflow (1 site); continuous temperature and specific conductance of hot springs (3 sites); and semi-annual chemical and isotopic samples (30 sites). The data are summarized in a report pending publication. An oral presentation on electronic instrumentation for hydrologic monitoring was given at the fall meeting of American Geophysical Union. An exploration hole, SR-1, was cored to 2,346 feet in cooperation with Lawrence Berkeley Laboratory and Mono County. The core shows extensive fracture permeability in the Bishop Tuff and a maximum temperature of 201 degrees Celsius (EOS Transactions, American Geophysical Union, v. 67, no. 29, p. 582). Aquifer properties at five sites were quantified by slug tests. Study of the effects of magmatic intrusions focused on analyzing well hydrographs for water-level fluctuations caused by crustal deformation. The effects of barometric pressure and seasonal trends were removed from the hydrographs by digital filtering techniques. The filtered records were examined for fluctuations which correlated with periods of known crustal deformation.

Plans for Next Year: The hydrologic monitoring will be continued. Core hole SR-1 will be instrumented for continuous water-level recording and down-hole fluid samples will be collected following perforation of the casing. Since chloride concentration serves as a label for hydrothermal fluids, a budget for chloride flux in the basin will be determined and should allow for a better assessment of variations in thermal fluid discharge seasonally and with specific events. The study of magmatic intrusions will continue to analyze the interaction of ground water and rock strain.

Reports:

Farrar, C.D., Sorey, M.L., Rojstaczer, S.A., Janik, C.J., Winnett, T.L., and Clark, M.D., (in press), Hydrologic and geochemical monitoring in Long Valley Caldera, Mono County, California, 1985: U.S. Geological Survey Water-Resources Investigations Report 87-4090.

STABLE CARBON ISOTOPE STUDY OF PRIMARY CARBON FLUX OF FOOD CHAIN NETWORK OF STRIPED BASS IN THE SACRAMENTO-SAN JOAQUIN DELTA AQUATIC ECOSYSTEM

Number: CA432

Cooperating Agency: California State Water Resources Control Board

Project Chief: Walter Rast

Period of Project: October 1983 to September 1986

Problem: The striped bass fishery in the Sacramento-San Joaquin River Delta has been declining steadily for a number of years. One hypothesis for this decline is that the phytoplankton base of the striped bass food chain has been declining during the same period, causing a food shortage which has propagated through the striped bass food chain. This study will focus on tracing the major carbon flux through the striped bass food chain in this aquatic environment for the purpose of testing this hypothesis.

Objectives: Determine the stable carbon (and perhaps nitrogen) ratios of the principal components of the striped bass food chain, and use these ratios as a tracer for the major carbon flux of the striped bass food chain.

Approach: Samples will be taken of the principal component of the hypothesized striped bass food chain (phytoplankton, zooplankton neomysis, striped bass). Samples will be analyzed for 13C:12C (and perhaps 15N:14N) ratios. These ratios will be used to substantiate the likely food chain for the striped bass.

Progress: A contract laboratory was selected to analyze samples for stable carbon and nitrogen isotopes. The samples included specimens of striped bass, Neomysis shrimp, large and small zooplankton, phytoplankton and organic detritus. Based on discussions with fishery scientists at the California Department of Fish & Game Office (Stockton, California), the locations of these stations approximate the areal boundary of the primary striped bass spawning area in the Delta system. Samples of sewage effluent from the major municipal wastewater treatment plants in the region also were analyzed.

Although the data analysis is only preliminary, initial results indicate that the primary food chain, as postulated by fishery scientists, seems to be appropriate. The data exhibits some scatter, indicating that some organisms may have multiple food sources at least for some period of time. The stable-isotope ratios in the striped bass indicate a change coincident with increasing body length. This is consistent with their changing food habits as the striped bass progress from their larval stage through their juvenile stage.

Plans for Next Year: A final draft of the report will be submitted for review.

Reports: None.

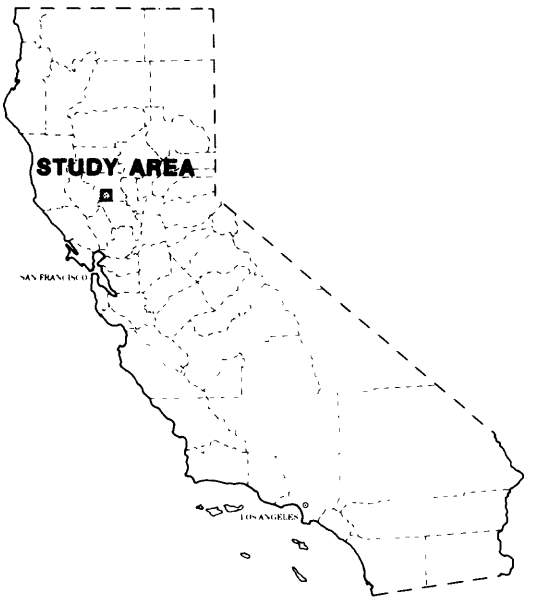
WATER-QUALITY CONDITIONS ON THE CORTINA RANCHERIA INDIAN RESERVATION

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 which fails to meet drinking-water standards due to 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: A thorough review of available literature describing the geology and hydrology of the western part of the Sacramento Valley was completed. In addition, all available precipitation, streamflow, and water-quality data were compiled for a large area surrounding Cortina Rancheria. On the basis of regional patterns in geologic and hydrologic characteristics, data from appropriate stations were used to estimate precipitation, streamflow, and surface- and ground-water quality on Cortina Rancheria by various correlative methods. Annual averages as well as seasonal distributions of the characteristics were estimated. During a reconnaissance visit to Cortina Rancheria, water-quality samples were collected from two wells and two springs. Suitable sites were identified for geophysical surveys and stream gages. Interviews with residents of Cortina Rancheria and personnel at the Indian Health Service and the Environmental Protection Agency provided information regarding future demand, infrastructure limitations, and drinking-water regulations. This information will be considered during preparation of the proposed data-collection plan.

Plans for Next Year: Water-quality samples will be analyzed. A proposed data-collection plan will be developed using compiled information. Additional information may be obtained if it seems to be essential to the overall geohydrologic interpretation or to accurate specification of the data-collection plan. A draft of the final report will be prepared.

Reports: None.

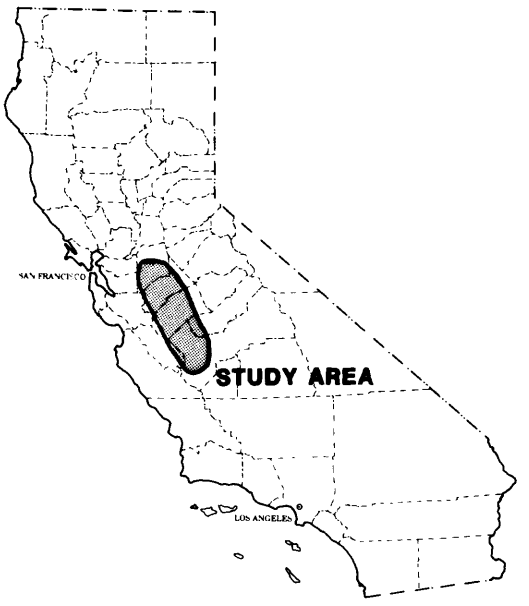
AN ASSESSMENT OF QUALITY AND CONTAMINANT TRANSPORT IN THE SOILS AND GROUND WATER OF WESTERN SAN JOAQUIN VALLEY

Number: CA441

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

Project Chief: James G. Setmire

Period of Project: October 1983 to January 1986 (terminated)



Problem: Current agricultural drainage and chemical application practices can lead to contamination of ground water. Toxic levels of certain trace elements, pesticides, and nitrogen are found in ground water associated with irrigated agriculture in many locations nationwide. Toxic concentrations of selenium and extremely high salinity levels were found in ground water on the west side of the San Joaquin Valley. Some organic and pesticide compounds also were found.

Objectives: (1) Assess current ground-water quality conditions with an emphasis on identifying contaminants, (2) relate conditions to the principal land-use types in the study area, (3) define the sources of contaminants identified in the assessment, and (4) determine the processes that control the transport of the identified contaminants to and in the ground-water system.

Approach: Concentrations of pesticides will be determined in drains and shallow ground water. Relations between water quality, geohydrology, land use, and agricultural practices will be investigated. Model simulations of pesticide transport will be used to assess the potential effects of selected organic compounds on ground-water quality.

Progress: A draft report describing the development of a data base of water quality, land use, soils, and pesticide-application information for the western San Joaquin Valley was prepared. Included in the report is a delineation of data deficient areas and identification of data needed for future detailed investigations. Simulations of pesticide transport were made with the pesticide root zone model (PRZM) using generalized information on soils, pesticide applications, and crops in an effort to classify the migration potential of selected pesticides. Applications of phorate, aldicarb, and toxaphene were used in these initial simulations. The geohydrology of the western San Joaquin Valley is also described. During the summer of 1985, 43 samples were collected from drains and shallow wells in the study area to determine the concentrations of a selected list of pesticides. Analytical services were provided by the U.S. Environmental Protection Agency, Office of Pesticide Programs through one of their contract laboratories. Results indicated that triazine herbicides were present in 40 percent of the wells sampled.

Plans for Next Year: This project was not selected for future funding as part of the National program. Currently, there are no plans to publish the draft report. The Environmental Protection Agency remains interested in pursuing further investigations of the triazines in the upper aquifer. Future triazine investigations will be conducted under project CA456, western San Joaquin Valley Hydrologic Studies.

Reports: None.

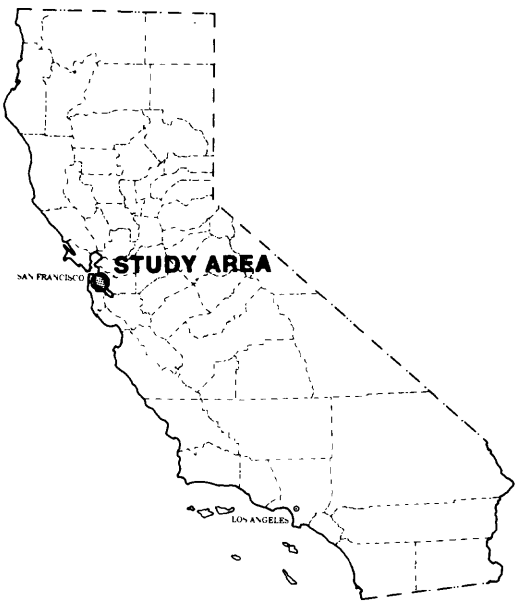
EVALUATION OF TECHNIQUES FOR MEASURING CURRENTS IN SAN FRANCISCO BAY

Number: CA443

Cooperating Agency: California State Water Resources Control Board

Project Chief: Richard N. Oltmann

Period of Project: October 1983 to February 1986



Problem: State and Federal agencies have been conducting numerous aquatic studies trying to understand relations among physical and chemical factors and biological species within the San Francisco Bay aquatic ecosystem. Hydrodynamics are an underlying driving force for this ecosystem; therefore, in order to understand their relations, a better understanding of the system's hydrodynamics is required. Development of that understanding will depend on the collection of field data and the translation of the data into mathematical models. Many hydrodynamic data have been collected but few data have been collected for shallow areas.

Objectives: Determine the feasibility of collecting reliable velocity data in shallow water areas of the bay system using recording-current meters and an acoustic Doppler current profiler in the deeper areas of the system.

Approach: Four different types of recording current meters will be field tested in a shallow water area (2 to 4 meters) in south San Francisco Bay. The current meters include (1) horizontal-axis-ducted impeller (Endeco 174[1]), (2) vertical-axis rotor (Aanderaa RCM-4), (3) inclinometer (General Oceanics 60112 MKII), and (4) electromagnetic sensor system (InterOcean S4). Speeds recorded by the meters at slack water and during maximum flows will be compared during calm and windy conditions and at various tide levels. Acoustic Doppler current profiler will be procured for use in deep water areas. The instrument will be vessel-mounted and its accuracy evaluated using current meters.

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[1]Use of brand names in the report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Progress: A report documenting the results of the evaluation of a vessel-mounted acoustic Doppler current profiler was presented at the Third Working Conference on Current Measurement on January 23, 1986, at Airlie, Virginia. The report was published in the conference proceedings in May 1986. The results of the comparison of recording current meters in shallow water of San Francisco Bay has been documented in a report that is in review.

Plans for Next Year: The Water-Resources Investigations Report documenting the comparison of recording current meters will be completed and submitted for Director's approval.

Reports:

Gartner, J.W., and Oltmann, R.N., 1985, Comparison of recording current meters used for measuring velocities in shallow waters of San Francisco Bay, California: Ocean Engineering and the Environment, IEEE Ocean Engineering Society, San Diego, November 12-14, 1985, Conference Record, v. 2, p. 731-737.

Simpson, M.R., 1986, Evaluation of a vessel-mounted acoustic Doppler current profiler for use in rivers and estuaries: IEEE 3d Working Conference on Current Measurement, Airlie, Virginia, January 22-24, 1986, p. 106-121.

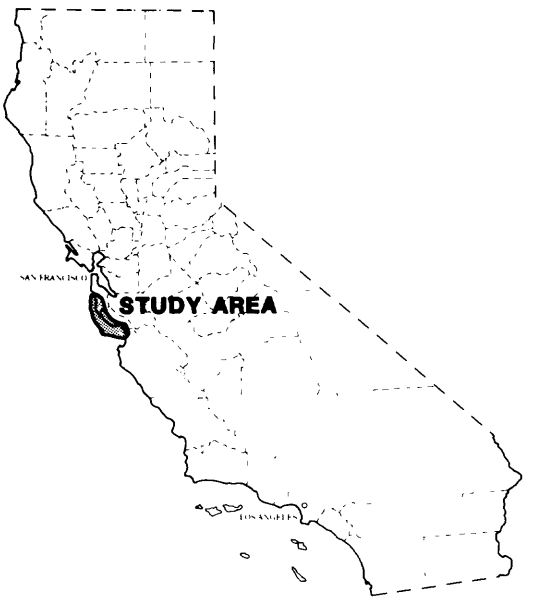
MONTEREY BAY SAND TRANSPORT

Number: CA444

Cooperating Agency: California Department of Boating and Waterways

Project Chief: K. Michael Nolan

Period of Project: October 1985 to September 1988



Problem: The planning and management of coastal resources require information about coastal processes such as beach formation and destruction, longshore transport of beach material, and the contributions of sediment from coastal streams and cliff retreat. The California Department of Boating and Waterways has undertaken the development of a management plan for beaches along the California coast. The formulation of such a plan requires knowledge of the extent of coastal erosion and sand transport. Because coastal streams are a significant source of beach material, the quantity of sand delivered by these streams is crucial data for development of the coastal management plan.

Objective: Estimate long-term discharge of sand from coastal streams to the California coast from Half Moon Bay to Monterey Bay.

Approach: Hydrologic and sediment records will be used to determine sediment-transport regimes of measured streams in the study area. Periodic total-load data will be collected and analyzed to determine the fraction of total load which is sand-sized or larger. Sand-transport relations will be applied to long-term water discharge records to determine the annual contribution of sand to the coast from measured streams. Appropriate sand-transport relations will be applied to unmeasured streams, depending on physiographic and hydrologic characteristics, to determine quantity of sand delivered to the coast.

Progress: Periodic samples of suspended-sediment and bedload discharge were taken at study sites. A total of 41 samples were collected at four sites. In addition to those four sites, suspended-sediment transport curves were determined for three additional sites where sediment data had previously been collected. Major physiographic parameters for all drainage basins draining into the coastal zone were measured.

Plans for Next Year: Project suspended until water year 1988 due to lack of cooperator funding.

Reports: None.

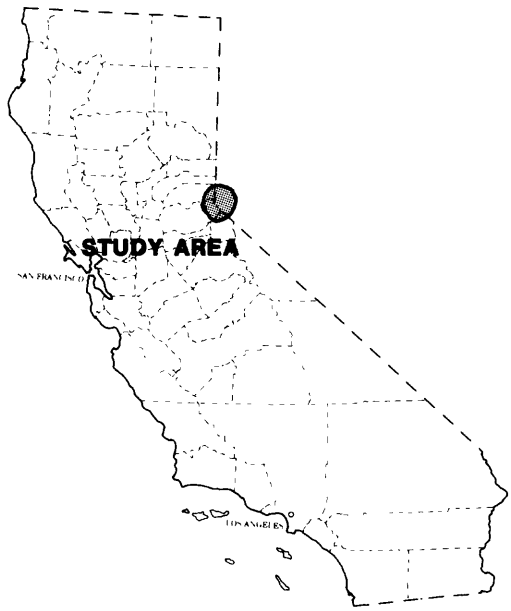
EROSIONAL PROCESSES IN THE LAKE TAHOE BASIN

Number: CA446

Cooperating Agency: Tahoe Regional Planning Agency

Project Chief: K. Michael Nolan

Period of Project: October 1983 to September 1988



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 quanitify processes that contribute sediment to tributaries, (3) quanitify 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: Analysis of stream channel cross profiles surveyed during water years 1984 and 1985 indicated changes in channel configurations were small. The data indicate that changes in the configuration of the main channels were not the sole source of fluvial sediment on some drainage basins. Some sources of sediment were probably from steeper areas within the drainage basins. To better quantify contributions from hillslopes, additional erosion boxes were installed in 1986. Initial data from the wet 1986 water year indicate that substantial channel changes have occured.

Plans for Next Year: Channel cross profiles and hillslope erosion plots will be resurveyed. Sediment storage and erosion will be mapped along the channels of Edgewood and Logan House Creeks. The location and volumes of major gullies will be mapped in Blackwood and Edgewood Creeks.

Reports:

Galton, J.H., and Nolan, K.M., 1986, Suspended-sediment transport, Lake Tahoe basin, Federal Interagency Sedimentation Conference, 4th, Las Vegas, Proceedings, v. 1, p. 4-152 to 4-161.

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 wastewater, 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 wastewater 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: Several geohydrologic characteristics of the study area were measured during the year. Three observation wells on the Morro Bay sandpit were sampled for major-ion concentrations. A multiple well aquifer test was done to measure hydraulic properties of the Paso Robles Formation. A brief report describing the test results was prepared. A temporary stream gage was installed on Los Osos Creek in order to measure seepage in a 1-mile reach extending downstream to a second gage. After the temporary gage was damaged during a storm, discharge measurements were continued manually on a weekly basis. Water levels were recorded monthly at 49 wells and continuously at 3 wells. Data analysis was begun using a three-dimensional finite-difference ground-water flow model. Preliminary steady-state and transient simulations were successfully obtained only after lumping the largely unsaturated surficial sand deposits with underlying saturated alluvium in the uppermost model layer. A baseline period from 1970-77 was selected as representative of long-term climatic conditions. A soil-moisture accounting algorithm was developed to estimate areally-distributed ground-water recharge using historic measurements of precipitation, temperature (evapotranspiration), and land use. A complex, rainfall-runoff model, calibrated to simulate recent discharge in Los Osos Creek, was used to estimate discharge in Los Osos Creek and runoff from small ungaged drainage basins during 1970-77. The ground-water model was modified to simulate dynamic interaction between ground water and discharge in Los Osos Creek.

Plans for Next Year: The model will be calibrated using steady-state and transient simulations of the 1970-77 and 1985-86 periods. The latter period also will be used as a starting point for simulations of potential management alternatives. Two reports will be prepared. One will describe the geohydrology of the basin, methods of analysis used, results of simulations, and interpretative conclusions. The other will document the details of model structure and input.

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 will probably 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: Streamflow during the 1986 water year presented the opportunity to quantify sediment yields at the gaging stations on Permanente and West Branch Permanente Creeks during an unusually wet winter. The 1986 data, presently being analyzed, are expected to document an extreme difference in sediment yields between the two basins. Lithologic analysis of one high-flow bedload sample from each study basin showed that 60 percent of the bedload from the main channel consisted of limestone, even though only 5 percent of the channel length is through naturally occurring limestone outcrops. Additionally, the U.S. Geological Survey rainfall runoff model was tested in the study basins.

Plans for Next Year: Sediment samples will be collected at both gaging stations. The rainfall-runoff model will be calibrated using stream chemistry and stable-isotope analysis. Channel cross profiles will be resurveyed.

Reports: None.

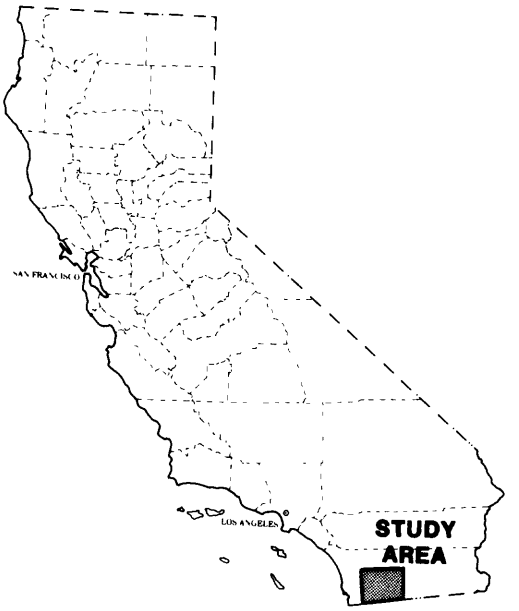
HYDROLOGIC APPRAISAL OF POTENTIAL LANDFILL SITES IN SOUTHEASTERN SAN DIEGO COUNTY

Number: CA450

Cooperating Agency: San Diego County Department of Public Works

Project Chief: Charles A. Kaehler

Period of Project: October 1984 to September 1986



Problem: Increasing urban growth in western San Diego County, plus population growth in the rural eastern part of the county has created a need for additional landfill sites for household-waste (class II) disposal. Currently, waste generated in the eastern part of the county is transported by truck to existing landfills in western San Diego County. Correspondingly, both the capacity in existing landfills and the number of suitable future landfill sites in western San Diego County are diminishing. Thus, the county has a need to develop methods for locating potential landfill sites and for evaluating their hydrologic suitability.

Objectives: (1) Develop methodology for the selection and evaluation of hydrologically suitable potential landfill sites in southeastern San Diego County, (2) select sites for preliminary evaluation as potential landfill sites, and (3) provide hydrologic and geologic data to aid in the evaluation of potential landfill sites.

Approach: Topographic and land-use information will be used to select approximately 13 potential landfill sites. Geological, hydrological, geophysical, and lineament information will be compiled for each of the sites. From the 13 sites, the county will select two sites for detailed surface-geophysical surveys, well drilling and testing, water sampling, and chemical analyses. This work will define the volume, structure, lithology, and hydraulic characteristics of unconsolidated deposits at the two sites.

Progress: During fiscal year 1986, the County Department of Public Works chose two of the preliminary sites for more detailed hydrologic investigation. In making their decision, the county staff used information from summaries of the 13 preliminary sites. The summaries, which were compiled for each site and presented in fiscal year 1985, included information on topography, drainage, ground-water movement and depth, lithology of fill and bedrock, presence of faults and joints, results of vertical-electrical soundings, and estimates of volumes of fill. Fieldwork for the two selected sites was completed in fiscal year 1986, and included drilling of test wells (five at the Vallecito site and three at the Manzanita site) and lithologic test holes (five at Vallecito, six at Manzanita); development of the test wells using compressed air; surveying land-surface altitudes; periodic measurements of water levels; collection of water-quality field data and samples; and aquifer tests using eight test wells and one existing well. Other work included the writing and review of the annotated outline, retrieval of water-quality analyses from the U.S. Geological Survey laboratory, preparation of data tables and report illustrations, analysis of the data, and the writing of a rough draft of a substantial part of the report.

Plans for Next Year: Complete report and incorporate changes resulting from colleague and cooperator reviews.

Reports: None.

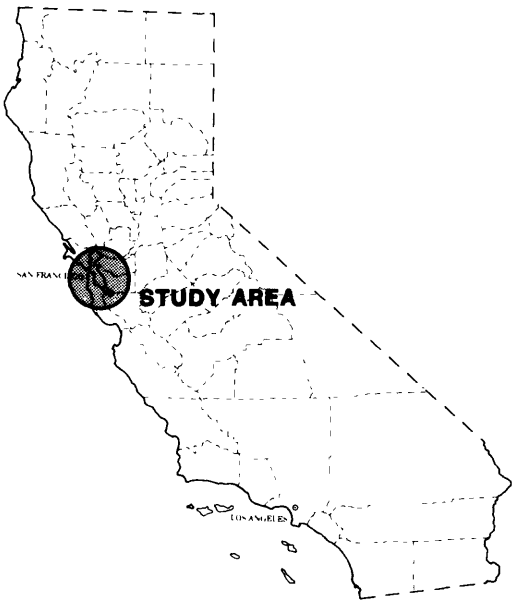
IMPLEMENTATION OF REGIONAL-EFFECTS MONITORING IN SAN FRANCISCO BAY

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 discernable 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 10-20 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 in the course of monitoring.

Progress: An addendum to the Draft Guidance Document for the implementation of the Regional Effects Monitoring Element of the San Francisco Bay-Delta Aquatic Habitat Program was completed and sent to the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Board) and to the Aquatic Habitat Institute (AHI). The addendum incorporates peer review comments and specific suggestions of the California District of the U.S. Geological Survey (USGS) in a detailed review of the Guidance Document. Along with the specific suggestions to each of the components of the document, the addendum ranks the components, as follows, in order of decreasing priority: Striped Bass Health Index, Fish and Shrimp Monitoring, Benthic Sampling, Macroalgae, Zooplankton, and Phytoplankton. Several meetings were held between the USGS, the Regional Board, and the AHI to plan the implementation of the Regional Effects Monitoring Program. A pilot sampling of the macroalgae component was initiated to set up the field sites, collect samples, and identify specimens. A pilot sampling of the benthic invertebrate component also was done to evaluate several bottom samplers for collection of specimens, to evaluate selected sites, and to train District personnel in sample collection.

Plans for Next Year: A second pilot sampling of benthic invertebrates will be done in December 1986, or January 1987, to provide additional training for District personnel and to evaluate and test sampling equipment and research vessel operations. A meeting is scheduled in early spring 1987, to present the results of the pilot samplings to AHI and the Regional Board for final decisions on the implementation of the monitoring program.

Reports: None.

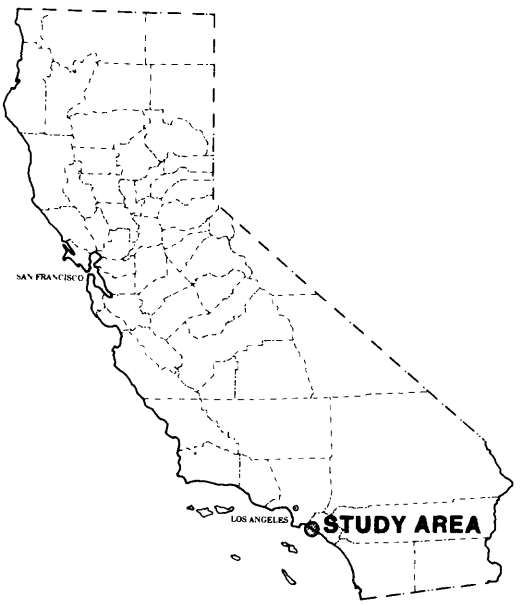
HYDROLOGIC EVALUATION OF A GASOLINE LEAK AT THE SEAL BEACH NAVAL WEAPONS STATION

Number: CA455

Cooperating Agency: U.S. Navy, Naval Weapons Station, Seal Beach

Project Chief: Roy A. Schroeder

Period of Project: October 1984 to September 1986



Problem: Unleaded gasoline from a leaky underground service station tank has contaminated a shallow aquifer at the Naval Weapons Station at Seal Beach, California. The storage tank has been emptied and sealed, and the spreading gasoline does not pose a threat to drinking-water supplies. The potential for contamination of a tidal marsh, which serves as a wildlife refuge, is reason for concern.

Objectives: (1) Determine the areal and vertical extent of gasoline contamination and the lithologic and hydrologic properties of the aquifer, (2) estimate the quantity of gasoline in the aquifer, and (3) evaluate the effectiveness of cleanup.

Approach: About 30 shallow holes will be drilled using a hollow-stem auger. Split-spoon cores from selected holes and depths will be taken for determination of grain-size and gasoline concentration. Shallow holes will be drilled and cased with 2-inch PVC pipe, and water levels will be measured to determine direction of flow. Selected wells will be sampled for major ions, macronutrients, and volatile organic compounds. A shallow hole will be drilled and cased with 6-inch PVC pipe for use in an aquifer test. A recorder will be installed to measure natural fluctuations in ground water.

Progress: Gasoline from a leaking underground service station tank was identified as a source of contamination to the shallow deposits at the Seal Beach Naval Weapons Station. Field observations and/or gas chromatographic hydrocarbon analyses of subsurface soils and ground water from 34 test holes and observation wells were used to delineate vertical and areal extent of contamination. An area of 160,000 square feet and a vertical zone of 1 to 2 feet thick above the shallow water table is contaminated. Seasonal and tidal fluctuations in ground water have spread the gasoline vertically and thereby decreased concentrations below residual saturation throughout nearly all of the contaminated area. Total quantity of gasoline contained in the unsaturated subsoil is estimated to be 5,700 gallons. The amount present in gasoline-saturated soils was not determined. A pumping scheme is proposed that will remove hydrocarbon fuel from saturated soils. Continuing chemical analyses are suggested to measure natural assimilation (biodegradation) rates and further migration beneath the marsh in the nearby Seal Beach National Wildlife Refuge.

Plans for Next Year: Field observations (odor) indicates that a source of diesel fuel is located away from the buried service station gasoline tanks. Results of analyses for diesel fuel/gasoline ratios in hydrocarbon fuel floating on water in two observation wells is pending. A final draft of the report will be prepared when results of the analyses are received.

Reports: None.

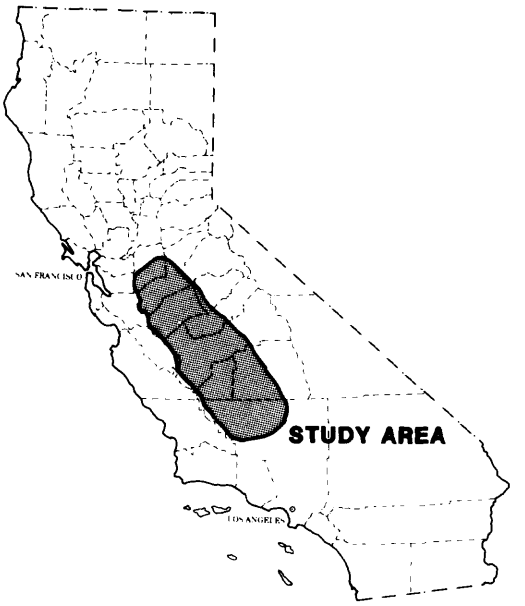
WESTERN SAN JOAQUIN VALLEY HYDROLOGIC STUDIES

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, and laboratory studies of trace-element geochemistry, and ground-water flow and solute-transport monitoring.

Progress: Extensive fieldwork and laboratory analyses are underway. Several reports are being prepared.

Plans for Next Year: Efforts will focus on data analysis, preparation of reports, and planning for changes in study direction.

Reports:

Belitz, Kenneth, 1986, Hydrogeology of alluvial fans on the west side of the San Joaquin Valley, California [abs]: EOS Transactions, American Geophysical Union, 1986 Fall Meeting, San Francisco, November 4, 1986, v. 67, no. 44, p. 936.

Clifton, D.G., 1986, Dissolved solids and trace elements, San Joaquin River Basin, California, September 1985 [ext abs]: 3d Selenium Symposium, March 15, 1986, Berkeley, proceedings, 13 p.

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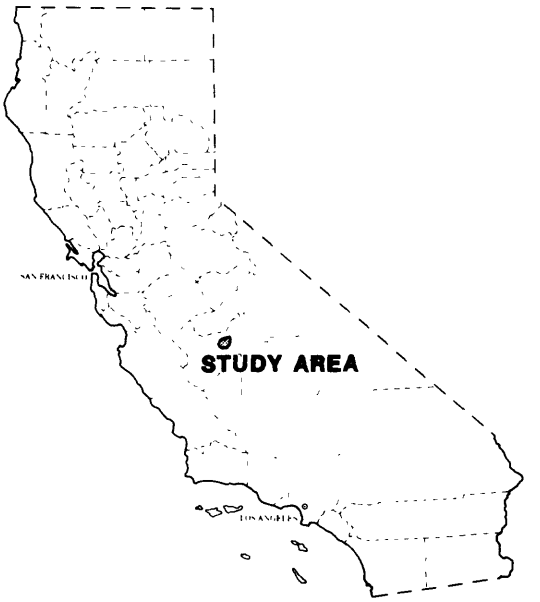
FRESNO SOIL AND GROUND WATER

Number: CA458

Cooperating Agency: Fresno Metropolitan Flood Control District

Project Chief: Roy A. Schroeder

Period of Project: October 1985 to September 1990



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.

Objective: (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 the recharge basin indicate that material is predominantly fine-grained sand. However, downward percolation of water from the pond is apparently restricted by an impermeable clay-rich layer, only a few centimeters thick, that has accumulated on its bottom since excavation in 1981.

Monitoring wells were installed in the two test holes, and water samples were collected for analyses of major ions, several toxic trace elements, macronutrients, organochlorine and organophosphorus insecticides, and volatile organic compounds. Preliminary 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 pond than in the shallow ground water, may be a useful indicator of potential migration of trace metals. Methylene-blue active substances (detergents) and colorimetric-responsive phenols found in the ponds, but not naturally occurring in ground water, may be useful indicators of organic chemical migration.

In a laboratory 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 will demonstrate the potential for attenuation of contaminants in the unsaturated zone. Surficial subbottom mud (0-1 centimeter depth) from six locations in the recharge pond was submitted for analyses of toxic trace elements, radiochemical isotopes, and organic chemicals. Several soil samples from a profile to a subbottom depth of 1.5 meters were also submitted for similar analysis to evaluate the relation between toxics attenuation and depth in the unsaturated zone beneath the pond.

Plans for Next Year: A meeting will be held with the cooperator to discuss plans for additional study (if needed), and a final report will be prepared.

Reports: None.

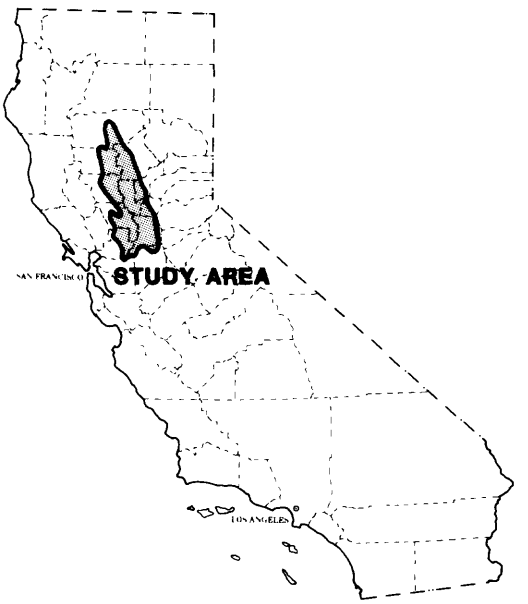
INVESTIGATION OF LAND SUBSIDENCE, SACRAMENTO VALLEY; APPLICATION OF A NEW TECHNIQUE FOR INVESTIGATION OF LAND SUBSIDENCE

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 benchmarks used to measure subsidence have questionable elevations. Further, the aquifer mechanics responsible for land subsidence in the Sacramento Valley are not understood.

Objective: (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 benchmarks and a secondary network in areas of possible subsidence. Also, a field inventory of unused or abandoned wells will be made in areas of suspected subsidence that are suitable for extensometer, piezometer, and possibly strain meter installation. If suitable existing wells cannot be located, new wells will be drilled. These completed installations will be used to monitor the overall rate of subsidence at each site.

Progress: Global Positioning System surveys of the Sacramento Valley were completed by the U.S. Geological Survey National Mapping Division to establish vertical control in the area of suspected subsidence. Thirty-three vertical control points were established and 41 control lines were surveyed in an area of about 2,000 square miles. Processing of these data by the National Mapping Division has begun with scheduled completion by December 31, 1986. Concurrent with the Global Positioning System surveys, a well inventory was done to locate suitable wells for extensometer installation. Four wells were located in the study area and evaluation of these sites for use as subsidence monitoring stations was begun.

An additional survey of the Global Positioning System vertical control points by use of new and existing gravity surveys were discussed with National Mapping Division. These data would assist in preparing geoidal separation data throughout the study area so that historical benchmark elevation data can be related to Global Positioning System survey data.

Plans for Next Year: The 1985 and 1986 Global Positioning System survey data will be compared to determine areas of possible subsidence. Available gravity-survey data will be used to define areas and estimate magnitude of subsidence. Resurveys will be conducted during the summer of 1987 in selected areas and new Global Positioning System surveys will begin in northern areas of the Sacramento Valley. After selection of a suitable site, installation of the first subsidence monitoring station will begin.

Reports: None.

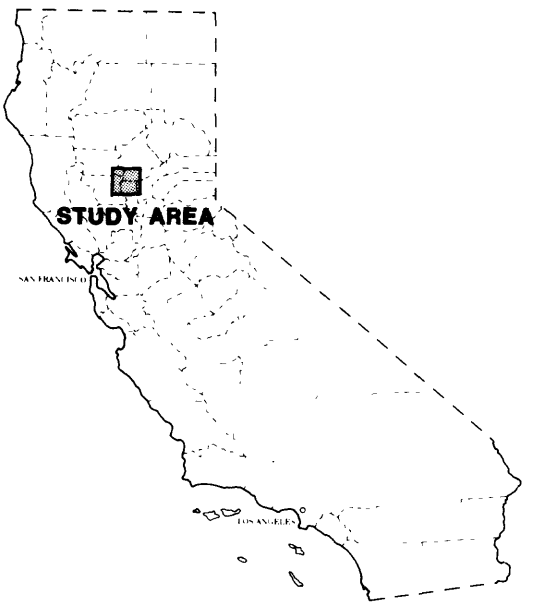
GEOHYDROLOGIC INVESTIGATION OF THE SACRAMENTO VALLEY AREA

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 Redding Basin. Previous studies have revealed difficulties in characterization of aquifer properties, quantification of stream-aquifer interaction, and estimation of ground-water pumpage.

Objective: (1) Describe and analyze the ground-water flow system in the Sacramento Valley and Redding Basin to aid the decisionmaking process of water-resource managers, (2) quantify the hydrologic and geologic characteristics of the ground-water flow system, the stresses on that 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 Redding Basin.

Approach: A GIS controlled data base will be created in order to manage data compiled from driller's/electric logs, geologic maps, soil surveys, power company pumpage records, and existing topographic, geologic, and hydrologic data. Stream-aquifer interactions will be quantified by combining a water-budget approach and flow modeling. Methods currently used to estimate agricultural ground-water pumpage will be improved by comparing method-generated pumpage estimates with measured pump discharge at field locations. 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: A study workplan and an extensive literature search were completed. Geologic and hydrologic information was compiled from reports by the U.S. Geological Survey, California Department of Water Resources, California Division of Mines and Geology, and engineering consultants. Publications and journal articles by various universities also were complied. The literature review indicates that an extensive amount of hydrologic and geologic information is available for parts of the Sacramento Valley, however, similar information for the Redding Basin is limited, and quantitative information on stream-aquifer interaction is lacking.

Electric logs from 1,221 test wells were collected from the files of water-well drilling contractors. Test-well locations were plotted on county land-ownership maps. Most test wells are in Yolo and Colusa Counties and range from 40 to 1,200 feet in depth. Determination of aquifer characteristics was begun using sedimentary-texture information from the electric logs. Digital data files compiled during the Central Valley Aquifer Project were retrieved from the AMDAHL Computer in Reston. These files contain aquifer-parameter data, stress-parameter data, water levels, model-input data, and the FORTRAN code developed for ground-water flow in the Central Valley.

Plans for Next Year: A Geographic-Information-System data base will be established for the storage and manipulation of data collected during this study and the Central Valley Aquifer Project. The collection of electric logs from water wells in the northern and eastern Sacramento Valley and the Redding Basin will continue. Interaction between surface and ground-water systems will be analyzed using existing streamflow, ground-water levels, and stream and reservoir-seepage data. The need for additional data collection, streamflow-gage construction, and water-well installations will be determined.

Reports: None.

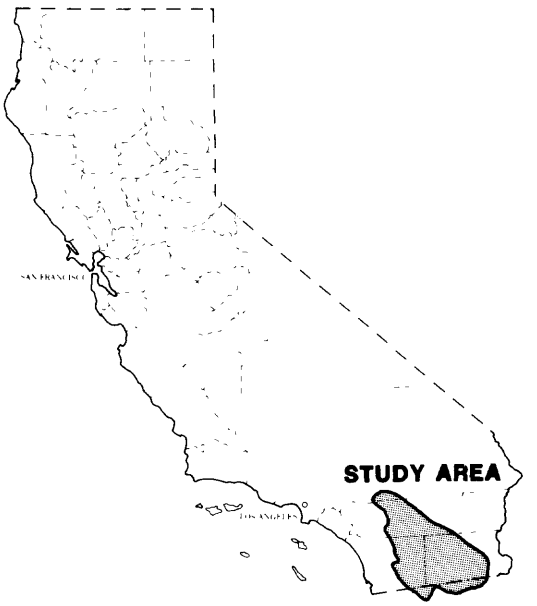
IRRIGATION DRAINAGE, SALTON SEA AREA

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 has initiated 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: The U.S. Fish and Wildlife Service collected 79 biological specimens for analyses of trace elements and organochlorine pesticides. Of these specimens, five were fish, three were invertebrates, and the remainder were birds. Specimens were collected on the New and Alamo River deltas, the Salton Sea, and the Whitewater River delta.

The U.S. Geological Survey collected 15 bottom-material and 12 water samples for analyses of trace elements and several types of pesticides. Samples were collected from the New and Alamo Rivers, the Salton Sea, the Whitewater River, and selected drains in the Imperial and Coachella Valleys.

Plans for Next Year: The U.S. Fish and Wildlife Service will complete its biological sampling, and results from the U.S. Geological Survey bottom material and water samples will be reviewed. Data from previous investigations in the study area also will be reviewed and compared with current analyses prior to preparation of a final report. Future plans include continued contact with the U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation as well as completion of scheduled quarterly reports and a final report.

Reports: None.

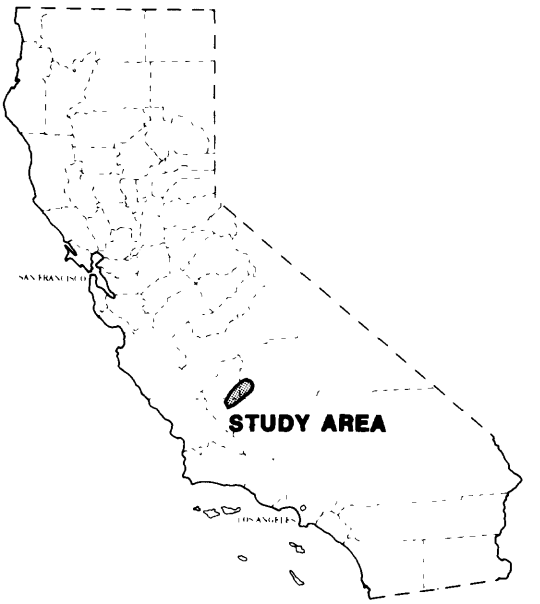
IRRIGATION DRAINAGE, TULARE LAKE

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 has initiated 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: Personnel from the U.S. Geological Survey and U.S. Fish and Wildlife Service prepared a workplan for study of the Tulare Lake area in response to the Department of Interior's Irrigation Drainage Program. Nine sites were selected for sample collection which include 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 was collected for analyses of major cations, major anions, macronutrients, pesticides (organochlorines, organophosphates, carbamates, triazines, and chlorophenoxy acids), 14 toxic trace elements (including selenium), and the common alpha-emitting radionuclides. Bottom material collected from several places at each site was composited, and a portion was wet-sieved to obtain clay plus silt. This fine-sized material will be analyzed for organochlorine pesticides. Particle-size distribution will be determined on the unsieved material.

The U.S. Fish and Wildlife Service collected fish, birds, and bird eggs from the study area for analysis of organochlorines, organophosphates, and 14 toxic trace elements. Invertebrates and plants were archived for future analyses.

Plans for Next Year: Some additional collection of biological samples is planned by the U.S. Fish and Wildlife Service after the return of migratory waterfowl in the winter. The U.S. Geological Survey plans no further collection of water or bottom material. Interpretation of results will begin as soon as data are received. Quarterly reports and a final report will be prepared as requested by the Irrigation Drainage Program Coordinator.

Reports: None.

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SOURCES OF WRD PUBLICATIONS AND INFORMATION

Publications of the U.S. Geological Survey (USGS). -- Professional Papers, Water-Supply Papers, Bulletins, Circulars, Water-Resources Investigations Reports, and Open-File Reports are sold by the U.S. Geological Survey, Books and Open-File Reports Section, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Hydrologic Investigations Atlases, Hydrologic Unit Maps, and other maps pertaining to California are sold by the U.S. Geological survey, Map Distribution, Federal Center, Bldg. 41, Box 25286, Denver, CO 80225.

U.S. Geological Survey Water-Resources Investigations Reports and Open-File Reports are available for inspection at the California District Office, Water Resources Division, U.S. Geological Survey, Federal Building, Room W-2234, 2800 Cottage Way, Sacramento, CA 95825; U.S. Geological Survey, 5201 Ruffin Road, Suite F, COC Annex, San Diego, CA 92123; information on their availability also may be obtained for the District Chief at the above address.

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.

NAWDEX maintains two data bases: (1) a Water-Data Sources Directory and (2) a Master Water-Data Index which identifies and describes available water data. NAWDEX sources can be obtained from the California District Chief. A leaflet explaining NAWDEX services is available from the NAWDEX Program Office, U.S. Geological Survey, 421 National Center, Reston, VA 22092.

WHERE TO OBTAIN ADDITIONAL INFORMATION ON U.S. GEOLOGICAL SURVEY PROGRAMS

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MAPS

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