ACTIVITIES OF THE WATER RESOURCES DIVISION, CALIFORNIA DISTRICT, IN THE 1985 FISCAL YEAR

Compiled by Peter W. Anttila

U.S. GEOLOGICAL SURVEY

Open-File Report 86-244

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Sacramento, California
June 1986

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
Federal Building, Room W-2234
2800 Cottage Way
Sacramento, CA 95825

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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 over 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 studies changes almost decade by decade, two elements of research do not--good systematic data networks and adherence to the essence of science. The essence of science, indeed the logic of the scientific method itself, requires the collection of data, analysis of the data, formulation of hypotheses, testing of the hypotheses (experiments), and finally, reasoned conclusions. To truly study the water resources of California, we, as hydrologists, must assume multidisciplinary roles placing greater emphasis on the maintenance of high-quality data networks, and faster data tabulation and analysis by using sophisticated computer systems; and, by all means, strive to produce products that result from strict adherence to the logic of the scientific method.

During fiscal year 1985, the District was called upon by the Department of the Interior to study one of the most controversial hydrologic problems to arise in many years--selenium toxicity in the San Luis agricultural drain service area and Kesterson Reservoir. In addition, major studies in Owens Valley, the Central Valley, Southern California Regional Aquifer Systems Analysis, San Francisco Bay, Long Valley, and San Bernardino were being done. All these studies are providing information and methodology that contribute substantially to the science of hydrology. In fiscal year 1986, we look forward to continuing the aforementioned studies and will add two major studies in the Sacramento Valley (one of which will experiment with new methods to measure land subsidence), one in Santa Barbara (seawater intrusion), one in San Francisco Bay, and several topical studies on urban runoff and erosion at various locations throughout the State.

The next few years promise continued program growth, but more importantly, continued broadening of the scientific scope of our research.

Gilbert L. Bertoldi
District Chief
U.S. Geological Survey
Sacramento, California

NOTE: Gilbert L. Bertoldi resigned November 15, 1985;
John M. Klein appointed District Chief May 1986.

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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."

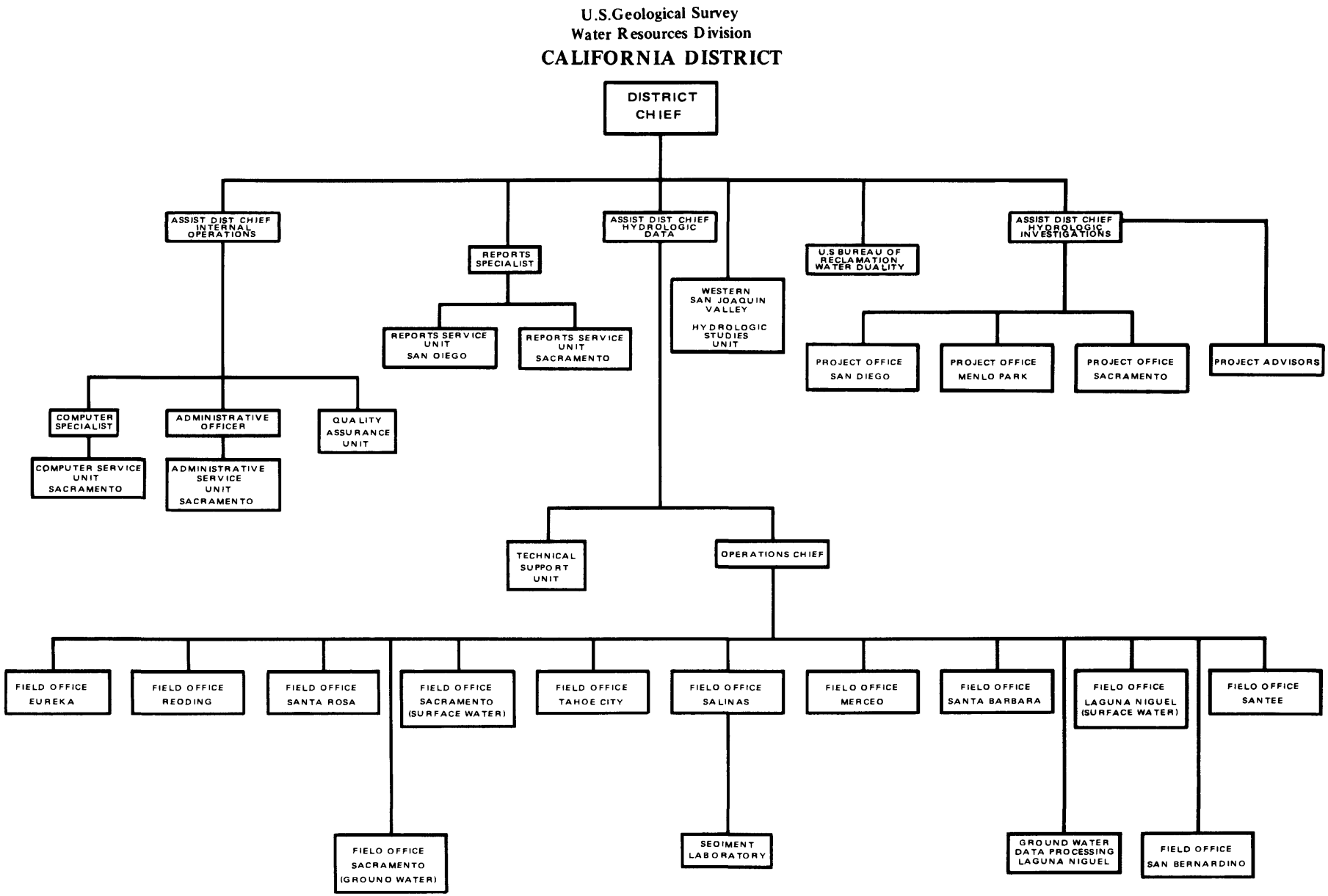

FIGURE 1. Organization chart for the California District, 1985.

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 hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.

CALIFORNIA DISTRICT ORGANIZATION

During 1981, the California District was reorganized. The traditional district-subdistrict concept was restructured into project and field offices with supporting units maintained at the District level. The organization chart (fig. 1) shows the supporting units and technical and field offices for the California District.

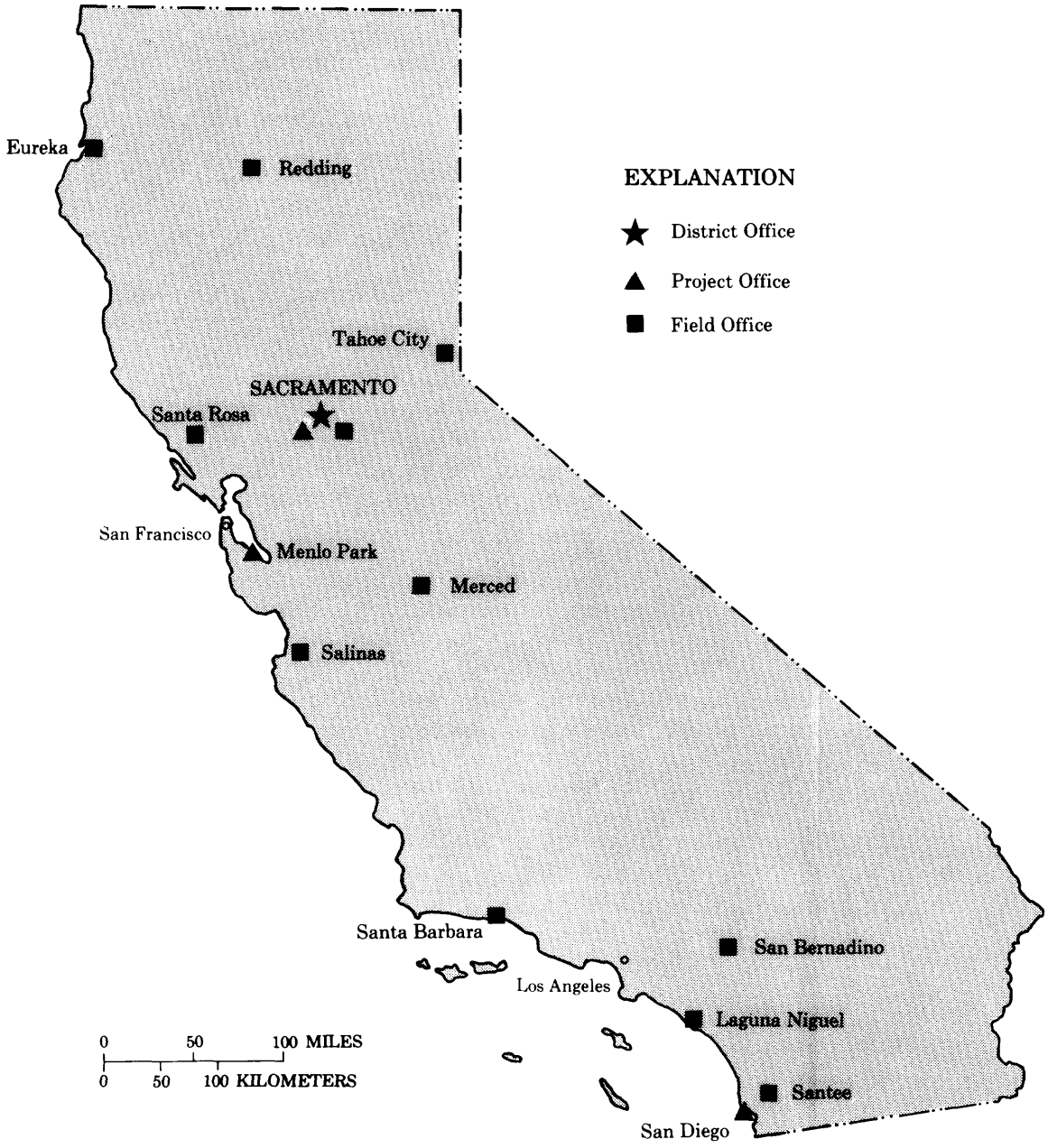

FIGURE 2. Location of offices in the California District.

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	(415) 323-8111 ext. 2256	345 Middlefield Rd., MS 439 Menlo Park, CA 94025
Sacramento	(916) 978-4648	2800 Cottage Way, Rm. W-2234 Sacramento, CA 95825
San Diego	(619) 293-6700	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) 831-4232	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	(714) 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 1984 and 1985, 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 for fiscal year 1985 in each of the broad categories of hydrologic-data collection, areal appraisals and interpretive studies, and research projects.

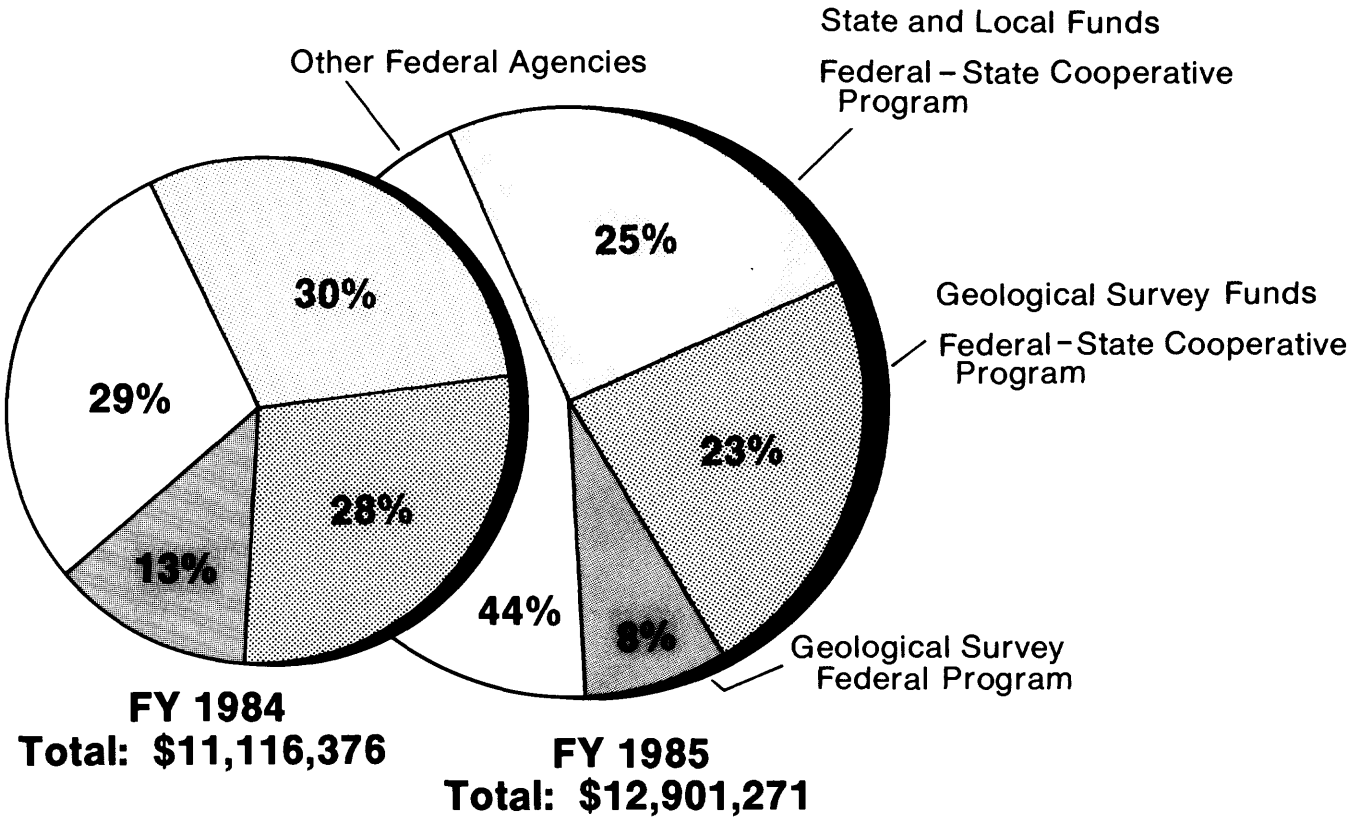

FIGURE 3. Sources of funds in fiscal years 1984 and 1985.

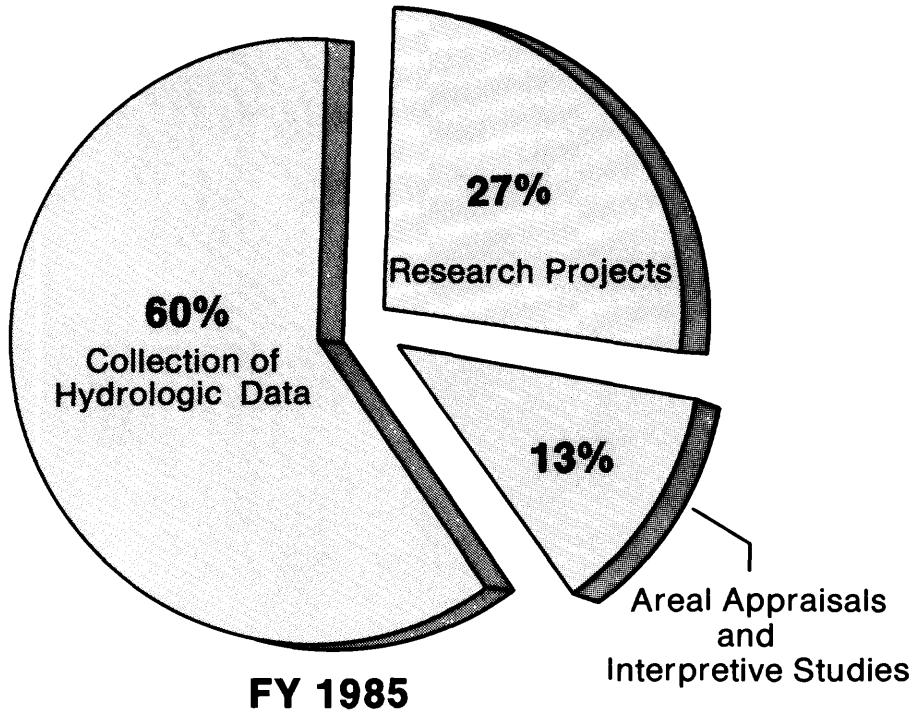

FIGURE 4. Categories of investigations, fiscal year 1985.

In fiscal year 1985, 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 Health Services
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

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 County Water District
Contra Costa County
Crestline-Lake Arrowhead Water Agency
Desert Water Agency
East Bay Municipal Utilities District

Local Agencies--Continued

East San Bernardino County Water District
El Dorado County
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
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
Newport Beach, City of
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
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, City of
San Francisco, City and County, Hetch Hetchy
San Francisco Water Department
San Joaquin County Flood Control and Water Conservation District
San Luis Obispo County Engineering Department
San Mateo County
Santa Barbara County Flood Control and Water Conservation District
Santa Barbara County Water Agency
Santa Barbara, City of
Santa Clara Valley Water District
Santa Cruz County Flood Control and Water Conservation District
Santa Maria Valley Water Conservation District

Local Agencies--Continued

Scotts Valley County Water District
Siskiyou County Flood Control and Water Conservation District
Sonoma County
Sonoma County Water Agency
Southern California Edison Company
Tahoe Regional Planning Agency
Terra Bella Irrigation District
Tulare County Flood Control District
Turlock Irrigation District
United Water Conservation District
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 Air Station, El Toro
- Marine Corps Base, Camp Pendleton
- Naval Weapons Center, China Lake
- Naval Weapons Station, Seal Beach

WATER CONDITIONS

The tremendous economic development of California is tied closely to the use of impressive quantities of water. In 1980, the estimated offstream use of freshwater was 44 bgd (billion gallons per day), (Solley and others, 1983). This was nearly 12 percent of the nationwide use, and more than 2.4 times the use in any other State. Ground-water sources yielded 21 bgd of freshwater, and surface-water sources provided 23 bgd. Irrigation was the major use of both sources of water, requiring 37 bgd. The comparison of water withdrawals, by States, is graphically shown in figure 5. Average discharges for the principal rivers of California are shown in figure 6. Surface runoff is regulated by several hundred reservoirs throughout the State; about 260 of these reservoirs have storage capacities exceeding 50,000 acre-feet.

Water use on the scale practiced in California requires an immense amount of monitoring of streamflows, ground-water levels, and water quality for the ongoing refinement of information regarding the location, quantity, and quality of this resource and the effects of various management practices and plans. The California Department of Water Resources (1983) has predicted a 10-percent increase in net water use between the years 1980 and 2010. Drought years have little effect on water usage except when the drought spans 2 or more years, as occurred in 1976 through 1977. The pressure for more and better water information will grow with the difficult task of increasing the present supply.

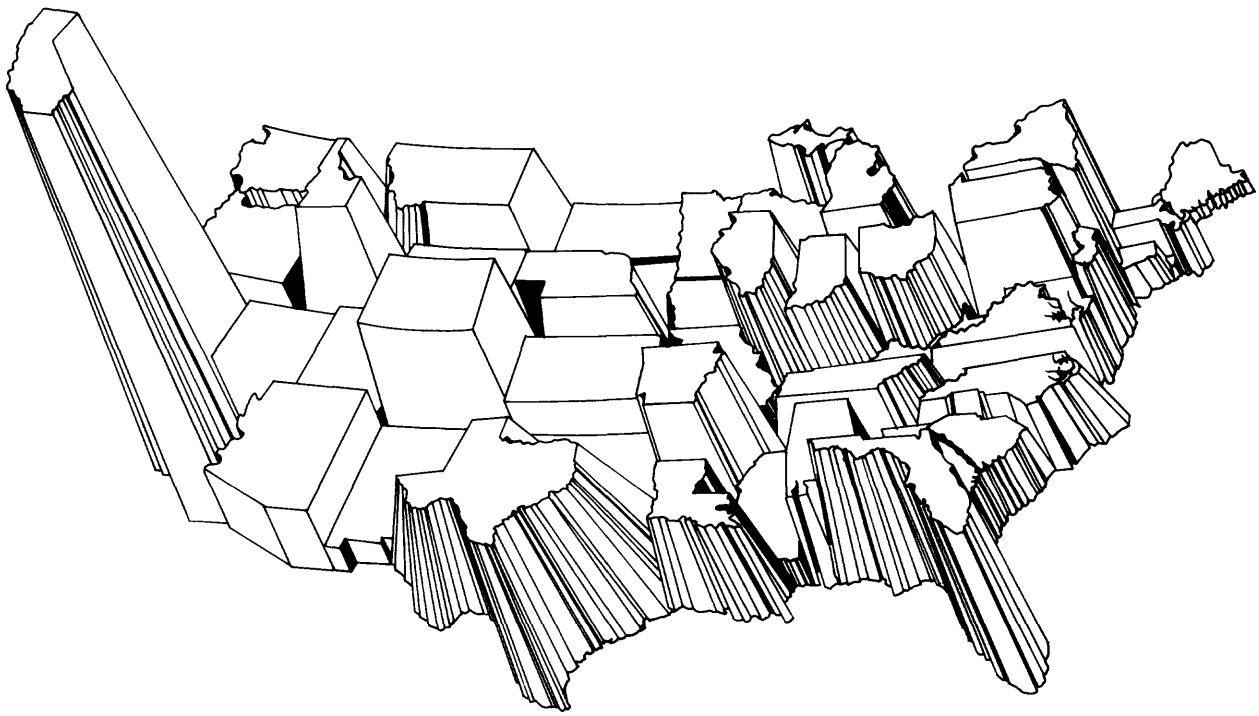

FIGURE 5. Graphic comparison of water use in the conterminous United States, as of 1980. (From Solley, Chase, and Mann, 1983.)

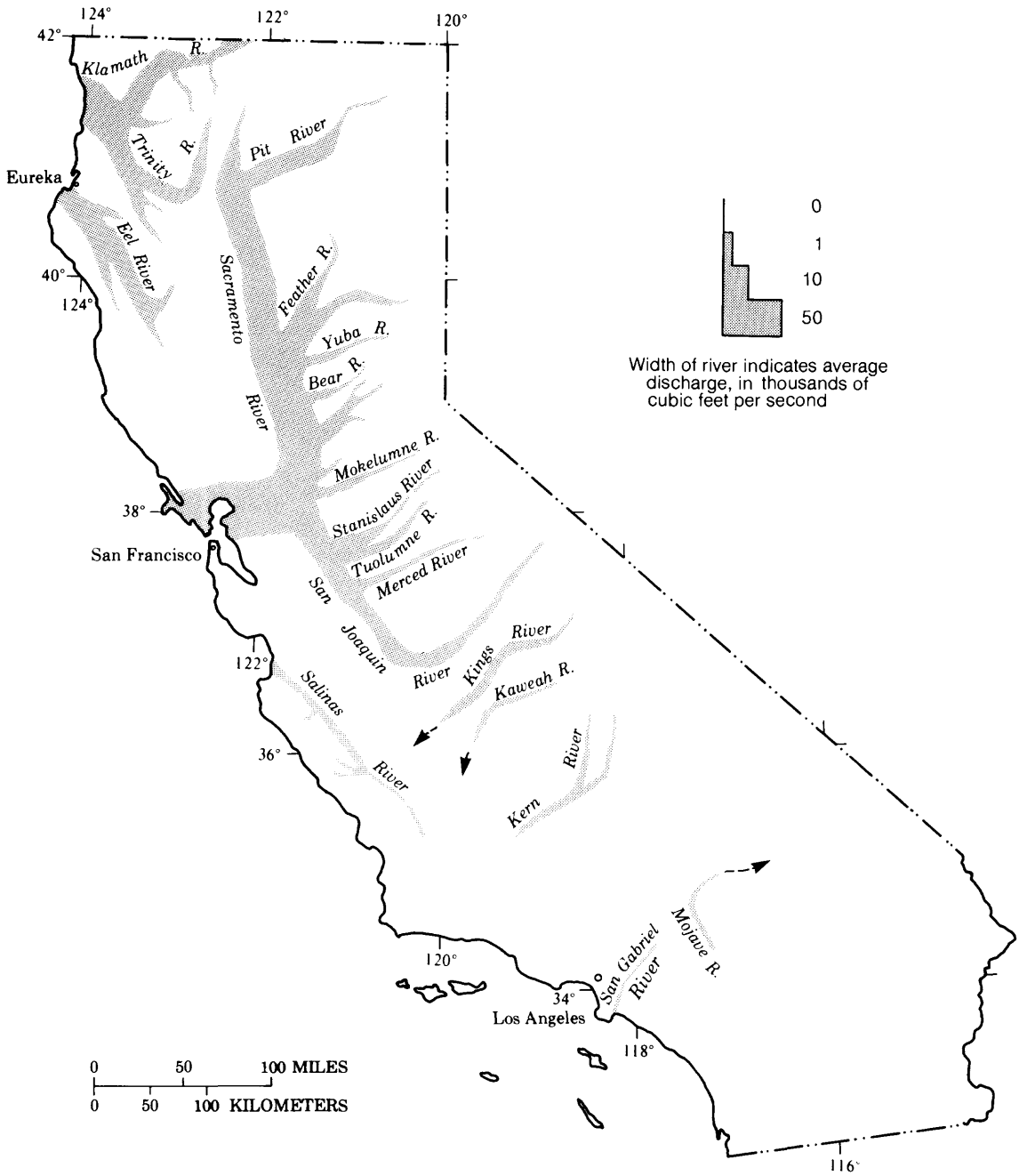

FIGURE 6. Average annual discharge of principal rivers.

The ground-water trend is generally one of declining water levels in basins where imported water is not available for recharge or supplemental use. As of 1980, the California Department of Water Resources (1980, p. 3) had identified 42 ground-water basins in overdraft. Statewide overdraft in 1980 was estimated at 1.6 bgd (California Department of Water Resources, 1983, p. 88). In many basins, such as the Santa Clara Valley, water levels are virtually static because of recharge programs using basin runoff and imported water.

Water quality in the upland streams of the State is generally excellent but it deteriorates in lowland agricultural and urban areas where streams pick up return-irrigation flow or urban runoff with higher concentrations of dissolved minerals and organic compounds. Sediment yields of streams in the north coastal mountains are very high and can be a problem, whereas sediment yields in the streams of the Sierra Nevada are generally moderate because of the less erodible granitic bedrock of that range. Sediment transport necessary to maintain the beaches of southern California was affected adversely in many areas by reservoirs that trap sands before they reach the ocean.

In the 1985 water year, precipitation and streamflow were generally deficient. Precipitation was 94 percent of the 1951-80 averages in Eureka, 79 percent in Santa Rosa, and 70 percent in Los Angeles. Figure 7 is a map of average annual precipitation. Runoff for the water year was considerably below average, with 72 percent of the median 1951-80 flow in the Smith River near Crescent City, 48 percent in the Napa River near St. Helena, 69 percent in the Merced River at Pohono Bridge, near Yosemite, and 86 percent in the Arroyo Seco near Pasadena. Streamflow during the normally heavy runoff months of December through May was generally about two-thirds of the 1951-80 median discharges. January runoff was exceptionally low, with less than 30 percent of the median flow occurring in most northern and central California streams. Water managers were decidedly uneasy with the prospect of reservoirs being depleted of potential carryover for a cushion against another possibly deficient runoff season in 1986. At the end of the 1985 water year, Shasta Lake, the largest reservoir in the State, held only 61 percent of the median year-end contents. This was the third lowest year-end level since completion of the dam in 1949. Lake Oroville, the second largest reservoir, finished the year with 82 percent of the median year-end contents, and Pine Flat Lake, the largest reservoir in the Tulare Lake basin, ended the year with 57 percent of the median year-end contents.

A major water concern of 1985 is related to water quality. Awareness of return-irrigation-water problems grew as elevated selenium levels were reported in the Tulare basin and the Salton Sea. The selenium problem in the Kesterson National Wildlife Refuge Reservoir finally forced the Department of Interior to order the phased cutoff of all irrigation-return flow to this waterfowl refuge by 1988. An interagency committee formed to evaluate agricultural drainage problems throughout the western United States is now making plans to investigate several basins in California.

Ground-water contamination may be the most serious water-quality problem. The California State Water Resources Control Board has scheduled 205 industrial and military waste sites for cleanup action. Fourteen of these sites are on the U.S. Environmental Protection Agency's priority list. Seawater intrusion is another ground-water quality problem that continues to threaten coastal areas of the State, such as the Watsonville, Castroville, Morro Bay, and Santa Barbara areas. Much investigation remains to be done in all the water-quality-problem areas to define the extent and severity of contamination and to evaluate techniques to rectify the problems.

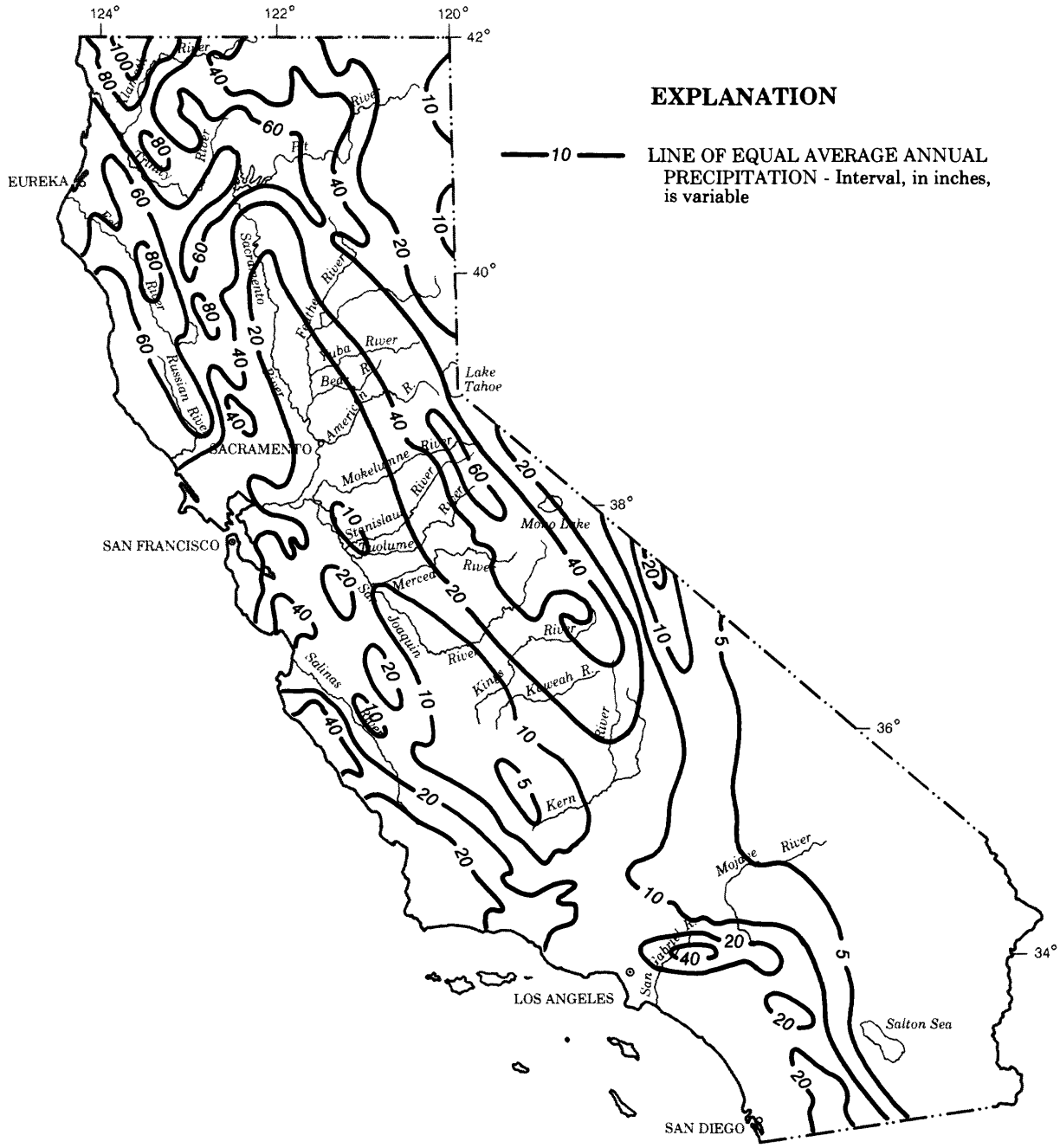

FIGURE 7. Average annual precipitation, 1951-80.

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_____1983, The California water plan--Projected use and available supplies to 2010: California Department of Water Resources Bulletin 160-83, 268 p.

Mendenhall, W.C., 1908, Preliminary report on the ground waters of San Joaquin Valley, California: U.S. Geological Survey Water-Supply Paper 495, 285 p.

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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.

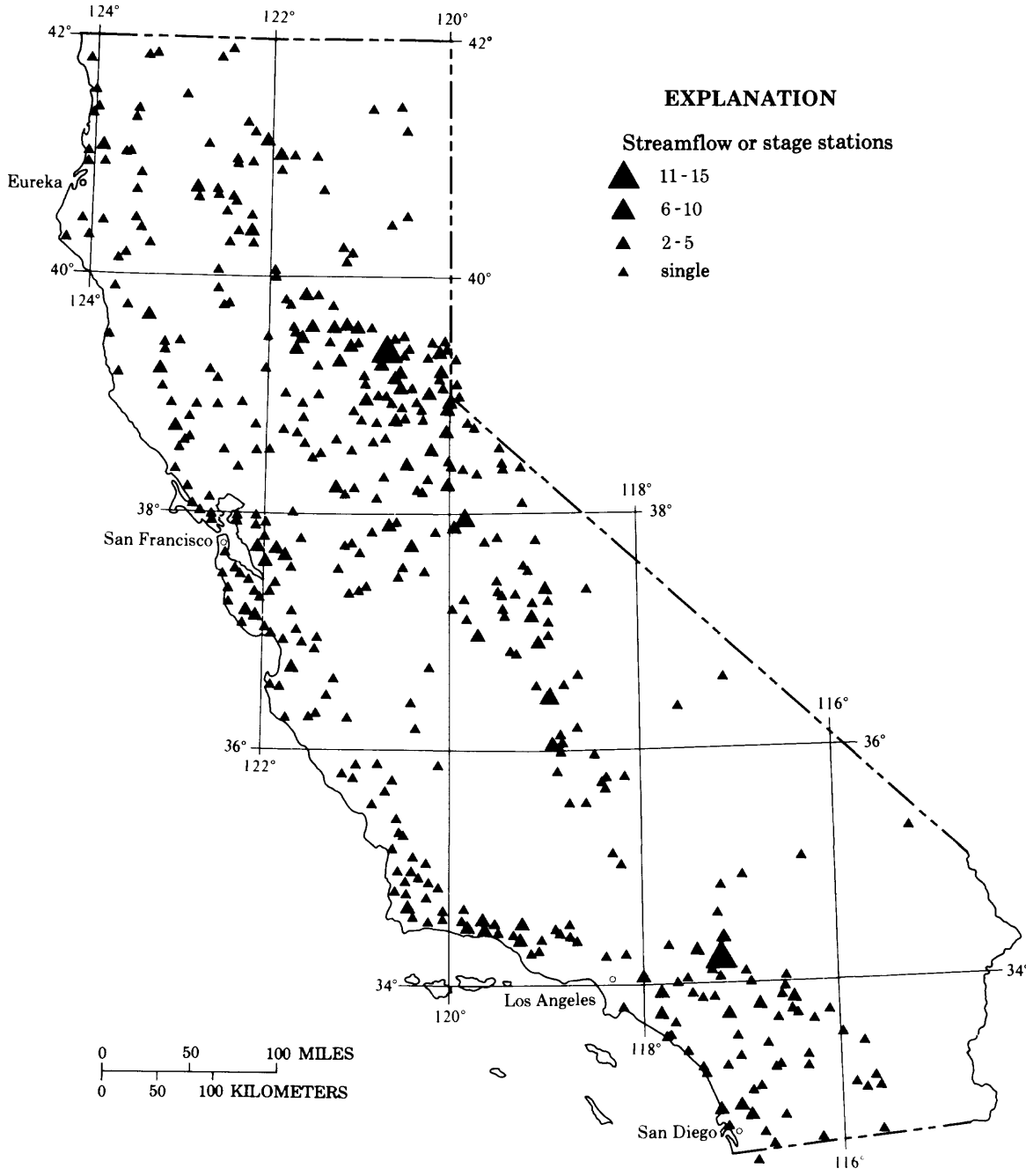
Objectives: Collect and publish surface-water data to meet the needs for (1) assessment of quantity, and distribution of surface-water resources; (2) operation of reservoirs for power, flood control, and irrigation; (3) flow forecasting; (4) monitoring of flow for instream use requirements; (5) determination of 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, planning, and design of dams, bridges, culverts, canals, flood management projects, and ground-water recharge facilities.

Approach: Measure and record stage and discharge of streams and stage and contents of lakes and reservoirs. 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: Continued collection and compilation for publication of surface-water data for 498 continuous streamflow measuring stations, and reviewed for publication 130 streamflow records provided by other agencies and FERC (Federal Energy Regulatory Commission) licensees. Collected and compiled data for publication of 35 records of reservoir contents, and reviewed for publication 50 additional reservoir records provided by cooperators. Collected and compiled for publication data for 33 partial record sites providing peak flow, low flow, seasonal flow, or limited range of discharge information. Data for Water Year 1983 were published in the report, Water Resources Data for California, Water Year 1983. Unpublished data for an additional 74 partial-record sites were collected for contemplated future hydrologic studies, and 238 unpublished records provided by FERC licensees were reviewed.

A major thrust in the surface-water data program has been the cost-effectiveness study of the stream-gaging network. This study began in 1983 and continued through 1985. Approximately 60 percent of the network has now been analyzed. A few minor adjustments in operations have resulted from the analysis. But to date, the study indicates that the current mode of operation is yielding data with an average accuracy only 1 to 2 percent less than theoretically obtainable using computer-optimized operational strategies.

Plans for Next Year: Continue program of statewide data collection and review. The cost-effectiveness study of the gaging station network also will continue. Installation of 20 satellite data collection platforms is planned for real-time transmission of streamflow information from selected remote gaging stations. Four stations are presently equipped with satellite-relay data in transmitters installed by the U.S. Geological Survey.



Locations of streamflow-measuring stations.

GROUND-WATER STATIONS

Number: CA002

Project Chief: Charles E. Lamb

Location: Statewide (See accompanying map)

Period of Project: Continuing

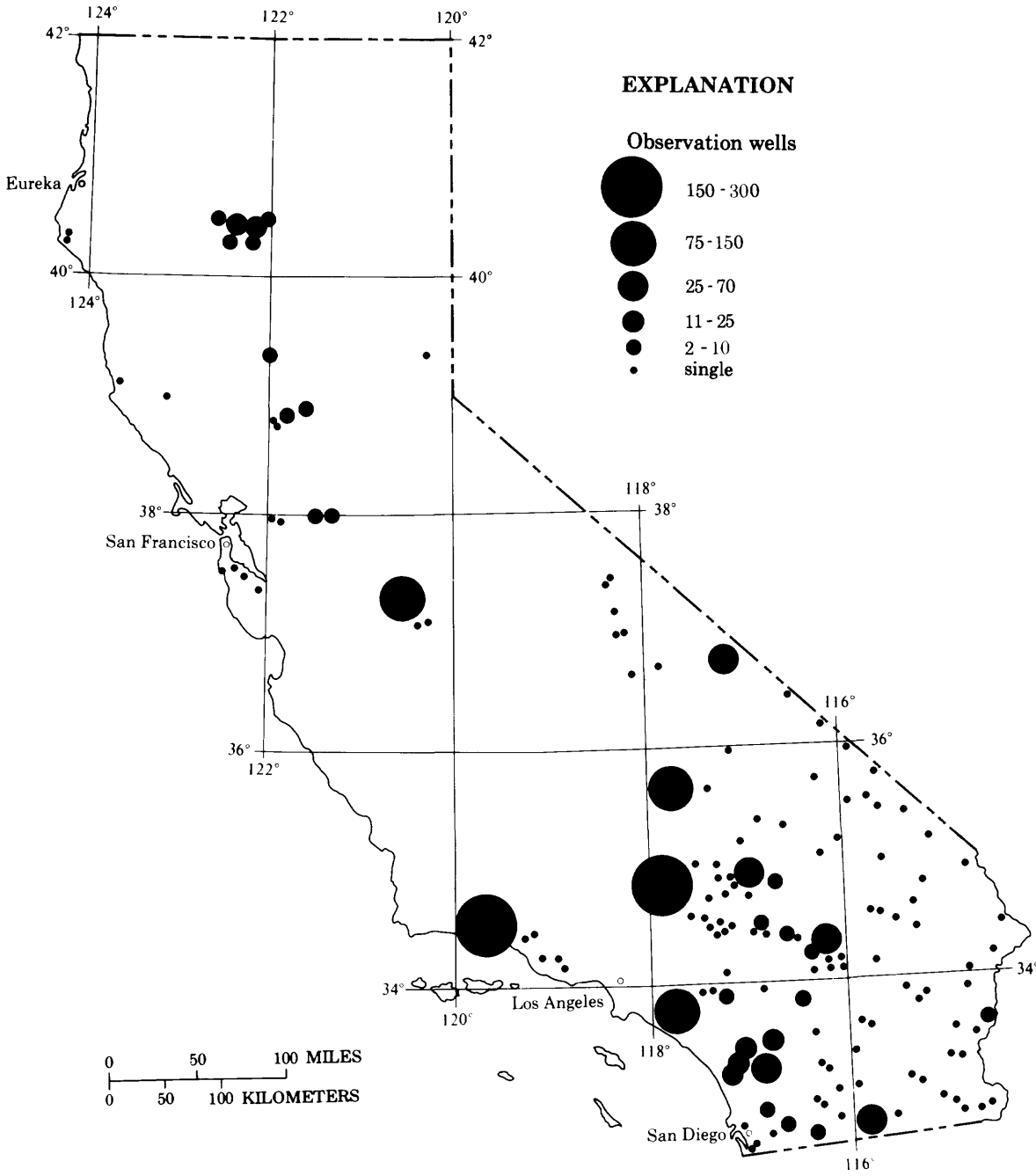
Problem: Ground water accounts for about 48 percent of freshwater withdrawals in California--about 21 billion gallons per day (1980). Nearly 10 million people are served by ground-water supplies. Significantly, 18 billion gallons per day were withdrawn for irrigation (1980). The distribution of ground 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 and local water planning.

Approach: Measure, record, and computerize water-level data on varying frequencies, including continuous, monthly, semiannual, and annual. Standard methods of data collection are used as described in "National Handbook of Recommended Methods for Water-Data Acquisition" and the Water Resources Division manuals and memoranda.

Progress: Continued collection and compilation of ground-water level data at 1,240 long-term and 112 short-term sites, and at 40 continuous recorder wells. Publication of some data was included in the annual data report.

Plans for Next Year: Continue the data collection and record processing. Publish all processed data in a separate volume of the annual report series, Water Resources Data for California.



Locations of selected observation wells.

WATER-QUALITY STATIONS

Number: CA003

Location: Statewide (See accompanying map)

Project Chief: Kenneth W. Lee

Period of Project: Continuing

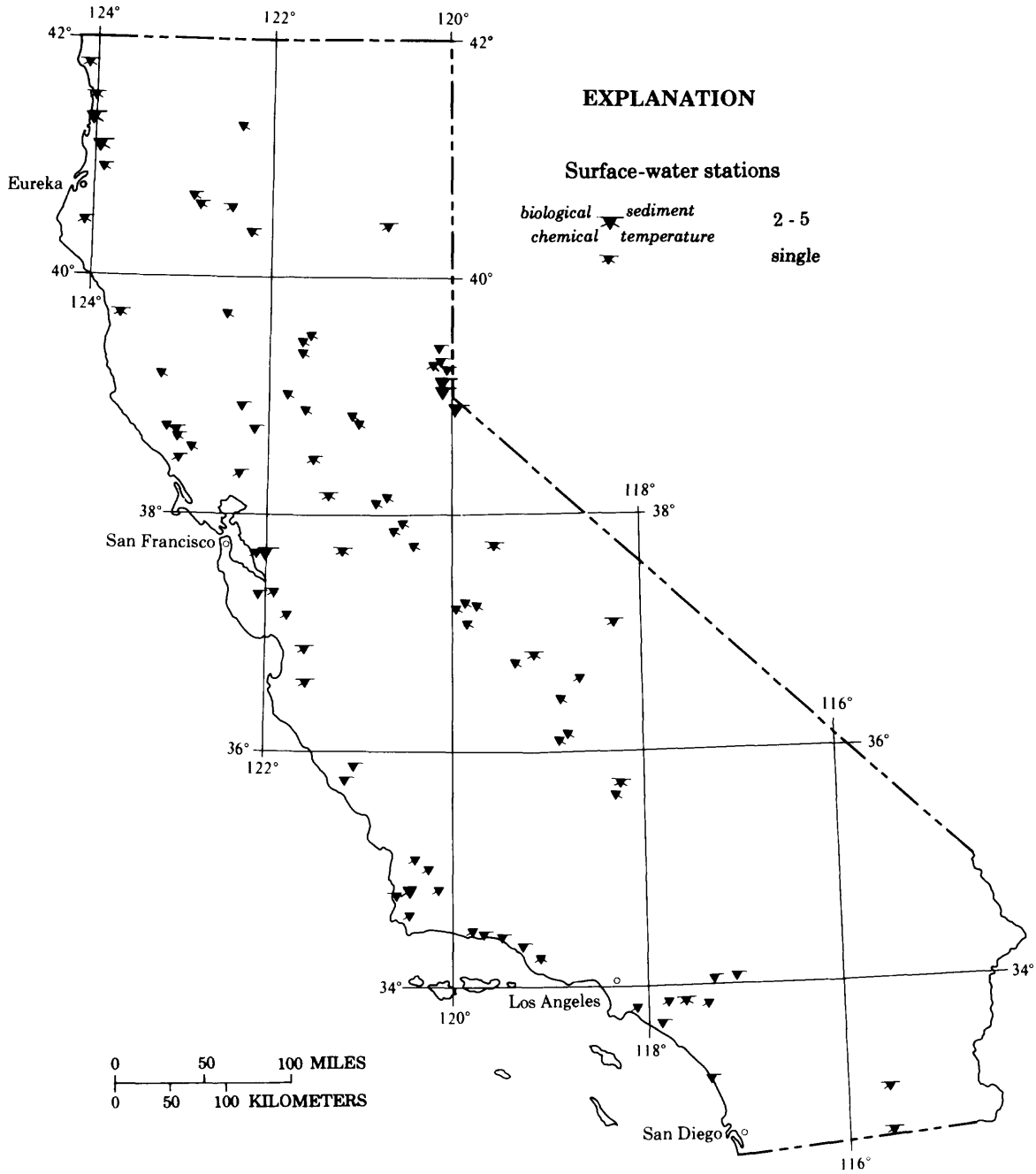
Problem: In order to properly manage the water resources of the State, the quality of surface waters must be delineated and monitored.

Objectives: To collect and publish both long-term and short-term records of the quality of water at selected stream, ground-water, 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: Establish and operate a network of water-quality stations 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 memoranda.

Progress: Water-quality data were gathered periodically at a multitude of sites located throughout California. Water-quality samples were collected at bimonthly at 13 and quarterly at 8 NASQAN (National Stream Quality Accounting Network) sites, and quarterly at 2 Hydrologic Benchmark sites. Due to a potential health hazard, sampling at the New River near Calexico NASQAN site was terminated in April until an environmental risk evaluation could be made. Water temperature and specific conductance were measured continuously at 36 and 5 sites, respectively. Precipitation samples were collected weekly at the National Trends Network site located in Los Padres National Forest. In addition to these sites, water-quality data were collected at 44 stream and reservoir sites. Ground-water samples were collected and analyzed for 323 long-term wells and 90 short-term sites. Data for water year 1983 were published in the report, Water Resources Data for California, Water Year 1983.

Plans for Next Year: Continue the collection of water-quality data. Discontinue all activities at the New River near Calexico NASQAN site and remove one continuous temperature recorder from the Cottonwood study area. Add Sagehen Creek near Truckee to the Hydrologic Benchmark program.



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 our environment can be devastating. Knowledge of sediment transported by streams is essential in both 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 for (1) developing land-management practices that will reduce erosion rates; (2) evaluating the impact of timber harvesting on fisheries; (3) determining the effects of debris basins and drop structures on sediment transport; (4) monitoring reservoir capacity losses for flood control and water-supply purposes; (5) determining the relation of sediment to lake algae growth; (6) evaluating changes in coastal morphology caused by coastal river sediment; (7) determining the effects of urbanization on channel morphology; (8) estimating channel changes that may result from proposed dam sites.

Approach: Collect suspended-sediment and bed-material samples at specific sites on streams within the State. Collect bedload samples at those stream sites that are total-load stations if the stream characteristics warrant the use of a bedload sampler. Compute daily concentration and suspended-sediment discharge for all daily sediment stations. Estimate monthly bedload discharge for all daily total-load stations. Analyze selected suspended-sediment, bedload, and bed-material samples. Analyze for particle-size distribution.

Progress: Sediment data collected during water year 1983 were published in the report, Water Resources Data for California, Water Year 1983. Sediment data collected at 39 daily, 22 periodic, 16 NASQAN, and 2 Hydrologic Benchmark stations during water year 1984 were compiled and reviewed. Daily suspended-sediment samples were collected at 35 daily sediment stations. Bedload samples and/or indirect bedload computations were made at 21 of these sites. Monthly and storm-related suspended-sediment samples were collected at 30 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 16 NASQAN and 2 Hydrologic Benchmark stations.

Plans for Next Year: Complete compilation and review procedures for all 1985 sediment records. Collect sediment data at 27 daily, 22 periodic, and 17 NASQAN/Benchmark stations in water year 1986. A sand transport study along the coast of Monterey Bay may result in the addition of four periodic total-load stations to the 1986 program.

NATIONAL TRENDS NETWORK FOR MONITORING ATMOSPHERIC DEPOSITION

Number: CA005

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 and determine the annual loading in areas of California. Sampling sites in California are part of a National network.

Approach: Install and operate one atmospheric-deposition sampler at Chuchupate Ranger Station in Los Padres National Forest, in Ventura County, California, and collect weekly samples for chemical analysis. The California District function is to collect and ship the samples to the laboratory. Thereafter, the data are handled by the National program.

Progress: Continued operation of atmospheric-deposition sampler and rain gage.

Plans For Next Year: Continue to collect samples of atmospheric deposition and ship them to the laboratory. A second site installed at Yreka is operated by Siskiyou County under the direction of the National program. The California District will field inspect this site once or twice annually but will have no other responsibility for this station.

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. 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. Present and future National water-use information needs must be met in the most efficient and cost-effective manner possible.

Objectives: (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. (4) Explain the values and applications of water-use information, and make this information available to those involved in establishing water-resources policies.

Approach: Regional information for all of California will be developed to meet the needs of the U.S. Geological Survey's 1985 National water-use report. The existing water-use information sources and the types of information they produce will be determined. Computer software are being developed to store the 1985 water-use data at the State level. Site-specific information will be input into the Survey's State Water-Use Data System as time, personnel, and funds allow.

Progress: The State Water-Use Data System was revised, loaded on the California District's Prime[1] Computer, and tested for operational functions. A "draft" program plan was written to provide long-term guidance, and a project proposal was written to provide short-term guidance for next year.

Plans for Next Year: The primary goal for next year is to provide the information needed for the 1985 National water-use report. Existing water-use information sources will be identified. The "draft" program plan will be finalized. The first annual California water-use program progress report will be written.

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

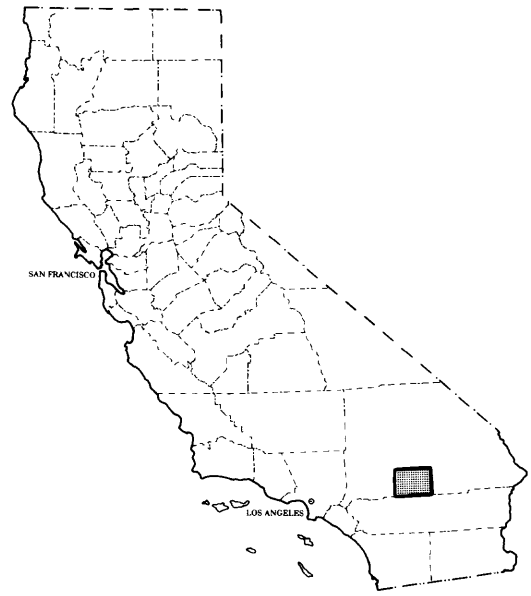
GROUND-WATER APPRAISAL, U.S. MARINE CORPS BASE, TWENTYNINE PALMS

Number: CA027

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

Project Chief: Richard J. Mandle

Period of Project: September 1981 to September 1986



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 may be adversely impacted, particularly by high concentrations of fluoride.

Objectives: To determine the quantity and quality of ground water and to maintain a water-level and water-quality monitoring network in the western part of the Base.

Approach: Locate and determine status of all wells in project area. Measure water levels and compare with past data to determine water-level change. Collect and analyze samples of water from pertinent wells. Make gravity survey to determine the thickness of aquifers and basin configuration. Use previously estimated specific yields and gravity data to refine storage estimate. Develop a digital model of the ground-water system to assess the effect of future ground-water pumping.

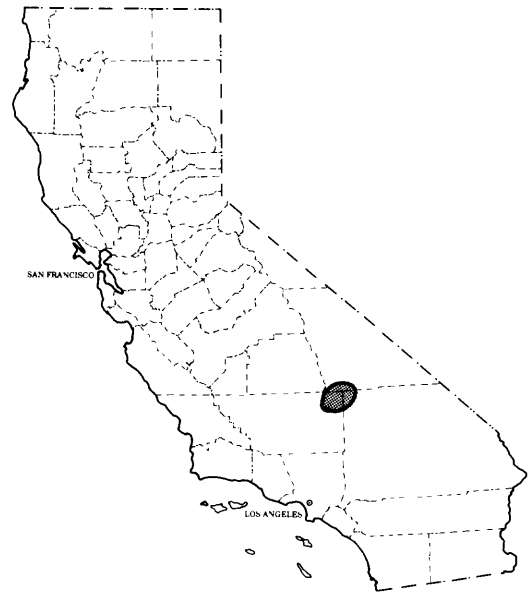
Progress: A preliminary digital model of ground-water flow for Surprise Spring subbasin was constructed. Two reports were approved for publication.

Plans for Next Year: Proposed plans are (1) Conduct seismic and surface-resistivity surveys of the basins to help locate geologic faults in the area and to better define the water table and bottom of the aquifer system. (2) Drill up to 15 test wells to accurately determine the water levels in the areas of the faults and to help define the water quality of the area, particularly in the Deadman Lake subbasin. (3) Collect and analyze water-quality samples from both existing wells and the new test wells. (4) Further develop and refine the ground-water flow model of the Surprise Spring subbasin. Make model runs to predict the effects of proposed changes in the existing well field and of artificial recharge with imported water.

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 and is faced with the problem of managing water resources of the area in order to best meet future needs.

Objectives: Define current ground-water conditions in the valley using a water-level and water-quality monitoring network. Develop a management tool (computer model) that can be used to predict response of the ground-water system to future ground-water development.

Approach: Measure water levels, estimate the quantity of ground-water pumpage, and estimate evapotranspiration using eddy-correlation measurements. Reorganize and reevaluate previous model data in order to develop a steady-state and transient-state digital computer model of the basin using the U.S. Geological Survey Modular Model. Update this model from 1976 to the present. Use this computer model to predict ground-water levels under selected management alternatives, primarily in the current pumping centers of the basin.

Progress: Water-level measurements and water-quality sampling for fiscal year 1985 were completed. A ground-water data report for Indian Wells Valley for 1977-84 was prepared and currently is in review.

Plans for Next Year: Continue the water-level and water-quality monitoring programs. In addition, sample wells for deuterium to help determine ground-water flow near suspected subsurface barriers in the valley. Update ground-water pumpage estimates and determine ground-water depletions. Also refine the Indian Wells ground-water model that was completed in 1970 with current information in order to predict the effect of future pumpage on the ground-water system.

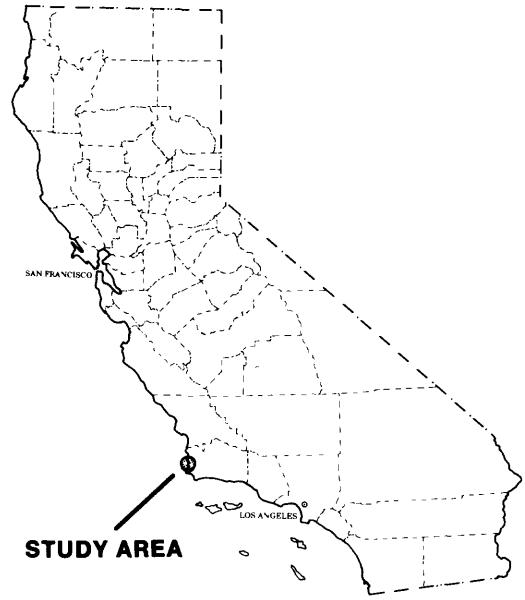
WATER-RESOURCES APPRAISAL, VANDENBERG AIR FORCE BASE

Number: CA051

Cooperating Agency: U.S. Air Force, Vandenberg Air Force Base

Project Chief: Charles E. Berenbrock

Period of Project: Project end date, September 1985



Problem: The Vandenberg Air Force Base landfill has the potential to develop leachates which could degrade the water quality of nearby ground- and surface-water resources. The landfill started in 1950, and it will be in operation until about 1995. Currently about 9,000 tons of solid waste are deposited annually, and, projecting this figure to 1995, about 120,000 additional tons of solid waste will be deposited into the landfill. As more solid waste accumulates, landfill leachates will increase in volume and concentration.

Objectives: Assist Vandenberg Air Force Base in its water-management plan, by evaluating the impact of the landfill on the nearby water resources. Specific objectives are to (1) determine the quality of native ground and surface water at the landfill, (2) determine the quality of leachate within the landfill, (3) determine the quality of ground and surface waters downstream from the landfill, and (4) evaluate potential ground- and surface-water pollution caused by the landfill.

Approach: Establish a water-quality monitoring network in the area of the Vandenberg landfill. The network will consist of four monitoring wells, two streamflow stations, and a leachate retention pond. Collect water samples from the landfill water-quality-monitoring sites four times a year. In January, March, and September, analyze water samples for major ions, nutrients, total organic carbon, and manganese. In June, analyze water samples for major ions, trace elements, nutrients, total organic carbon, and volatile organic compounds. Measure specific conductance, pH, temperature, and alkalinity at each site when samples are collected.

Progress: The Vandenberg Air Force Base landfill contains high concentrations of several volatile organic compounds that were identified in samples from two wells. At one well, the concentration of trichloroethylene ranged from 2,000 to 80,000 micrograms per liter in eight samples. At two of the monitoring wells, 15 organic compounds on the Environmental Protection Agency list of priority pollutants were identified.

Plans for Next Year: The water-quality monitoring network will be continued under data-collection project CA003.

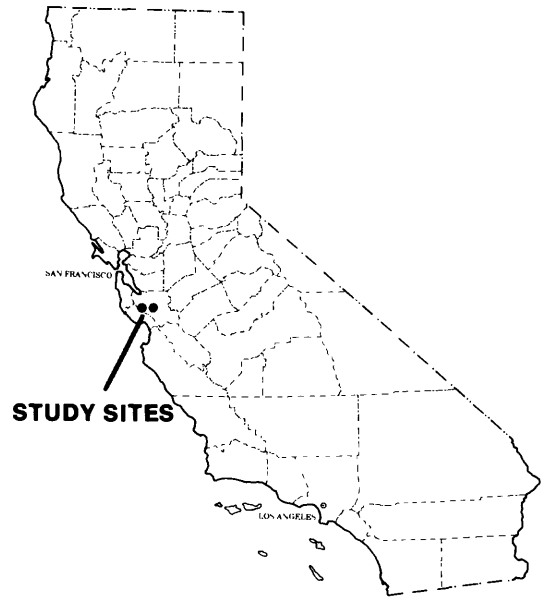
CHARACTERISTICS OF SELECTED LAKES AND RESERVOIRS

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 (SCVWD) 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.

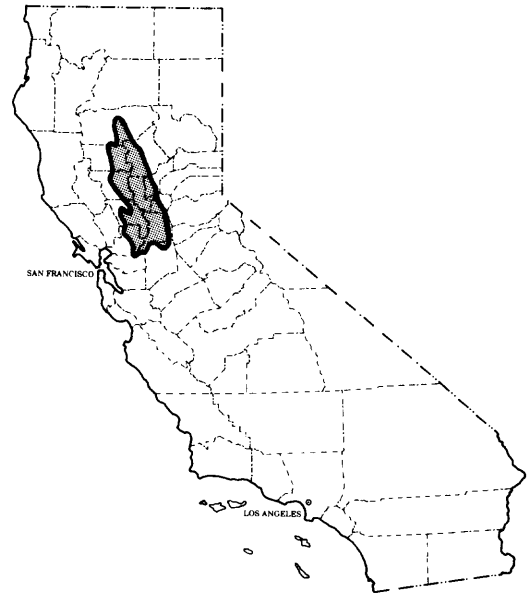
Objectives: Describe present water-quality conditions of Lexington and Calero Reservoirs including: (1) estimates of primary productivity at reservoir center; (2) comparison of water-quality conditions and water-quality objectives; (3) evaluation of present reservoir monitoring to see whether SCVWD's monitoring objectives are being met, and (4) definition of baseline water quality before water imported by the San Filipe Project is introduced.

Approach: Collect data four times per year or as required by changes in hydrologic conditions. Describe physical, chemical, and biological characteristics of the reservoir and its major tributary by using graphical and tabular summaries of the collected data. Delineate areal and seasonal variations and note water-quality conditions that do not comply with water-quality objectives established and/or proposed by the Regional Water Quality Control Board, San Francisco Bay Region.

Progress: A report for Calero Reservoir that describes data collected from December 1980 to September 1983 was written and is in review. Monitoring constituents and schedule were modified based on the findings. Calero Reservoir was sampled four times in fiscal year 1985. A report for Lexington Reservoir that describes the data collected from 1978 to 1982 was written and is in review. The monitoring program has been adjusted on the basis of the findings. Because Lexington Reservoir was drained this summer, monitoring was conducted only twice in fiscal year 1985.

Plans for Next Year: Obtain approval and print report on Calero Reservoir; the reservoir will be sampled four times. Two major changes took place at Lexington Reservoir in 1985: (1) The lake was drained so a leak in the dam could be repaired, and (2) most of the drainage area was burned. As the lake fills this winter, it will be sampled monthly to attempt to document water-quality changes that may occur as the lake gets reestablished under different hydrologic conditions.

SACRAMENTO VALLEY GROUND-WATER APPRAISAL



Number: CA237

Cooperating Agency: California Department of Water Resources

Project Chief: Ronald P. Fogelman

Period of Project: July 1970 to September 1985

Problem: Implementation of the California water plan includes transport and use of ground water from the Sacramento Valley as part of the overall water supply. Detailed knowledge of the ground-water system is needed by the cooperator to manage the total water resource of California.

Objective: Provide detailed knowledge of the ground-water system in the Sacramento Valley.

Approach: The Sacramento Valley was arbitrarily divided into six areas for study of baseline ground-water quality data. Extensive well inventories and water-quality sampling provided the information needed for baseline ground-water quality interpretation.

Progress: A report for Sacramento and Placer Counties was approved for publication on June 20, 1985. This is the final report in a series of twelve reports.

Plans for Next Year: None.

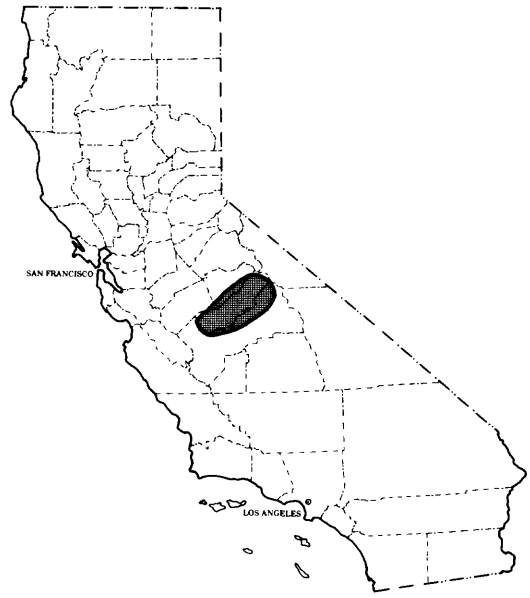
MADERA AREA GROUND-WATER MODEL

Number: CA248

Cooperating Agency: Madera County Flood Control and Water Conservation Agency

Project Chief: Clark J. Londquist

Period of Project: July 1971 to September 1986



Problem: The cooperating agency needs a digital simulation model of the ground-water system of Madera County for testing responses to alternate management plans. Previous investigations and data currently available indicate that a calibrated model suitable for quantitative analysis cannot be developed without additional data. Data requirements for calibration of a model can be defined by constructing a preliminary model using available data.

Objectives: Construct and calibrate a computer model of the ground-water system in Madera County to test hydrologic responses and determine additional data requirements.

Approach: Construct a preliminary finite-difference digital model using available data. Use the preliminary model to: (1) analyze the adequacy of available data for a quantitative analysis of the hydrologic system, and (2) design a data-collection program for model calibration. Collect needed data and calibrate model. Prepare final report.

Progress: (1) Completed preliminary model calibration adjusting only net flux. (2) Using linear regression determined a relation between flow in the San Joaquin River and total net flux for the model area. The correlation coefficient for this relation was 0.99. (3) Using this relation, estimated net-flux arrays were generated for each stress period and the model was run. The match between measured and predicted water levels was poor. (4) Wrote a program to do a linear regression of net flux to river flow for each node in the model. Correlation coefficients varied from almost no correlation to very good correlation. (5) Used these regression relations to generate new estimated fluxes on a node by node basis rather than overall. The match between measured and predicted water levels using these fluxes was good in some areas, generally in the area of interest, but poor in others. (6) Refined model calibration of the net fluxes to improve the match between measured and predicted water level over the entire area. (7) Through the use of this technique of estimating net fluxes, the model should be a useful predictive tool. (8) Completed the rough draft of the report.

Plans for Next Year: (1) Complete the calibration of the model. (2) Verify the model using the estimated net fluxes. (3) Complete the report.

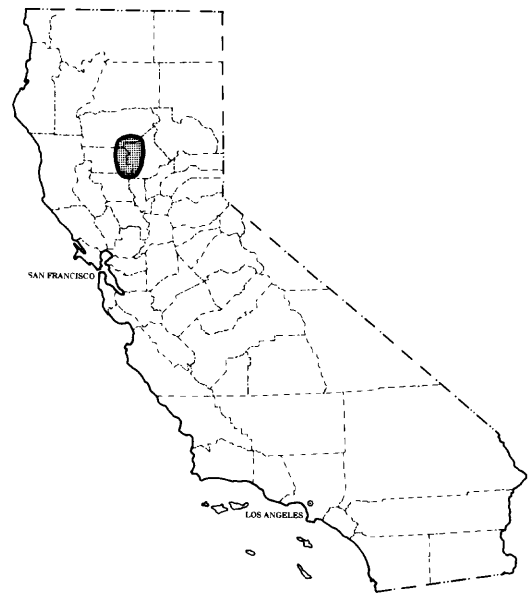
CHARACTERISTICS OF FLOODING AND CHANNEL CHANGES OF THE SACRAMENTO RIVER BETWEEN BUTTE CITY AND CHICO

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: Periodic 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 along the channel. 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: Evaluate the magnitude and duration of historic floods, rates of lateral migration through scour and deposition, and changes in geomorphic features of the channel. 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: Collect flood data (part of the ongoing data collection program, CA001), obtain aerial photos of the study area, and evaluate existing streamflow and bank erosion and deposition data. Prepare a report summarizing available data and addressing study objectives.

Progress: All crest-stage sites (41) were serviced prior to the flood season. One recording gage was transferred from Butte Creek at Gridley-Colusa Road to a site on the Sacramento River at Goose Lake pumping station. During low flow in August 1984, resurveys at six cross sections were made to document channel changes. No flood profiles of the Sacramento River were made during the year.

Plans for Next Year: Continue collection of flood data at selected sites and profile of Sacramento River depending on flow conditions. Assemble data for report to be prepared, possibly, in fiscal year 1987, depending on flood conditions during winter of 1985-86.

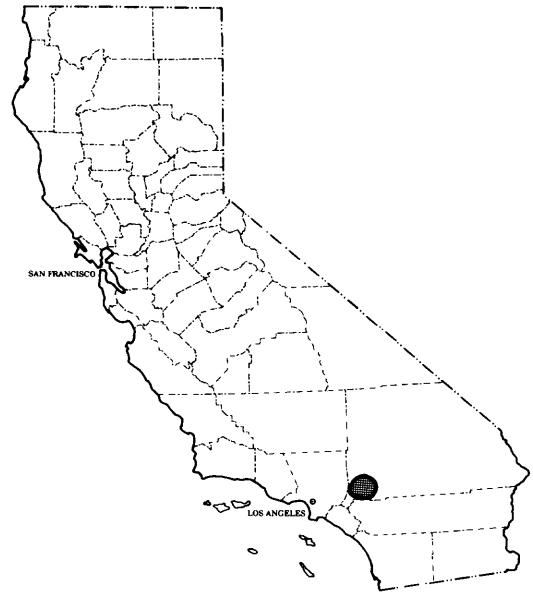
SAN BERNARDINO VALLEY CONFINED AQUIFER STUDY

Number: CA278

Cooperating Agency: San Bernardino Valley Municipal Water District

Project Chief: John R. Freckleton

Period of Project: July 1972 to September 1984



Problem: Up until the end of the late 1940's, the southern end of the San Bernardino Valley had several flowing wells and considerable swampland. During the most recent dry cycle, extensive use of ground water has resulted in the lowering of water levels below the land surface in the southern part of the valley. Scheduled to be added to the ground-water supply is northern California water from the State Water Project. Serious problems could occur if large quantities of artificial recharge caused the ground-water levels to again rise above the land surface, thus, causing extensive damage to the buildings, public works, and utilities in the city of San Bernardino.

Objectives: Determine the water-level response on the southern end of the valley to additional artificial recharge.

Approach: Geologic and well data will be computerized and evaluated to determine water-level response to varied pumpage distributions and artificial recharge. A two-dimensional mathematical model will be prepared, using the Galerkin finite-element procedure. The model, when verified, will simulate various management schemes.

Progress: Final report on the study was completed through colleague review. Simulation runs of the two-dimensional model were made to evaluate several management alternatives formulated by the cooperator.

Plans for Next Year: Revise final report to comply with review comments, obtain publication approval, and print report. Additional simulation runs of the model are planned.

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 small Indian reservations in California are under the jurisdiction of the Bureau of Indian Affairs, who, from time to time, request assistance in assessing the reservations water resources. Commonly, there is a need to develop small supplies of good quality water.

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

Progress: A hydrologic study of the Twenty-Nine Palms Indian Reservation in Riverside County was completed; the report is in review. Assistance was given on the siting, drilling, and construction of a public-supply well on the Rincon Indian Reservation in San Diego County. Work began on a hydrologic study of the Cahuilla Indian Reservation in Riverside County.

Plans for Next Year: Complete review response and obtain publication approval of report on the Twenty-Nine Palms Indian Reservation. Complete the study of ground-water conditions in the vicinity of the Cahuilla Indian Reservation in Riverside County.

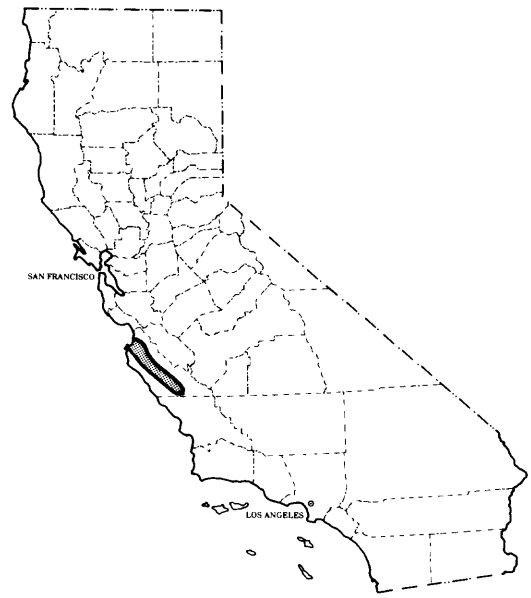
DEVELOPMENT AND USE OF DIGITAL GROUND-WATER-FLOW MODEL OF THE SALINAS VALLEY, MONTEREY COUNTY

Number: CA315

Cooperating Agency: Monterey County Flood Control and Water Conservation District

Project Chief: Eugene B. Yates

Period of Project: June 1975 to September 1985



Problem: Seawater intrusion has been occurring in coastal aquifers of the Salinas Valley as a result of ground-water pumping. Previous mitigation efforts, including the construction of two water-supply reservoirs, have failed to completely halt the intrusion.

Objectives: The objectives of the project are to develop a digital flow simulation model of the Salinas ground-water basin in order to quantitatively evaluate the interaction of different aspects of basin hydrology and to simulate the effects of water-resources management alternatives.

Approach: Create an up-to-date simulation model by reactivating the two- and three-dimensional models previously developed in a cooperative program between the U.S. Geological Survey and the U.S. Army Corps of Engineers. Improve the models by including new algorithms and data. Direct improvements toward the weakest parts of the models as identified by model calibration and a sensitivity analysis. Select one model for simulation of management alternatives.

Progress: A final report was written and colleague review was completed.

Plans for Next Year: Revise final report to comply with review comments, obtain publication approval, and print report.

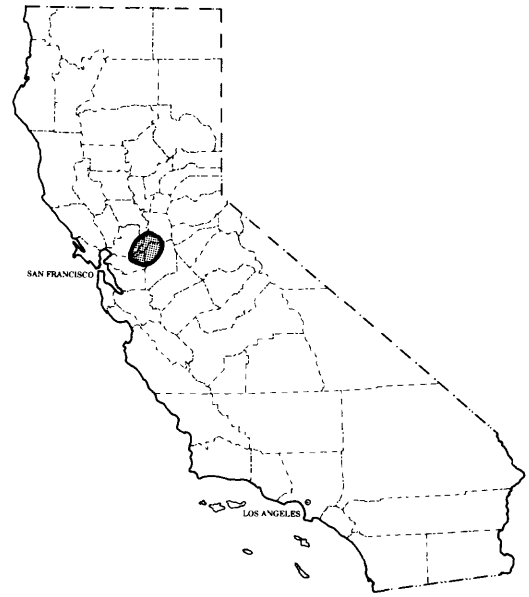
COMPUTER MODELS FOR COMPUTATION OF TIDAL RIVER DISCHARGE

Number: CA324

Cooperating Agency: California Department of Water Resources

Project Chief: Richard N. Oltmann

Period of Project: July 1975 to September 1986



Problem: Work is being done by many different organizations within the Sacramento River Delta with respect to water-quality and sediment. However, data on instantaneous flows and the flow distribution within the many channels that make up the delta area are not available. Because the transporting medium of the sediment and water-quality constituents is the water, the need for a flow record within this area is quite apparent.

Objectives: Evaluate the feasibility of applying the U.S. Geological Survey's implicit finite difference branch-network flow-simulation computer model to a large part of the upper Sacramento River Delta. The area will include Georgiana, Steamboat, Sutter, Elk, Miner, and Cache Sloughs in addition to the Sacramento River from Sacramento to Threemile Slough.

Approach: Collect synchronized stage data at existing State and Federal gages throughout the study area and use as boundary condition data for the model. Obtain channel cross-section data from other agencies or field collect data where necessary to simulate channel geometry. Calibrate model by comparing simulated and measured stage and discharge data. Verify model verification by using Survey collected stage and discharge data. Prepare a report documenting the results of the study.

Progress: The existing stage gages within the delta area were located in such a way to enable the model area to be divided into two models to simplify calibration. The upper model includes the Sacramento River from Sacramento to Walnut Grove, Steamboat Slough from the Sacramento River to its confluence with Sutter Slough, Sutter Slough, Miner Slough, Elk Slough, and the Delta Cross Channel. This model has been calibrated and verified using measured stage and discharge data.

Plans for Next Year: Complete calibration of full area model and prepare report documenting results.

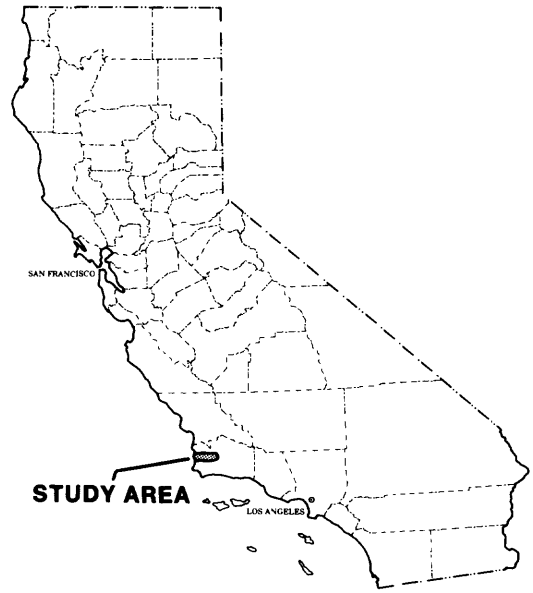
APPRAISAL OF GROUND-WATER RESOURCES IN SAN ANTONIO CREEK GROUND-WATER BASIN, SANTA BARBARA COUNTY

Number: CA337

Cooperating Agency: U.S. Air Force, Vandenberg Air Force Base

Project Chief: Peter Martin

Period of Project: April 1977 to September 1985



Problem: Demand for ground water in the predominantly rural San Antonio Creek valley has increased significantly since 1978 because of the establishment of extensive irrigated vineyards on formerly nonirrigated pastureland and increased pumpage from the valley by VAFB (Vandenberg Air Force Base). Previous studies have indicated that pumpage in the valley by 1978 was already greater than perennial yield. To plan for anticipated growth in the valley, methods to evaluate and predict changing ground-water conditions resulting from current and proposed pumpage need to be developed.

Objectives: In 1976, VAFB, entered into a cooperative study with the U.S. Geological Survey to evaluate the long-term availability of the ground-water supply in San Antonio Creek valley. The first phase of the program, completed in 1979, involved developing a comprehensive water budget for the valley for 1958-77. The second phase of the program, completed in 1984, involved using the water budget to develop a computer model of the valley that could be used as a predictive tool for testing alternative ground-water management plans.

Approach: Collect and evaluate hydrologic data and compile a water budget for the valley. Using data compiled for the water budget, develop a steady-state and transient-state computer ground-water flow model. Verify the model and the calibrated input values with data collected during the study period.

Progress: The second phase of the project was completed, and the final report describing development and calibration of the ground-water flow model was published. The model was used to simulate different pumpage patterns proposed by VAFB.

Plans for Next Year: None.

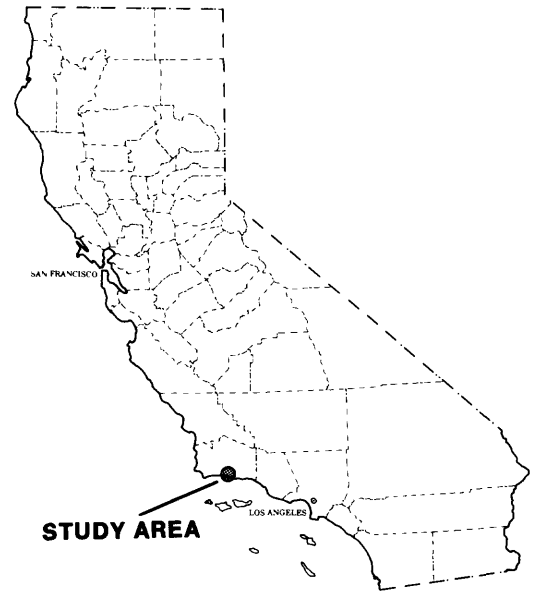
GROUND-WATER RESOURCES OF THE SANTA BARBARA AREA

Number: CA342

Cooperating Agency: Santa Barbara, city of

Project Chief: Peter Martin

Period of Project: July 1977 to September 1986



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 seawater intrusion into the freshwater aquifer, it has become necessary to develop and implement a ground-water program capable of evaluating the effects of anticipated stresses on the ground-water basin.

Objectives: Design a comprehensive program to regularly monitor water levels and quality of water in the ground-water basin to observe the effects of increased pumping and the potential movement of seawater 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 the water resources of the basin.

Approach: Construct eight monitor wells at two sites along the coast to provide an early warning of saltwater intrusion. Design a monitoring network to determine the effects of ground-water pumping on water levels and water quality in the basin. Use the data collected from the monitoring network to develop and calibrate ground-water flow models. Use the models to help predict the response of the basin to different management plans.

Progress: A ground-water flow model was developed and calibrated for Storage Unit I, and a report describing the model was completed. Geohydrologic data were collected for Storage Unit II and the Goleta-East subbasin. These data were used to help construct a ground-water flow model of the Goleta-East subbasin.

Plans for Next Year: The final calibration of the ground-water flow model for Storage Unit I and the Goleta-East subbasin will be completed. The model will be used to simulate different management plans for the basin. A report describing the geohydrology of the Goleta-East subbasin and the development and calibration of the model will be completed. As part of a new study, work will be started on a solute-transport model in Storage Unit I. At least two wells will be constructed to delineate the inland extent of saltwater intrusion. Chemical analyses will be collected to help calibrate the model.

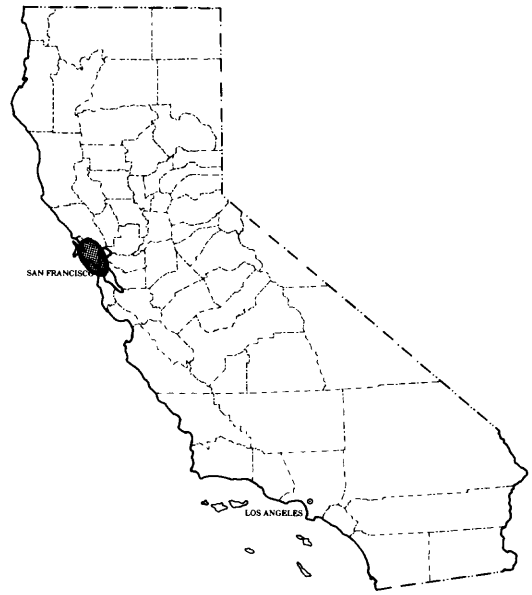
WATER QUALITY IN NATIONAL PARK SERVICE LANDS

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: 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. (5) Identify personnel needs and program costs.

Progress: No funding was available for work during fiscal year 1985.

Plans for Next Year: The National Park Service has approved a work plan for a 3-year water-quality sampling program in the Golden Gate National Recreation Area, north of San Francisco. During the next year, samples will be collected at eight sites within the recreation area for major ions, nutrients, fecal coliform and selected organics during the winter storm period and summer low-flow period. Results will be used to determine if there are any existing or potential water-quality problems that require further investigation.

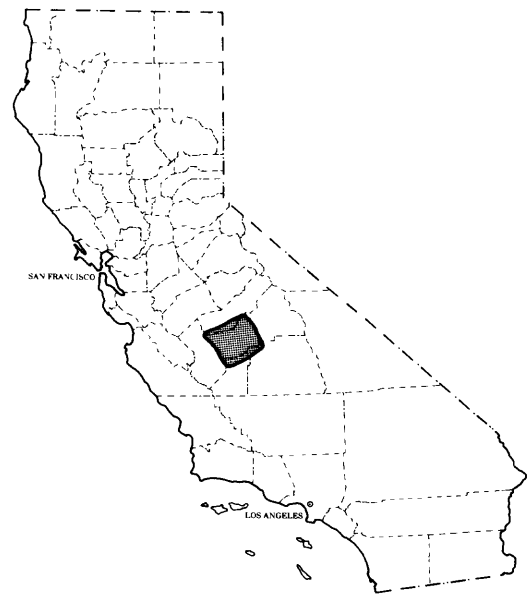
FRESNO COUNTY GROUND-WATER MODEL

Number: CA360

Cooperating Agency: Fresno County

Project Chief: Hugh T. Mitten

Period of Project: October 1979 to September 1985



Problem: Available water resources in an area of about 1,800 square miles of the Central Valley in the vicinity of the city of Fresno need to be managed to best meet future agricultural and urban requirements. The study area contains a large and rapidly growing metropolitan area surrounded by extensively developed agricultural land. The metropolitan area is dependent on ground water for water supply, and agriculture in the vicinity also makes substantial use of ground water. There is evidence of declines in the ground-water levels which may eventually limit usability of the ground-water resource.

Objectives: Use existing data to improve the understanding of the aquifer system as an aid to managing the ground-water resource.

Approach: Using current and historic data, estimate aquifer properties, ground-water pumpage, and surface-water deliveries. Make assumptions about the ground-water basin. Test assumptions, estimated aquifer properties, pumpage, deliveries, and other data using a mathematical model. Calibrate the model as an aid to basin management.

Progress: Considerable difficulty in model calibration was encountered. The model is in the final stages of calibration. A rough draft of the final report describing the model was completed.

Plans for Next Year: Complete calibration of the model, complete the report, and process the report through reviews and publication approval.

POTENTIAL OF ARTIFICIAL GROUND-WATER RECHARGE IN SAN JOAQUIN COUNTY

Number: CA373

Cooperating Agency: San Joaquin County Flood Control and Water Conservation District

Project Chief: Peter W. Anttila

Period of Project: February 1980 to September 1985

Problem: The need for and use of ground water in San Joaquin County has caused ground-water levels to decline about 1.5 to 2 feet per year. Anticipated increases in surface-water supplies have been delayed indefinitely. Also, saline ground water is migrating into fresh water at about 150 feet per year.

Objectives: The study will evaluate the potential for artificial recharge of surface water by the spreading basin method to the unconfined aquifer system in two areas in the eastern part of San Joaquin County.

Approach: Use a well inventory and analyses of existing hydrologic and geologic data to select locations for drilling about 20 exploratory holes. The exploratory holes are needed to define the alluvial material overlying the zone of saturation. Data from the exploratory drilling will be analyzed to evaluate the suitability of the represented areas as recharge sites and to determine locations of recharge test sites. A maximum of three recharge test sites will be selected. Results of tests, if made, will be used to estimate effects of artificial recharge.

Progress: A first draft describing the results of the January 1984 artificial recharge test at Lockford (0.25 mile northwest of Lockford) was prepared as part of the final report for the study. A second artificial recharge test was completed in November 1985 at a site about 3 miles northeast of Linden. Preliminary analysis of the Linden test data was completed.

Plans for Next Year: Next year's objective is to complete the study by publication of the final report. Remaining tasks to meet this objective are (1) complete data analysis of Linden test site, (2) prepare draft description of Linden test results and incorporate with Lockford test into final report, and (3) obtain colleague reviews and approval for publication.

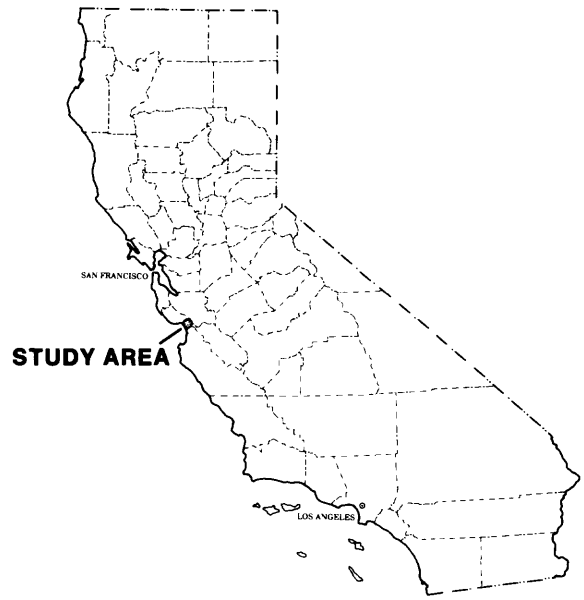
DIGITAL MODEL OF PAJARO VALLEY GROUND-WATER SUBAREA

Number: CA376

Cooperating Agency: Santa Cruz County

Project Chief: Michael J. Johnson

Period of Project: March 1980 to September 1985



Problem: The economy of Pajaro Valley, the largest farming area in Santa Cruz County, is dependent upon reliable water supplies to meet irrigation needs. With increasing demand and an insufficient surface-water supply, ground-water use has increased and will continue to do so in the future. Ground-water resources, however, are limited, and pumping has already caused declining water levels and seawater intrusion near Monterey Bay. To minimize these problems, careful management of the basins ground-water supplies will be required in the future.

Objectives: To develop an effective predictive digital model to better understand the hydraulics and geohydrology of the Pajaro Valley ground-water subarea.

Approach: A finite-difference digital model will be developed and calibrated based on historical water-level pumpage and recharge data and on a quantitative description of the physical properties of the subarea.

Progress: Project is complete except for sections of report describing model calibration and predictive simulation runs.

Plans for Next Year: Complete report and process through reviews and approval for publication.

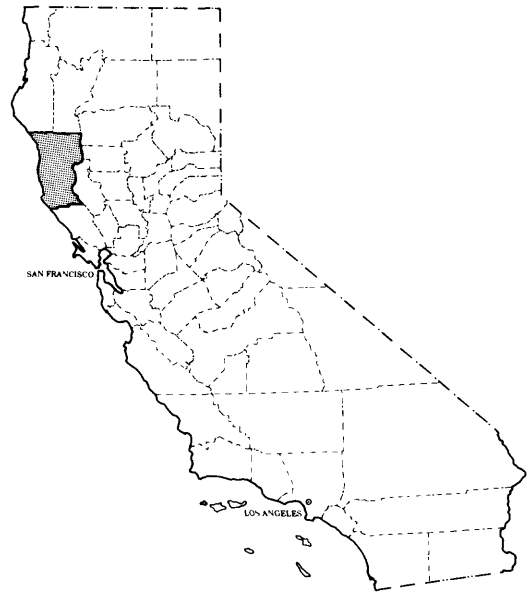
GROUND-WATER RESOURCES OF MENDOCINO COUNTY

Number: CA380

Cooperating Agency: Mendocino County

Project Chief: Christopher D. Farrar

Period of Project: April 1980 to September 1983



Problem: Mendocino County is experiencing rapid population growth. County planners have expressed the view that, to meet future demand for water, increased use of ground water will be necessary. At present, knowledge of ground-water hydrology in Mendocino County is very limited and is inadequate to meet the planners' needs.

Objectives: Describe the ground-water regime, identify aquifers and their areal extent; determine source and direction of movement of ground water; determine variations in water quality; calculate storage capacities of ground-water basins; and set up network of observation wells for water-level and water-quality monitoring.

Approach: Identification of aquifers and areal extent will be determined from field relationships, geologic maps, and well logs. Water-level measurements will be used to determine source and direction of movement of ground water. Water samples will be analyzed by the Central Laboratory to determine water quality. Well logs, gravity surveys, and geologic maps will provide the means for calculating storage capacities.

Progress: Final report was approved for publication.

Plans for Next Year: Print final report to complete study.

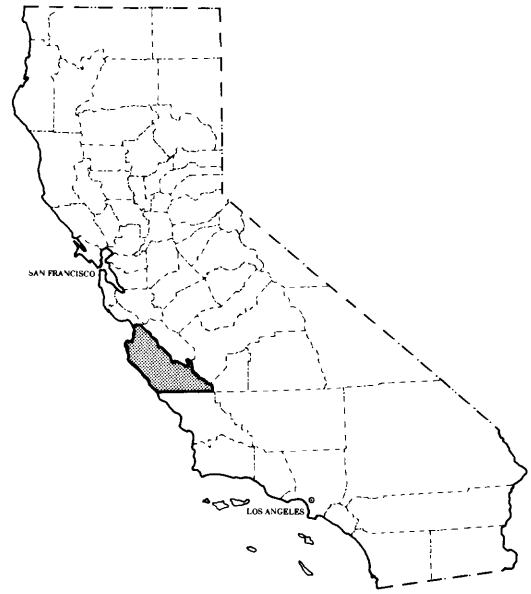
A WATER-RESOURCES DATA NETWORK EVALUATION FOR MONTEREY COUNTY

Number: CA388

Cooperating Agency: Monterey County Flood Control and Water Conservation District

Project Chief: William E. Templin

Period of Project: October 1980 to September 1985



Problem: Efficient water-resources management requires information on which to assess water-supply and water-quality conditions. When information is generated from data-collection programs, periodic evaluation of those programs is necessary to insure that resources managers have information representing current conditions.

Objectives: The existing hydrologic data-collection networks will be identified and evaluated. Modifications in the networks will be proposed, as necessary, to reflect changes in needs for information by water-resources managers in Monterey County.

Approach: Monterey County will be divided into three study areas, the Upper Salinas Valley (Study Area 1), the North County and Coastal areas (Study Area 2), and the Lower Salinas Valley (Study Area 3). The study areas will be evaluated during a 3-year period. The existing networks will be evaluated using the following six steps. (1) Network inventory and literature search. (2) Interview local water authorities. (3) Develop monitoring objectives and set priorities. (4) Design an "ideal" network as a goal. (5) Develop a rating system to evaluate monitoring sites. (6) Design an "actual" network to approximate the "ideal".

Progress: Report on Study Area 1 was approved for publication and prepared for printing. Study Area 2 report was processed through colleague review. Study Area 3 report was processed to colleague review stage.

Plans for Next Year: Publish Study Area 1 report; revise and publish Study Area 2 report; review, revise, and publish Study Area 3 report.

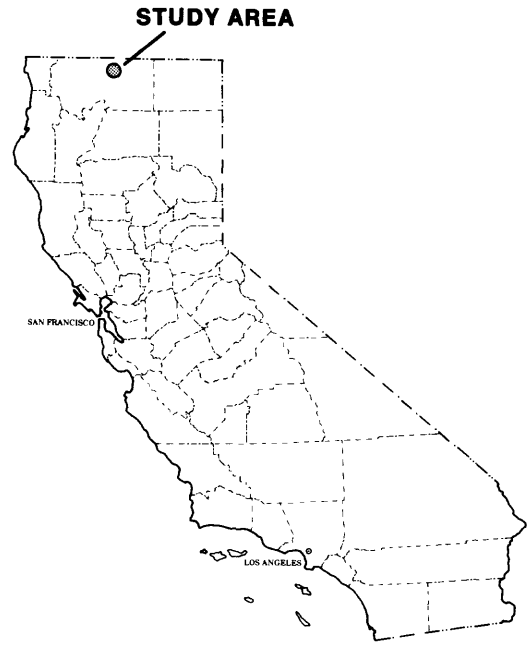
HYDROLOGIC HAZARD ASSESSMENT FOR MOUNT SHASTA AREA

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 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. Planners need information on the character and location of abnormal hydrologic events that might follow an eruption or mudflow. These plans to deal with floodflows caused by volcanic and hydrologic events would save lives and property.

Objectives: Baseline information of streamflow, water quality of aquifers, springs, streams, and lakes that could be influenced by mudflows or volcanic activity are needed. Other programs will assess flood and mudflow hazards, and document existing cultural and hydrologic features. The magnitude, frequency, and other characteristics of floods and mudflows will be evaluated.

Approach: Postulate various eruptive events and assess associated hazards. 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. Available water-quality data will be evaluated. Stream and channel data will be collected for some streams recently affected by mudflows.

Progress: A new debris flow occurred July 6, 1985 on Whitney Creek. This is the largest such event since 1935. Field surveys of this event are underway. Aerial photography in color and black and white of the flooded area was obtained July 24.

Plans for Next Year: The project is scheduled for completion with the publication of a three chapter final report. Remaining work will consist of the following: (1) Response to reviewer comments, (2) preparation of a brief discussion on the Whitney Creek flood of July 1985 in Chapter A, and (3) Some additional fieldwork to complete documentation of the 1985 debris flow on Whitney Creek may be needed.

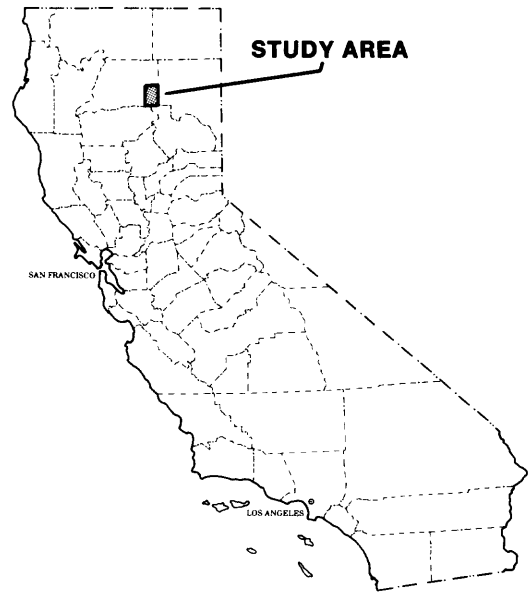
MUDFLOW HAZARDS IN THE VICINITY OF LASSEN PEAK

Number: CA393

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

Project Chief: Donna C. Marron

Period of Project: May 1984 to September 1985



Problem: Mudflows are the most laterally extensive and perhaps the most severe hydrologic hazard associated with volcanic activity in the Pacific Northwest. The eruptions of Lassen Peak volcano in northern California in 1915 caused destructive mudflows in the stream valleys on the northern flanks of the volcano. Future eruptions have the potential to cause similar hazards that threaten life and property. Understanding the likelihood and potential magnitude of future mudflows is important for the protection of communities in the area and Lassen Peak National Park.

Objectives: Potential mudflow hazards in the Lassen area will be investigated. Areas most likely to be affected by future mudflow will be identified along with the physical conditions that control the volume, extent, and direction of mudflows in the Lassen area.

Approach: The stratigraphy of existing mudflow deposits in the Lassen area will be mapped to assess the frequency and magnitude of past mudflows. Carbon-14 age dates will be determined for charcoal taken from some of the mudflow deposits to establish their relative ages. In addition, historical records of the 1915 eruption of Lassen Peak will be examined along with research on volcanic mudflow generation in other areas in order to understand how future mudflows may initiate and mobilize in the Lassen area.

Progress: Carbon-14 age dating of charcoal samples was completed, and the field data collected during July 1984 were interpreted. A review of pertinent historical records and research was conducted, and a final report was written. Director's approval of the final report is pending.

Plans for Next Year: Print final report to complete project.

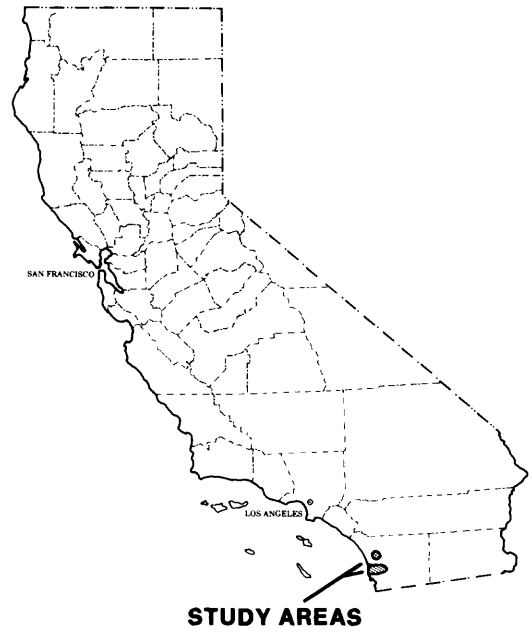
WASTEWATER REUSE, SAN DIEGO COUNTY

Number: CA399

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

Project Chief: Kristen D. Evenson

Period of Project: July 1981 to September 1986



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 the ground-water basins as sites for wastewater reuse. Many logistical problems are associated with using reclaimed wastewater such as the ambient quality of the ground water, the storage capacity of the aquifer, the quality of the reclaimed water, and soil suitability. This is the third wastewater reuse investigation conducted by the U.S. Geological Survey in California; it includes the Moosa, Poway, and Soledad hydrologic unit subareas.

Objectives: Evaluate the ground-water and surface-water quantity and quality for each subarea. Samples will be collected and measurements made to provide a current data base. Evaluate the ability of each basin to accept reclaimed water. Define past, present, and future beneficial uses. Determine future plans of water purveyors, public agencies, and other water users concerning the use of reclaimed water. Assess the environmental impact of the use of reclaimed water on each subarea.

Approach: Compile background information. Compile available ground-water data and inventory wells to determine sampling locations. Collect data required to define quality and quantity. Assess quality and determine basin yield. Compile existing surface-water records. Collect data required to determine present and future water use. Collect information on reclaimed water. Assess the affect of reclaimed water recharge on ground-water quality and determine percentage of water supply it might replace. Assess potential uses of reclaimed water.

Progress: Historical ground-water and surface-water data were obtained and reviewed. Water levels were measured at about 40 wells. Twenty-six wells were selected to form the ground-water quality network. These wells have been sampled twice; October 1984 and March 1985. During these periods, ground-water level measurements also were made. A surface-water quality and streamflow network was designed to complement the gages in the Poway and Soledad areas and to supply surface-water information for the Moosa area. Streamflow measurements were made and water-quality samples collected during the ground-water sampling periods. Recharge studies were conducted in July 1984. Background information on land use, soils, precipitation, geology, population, water use, and imported water quality was compiled. Preliminary base maps and generalized maps of soils, surface geology, ground-water quality, and historic water levels where data were available were compiled.

Plans for Next Year: Work will include correlation of historic and present hydrologic data, estimation of specific yield and storage capacity, and report writing. Current chemical analyses of water from wells that also have historic water-quality data will be used to determine changes in water quality over time. Surface-water flow records will be summarized and tabulated for the period of available record. Specific yield of the alluvial material for each major aquifer in each of the basins will be estimated from available drillers logs and used to calculate storage. A report will be written and prepared for review, approval, and publication.

EVALUATION OF DESIGN PRACTICES FOR RIPRAP USED IN PROTECTION OF HIGHWAY CROSSINGS

Number: CA412

Location: California, Nevada, Oregon, and Washington

Cooperating Agency: Federal Highway Administration

Project Chief: James C. Blodgett

Period of Project: October 1981 to September 1985

Problem: The Federal Highway Administration personnel need better design guidelines applicable to all channel and flow situations where riprap protection is needed along highway embankments placed in the floodway. To date, personnel use procedures presented in Hydrologic Engineering Circulars 11 and 15, but these guidelines are of limited application, and confusion exists as to the limitations of existing procedures.

Objectives: Evaluate deficiencies in procedures and guidelines presently used in design of riprap countermeasures, and develop procedures and relations that describe the magnitude and significance of hydraulic factors that should be considered in the hydraulic performance of riprap. These relations will provide the basis for preparation of a comprehensive hydrologic engineering circular in the future.

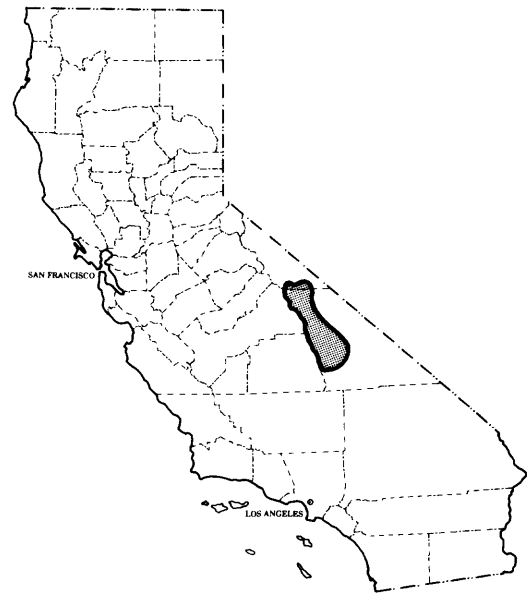
Approach: Collect field data that describe the hydraulic and morphologic features of at least 50 sites. Sites will be chosen to provide a variety of flow and channel geometry conditions, and revetment installations. Performance of the revetment installations and estimates of stresses acting on riprap revetment will be evaluated.

Progress: Progress reports for the Federal Highway Administration are completed. Project report format was changed to include three volumes because of the diversity of material assembled and analyzed. Volume 1 discusses hydraulic and geomorphic characteristics of open channels. Report is approved and pending publication. Volume 2 discusses the characteristics of bank erosion and identifies four basic types of bank failures. Seven rock riprap design procedures are evaluated on the basis of theoretical concepts and comparative prototype hydraulic data. The use of tractive force as a measure of erosive stresses acting on the bank channel gradient was found to be inferior to the use of velocity vectors. Volume 2 report has been reviewed and is pending approval. The volume 3 report uses data presented in volumes 1 and 2 and presents new approaches for the design of rock riprap bank protection. The data and approaches will be presented so that a new riprap design manual may easily be prepared by the FHWA. Preparation of volume 3 was started.

Plans for Next Year: Print volume 1. Obtain publication approval and print volume 2. Complete writing, obtain and respond to reviews, and submit for publication approval of volume 3.

VEGETATION SURVIVABILITY STUDIES IN OWENS VALLEY

Number: CA413



Cooperating Agencies: City of Los Angeles, 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 (2-10 feet) water table 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, due, in part, to 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 valley water resources and to save the phreatophytes.

Objectives: To define those factors which control the ability of native phreatophytic vegetation to survive and adapt to lowering water tables. To quantitatively link physiological responses in the plants, such as internal water stress and 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. The results will be linked to a ground-water optimization model that will help to evaluate alternative strategies for mitigating the effects of ground-water pumping on the phreatophytic vegetation communities.

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

Progress: All four controlled drawdown sites have been functioning the entire 1985 growing season. Measurements of plant growth, predawn and midday plant stress, transpiration, and plant cover have been made. In addition, neutron access tubes have been placed at each sampling site and soil profiles taken to calibrate each tube so that soil-moisture content may be obtained using the neutron probe. A modeling approach has been developed to enable conversion of soil-moisture content data into soil-moisture stress data. Near the end of the growing season some of the plants at one of the drawdown sites showed an apparent adverse response to the drying soil resulting from the pumping. A literature review of publications pertinent to plant responses to moisture stress has been completed, and a report on the findings is in review. A rough draft of the techniques used for the soil-moisture modeling has been prepared and will be ready for review soon.

Plans for Next Year: Controlled pumping will continue at all test sites and the same sampling schedule as in 1985 will be followed. As the plants show further responses to the drawdown, attempts will be made to correlate directly plant responses to water-table depth and soil-moisture quantity and stress. Work will continue to further develop and refine the soil-moisture models developed in 1985.

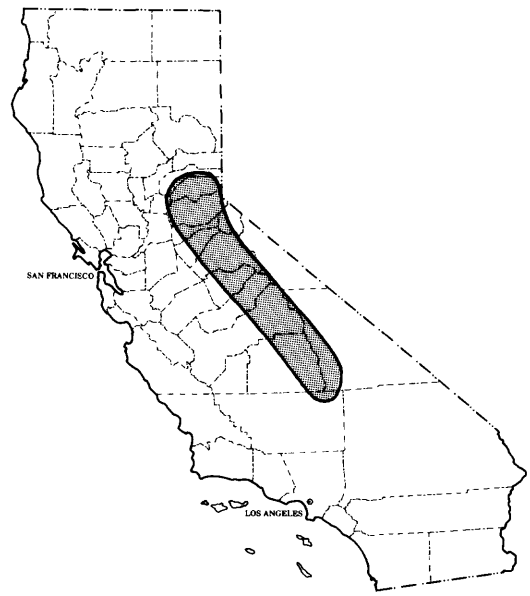
GIARDIA IN THE SIERRA NEVADA

Number: CA414

Cooperating Agency: California Department of Health Services

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 Alpine and sub-Alpine wilderness areas of the Western 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*, and (2) Evaluate the persistence and mobility of *Giardia* cysts in the hydrologic environment in the Alpine and sub-Alpine regions of the Sierra Nevada.

Approach: The California Department of Health Service 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: During 1985, the laboratory techniques used to isolate and enumerate *Giardia* cysts were further evaluated in an effort to determine which phases of the procedure are the most critical in terms of total *Giardia* cyst recovery. The objective of these evaluations was to develop a quantitative method that would be a reasonable estimate of cyst numbers in the sampled waters. The U.S. Geological Survey laboratory in Sacramento evaluated water samples from Modoc National Forest, California and from an area near Grand Junction, Colorado. This type of analysis will continue to be performed for other USGS offices and governmental agencies as needed and as manpower permits. A publication to summarize the field and laboratory techniques used and the results of the water and animal sampling conducted in 1984 was started.

Plans for Next Year: Further evaluation of the field and laboratory methods will be made in an effort to improve their reliability and accuracy. The Sacramento laboratory will continue to provide laboratory analysis of water samples collected by other agencies. Efforts continue to develop cooperative programs with other agencies to evaluate the occurrence of *Giardia* in their drainage basins. The summary report on field and laboratory techniques will be completed and processed through approval for publication.

FUEL SPILL AT THE U.S. MARINE CORPS AIR STATION AT TUSTIN

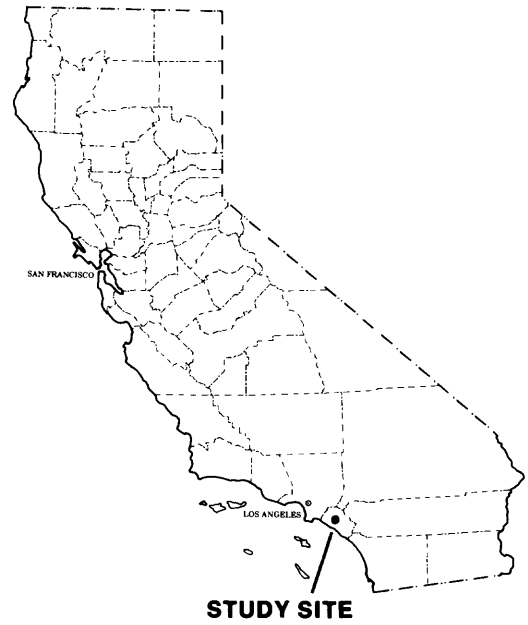
Number: CA416

Cooperating Agency: U.S. Marine Corps Air Station, El Toro

Project Chief: Roy A. Schroeder

Period of Project: April 1983 to September 1985

Problem: JP-5 jet fuel has contaminated ground water at the U.S. Marine Corps Air Station in Tustin, California and is seeping into the Peters Canyon channel which empties ultimately to Newport Bay. The source is unlined earthen burn pits used for helicopter crash-crew training for 20 years.



Objectives: To delineate the areal and vertical extent of contamination and to determine the hydrologic parameters governing movement of the contaminant.

Approach: Monitor wells will be constructed in the vicinity of the burn pits. Soil borings and well water will be analyzed for concentration of fuel and selected toxic organic compounds. Water levels will be measured to determine direction of flow. Lithology will be determined from soil borings.

Progress: Chemical analyses show that nitrate and oxygen are absent within the area contaminated by jet fuel. General characterization of microbes present reveal anaerobes, methanogens, and hydrocarbon degraders. Results were published. Depression-pump skimming has proved marginally effective for removal of jet fuel because of the impermeable nature of the soils. The fuel has changed the structure of clays, making them more friable and permeable.

Plans for Next Year: District program completed in fiscal year 1985. The Survey will continue in an advisory role to U.S. Marine Corps during cleanup phase as requested.

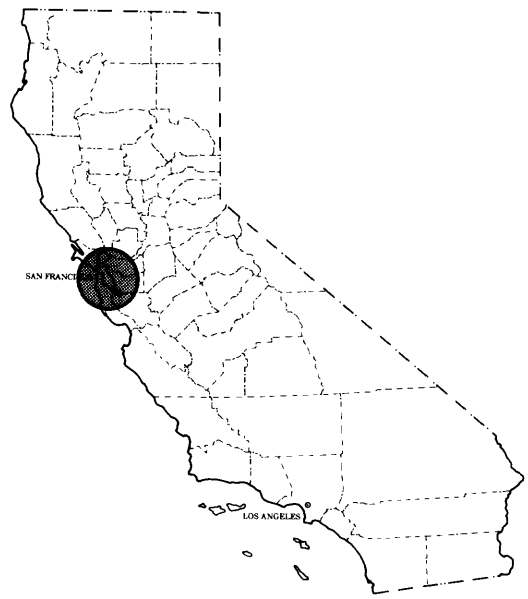
ESTIMATING TIDAL AND RESIDUAL CIRCULATION IN SAN FRANCISCO BAY

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: To 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 on site conductivity-temperature-depth system will be used to measure vertical salinity profiles. Field data collected will be used as appropriate to calibrate and validate mathematical models.

Progress: A two-dimensional tidal circulation and salt transport model was developed for Suisun Bay. A new improved Eulerian-Lagrangian solution scheme for the salt transport equation was added, and the flow equations were modified to include baroclinic (density-driven) effects. The model was calibrated and verified with observed tidal effects. The model was calibrated and verified with observed tidal and current-meter data and used to investigate the effects of bathymetry, wind stresses, and longitudinal salinity gradients upon circulation patterns. A three-dimensional model for use on the project was developed under contract with Aeronautical Research Associates of Princeton. The model is presently being applied to San Pablo Bay and will be used to calculate vertical gravitational circulations. The data-collection program will not be fully underway until next year. This year's effort was spent procuring and equipping a new 33-foot boat for use in the data program. An acoustic doppler current profiler was purchased and mounted in the hull of the boat. Field testing was performed and the results look encouraging. Several current meters and equipment for measuring vertical salinity profiles also were purchased.

Plans for Next Year: A three-dimensional model of San Pablo Bay will be developed, and work on a two-dimensional model of the entire bay will begin. A journal paper describing the two-dimensional modeling of Suisun Bay will be completed and submitted for review. Three field experiments to measure salinity profiles in the northern reach of the bay will be conducted at different delta flows. During each of these experiments up to 15 continuous-recording current meters will be deployed in shallow water areas of the bay. Testing of the acoustic doppler current profiler will continue, and the profiler will be used to collect velocity profiles along cross sections of the bay.

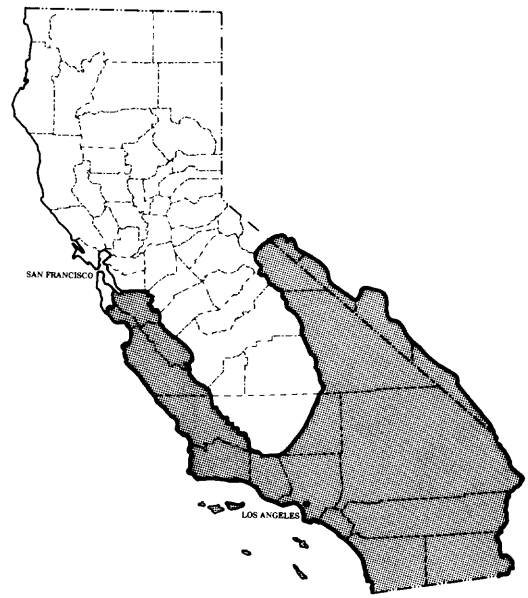
SOUTHERN CALIFORNIA REGIONAL AQUIFER SYSTEMS ANALYSIS--ALLUVIAL BASINS

Number: CA424

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

Project Chief: Peter Martin

Period of Project: October 1983 to September 1985 (suspended)



Problem: This study is one of the series of National studies of regional aquifer systems. The program is a systematic effort at studying a number of regional ground-water systems that together underlie much of the United States and compose a major part of the Nation's water supply. In southern California, water-quality degradation resulting from agriculture and saltwater intrusion is a common problem in the coastal basins. Ground-water availability and naturally occurring high concentrations of fluoride, boron, sulfate, and dissolved solids are the major problems in the desert basins.

Objectives: The objectives of the study are to (1) identify previous hydrologic studies in southern California; (2) define regional ground-water conditions; (3) determine the general geohydrologic framework of the southern California basins; and (4) describe and analyze the major problems that affect the use of ground water in those basins.

Approach: A bibliography will be compiled to identify previous hydrologic studies and existing hydrologic information. Ground-water conditions and problems will be described in a hydrologic altas. Geohydrologic framework of the different basins will be described using available data; however, fieldwork may be necessary to collect sufficient data to categorize some of the basins. Models will be used to evaluate and analyze the major problems affecting the use of ground water in southern California. Due to the large number of basins, generalized models will be developed for the different basin categories. The models will be generalized by considering the range of geology, hydraulic properties, and initial and boundary conditions found within a particular category of the basin.

Progress: A comprehensive bibliography containing about 4,000 entries indexed by location and subject was compiled. This compilation along with a description for its use was prepared for review. The hydrologic atlas was completed except for the text for the individual maps.

Plans for Next Year: Reports prepared in fiscal year 1985 will be processed for review and publication approval.

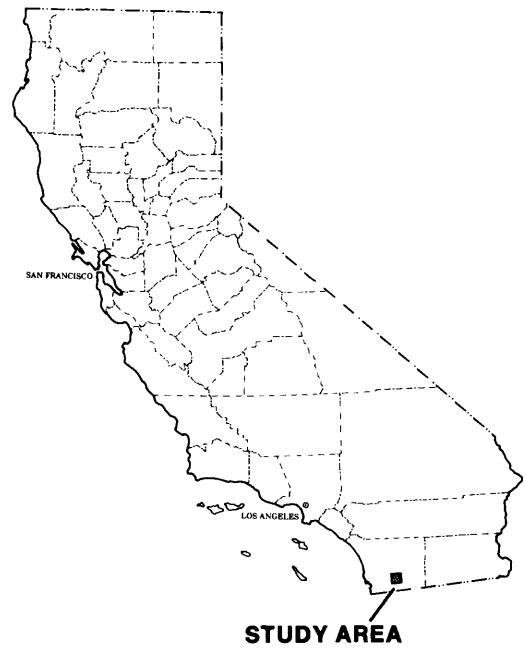
EVALUATION OF THE HYDROLOGY OF CONSOLIDATED-ROCK TERRAINS, WITH EMPHASIS ON LEE VALLEY, SAN DIEGO COUNTY

Number: CA425

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

Project Chief: Gregory C. Lines

Period of Project: July 1983 to September 1985 (suspended)



Problem: The population of San Diego County is increasing rapidly, with much of the growth and land development in the hard-rock areas east of San Diego. The County Department of Planning and Land Use is responsible for issuing building permits for new developments, but has little geohydrologic data to make decisions as to optimum development in the many bedrock valleys.

Objectives: The objective is to assist San Diego County in evaluating, in detail, the water budget of a typical bedrock basin (Lee Valley), including recharge, movement, and storage in fractured bedrock aquifers. The county desires to avoid overdevelopment and pollution of ground water.

Approach: The study will include the following data collection in order to define the water budget and hydraulic characteristics of bedrock aquifers in Lee Valley: (1) precipitation at three rain gages, (2) continuous water-level monitoring at two wells, (3) continuous measurement of surface water leaving the valley, (4) a well inventory with valleywide water-level measurements in wells, (5) soil-moisture studies, (6) evapotranspiration studies, (7) geologic mapping, and (7) aquifer tests.

Progress: A gaging station was operated on Jamul Creek at the lower end of the basin, and continuous water-level rcorders were maintained on two wells.

Plans for Next Year: Project activity suspended on this study. The U.S. Geological Survey will operate the gaging station on Jamul Creek for stage record only; San Diego County will maintain the two continuous water-level recorders on wells.

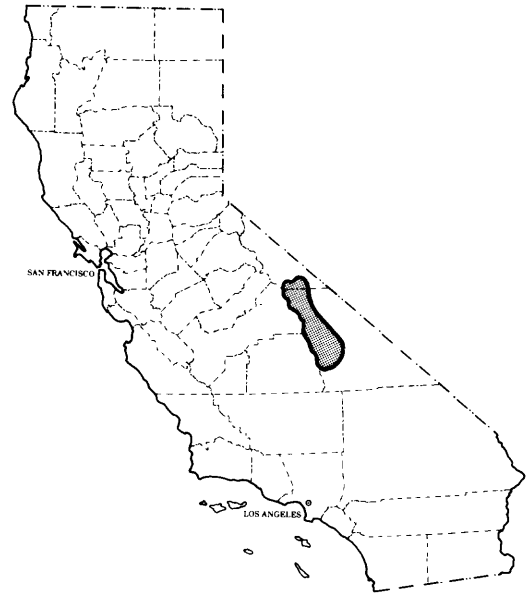
GROUND-WATER INVESTIGATIONS IN OWENS VALLEY

Number: CA426

Cooperating Agencies: City of Los Angeles, 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 is 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: Develop quantitative computer models that can be used to evaluate alternative strategies for mitigating the impacts of ground-water pumpage on phreatophytes. 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, vertical-slice models in areas of complex geohydrology and heavy pumping in order to quantify vertical leakage between aquifers and losses from the system due to evapotranspiration and pumping and to verify detailed conceptual models; and (4) valleywide, three-dimensional, predictive and optimization models that could help develop pumping strategies with the minimum effect on valley vegetation.

Progress: Owens Valley project personnel completed an intensive data-collection phase. Micrometeorological evapotranspiration data were collected for two seasons. Two journal articles were published and three water-supply paper manuscripts were started. In addition, 2 years of water-level data were collected, deep aquifer wells were completed, and aquifers were tested at sites. Borehole- and surface-geophysical surveys were combined with existing hydrogeological information to better define the essential boundary and initial conditions identified by probabalistic-deterministic and preliminary ground-water flow simulations. A one-dimensional, soil-moisture transport and phreatophyte-evapotranspiration model was developed and is being tested. Two-dimensional, cross-sectional ground-water flow models also were constructed and calibrated for selected cross sections of the valley. These two-dimensional models are being used in the construction and calibration of the valleywide, three-dimensional predictive and optimization models.

Plans for Next Year: Fiscal year 1986 will be the fourth year of the 5-year study. The project plan for the year includes calibration and testing of the valleywide, three-dimensional steady- and transient-state ground-water flow models and construction of the hydroeconomic optimization model. Long-term plant-survivability data should be available to test the constraints and objectives of the optimization model by the summer of 1986. All project reports, with the exception of the first and last volumes in the Owens Valley Ground-Water and Plant-Survivability Studies Water-Supply Paper series, should be in preparation or review.

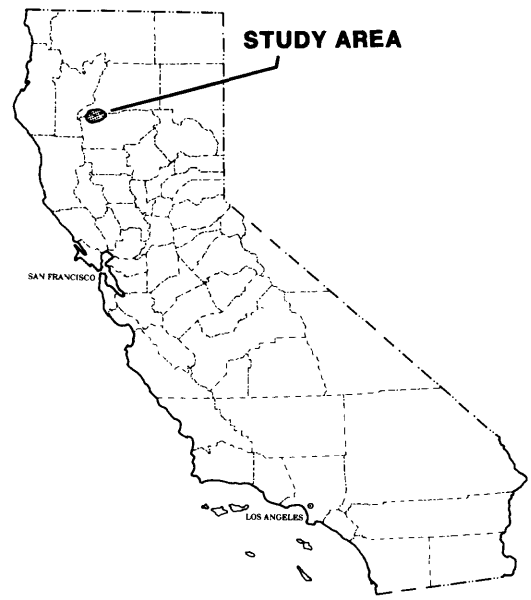
STREAMFLOW CHARACTERISTICS AND GEOMORPHIC CHANGES OF COTTONWOOD CREEK

Number: CA427

Cooperating Agency: U.S. Army Corps of Engineers

Project Chief: James C. Blodgett

Period of Project: June 1983 to September 1985



Problem: The U.S. Army Corps of Engineers are studying the feasibility of constructing two dams on Cottonwood Creek near Cottonwood. Potential impacts from the dams include degradation of the channel, changes in channel morphology and alignment, change in the deposition at the confluence of Cottonwood Creek and the Sacramento River, and potential changes in surface-water and ground-water relations. In order to assess these impacts, current channel and streamflow characteristics need to be defined.

Objectives: To establish baseline information on the streamflow characteristics, flow capacity, and geomorphic characteristics of the Cottonwood Creek channel downstream of the proposed damsites, and to determine the range of changes in the geomorphology of the Cottonwood Creek and channel conditions at the mouth since about 1940.

Approach: Discharge values will be used to calculate low-flow frequency curves, to examine relations between low-flow properties and drainage area, and to quantify streamflow gains and losses for various flow conditions. Cross-section data will be used to document present channel and flood-plain geometry, thalweg elevation, and flow capacity. Bed- and bank-material samples will be collected to define resistance of the channel to erosion. Photography and maps will be used to document changes.

Progress: All field data for the project have been collected. Aerial photographs in 1940, 1960, 1970, and 1980 decades are being analyzed to indicate the geomorphic characterization for a reach of Cottonwood Creek between the proposed damsites and the mouth. Low-flow data collected during the water year are being analyzed and regressed with gaging-station data so that gains and losses, and associated geomorphic characteristics, can be defined for the study reach. Reports on the low-flow and geomorphic characteristics are being prepared.

Plans for Next Year: Complete analysis of low-flow and geomorphic characteristics of Cottonwood Creek. A report on the low-flow analysis and a report on the geomorphic characteristics will be completed.

HYDROLOGIC STUDIES RELATED TO VOLCANIC ACTIVITY IN LONG VALLEY

Number: CA431

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

Project Chief: Peter W. Anttila

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 cm 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 with the following objectives: Phase 1 -- Monitor ground water and surface water 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 the 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 -- Operate a network to monitor surface-water quality and ground-water levels, water temperature, and quality and surface-water quality. Relate data to geologic events. Phase 2 -- apply General Purpose Dam-Break Flood Simulation Model (K-634) for a hypothetical dam failure. Application of other models or development of a new diffusion model will be considered. Phase 3 -- Develop quantitative models capable of analyzing pressure response in water saturated rock from magmatic intrusions.

Progress: A comprehensive hydrologic monitoring network was operated during the year. Monitoring consists of quarterly ground-water-level measurements (40 wells); continual recording of ground-water levels (6 wells), spring flows (7 sites), and streamflow (1 site); continual temperature and specific conductance of hot springs (3 sites); and semiannual chemical and isotope samples (15 springs, 6 streams, and 10 wells). At four of the continual ground-water monitoring sites, data are transmitted via the GOES satellite. A report on hydrologic and geochemical monitoring in Long Valley from 1982-84 was approved for publication. In addition, a poster presentation on monitoring the hydrothermal system in Long Valley was made at the August International Meeting of the Geothermal Resources Council. The study on the effects of magmatic intrusions focused on analyzing the well hydrographs from Long Valley for water-level fluctuations due to crustal deformation induced by tectonic activity. The effects of barometric pressure were removed from the hydrographs using digital filtering techniques. Long-term fluctuations in water levels (with frequency less than 1 cycle/month) were also removed from the water-well hydrographs. The residual water-level records were examined for fluctuations which correlated with periods of known crustal deformation. A description of these analyses was presented at the American Geophysical Union spring 1985 conference in Baltimore, Maryland.

Plans for Next Year: The hydrologic monitoring will be continued and analysis of an expanding data base will be intensified. The study of magmatic intrusions will be continued by analysis of the interaction of ground water and rock strain, filtering of barometric pressures and earth tides, influence of pore-fluid pressure on tectonic deformation, and barometric response of wells to determine hydraulic properties of rocks.

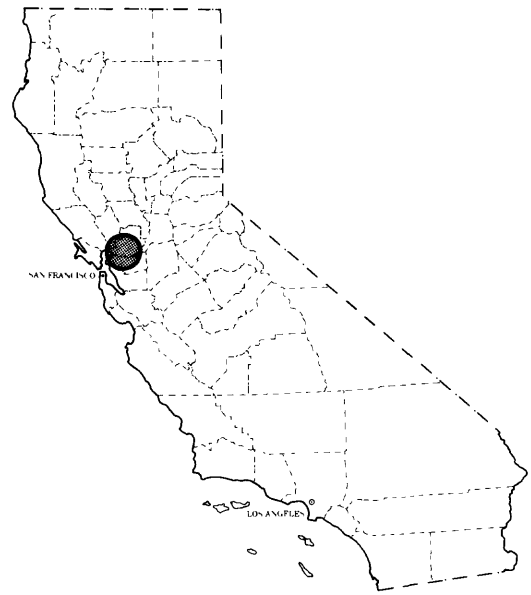
STABLE CARBON ISOTOPE STUDY OF PRIMARY CARBON FLUX OF FOOD CHAIN NETWORK OF STRIPED BASS IN THE SACRAMENTO-SAN JOAQUIN DELTA AQUATIC ECOSYSTEM

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 throughout 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: To determine the stable carbon (and perhaps nitrogen) ratios of the principal components of the striped bass food chain, and using these ratios as a tracer for the major carbon flux of the striped bass food chain.

Approach: To take samples of the principal component of the hypothesized striped bass food chain (i.e. phytoplankton, zooplankton neomysis, striped bass); analyze for 13C:12C (and perhaps 15N:14N) ratios; and use these ratios to substantiate the likely food chain for the striped bass.

Progress: Fish, neomysis, zooplankton, and phytoplankton samples have been taken in four striped bass spawning areas of the Sacramento-San Joaquin River Delta. Coordinated efforts were established between U.S. Geological Survey and the California Department of Fish and Game to collect fish, neomysis, zooplankton, and phytoplankton biweekly at these stations throughout the striped bass spawning season.

Plans for Next Year: The project is scheduled to be completed in fiscal year 1986. Laboratory isotope analyses will be completed, reviewed, and interpreted. A final report will be prepared, reviewed, and submitted for publication approval.

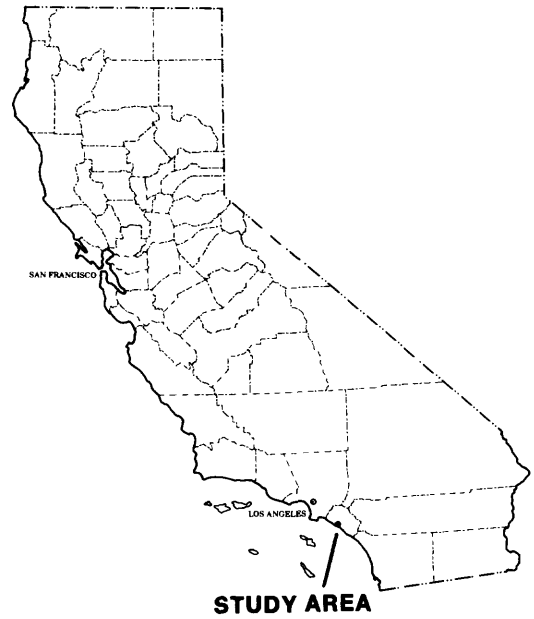
SEDIMENT TRANSPORT IN THE SAN DIEGO CREEK BASIN

Number: CA436

Cooperating Agency: Newport Beach, city of

Project Chief: Christopher E. McConaughy

Period of Project: October 1982 to
September 1985 (terminated)



Problem: During the last 20 years, urbanization has greatly increased in the San Diego Creek drainage basin. As a consequence, Upper Newport Bay has been subjected to accelerated sediment deposition due to changing land use. There has been increasing concern by numerous governmental and private agencies regarding the sedimentation problem and its possible remedies. Insufficient sediment data have prevented a clear understanding of sediment production and transport in the San Diego Creek basin.

Objectives: (1) Document annual sediment discharge and particle size into Upper Newport Bay and determine trap efficiency of new, in-channel siltation basins. (2) Develop a method for predicting sediment yield in the upper drainage basin. (3) Document channel changes between confluence of San Diego and Peters Canyon to inlet of upper siltation basin.

Approach: (1) Construct and operate two streamflow and sediment stations on San Diego Creek and one on Peters Canyon Wash to begin identification of sediment sources and to determine sediment discharge to bay. (2) Survey siltation basins annually and collect samples of deposited sediment for specific dry-weight determination. (3) Periodically measure and sample larger, secondary tributaries to bay. (4) Apply or adapt the U.S. Geological Survey's precipitation-runoff modeling system to simulate storm and daily runoff and sediment discharge. The model will be calibrated and verified by comparing measured water and sediment discharges with simulated discharges.

Progress: The Survey's participation in the study was terminated at the end of fiscal year 1985. Thus, work consisted entirely of collection and processing data. Streamflow data were collected to the end of the fiscal year. Sediment data were collected to the end of the rainy season (April 1985). Previous years streamflow and sediment data were processed for publication.

Plans for Next Year: None. Project terminated.

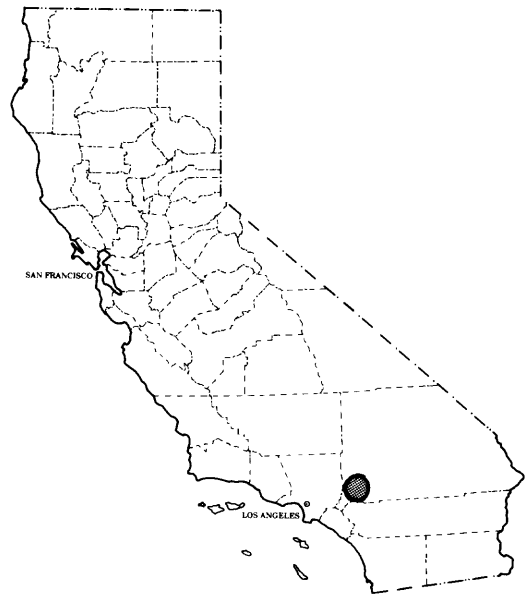
GROUND-WATER-FLOW MODELING AND OPTIMIZATION TECHNIQUES APPLIED TO HIGH GROUND-WATER PROBLEMS IN SAN BERNARDINO

Number: CA437

Cooperating Agency: San Bernardino Valley Municipal Water District

Project Chief: John R. Freckleton

Period of Project: October 1982 to September 1985



Problem: High ground-water levels in the southern part of the San Bernardino Valley have flooded basements, buckled streets, and damaged concrete-lined flood-control channels. In addition, ground water near the land surface has created the potential for soil liquefaction during an earthquake.

Objectives: To determine the most efficient ground-water pumping plan that will lower ground-water levels an acceptable amount.

Approach: Optimization techniques will be used with an existing ground-water flow model in order to evaluate different pumping plans. This optimization model permits determining the minimum pumpage necessary to lower ground-water levels an acceptable amount at all locations of interest. Other constraints, which may be included, limit the amount of pumpage into pipelines and canals and limit the amount of drawdown near existing wells. Lowering water levels will produce a nonlinear change in the evapotranspiration rate. This effect will be included in the optimization model using an iterative technique developed for this study.

Progress: Different management plans have been simulated and the results evaluated. The presently installed pumping capacity appears insufficient to dewater the aquifer to a depth of 30 feet within 1 year. A proposed pumping plan is also unable to meet the 30-foot target, but does have a more favorable arrangement of wells. Fluctuations in the annual pumping capacity were found to have a significant affect on maintaining low water levels. A report describing the study and results was prepared.

Plans for Next Year: Technical advancements in applying optimization techniques to ground-water problems involving evapotranspiration will be presented at the American Geophysical Union meeting in San Francisco, December 1985. Report preparation and reviews will be completed, Survey approval for publication obtained, and report will be submitted for publication to a technical journal.

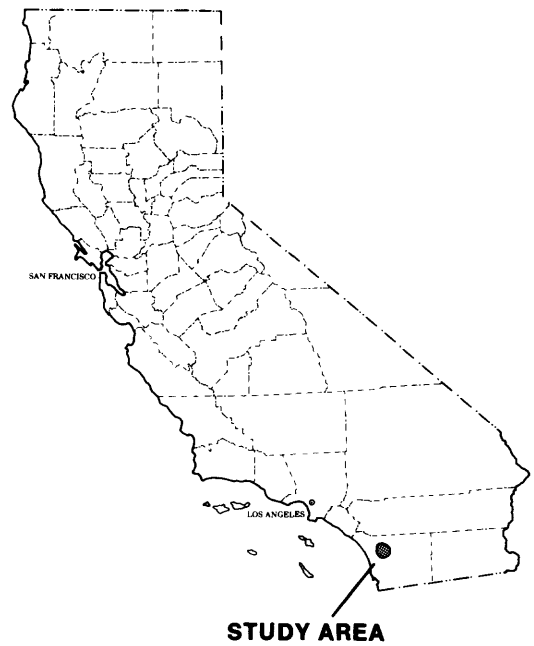
BONSALL GROUND-WATER STUDY, SAN DIEGO COUNTY

Number: CA438

Cooperating Agency: Rainbow Municipal Water District

Project Chief: Linda R. Woolfenden

Period of Project: October 1983 to September 1985 (terminated)



Problem: In response to increasing demand for water and expected shortages of imported water, Rainbow Municipal Water District has decided to exercise rights to local ground water in the Bonsall basin of the San Luis Rey River valley. Irrigation return and several wet winters have produced year-round flow in the San Luis Rey River. This is a significant change in the hydrologic system which may necessitate changes in river infiltration and boundary conditions of the existing ground-water flow model prior to its use as a management tool. Additionally, irrigation return of poor quality and streamflow of variable quality pose constraints on ground-water management.

Objectives: (1) Determine present ground-water levels, storage, movement, and quality. (2) Determine present streamflow characteristics and surface-water quality. (3) Compare and contrast present and historic hydrologic regimes. (4) Estimate effects of ground-water pumpage in wet periods using digital models. (5) Determine distribution of ground-water pumpage that will maximize yield while satisfying water-quality standards.

Approach: Data collection will determine present ground-water levels, storage, movement, and quality and determine present streamflow characteristics and surface-water quality. Comparison of current and historic streamflow will provide information necessary to evaluate changes in streamflow infiltration and ground-water recharge. Existing digital models will be recalibrated to estimate effects of ground-water pumpage during wet periods. Optimization modeling will determine distribution of ground-water pumpage that will maximize yield while satisfying water-quality standards.

Progress: (1) Bonsall Narrows stream gage installed and operational; (2) 10 wells drilled by U.S. Geological Survey; (3) water-level network developed and operational; (4) water-quality network developed and operational; and (5) map series report describing hydrology of basin was approved for publication.

Plans for Next Year: None. Project was terminated prior to the start of recalibration of existing ground-water model.

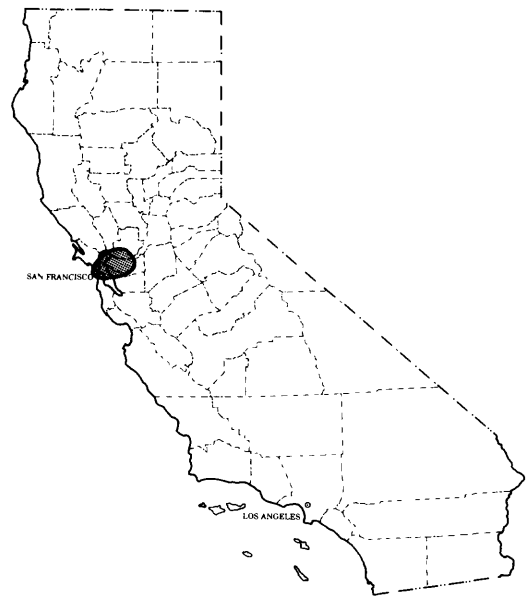
PRELIMINARY ASSESSMENT OF SHOALING IN SAN LEANDRO BAY, ALAMEDA COUNTY

Number: CA439

Cooperating Agency: Alameda County Flood Control and Water Conservation District

Project Chief: K. Michael Nolan

Period of Project: October 1983 to September 1984



Problem: The Alameda County Flood Control and Water Conservation District has become concerned about potential effects of recent shoaling in San Leandro Bay on flood control operations. Rates of sedimentation in the bay are apparently sufficient to close off channel systems within that water body. This has raised concerns that flood waters entering the bay may back up towards inland locations rather than exiting into the main body of San Francisco Bay.

Objectives: To provide a preliminary assessment of rates and causes of recent shoaling in San Leandro Bay. Establish whether or not additional study of shoaling is warranted.

Approach: Changes in the configuration of San Leandro Bay will be mapped using historic data and time sequential aerial photographs. Sedimentation rates will be assessed using lead-210 profiles and the presence of cesium-137 in the salt sediments. Sedimentation rates in areas dredged in 1947 will be quantified by comparing 1983 bathymetry with 1948 bathymetry.

Progress: Ten sediment cores were taken from the bay. Four of these cores were subsampled and analyzed for lead-210 and cesium-137. Dredging records from 1948 were studied and compared to 1983 bathymetry. Preliminary analysis of lead-210 data indicate sedimentation rates between 0.2 and 0.3 centimeters per year. Rates determined from cesium-137 are as high as 0.8 centimeters per year. Discrepancy between these two data sets probably indicates reworking of sediments and/or difficulty in correctly estimating incoming lead-210 activity. Sedimentation in excess of 6.7 meters in 35 years has been found at dredged sites. Estimates of sediment input derived from adjacent land surfaces indicate that only 20-40 percent of sediment accumulating in San Leandro Bay is coming from this source. Remaining sediment must be coming from general circulation within San Francisco Bay. A final report was prepared and received colleague reviews.

Plans for Next Year: Complete project by submitting report for publication approval and subsequent printing of report.

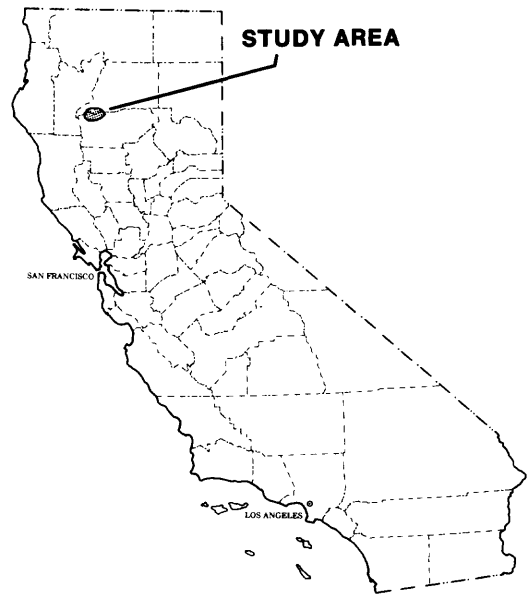
HYDROLOGIC IMPACTS OF DAMS TO BE CONSTRUCTED ON COTTONWOOD AND SOUTH FORK COTTONWOOD CREEKS

Number: CA440

Cooperating Agency: U.S. Army Corps of Engineers

Project Chief: Michael J. Johnson

Period of Project: October 1983 to September 1985 (terminated)



Problem: The construction of two dams are planned on Cottonwood Creek and South Fork Cottonwood Creek near Redding, California. The proposed dams will be constructed in areas underlain principally by the Tehama Formation, which comprises important water-bearing alluvial deposits. It is expected that both the dewatering of the construction sites and filling of the reservoirs after construction will produce changes in the regional ground-water levels.

Objectives: To evaluate the impact of reservoirs on Cottonwood Creek and South Fork Cottonwood Creek on the regional ground-water system. The evaluation will include both the regional impacts of dewatering during construction and the impacts of the reservoir after construction.

Approach: The hydrologic impacts of the dams will be evaluated by developing a model of the ground-water and surface-water systems of the study area. The model will simulate ground-water levels and streamflow in response to natural conditions and to conditions imposed by construction of the dams or operation of the reservoirs. The ground-water levels will be simulated by a three-dimensional representation of the Tehama Formation. Linked to the ground-water model will be a model of the surface-water system. This model will simulate streamflow and exchanges of water between the ground-water and surface-water systems.

Progress: The State of California decided not to proceed with construction plans for the two Cottonwood Dams. As a result of this decision, work on the study was limited to the preparation of a report that describes the field investigation made in fiscal year 1984 and presents data collected during that investigation. These data include logs of the exploratory wells drilled to collect quantitative information on ground-water recharge by streamflow infiltration.

Plans for Next Year: Project was terminated as a result of a decision not to proceed with construction plans for the two dams on Cottonwood Creek and South Fork Cottonwood Creek.

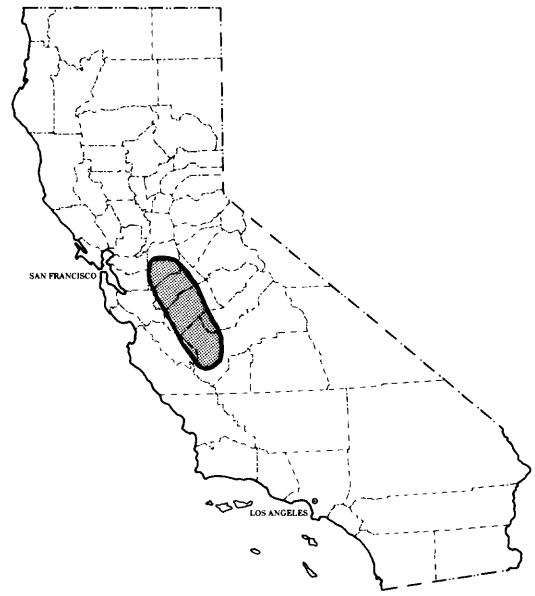
AN ASSESSMENT OF QUALITY AND CONTAMINANT TRANSPORT IN THE SOILS AND GROUND WATER OF WESTERN SAN JOAQUIN VALLEY

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

Approach: Extensive sampling to determine concentrations of pesticides in the drains and shallow ground water and a review of existing data will be done. Relationships between water quality, geohydrology, land use, and agricultural practices will be determined. Model simulations of pesticide transport will be made to assess the potential effects of selected organic compounds on ground-water quality.

Progress: An extensive data base was established for ground-water quality, pesticide use, land use, and water management in the San Luis Drain service area. Inorganic and organic constituents were determined on 130 ground-water samples collected during a reconnaissance study in May. A report that summarizes the results of the sampling and describes the data bases and plans for future study is in review.

Plans for Next Year: Continued study will assess the areal distribution of pesticides in the water table aquifers of the San Joaquin Valley in relation to pesticide use and geohydrologic characteristics. Work will consist of sampling design, sample collection, laboratory analysis, and initial data analysis. The preliminary report prepared in 1985 will be processed through publication.

EVALUATION OF TECHNIQUES FOR MEASURING CURRENTS IN THE SAN FRANSCISCO 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-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 by using an acoustic doppler current profiler in the deeper areas of the system.

Approach: Field test four different types of recording current meters 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), (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. Procure acoustic doppler current profiler for use in deep water areas. Instrument will be vessel-mounted and its accuracy evaluated using current meters.

Progress: Data collected by the meters were compared using time-series overlay plots, speed intercomparison plots, and comparison of harmonic analysis results. Limited amounts of Price AA current meter speed readings also were used for comparison. Results showed that the speed readings from the Aanderaa and General Oceanics meters were higher than those recorded by the other two types of meters due to the orbital water movement caused by wind induced waves. However, if the depth of water above the current meter was about 2.25 meters, the meters were no longer subjected to orbit wave motion. The Endeco and InterOcean meters performed well under all field conditions, but disagree in speed during maximum speed conditions. Further testing is necessary to resolve this difference. The first draft of the final report was prepared and colleague reviewed.

Plans for Next Year: The project will be completed by obtaining publication approval and printing of final report.

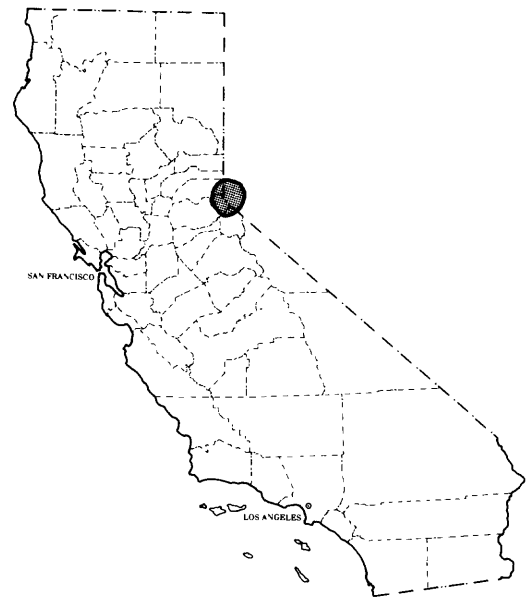
EROSIONAL PROCESSES IN THE LAKE TAHOE BASIN

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: To quantify rates at which sediment is supplied to Lake Tahoe by tributary streams and to identify and quantify processes that contribute sediment to tributaries. To quantify those 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. Where possible, processes in undeveloped areas will be compared to those operating in developed areas.

Approach: Assess the magnitude and frequency of sediment transport in tributaries. Measure rates of erosional processes in drainage basins which have been selected to include geology, land use, and physiography representative of significant areas of the Tahoe basin. Quantify hillslope erosion by mapping erosional landforms from aerial photographs and field observations and by installing erosion plots. Quantify sediment removed from and stored in stream channels by repetitively surveying monumented channel cross profiles and by strip mapping channel conditions using field observations.

Progress: Preliminary assessment of erosional processes in the Tahoe basin indicated that stream channels are the major source of sediment. To identify the part(s) of the channels from which sediment is most commonly removed and to quantify rates at which channel changes occur, a total of 145 channel cross profiles have been monumented and will be resurveyed at least annually in Blackwood, General, Logan House, Edgewood, and Third Creeks. Sediment storage and erosion sites have been mapped along the main channel of Blackwood Creek and along the lower 2.5 miles of the General Creek channel. Using data collected between 1972 and 1981, the magnitude and frequency of sediment transport in Ward Creek, Blackwood Creek, Trout Creek, and the Upper Truckee River have been analyzed. This analysis indicated that average annual suspended-sediment yields ranged from 7.8 to 45.5 megagrams per square kilometer and that more than 70 percent of the sediment is transported during snowmelt periods. Bedload-discharge measurements started in 1984 indicated that bedload composes between 24 and 64 percent of total sediment transport during periods of high flow. A total of 35 sites have been instrumented to study rates of sheetwash and erosion on hillslopes in Blackwood and Edgewood Creek basins.

Plans for Next Year: Resurvey channel cross profiles, remeasure hillslope erosion plots, continue mapping additional stream channels for sediment storage and erosion, continue collecting bedload discharge data on Blackwood, General, Edgewood, and Logan House Creeks, collect synoptic data describing variations in sediment discharge throughout selected drainage basins during snowmelt.

WATER QUALITY OF THE U.S. LAKES AND RESERVOIRS, WITH EMPHASIS ON EUTROPHICATION

Number: CA447

Location: Nationwide

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

Project Chief: Walter Rast

Period of Project: April 1984 to September 1986

Problem: Deterioration of water quality in lakes and reservoirs is an inevitable consequence of man's settlement of a drainage basin. Pollution of surface waters is one of the most serious water problems in the United States today. To provide for scientifically-sound and cost-effective management of such resources, it is necessary to provide accurate lakes/reservoir information for those officials, individuals, and agencies responsible for policy formulation and management of the Nation's water resources.

Objectives: (1) To identify and compile relevant water-related information and data bases descriptive of overall water quality of U.S. lakes and reservoirs. (2) To prepare an overview description of water quality of U.S. lakes and reservoirs for U.S. Geological Survey National Water Summary, especially conditions descriptive of polluted waters.

Approach: Identify and compile water-quality information from existing data bases and reports of relevant Federal, State, local, and university studies. Assess scientific adequacy of such information and data for providing an overview assessment of water quality of the U.S. lakes and reservoirs. Using statistical techniques and knowledge of conditions which are indicative of polluted waters, prepare an assessment of overall water quality in U.S. lakes and reservoirs, focusing on eutrophication and general water quality and their potential impacts on water uses.

Progress: An initial data retrieval of available U.S. lake and reservoir data in the Environmental Protection Agency STORET system has been completed. Techniques for data analysis, compression, and synthesis have been developed. Techniques for graphic presentation of the results have also been developed. Additional non-STORET data sources have been identified, and data retrieval from these sources will begin late fiscal year 1985.

Plans for Next Year: Project to be transferred to the Water Resources Division, Texas District with the transfer of the project chief to the Texas District Office, Austin, Texas. Work will consist of (1) retrieval of all relevant data bases; (2) quality assessment of all retrieved data; (3) statistical analyses of retrieved data bases; (4) development of desired overview statement; and (5) preparation of final report on study results.

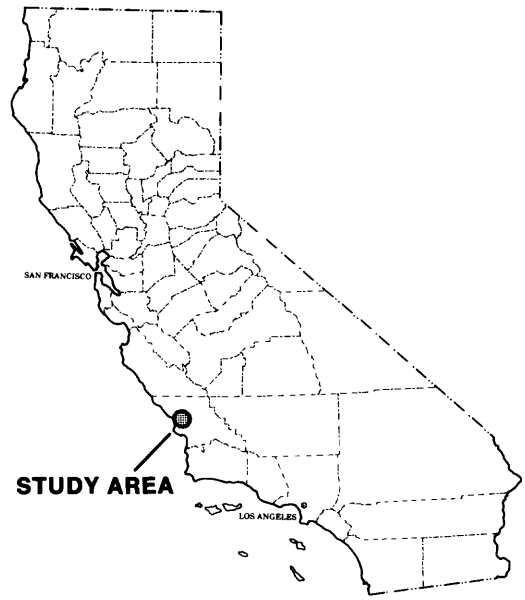
GEOHYDROLOGY OF THE LOS OSOS GROUND-WATER BASIN, SAN LUIS OBISPO COUNTY

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 designed by the U.S. Geological Survey.

Objectives: To develop a ground-water flow model of Los Osos ground-water basin, which will be capable of simulating the hydrologic effects of alternative management plans concerned with ground-water withdrawals, seawater intrusion, and wastewater disposal.

Approach: Designing 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 computer model.

Progress: During the 1985 fiscal year, geology of the basin and surrounding areas was field mapped on a scale of 1:12,000. Wells were drilled to bedrock at six locations in the basin. Lithologic and geophysical logs were made of each well. Piezometers were installed at all locations; at four of the six sites, multiple piezometers were installed to monitor different vertical intervals. Water samples were collected from each well and analyzed for concentrations of major ions and nitrate. Electromagnetic surface-geophysical measurements were made along the northern edge of the ground-water basin to determine the stratigraphy and total thickness of basin sediments. A review of previous investigations of the hydrogeology of the Los Osos ground-water basin was completed. A conceptual model of the ground-water flow system was formulated in preparation for subsequent development of a digital computer model.

Plans for Next Year: Continued data-collection efforts will consist of 1) monthly water-level measurements at selected wells, 2) seepage measurements along Los Osos Creek, 3) aquifer tests to determine the hydraulic properties of the Paso Robles Formation, and 4) water-quality analysis of wells along the Morro Bay sandpit. A digital computer model of the ground-water flow system will be developed and calibrated. The calibration process will combine all available field measurements with a sensitivity analysis of model parameters to obtain the best possible simulation of observed historic flows and water levels.

EROSION AND SEDIMENT TRANSPORT IN THE DRAINAGE BASIN OF PERMANENTE CREEK

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: Objectives are (1) to quantify rates of sediment transport and identify major sources of sediment within the Permanente Creek drainage basin, and (2) to 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: Gaging stations were installed and have operated for 1 year. Erosional landforms were mapped in both basins using aerial photography taken in 1984, 1968, and 1948.

Plans for Next Year: Continue to collect total-load sediment data at both stations. Map erosion and sediment storage along the channel of Permanente Creek and the North Fork Permanente Creek. Model runoff in both drainage basins to determine if contrast in runoff behavior observed to date are due to differences in the amount of impervious surface in the two basins.

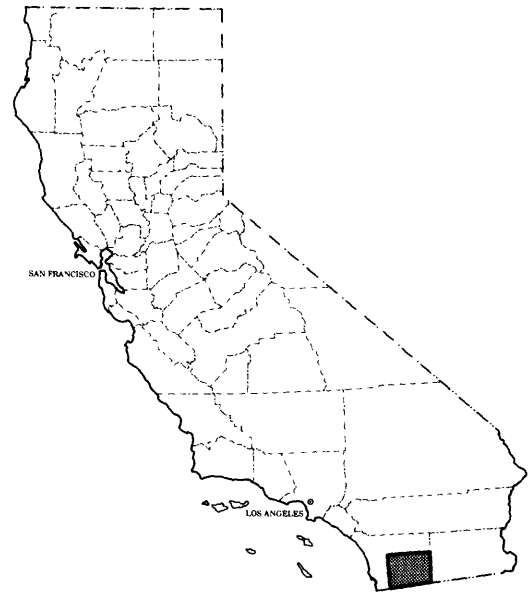
HYDROLOGIC APPRAISAL OF POTENTIAL LANDFILL SITES IN SOUTHEASTERN SAN DIEGO COUNTY

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, especially in the San Diego metropolitan area, has created a need for additional landfill sites for waste disposal. Correspondingly, urban growth has reduced the number of suitable landfill sites near or within the urban area. Faced with this problem, San Diego County has decided to look in the southeastern part of the county for potential landfill sites. The potential landfill sites need to be evaluated for their hydrologic suitability.

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

Approach: In the first phase, topographic and land-use information will be used to select approximately 12 potential landfill sites. Geological, hydrological, geophysical, and lineament information will be compiled for the 12 sites. The second phase will consist of detailed surface-geophysical surveys, well drilling and testing, water sampling, and chemical analyses at two of the potential sites. This work will define the volume, structure, lithology, and hydraulic characteristics of unconsolidated deposits at the two sites.

Progress: The first phase of the study involving 13 preliminary sites was completed. The following items have been presented to the County: Summary sheets containing topographic, geologic, and hydrologic information; and summary of results from surface-geophysical soundings; and maps showing the locations of hydrologic data points on or near the sites.

Plans for Next Year: Complete phase two of the study and prepare report summarizing results.

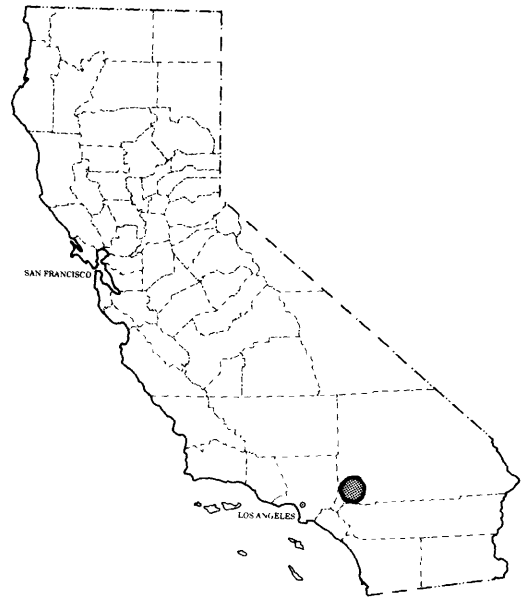
DEVELOPMENT OF AN ECONOMIC OPTIMIZATION MODEL FOR SAN BERNARDINO VALLEY

Number: CA451

Cooperating Agency: San Bernardino Valley Municipal Water District

Project Chief: Wesley R. Danskin

Period of Project: October 1984 to September 1988



Problem: In upper parts of the San Bernardino Valley, the ground-water system is used to store excess surface water for artificial recharge. At the same time in lower parts of the valley, ground-water levels are near the land surface and are creating severe problems, including the flooding of basements, structural damage to foundations, and the potential for soil liquefaction during an earthquake. Current rates of ground-water pumping for agriculture and municipal uses have not been sufficient to lower water levels in those areas with problems.

Objectives: The primary objective is to determine a pattern of municipal pumping which prevents high water levels in critical areas, satisfies all water demands, and minimizes the total cost of ground-water pumping. Secondary objectives include: (1) Developing methods which will permit the variable effect of evapotranspiration to be included in the analysis, and (2) extending the scope of the solution so that the operating costs associated with surface- and ground-water use of the basin are minimized.

Approach: A hydraulic-economic optimization model will be developed to aid in determining the most effective solution to the high ground-water problem. An existing two-layer, ground-water flow model will be used to simulate the response of the ground-water system. The optimization model will consist of a nonlinear objective function which calculates the cost of pumping each well with constraints on water levels, quantities of pumpage, and maximum costs of operation. Feasible management alternatives as well as data on pumping costs and model constraints will be obtained from the local water authority.

Progress: The purpose and scope of the original project was significantly changed. Economic optimization will now encompass the entire San Bernardino Valley including all major surface-water and ground-water interactions. This will permit investigating optimal combined recharge and pumping programs.

Plans for Next Year: Fiscal year 1986 will involve defining the water-quality constraints with a data-collection and analysis program.

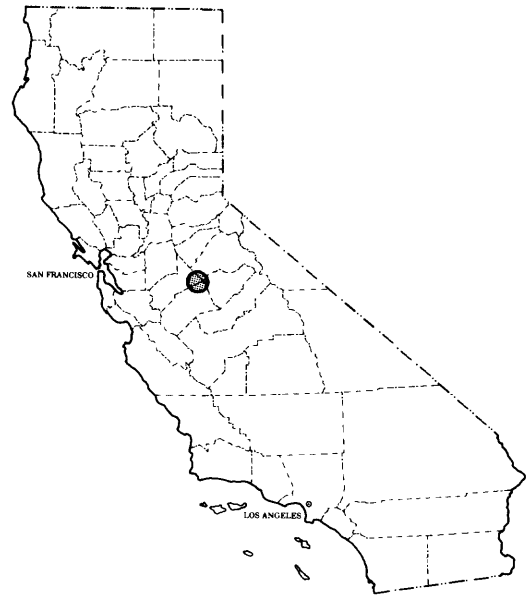
PERFORMANCE EVALUATION OF AN ELECTROMAGNETIC STREAMFLOW GAGE ON TURLOCK CANAL

Number: CA454

Cooperating Agency: Turlock Irrigation District

Project Chief: Thomas C. Hunter

Period of Project: October 1984 to September 1987



Problem: The installation and subsequent operation of a low-head hydroelectric power generation facility on Turlock Canal has precluded the use of standard open channel flow monitoring methods. Turlock Irrigation District has to provide an accurate flow record for the canal, and has, therefore, purchased and installed an electromagnetic flowmeter system that is able to monitor unsteady flow. However, Turlock Irrigation District does not have the equipment or manpower to measure the flow in the canal in order to calibrate the flowmeter.

Objectives: Calibrate the electromagnetic flowmeter, and evaluate its operation and accuracy.

Approach: Calibration of the flowmeter will be accomplished by making flow measurements during various backwater conditions, and comparing the results with those flows provided by the electromagnetic flowmeter. Because of rapidly varying flow conditions due to the operation of the hydroelectric facility, conventional discharge measuring techniques will not always be applicable. Therefore, a 0.6-depth line-velocity method (similar to moving-boat method) will be attempted. After the flowmeter has been calibrated, additional flow measurements will be made in order to verify the meter's calibration and to evaluate its accuracy.

Progress: A few flow measurements at different flow rates were made so that the instrument manufacturer could quasi-calibrate the meter. Additional measurements have shown that the flowmeter is recording lower flows than indicated by the measurements. This discrepancy has been traced to water drawdown in the water level stilling well due to the water velocity in the canal at the well intakes. Thus, the stilling well is indicating to the flowmeter a shallower water depth in the canal than is actually present. Flow is computed by correlating water depth to canal cross-sectional area, and multiplying the area by the water velocity determined by the meter. The drawdown problem, hopefully, will be rectified by using a transponder installed on the measuring bridge just downstream of the stilling well. Work will not begin on perfecting a 0.6-depth line velocity measuring method until the drawdown problem has been eliminated.

Plans for Next Year: A 0.6-depth line velocity measuring method will be perfected if not completed this year. This will involve (1) collecting vertical velocity profiles in the canal to see if a 0.6 depth current-meter setting will provide an adequate measure of the mean velocity, and (2) fabricating the necessary measuring hardware (rail system for moving the current meter across the canal at a uniform rate). A series of flow measurements will be made on a regular basis for comparison with the electromagnetic flowmeter. An annotated outline of the final report will be prepared and colleague reviewed.

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

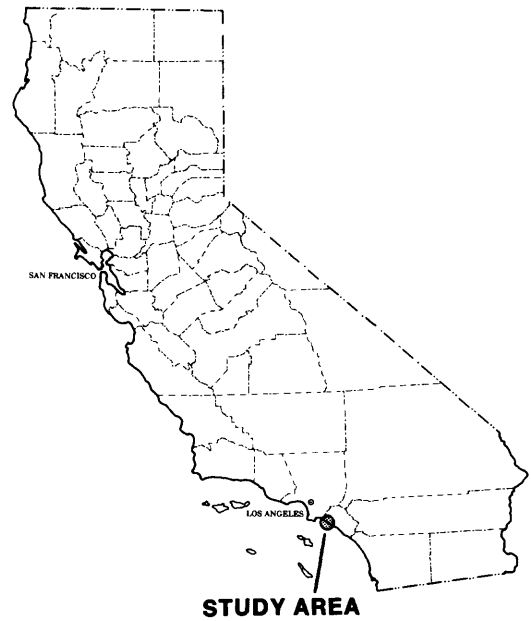
Number: CA455

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: The objectives are (1) to determine the areal and vertical extent of gasoline contamination; (2) to determine lithologic and hydrologic properties of the aquifer; (3) estimate the quantity of gasoline in the aquifer; and (4) to 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 pump tests, and a recorder will be installed to measure effects of tidal fluctuations on ground-water levels.

Progress: The horizontal and vertical zones of gasoline contamination were delineated using visual inspection and gas chromatographic analysis of soil cores from 34 test holes. An area of 160,000 square feet and vertical zone 1 to 2 feet thick above the shallow water table contains gasoline. Total volume of spill is estimated from chemical data to be 6,000 gallons. Seasonal and tidal fluctuations of the water table has spread the gasoline vertically through the subsoil and thereby reduced its concentration below residual saturation (specific retention) over nearly all of the contaminated area. Hence, removal by pumping is possible only near the storage tank where monitor wells contain a layer of floating gasoline.

Plans for Next Year: A gasoline recovery well will be installed and operated by a private contractor. The U.S. Geological Survey will install two additional wells nearby to monitor progress of the recovery. The leading edge of the spreading gasoline will be precisely located on three east/west transects in the marsh. Six soil cores will be recovered from the contaminated zone and their soil gasoline concentration will be measured to determine rate of natural assimilation.

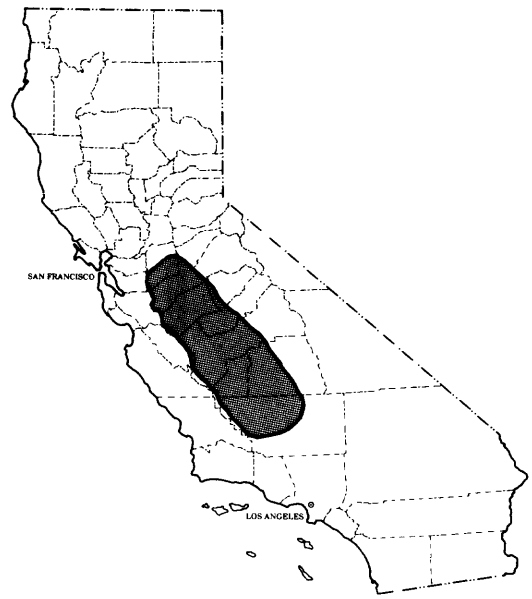
WESTERN SAN JOAQUIN VALLEY HYDROLOGIC STUDIES

Number: CA456

Cooperating Agency: U.S. Department of the Interior, U.S. 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 waters, 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 of the sources, distribution, movement, and fate of selenium and other trace elements in the hydrologic system of the western San Joaquin Valley.

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

Progress: Progress on studies is on or ahead of schedule. About 3,000 soil samples were collected on a square-mile grid on Cantua and Panoche Creek Fans. Analytical work is underway. More than 500 soil samples and over 100 ground-water samples were collected in detailed field studies. Laboratory studies of selenium mobility are underway on more than 500 soil samples. Water samples were collected and analyzed for 66 deep wells in the western San Joaquin Valley. More than 500 lithologic logs for the valley wells were collected for mapping geology. Three clusters of deep piezometers to several hundred feet and more than 100 shallow piezometers were installed. Preliminary ground-water model development was begun for simulating regional and field-scale flow systems. A model of the Kesterson-area ground-water flow system was completed. Sampling continues biweekly at 11 sites in the San Joaquin River drainage, and synoptic samplings of water and bed sediments at more than 40 sites is completed--analytical work is underway.

Plans for Next Year: Efforts will focus on interim data analysis, preparation of reports, and planning for changes in study direction. Data collection continues, with a new major effort to canvass wells throughout the San Joaquin Valley for a valleywide study of ground-water geochemistry.

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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 from 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.

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U.S. Geological Survey
2800 Cottage Way
Room W-2234, Federal Bldg.
Sacramento, CA 95825
Phone: (916) 978-4633

MAPS

Western Distribution Center
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225

Phone: (303) 236-7476

GEOLOGY

Assistant Chief Geologist
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025
Phone: (415) 323-8111 (ext. 2214)

GENERAL INFORMATION

Regional Hydrologist
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025
Phone: (415) 323-8111
(ext. 2337)

Public Inquiries Office
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025
Phone: (415) 323-8111
ext. 2818

Public Inquiries Office
U.S. Geological Survey
504 Custom House
555 Battery St.
San Francisco, CA 94111
Phone: (415) 556-5627

Public Inquiries Office
U.S. Geological Survey
7638 Federal Bldg.
300 North Los Angeles St.
Los Angeles, CA 90012
Phone: (213) 688-2850