# A WATER-RESOURCES DATA-NETWORK EVALUATION FOR MONTEREY COUNTY, CALIFORNIA, PHASE 3: NORTHERN SALINAS RIVER DRAINAGE BASIN

By *William E. Templin* and *Randall C. Schluter*

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# CONTENTS

## ILLUSTRATIONS

## TABLES



## CONVERSION FACTORS

For readers who prefer metric and International System (SI) units to inch-pound units, the conversion factors for the terms used in this report are as follows:

| Multiply | By | To obtain |
|---|---|---|
| acre | 0.4047 | hectare |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second |
| foot | 0.3048 | meter |
| gallon per minute (gal/min) | 0.06308 | liter per second |
| gallon per day | 0.06308 | liter per day |
| inch | 25.4 | millimeter |
| inch per year (in/yr) | 25.4 | millimeter per year |
| mile | 1.609 | kilometer |
| square mile ($mi^2$) | 2.590 | square kilometer |

Abbreviations:

μg/L microgram per liter
mg/L milligram per liter

Degree Celsius (°C) can be converted to degree Fahrenheit (°F) by the following formula:

$$°F = 1.8 \times °C + 32.$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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## ABSTRACT

This report presents an evaluation of water-resources data-collection networks in the northern Salinas River drainage basin, Monterey County, California. The evaluation, done in cooperation with the Monterey County Flood Control and Water Conservation District, covers both quantity and quality monitoring by precipitation, surface-water, and ground-water networks. The report describes existing networks in the study area and possible additional data collection.

The study identified 34 precipitation gages in the study area, of which 20 are active. The stations are concentrated in the northwestern part of the study area. Data are lacking for the eastern and southern parts of the study area, as well as the southwestern slopes of the Gabilan Range. No precipitation-quality networks were identified. Possible data-collection efforts for precipitation quality include monitoring for acid rain and for pesticides in precipitation.

The study identified 10 streamflow-gaging stations, of which 6 are active. To meet the objectives for streamflow networks that are outlined in the report, all sites could be reactivated, and two of the inactive sites could be relocated to improve the reliability of the data. Besides these stations, nine possible additional streamflow-gaging sites were identified.

The Monterey County Flood Control and Water Conservation District samples one surface-water site for suspended sediment, specific conductance, and chlorides. Several agencies have done water-quality sampling in the past, but only five sites are active. Reactivation of the 45 inactive sites might help to meet the various surface-water-quality objectives described in the report. Development of a stream-reach rating system also could help to identify parts of the study area most in need of sampling.

The Monterey County Flood Control and Water Conservation District maintains three networks to measure ground-water levels on a monthly basis, during peak irrigation, and at the end of the irrigation season. The District measures water levels in 318 wells. The only other network identified for this report was operated by the U.S. Geological Survey, and none of its five wells are active. The study identified 128 sections in which no ground-water-level monitoring is presently done. Well coverage is densest in the saltwater-intrusion areas near Castroville, California. Wells in the rest of the study area are more sparsely distributed and are concentrated down the center of the drainage basin in the alluvial ground-water basin.

The ideal initial baseline network of ground-water-quality wells would be an evenly spaced grid of index wells within each aquifer, with a density of one per section. Once baseline conditions were established, representative wells could be selected and monitored annually. As of 1985, the Monterey County Flood Control and Water Conservation District monitored 379 study wells in the area for various water-quality conditions. Other networks monitor (or propose the monitoring of) 135 wells. The District collects samples in summer months to monitor saltwater intrusion near Castroville. Annual samples also are analyzed for chloride, specific conductance, and nitrate. Every 5 years, the District does a complete mineral analysis on each study well. Improvements in network coverage are suggested to better approximate ideal network coverage. The adequacy of wells in existing monitoring networks for representing actual conditions in the ground-water basins was not established conclusively. Possible redundancy of information from existing networks was not evaluated statistically. Despite these limitations, this report does provide a basis for assessing the adequacy of ground-water-level networks in the study area. The computerized Geographic Information System (GIS) that is planned for Monterey County could easily use the information in this report for the needed initial analysis of network adequacy. The feasibility of management and analysis of large complicated data bases (such as the ground water networks identified in this report) is substantially improved through the use of state-of-the-art GIS tools now available.

# INTRODUCTION

Continuing data collection and analysis are vital to efficient development and management of water resources. To insure that water managers have adequate information on conditions and trends, data-collection programs must be evaluated and updated periodically. Changes in population, land use, and agricultural practices may increase the demand for water, so that effective water management and supporting data collection become even more critical. Consideration of cost effectiveness, however, means that every site must count, and redundancy must be minimized. Water-resources management and monitoring are ever-changing, and periodic reevaluation is a necessary part of this process.

This report presents an evaluation of precipitation, surface-water, and ground-water monitoring networks in the northern Salinas River drainage basin of Monterey County, California (fig. 1). This report is third in a series of reports prepared in cooperation with the Monterey County Flood Control and Water Conservation District (MCFCWCD). The phase 1 report (Showalter and Hoffard, 1986) covers the southern Salinas River drainage basin, the phase 2 report covers the north county and coastal areas of Monterey County (W.E. Templin, P.E. Smith, and R.C. Schluter, U.S. Geological Survey, written commun., 1989), and this report (phase 3) covers the northern Salinas River drainage basin (fig. 1).

## Purpose, Scope, and Objectives

This report presents an evaluation of water-resources data-collection networks in the northern Salinas River drainage basin of Monterey County (fig. 1). Possible additional monitoring is described for networks that presently do not meet objectives defined in this report. The report includes an evaluation of networks that monitor quantity and quality of precipitation, surface water, and ground water in the study area. The report also describes factors influencing water-resources network design in the area, including geology, climate, water use, hydrologic conditions, and land use. Generalized management and network objectives are summarized in table 1. These objectives, developed with significant assistance from the staff of the Monterey County Flood Control and Water Conservation District, guided the network evaluations and the preparation of this report.

TABLE 1.--*Generalized management and network objectives*

I. Generalized management objectives

A. Precipitation networks

1. Determine regional variations to establish spatial and temporal trends for storm events and for average periods of time (such as daily, monthly, and annual totals).
2. Identify factors which may influence quantity or quality:
   a. Determine the effects of the presence of natural and human-influenced point and regional factors that may affect precipitation characteristics, such as lakes, reservoirs, oceans, estuaries, wetlands; regionally irrigated areas; multiple-story buildings; and industries with emissions into the air.
   b. Determine the presence of measurement conditions that may affect measurement values, such as standard methods of gaging-station installation (gage types, distance above ground and away from structures, and sampling and analytical practices).

B. Streamflow networks

1. Determine benchmark flow characteristics, such as peaks and mean daily flows, for all major and minor streams.
2. Identify temporal and spatial trends.
3. Identify causes of quantity changes, such as annual precipitation variation, land use changes, instream uses, diversions, agricultural return, channel stabilization, or channelization.
4. Determine best management options among the various water uses, such as instream fish habitat, recreation, ground-water recharge, or diversions for agricultural, industrial, or municipal and domestic uses.

C. Surface-water-quality networks

1. Determine ambient concentrations of all water-quality constituents.
2. Determine spatial and temporal trends.
3. Identify sources of constituents:
   a. Native (soils and geologic parent materials).
   b. Point sources (industrial, municipal and domestic, solid-waste disposal sites, and agriculturally related sites).
   c. Nonpoint sources, including but not limited to applied agricultural chemicals (pesticides and herbicides from agricultural and forest land use and land cover categories); cumulative effects of septic systems, mines, urban runoff, underground storage tanks, and rainfall ground-water discharge from water sources of lower quality than streams.
4. Develop a management plan to control stream quality.

D. Ground-water-level networks

1. Determine regional water-level conditions to establish spatial and temporal trends.
2. Identify sources of pumpage and recharge.
3. Determine storage capacities and best management practices to prevent overdraft and saltwater intrusion.

E. Ground-water-quality networks

1. Determine regional ambient water-quality conditions to establish spatial and temporal trends.
2. Identify sources of ground-water use and potential contamination to minimize contaminant buildup, reduce and eliminate sources of contamination, prevent additional contamination, and improve degraded water conditions whenever possible.

II. Generalized network objectives for all networks

A. Ideal-network objectives (Pederson and others, 1978, p. 77).

1. Establish a data base for water quantity and quality to achieve management objectives.
2. Provide complete spatial and temporal coverage to satisfy all data needs of Monterey County Flood Control and Water Conservation District at an adequate level of accuracy.

B. Actual-network objectives (Moss and others, 1982, p. 1).

1. Optimum distribution of monitoring sites to provide a minimum-cost network or integrated information system that will attain a prespecified accuracy and reliability.
2. Maximum information within budgetary and time constraints.

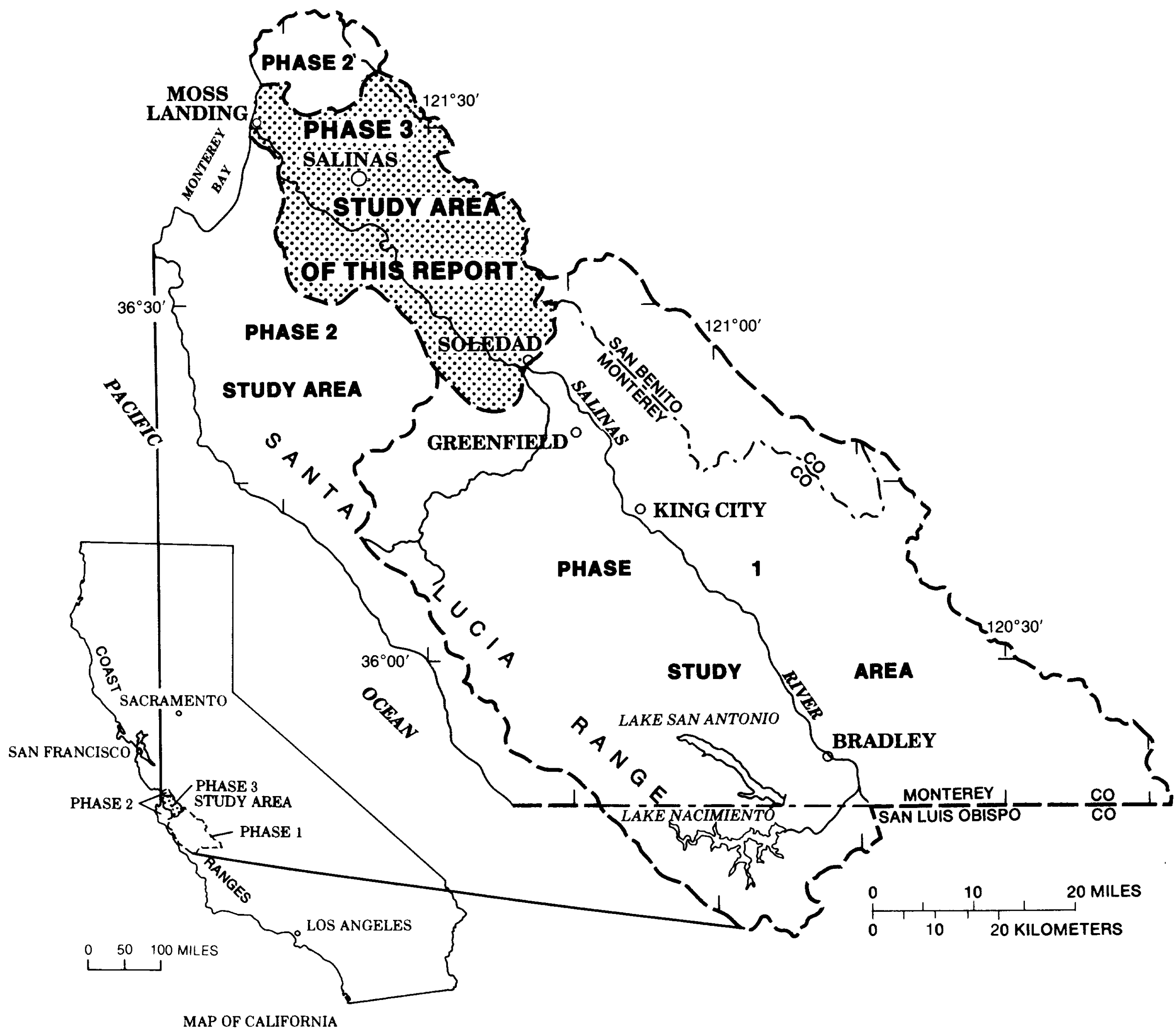
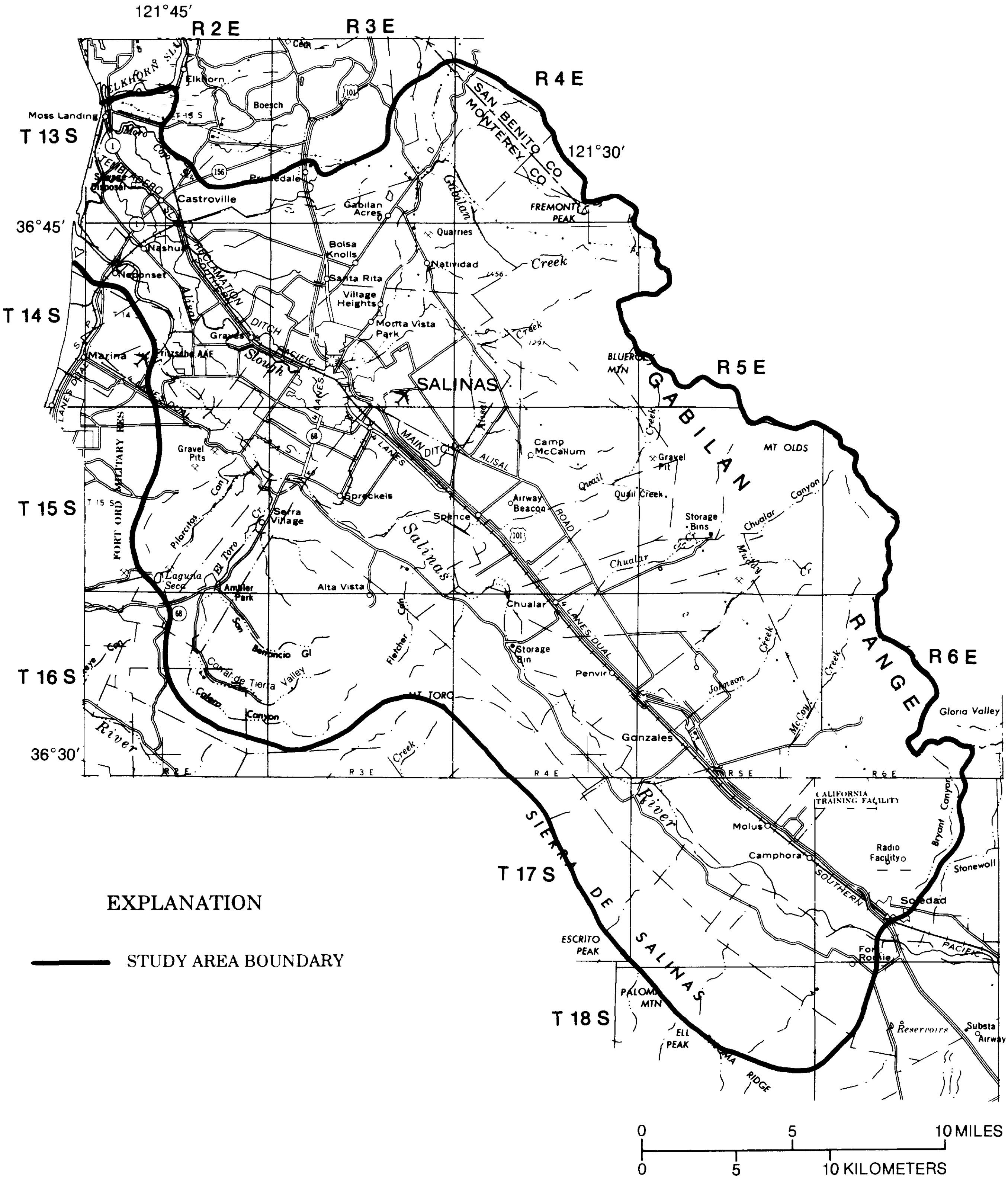



**FIGURE 1.—Location of the study area.**




EXPLANATION

STUDY AREA BOUNDARY

## Approach

The approach of this report is similar to the one used by Showalter and Hoffard (1986, p. 7). In general, the principal steps include (1) assessment of data needs for the study areas, (2) design of ideal network coverage, (3) description and evaluation of existing networks, and (4) suggestion of improvements to network coverage. Specific approaches for each network evaluation vary considerably because of differences both in the level of knowledge about precipitation, surface water, and ground water in the study areas and in the general state of the art for each of the water-resources disciplines. For example, considerably more research has been completed in the specialities of streamflow and precipitation network evaluation than in water-quality and ground-water network evaluation.

## Location of Study Area

Monterey County (fig. 1) is south of San Francisco in central coastal California. For the network evaluations, the Salinas River drainage basin was divided into the southern and northern parts. The study area for this report is the northern Salinas River drainage basin in Monterey County. Showalter and Hoffard (1986) reported on the southern basin.

The study area for this report is about 40 miles long, about 25 miles wide near Chualar, and about 600 $mi^2$ in area. The communities of Soledad, Gonzales, Chualar, Salinas, Castroville, and Moss Landing lie in the study area (fig. 1). The Salinas River is braided from its confluence with the Arroyo Seco near Soledad, meanders to near Spreckels, and is mostly straight or confined from Spreckels to Monterey Bay. The Salinas River drains an area of about 5,000 $mi^2$, which extends southward from its mouth about 150 miles. The basin rises in altitude from sea level at the mouth of the Salinas River to about 50 feet at Salinas and about 200 feet at Soledad, which is at the southern edge of the study area.

## Limitations

The lack of an up-to-date, computerized data base precluded the use of many sophisticated statistical and geographical tools for network evaluation. Efforts to identify current data-collection activities were restricted to reviews of such computerized data bases as STORET, U.S. Geological Survey Water-Data Storage and Retrieval System (WATSTORE), National Water Data Exchange (NAWDEX), and California Department of Water Resources Water Information System (WDIS); reviews of published versions of these data bases; and telephone interviews with water-resources agencies in the local area. An attempt was made to identify all hydrologic monitoring in the area, but the compilation of networks is not as thorough as is needed and was necessary for a ground-water-quality monitoring network design done in cooperation with the California State Water Resources Control Board (Templin, 1984). Monitoring activities change rapidly in location and number of sites as well as in the properties, characteristics, and constituents monitored. Consequently, periodic inventories of active data collection are vital to investigations of the sort undertaken for this report.

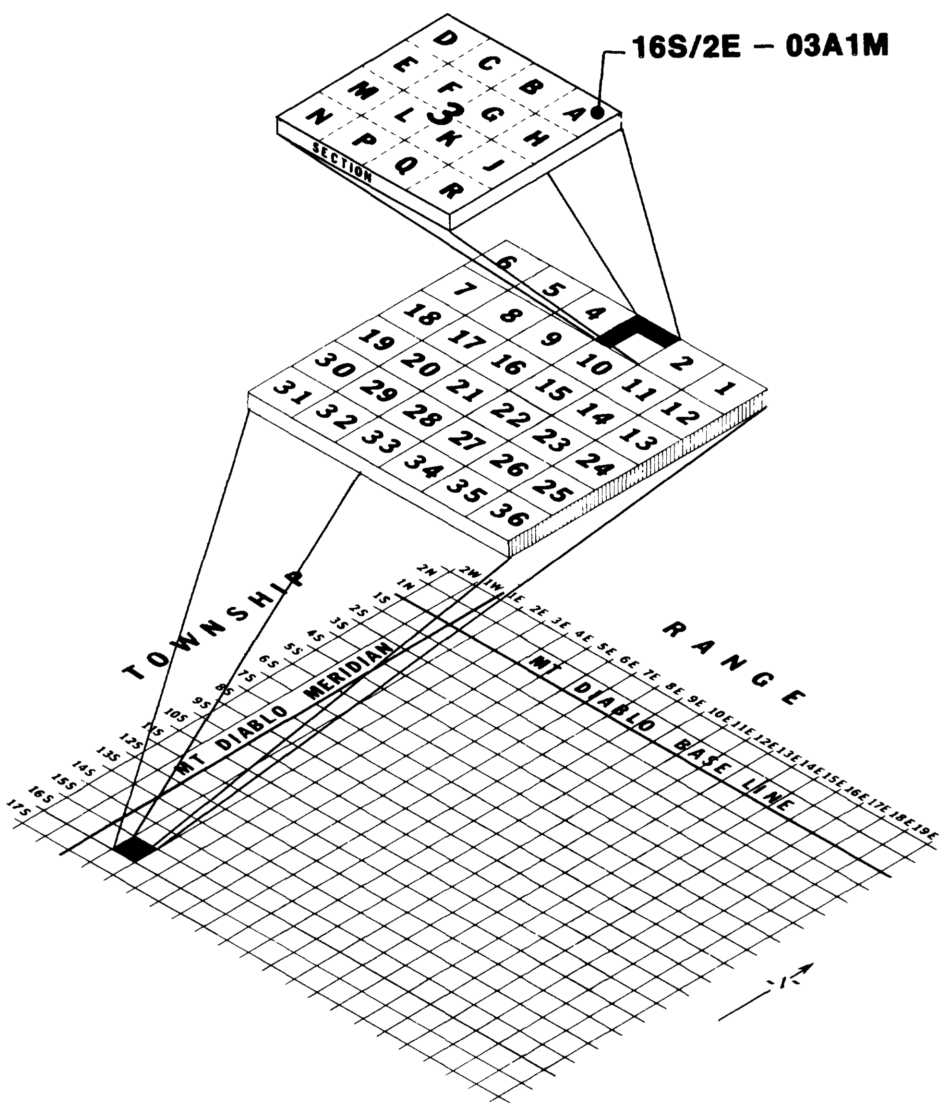
## Acknowledgments

The authors appreciate the assistance of personnel of many agencies, without whom this report could not have been completed:

Association of Monterey Bay Area Governments
California Air Resources Control Board
California Department of Fish and Game
California Department of Food and Agriculture
California Department of Forestry
California Department of Health Services
California Department of Parks and Recreation
California Department of Water Resources
California Regional Water Quality Control Board
California Water Resources Control Board
Marina County Water District
Monterey Bay Air Pollution Control District
Monterey County Flood Control and Water Conservation District
Monterey County Health Department
Monterey County Planning Department
Northern Salinas Valley Mosquito Abatement District
Santa Cruz County Planning Department
U.S. Naval Postgraduate School
U.S. Soil Conservation Service

## Well-Numbering System

Wells are identified according to their location in the rectangular system for the subdivision of public lands. Identification consists of the township number, north or south; the range number, east or west; and the section number. Each section is divided into sixteen 40-acre tracts lettered consecutively (omitting the letters I and O), beginning with A in the northeast corner of the section and progressing in a sinusoidal manner to R in the southeast corner. Within the 40-acre tract, wells are numbered sequentially in the order in which they are inventoried. The final letter of the identification refers to the base line and meridian from which the well location is referenced. All wells in Monterey County are referenced from the Mount Diablo base line and meridian, and so the final letter in the official State well number of all wells in this report is M for Mount Diablo. The following diagram of the well-numbering system shows how well number 16S/2E-03A1M is derived.



The California Department of Water Resources (DWR) has sole authority for assigning official State well numbers. In some instances, the DWR has delegated this authority; the Monterey County Flood Control and Water Conservation District, for example, has been authorized to assign State well numbers. In order to assign a well number, the authorized agency needs the well location on the appropriate U.S. Geological Survey 7.5-minute quadrangle map and such well-construction information as completed drillers' logs and local-agency numbers. Accurate location and construction information on wells can enhance greatly the reliability of ground-water research.

## CLIMATE

The northern Salinas River drainage basin (fig. 1) has a Mediterranean climate: temperatures are moderate all year; the rainy winter seasons are short; and the summers are cool and dry. The Pacific Ocean moderates weather conditions, but this influence decreases towards Soledad on the southern edge of the study area (fig. 1). Seasons are weakly defined, and temperature variations are small. At Salinas, more than 91 percent of the average annual precipitation falls during November through April (California Department of Water Resources, 1981a, p. 18). Annual precipitation actually can vary much more widely than the average annual precipitation values indicate. For example, annual precipitation at Salinas has ranged from a low of 5.74 inches to a high of 28.10 inches (Monterey County Planning Department, 1980, p. 9).

The Salinas River drainage basin lies between the Sierra de Salinas and Santa Lucia Range to the west and south and the Gabilan Range to the northeast of the study area (fig. 1). Between March and October, northwesterly winds blow directly into the Salinas River drainage basin and parallel to the Santa Lucia Range. These winds cause upwelling of cold ocean water in Monterey Bay, and fog forms as saturated ocean air passes over the cold bay water. The fog moves along the coast and into the Salinas River drainage basin. Typically, the fog reduces temperatures and moderates the potential imbalance between the moisture-deficient conditions and the increased potential evapotranspiration during the growing season. The foggy, moisture-laden sea air usually warms and dries by the time it reaches the southern boundary of the study area at Soledad (Showalter and Hoffard, 1986, p. 8). During the rainy season, the winds typically blow from the south to the north across the Santa Lucia Range, and the Salinas River drainage basin lies in the "rain shadow" of the mountains. Precipitation in the Salinas River drainage basin is typically less than in the coastal areas to the south and west on the other side of the Santa Lucia Range (fig. 1).

# LAND USE

Land use can affect water quality at all stages of the hydrologic cycle. Industrial emissions and pesticides can enter the atmosphere and return in precipitation. Industrial and agricultural wastes can wash into streams or seep into ground water. Most water-supply contamination may result from point sources such as chemical spills, disposal of toxic consumer products, leaks from underground storage tanks, and nonpoint sources such as runoff from agricultural and urban land (Magnuson, 1983). Correlations between feed lots and nurseries and areas of nitrate contamination of ground water already have been substantiated in certain areas of Monterey County (Bruce LaClergue, Monterey County Flood Control and Water Conservation District, written commun., 1984), and other similar correlations have been found in other areas of California, such as orchards and vineyards with DBCP (dibromochloropropane). Karubian (1974) suggested that because data on the quality of ground water commonly are sparse and usually expensive to obtain, a supplementary approach might be to estimate kinds, amounts, and trends of ground-water pollution by relating them to human activities. His preliminary research was on the methodology for estimating the polluting effects of human activities on ground water. In particular, he studied the effects of unlined sedimentation basins and lagoons used by pulp and paper, petroleum refining, and primary metals industries; wastewater ponds in phosphate mining; agricultural use of chemical fertilizers; and cattle feedlot operations. Land use is therefore an important consideration in water-quality data collection and network evaluation for Monterey County.

A generalized land-use and land-cover map (fig. 2) was prepared for the study area based on detailed U.S. Geological Survey maps (1976a, 1976b, and 1978). Cropland, pasture, and other agricultural land (fig. 2) make up the highest percentage of the land use in the study area, followed by forest and range lands (fig. 2). Showalter and others (1984, p. 10) noted a distinct relation in the northern Salinas River drainage basin between the agricultural, range, and forest land uses and land slope. Agricultural land typically is flat, range land is rolling or steep, and forest land is steep in slope.

Urban areas and areas of orchards, vineyard, and nursery (fig. 2) also cover significant portions of land. Salinas is by far the largest urban area, followed by Santa Rita, Laguna Seca, Castroville, Spreckels, Gonzales, Moss Landing, and Soledad. There are three confined feeding areas between Gonzales and Soledad. Wetland areas lie in the Salinas River drainage. A major quarry lies northeast of Salinas, and several smaller quarries are scattered around the northern one-half of the study area.

More detailed (7.5 minute scale) land-use information also is available from the California Department of Water Resources land-use surveys that have a recurrence mapping interval of about 7 years (California Department of Water Resources, 1971). Land-use information is available for Monterey County by U.S. Geological Survey 7.5 minute quadrangle area for 1976, 1982, and will be available soon for 1989 (Fred Stumpf, California Department of Water Resources, oral commun., 1989).

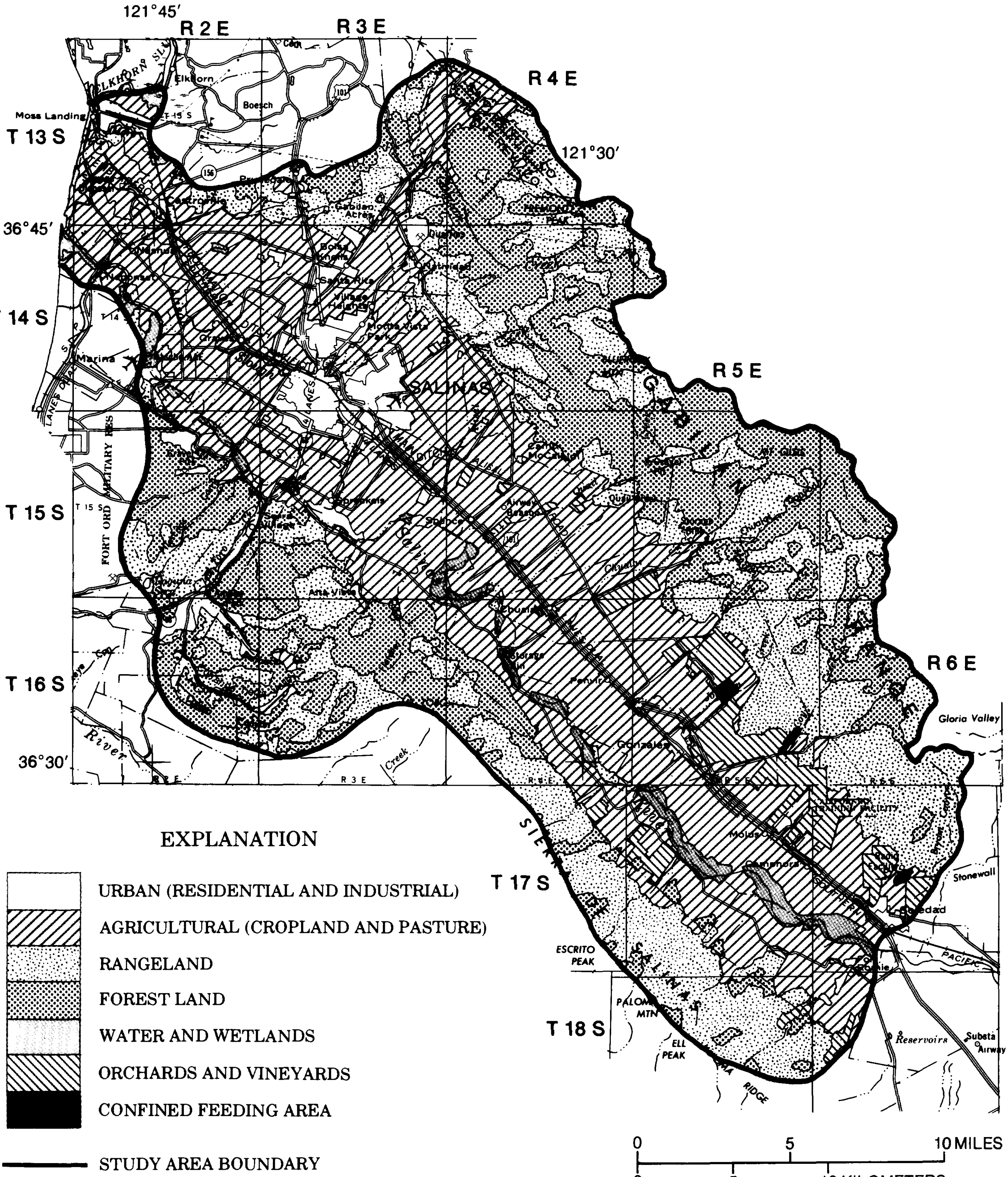



**FIGURE 2.—Land use and land cover in the northern Salinas River drainage basin (modified from U.S. Geological Survey, 1976a, 1976b, and 1978).**

Potential point and regional sources of water-quality degradation are shown in figure 3, and major point-source dischargers to land are noted in detail in table 2. Mineral deposits indicated on Hart's (1966, pl. 1) geologic map also may be point sources because of their natural constituents or the effects on them of human activities (such as leaching of trace elements from soils by irrigation activities).

## WATER USE

Water and land use have similar effects on water quality. This relation in the study area was recognized as early as 1946 (California Department of Water Resources, 1946). Applications of water to agricultural fields is a major source of incidental ground-water recharge and flow in streams during summer months. The pesticides, fertilizers, and soil amendments used in agriculture and minerals leached from soils can have significant effects on surface- and ground-water quality.

The largest water use in the Salinas River drainage basin is irrigation, and the second largest is domestic and municipal (Showalter and others, 1984, p. 11). Irrigation water is used primarily during the summer. Domestic and municipal use, by contrast, is fairly constant throughout the year, except for increases attributable to lawn watering in the summer months. About 89 percent of the water used in the Salinas Valley was from ground-water sources during 1985 (W.E. Templin, U.S. Geological Survey, written commun., 1988), which was a decrease from 95 percent in 1969 (Showalter and others, 1984, p. 14).

Knowledge of land-use patterns can be used (especially for irrigated areas) to estimate locations and quantities of water use when detailed water-use data are not available. The establishment and maintenance of a site-specific water-use data base (including withdrawal, delivery, release, and return data as described in Templin, 1986) could add substantially to knowledge of the surface-water and ground-water hydrology of Monterey County.

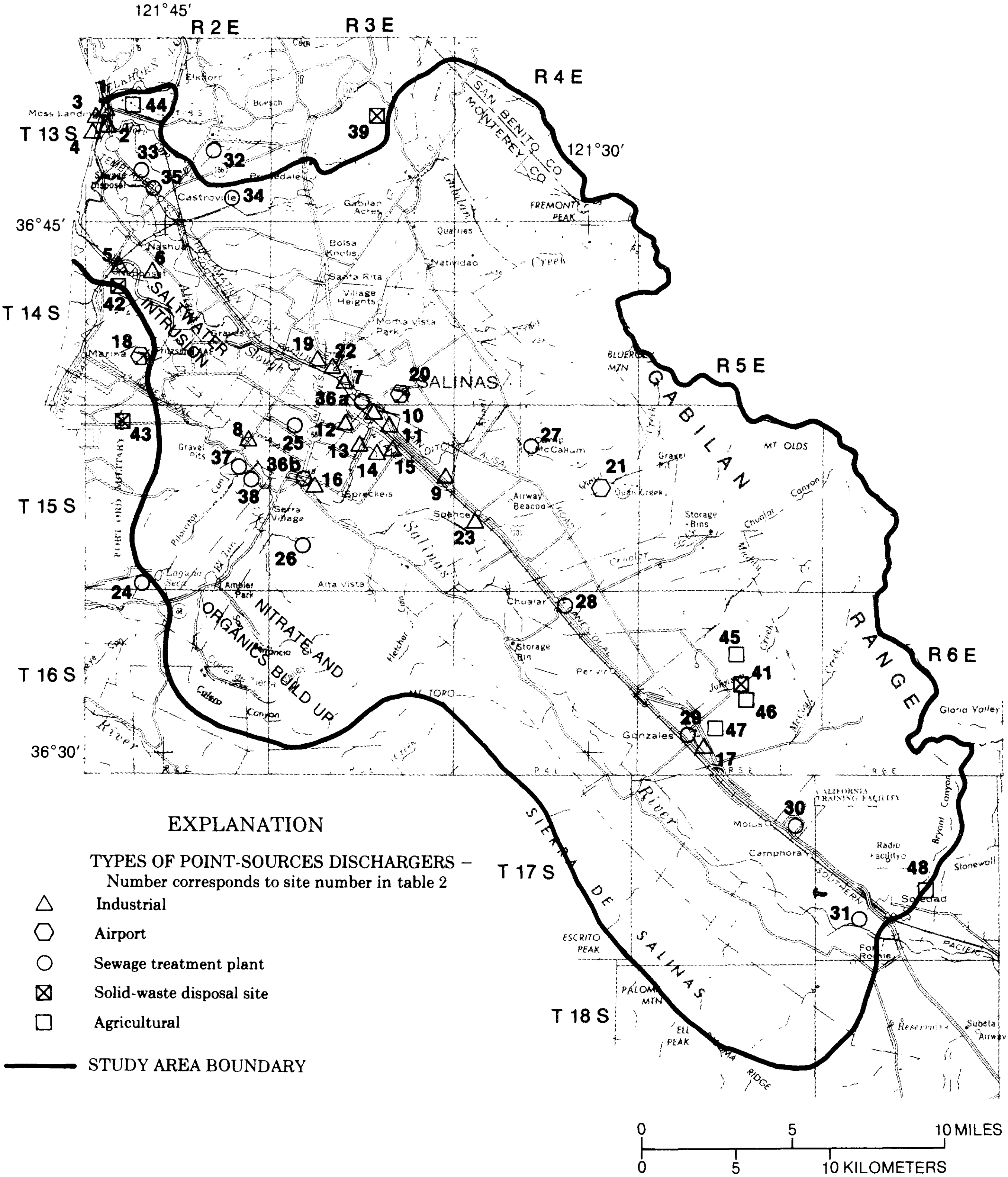



**FIGURE 3.—Point and regional sources of concern for possible water-quality degradation.**

TABLE 2.--*Major point-source*

[Modified from information on industrial dischargers under National Pollution Discharge Elimination System
Obispo, California. Sites are shown in figure 3.

Location: Township, range, and section are given. Sites are ordered by township, range, and section in ascending order.

Properties and constituents of concern:
Biochemical oxygen demand, 5-day test ($BOD_5$) analysis recommended by California Regional Water Quality Control Boards; Dermer and others (1980) and Pye and others (1983, p. 181) suggest $BOD_5$ may not be appropriate for ground-water-quality monitoring
Chlorine, total available, free available and/or dosage; see Industrial dischargers under National Pollution Discharge Elimination System permit

| Site No. | Discharger | Location | Type of waste | Disposal method |
|---|---|---|---|---|
| | Industrial dischargers under National Pollution Discharge Elimination System permit | | | |
| 1 | Kaiser Refractories | 13S/2E-18 | Process water | Ocean outfall |
| 2 | Pacific Gas and Electric | 13S/2E-18 | Cooling water | do. |
| *3 | Santa Cruz Canning | 13S/2E-18 | Food processing | do. |
| *4 | Sea Products | 13S/2E-18 | do. | do. |
| 5 | Bud Antle, Marina | 14S/2E-8 | do. | Unknown |
| 6 | Union Ice | 14S/2E-9 | Refrigerant cooling | Discharge to Tembladero Slough |
| 7 | Sun Harvest | 14S/3E-33 | Unknown | Unknown |
| 8 | Salinas Industrial | 15S/2E-12 | Industrial wastes | Evaporation ponds (possibly Salinas River) |
| *9 | Firestone Rubber | 15S/3E-13 | Unknown | Percolation ponds |
| 10 | Salinas Tallow | 15S/3E-3 | Animal carcasses | Unknown |
| 11 | Shippers Development Company | 15S/3E-3 | Vegetable processing | do. |
| 12 | John Inglis, Salinas | 15S/3E-4 | do. | do. |
| 13 | Valley Cooling | 15S/3E-9 | do. | do. |
| 14 | Dalgety Foods | 15S/3E-10 | Unknown | do. |
| 15 | Merchants Refrigerating | 15S/3E-11 | do. | do. |
| *16 | Spreckels Sugar | 15S/3E-17 | Sugar refining | do. |
| 17 | Gonzales Potato | 16S/5E-28,29,32,33 | Vegetable processing | Evaporation ponds |

permit provided by the California Regional Water Quality Control Board, Central Coastal Region, San Luis Site No., asterisk (*) indicates discharger site is closed. Do., ditto]

Properties and constituents of concern--Continued
Flow, quantity of water entering or leaving the site (volume in gallons, monthly summaries of mean and maximum daily flow)
pH, negative logarithm of the hydrogen ion (acid/base conditions)
Total chlorinated pesticides, measured by summing the individual concentrations of aldrin, BHC, chlordane, DDD, DDE, DDT, dieldrin, endrin, heptachlor, lindane, and polychlorinated biphenyls
Toxicity concentration, as described in written and oral communications with California State Water Resources Control Board and California Department of Fish and Game (1976)

| Properties and constituents of concern |
|---|
| Industrial dischargers under National Pollution Discharge Elimination System permit--Continued |
| Effluent: Flow, pH, temperature (degrees Fahrenheit), turbidity, biochemical oxygen demand, total solids (dissolved, suspended, settleable), nitrogen (also may be used to indicate ammonia), arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, cyanide, phenolic compounds, polychlorinated biphenyls, total chlorinated pesticides, oil and grease, toxicity concentration<br>Receiving water: Light transmittance, pH, salinity, temperature (degrees Fahrenheit), turbidity, dissolved oxygen, coliform bacteria organisms<br>Bottom sediment: Benthic (bottom dwelling) organisms, particle-size analysis |
| Influent: pH, temperature (degrees Fahrenheit), total solids (dissolved, suspended, settleable), nitrogen (also may be used to indicate ammonia), arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, cyanide, phenolic compounds, oil and grease<br>Effluent: Flow, pH, temperature (degrees Fahrenheit), chlorine, total solids (dissolved, suspended, settleable), dissolved oxygen, nitrogen (also may be used to indicate ammonia), arsenic, cadmium, chromium, copper, total iron, lead, mercury, nickel, silver, zinc, toxicity concentration, cyanide, phenolic compounds, polychlorinated biphenyls, oil and grease |
| Unknown |
| Do. |
| Do. |
| Do. |
| Do. |
| Do. |
| Toxics |
| Unknown |
| Pesticides in wash/cooling water |
| Do. |
| Do. |
| Do. |
| Do. |
| Pesticides |
| Do. |

TABLE 2.--*Major point-source*

| Site No. | Discharger | Location | Type of waste | Disposal method |
|---|---|---|---|---|
| | | Other potential industrial dischargers | | |
| 18 | Fritzscbe Field (Fort Ord Army Air Field) | 14S/2E-29 | Airplane maintenance and burn pit | Land disposal |
| 19 | Henningson Salvage | 14S/3E-29 | Auto dismantling | do. |
| 20 | Salinas | 14S/3E-35 | Airplane maintenance | do. |
| 21 | Verticare (Quail Creek) | 15S/4E-14 | Airplane maintenance and crop dusting | do. |
| 22 | Puregrow | 14S/3E-29 | Agricultural chemicals | do. |
| 23 | Berman Steel | 15S/4E-19 | Transformer insulation | do. |
| | | Municipal and domestic dischargers: Sewage treatment plants under National Pollution Discharge Elimination System permit | | |
| 24 | Laguna Seca Recreation Area, Road Race Agte, Ranch Estates | 15S/2E-32 | Sewage | Septic systems |
| 25 | Salinas, Main | 15S/3E-6 | do. | Ocean outfall (historically to Salinas River) |
| 26 | Indian Springs | 15S/3E-29 | do. | Unknown |
| 27 | San Jerardo | 15S/4E-9 | do. | do. |
| 28 | Chualar Sanitation District | 16S/4E-3 | do. | do. |
| 29 | Gonzales | 16S/5E-29 | do. | do. |
| 30 | Soledad Correction Facility | 17S/5E-12 | do. | do. |
| 31 | Soledad, City of | 17S/6E-29 | do. | do. |
| 32 | Oak Hills | 13S/2E-23 | do. | Evaporation/percolation ponds and land-surface disposal |
| 33 | North Monterey County High School | 13S/2E-29 | do. | Unknown |
| 34 | Monte del Lago Mobile Home Park | 13S/2E-35 | do. | Evaporation/percolation ponds |
| 35 | Castroville Wastewater Treatment Plant | 13S/2E-29 | do. | do. |
| 36 | Salinas | 14S/3E-33,34 | do. | Outfill |
| 37 | Alisal | 15S/3E-17 | do. | do. |
| 38 | Bluff's Subdivision | 15S/2E-11,12 | do. | do. |
| 39 | Salinas Utilities (Toro Management) | 15S/2E-13 | do. | Outflow (overflow to Salinas River) |

| Properties and constituents of concern |
|---|
| Other potential industrial dischargers--Continued |
| Trichloroethane and other similar solvents and unknown contaminants |
| Lead in soil and slough sediments |
| Trichloroethane and other similar solvents |
| Trichloroethane and other similar solvents and pesticides |
| Pesticides in shallow ground water |
| Polychlorinated biphenyls in soil (none found in ground water or surface water) |
| Municipal and domestic dischargers: Sewage treatment plants under National Pollution Discharge Elimination System permit--Continued |
| Flow, sludge depths, total sludge volume, total usable storage, percent full, depth of effluent in drain fields |
| Do. |
| Do. |
| Do. |
| Do. |
| Do. |
| Do. |
| Do. |
| Influent: Flow, sodium, chlorine, dissolved solids<br>Pond: Sodium, chlorine, dissolved solids, nitrogen (also may be used to indicate ammonia), nitrate, ammonia<br>Ground water: Ground-water levels, chlorine, dissolved solids, nitrogen (also may be used to indicate ammonia), nitrate, ammonia<br>Effluent: Coliform bacteria organisms |
| Unknown |
| Effluent: Flow, sodium, coliform bacteria organisms, chlorine, total solids (dissolved, suspended, settleable) |
| Do. |
| Do. |
| Do. |
| Do. |
| Do. |

TABLE 2.--*Major point-source*

| Site No. | Discharger | Location | Type of waste | Disposal method |
|---|---|---|---|---|
| | | Municipal and domestic dischargers: Solid-waste disposal sites | | |
| 40 | Crazy Horse | 13S/3E-15 (Phase 2 area) | Solid wastes | Landfill |
| 41 | Lewis Road site | Phase 2 area (off the map, north of Phase 3) | do. | do. |
| 42 | Gonzales (Johnson Canyon Road) | 16S/5E-22 | do. | do. |
| 43 | Monterey Peninsula | 14S/2E-7,8,17,18 | do. | do. |
| 44 | U.S. Army, Fort Ord | 15S/2E-5,6 | Solid and demolition wastes | do. |
| | | Agricultural point sources | | |
| 45 | Moon Glow Dairy | 13S/2E-8,17 | Dairy effluent | Land disposal |
| 46 | Fat City Feedyard | 16S/5E-9 | Feed lots 10, 15, 16 | do. |
| 47 | Trico Feeders | 16S/5E-22 | do. | do. |
| 48 | Mission Dairy | 16S/5E-28 | do. | do. |
| 49 | Hamby and Sons | 17S/6E-22 | do. | do. |

# PRECIPITATION NETWORKS

## Precipitation-Quantity Networks

### Precipitation Conditions

Distribution of mean annual precipitation in the study area is uneven (fig. 4). The greatest precipitation has been recorded in the mountains along both sides of the Salinas River drainage basin where estimated mean annual totals range from 18 to 75 in/yr. The scarcity of data and the extreme differences in areal distribution of precipitation at those altitudes make accurate estimates difficult, as can be seen in the three estimates of mean annual precipitation for the study area (fig. 4). The lowest mean annual precipitation, recorded in the lower altitudes of the study area, is about 12 in/yr. More than 90 percent of the precipitation in the study area falls from November through April. From May to October, mean annual precipitation is normally less than 1 inch.

*dischargers to land*--Continued

| Properties and constituents of concern |
|---|
| Municipal and domestic dischargers: Solid-waste disposal sites--Continued |
| Ground water: Two wells in Aromas Formation: Ground-water levels, specific conductance, pH, bicarbonate, chlorine, nitrogen (also may be used to indicate ammonia) Leachate: Six monitoring wells: Ground-water levels, flow, specific conductance, pH, chemical oxygen demand, chlorine, nitrogen, total Kjeldahl |
| Do. |
| Do. |
| Unknown |
| Do. |
| Agricultural point sources--Continued |
| Potassium, sulfate, nitrate, ammonia, phosphate |
| Do. |
| Do. |
| Do. |
| Do. |

## Objectives

Precipitation-quantity networks have two major objectives: (1) to determine regional variations in precipitation to establish trends, and (2) to identify factors that may influence the quantity of precipitation in the region (table 1). Precipitation-quantity networks help to establish spatial and temporal trends for the short term, as with storm intensity and duration, and in the long term, as with mean daily, monthly, and annual precipitation. The networks also can help to determine the effects on precipitation of natural and artificial features, such as lakes, reservoirs, and other large water bodies; regionally irrigated areas; multiple-story buildings; and industrial emissions into the air. Finally, precipitation-quantity networks determine the presence of measurement conditions that may affect the values obtained, such as standard methods of station installation, including precipitation-gage types; locations above ground and away from structures; and sampling and analytical practices (Linsley and others, 1982, p. 61).

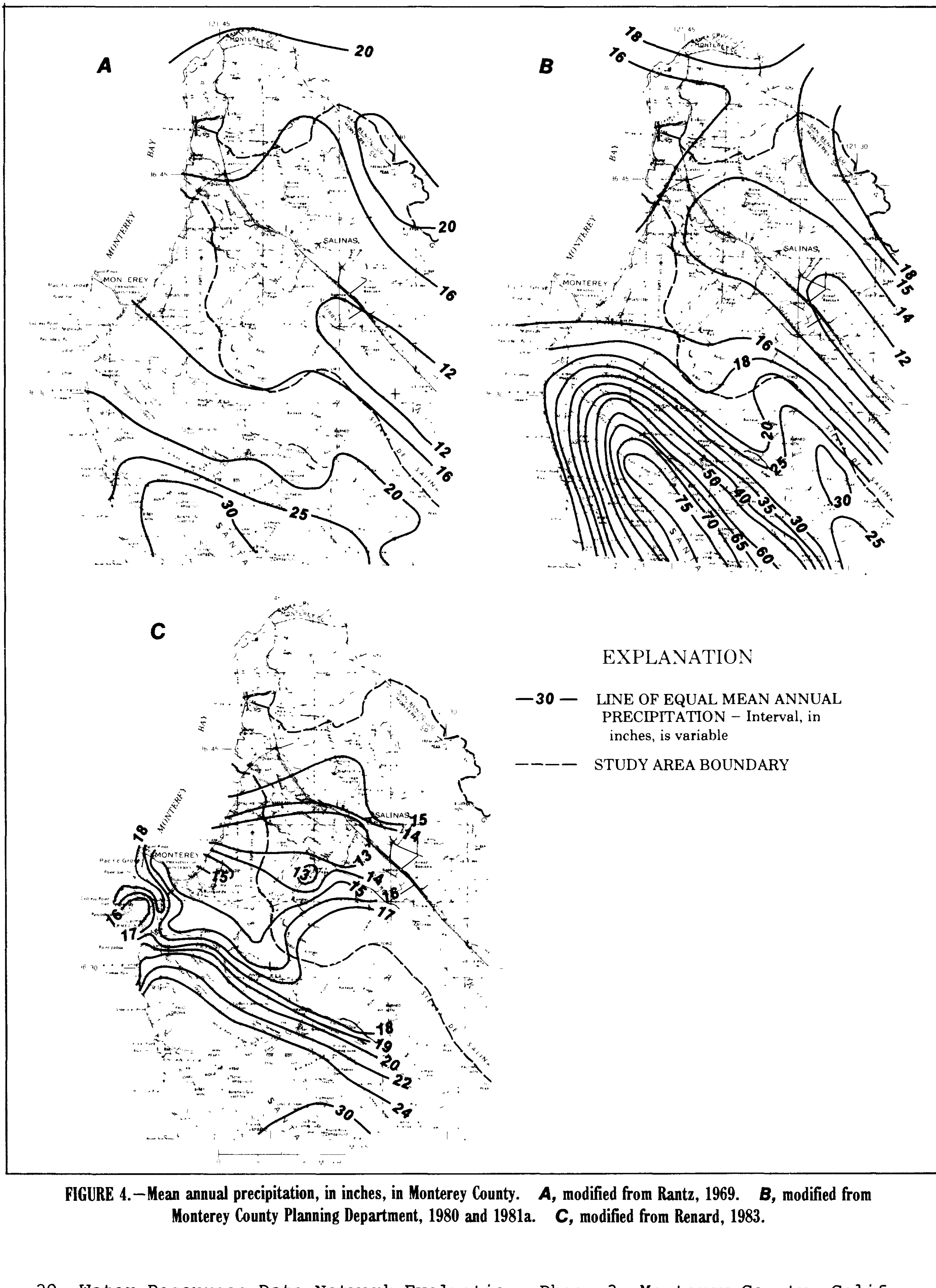



**FIGURE 4.—Mean annual precipitation, in inches, in Monterey County. *A*, modified from Rantz, 1969. *B*, modified from Monterey County Planning Department, 1980 and 1981a. *C*, modified from Renard, 1983.**

Monterey County's precipitation-quantity networks have a number of specific objectives, which are noted in table 3. These specific objectives include (1) measurement of regional ambient conditions to help in estimating ground-water recharge; (2) help in estimating water supply for agricultural, domestic, and industrial uses; (3) flood warning; and (4) provision of specific site data to aid erosion control, water-related engineering, water-rights management, and fire-hazard assessment.

The method of analysis used to evaluate precipitation-quantity networks involved the following steps: (1) design of an ideal network, which would give maximum coverage to the study area; (2) identification of existing precipitation-quantity monitoring; (3) examination of existing precipitation maps of the study area to identify discrepancies between maps and possible weaknesses in network coverage; and (4) description of possible additional precipitation-quantity monitoring in the study area.

Data needs for precipitation-quantity networks are presented in table 3 in order of the priority of their specific network objectives. Network priorities reflect the precipitation-data uses reported by the Monterey County Flood Control and Water Conservation District (1977). The two primary data needs include (1) measurement of areal daily precipitation and (2) measurement of storm precipitation in 15- to 30-minute intervals. In the study area, precipitation data have been used principally for water-balance computations to determine ground-water recharge and to improve long-term estimates of water available for domestic and industrial uses. As a result, accurate estimates of monthly and annual precipitation seem most important. In this report, only mean annual precipitation is examined, using available precipitation maps to define spatial distribution. It was beyond the scope of this report to analyze the distribution of storm precipitation, but table 4 does identify the recording gages in the study area that could be used for this purpose.

Precipitation-quantity data, together with other climatic data (such as humidity, temperature, wind, and evapotranspiration), are needed to estimate water use and water supply. As of 1987, the only sites at which climatic data are known to be collected are near Spence (U.S. Department of Agriculture property) and at Soledad (U.S. Highway 101 near Camphora Gloria Road). Before 1978, climatic data also were collected at the Hartnell College East Campus site near Alisal Road in Salinas. Irrigation applied water and related climatic data were collected during the 1960's and 1970's from various sites as part of a county crop water-use study (Bruce LaClergue, Monterey County Flood Control and Water Conservation District, oral commun., 1988).

The determination of water supply and water use also entails having information on the other climatic data as well as withdrawal and release information by water suppliers. If a local network of climatic data stations was established, the accuracy of estimates of water use would improve because the data used to calculate these estimates would be more accurate. The results of studies of phreatophyte water use (Anderson-Nichols and Co., 1985) also could benefit from improved climatic-data stations complemented by collection of data from mobile installations similar to those described by Simpson and Duell (1984). Mobile agricultural water-use efficiency monitoring labs also are available that may be of use in Monterey County (Thomas Hawkins, California Department of Water Resources, oral commun., 1985).

TABLE 3.--*Ideal networks,*

[Priority points were developed for Monterey County Flood Control and Water Conservation District

Proposed monitoring components:

A, physical and indicator characteristics, such as temperature, pH, electrical conductivity, odor
B, common chemical analyses
Bio., biological (phytoplankton, zooplankton, algal growth potential, microplankton, fish tissue, muscle, and other biological indicator analyses)
$BOD_5$, biochemical oxygen demand, 5-day test
CD, climatic data, such as rain, air temperature, solar radiation, evaporation, evapotranspiration, relative humidity, wind movement

Proposed frequency:

A, annual
B, bimonthly
C, continuous
CS, continuous seasonally as needed
D, daily
M, monthly
Q, quarterly
T, twice annually
W, weekly

| Network name | Specific network objectives | Priority points | Data needs |
|---|---|---|---|
| | Precipitation-quantity networks | | |
| A1a | Ground-water recharge (regional ambient conditions | 10 | Areal daily storm precipitation (U.S. Army Corps of Engineers, 1957) and other climate data |
| A1b | Water-supply estimates (for agricultural, domestic, and industrial uses) | 9 | do. |
| A1c | Flood warning | 8 | 15- to 30-minute interval storm precipitation data |
| A1d | Specific site data for runoff determinations used in erosion control; designing culverts, levees, bridges, storm drains, flood channels, and dams; water-rights management; also rainfall duration for use in National Forest Fire Danger Rating Components | 7 | do. |
| | Precipitation-quality networks | | |
| A2a | Effects on surface- and ground-water quality (regional ambient conditions) | 2 | Daily wet and dry deposition volume and quality, and climate data |
| A2b | Effects on vegetation and personal property | 1 | do. |
| | Streamflow networks | | |
| B1a | Ground-water recharge (regional ambient conditions) | 10 | Long-term areal integrated information system of continuous record and regional correlations with precipitation (Fontaine and others, 1983, p. 1) |
| B1b | Water-use quantity | 9 | do. |
| B1c | Flood warning | 8 | Telemetered stage record at key lake and stream locations |

*priority, and pertinent data*

(Showalter and Hoffard, 1986, tables 4 and 13) Abbreviations: ft, feet; do., ditto]

EI, environmental isotopes, such as $H_2$, $H_3$ (tritium), oxygen-18, and carbon-14
F, sanitary (total-coliform and fecal-coliform bacteria viruses)
FT, total flow, in gallons per day
G, all of the above quality constituents including trace elements, pesticides, and nutrients
SD, continuous stage-discharge record, with periodic flow measurements to establish and maintain the relation

| Ideal network | | | |
|---|---|---|---|
| Site distribution | Site density | Proposed monitoring component | Proposed frequency |
| Precipitation-quantity networks--Continued | | | |
| Countywide | One or two per township | CD | C |
| do. | do. | CD | C |
| do. | do. | CD | C |
| do. | Three per township | CD | C |
| Precipitation-quality networks--Continued | | | |
| do. | One per township | pH and pesticides<br>CD | D during storms<br>C |
| do. | do. | pH and pesticides<br>CD | D during storms<br>C |
| Streamflow networks--Continued | | | |
| Major tributaries | At first point of recharge, one per stream (also at major confluences) | SD | C at 30-minute intervals |
| All streams | Upstream and downstream from each point of inflow and outflow | SD | C at 30-minute intervals |
| do. | do. | SD, peak flow | C at 30-minute intervals |

TABLE 3.--*Ideal networks, priority,*

| Net-work name | Specific network objectives | Prior-ity points | Data needs |
|---|---|---|---|
| | Streamflow networks--Continued | | |
| B1d | Water rights | 7 | Continuous record upstream and downstream from all diversions (daily means, maximums, and minimum flows) |
| B1e | Site data for design of storm drains, dams, levees, flood channels, bridges, and culverts | 7 | Periodically revised rainfall/runoff relations following significant land-use changes or cumulatively significant changes, including flood-plain elevations developed from network B1a (recharge) |
| B1f | Determine sediment transport | 6 | Periodic nonstorm, during and after storm sediment samples to estimate rates of reservoir siltation and effects of levee construction, recent urban growth areas, and agriculturally fire disturbed areas |
| B1g | Manage irrigation diversions and recharge | 6 | Data generated in network B1d and continuous records of all agricultural return flows and diversions |
| B1h | Instream use management/planning | 4 | Data from network B1d |
| B1i | Determine streamflow characteristics to develop regional relations to ungaged sites | 3 | 25-year recurrence interval flood, drainage areas, mean annual precipitation (Riggs, 1973, p. 4) |
| B1j | Manage municipal and industrial uses | 2 | Data from network B1d, and continuous records of all agricultural return flows and diversions |
| B1k | Determine sediment-transport rates upstream from dams | 1 | Network B1f data, supplemented with similar data upstream from dams |
| B1l | Potential hydropower plants | 1 | Site selection information and begin developing continuous record at sites |
| | Surface-water-quality networks | | |
| B2a | Monitor water quality for domestic and irrigation uses | 10 | Routine, periodic complete analyses |
| B2b | Assess reservoir discharges for irrigation, domestic, and fish and wildlife uses | 10 | Routine periodic samples (during discharge periods) and determination of lake trophic levels (outside study area) |
| B2c | Develop a water-quality baseline (regional ambient conditions) | 9 | Stream-reach rating system for priority based on specific needs. Complete analyses in relation to needs, with correlation to continuously measured indices, such as temperature and specific conductance |

| Ideal network | | | |
|---|---|---|---|
| Site distribution | Site density | Proposed monitoring component | Proposed frequency |
| Streamflow networks--Continued | | | |
| One station at each location of change in stream characteristics | Upstream and downstream from each point of inflow and outflow | SD | C at 30-minute intervals |
| Countywide | do. | Network Ald, flow at sites (streams and bridges | C |
| Upstream and downstream from dams | do. | Total sediment discharge<br>SD, water temperature<br>Trace elements<br>Bed and bank samples for size analysis, composition, and sources | D<br>C<br>M<br>Q |
| Upstream and downstream from all diversions | Two per diversion | SD | CS |
| Salinas River; other creeks as needed for water rights, appropriations, and water balance | As needed | SD<br>Water temperature<br>Total sediment discharge<br>Low flow | C<br>C<br>D<br>CS |
| All major drainages | do. | SD<br>Precipitation volume, in inches | C<br>D |
| Upstream and downstream from all diversions | Two per diversion | SD | C |
| Upstream from dams (none in study area) | One per dam | Total sediment discharge | D |
| Site specific (none in phase 3 study area) | One per site | SD | CS |
| Surface-water quality networks--Continued | | | |
| At all withdrawal locations | One per location | A<br>B, trace elements<br>Pesticides, nutrients<br>F | C<br>M<br>B<br>W |
| Salinas River | Two sites downstream from dam<br>1-30 ft<br>1-500 ft | Hydrogen sulfide, dissolved oxygen, water temperature, Quality:A,B | T |
| Salinas River<br>Sloughs: Elkhorn, Moro Cojo, Tembladero<br>Reclamation Ditch | In reaches of known hydraulic connection with ground water | Quality:A,B, water temperature, specific conductance | Q<br>C |

| Net-work name | Specific network objectives | Prior-ity points | Data needs |
|---|---|---|---|
| | | | Surface-water-quality networks--Continued |
| B2d | Determine flow and quality from specific creeks | 8 | Baseline for specific creeks with present or potential for significant future development |
| B2e | Determine trends for reservoir water quality | 6 | Water-quality monitoring, especially for effects of land uses (such as residential, timber harvest, forest fire, and mining) and natural geologic influences |
| B2f | Evaluate water-quality effects on instream uses (fish, recreation) | 5 | Stage/discharge data from network Bla and water-quality data to compare existing conditions to standards established for each type of water use (Templin, 1986) |
| B2g | Mosquito abatement | 4 | Data pertinent to growth and reproduction of mosquitos and other pest insects, also possibly data on chemical abatement methods used |
| | | | Ground-water-level networks |
| Cla | Determine each basin's water balance and seawater intrusion portion of inflow (regional ambient conditions) | 10 | Precipitation data from network Ald, streamflow data from network Bla, collect pumpage and water-level trend data (inflow, outflow, and storage) |
| Clb | Determine effect of reservoir discharges on ground-water storage | 9 | Streamflow data from network Bla, diversions data from network Bld, information on hydraulically connected areas from network B2c, water-level and pumpage data from network Cla |
| Clc | Determine ground-water storage in each basin | 9 | Water-level and pumpage data from network Cla, perform pump and aquifer tests where not already available, interpret the data (Freeze and Cherry, 1979, p. 343; Todd, 1980, p. 45 and 362). Geologic information on location of fresh water-bearing deposits and formation characteristics |
| Cldl | Determine accuracy of annual water-level measurements in monitoring changes in storage | 7 | Evaluation of existing water-level network and resultant data for its representativeness of regional conditions. Use of variables similar to what has been done by Sophocleous and others (1982) may be applicable to this analysis to determine the adequacy of current well densities for this purpose.<br>A correlation analysis of the recharge flow data from network Blj and the storage data from network Clc needs to be accomplished and an inflow/outflow/storage relation developed (Todd, 1980, p. 361-363).<br>Use of available, or adaptable, management models (Bachmat and others, 1980, p. 39-40) could facilitate the effective use of available natural and financial resources |

| Ideal network | | | |
|---|---|---|---|
| Site distribution | Site density | Proposed monitoring component | Proposed frequency |
| Surface-water-quality networks--Continued | | | |
| Sloughs: Moro Cojo, Tembladero<br>Creeks: El Toro, Gabilan, Quail, Chualar, Johnson, Alisal, Natividad, San Miguel, Santa Rita<br>Reclamation Ditch | Upstream from confluence with major tributary | SD<br>Quality:A,B | C<br>Q |
| Chualar Reservoir<br>Lakes: Espinosa, Carr, Merritt, Sherwood | Three sites on each lake | Quality:A,B; bio. | M |
| Salinas River<br>Sloughs: Elkhorn, Moro Cojo, Tembladero | Sites near mouths, and downstream from all major diversions | SD, water temperature<br>Quality:A,B<br>Trace elements, pesticides | C<br>M<br>Q |
| Lakes, streams, wetlands, stock ponds, industrial holding ponds, street drains | As needed | Quality:A, specific gravity, turbidity, $BOD_5$, nutrients, bio.<br>Mosquito larvae and adults | M<br>W |
| Ground-water-level networks--Continued | | | |
| Subarea and countywide grid | One per subarea; as needed | Water levels<br>Pumpage (from meters) and electrical usage | C,T<br>C |
| Salinas Valley | As needed | Water levels<br>Pumpage<br>SD | C,T<br>C<br>M |
| Grid ground-water basins | Density as needed to draw adequate contours | Water levels | C,M,T as needed |
| Salinas Valley | Existing water-level monitoring sites | Water levels, geologic formation characteristics | C,M |

| Network name | Specific network objectives | Priority points | Data needs |
|---|---|---|---|
| | | Ground-water-level networks--Continued | |
| Cld2 | Monthly water-level measurements in monitoring changes in storage due to seasonal pumping demands | 6 | Evaluation of existing water-level network and resultant data for its representativeness of regional conditions. Use of variables similar to what has been done by Sophocleous and others (1982) may be applicable to this analysis to determine the adequacy of current well densities for this purpose.<br>A correlation analysis of the recharge flow data from network Blj and the storage data from network Clc needs to be accomplished and an inflow/outflow/storage relation developed (Todd, 1980, p. 361-363).<br>Use of available, or adaptable, management models (Bachmat and others, 1980, p. 39-40) could facilitate the effective use of available natural and financial resources |
| Cle | Determine annual ground-water pumpage | 7 | PG&E records and pumpage following Mitten (1976). Also collect pumpage from metered wells needed for networks Cla and Clc. Compare with California Department of Water Resources (1983a, p. 97-99) estimates based on land use |
| Clf | Determine annual consumptive use of applied water, phreatophytes, and precipitation in agriculture and urban areas | 7 | Land-use map (fig. 2) and determine areas of each land use, determine unit values of consumptive use for each land use, combine areas and values of interest (Todd, 1980, p. 361-362). See also California Department of Water Resources (1975, p. 5, 1982, 1983a, 1983b); Dunne and Leopold (1978, p. 95-162) |
| Clg | Monitor ground-water flow patterns | 4 | Requires information on topography, piezometric patterns, hydrochemical trends, environmental in the area isotopes, and soil/land surface features (Freeze and Cherry, 1979, p. 200-203). |
| Clh | Determine ground-water outflow (recharge) from streams and creeks | 4 | Using information developed in networks Bla, Clc, Clg, and C2c, and determine baseflow, and use hydrograph separation to differentiate subsurface contributions |
| Cli | Determine locations where river percolation could be enhanced to increase ground-water storage | 4 | Using information from networks Clg and Clh, determine areas of recharge, storage, and discharge. Study the effects of increased artificial recharge in stream channels on storage and discharge down gradient. Use of a refined ground-water-flow model could be preferable to trial and error |
| Cljl | Determine aquifer characteristics | 5 | A literature search needs to be conducted to determine the level of available information on aquifer properties for each ground-water basin. Where gaps exist, pumping tests need to be made, and the information used to determine hydraulic conductivity, storativity, and transmissivity (Todd, 1980, p. 78 and 124). Physical aquifer properties of thickness and confined or unconfined nature of the existing aquifers in each basin also need to be determined, if not already done, and noted in the literature search for this information category |

*and pertinent data*--Continued

| Ideal network | | | |
|---|---|---|---|
| Site distribution | Site density | Proposed monitoring component | Proposed frequency |
| Ground-water-level networks--Continued | | | |
| Salinas Valley | Existing water-level monitoring sites | Water levels, geologic formation characteristics | C,M |
| do. | All wells in basin | Metered pumpage and PG&E records | M,A |
| do. | Climatic data stations, one per area; | CD | C,D |
| | Meters, one per well, and one per customer supplied | FT | C,D |
| All ground-water basins | Wells as needed | Water levels, pumpage (from meters and electrical usage) | C |
| | | Quality:A,B,EI | M |
| Salinas River; other creeks as needed | As needed | SD, water levels, pumpage (from meters and electrical usage) | C |
| Salinas River; other creeks as appropriate (for example, Santa Rita Creek) | do. | SD, water levels, pumpage (from meters and electrical usage) | C |
| All ground-water basins | do. | Storage coefficient (storativity), hydraulic conductivity, transmissivity | A |

| Net-work name | Specific network objectives | Prior-ity points | Data needs |
|---|---|---|---|
| | | | Ground-water-level networks--Continued |
| C1j2 | Determine aquifer boundaries | 4 | Need geologic information on flow barriers (faults and impermeable strata) |
| C1k | Determine areas of influence or cone of depression for large and small wells | 2 | Need to know the influence of each well in the water-level networks on each other well in the network, if there is any influence, in order to evaluate that well's utility in the network |
| | | | Ground-water-quality networks |
| C2a | Determine water-quality baseline, including specific conductance | 10 | Establish regional networks of representative wells monitored annually for complete analyses |
| C2b | Determine distribution of nitrates in expected problem areas | 9 | Would be done in network C2a |
| C2c1 | Determine effect of ground-water quality on effluent (gaining) streams | 8 | Would entail study of geochemistry of streams and adjacent ground water (network C1g) for determination of which are losing or gaining and a comparison with baseline surface-water quality from network B2c |
| C2c2 | Determine the need for establishing a ground-water data base for tributary areas | 8 | Use data gathered in networks B2c, B2d, and C2a to compare areal quality in tributary areas to the downstream ground-water basins to understand the influence of geologic parent materials and land uses in tributary areas on major basin ground-water quality |
| C2d | Develop a baseline of organics in ground water | 7 | Need data on total organic carbon and volatile organic carbon for comparison with results from network C1g and known point sources to determine the relations at point sources to the surrounding environment |
| C2e | Determine regional effects of point sources and cumulative effects of point sources | 6 | Collect data on the extent of point-source plumes, and compare with data from networks C2a and C2d |
| C2f | Determine regional effects of nonpoint sources (such as agricultural and urban areas) | 5 | Study typical areas of land use to determine cause and effect of land-use practices |
| C2g | Determine native and human-caused sources of radioactive substances | 4 | Regional analyses for indicators of broader categories of substances and more specific analyses where high values are noted |

*and pertinent data*--Continued

| Ideal network | | | |
|---|---|---|---|
| Site distribution | Site density | Proposed monitoring component | Proposed frequency |
| Ground-water-level networks--Continued | | | |
| All ground-water basins | As needed | Storage coefficient (storativity), hydraulic conductivity, transmissivity | A |
| do. | do. | Pump and aquifer tests, storage coefficient (storativity), hydraulic conductivity, transmissivity | A |
| Ground-water-quality networks--Continued | | | |
| All ground-water basins | Grid basins | G | Q |
| Salinas Valley | Bound and grid septic tank areas | A, nutrients, F, water levels | M |
| All ground-water basins | Wells as needed | Water levels, pumpage (from meters and electrical usage)<br>Quality:A,B,EI | C<br>M |
| Selected wells in recharge points areas at points where tributaries enter the ground-water basin | As needed | Quality:A,B, geology, land use | Q |
| Bound and grid all ground-water basins | do. | Total organic carbon, volatile organic carbon, EI | A |
| In areas of concentrations of point sources (table 2, figure 3) | do. | As needed | As needed |
| Select major urban and agricultural areas from figure 2 | do. | do. | As needed |
| Grid basin, more dense in industrial and military areas | do. | Gross: Alpha, Beta, radium, (Safe Drinking Water Act regulations, U.S. Environmental Protection Agency, 1986) | T |

## TABLE 4.--*Precipitation gages*

[Data from California Department of Water Resources (1981b) and National Oceanic and Atmospheric Administration (1985). Gage numbers are assigned by the California Department of Water Resources. Site numbers refer to locations in figure 5. --, no data available]

Operating agency:

3922, U.S. National Weather Service
5003, U.S. Department of Navy
5050, California Department of Water Resources
5115, Monterey County Flood Control and Water Conservation District
5702, Individual owner
5706, Pacific Gas and Electric Company (PG&E)

Gage type:

Active: Gages where data are still being collected.
- Nonrecording: Gages that collect rain, but must be read by someone.
- Telemetered: Gages where records are transmitted in real-time to a central receiving location by phone or satellite media.
- Recording: Gages having mechanical automatic recording capabilities (for example, paper tapes, charts, or data logger computer equipment).

Inactive: Gages where data have been collected (and records exist) but are not now known to be data collection/measurement sites.

| Site No. | Gage name | Gage No. | Operating agency | Location: Township/ range | Location: Latitude/ longitude | Period of record | Gage type |
|---|---|---|---|---|---|---|---|
| 1 | Associated Oil 6H | 0354-08 | 5702 | 17S/5E | 36°27'12"/ 121°22'12" | 1923-30 | Inactive |
| 2 | Associated Oil 7 | 0354-09 | 5702 | 16S/5E | 36°31'18"/ 121°27'48" | 1923-32 | Inactive |
| 3 | Associated Oil 8 | 0354-11 | 5702 | 15S/3E | 36°37'48"/ 121°41'00" | 1923-31 | Inactive |
| 4 | Castroville | 1585-01 | 5050 | 13S/2E | 36°46'00"/ 121°45'00" | 1974 | Inactive |
| 5 | Castroville Hardware | 1586-00 | 5702 | 13S/2E | 36°46'00"/ 121°45'30" | 1931-61 1931-39 | Inactive |
| 6 | Castroville Wastewater Treatment Plant | 1586-25 | 5115 | 13S/2E | 36°46'00"/ 121°46'00" | 1968- present | Active recording |
| 7 | Moss Landing PG&E Powerplant | 5878-50 | 5706 | 13S/2E | 36°48'23"/ 121°46'57" | 1980- present | Active nonrecording |
| 8 | Salinas 2 E | 7668-00 | 3922 | 14S/3E | 36°40'00"/ 121°37'00" | 1958-70 | Inactive |
| 8a | Salinas 3 E | 7668-04 | 3922 | 14S/3E | 36°40'00"/ 121°36'00" | 1970- present | Active recording |
| 9 | Salinas-Miller | 7669-60 | 5003 | 15S/3E | 36°35'55"/ 121°37'44" | 1980- present | Active nonrecording |
| 10 | Spreckels Highway Bridge | 8446-00 | 3922 | 15S/3E | 36°36'00"/ 121°41'00" | 1905-80 | Inactive nonrecording |
| 10a | Spreckels Highway Bridge | 8446-04 | 3922 | 15S/3E | 36°36'00"/ 121°41'00" | 1980- present | Active nonrecording |
| 11 | Spreckels | 8446-01 | 5702 | 15S/3E | 36°37'14"/ 121°39'27" | 1961-80 | Inactive |
| 12 | Associated Oil 7A | 0354-10 | 5702 | 15S/4E | 36°36'42"/ 121°33'54" | 1923-36 | Inactive |
| 13 | Salinas Airport (Federal Aviation Administration) | 7669-00 | 3922 | 14S/3E | 36°40'00"/ 121°36'00" | 1873- present | Active nonrecording |

TABLE 4.--*Precipitation gages*--Continued

| Site No. | Gage name | Gage No. | Operating agency | Location: Township/ range | Location: Latitude/ longitude | Period of record | Gage type |
|---|---|---|---|---|---|---|---|
| 14 | Chualar-Jacks Ranch | 1751-00 | 5702 | 16S/4E | 36°33'48"/ 121°30'54" | 1897- 1931 | Inactive |
| 15 | Soledad | 8338-00 | 3922 | 17S/6E | 36°26'00"/ 121°19'00" | 1874- 1980 | Inactive |
| 16 | Soledad (California Training Facility) | 8338-01 | 5050 | 17S/5E | 36°28'26"/ 121°22'34" | 1963-72 | Inactive |
| 17 | Soledad Milling Co. | 8338-05 | 5702 | 17S/6E | 36°25'42"/ 121°19'54" | 1916-39 | Inactive |
| 18 | Corral de Tierra Hendrichs | 2047-00 | 5003 | 16S/3E | 36°30'51"/ 121°41'05" | 1961- present | Active nonrecording |
| 19 | Salinas Golf and Country Club | 7669-30 | 5115 | 14S/3E | 36°45'00"/ 121°38'00" | 1968- present | Active recording |
| 20 | Salinas Haney | 7669-40 | 5003 | 15S/2E | 36°35'40"/ 121°42'20" | 1972- present | Active nonrecording |
| 21 | Toro Regional Park | 8972-11 | 5115 | 15S/2E | -- | 1969- present | Active nonrecording |
| 22 | Monterey Bay Packing | -- | 5115 | 13S/2E | -- | 1960- present | Active nonrecording |
| 23 | Marina County Water District | 5370-00 | 5003 | 14S/1E | 36°41'57"/ 121°48'21" | 1970- present | Active nonrecording |
| 24 | Fort Ord | 3186-00 | 3922 | 14S/2E | 36°41'00"/ 121°46'00" | 1967-78 | Inactive nonrecording |
| 25 | Salinas-Kaiser Refractories Quarry | 7669-50 | 5115 | 14S/3E | -- | 1958- present | Active nonrecording |
| 26 | Natividad (no. 40) | -- | 5115 | 14S/3E | 36°41'34"/ 121°37'29" | 1985- present | Active telemetered |
| 27 | Los Laureles Grade, Leipper | 5127-10 | 5003 | 15S/2E | 36°37'32"/ 121°45'31" | 1972- present | Active nonrecording |
| 28 | Harper Canyon | 3778-80 | 5702 | 16S/2E | 36°34'03"/ 121°42'00" | 1969- present | Active nonrecording |
| 29 | Carmel Valley, Wallace, Jr. | 1534-90 | 5003 | 16S/2E | 36°30'01"/ 121°42'13" | 1960- present | Active nonrecording |
| 30 | Carmel Valley, Elsberry | 1534-05 | 5003 | 16S/2E | 36°29'39"/ 121°41'01" | 1972- present | Active nonrecording |
| 31 | Los Laureles | -- | 5115 | 16S/2E | 36°33'00"/ 121°43'00" | 1968- present | Active recording |
| 32 | Mount Toro | -- | 5115 | 16S/3E | 36°33'00"/ 121°38'00" | 1968- present | Active recording |

## Factors Affecting Design

The density of a precipitation-quantity network can be determined from the spatial distribution of precipitation and the intended uses of the data (Linsley and others, 1982, p. 61). In hydrologic studies, precipitation data commonly are used to determine long-term mean precipitation, averaged for monthly, seasonal, or annual intervals. Mean precipitation is used in studies of water balance. Precipitation data also are used to determine total storm precipitation, which is used in flood-related studies. In general, studies requiring storm precipitation use a much denser network of precipitation-quantity stations than studies requiring long-term mean precipitation.

A precipitation-quantity network usually is designed to give a representative picture of the distribution of precipitation for a given area. Generally, topography has the most influence on distribution of precipitation. Precipitation is typically more evenly distributed on level or gently sloping terrain than on rugged terrain. A mountainous area may therefore require a dense network of gages if accurate areal precipitation data are needed. The cost of installing and maintaining a network in mountainous areas can be high because gages may not be accessible and observers may not be readily available.

Many factors affect the measurement of precipitation data, such as standard methods of gaging-station installation, location, and density (including effects of different types of rain gages, distances above ground or away from structures) as well as sampling and analytical practices (Linsley and others, 1982, p. 61). Other natural and artificial factors also may affect precipitation characteristics, including location of lakes, reservoirs, oceans, and other large water bodies; mountain ranges; and microclimatic factors such as irrigated regions, multiple-story buildings, industrial emissions into the air, wind patterns, and cloud-seeding operations. Showalter and Hoffard (1986, p. 25) gave information on selection of type of precipitation gage, maintenance, and operations that is appropriate for all Monterey County if other factors in site location and operation are kept in mind. Oltmann and others (1987, p. 7-8) describe their use of tipping-bucket rain-gaging instruments and how they operate. References to similar studies are important in maintaining and improving data collection functions.

## Precipitation Maps

Several precipitation maps that include the study area are available (fig. 4). Rantz (1969) compiled a statewide map of mean annual precipitation; the section of the map covering the study area was modified from a map by the U.S. Army Corps of Engineers (1957). Rantz's (1969) map is not highly detailed. The interval of lines of equal precipitation in rugged terrain is 10 inches and in level terrain 4 inches. More recently, the Monterey County

Planning Department (1980 and 1981a) published a precipitation map in two reports. Intervals of lines of equal precipitation on this map range from 2 to 5 inches. The most recent and detailed precipitation map of the study area was prepared by Renard (1983); this map has intervals ranging from 1 to 6 inches. Renard's (1983) map is based on 10 years of precipitation record (1969-79) and covers all the study area except south and east of Gonzales. The map is based on a dense network of precipitation gages, particularly in the Monterey Peninsula area. Many of the gages in the network are part of a network operated by Renard and a number of observers whom he has enlisted. These observers record daily rainfall totals in 2-month intervals after which they send the data to Renard, who maintains the data on file. The operating agency given for Renard's stations in table 4 is the U.S. Department of the Navy. Much of these data are not entered in the WDIS computer file operated by the California Department of Water Resources and are not readily available for review.

The maps published by Rantz (1969) and Monterey County Planning Department (1980 and 1981a) (fig. 4) are in fairly good agreement except in the southwestern part of the study area, but they disagree somewhat with the Renard (1983) map. This discrepancy probably is due to different periods of record, different gages used in analysis, and the limited amount of available data for this area. Specific gages used to prepare these maps are not known. Taken together, the three maps indicate some possible areas for additional network coverage, especially where differences occur among the maps; the maps also indicate a need for a well-documented and routinely updated official mean annual precipitation map and data base for Monterey County.

## Description

The precipitation-quantity network, which includes all sites in the study area where data historically have been collected, is shown in figure 5 and summarized in table 4. These sites were identified initially through the California Department of Water Resources (1981b); this information was modified with input from the Monterey County Flood Control and Water Conservation District and it represents all currently known sources of precipitation data in the study area.

The Monterey County Flood Control and Water District, in cooperation with the California Department of Water Resources (DWR) and the National Weather Service (NWS), has installed nine telemetered recording gages in remote parts of the Monterey County as part of the ALERT network (eight of which are outside this report area). The primary purpose of these gages is flood warning, but, as the record for each gage becomes longer, the data also can be used for estimating mean precipitation totals in areas where data are presently lacking. The district maintains a network of eight gages in the area of this report. In 1985, a telemetered recording gage was installed at the District headquarters (site 26, table 4 and fig. 5). The other seven gages include four recording gages and three nonrecording gages in the study area.

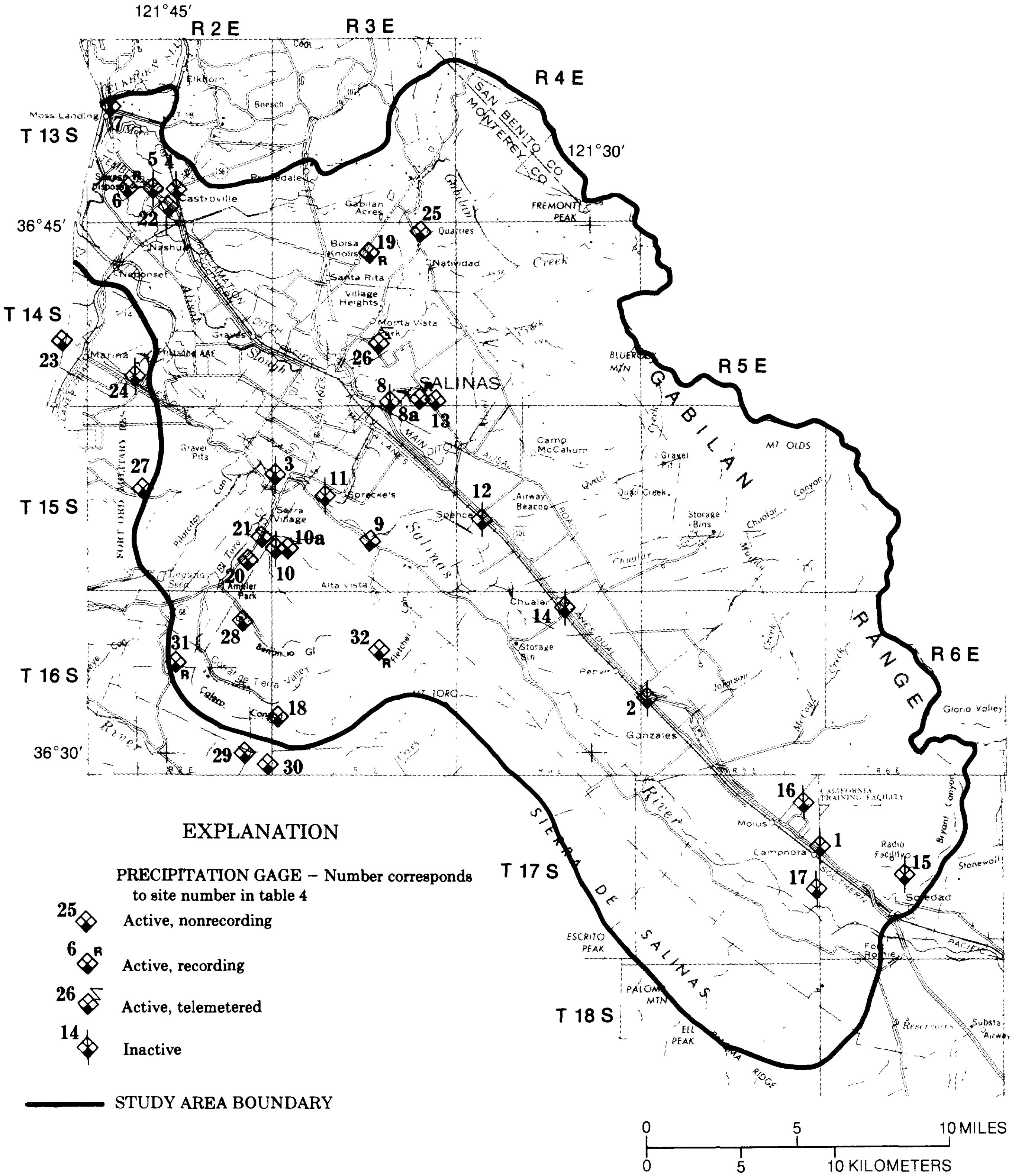



**FIGURE 5.—Precipitation gages.**

According to the California Department of Water Resources (1981b, p. 515-678), precipitation gages in or near the study area have been maintained by the California Department of Water Resources (two gages), the U.S. National Weather Service (seven gages), the U.S. Department of the Navy (seven gages), Pacific Gas and Electric Co. (one gage), and private individuals (nine gages). A total of 34 precipitation gages have been identified in the study area, including the 8 maintained by Monterey County Flood Control and Water District. Of these 34 stations, 20 are still active.

### Possible Additional Monitoring

An improved network of recording precipitation gages in the study area could provide more basis for extending short-term records, estimating daily or hourly precipitation data for flood-damage studies, and precipitation duration and intensity studies. The areal distribution of the gages in the active and historic network (fig. 5 and table 4) indicates a concentration in the northwestern part of the study area; stations are sparse in the eastern and southern parts of the study area. There also is an apparent lack of data for the southwestern slopes of the Gabilan Range in the eastern part of the study area. The network might be modified by selecting 3 or 4 of the most representative gages from the 11 shown in figure 5 in the El Toro Creek basin area and locating some new gages along the eastern county boundary. In 1986, the Gloria Grade gage was installed and may help fill the data void for the southwestern slopes of the Gabilan Range. The ALERT network may help define the annual precipitation values in high elevation areas as the period of record increases. Additional solid-state recording precipitation instruments might be installed in strategically located drainages where large developments are being approved, for example, El Toro Creek basin. Rainfall-runoff correlations need to be maintained countywide. Many quality control factors need to be considered in developing rainfall-runoff correlations. Oltmann and Shulters (1989, p. 13) analyzed the correlations they developed in urban situations around the city of Fresno, California. Their discussion provides prime examples of specific situations to avoid to reduce data-collection inaccuracies.

## Precipitation-Quality Networks

### Objectives

Generalized objectives for the precipitation-quality network are similar to those for the precipitation-quantity network (table 1). These objectives include (1) determination of the actual precipitation quality and the effects of natural and artificial point and regional factors and (2) determination of conditions that affect measurement of precipitation quality. Specific objectives for the precipitation-quality network include (1) determination of the effects of precipitation quality on surface- and ground-water quality and (2) determination of the effects of precipitation quality on property (table 3).

## Possible Problems

Little is known about precipitation quality in the Monterey area, and no known sampling network is operating at present (Jim Goodridge, California Department of Water Resources, oral commun., 1983; Harold Hillman, Monterey Bay Air Pollution Control District, oral commun., 1983; Doug Lawson, California Air Resources Control Board, oral commun., 1983). Air quality in the Monterey area generally has been considered good, and so concern for such problems as acid rain has not been great. Such concerns may arise in the future, and a data base could help precipitation-quality investigations. Nearby Santa Cruz County has considered sampling from the County's precipitation gages (Robert Golling, Santa Cruz County Planning Department, Watershed Management Section, oral commun., 1987), but so far has not begun any sampling because no need has been identified. The following discussion indicates some concerns that a precipitation-quality network might address.

Acid rain and acid fog.--One condition that a precipitation-quality network could monitor is acid rain and fog. A report by the Monterey County Planning Department (1981b) deals with air and water quality but makes no reference to the potential effects of acid rain or fog. A review of acid deposition research in California also shows no research activity in the Monterey County area (Western Oil and Gas Association, 1983), but acid fog conditions observed further south along the California coast may eventually be observed in this area.

Acidic gases in the atmosphere can derive from natural sources, such as volcanoes and forest fires, but this condition results especially from human activities, such as burning fossil fuels in powerplants and motor vehicles (U.S. Geological Survey, 1984, p. 61). In areas fairly unaffected by industrial emissions, precipitation has a minimum pH of about 5.0. In California during 1981, the average pH of precipitation ranged from 5.2 to 5.8 at six sampling sites (U.S. Geological Survey, 1984, p. 62). In comparison, a retrieval from the U.S. Environmental Protection Agency's STORET file indicated that average ground-water pH for 1953-80 for Monterey County was 7.5.

In the Western United States, nitric acid is typically dominant in acid rain, whereas in the eastern United States sulfuric acid is dominant (Payton, 1982). Even so, Melack and others (1982, p. 35) reported that "sulfuric acid contributed about twice the acidity of nitric acid" in the east-central Sierra Nevada in their study, which measured pH of convective-storm precipitation during the dry season of 1981. Values of pH in their study ranged from 3.7 to 4.9.

Pesticides.--Pesticides in precipitation is another condition that a precipitation-quality network could monitor. A recent study in Fresno, California, found the insecticides diazinon, malathion, and parathion in precipitation samples in concentrations as high as 0.93, 0.11, and 1.0 µg/L, respectively (Oltmann and Shulters, 1989, p. 59). The detection of these pesticides in precipitation was tentatively related to their application to dormant fruit trees by truck-mounted sprayers (Oltmann and Shulters, 1989, p. 36). This method of application suspends large quantities of spray in the air, which may then move with wind currents. Other application methods, such as aerial crop dusting, may have similar results in certain areas, but probably will not have such high concentrations because of the greater potential for dispersion over a larger area.

## Design

The ideal distribution of precipitation-quality sites is purely speculative at this time because no baseline data of precipitation quality in the study area are available at present. Precipitation-quality networks probably would be similar to regional networks for monitoring distribution of precipitation quantity. Possible specifications for an ideal network are presented in table 3. An ideal network might have only one sampling site per township, depending upon the results of a denser synoptic sampling project. Sampling would measure daily wet and dry deposition volume and quality, particularly for pH and pesticides. Samples would be taken daily and during storms. Ideally, this sampling would be coupled with continuous daily climatic-data collection. Spaite and others (1980, p. 2) suggest that acid rain may be chiefly a local phenomenon, and so specific local networks may need to be established.

Methods of sampling, data collection, and analysis have been established by several past studies of precipitation quality (Mehra, 1982; Melack and others, 1982; Strachan and Huneault, 1982; and Oltmann and others, 1987). These methods are not covered in detail in this report because methods vary with the specific type of data collected. A detailed review of the various methods might be undertaken before a network is established in the study area to assure that the data are representative and statistically sound.

The precipitation-quality network could be an initial selection of some of the active precipitation-quantity sites. The distribution of these sites initially could be one, two, or more sites per township to establish the baseline distribution of precipitation quality in the study area. After selecting standardized sampling methods and determining the constituents that could be monitored accurately at existing precipitation gages or after modifying the existing gages, a review of the data could help determine if enough sites were selected or if some sites could be discontinued. As monitoring progressed, the stations could be evaluated to determine how representative they were for measuring precipitation quality in each township or other selected area.

## SURFACE-WATER NETWORKS

### Surface-Water Conditions

Streamflow is closely related to precipitation and has about the same seasonal distribution. Streamflows are normally high during the rainy season (November to April), and flooding can be a problem during years of greater-than-normal precipitation. Streamflows decline sharply in the summer months, and some streams dry up. Demand for water is greatest during the dry season when supplies are least plentiful. In the Salinas River drainage basin, water supply is an especially critical issue. Surface water is stored in reservoirs mainly in the southern Salinas River drainage basin (Showalter and Hoffard, 1986), south of this report's study area in Monterey and San Luis Obispo Counties. Reservoir releases are used to recharge ground water, which in turn is tapped for water supply. Thus, surface and ground water in the area are closely interrelated.

### Streamflow Networks

Data needs for the streamflow networks (table 3) are diverse. The highest-priority needs include (1) formation of an integrated information system of continuous streamflow record, which can be correlated with precipitation; (2) use of telemetered stage recorders at key lakes and streams; and (3) periodic and continuous data collection relating to water use, storm runoff, and dam and hydroelectric sites. These and other data needs are outlined in table 3.

### Objectives

Generalized management objectives for streamflow networks (table 1) include (1) determination of benchmark flow characteristics such as peaks, mean daily flows, and low flows for all major and minor streams in the county; (2) identification of temporal and spatial trends in streamflow, both seasonally and annually; (3) identification of the causes of changes in streamflow, such as variation in annual precipitation, land use, instream water use, diversion, agricultural return flow, and channelizations; and (4) determination of the best use of surface water. Once the uses, timing, and volumes of use are identified, management decisions can be made on how best to allocate the resources among the various uses.

Specific streamflow-network objectives are more fully described in table 3, along with priority rankings (Showalter and Hoffard, 1986) and other pertinent data. The objectives can be summarized to include (1) assessment of effects of streamflow on ground-water recharge; (2) measurement of surface-water use; (3) flood warning; (4) data gathering for water-rights adjudication and design of storm-drain systems and flood-control structures; (5) determination of sediment transport; (6) management of irrigation diversions; (7) instream-use management and planning; (8) development of relations to ungaged sites; (9) management of irrigation, municipal, and industrial development; and (10) assessment of potential hydropower-plant sites.

## Method of Evaluation

Following the example of Showalter and Hoffard (1986, p. 36), an ideal network was developed that reflects generalized management and network objectives (table 1) as well as specific objectives and data needs (table 3). Definitions of generalized ideal- and actual-network objectives are derived from Pederson and others (1978, p. 77) and Moss and others (1982, p. 1), respectively. The various networks also were given priority points according to the scheme devised by Showalter and Hoffard (1986, p. 37), and an ideal number of sites for each network was projected (table 3).

Available information on existing streamflow-gaging stations was collected, and existing sites were evaluated in terms of the objectives and data needs indicated by the ideal network (table 3). The six sites in the study area where data presently are collected (table 5) are important to existing planning and management activities, so that continuation of all sites is indicated. Reactivation of the four discontinued sites also is indicated; two of these sites, Alisal Creek near Salinas and Salinas River near Gonzales, might be relocated to improve record quality. The existing sites are discussed in detail at the end of the streamflow-networks section of this report. Additional gages can be located to fulfill objectives described in table 3 as need and funds dictate they should be established.

## Criteria for Site Selection

Site selection for a streamflow network is a complex process in which sometimes conflicting objectives and conditions must be reconciled (table 3). Information requirements for a streamflow-gaging station may include peak stage and low-flow discharge and depth or continuous record of stage and discharge. The selection of sites for streamflow-gaging stations is dictated by the requirements of a hydrologic network and the needs of water management (Carter

TABLE 5.--*Streamflow-gaging stations*

[Sources of information include California Department of Water Resources (1981b, p. 20-163); U.S. Geological Survey (1974, p. 325; 1979, p. 59); Anderson and others (1985). Site numbers refer to locations in figure 6. Operating agency: 5000, U.S. Geological Survey (USGS); 5050, California Department of Water Resources (DWR); 5115, Monterey County Flood Control and Water Conservation District]

| Site No. | Station name | Station number (DWR, USGS) | Operating agency | Location: Township/ range | Location: Latitude/ longitude | Period of record |
|---|---|---|---|---|---|---|
| 1 | Salinas River at Soledad | D2-1500, 11151700 | 5000 | 17S/6E | 36°24'40"/ 121°19'06" | 1968-78, 1983-present |
| 2 | Salinas River near Gonzales | D2-1325, 11152200 | 5050 | 17S/5E | 36°29'12"/ 121°28'06" | 1976-80 |
| 3 | Salinas River near Chualar | D2-1310, 11152300 | 5000 | 16S/4E | 36°33'14"/ 121°32'53" | 1966-present |
| 4 | Salinas River near Spreckels | D2-1220, 11152500 | 5000 | 15S/3E | 36°37'52"/ 121°40'17" | 1900-01, 1929-present |
| 5 | El Toro Creek near Spreckels | D2-1180, 11152540 | 5000 | 15S/2E | 36°35'00"/ 121°42'50" | 1961-present |
| 6 | El Toro Creek near Spreckels | D2-1170, 11152550 | 5115 | 15S/3E | 36°37'30"/ 121°41'12" | 1960-61 |
| 7 | Alisal Creek near Salinas | D2-1225, 11152570 | 5000 | 14S/4E | 36°41'33"/ 121°34'04" | 1965-74 |
| 8 | Gabilan Creek near Salinas | D2-1240, 11152600 | 5115/5000 | 13S/3E | 36°45'21"/ 121°36'34" | 1959-present |
| 9 | Reclamation Ditch near Salinas | D2-1009, 11152650 | 5115/5000 | 14S/2E | 36°42'18"/ 121°42'14" | 1968-present |
| 10 | Santa Rita Creek at Santa Rita | D2-1007 -- | 5115 | 14S/3E | 36°43'30"/ 121°39'12" | 1968-78 |

and Davidian, 1968, p. 2). Station locations for a hydrologic network generally are chosen to take advantage of the best available conditions for stage and discharge measurements and for developing discharge ratings. Stations established for water-management purposes, by contrast, commonly have little freedom of site selection, and frequently records must be obtained under adverse hydraulic conditions. For example, many of the principal streams in an area may have been converted into a series of pools by the construction of dams, and yet dam operation may require precise records. Water management also may need records of tidal-affected reaches of stream channels for information on water supply, salinity repulsion, or waste-disposal contamination. Streamflow-gaging conditions may be poor in areas that have only sand-channel streams in which stage-discharge relations change continually. The Salinas River and Prunedale Creek in this study area are examples of this condition.

Despite the problems in site selection, Carter and Davidian (1968, p. 2-3) proposed several criteria for selecting gaging-station locations:

1. Channel characteristics relative to a fixed and permanent relation between stage and discharge at the gage. A rock riffle or falls * * * indicates an ideal site. If a site on a stream with a movable bed needs to be accepted--for example, a sand-channel stream--it is best to locate the gage in as uniform a reach as possible, away from obstructions in the channel such as bridges.

2. Opportunity to install an artificial control.

3. Possibility of backwater from downstream tributaries or other sources. If a site where backwater occurs has been accepted, a uniform reach for measurement of slope needs to be sought, in addition to the proper placement of an auxiliary gage. Unsteady flow such as occurs in tidal-affected stream channels requires similar consideration but, in addition, line power needs to be available to insure simultaneous recording of stage at the two gages.

4. Availability of a nearby cross section where good discharge measurements can be made.

5. Proper placement of a stage gage with respect to the measuring section and to that part of the channel which controls the stage-discharge relation.

6. Suitability of existing structures for use in making high-flow discharge measurements, or the proper placement of a cableway for this purpose.

7. Possibility of flow bypassing the site in ground water or in flood channels.

8. Availability of line power or telephone lines where needed, for special instrumentation or for Telemark units.

9. Accessibility of the site by roads, particularly during flood periods.

Frequent discharge measurements are normally necessary for defining the stage-discharge relation at any given time. The stage-discharge relations are rarely permanent because of changes in the stream channel such as aquatic growth, debris or ice accumulation, and conditions of scour and fill. Consequently, the frequency of measurements ultimately relates to the needed reliability of the resulting data. As measurements and station visits become less frequent, the reliability of the resulting data decreases.

## Description of Streamflow-Gaging Stations

There have been 10 streamflow-gaging stations operated in the study area (table 5 and fig. 6). Five active stations are operated by the U.S. Geological Survey: Salinas River at Soledad, Salinas River near Chualar, Salinas River near Spreckels, El Toro Creek near Spreckels, and Gabilan Creek near Salinas. One active station, Reclamation Ditch near Salinas, is operated by the Monterey County Flood Control and Water Conservation District. The District has operated two other discontinued streamflow-gaging stations in the study area. The station at El Toro Creek near Spreckels was replaced in 1961 by a nearby station operated by the U.S. Geological Survey. The other station, Santa Rita Creek at Santa Rita, was discontinued in 1978. The other two discontinued streamflow-gaging stations (table 5) are Alisal Creek near Salinas and Salinas River near Gonzales. Alisal Creek is a tributary in the Tembladero Slough basin. The station at Alisal Creek near Salinas was operated between 1965 and 1974. The station was operated by the District from December 1965 to September 1970 and by the U.S. Geological Survey from October 1970 through September 1974. A small reservoir upstream from the station diverted water for irrigation during most flow periods and controlled all but high flows (U.S. Geological Survey, 1974, p. 325). The station at Salinas River near Gonzales operated from 1976 to 1980. In much of the study area, the Salinas River meanders in a wide, flat, braided channel, and so communication between gage and flow is difficult. This condition at the Gonzales station evidently led to discontinuation. Each station is described in the following sections, and the reasons for retaining or excluding them from future monitoring are discussed.

Salinas River at Soledad.--The U.S. Geological Survey installed the streamflow-gaging station at Salinas River at Soledad (site 1 in table 5 and fig. 6) in October 1968. The station was inactive between October 1978 and September 1983. Ground-water withdrawals and small surface-water diversions are made upstream from this station; several large reservoirs also regulate flow (Anderson and others, 1985, p. 49). The drainage area for this station is 3,563 $mi^2$. The peak discharge, recorded on February 25, 1969, was 106,100 $ft^3/s$. The no-flow condition during March 9-16, 1977, was the minimum flow recorded at this station. Land use in this area is cropland and pasture (fig. 2). This station is about 1.2 miles upstream from the Soledad wastewater-treatment facility and less than 0.5 mile south of Soledad. Water quality was sampled infrequently at this station between 1971 and 1977 (site 20 in table 6 and fig. 6). The continued operation of this station is justified as part of the highest priority streamflow network for identification of ground-water recharge, as well as several other networks (table 3).

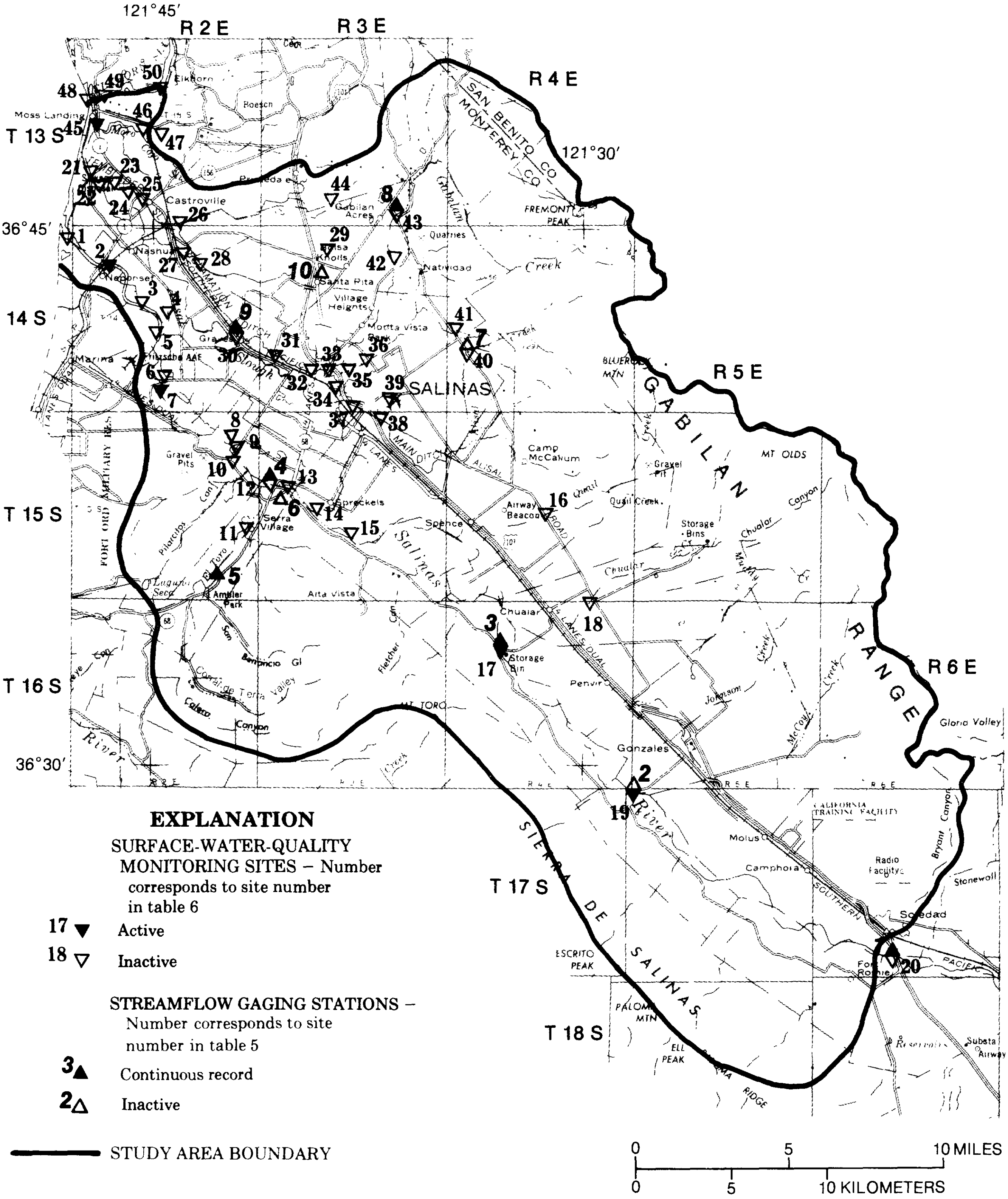



**FIGURE 6.—Surface-water-quality monitoring sites and streamflow-gaging stations.**

Salinas River near Gonzales.--The California Department of Water Resources (DWR) installed a station at Salinas River near Gonzales (site 2 in table 5 and fig. 6) in 1976. Streamflow has been measured there several times, but a peak of 43,000 ft$^3$/s in 1978 shifted the main channel and destroyed communication between the gage and the stream. No stage-discharge relation was ever established for this site because of channel instability. Streamflow measurement was discontinued at the station in 1980 because of channel instability, funding reductions, and installation of the station near Chualar (Bill Mancebo, California Department of Water Resources, oral commun., 1985). From 1969 to 1985, the DWR took water-quality samples twice a year at this site for the California State Water Resources Control Board (site 19 in table 6 and fig. 6). The California Department of Water Resources (1981b, p. 68 and 125) stated that a streamflow-gaging station has been in operation at this site since 1969, but the DWR did not verify this site for the present report. Upstream reservoirs typically discharge at rates that maximize recharge of Salinas aquifers, but by the time these flows reach Chualar much of the water already has percolated into the ground (Jagger, 1981, p. 25). Quantification of the remaining streamflow of the Salinas River between Soledad and Chualar might help to relate streamflow to ground-water recharge in this area. Therefore, the relocation of a streamflow-gaging station at a suitable site is justified, if such a site can be found, to become a part of the highest priority streamflow network, identifying ground-water recharge (table 3), as well as for determining conveyance capacity and sediment transport. Streamflow correlations may be possible, however, between the Gonzales station and the stations at Soledad and Chualar.

Salinas River near Chualar.--The U.S. Geological Survey has operated the streamflow-gaging station at Salinas River near Chualar (site 3 in table 5 and fig. 6) since 1966. From October 1976 through December 1978, the gage was nonrecording. Since January 1979, a continuous water-stage recorder has been in operation. Daily discharge for 1976-78 has been determined by correlation of discharge measurements at this station with Salinas River near Soledad and Salinas River near Spreckels (Anderson and others, 1985, p. 55). Low flow during the drought included periods of no flow during January through April 1977 (U.S. Geological Survey, 1979, p. 71). The flow passing this station has been regulated partly by three upstream reservoirs, which are outside the study area. Large ground-water withdrawals and small surface-water diversions are made upstream of the Chualar station for municipal and irrigation uses. Water quality has been sampled at this station (site 17 in table 6 and fig. 6) since 1977 as part of the U.S. Geological Survey's National Stream-Quality Accounting Network (NASQAN). Chemical water-quality analyses and sediment records have been available for this site since 1977. Biological, continuous water-temperature, and specific-conductance data are available for 1977-81. Because this station is downstream from diversions, it is needed for the following networks: ground-water recharge, water use, water rights, sediment transport, irrigation use, water balance, saltwater intrusion, instream use, and municipal and industrial use (table 3). The continued operation of the station therefore is highly justified, although improvements in record quality for high and low flows might be necessary.

Salinas River near Spreckels.--The U.S. Geological Survey installed the streamflow-gaging station at Salinas River near Spreckels (site 4 in table 5 and fig. 6) in January 1900. Record was published as "Salinas River near Salinas" for 1900-01. The station was inactive after August 1901 until October 1929. Upstream, large ground-water withdrawals and small surface-water diversions are made for municipal use and for irrigation of about 95,000 acres (Anderson and others, 1985, p. 58). The drainage area for this station is 4,156 $mi^2$. The peak discharge, recorded on February 26, 1969, was 83,100 $ft^3/s$; a peak of 63,000 $ft^3/s$ was recorded on March 3, 1983. The minimum flow, recorded in 1983, was 181 $ft^3/s$ on December 21, but no flow was recorded on several occasions during 1929-40. Land use in this area is cropland and pasture (fig. 2). Water quality was monitored near this station between 1951 and 1977 (site 12 in table 6 and fig. 6). Between October 1974 and January 1977, water quality was monitored monthly as part of NASQAN. This station is about 1 mile downstream from the closed Spreckels sugar refinery and just downstream from the outfall for the Alisal sewage-disposal plant. Historically, low flow at this station represented primarily wastewater from these two sources. Laboratory work continues at the refinery site, but discharges are now minimal. The continued operation of this station is justified as part of the highest priority streamflow network for identification of ground-water recharge downstream from the Chualar station, as well as several other network categories (table 3).

El Toro Creek near Spreckels.--The present streamflow-gaging station at El Toro Creek near Spreckels (site 5 in table 5 and fig. 6) is about 3 miles upstream from the original station (11152550)(site 6 in table 5 and fig. 6). The U.S. Geological Survey operates the present station; the Monterey County Flood Control and Water Conservation District operated the old station until September 1961. The original station was installed in 1960, so that about 25 years of record are available near this site. Seepage under the concrete control at the new station resulted in a poor record for 1983, and so the station was moved 700 feet downstream. The flow in El Toro Creek is extremely low during most of the year, but the peak flow for the period of record was 630 $ft^3/s$ on March 2, 1983, even though the drainage area upstream from the station is only 31.9 $mi^2$ (Anderson and others, 1985, p. 59). Small stock ponds are the only regulation or diversion upstream from this site. This station is in a forested area between two residential areas, Ambler Park and Serra Village (fig. 6). The station lies just inside the boundary of the Fort Ord Military Reservation and about 2 miles downstream from the Laguna Seca raceway. The continued operation of this station is justified as part of the highest priority streamflow network, identification of ground-water recharge, as well as several other networks (table 3).

Alisal Creek near Salinas.--The Monterey County Flood Control and Water Conservation District operated the Alisal Creek near Salinas streamflow-gaging station (site 7 in table 5 and fig. 6) between December 1965 and September 1970, when the U.S. Geological Survey assumed operation until September 1974. A small reservoir controls all but high flows passing this station (U.S. Geological Survey, 1974, p. 325). Much of the flow of Alisal Creek probably is controlled by regulation of tributaries, including several small reservoirs and one diversion to a reservoir in the Natividad Creek drainage. The drainage area for this station is 14.2 $mi^2$. The peak discharge is 780 $ft^3/s$, recorded on April 1, 1974, the date of the peak of record for Gabilan Creek near Salinas (fig. 6), which is still in operation. Land use in this area (fig. 2) is cropland and pasture; upstream from the station lie rangeland and forest. The original station was located on a bend of the creek where debris and sand tended to build up, reducing the quality of record (Wendell Ayers, U.S. Geological Survey, oral commun., 1985). If the station is reactivated, a change in location might alleviate this problem. A single water-quality sample was taken in 1974 from the Natividad Creek drainage downstream from the reservoir, which receives diversions from Alisal Creek (site 40 in table 6 and fig. 6). Reestablishment of this station is justified as part of the highest priority streamflow network for identifying ground-water recharge, as well as for determining conveyance capacity and sediment transport (table 3).

Gabilan Creek near Salinas.--The Monterey County Flood Control and Water Conservation District installed the streamflow-gaging station at Gabilan Creek near Salinas (site 8 in table 5 and fig. 6) in January 1959 and operated it until October 1970, when the U.S. Geological Survey assumed operation. A concrete control feature was installed on October 9, 1975, to improve the accuracy of stage-discharge monitoring. Diversions and small detention reservoirs upstream from the station provide some regulation of the flow (Anderson and others, 1985, p. 60). The drainage area for this station is 36.7 $mi^2$; the peak discharge, originally recorded on April 1, 1974, as 800 $ft^3/s$, was later modified to 898 $ft^3/s$ (S.H. Hoffard, U.S. Geological Survey, oral commun., October 1985). A peak of 217 $ft^3/s$ was recorded at 0445 hours on March 3, 1983. By contrast, El Toro Creek near Spreckels recorded a historic high flow of 630 $ft^3/s$ from the same storm, even though the drainage area for that station is smaller than for Gabilan Creek near Salinas. Comparisons could indicate differences in characteristics influencing runoff in the two drainages, such as distribution and intensity of precipitation. The land use in this area (fig. 2) is cropland and pasture. A tributary entering Gabilan Creek 0.3 mile upstream of the station partly drains from the largest strip-mine and quarry area in Monterey County. In 1973, a single water-quality sample was collected near this site (site 43 in table 6 and fig. 6). The continued operation of this station is justified as part of the highest priority streamflow network (table 3), identification of ground-water recharge, as well as several other networks.

Reclamation Ditch near Salinas.--The Monterey County Flood Control and Water Conservation District installed the streamflow-gaging station at Reclamation Ditch near Salinas (site 9 in table 5 and fig. 6) in March 1968 and operated it until October 1970. The U.S. Geological Survey then operated the station until 1986 when the District assumed operation again. Reclamation Ditch is in the Tembladero Slough basin. The station measures drain flow mostly from Carr Lake (T. 14 S., R. 3 E., sec. 22); the water is used primarily for farming (Anderson and others, 1987, p. 71). The drainage area for this station is 53.2 $mi^2$, and the peak discharge, recorded on March 1, 1983, was 524 $ft^3/s$. The gage has a concrete control, but otherwise the ditch is unlined. The land use in this area is cropland and pasture (fig. 2). Very infrequent water-quality samples were collected near this site before 1973 (site 30 in table 6 and fig. 6). The continued operation of this station is justified as part of the second-highest priority streamflow network, identification of water-use quantities, as well as several other network categories (table 3).

Santa Rita Creek at Santa Rita.--The Monterey County Flood Control and Water Conservation District operated the streamflow-gaging station at Santa Rita Creek at Santa Rita (site 10 in table 5 and fig. 6) between October 1968 and September 1978. Several small reservoirs in the Santa Rita Creek drainage probably influence flows at this station. The drainage area for this station is 4 $mi^2$, according to the Monterey County Flood Control and Water Conservation District (1978, p. 31), but California Department of Water Resources (1981b, p. 125) stated that the drainage area is 10.4 $mi^2$. The 4-$mi^2$ drainage area has been verified recently (Bruce LaClergue, Monterey County Flood Control and Water Conservation District, oral commun., 1985). The peak discharge of 178 $ft^3/s$ was recorded on April 1, 1974, the date of the peak of record for Gabilan Creek near Salinas (site 8 in table 5 and fig. 6) and Alisal Creek near Salinas (site 7 in table 5 and fig. 6). Land use in this area is primarily residential and industrial, but croplands and pastures also lie within the drainage area (fig. 2). Historically, infrequent streamflow measurements have reduced the quality of record at this station (S.H. Hoffard, U.S. Geological Survey, oral commun., 1985). Frequency of streamflow measurement can be established on a periodic schedule. To maintain the accuracy of continuous flow records, measurements must be frequent enough to detect changes in the stage-discharge relation; this might require six or more measurements per year, depending on the measured flow for the year. Reestablishment of the Santa Rita station is justified as part of the highest priority streamflow network for identifying ground-water recharge, as well as for several other networks (table 3). Urban development is concentrating in the immediate and upstream areas near this site, which may require improved data for various hydrologic planning needs.

# TABLE 6.--*Surface-water-quality monitoring sites*

[Site numbers refer to station locations in figure 6. --, no data available]

Operating agency:

1257, Northern Salinas Valley Mosquito Abatement District
5000, U.S. Geological Survey (USGS)
5050, California Department of Water Resources (DWR)
5115, Monterey County Flood Control and Water Conservation District

Sampling frequency codes:

S, single, one-time sample
1, very infrequent (less than 5 analyses)
2, infrequent (5-25 analyses)
3, frequent (more than 25 analyses)
A, currently active
N, no sampling identified

Summary of sampling frequencies

| Frequency | Number of stations | Percent |
|---|---|---|
| S | 9 | 18 |
| 1 | 14 | 28 |
| 2 | 11 | 22 |
| 3 | 14 | 28 |
| N | 2 | 4 |
| Total....... | 50 | 100 |

| Site No. | Station name | Station number (DWR, USGS) | Operating agency | Location: Township/range | Location: Latitude/longitude | Period of record | Sampling frequency: Before 1973 | Sampling frequency: 1973-present | Sampling frequency: Number of analyses | Sampling frequency: Code |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Salinas River near Bank from Mulligan Highway | D2-1100.30<br>-- | 5050 | 14S/1E | 36°44'54"/ 121°48'06" | 1964 | S | N | 1 | S |
| 2 | Salinas River at Twin Bridges[1] | D2-1110.50<br>-- | 5050 | 14S/2E | 36°44'00"/ 121°46'42" | 1964-present | 2 | 2 | 32 | 3,A |
| 3 | Salinas River 1.9 miles above Highway 1 Bridge | D2-1110.70<br>-- | 5050 | 14S/2E | 36°43'06"/ 121°45'00" | 1964-77 | 1 | 2 | 11 | 2 |
| 4 | Blanco Drive at Pump Lift[1] | D2-1030.30<br>-- | 5050, 5000 | 14S/2E | 36°42'36"/ 121°44'36" | 1970-75 | 2 | 1 | 15 | 2 |
| 5 | Salinas River at Blanco Drive | D2-1120.50<br>-- | 5050 | 14S/2E | 36°42'24"/ 121°44'48" | 1964-77 | 1 | 2 | 11 | 2 |
| 6 | Salinas River at Blanco Road | --<br>-- | 1257 | 14S/2E | -- | 1975-84 | N | 3 | 118 | 3 |
| 7 | Salinas River at Blanco Road[1] | D2-1150.30<br>-- | 5050 | 14S/2E | 36°40'42"/ 121°44'42" | 1964-present | 2 | 2 | 28 | 3,A |
| 8 | Salinas Oxidation Pond 2 | --<br>-- | 1257 | 15S/2E | -- | 1975-84 | N | 2 | 118 | 3 |
| 9 | Salinas Oxidation Pond 1 | --<br>-- | 1257 | 15S/2E | -- | 1975-84 | N | 2 | 118 | 3 |
| 10 | Salinas River at Davis Road[1] | D2-1160.20<br>-- | 5050 | 15S/2E | 36°38'30"/ 121°42'00" | 1971-77 | S | 2 | 7 | 2 |
| 11 | El Toro Creek near San Benancio Bridge[1] | D2-1185.20<br>-- | 5050, 5000 | 15S/2E | 36°34'42"/ 121°43'12" | 1970-72 | S | N | 1 | S |
| 12 | Salinas River near Spreckels[1] | D2-1220.00<br>11152500 | 5050, 5000 | 15S/3E | 36°37'48"/ 121°40'42" | 1951-77 | 3 | 2 | 160 | 3 |
| 13 | Salinas River at Highway 68 | --<br>-- | 1257 | 15S/3E | -- | 1975-84 | N | 3 | 118 | 3 |
| 14 | Spreckels Holding Pond, Old 1-E | --<br>-- | 1257 | 15S/3E | -- | 1975-84 | N | 3 | 118 | 3 |

Footnotes at end of table.

## TABLE 6.--*Surface-water-quality monitoring sites*--Continued

| Site No. | Station name | Station number (DWR, USGS) | Operating agency | Location: Township/range | Location: Latitude/longitude | Period of record | Sampling frequency: Before 1973 | Sampling frequency: 1973-present | Sampling frequency: Number of analyses | Sampling frequency: Code |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | Spreckels Pond, 5-6-W | -- -- | 1257 | 15S/3E | -- | 1975-84 | N | 3 | 118 | 3 |
| 16 | Quail Creek above Old Stage Road | D2-1260.50 -- | -- | 15S/4E | 36°37'00"/ 121°31'18" | 1973 | S | N | 1 | S |
| 17 | Salinas River near Chualar | D2-1310.10 11152300 | 5050, 5000 | 16S/4E | 36°33'14"/ 121°32'53" | 1952-69 1977-present | 2 | 3 | 50 | 3,A |
| 18 | Chualar Creek at Old Stage Road | D2-1290.50 -- | 5050, 5000 | 15S/4E | 36°34'42"/ 121°29'42" | 1952-70 | 1 | N | 4 | 1 |
| 19 | Salinas River near Gonzales[1] | D2-1325.10 11152200 | 5050 | 17S/5E | 36°29'12"/ 121°28'06" | 1969-present | 2 | 3 | 59 | 3,A |
| 20 | Salinas River at Soledad | D2-1500 11151700 | 5000 | 17S/6E | 36°24'40"/ 121°19'06" | 1971-77 | 2 | 2 | 9 | 2 |
| 21 | Old Salinas River above Tembladero Slough[1] | D2-1006.50 -- | -- | 13S/2E | 36°46'12"/ 121°47'12" | 1972-77 | 1 | 1 | 6 | 2 |
| 22 | Tembladero Slough at Molera Road[1 3] | D2-1006.30 -- | -- | 13S/2E | 36°46'18"/ 121°47'12" | 1970-78 | 2 | 2 | 14 | 2 |
| 23 | Tembladero Slough below sewage treatment plant | -- -- | 5115 | 13S/2E | -- | 1969-70 | 1 | N | 3 | 1 |
| 24 | Tembladero Slough at Highway 183 | -- -- | 5115 | 13S/2E | -- | 1969-70 | 1 | N | 3 | 1 |
| 25 | Tembladero Slough at Preston[1 4] | D2-1006.52 -- | -- | 13S/2E | 36°46'20"/ 121°47'11" | 1977-78 | N | 2 | 6 | 2 |
| 26 | Merritt Lake drain at pump[1] | D2-1006.60 -- | -- | 13S/2E | 36°45'06"/ 121°44'12" | 1970-75 | 2 | 1 | 9 | 2 |
| 27 | Salinas Reclamation Canal below Alisal Slough | D2-1009.20 -- | 5050 | 14S/2E | 36°44'30"/ 121°44'18" | 1970-72 | 1 | N | 2 | 1 |
| 28 | Reclamation Canal at Tembladero Slough[1] | -- -- | -- | 14S/2E | -- | -- | N | N | N | N |
| 29 | Reclamation Canal at Highway 183 (Santa Rita lateral) | -- -- | 5115 | 14S/3E | -- | -- | N | N | N | N |
| 30 | Salinas Reclamation Canal at San Jon Road | -- 11152650 | 5115 | 14S/2E | 36°42'18"/ 121°42'14" | 1969-70 | 1 | N | 3 | 1 |
| 31 | Salinas Reclamation Canal at Boronda Road | D2-1010.20 -- | 5050 | 14S/3E | 36°41'24"/ 121°40'48" | 1970 | 1 | N | 2 | 1 |
| 32 | Salinas Reclamation Canal at Preston Street | D2-1011.50 -- | 5050 | 14S/3E | 36°41'06"/ 121°39'12" | 1974 | N | S | 1 | S |
| 33 | Salinas Reclamation Canal at Main Street | -- -- | 5115 | 14S/3E | -- | 1969-70 | 1 | N | 3 | 1 |

Footnotes at end of table.

## TABLE 6.--*Surface-water-quality monitoring sites*--Continued

| Site No. | Station name | Station number (DWR, USGS) | Operating agency | Location: Township/ range | Location: Latitude/ longitude | Period of record | Sampling frequency: Before 1973 | Sampling frequency: 1973-present | Sampling frequency: Number of analyses | Sampling frequency: Code |
|---|---|---|---|---|---|---|---|---|---|---|
| 34 | Salinas Reclamation Canal at end Merced Street | D2-1015.50 -- | 5050 | 14S/3E | 36°40'30"/ 121°38'24" | 1970 | 1 | N | 2 | 1 |
| 35 | Sherwood Lake, east shore | -- -- | 1257 | 14S/3E | -- | 1975-84 | N | 3 | 118 | 3 |
| 36 | Natividad Creek at East Laurel Drive | D2-1264.50 -- | 5050 | 14S/3E | 36°41'18"/ 121°37'30" | 1974 | N | S | 1 | S |
| 37 | Salinas Reclamation Canal at Alisal Sewage Treatment Plant | D2-1016.50 -- | -- | 14S/3E | 36°40'06"/ 121°38'06" | 1973-75 | 1 | 1 | 4 | 1 |
| 38 | Salinas Reclamation Canal at Airport Boulevard[1] | D2-1020.70 -- | -- | 15S/3E | 36°39'42"/ 121°37'18" | 1970-77 | 2 | N | 6 | 2 |
| 39 | Salinas Airport northeast moat | -- -- | 1257 | 14S/3E | -- | 1975-84 | N | 3 | 118 | 3 |
| 40 | Alisal Creek at Old Stage Road | D2-1255.50 -- | 5050, 5000 | 14S/4E | 36°41'30"/ 121°34'06" | 1952-74 | 2 | S | 11 | 2 |
| 41 | Natividad Creek at Old Stage Road | D2-1266.50 -- | 5050 | 14S/4E | 36°42'00"/ 121°34'24" | 1974 | N | S | 1 | S |
| 42 | Gabilan Creek at Natividad Bridge Crossing | D2-1261.50 -- | 5050 | 14S/3E | 36°43'54"/ 121°36'42" | 1974 | N | S | 1 | S |
| 43 | Gabilan Creek near Santa Rita | D2-1240.00 -- | 5000 | 13S/3E | 36°45'18"/ 121°36'36" | 1973 | S | N | 1 | S |
| 44 | San Miguel Creek east of Backie Road | D2-1060.20 -- | 5050 | 13S/3E | 36°46'01"/ 121°39'08" | 1970 | S | N | 1 | S |
| 45 | Old Salinas River channel above First Tide Gate[2] | D1-3111.30 -- | 5115 | 13S/2E | 36°48'00"/ 121°47'15" | 1977-present | N | 1 | 10 | 1,A |
| 46 | Moro Cojo Slough West Bank, northeast of Highway 1[2] | D1-3114.3 -- | 5000 | 13S/2E | 36°47'51"/ 121°45'58" | 1977 | N | 1 | 2 | 1 |
| 47 | Moro Cojo Slough at Railroad, south of Dolan Road[2] | D1-3113.3 -- | 5000 | 13S/2E | 36°47'22"/ 121°45'10" | 1977 | N | 1 | 2 | 1 |
| 48 | Elkhorn Slough South Bank, north of Dolan Road[2] | D1-3116.3 -- | 5000 | 13S/2E | 36°48'48"/ 121°44'40" | 1977 | N | 1 | 2 | 1 |
| 49 | Elkhorn Slough at Highway 1 bridge[2] | -- -- | 1257 | 13S/2E | -- | 1975-84 | N | 3 | 118 | 3 |
| 50 | Elkhorn Slough at Highway 1[2] | D1-3150.3 -- | 5000 | 13S/2E | 36°48'36"/ 121°47'00" | 1953-70 | 2 | N | 2 | 1 |

[1]Site(s) recommended in Burau and others (1981, v. 1, p. 52-54).
[2]Site(s) noted by W.E. Templin, P.E. Smith, and R.C. Schluter (U.S. Geological Survey, written commun., 1989).
[3]Called "at Nashua Road" (site 14) in Burau and others (1981).
[4]Called "at Merritt Lake Drain" (site 15) in Burau and others (1981).

## Surface-Water-Quality Networks

### Surface-Water Quality Conditions

Quality of surface water in the Salinas River varies greatly with location (Monterey County Planning Department, 1981b, p. 127-128). The basin can be divided into two areas, a lower basin downstream from Chualar and an upper basin. Although the upper part has generally good quality, contamination does exist. Natural contamination is present in water draining from the east side of the Salinas Valley; water draining the Diablo Range (outside the study area) is typically high in mineral concentrations. Dissolved solids, which are minerals that remain combined with water after filtering, can be 10 times higher in concentration in water draining from the eastside range than in water from the westside. Surface-water quality also is affected by land use in the Salinas River basin. Communities and cities south of Chualar discharge their sewage into holding ponds before release into the river to prevent high nutrient discharges. Irrigated agriculture, a major land use in the Salinas River basin, demands a large part of the total water used from the Salinas River. About 20 to 50 percent of irrigation water returns to the river as surface drainage or to the ground water by percolation. High nutrient levels in the river are the result. Clean water coming from outside the study area (from Lake Nacimiento, Lake San Antonio, and the Arroyo Seco) flushes out these nonpoint sources of pollution, resulting in good-quality water from the upper Salinas River. The lower Salinas River does not benefit from this flushing action because summer water flows are limited to reaches upstream from Spreckels and State Highway 68 bridge.

Water quality in the lower Salinas River has been degraded by waste disposal, land development, and agricultural practices. The city of Salinas has two sewage outfalls on the Salinas River near the Highway 68 bridge (fig. 3). Treated sewage and agricultural drainage comprise more than 90 percent of the summer flow of the Salinas River downstream of the Highway 68 bridge. Excessive nutrient buildup has resulted in eutrophication, large amounts of algae, sludge deposits, and foul odors. Because of such conditions, the State of California has listed the Salinas River from the community of Spreckels to Monterey Bay as one of the five dirtiest rivers in the State (Walter Wong, Monterey County Environmental Health Department, oral commun., 1980). During the winter rainy season, these conditions are improved as high flows produce good-quality water throughout the Salinas River.

### Objectives

Generalized management and network objectives (table 1) for surface-water quality include (1) determination of ambient concentrations of water-quality constituents; (2) determination of spatial and temporal trends; (3) identification of native, point, and nonpoint sources of constituents; and (4) development of a surface-water-quality management plan.

Koryak (1980, p. 1) said that "the design of water-quality monitoring networks has traditionally been a subjective process. Decisions as to the number of stations in a network, station locations, sampling frequencies, and parameter coverage are based primarily on the intuitions and judgment of the individual designers." Koryak also stated that the initial step of network design, definition of objectives, probably was the most subjective and potentially controversial part of the process; he suggested two basic categories of water-quality monitoring objectives which require correspondingly different strategies.

The first category consists of water-quality characterization and trend identification, which require routine monitoring. Routine monitoring entails long-term, fixed-time increment sampling at permanent station locations for which no termination date is designated. The second category includes deterministic water-quality investigations, which entail synoptic monitoring. This type of monitoring often is required for regulatory enforcement, primarily involving effluent and receiving-water monitoring. Synoptic monitoring can be (1) scheduled, to measure chronic water-quality conditions; or (2) unscheduled, to measure acute conditions. Synoptic monitoring normally has a short-term or designated termination date. In this report, generalized management and network objectives for surface-water quality (table 1) have tried to accommodate both categories of monitoring objectives, as well as the objectives outlined by the United Nations Educational, Scientific, and Cultural Organization and others (1978, p. 25-27).

## Method of Evaluation

The method used in this report to evaluate the surface-water-quality monitoring networks was (1) assessment of data needs of the area, (2) assessment of ideal-network coverage for the study area, (3) location and evaluation of existing and potential sites for surface-water-quality sampling, and (4) determination of possible improvements to network coverage. The ideal network summarized in table 3 follows the example of Ponce's (1980, p. 35) water-quality matrix in developing a systematic understanding of water-quality monitoring in the study area. An ideal network for monitoring surface-water quality would provide information on the general chemical quality, trace elements, bacteria, and all other potential contaminants at any stream site anywhere in the study area, at any time requested. Because such a saturation of information is impractical, an ideal network could be expected to produce more information than is being produced currently, but less than saturation level. An example of some of the potential needs for data is provided along with some preliminary priorities and other pertinent data in table 3. These networks and priorities should be reviewed and improved periodically as needs change and more information is gathered.

Data needs for surface-water quality (table 3) include routine, periodic, complete analyses of stream and reservoir water to monitor for domestic, agricultural, and fish and wildlife uses. Ideally, sampling should (1) determine water quality of flow from reservoirs; (2) monitor for the effects of geology and land use on water-quality trends; and (3) establish baseline water-quality characteristics, such as temperature and specific conductance, for the entire basin and for specific streams. Data collection can assist in mosquito abatement, evaluate compliance with water-quality criteria and standards, and develop a water-quality rating system for stream reaches.

## Station Location and Sampling Frequency

According to Brown and others (1970, p. 4-8), the overall needs of a data-collection program determine the location of a station and the frequency of sampling. If a sampling network is set up to measure overall water quality of a stream, sampling should represent the entire stream; sampling stations therefore should not be established where mixing of water is incomplete or where water composition differs significantly in the stream cross section. A sampling station may be set up to measure water quality at a specific intake point, but care should be taken not to mislead data users as to the representativeness of the sample for the entire stream. For most streams, sampling should be every day or two--in some cases every few hours--to ensure reliability of the record. Sampling may be infrequent for streams completely controlled by large storage reservoirs or by large constant ground-water inflow. To establish continuous water-quality conditions of a stream, continuous recording and telemetering equipment may be used in conjunction with periodic complete water-quality analyses. The use of the proper tools for the job (in this case instruments for the specific sample and desired analysis) commonly is taken for granted, but this approach can be a serious mistake. Reports by Skougstad and others (1979) and Claassen (1982) review various analytical and instrumentation approaches suggested for use in water-quality sampling.

## Description

The Monterey County Flood Control and Water Conservation District (MCFCWCD) presently is sampling surface-water quality at one site for suspended sediment, specific conductance, and chlorides as requested routinely by the California Coastal Commission (site 45 in fig. 6 and table 6). The following agencies also have conducted surface-water-quality monitoring in the study area: the U.S. Geological Survey (USGS); the California Department of Water Resources (DWR); Monterey County Environmental Health Department; and the Northern Salinas Valley Mosquito Abatement District (fig. 6 and table 6).

Fifty sites were identified during this study as historic or recommended by other investigators for surface-water quality monitoring. A review of the sampling frequency was done (table 6) which indicates that most (36 sites, 72 percent) sites have been sampled infrequently at best. As of 1985, only five monitoring sites were active: Salinas River at Twin Bridges (DWR), Salinas River at Blanco Road (DWR), Salinas River near Chualar (DWR and USGS), Salinas River near Gonzales (DWR), and Old Salinas River channel above First Tide Gate (table 6 and fig. 6). Sampling frequencies, locations, and results need to be reviewed periodically by local agencies to remain current with available information. The U.S. Environmental Protection Agency maintains a computerized system that can be accessed to obtain information on sampling locations, results, and frequencies in relation to various other related information (including waste dischargers and water-supply withdrawal locations) (Phil Daniels, California State Water Resources Control Board, oral commun., July 1989). Additional data may be available from the California Regional Water Quality Control Board, Central Coastal Region, San Luis Obispo, as required by discharge permits. The stations identified for this report include 45 inactive and 5 active sites.

Showalter and others (1984, p. 54-55) suggested continued monthly sampling and sampling during storms at the streamflow-gaging station Salinas River near Chualar (11152300) (site 17 in table 6 and fig. 6) and Salinas River at Soledad (11151700) (site 20 in table 6 and fig. 6) for three reasons: (1) infiltration through stream channels is the major source of recharge to ground water; (2) streamflow records are available; and (3) sampling could correspond to regular streamflow measurement visits, thereby reducing additional costs. To meet specific data needs for future seawater intrusion problems, a routine long-term, deterministic program developing water-quality parameters to characterize the existing conditions also is important. Similar data are needed on Gabilan and Natividad Creeks for characterizing the quality of water currently recharging the ground-water basins in those areas. These streams would be likely candidates for high ratings in the stream-reach rating system discussed below.

Burau and others (1981, p. 54) recommended 13 sites in the study area for monthly or at least quarterly sampling for various environmentally hazardous substances and standard water analyses (table 6). These sites are included in table 6 and figure 6 as surface-water-quality sites 2, 4, 7, 10, 11, 12, 19, 21, 22, 25, 26, 28, and 38. The authors then modified their proposed monitoring program to include quarterly water samples at five sites and annual water samples at eight sites (Burau and others, 1981, p. 75-76). The list of constituents suggested for analysis included arsenic, boron, cadmium, lead, mercury, DDT, PCB's, and metabolites, 10 chlorinated hydrocarbons, parathions, and nitrates. Burau and others (1981) also suggested semiannual sampling at five sites with analysis of sediment, and tissue analyses from fish and crayfish. Wastewater from 12 known dischargers was recommended for quarterly sampling, and three marine-environment sites were recommended for semiannual sampling of sediment, water, and various plant and animal species.

Since 1977, the California Department of Fish and Game and the California State Water Resources Control Board have monitored biological indicators of the quality of coastal bay and estuarine waters in Monterey County as part of the State Mussel Watch Program and the Toxic Substances Monitoring Program (California State Water Resources Control Board, 1984, p. 41-46). Surface-water-quality sampling at the Salinas River near Gonzales station (site 19 in table 6 and fig. 6) has been ended, and sampling at Salinas River near Chualar (site 17 in table 6 and fig. 6) as part of the U.S. Geological Survey's National Stream-Quality Accounting Network (NASQAN) is used instead (Tom Lavenda, California State Water Resources Control Board, oral commun., 1985). The Geological Survey site could be used as an example of the frequency and constituents for sampling stream quality that is needed throughout Monterey County.

Although the objectives for surface-water-quality monitoring summarized in tables 1 and 3 are extensive, at present only five sites are active (sites 2, 7, 17, 19, and 45 in table 6 and fig. 6). Establishment of additional sites would be necessary to meet the proposed monitoring objectives. Possible sampling sites include the 45 inactive sites included in table 6, and further canvassing of the study area might identify other active sites. A stream-reach rating system would help to determine possible additional sites and establish the priority of the sites.

## Stream-Reach Rating System

A method of determining priorities for individual streams and reaches of streams is needed so that Monterey County Flood Control and Water Conservation District can start to monitor additional surface-water-quality sites. Sanders (1980, p. 118) presented a method for selecting river reaches that need a sampling station. This method identified each major stream and subdivided the streams into tributaries. Each stream and tributary was assigned a rating of its need for monitoring on the basis of the number and types of diversions from and discharges into them. This approach is typical of what is needed in the design of a surface-water-quality-monitoring network for Monterey County. The drainage-basin numbering system proposed by Durbin and others (1978, p. 44-46) for small tributary streams of the Salinas River needs to be expanded to include separate reaches of the Salinas River itself. The use of stream reach numbers and segmentation of the U.S. Environmental Protection Agency would adequately meet the needs of Monterey County and lead to improved cooperation between local and Federal agencies with common interests. The result would provide an initial list of specific stream reaches that would need to be ranked by their priority of need for streamflow and surface-water-quality data. Beyond identifying all reaches of the Salinas River as higher priority than the 25 other tributaries identified by Durbin and others (1978, p. 38) in the study area, the assignment of priorities to segments of streams is beyond the scope of this study.

# GROUND-WATER NETWORKS

## Ground-Water Conditions

The conditions of ground water in the study area have been reported as early as 1946 (California Department of Water Resources, 1946). Hart (1966, p. 5) describes the geology of the Salinas River drainage basin as "typical of the southern Coast Ranges, being structurally and stratigraphically complex." Durbin and others (1978, p. 15) divided the geologic formations of the area into three general units on the basis of their capacity to yield ground water. These geologic units are consolidated rocks, semiconsolidated deposits, and unconsolidated deposits. The consolidated rocks yield only a small quantity of water; the semiconsolidated deposits yield small to appreciable amounts of water; and the unconsolidated deposits, which form the prolific aquifers of the area, yield the most water. For a detailed discussion of the geology of the study area, the reader is referred to Hart (1966).

## Occurrence of Ground Water

Many reports have been published on ground-water occurrence in specific geographic areas of Monterey County, and for convenience, this report uses the geographic names used historically by the Monterey County Flood Control and Water Conservation District and other agencies. The study area for this report includes the following geographic areas: El Toro Creek basin area, Pressure area, East Side area, and the northern one-half of Forebay area (fig. 7).

Ground water in the El Toro Creek basin area occurs in six major geologic units in ascending order: the basal sand unit, the Monterey Formation, the Santa Margarita Sandstone, the Paso Robles Formation, the Aromas Sand, and alluvium, all of late Tertiary and Quaternary age (Anderson-Nichols and Co., 1981, p. 15). The Santa Margarita Sandstone, Paso Robles Formation, and Aromas Sand are the principal sources of ground water for the area. Water-bearing units in the El Toro Creek basin area have extreme variability in permeability, no noted confinement, and some influence by faults (Anderson-Nichols and Co., 1981, p. 15-20).

Ground-water occurrence in the Pressure, East Side, and Forebay areas is distinguished by three characteristics: (1) degree of confinement, (2) source of ground-water recharge, and (3) specific capacity of wells (Durbin and others, 1978, p. 8-9). According to Showalter and others (1984, p. 29), the Pressure area contains a shallow, perched water table and at least three confined aquifers that are separated by interconnecting clay layers. These aquifers are formed of alluvium and the Paso Robles Formation or its equivalents.

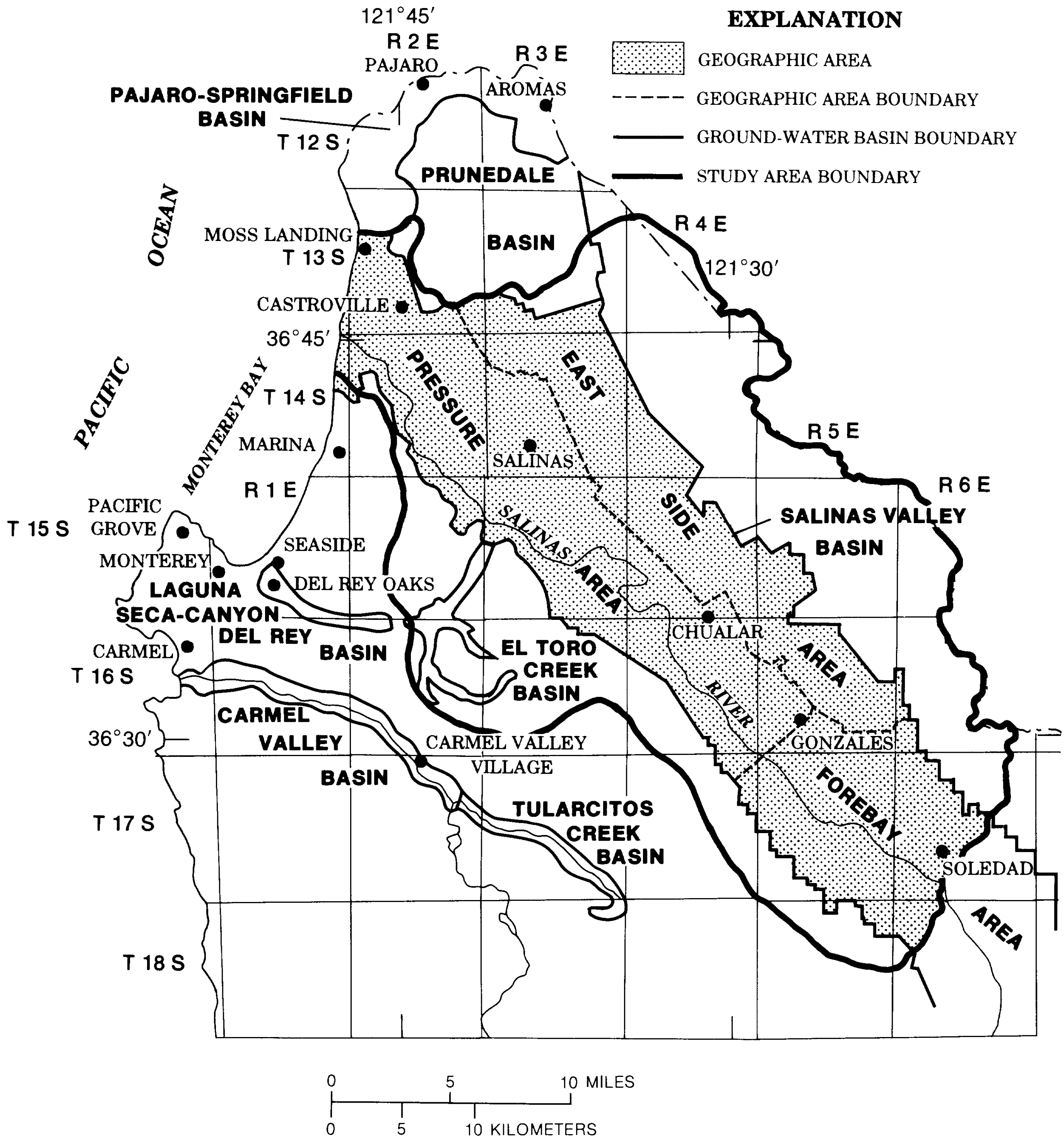



FIGURE 7.—Ground-water geographic areas.

The confined aquifers are known as the 180-foot, 400-foot, and deep aquifers on the basis of the general depth to the top of each. The 180-foot and the 400-foot aquifers are heavily used, and saltwater intrudes both aquifers in areas of heavy pumping near Monterey Bay. In 1981, the front of the advancing saltwater was about 4.6 miles inland in the 180-foot aquifer and about 1.8 miles inland in the 400-foot aquifer. Continued monitoring provides important information on changes in this saltwater front over time, with changes in land-use and water-use management.

The aquifers of the Pressure area are recharged primarily by underflow from the Forebay area, direct percolation from Quail Creek at Spence, and percolation from shallower to deeper aquifers (Showalter and others, 1984, p. 32). Ground water in the East Side area is mostly semiconfined and in the Forebay area is mostly unconfined. The main source of recharge to the East Side and Forebay areas is infiltration from the Salinas River and its tributaries. Some recharge to the East Side, however, is attributed to underflow from the Pressure and Forebay areas. In the Forebay area, some recharge also is attributed to underflow from the southern Salinas River drainage basin. Modeling of ground water indicates that the Pressure area is recharged by upward movement of water from the deep zone (Hydrocomp, Inc., 1985, p. 35).

Average specific capacities, in gallons per minute, for the study area are as follows: Forebay area, 109; Pressure area 180-foot aquifer, 63; Pressure area 400-foot aquifer, not available; Pressure area deep aquifer and East Side area, 21 (Durbin and others, 1978, p. 8; Showalter and others, 1984, p. 32; Schmidt, 1985, p. 5).

## Ground-Water Flow

The natural direction of ground-water flow in the Salinas River basin generally parallels the surface-water flow. Ground water in the Forebay area generally moves in a northwesterly direction along a fairly uniform gradient toward Gonzales, and in the East Side and Pressure areas, ground water moves in a northerly direction toward Chualar and Salinas (Leedshill-Herkenhoff, Inc., 1985, p. 3-3). Localized pumping of wells, however, strongly influences three-dimensional flow of ground water in the area. Near Salinas, ground-water movement turns eastward because of pumpage patterns. Significant parts of the Pressure and East Side areas have water-surface altitudes below sea level. Fresh ground water no longer flows westward toward the ocean because pumpage has reversed the typical flow gradient. This reversal in flow direction has allowed saltwater to intrude from the Pacific Ocean into the major producing aquifers near the mouth of the Salinas River.

Anderson-Nichols and Co. (1981, p. 35) found that the flow of ground water in the El Toro Creek basin generally follows the pattern of surface drainage north along El Toro Creek and west towards Laguna Seca. A more even distribution of water-level measurements is needed to confirm the directions of ground-water flow in this area.

## Flow Barriers

The only known barrier to ground-water flow in the study area is north of Salinas (T. 14 S., R. 3 E., sec. 14). Wells in the area indicate a fault-created flow barrier that has offset the water table 130 feet (Showalter and others, 1984, p. 42). In the El Toro Creek basin area, much of the hydrology is controlled by northwest-southeast trending folds and faults, such as the Harper Canyon, Harper, Chupines, and Corral de Tierra Faults (Anderson-Nichols and Co., 1981, p. 19-20). In particular, the Corral de Tierra Fault and the Chupines Fault influence the flow of ground water in the area.

## Water-Level Changes

Showalter and others (1984, p. 44) summarized the changes in water levels that have been measured in the Salinas River basin since ground-water-level monitoring began in 1944. Between 1944 and 1980, measurements of the average water levels and potentiometric surfaces in the East Side, Pressure, and Forebay areas declined 43, 18, and 2 feet, respectively. Furthermore, according to Showalter and others (1984),

> The decline in the East Side subarea has been most severe where transmissivities are low and recharge slow. Because saltwater intrusion was already a problem in the Pressure Area in 1944, an additional decline of 18 feet since then is serious. Water-level declines in the Pressure Area near the coast are somewhat stabilized by the intrusion of seawater. The rate of decline has not been constant over time. During the 1976-77 drought, the water levels dropped substantially throughout the basin. By 1980, the water levels in the Forebay * * * had recovered to their pre-drought levels, but the water levels in the Pressure Area and East Side had not.

The mean changes in autumn ground-water levels for the Salinas River drainage basin and El Toro Creek basin between 1973 and 1978 (fig. 8) indicate the effects of the 1976-77 drought on ground-water levels in these areas (Monterey County Flood Control and Water Conservation District, 1978, p. 12).

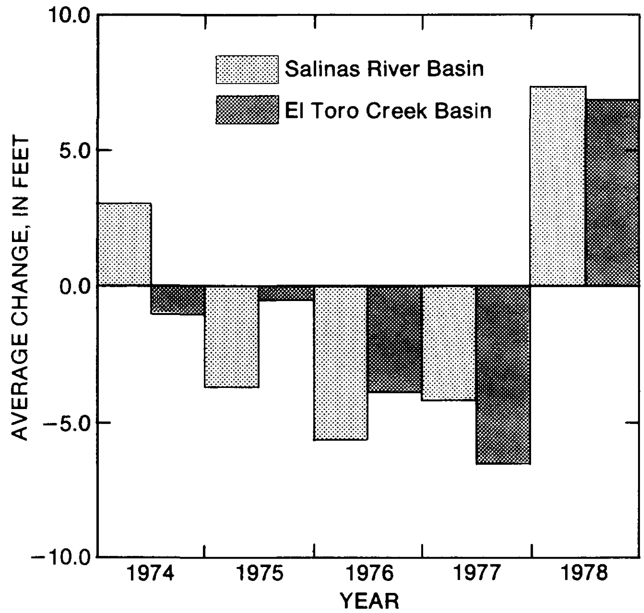



**FIGURE 8.—Mean changes in autumn ground-water levels, 1974-78.**

## Ground-Water-Quality Conditions

The quality of ground water in the El Toro Creek basin is generally fair to poor; concentrations of dissolved solids, sulfate, chloride, nitrate, iron, and manganese commonly exceed California State drinking-water standards (Anderson-Nichols and Co., 1981, p. 76). Water-quality problems have been noted in all areas of the El Toro Creek basin but most commonly in the Calera Canyon and Watson Creek basins. The problems presumably relate to the natural aquifer mineralogy of the area because current land use (fig. 2) does not indicate that known problems result from development.

Ground water in the East Side area from Gonzales to Castroville generally contains less than 1,000 mg/L (milligrams per liter) of dissolved solids (Showalter and others, 1984, p. 48). Ground-water type is principally sodium chloride or sodium calcium chloride but in a few scattered areas, it is calcium bicarbonate. The chloride dominance in some of these wells probably does not result from saltwater intrusion because the dissolved-solids concentration is low. North of Gonzales along the east side of the drainage basin, the ground water is dominantly of the sodium sulfate and calcium sulfate types (Showalter and others, 1984, p. 48 and pl. 5).

In the Pressure area, the 180-foot and 400-foot aquifers generally contain a similar water type, but water in the 180-foot aquifer has a higher dissolved-solids concentration (Showalter and others, 1984, p. 48). In both aquifers, sodium calcium (or calcium sodium) bicarbonate water types dominate, but the 180-foot and 400-foot aquifers contain some calcium sulfate and calcium bicarbonate water types, respectively. Three conditions have affected adversely the quality of water in both aquifers: (1) percolation from irrigation, (2) downward migration of water through unsealed and otherwise poorly constructed wells, and (3) saltwater intrusion.

In the deep aquifer, water types are dominantly sodium bicarbonate (Ares, 1982, p. 7). The available data indicate that the dissolved-mineral concentrations of water in the deep aquifer are within acceptable limits for class 1 irrigation water. The high sodium content of the water, however, has created some concern about soil-permeability problems related to the long-term use of this water for irrigation. Boron levels detected in soil water extracts in areas irrigated with water from this aquifer indicate that careful monitoring and farming practices may be required for this aquifer to be a good source of supplemental irrigation water to the Castroville area (Ares, 1982, p. 2; Bruce LaClergue, Monterey County Flood Control and Water Conservation District, written commun., 1988).

## Ground-Water-Level Networks

### Objectives

Generalized management and network objectives (table 1) for ground-water levels include (1) determination of regional water-level conditions to establish temporal and spatial trends; (2) identification of ground-water pumpage and recharge sources; and (3) determination of storage capacities and best management practices for preventing overdraft and saltwater intrusion.

The objectives for ground-water level networks (table 3) include the need for information on pumpage (ground-water use) as an indication of outflow from the region's aquifers. For ideal water-use efficiency, pumpage would be metered with permanently installed and routinely maintained flow-totalizing meters on each well. In the absence of flow meter data, ground-water withdrawals can be estimated in different ways. Unless the method used is specified, the results may not be comparable. For example, outflow could be determined from the correlation between electrical-use records and the approximate pumpage volume allowed by that electricity, or it could be determined from the approximate applications of water necessary for the production of specific crop types (M.J. Johnson, U.S. Geological Survey, oral commun., 1984). Depending on the assumptions made for the computation, significant differences can result. For example, outflow estimates can differ, depending on whether a high or low estimate of crop utilization of water is used. Similarly, if pumpage estimates are based on electrical usage, corrections made in the meter readings for other possible electrical uses may change outflow estimates significantly. In both cases, calculations of annual trends must be based on comparable periods, such as calendar years, water years, fiscal years, or rainfall years; the months included in the year used in the trend analysis must be explicit.

### Method of Evaluation

Ground-water networks may be analyzed in at least three ways: qualitatively, quantitatively, and statistically. Two examples of qualitative analysis were provided by Blankenbaker and Farrar (1981, p. 6) and Winner (1981, p. 18) where characteristics of wells were discussed and the wells are assigned subjectively to qualitative categories. Showalter and others (1984) and Templin (1984) took a quantitative approach, in which numerical ratings were assigned to monitoring wells on the basis of the availability of well-construction information. A statistical method for network analysis was proposed by Karlinger and Skrivan (1978) and implemented by Sophocleous and others (1982) using the concept of kriging, which incorporates the use of regionalized variables and semivariograms to help decide the needed number of monitoring sites to attain the desired level of accuracy. Recent (1988) development of computerized data bases that incorporate mapped information in a relational environment would have been helpful in this evaluation. A geographic information system (GIS) can simplify problems encountered with manipulating and analyzing large spatial data bases while also incorporating historic information.

The method of analysis of ground-water networks used in this report is adapted from Showalter and others (1984) and Templin (1984). First, an ideal network was developed (table 3) that would encompass all known data needs for ground-water levels in the study area. Second, existing networks were identified, and wells and networks were classified according to well-construction data. Third, changes in network density were suggested to better approximate ideal-network coverage. Although statistical analysis of well networks is desirable, an evaluation of the type done by Karlinger and Skrivan (1978) or Sophocleous and others (1982) was beyond the scope of this report. The adequacy of wells in existing monitoring networks for representing actual conditions in the ground-water basins therefore has not been established conclusively nor has the possible redundancy of information from existing networks been evaluated statistically. Despite these limitations, this report does provide a basis for assessing the adequacy of ground-water-level networks in the study area.

## Well and Network Classification

The networks operated by the Monterey County Flood Control and Water Conservation District were evaluated following an example of well and network classification established in recent work by Templin (1984). For the present report, only networks operated by the District were evaluated. Networks operated or proposed by others were provided as a source of supplemental wells that might be considered for inclusion in the the District networks.

Well classification system.--For the networks maintained by the Monterey County Flood Control and Water Conservation District, each well was classified according to the availability of data concerning its construction and lithology (table 7). The classification of each well was based on the availability of five key items of information:

1. Opening records (perforation intervals),
2. Well depth,
3. Casing record,
4. Sealing (record that a seal exists), and
5. Well-log availability.

Each well was classified according to which and how many of these five key items are available for that particular well as follows:

Class 1. All five key items are available and complete.

Class 2. The opening record is available, but any one or all of the remaining key items may be lacking or incomplete.

Class 3. The opening record is lacking, but one or more of the remaining key items is available.

Class 4. All five key items are lacking.

# TABLE 7.--*Classification of ground-water networks*

Well Classification System: The classification of wells is based on the availability of five key items of information:

1, opening records (perforation intervals)
2, well depth
3, casing record
4, sealing (record that a seal exists)
5, well-log availability

Each well was classified according to which and how many of the five key items are available for that particular well, as follows:

Class 1, all five key items are available and complete
Class 2, the opening record is available, but any one or all of the remaining key items may be lacking or incomplete
Class 3, the opening record is lacking, but one or more of the remaining key items is available
Class 4, all five key items are lacking.

Network Classification System: Each ground-water network was assigned to one of the following four classes on the basis of the relative number of class 1 and class 4 wells in the specific network. A class 1 well would be most preferred and a class 4 network would be least preferred.

Class 1, more than 50 percent of the wells in the network are class 1 wells.
Class 2, 50 percent or less of the wells in the network are class 1 wells, and less than 50 percent are class 4 wells.
Class 3, 50 percent of the wells in the network are class 1 wells, and 50 percent are class 4 wells.
Class 4, 50 percent or more of the wells in the network are class 4 wells, and less than 50 percent are class 1 wells.

| Total number of wells | Well-class distribution | | | Network class | Total number of wells | Well-class distribution | | | Network class |
|---|---|---|---|---|---|---|---|---|---|
| | Well class | Number of wells | Percent | | | Well class | Number of wells | Percent | |
| Monterey County Flood Control and Water Conservation District | | | | | | | | | |
| Autumn water-level measurements | | | | | Monthly water-level measurements | | | | |
| Network L1a. Pressure area, 180-foot aquifer | | | | | Network L2a. Pressure area, 180-foot aquifer | | | | |
| 73 | 1 | 1 | 1 | 2 | 10 | 1 | 0 | 0 | 4 |
| | 2 | 15 | 21 | | | 2 | 1 | 10 | |
| | 3 | 33 | 44 | | | 3 | 4 | 40 | |
| | 4 | 24 | 34 | | | 4 | 5 | 50 | |
| Network L1b. Pressure area, 400-foot aquifer | | | | | Network L2b. Pressure area, 400-foot aquifer | | | | |
| 70 | 1 | 27 | 39 | 2 | 12 | 1 | 5 | 42 | 2 |
| | 2 | 30 | 43 | | | 2 | 6 | 50 | |
| | 3 | 7 | 10 | | | 3 | 1 | 8 | |
| | 4 | 6 | 8 | | | 4 | 0 | 0 | |
| Network L1c. East Side area | | | | | Network L2c. East Side area | | | | |
| 81 | 1 | 2 | 3 | 2 | 16 | 1 | 0 | 0 | 2 |
| | 2 | 36 | 44 | | | 2 | 8 | 50 | |
| | 3 | 35 | 43 | | | 3 | 4 | 25 | |
| | 4 | 8 | 10 | | | 4 | 4 | 25 | |
| Network L1d. Forebay area | | | | | Network L2d. Forebay area | | | | |
| 44 | 1 | 2 | 4 | 2 | 9 | 1 | 0 | 0 | 4 |
| | 2 | 17 | 39 | | | 2 | 3 | 33 | |
| | 3 | 10 | 23 | | | 3 | 1 | 11 | |
| | 4 | 15 | 34 | | | 4 | 5 | 56 | |
| Network L1e. Pressure area, deep aquifer | | | | | Network L2e. Pressure area, deep aquifer | | | | |
| 5 | 1 | 4 | 80 | 1 | 5 | 1 | 5 | 100 | 1 |
| | 2 | 0 | 0 | | | 2 | 0 | 0 | |
| | 3 | 0 | 0 | | | 3 | 0 | 0 | |
| | 4 | 1 | 20 | | | 4 | 0 | 0 | |
| Network L1f. El Toro Creek basin | | | | | Network L2f. El Toro Creek basin | | | | |
| 32 | 1 | 11 | 34 | 2 | 6 | 1 | 3 | 50 | 2 |
| | 2 | 12 | 38 | | | 2 | 3 | 50 | |
| | 3 | 4 | 12 | | | 3 | 0 | 0 | |
| | 4 | 5 | 16 | | | 4 | 0 | 0 | |

TABLE 7.--*Classification of ground-water networks*--Continued

| Total number of wells | Well-class distribution | | | Network class |
|---|---|---|---|---|
| | Well class | Number of wells | Percent | |
| **Monterey County Flood Control and Water Conservation District August water-level measurements** | | | | |
| **Network L3a. Pressure area, 180-foot aquifer** | | | | |
| 38 | 1 | 1 | 3 | 2 |
| | 2 | 3 | 8 | |
| | 3 | 19 | 50 | |
| | 4 | 15 | 39 | |
| **Network L3b. Pressure area, 400-foot aquifer** | | | | |
| 37 | 1 | 22 | 60 | 1 |
| | 2 | 9 | 24 | |
| | 3 | 4 | 11 | |
| | 4 | 2 | 5 | |
| **Network Q1. U.S. Geological Survey[1]** | | | | |
| 5 | 1 | 1 | 20 | 2 |
| | 2 | 1 | 20 | |
| | 3 | 3 | 60 | |
| | 4 | 0 | 0 | |
| **Network Q2. U.S. Army Health Service** | | | | |
| 2 | 1 | 0 | 0 | 4 |
| | 2 | 0 | 0 | |
| | 3 | 0 | 0 | |
| | 4 | 2 | 100 | |
| **Network Q3a. Monterey County Flood Control and Water Conservation District Summer network, monthly analyses (May-Sept.)** | | | | |
| 52 | 1 | 16 | 31 | 2 |
| | 2 | 15 | 29 | |
| | 3 | 12 | 23 | |
| | 4 | 9 | 17 | |
| **Network Q3b. Monterey County Flood Control and Water Conservation District Summer network, annual analyses** | | | | |
| 366 | 1 | 63 | 17 | 2 |
| | 2 | 131 | 36 | |
| | 3 | 102 | 28 | |
| | 4 | 70 | 19 | |

| Total number of wells | Well-class distribution | | | Network class |
|---|---|---|---|---|
| | Well class | Number of wells | Percent | |
| **Network Q4. California Department of Health Services** | | | | |
| 30 | 1 | 9 | 30 | 2 |
| | 2 | 11 | 37 | |
| | 3 | 1 | 3 | |
| | 4 | 9 | 30 | |
| **Network Q5. Monterey County Department of Environmental Health** | | | | |
| 19 | 1 | 10 | 53 | 1 |
| | 2 | 6 | 32 | |
| | 3 | 2 | 10 | |
| | 4 | 1 | 5 | |
| **Network Q6. California Regional Water Quality Control Board, Central Coast Region** | | | | |
| 17 | 1 | 2 | 12 | 4 |
| | 2 | 2 | 12 | |
| | 3 | 4 | 23 | |
| | 4 | 9 | 53 | |
| **Network Q7. California Water Service Company** | | | | |
| 25 | 1 | 20 | 80 | 1 |
| | 2 | 2 | 8 | |
| | 3 | 0 | 0 | |
| | 4 | 3 | 12 | |
| **Network Q8. Showalter and others (1984)** | | | | |
| 131 | 1 | 29 | 22 | 2 |
| | 2 | 47 | 36 | |
| | 3 | 13 | 10 | |
| | 4 | 42 | 32 | |
| **Network Q9. Burau and others (1981) Monterey Basin Pilot Monitoring Project** | | | | |
| 63 | 1 | 23 | 37 | 2 |
| | 2 | 21 | 33 | |
| | 3 | 2 | 3 | |
| | 4 | 16 | 27 | |

[1]No wells were sampled as of 1987 by the U.S. Geological Survey (Gail Keeter, U.S. Geological Survey, oral commun., 1987).

The accuracy of this method of classification relies on drillers' logs and other sources of data. Improvements in the information used also can improve the results of this method. Therefore, if drillers accurately fill out the State-required log when wells are drilled, that source of data and the quality of subsequent ground-water data is more reliable.

Network classification system.--Each of the five ground-water networks maintained by the Monterey County Flood Control and Water Conservation District was assigned to one of the following four classes according to the relative number of class 1 and class 4 wells in the network (table 7). A class 1 network is most preferred, and a class 4 network is least preferred. This classification system emphasizes use of wells having good information on their construction characteristics. This information helps the analyst know more about the data collected in these networks and the relation to the geohydrology of the area.

Class 1. More than 50 percent of the wells in the network are class 1 wells.

Class 2. 50 percent or less of the wells in the network are class 1 wells, and less than 50 percent are class 4 wells.

Class 3. 50 percent of the wells in the network are class 1 wells, and 50 percent are class 4 wells.

Class 4. 50 percent or more of the wells in the network are class 4 wells, and less than 50 percent are class 1 wells.

The objective of this classification system is to eliminate all wells from the network that are not optimal for monitoring. Information exists on all wells with class 1 designations that can help validate the data collected from them. Ideally, all wells in all networks would have class 1 designations, and the networks would contain enough wells to provide the needed information.

## Description

Three ground-water-level networks (table 8) are maintained by the Monterey County Flood Control and Water Conservation District in the northern Salinas River drainage basin: the autumn network, the monthly network, and the August network. The autumn network (table 8, networks L1a-f) is a set of wells usually measured in December or January to obtain static water-level measurements at the end of the irrigation season. The purpose of these measurements is to indicate the changes in ground-water storage during the preceding year. These changes in storage are considered the net result of all recharge and withdrawal from the individual aquifers. Wells in the autumn network are among those shown in figure 9.

## TABLE 8.--*Inventory of ground-water-level networks*

[Well class is explained in table 7. Dagger (†) indicates that area within section has been proposed for the location of a monitoring well]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| Monterey County Flood Control and Water Conservation District Autumn water-level networks [Total well count, 305] | | | | | | | |
| Network L1a. Pressure area, 180-foot aquifer [Well count, 73] | | | | | | | |
| 13S/2E-27L1 | 4 | 14S/2E-16E2 | 4 | 14S/3E-31F1 | 3 | 16S/4E-13H1 | 3 |
| 27M1 | 3 | 17A1 | 4 | 15S/2E-01Q1 | 3 | 13R2 | 2 |
| 29R1 | 4 | 21J1 | 4 | 2J1 | 4 | 15D1 | 2 |
| 33R1 | 3 | 21L1 | 4 | 12E2 | 2 | 15R2 | 2 |
| 35L1 | 3 | 22F1 | 3 | 15S/3E-09E3 | 2 | 16E1 | 3 |
| 14S/2E-03C1 | 4 | 22N1 | 3 | 13N1 | 2 | 24C1 | 3 |
| 3F1 | 3 | 22P2 | 2 | 14C1 | 3 | 25C1 | 4 |
| 3K1 | 4 | 23A1 | 3 | 16M1 | 3 | 25P1 | 3 |
| 3R1 | 4 | 23L1 | 3 | 18B1 | 3 | 27B2 | 3 |
| 4A1 | 3 | 24J1 | 3 | 18C2 | 2 | 16S/5E-19F1 | 4 |
| 4R1 | 3 | 26P1 | 3 | 22G1 | 4 | 30E1 | 4 |
| 10K1 | 3 | 27G2 | 3 | 25Q1 | 4 | 31A1 | 4 |
| 10P1 | 4 | 28H2 | 2 | 26F1 | 2 | 31M1 | 4 |
| 10R1 | 4 | 34B1 | 3 | 15S/4E-31A2 | 2 | 31Q1 | 3 |
| 11G1 | 3 | 36E1 | 3 | 16S/4E-05M2 | 2 | 32B2 | 2 |
| 13B2 | 1 | 14S/3E-19G1 | 3 | 8B1 | 4 | 32C1 | 4 |
| 14E1 | 2 | 19Q2 | 3 | 8J1 | 3 | 32E1 | 4 |
| 14L1 | 4 | 30N1 | 3 | 9A1 | 2 | 17S/4E-01D1 | 3 |
| 15G1 | 4 | | | | | | |
| Network L1b. Pressure area, 400-foot aquifer [Well count, 70] | | | | | | | |
| 13S/2E-19H1 | 2 | 13S/2E-32E3 | 2 | 14S/2E-15B1 | 1 | 15S/3E-07G1 | 3 |
| 19R1 | 1 | 32J3 | 1 | 15P1 | 2 | 8F1 | 2 |
| 20J1 | 3 | 33N3 | 3 | 17B2 | 2 | 8N3 | 2 |
| 21N1 | 1 | 14S/2E-03K2 | 1 | 26J3 | 4 | 15B1 | 2 |
| 27P1 | 2 | 3M2 | 1 | 27G3 | 1 | 16B3 | 1 |
| 29C2 | 1 | 4B1 | 2 | 34A1 | 2 | 18F1 | 2 |
| 29D3 | 1 | 4H1 | 1 | 34B3 | 2 | 18M2 | 2 |
| 29F2 | 1 | 5C2 | 2 | 35L2 | 1 | 28B1 | 4 |
| 29M2 | 1 | 5F4 | 1 | 36G1 | 2 | 15S/4E-19D2 | 2 |
| 30A1 | 1 | 5K1 | 1 | 14S/3E-18J1 | 2 | 29D1 | 3 |
| 30H1 | 4 | 5P2 | 1 | 31F2 | 2 | 29Q1 | 3 |
| 30Q2 | 2 | 6J3 | 1 | 15S/2E-01A3 | 1 | 29R1 | 2 |
| 31D2 | 1 | 7K1 | 3 | 2G1 | 2 | 16S/4E-02Q3 | 2 |
| 31G4 | 1 | 7L3 | 4 | 12A1 | 2 | 4C1 | 2 |
| 31N2 | 1 | 8C3 | 1 | 15S/3E-04K3 | 2 | 10R2 | 2 |
| 31P1 | 2 | 8M2 | 1 | 6D2 | 2 | 25G1 | 4 |
| 32A2 | 2 | 10C1 | 1 | 6K1 | 3 | 16S/5E-30J2 | 4 |
| 32C1 | 1 | 12Q1 | 2 | | | | |
| Network L1c. East Side area [Well count, 81] | | | | | | | |
| 13S/2E-36F1 | 3 | 14S/3E-10F3 | 2 | 14S/3E-24N1 | 3 | 15S/3E-13G4 | 4 |
| 13S/3E-35N1 | 2 | 10Q1 | 2 | 24R1 | 4 | 15S/4E-05C1 | 2 |
| 14S/3E-02E3 | 3 | 10R2 | 2 | 25L1 | 3 | 5M1 | 3 |
| 3K1 | 3 | 11H1 | 2 | 25L2 | 2 | 6R1 | 2 |
| 4E1 | 3 | 12E1 | 2 | 27G2 | 3 | 7A1 | 2 |
| 4N1 | 3 | 14C1 | 3 | 36A1 | 3 | 7R1 | 3 |
| 4Q1 | 4 | 14N1 | 3 | 36P2 | 2 | 8C1 | 3 |
| 5B2 | 3 | 15C1 | 3 | 14S/4E-30N1 | 2 | 8L1 | 3 |
| 6L1 | 3 | 15H3 | 2 | 30R1 | 3 | 8N1 | 3 |
| 6L2 | 2 | 16D1 | 3 | 31F1 | 3 | 8Q1 | 3 |
| 6R1 | 3 | 16E1 | 2 | 15S/3E-02Q1 | 3 | 9D1 | 3 |
| 7A1 | 2 | 22A1 | 2 | 12E2 | 2 | 9J1 | 3 |
| 8C1 | 3 | 24H1 | 2 | 12F2 | 2 | 9M1 | 2 |

TABLE 8.--*Inventory of ground-water-level networks*--Continued

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| Monterey County Flood Control and Water Conservation District--Continued<br>Autumn water-level networks--Continued | | | | | | | |
| Network L1c. East Side area--Continued | | | | | | | |
| 15S/4E-14N1 | 2 | 15S/4E-21L2 | 3 | 15S/4E-36P1 | 4 | 16S/5E-17R1 | 2 |
| 15D2 | 1 | 22L2 | 3 | 36R2 | 2 | 20G2 | 3 |
| 15P2 | 4 | 24N3 | 2 | 16S/4E-01L1 | 1 | 20R1 | 2 |
| 16D1 | 3 | 27G1 | 3 | 16S/5E-05N1 | 2 | 21R1 | 3 |
| 16E2 | 3 | 33A1 | 2 | 7G1 | 2 | 27Q1 | 4 |
| 17P2 | 2 | 34L1 | 2 | 8Q1 | 4 | 28D1 | 2 |
| 20B2 | 2 | 36H1 | 2 | 17P1 | 2 | 28P1 | 4 |
| 21F4 | 2 | | | | | | |
| Network L1d. Forebay area<br>[Well count, 44] | | | | | | | |
| 16S/5E-32H2 | 2 | 17S/5E-6Q1 | 2 | 17S/5E-36F2 | 2 | 17S/6E-29K1 | 3 |
| 32M1 | 3 | 8L1 | 3 | 36J1 | 4 | 29Q1 | 2 |
| 33Q1 | 3 | 9R1 | 3 | 17S/6E-16N1 | 2 | 30F1 | 3 |
| 17S/5E-01Q1 | 1 | 10Q1 | 2 | 18G1 | 2 | 34E1 | 4 |
| 2N2 | 2 | 12E1 | 1 | 19D1 | 3 | 35F1 | 4 |
| 2N4 | 4 | 13E1 | 4 | 20E2 | 2 | 18S/6E-05R2 | 4 |
| 3L1 | 2 | 14D1 | 4 | 27E3 | 2 | 6M1 | 4 |
| 4K1 | 4 | 21A1 | 2 | 27K1 | 4 | 7A1 | 4 |
| 4N1 | 2 | 24G1 | 4 | 28B1 | 4 | 8R1 | 4 |
| 4R1 | 2 | 25L1 | 3 | 28K1 | 3 | 9M1 | 3 |
| 5G1 | 4 | 27A1 | 2 | 29C1 | 2 | 9M2 | 2 |
| Network L1e. Pressure area, deep aquifer<br>[Well count, 5] | | | | | | | |
| 13S/1E-36J1 | 1 | 13S/2E-32E5 | 1 | 14S/2E-06L1 | 1 | 14S/2E-18E1 | 4 |
| 13S/2E-19Q3 | 1 | | | | | | |
| Network L1f. El Toro Creek basin<br>[Well count, 32] | | | | | | | |
| Corral de Tierra | | | | | | | |
| 16S/2E-03A1 | 2 | 16S/2E-04L1 | 1 | 16S/2E-10Q1 | 2 | 16S/2E-23H1 | 4 |
| 3G1 | 1 | 9H1 | 4 | 10Q2 | 4 | 24C1 | 3 |
| 3H1 | 2 | 9J1 | 1 | 15F2 | 2 | 16S/3E-17N1 | 2 |
| 3J1 | 3 | 10B1 | 2 | 15J1 | 2 | 19L1 | 4 |
| 4H1 | 1 | 10H1 | 2 | 15P1 | 2 | 19L2 | 4 |
| San Benancio | | | | | | | |
| 16S/2E-01E1 | 2 | 16S/2E-02D1 | 1 | 16S/2E-02D5 | 1 | 16S/3E-07L1 | 2 |
| 1L1 | 1 | 2D2 | 2 | 2G1 | 1 | 7N1 | 1 |
| 1M1 | 1 | 2D3 | 3 | 2H1 | 1 | 17F2 | 3 |
| Monterey County Flood Control and Water Conservation District<br>Monthly water-level networks<br>[Well count 58] | | | | | | | |
| Network L2a. Pressure area, 180-foot aquifer<br>[Well count, 10] | | | | | | | |
| 13S/2E-33R1 | 3 | 14S/3E-31F1 | 3 | 15S/3E-07C1 | 2 | 15S/3E-25Q1 | 4 |
| 14S/2E-03R1 | 4 | 15S/2E-01Q1 | 3 | 16M1 | 3 | 16S/5E-30E1 | 4 |
| 14L1 | 4 | 2J1 | 4 | | | | |
| Network L2b. Pressure area, 400-foot aquifer<br>[Well count, 12] | | | | | | | |
| 13S/2E-21N1 | 1 | 13S/2E-32A2 | 2 | 14S/2E-34A1 | 2 | 15S/3E-16B3 | 1 |
| 30A1 | 1 | 14S/2E-08M2 | 1 | 14S/3E-18J1 | 2 | 15S/4E-29Q1 | 3 |
| 31N2 | 1 | 12Q1 | 2 | 31F2 | 2 | 16S/4E-10R2 | 2 |

TABLE 8.--*Inventory of ground-water-level networks*--Continued

Monterey County Flood Control and Water Conservation District--Continued
Monthly water-level networks--Continued

Network L2c. East Side area
[Well count, 16]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 14S/3E-06R1 | 3 | 14S/3E-25L2 | 2 | 15S/4E-07R2 | 2 | 16S/5E-08Q1 | 4 |
| 9F3 | 2 | 15S/3E-12E2 | 2 | 21L2 | 3 | 20R1 | 2 |
| 15H3 | 2 | 15S/4E-06R1 | 2 | 22L2 | 3 | 27Q1 | 4 |
| 24R1 | 4 | 7R1 | 3 | 36P1 | 4 | 28D1 | 2 |

Network L2d. Forebay area
[Well count, 9]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 17S/5E-02N4 | 4 | 17S/5E-36J1 | 4 | 17S/6E-19D1 | 3 | 18S/6E-02N1 | 2 |
| 3L1 | 2 | 17S/6E-16N1 | 2 | 28B1 | 4 | 6M1 | 4 |
| 5G1 | 4 | | | | | | |

Network L2e. Pressure area, deep aquifer
[Well count, 5]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 13S/1E-36J1 | 1 | 13S/2E-31A2 | 1 | 13S/2E-32E5 | 1 | 14S/2E-06L1 | 1 |
| 13S/2E-19Q3 | 1 | | | | | | |

Network L2f. El Toro Creek basin
[Well count, 6]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 16S/2E-02D1 | 1 | 16S/2E-02H1 | 1 | 16S/2E-15J1 | 2 | 16S/2E-17N1 | 2 |
| 2G1 | 1 | 10Q1 | 2 | | | | |

Monterey County Flood Control and Water Conservation District
August water-level networks
[Total well count, 75]

Network L3a. Pressure area, 180-foot aquifer
[Well count, 38]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 13S/2E-27L1 | 4 | 14S/2E-04A1 | 3 | 14S/2E-15H1 | 4 | 14S/2E-34B1 | 3 |
| 27M1 | 4 | 4R1 | 3 | 16E2 | 4 | 36E1 | 3 |
| 28L2 | 2 | 10K1 | 3 | 17A1 | 4 | 14S/3E-19G1 | 3 |
| 33R1 | 3 | 10P1 | 4 | 21J1 | 4 | 19Q2 | 3 |
| 35L1 | 3 | 10R1 | 4 | 22F1 | 3 | 30N1 | 3 |
| 14S/2E-03C1 | 4 | 11G1 | 3 | 22P2 | 2 | 31F1 | 3 |
| 3F1 | 3 | 13B2 | 1 | 23A1 | 3 | 15S/2E-01Q1 | 3 |
| 3K1 | 4 | 14E1 | 2 | 24J1 | 3 | 2J1 | 4 |
| 3L1 | 4 | 14L1 | 4 | 26P1 | 3 | | |
| 3R1 | 4 | 15G1 | 4 | 27G2 | 3 | | |

Network L3b. Pressure area, 400-foot aquifer
[Well count, 37]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 13S/2E-19H1 | 2 | 13S/2E-31G4 | 1 | 14S/2E-04B1 | 2 | 14S/2E-10C1 | 1 |
| 19R1 | 1 | 31N2 | 1 | 4H1 | 1 | 15A1 | 1 |
| 20J1 | 3 | 31P1 | 2 | 5C2 | 2 | 15P1 | 2 |
| 21N1 | 1 | 32A2 | 2 | 5F4 | 1 | 17B2 | 2 |
| 26L1 | 3 | 32J3 | 1 | 5K1 | 1 | 26J3 | 4 |
| 29C2 | 1 | 33N3 | 3 | 5P2 | 1 | 34A1 | 2 |
| 29F2 | 1 | 34G1 | 1 | 6J3 | 1 | 15S/3E-06D2 | 2 |
| 30A1 | 1 | 34M1 | 1 | 7K1 | 3 | | |
| 30H1 | 4 | 14S/2E-03K2 | 1 | 8C3 | 1 | | |
| 31D2 | 1 | 3M2 | 1 | 8M2 | 1 | | |

Network L4. U.S. Geological Survey stream channel/aquifer
response network[1]
[Well count, 5]

| Well No. | Well class | Well No. | Well class | Well No. | Well class | Well No. | Well class |
|---|---|---|---|---|---|---|---|
| 17S/5E-23F† | (H1) | 17S/5E-23F | (H3D) | 17S/5E-23F | (H4) | 17S/5E-23F | (H5) |
| -23F | (H2S) | | | | | | |

[1] Monthly water levels, January through September 1985. No wells active since 1985 (Lawrence F. Trujillo, U.S. Geological Survey, oral commun., 1987).

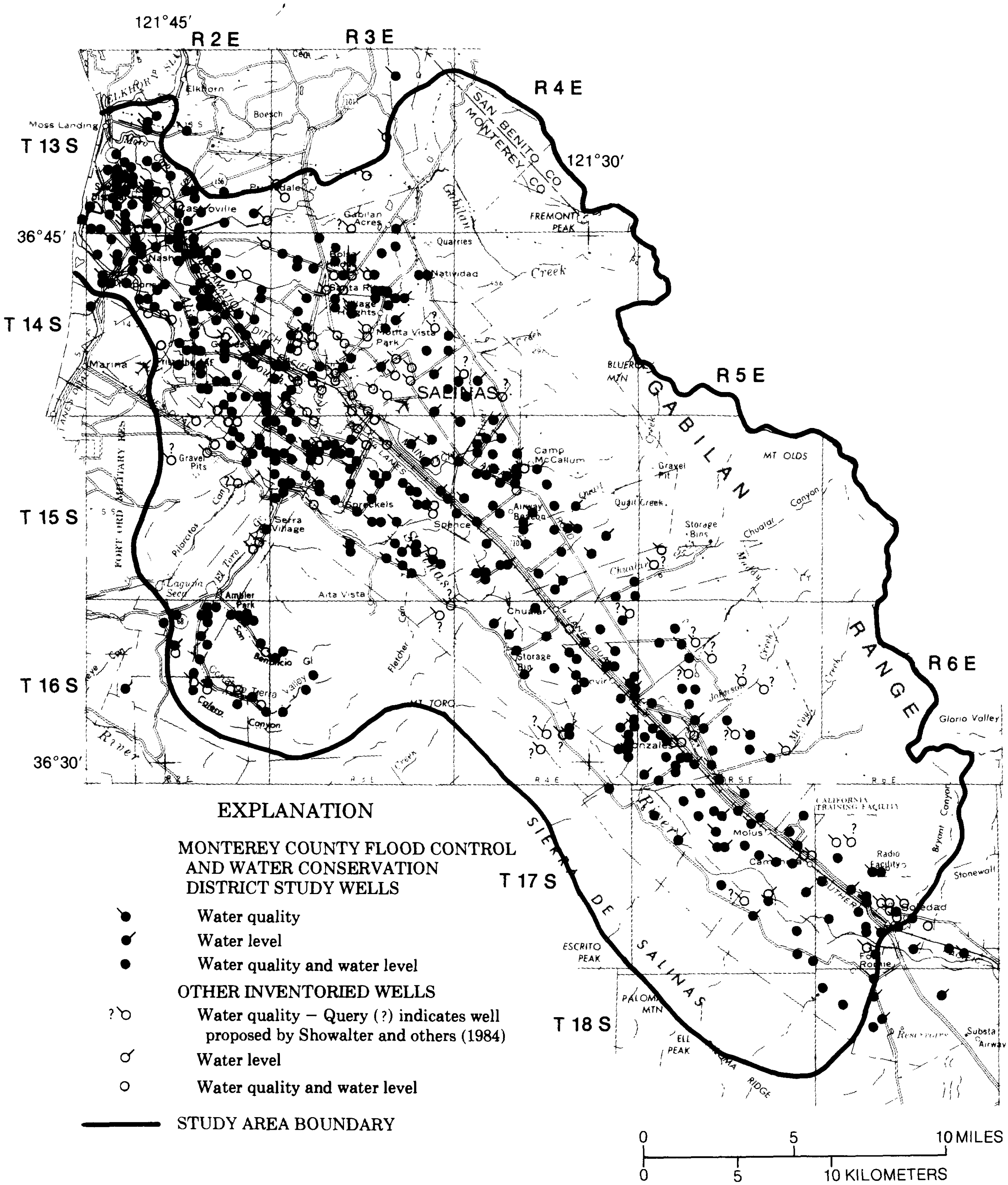



**FIGURE 9.—Ground-water monitoring wells.**

The monthly network (table 8, networks L2a-f) consists of key wells measured throughout the year to determine the variations in ground-water levels. The changes in the water levels of wells in each ground-water basin are averaged, graphed, and compared with previous years to indicate trends (Monterey County Flood Control and Water Conservation District, 1977, p. 40-41). It is not always possible to obtain static water-level measurements for every well each month because of the heavy use of wells for irrigation for long periods of time. Missing measurements, therefore, are estimated from known well characteristics and from measurements of nearby wells. Wells in the monthly network are among those shown in figure 9. These water levels need to be closely monitored soon after their collection to provide timely information for use in water-resources management, but staffing limitations have often prevented proper monitoring of the data in Monterey County.

The August network (table 8, networks L3a-b) consists of wells near the coast which are measured annually to determine the location and extent of ground-water troughs during the peak irrigation period. These troughs occur near the mouth of the Pajaro River and west of Salinas in the Pressure-area aquifers. According to Monterey County Flood Control and Water Conservation District (1977), the troughs result from ground-water withdrawal in excess of recharge. The "August troughs" develop when "the water level in wells falls below sea level and water flows both from the direction of the ocean and from inland to fill the trough" (Monterey County Flood Control and Water Conservation District, 1977, p. 3). The location and depth of the troughs indicate the potential landward intrusion of saltwater from the ocean. The troughs vary in position and depth from year to year because of changes in pumping and recharge conditions. Wells in the August network are among those shown in figure 9. Besides the three District networks, the only other ground-water-level monitoring network identified was operated by the U.S. Geological Survey. Of the five wells that have been measured historically, none are currently measured (table 8, network L4).

## Possible Additional Monitoring

Currently, water levels in 318 wells are being measured by the Monterey County Flood Control and Water Conservation District in the study area. The addition of the five wells installed by the U.S. Geological Survey could be beneficial to the understanding of ground-water and surface-water relations along the Salinas River. This study identified 128 sections (table 9) (each section is 1 $mi^2$) where no water levels currently are being measured. The addition of wells in these areas to create an evenly spaced monitoring grid would provide valuable data for use in subsequent analyses of the adequacy of the ground-water-level networks. An inventory of wells operating in these areas would determine if existing wells could be used or if wells need to be drilled specifically for water-level monitoring.

TABLE 9.--*Network locations that presently do not have water-level wells monitored by the Monterey County Flood Control and Water Conservation District*

| Township/ Range | Section |
|---|---|
| T13S/R2E | 16,17,18 |
| T13S/R3E | 30,31,32,33,34 |
| T14S/R2E | 1,2,25,33 |
| T14S/R3E | 1,13,17,20,21,23,26,28,29,32,33, 34,35 |
| T14S/R4E | 32 |
| T15S/R2E | 3,4,9,10,11,13,14,24,25,26,34,35,36 |
| T15S/R3E | 1,3,5,10,11,17,19,20,21,23,24,27,33, 34,35,36 |
| T15S/R4E | 4,18,23,25,26,28,30,32,35 |
| T15S/R5E | 31 |
| T16S/R2E | 12,14,22 |
| T16S/R3E | 8,18 |
| T16S/R4E | 3,6,11,12,14,22,23,26,28 |
| T16S/R5E | 6,9,14,15,16,18,22,23,26,29,34,36 |
| T17S/R4E | 2,3,10,11,12,13,14,23,24,25,26,36 |
| T17S/R5E | 7,11,15,16,23,26 |
| T17S/R6E | 7,8,17,21,22,31,32 |
| T18S/R5E | 1,2,3,4,5,9,10,11,12,13,14 |
| T18S/R6E | 18 |

The well coverage in saltwater-intrusion areas near Castroville is denser than in other parts of the study area. In the saltwater-intrusion areas, continuous water-level recorders might be installed in a few of the currently monitored wells, and the remaining wells could be measured monthly until a correlation could be established between the monthly measurements and the continuous records. Wells in the rest of the study area are distributed more sparsely, but they are concentrated down the center of the drainage in the alluvial ground-water basin. To provide an even spatial distribution of each network in the study area, wells could be identified that are in sections that currently do not have water-level monitoring wells (table 9).

All available data from monitoring networks should be entered into a computer data-base management system. This would allow easier (and less manpower intensive) statistical analysis for extracting additional needed information. Analysis of variance, cluster analysis, and other statistical applications, as well as the newest in geographic information system technologies, are readily available as software packages that usually are maintained on computers as tools for analyzing data. In addition, mechanical plotting of all wells from a computer file for each specific network objective within each basin or study area could provide spatial analyses that are often too time consuming and costly to be done routinely by hand.

The installation of continuous recorders at key wells could help to determine representative hydrographs for the various regions to ensure that measurements are timed appropriately to provide the highest priority data. Once the typical hydrograph for each region is determined, the measurement frequency may be reduced to semiannually or quarterly as long as the key wells are reinstalled with continuous recorders periodically to reconfirm their representativeness. For ground-water modeling uses, the highest priority water-level data are the measurements of the static levels midway between the highs and lows; these static levels usually occur in November (T.J. Durbin, U.S. Geological Survey, oral commun., 1984). Second priority are the summer low and winter high water levels, which may occur in September and March or April, respectively. Third priority is the midpoint in the declining hydrograph, which may occur in May. At least one continuously recorded well in each region within each aquifer would be needed to determine when these measurements should be made.

Measurement of wells during peak pumping periods can be difficult. At the time of measurement, many of the wells may be pumping or may have recently ceased pumping, and so accurate water-level measurement is difficult to obtain. The current practice is to make estimates of the water level at these wells on the basis of historic information on the water levels at that well in comparison with other nearby wells. Thorough study of each well in each network could determine whether the water-level measurements from a well are accurate enough for network use or whether an observation well should be installed nearby and used instead.

## Ground-Water-Quality Networks

### Objectives

The generalized management objectives for ground-water quality (table 1) include (1) determination of the regional ambient water-quality conditions to establish spatial and temporal trends; and (2) identification of ground-water use and potential sources of contamination to minimize contaminant buildup, reduce and eliminate sources of contamination, prevent additional contamination, and improve degraded water-quality conditions whenever possible.

The highest-priority network goals (table 3) include determining (1) a ground-water-quality baseline, (2) distribution of nitrates in probable problem areas, (3) effects of ground-water quality on surface-water quality, and (4) effects of geology and land use in tributary areas on major-basin ground-water quality. Following the examples of Showalter and others (1984) and Templin (1984), the information summarized in table 3 has been used to develop an ideal-network coverage for the study area. Suggestions for improving network coverage derive from this ideal conception.

Land use, geology, contamination sources, ground-water levels, and ground-water quality also should be considered in establishing ground-water-quality monitoring networks. For a network monitoring ambient conditions, the types of land use may affect the results of the ground-water-quality samples. For this reason, unless ambient ground-water conditions are uniformly affected by a specific land use within an area, specific wells showing effects of land use should be avoided in a baseline network. Such wells should be included in a separate network measuring the effects of point and regional contamination sources (table 3, networks C2f-g).

Existing data on geology, historic ground-water levels, and ground-water quality are important in identifying sources of naturally occurring minerals and trace elements, aquifers, direction of ground-water flow, and known distribution of specific water constituents. Identifying the locations of presently known and potential sources of contamination (fig. 3) is important in establishing a ground-water-quality monitoring network because such areas may affect ambient conditions. For example, a well selected to monitor baseline conditions probably should not be influenced by a known contamination source other than a natural source.

The goal for the ideal baseline network would be to form a spatially consistent grid of wells covering all basins with a density of one representative well per section (table 3); this regional network would be monitored quarterly until a baseline is established, and then wells representative of larger areas could be monitored at least annually to maintain the reliability of the network. The ideal nitrate network would consist of a grid of wells around locally concentrated septic-tank and other points and regional contamination areas in the Salinas River drainage basin. Sampling for a number of constituents and water levels would take place monthly. Line-source networks would be established on an as-needed basis in all basins in order to better characterize the linear effects of (1) ground-water quality on surface water and (2) surface-water quality of tributary area on regional ground-water quality. These networks would sample a number of constituents on a monthly basis; they also would work in conjunction with other networks continuously monitoring water levels and pumpage in order to determine the effects of line sources on ground-water and surface-water quality. Besides these highest priority networks, other ideal networks include baseline monitoring for organics in ground water, for regional and cumulative effects of point and nonpoint sources of contamination, and for natural and artificial sources of radioactive and other substances.

## Description

The ground-water-quality networks identified for this report are inventoried in table 10. In addition to the monitoring by the Monterey County Flood Control and Water Conservation District (network Q3), the following agencies also collect ground-water-quality data in the study area: the U.S. Geological Survey (network Q1); the U.S. Army Health Service, Fort Ord, California (network Q2); the California Department of Health Services (network Q4); the Monterey County Department of Environmental Health (network Q5); the California Regional Water Quality Control Board (network Q6); and the California Water Service Company (network Q7). The networks proposed by Showalter and others (1984) (network Q8) and Burau and others (1981) (network Q9) also were included in table 10 for informational purposes. The compilation of networks and wells in tables 7, 8, 10, and 11 still may not include all the monitoring that is now active in the study area. The inclusion of these networks is intended to provide an initial point from which to progress in understanding the full extent of the active data collection. The extent of monitoring, overlap in monitoring, and the need for close coordination also is illustrated. The information collected by the California Regional Water Quality Control Board and the various public-supply networks should be incorporated into the data base maintained by Monterey County.

## TABLE 10.--*Inventory of ground-water-quality monitoring networks*

[Complete well number is given where available. Dagger (†) indicates that area within section has been proposed for the location of a monitoring well. An inspection of well log files and a field canvass are needed to determine if suitable wells exist in these locations. Networks identified by C.D. Farrar and F.M. Glenn (U.S. Geological Survey, written commun., 1980) or suggested by Showalter and others (1984). Networks from Farrar and Glenn were grouped in this report to condense all wells monitored by an agency as one network. Monitoring column abbreviations indicate the type of analysis that was being done at that well in 1980 and the reason for monitoring the well. Information on monitoring types and reasons was modified from Farrar and Glenn. Operating agency code is shown in parentheses following network name]

Monitoring type:
- B, common chemical
- C, trace elements (such as selenium)
- D, pesticides
- HM, heavy metals (such as arsenic, cadmium, lead, mercury, zinc)
- I, combination of common chemical and trace elements
- M, all or most of physical, common chemical, trace elements, and sanitary
- N, nitrates
- P, combination of physical, common chemical, and trace elements
- Z, other, not known

Monitoring reason:
- 1, public supply
- 2, base line data
- 3, saltwater intrusion
- 4, ground-water flow tracing
- 5, known contaminated
- 6, wastewater injection
- 7, SW/GW relations
- 8, nearby feed lot
- 9, nearby radioactive source
- 10, agricultural area
- 11, required by law
- 12, known dischargers
- 13, migration between aquifers

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Q1. U.S. Geological Survey (5000)[1] [Total well count, 5] | | | | | | | | | | | |
| 13S/2E-29M2 | 1 | B | 2 | 14S/3E-18J1 | 2 | B | 2 | 16S/5E-17R1 | 3 | B | 2 |
| 33R1 | 3 | B | 2 | 15S/2E-01Q1 | 3 | B | 2 | | | | |
| Network Q2. U.S. Army Health Service (USAHS) [Total well count, 2] | | | | | | | | | | | |
| 15S/2E-02N1 | 4 | M | 1 | 15S/2E-10A1 | 4 | M | 1 | | | | |
| Network Q3a. Monterey County Flood Control and Water Conservation District (5115) Summer network, monthly analyses (May-Sept.) [Total well count, 52] | | | | | | | | | | | |
| Pressure area, 180-foot aquifer [Well count, 9] | | | | | | | | | | | |
| 13S/2E-33R1 | 3 | B | 3 | 14S/2E-14L1 | 4 | B | 3 | 15S/2E-01Q1 | 3 | B | 3 |
| 14S/2E-03R1 | 4 | B | 3 | 16E2 | 4 | B | 3 | 2J1 | 4 | B | 3 |
| 10R1 | 4 | B | 3 | 14S/3E-31F1 | 3 | B | 3 | 15S/3E-16M1 | 3 | B | 3 |
| Pressure area, 400-foot aquifer [Well count, 27] | | | | | | | | | | | |
| 13S/2E-20J1 | 3 | B | 3 | 13S/2E-30J1 | 4 | B | 3 | 13S/2E-32N1 | 1 | B | 3 |
| 20M2 | 1 | B | 3 | 31D2 | 1 | B | 3 | 14S/2E-08M2 | 1 | B | 3 |
| 20P2 | 1 | B | 3 | 31N2 | 1 | B | 3 | 12Q1 | 2 | B | 3 |
| 21N1 | 1 | B | 3 | 31P1 | 2 | B | 3 | 34A1 | 2 | B | 3 |
| 29C2 | 1 | B | 3 | 32A1 | 3 | B | 3 | 14S/3E-18J1 | 2 | B | 3 |
| 29C4 | 1 | B | 3 | 32A2 | 2 | B | 3 | 31F2 | 2 | B | 3 |
| 29D3 | 1 | B | 3 | 32C1 | 1 | B | 3 | 15S/3E-16B3 | 1 | B | 3 |
| 29F2 | 1 | B | 3 | 32E3 | 2 | B | 3 | 15S/4E-29Q1 | 3 | B | 3 |
| 30H1 | 4 | B | 3 | 32J3 | 1 | B | 3 | 16S/4E-10R2 | 2 | B | 3 |
| East Side area [Well count, 10] | | | | | | | | | | | |
| 14S/3E-06R1 | 3 | B | 3 | 15S/3E-12E2 | 2 | B | 3 | 15S/4E-22L2 | 3 | B | 3 |
| 15H3 | 2 | B | 3 | 15S/4E-06R1 | 2 | B | 3 | 16S/5E-21R1 | 3 | B | 3 |
| 24R1 | 4 | B | 3 | 7R1 | 3 | B | 3 | 28D1 | 2 | B | 3 |
| 25L2 | 2 | B | 3 | | | | | | | | |

See footnotes at end of table.

TABLE 10.--*Inventory of ground-water-quality monitoring networks*--Continued

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Q3a. Monterey Flood Control and Water Conservation District (5115)--Continued | | | | | | | | | | | |
| Forebay area [Well count, 2] | | | | | | | | | | | |
| 17S/6E-16N1 | 2 | B | 3 | 17S/6E-19D1 | 3 | B | 3 | | | | |
| Pressure area, deep aquifer [Well count, 2] | | | | | | | | | | | |
| 13S/2E-19Q3 | 1 | B | 3 | 14S/2E-06L1 | 1 | B | 3 | | | | |
| El Toro Creek basin [Well count, 2] | | | | | | | | | | | |
| 13S/2E-17H3 | 4 | B | 3 | 13S/2E-17J1 | 2 | B | 3 | | | | |
| Network Q3b. Monterey Flood Control and Water Conservation District (5115) Summer network, annual analyses [Total well count, 366] | | | | | | | | | | | |
| Pressure area, 180-foot aquifer [Well count, 107] | | | | | | | | | | | |
| 13S/2E-28M1 | 3 | B | 2 | 14S/3E-29L4 | 1 | B | 2 | 15S/3E-21A1 | 2 | B | 2 |
| 29H1 | 1 | B | 2 | 30E1 | 3 | B | 2 | 22F1 | 3 | B | 2 |
| 29R1 | 4 | B | 2 | 30F1 | 4 | B | 2 | 22G1 | 4 | B | 2 |
| 33R1 | 3 | B | 2 | 30F2 | 2 | B | 2 | 23E1 | 3 | B | 2 |
| 35L1 | 3 | B | 2 | 30N1 | 3 | B | 2 | 25L1 | 2 | B | 2 |
| 14S/2E-02M1 | 4 | B | 2 | 31B1 | 3 | B | 2 | 25Q1 | 4 | B | 2 |
| 3F1 | 3 | B | 2 | 31F1 | 3 | B | 2 | 26D1 | 4 | B | 2 |
| 3R1 | 4 | B | 2 | 15S/2E-01K1 | 3 | B | 2 | 26H2 | 2 | B | 2 |
| 10R1 | 4 | B | 2 | 2Q1 | 3 | B | 2 | 28G1 | 1 | B | 2 |
| 11D1 | 3 | B | 2 | 12C1 | 3 | B | 2 | 35B5 | 2 | B | 2 |
| 11G1 | 3 | B | 2 | 12E2 | 2 | B | 2 | 15S/4E-32D2 | 2 | B | 2 |
| 13B2 | 1 | B | 2 | 15S/3E-05N1 | 4 | B | 2 | 32E1 | 4 | B | 2 |
| 13P1 | 2 | B | 2 | 5R1 | 3 | B | 2 | 16S/4E-08J1 | 3 | B | 2 |
| 14J1 | 4 | B | 2 | 6A3 | 4 | B | 2 | 9A1 | 2 | B | 2 |
| 14N2 | 2 | B | 2 | 7E1 | 4 | B | 2 | 13K1 | 2 | B | 2 |
| 21J1 | 4 | B | 2 | 7N1 | 3 | B | 2 | 14A1 | 4 | B | 2 |
| 22F1 | 3 | B | 2 | 8C1 | 3 | B | 2 | 15D1 | 2 | B | 2 |
| 22N1 | 3 | B | 2 | 9B1 | 3 | B | 2 | 15H2 | 2 | B | 2 |
| 22P2 | 2 | B | 2 | 9C1 | 4 | B | 2 | 24A1 | 1 | B | 2 |
| 22Q1 | 4 | B | 2 | 9H1 | 3 | B | 2 | 25K1 | 1 | B | 2 |
| 23A1 | 3 | B | 2 | 9H2 | 3 | B | 2 | 25Q1 | 3 | B | 2 |
| 23P1 | 3 | B | 2 | 9K1 | 3 | B | 2 | 27G1 | 3 | B | 2 |
| 24J1 | 3 | B | 2 | 10P1 | 3 | B | 2 | 36B1 | 3 | B | 2 |
| 24Q1 | 3 | B | 2 | 10P3 | 3 | B | 2 | 16S/5E-19F1 | 4 | B | 2 |
| 25F1 | 3 | B | 2 | 10R2 | 3 | B | 2 | 19R1 | 3 | B | 2 |
| 26C1 | 3 | B | 2 | 13N1 | 2 | B | 2 | 30C1 | 3 | B | 2 |
| 26N3 | 2 | B | 2 | 14C1 | 3 | B | 2 | 30E1 | 4 | B | 2 |
| 26P1 | 3 | B | 2 | 14G1 | 3 | B | 2 | 30G1 | 3 | B | 2 |
| 27K1 | 1 | B | 2 | 14H1 | 2 | B | 2 | 31A1 | 4 | B | 2 |
| 35G1 | 3 | B | 2 | 14R1 | 3 | B | 2 | 31Q1 | 3 | B | 2 |
| 35Q1 | 4 | B | 2 | 15L1 | 3 | B | 2 | 32B2 | 2 | B | 2 |
| 36E1 | 3 | B | 2 | 16M1 | 3 | B | 2 | 32C1 | 4 | B | 2 |
| 36H1 | 4 | B | 2 | 17B1 | 3 | B | 2 | 32E1 | 4 | B | 2 |
| 36R1 | 4 | B | 2 | 17B2 | 4 | B | 2 | 32M1 | 3 | B | 2 |
| 14S/3E-19Q2 | 3 | B | 2 | 17G1 | 3 | B | 2 | 17S/4E-01D1 | 3 | B | 2 |
| 29G2 | 1 | B | 2 | 18B1 | 3 | B | 2 | | | | |

TABLE 10.--*Inventory of ground-water-quality monitoring networks*--Continued

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Q3b. Monterey Flood Control and Water Conservation District (5115)--Continued | | | | | | | | | | | |
| Pressure area, 400-foot aquifer [Well count, 98] | | | | | | | | | | | |
| 13S/2E-20J1 | 3 | B | 2 | 14S/2E-06B1 | 4 | B | 2 | 15S/2E-01A3 | 1 | B | 2 |
| 27L1 | 4 | B | 2 | 6J3 | 1 | B | 2 | 2G1 | 2 | B | 2 |
| 27M1 | 3 | B | 2 | 6R2 | 1 | B | 2 | 12A1 | 2 | B | 2 |
| 27P1 | 2 | B | 2 | 7F2 | 1 | B | 2 | 15S/3E-04K3 | 2 | B | 2 |
| 28B1 | 1 | B | 2 | 7K1 | 3 | B | 2 | 4N3 | 2 | B | 2 |
| 29C2 | 1 | B | 2 | 8A1 | 1 | B | 2 | 6D2 | 2 | B | 2 |
| 29C4 | 1 | B | 2 | 8C3 | 1 | B | 2 | 6F2 | 1 | B | 2 |
| 29D3 | 1 | B | 2 | 8M2 | 1 | B | 2 | 6K1 | 3 | B | 2 |
| 29F2 | 1 | B | 2 | 9L2 | 1 | B | 2 | 7D2 | 3 | B | 2 |
| 29J1 | 2 | B | 2 | 9N1 | 1 | B | 2 | 7G1 | 3 | B | 2 |
| 29M2 | 1 | B | 2 | 10C1 | 1 | B | 2 | 8B4 | 1 | B | 2 |
| 30H1 | 4 | B | 2 | 12Q1 | 2 | B | 2 | 8C6 | 2 | B | 2 |
| 30J1 | 4 | B | 2 | 15A1 | 1 | B | 2 | 8F1 | 2 | B | 2 |
| 31D2 | 1 | B | 2 | 15P1 | 2 | B | 2 | 8F7 | 1 | B | 2 |
| 31N2 | 1 | B | 2 | 16H1 | 1 | B | 2 | 8N3 | 2 | B | 2 |
| 31P1 | 2 | B | 2 | 17B2 | 2 | B | 2 | 15B1 | 2 | B | 2 |
| 32A1 | 3 | B | 2 | 24E1 | 2 | B | 2 | 16B3 | 1 | B | 2 |
| 32A2 | 2 | B | 2 | 24P2 | 2 | B | 2 | 18F1 | 2 | B | 2 |
| 32C1 | 1 | B | 2 | 25D3 | 2 | B | 2 | 15S/4E-29D1 | 3 | B | 2 |
| 32E3 | 2 | B | 2 | 26J3 | 4 | B | 2 | 29Q1 | 3 | B | 2 |
| 32J3 | 1 | B | 2 | 28H2 | 2 | B | 2 | 16S/4E-02Q3 | 2 | B | 2 |
| 32N1 | 1 | B | 2 | 34A1 | 2 | B | 2 | 4C1 | 2 | B | 2 |
| 33H3 | 2 | B | 2 | 34B3 | 2 | B | 2 | 10K1 | 2 | B | 2 |
| 33N3 | 3 | B | 2 | 35L2 | 1 | B | 2 | 10R2 | 2 | B | 2 |
| 14S/2E-03M2 | 1 | B | 2 | 36G1 | 2 | B | 2 | 11E2 | 2 | B | 2 |
| 4B1 | 2 | B | 2 | 36J2 | 2 | B | 2 | 12M1 | 3 | B | 2 |
| 4E2 | 4 | B | 2 | 14S/3E-18J1 | 2 | B | 2 | 13D1 | 2 | B | 2 |
| 5C2 | 2 | B | 2 | 20D1 | 2 | B | 2 | 14M1 | 2 | B | 2 |
| 5F4 | 1 | B | 2 | 28B2 | 2 | B | 2 | 14M2 | 2 | B | 2 |
| 5G2 | 2 | B | 2 | 28F2 | 2 | B | 2 | 24R1 | 4 | B | 2 |
| 5K1 | 1 | B | 2 | 30E3 | 2 | B | 2 | 25A1 | 2 | B | 2 |
| 5K2 | 2 | B | 2 | 31F2 | 2 | B | 2 | 16S/5E-30J2 | 4 | B | 2 |
| 5P2 | 1 | B | 2 | 31Q2 | 2 | B | 2 | | | | |
| East Side area [Well count, 78] | | | | | | | | | | | |
| 13S/3E-02N1 | 4 | B | 2 | 14S/3E-22A1 | 2 | B | 2 | 15S/4E-08L1 | 3 | B | 2 |
| 14S/3E-02E3 | 3 | B | 2 | 24H1 | 2 | B | 2 | 8N1 | 3 | B | 2 |
| 3K1 | 3 | B | 2 | 24N1 | 3 | B | 2 | 9N1 | 4 | B | 2 |
| 4E1 | 3 | B | 2 | 36A1 | 3 | B | 2 | 15D2 | 1 | B | 2 |
| 4N1 | 3 | B | 2 | 14S/4E-30N1 | 2 | B | 2 | 15P2 | 4 | B | 2 |
| 5B2 | 3 | B | 2 | 31F1 | 4 | B | 2 | 16D1 | 3 | B | 2 |
| 6L1 | 3 | B | 2 | 15S/3E-01L1 | 3 | B | 2 | 17B1 | 3 | B | 2 |
| 6L2 | 2 | B | 2 | 12E2 | 2 | B | 2 | 17P2 | 2 | B | 2 |
| 7A1 | 2 | B | 2 | 13J2 | 2 | B | 2 | 18L1 | 4 | B | 2 |
| 10F2 | 3 | B | 2 | 26A1 | 1 | B | 2 | 19D2 | 2 | B | 2 |
| 10F3 | 2 | B | 2 | 26P1 | 2 | B | 2 | 19H3 | 1 | B | 2 |
| 10P1 | 3 | B | 2 | 27J1 | 2 | B | 2 | 20B2 | 2 | B | 2 |
| 10Q1 | 2 | B | 2 | 28B2 | 4 | B | 2 | 21B1 | 4 | B | 2 |
| 10R2 | 2 | B | 2 | 15S/4E-05K1 | 2 | B | 2 | 22J1 | 3 | B | 2 |
| 11H1 | 2 | B | 2 | 5M1 | 3 | B | 2 | 22L2 | 3 | B | 2 |
| 12E1 | 2 | B | 2 | 6D4 | 2 | B | 2 | 23M1 | 3 | B | 2 |
| 14D1 | 3 | B | 2 | 6R1 | 2 | B | 2 | 26G1 | 2 | B | 2 |
| 16E1 | 2 | B | 2 | 7A1 | 2 | B | 2 | 27G1 | 3 | B | 2 |
| 16G1 | 2 | B | 2 | 7E2 | 1 | B | 2 | 28C1 | 3 | B | 2 |
| 16K2 | 4 | B | 2 | 7R1 | 3 | B | 2 | 33A1 | 2 | B | 2 |
| 17D1 | 4 | B | 2 | 8C1 | 3 | B | 2 | 34G1 | 4 | B | 2 |

TABLE 10.--*Inventory of ground-water-quality monitoring networks*--Continued

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Q3b. Monterey Flood Control and Water Conservation District (5115)--Continued | | | | | | | | | | | |
| East Side area--Continued | | | | | | | | | | | |
| 15S/4E-36H1 | 2 | B | 2 | 16S/5E-07G1 | 2 | B | 2 | 16S/5E-20G2 | 3 | B | 2 |
| 36P1 | 4 | B | 2 | 8F1 | 4 | B | 2 | 27G1 | 2 | B | 2 |
| 36R2 | 2 | B | 2 | 8Q1 | 4 | B | 2 | 27Q1 | 4 | B | 2 |
| 16S/4E-01L1 | 1 | B | 2 | 17P1 | 2 | B | 2 | 28D1 | 2 | B | 2 |
| 16S/5E-05N1 | 2 | B | 2 | 17R1 | 2 | B | 2 | 28P1 | 4 | B | 2 |
| Forebay area [Well count, 45] | | | | | | | | | | | |
| 16S/5E-33F1 | 2 | B | 2 | 17S/5E-12E1 | 1 | B | 2 | 17S/6E-20Q3 | 2 | B | 2 |
| 33Q1 | 3 | B | 2 | 12P3 | 1 | B | 2 | 27E3 | 2 | B | 2 |
| 35C1 | 1 | B | 2 | 14D1 | 4 | B | 2 | 28B1 | 4 | B | 2 |
| 17S/5E-01Q1 | 1 | B | 2 | 14G1 | 2 | B | 2 | 28N1 | 3 | B | 2 |
| 2N4 | 4 | B | 2 | 21A1 | 2 | B | 2 | 29C1 | 2 | B | 2 |
| 3B1 | 2 | B | 2 | 23L1 | 2 | B | 2 | 29K1 | 3 | B | 2 |
| 4C1 | 2 | B | 2 | 25L1 | 3 | B | 2 | 29Q1 | 2 | B | 2 |
| 4K1 | 4 | B | 2 | 36F2 | 2 | B | 2 | 30F1 | 3 | B | 2 |
| 4N1 | 2 | B | 2 | 36J1 | 4 | B | 2 | 32J2 | 2 | B | 2 |
| 5G1 | 4 | B | 2 | 17S/6E-16N1 | 2 | B | 2 | 35F1 | 4 | B | 2 |
| 6Q1 | 2 | B | 2 | 17R1 | 4 | B | 2 | 35J1 | 4 | B | 2 |
| 9G1 | 3 | B | 2 | 18G1 | 2 | B | 2 | 18S/6E-05H1 | 4 | B | 2 |
| 9Q1 | 2 | B | 2 | 19D1 | 3 | B | 2 | 6M1 | 4 | B | 2 |
| 10A1 | 3 | B | 2 | 20K1 | 2 | B | 2 | 7A1 | 4 | B | 2 |
| 10Q1 | 2 | B | 2 | 20Q2 | 2 | B | 2 | 8R1 | 4 | B | 2 |
| Pressure area, deep aquifer [Well count, 4] | | | | | | | | | | | |
| 13S/1E-36J1 | 1 | B | 2 | 13S/2E-32E5 | 1 | B | 2 | 13S/2E-32M2 | 1 | B | 2 |
| 13S/2E-19Q3 | 1 | B | 2 | | | | | | | | |
| El Toro Creek basin [Well count, 34] | | | | | | | | | | | |
| Corral de Tierra | | | | | | | | | | | |
| 16S/2E-03A1 | 2 | B | 2 | 16S/2E-04L1 | 1 | B | 2 | 16S/2E-15J1 | 2 | B | 2 |
| 3G1 | 1 | B | 2 | 10H1 | 2 | B | 2 | 15P1 | 2 | B | 2 |
| 3H1 | 2 | B | 2 | 10Q1 | 2 | B | 2 | 24C1 | 3 | B | 2 |
| 3J1 | 3 | B | 2 | 10Q2 | 4 | B | 2 | 24J1 | 1 | B | 2 |
| 3J3 | 4 | B | 2 | 10Q3 | 4 | B | 2 | 16S/3E-17N1 | 2 | B | 2 |
| 4H1 | 1 | B | 2 | 15F2 | 2 | B | 2 | 19L2 | 4 | B | 2 |
| San Benancio | | | | | | | | | | | |
| 15S/2E-24J1 | 4 | B | 2 | 16S/2E-02D1 | 1 | B | 2 | 16S/3E-07L1 | 2 | B | 2 |
| 16S/2E-01E1 | 2 | B | 2 | 2G1 | 1 | B | 2 | 7N1 | 1 | B | 2 |
| 1L1 | 1 | B | 2 | 2H1 | 1 | B | 2 | 7N2 | 2 | B | 2 |
| 1M1 | 1 | B | 2 | 12G1 | 2 | B | 2 | 17F2 | 3 | B | 2 |
| Moro Cojo | | | | | | | | | | | |
| 13S/2E-15M1 | 4 | B | 2 | 13S/2E-17H3 | 4 | B | 2 | 13S/2E-17J1 | 2 | B | 2 |
| 16D1 | 4 | B | 2 | | | | | | | | |

TABLE 10.--*Inventory of ground-water-quality monitoring networks*--Continued

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Q4. California Department of Health Services (5060) [Total well count, 30] | | | | | | | | | | | |
| 13S/2E-28L2 | 2 | B | 1 | 14S/3E-19R1 | 2 | I | 1 | 15S/2E-25B1[2] | 4 | P | 1 |
| 33A1[2] | 4 | P | 1 | 26G3 | 1 | P | 1 | 25B2 | 1 | P | 1 |
| 33A2 | 4 | B | 1 | 26M1 | 2 | P | 1 | 25F1 | 1 | P | 1 |
| 14S/3E-09B1 | 2 | P | 1 | 26Q3 | 2 | P | 1 | 16S/5E-29H1 | 4 | I | 1 |
| 9E1 | 2 | P | 1 | 26Q4 | 2 | P | 1 | 29L1 | 1 | I | 1 |
| 9G2[2] | 4 | P | 1 | 27G3[2] | 4 | P | 1 | 29M1[2] | 4 | P | 1 |
| 9P3 | 1 | P | 1 | 35C2 | 2 | P | 1 | 17S/6E-21P1 | 4 | P | 1 |
| 10E3 | 2 | B | 1 | 35H2 | 2 | P | 1 | 28C1 | 3 | P | 1 |
| 10E4 | 2 | P | 1 | 15S/1E-23G2 | 1 | I | 1 | 28G5 | 1 | I | 1 |
| 19J1 | 1 | I | 1 | 15S/2E-24J3[2] | 4 | P | 1 | 28G6 | 4 | P | 1 |
| Network Q5. Monterey County Department of Environmental Health (5116) [Well count, 19] | | | | | | | | | | | |
| 13S/2E-20N1 | 1 | B | 1 | 16S/2E-12G1 | 2 | P | 1 | 16S/2E-15R1 | 2 | P | 1 |
| 13S/3E-30E1 | 2 | P | 1 | 12J1 | 3 | B | 1 | 24G1 | 1 | I | 1 |
| 14S/2E-01H1 | 2 | B | 1 | 14Q1 | 1 | P | 1 | 24G2 | 2 | P | 1 |
| 14S/3E-08R1 | 4 | B | 1 | 14R1 | 1 | B | 1 | 16S/3E-07N1 | 1 | P | 1 |
| 16S/2E-03A1 | 2 | B | 1 | 15L1 | 1 | B | 1 | 17S/5E-13A1 | 1 | D | 1 |
| 4L1 | 1 | P | 1 | 15L2 | 1 | B | 1 | 13B1 | 3 | P | 1 |
| 9J1 | 1 | P | 1 | | | | | | | | |
| Network Q6. California Regional Water Quality Control Board, Central Coast Region (8493) [Total well count, 17] | | | | | | | | | | | |
| 13S/3E-15R1 | 4 | B | 11 | 14S/2E-35N1 | 4 | B | 11 | 16S/4E-24A1 | 1 | B | 11 |
| 27D1 | 2 | B | 11 | 15S/2E-02B1 | 4 | B | 11 | 25K1 | 1 | B | 11 |
| 14S/2E-16L1 | 3 | Z | 11 | 15S/3E-13N1 | 2 | Z | 11 | 16S/5E-26R1 | 4 | B | 11 |
| 16Q1 | 3 | Z | 11 | 13P1 | 4 | Z | 11 | 17S/5E-14D1 | 4 | B | 11 |
| 17J1 | 3 | Z | 11 | 24C1 | 4 | Z | 11 | 17S/6E-21R1 | 4 | B | 11 |
| 17J2 | 3 | Z | 11 | 15S/4E-09L1 | 4 | B | 11 | | | | |
| Network Q7. California Water Service Company (5701) [Total well count, 25] | | | | | | | | | | | |
| 14S/3E-20F2 | 1 | P | 1 | 14S/3E-28N1[2] | 4 | P | 1 | 14S/3E-34C1 | 1 | P | 1 |
| 20L1 | 1 | P | 1 | 29P1 | 1 | P | 1 | 35N1 | 2 | P | 1 |
| 21E3 | 1 | P | 1 | 30R2 | 1 | P | 1 | 15S/3E-03C1 | 2 | P | 1 |
| 21L1[2] | 4 | P | 1 | 31L1 | 1 | P | 1 | 3N2 | 1 | P | 1 |
| 22D1 | 1 | P | 1 | 32B1[2] | 4 | P | 1 | 3R2 | 1 | P | 1 |
| 22E1 | 1 | P | 1 | 32N4 | 1 | P | 1 | 5C2 | 1 | P | 1 |
| 28M1 | 1 | P | 1 | 33G1 | 1 | P | 1 | 5Q5 | 1 | P | 1 |
| 28M2 | 1 | P | 1 | 33Q1 | 1 | P | 1 | 25F1 | 1 | P | 1 |
| 28M3 | 1 | P | 1 | | | | | | | | |

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|
| Network Q8. Showalter and others (1984) [Total well count, 131] | | | | | | | |
| 13S/2E-31N2 | 1 | M | 2,3,4,13 | 14S/2E-02M1 | 4 | M | 2,3,4,13 |
| 32E3 | 2 | M | 2,3,4,13 | 3M2 | 1 | M | 2,3,4,13 |
| 32N1 | 1 | M | 2,3,4,13 | 5F4 | 1 | M | 2,3,4,13 |
| 32Q3 | 1 | M | 2,3,4,13 | 5P2 | 1 | M | 2,3,4,13 |
| 33H3 | 2 | M | 2,3,4,13 | 6J3 | 1 | M | 2,3,4,13 |
| 36J1 | 1 | M | 2,3,4,13 | 6R2 | 1 | M | 2,3,4,13 |
| 13S/3E-30P1 | 4 | M | 2,3,4,13 | 7F2 | 1 | M | 2,3,4,13 |
| 33Q† | 4 | M | 2,3,4,13 | 8C3 | 1 | M | 2,3,4,13 |

See footnotes at end of table.

TABLE 10.--*Inventory of ground-water-quality monitoring networks*--Continued

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|
| Network Q8. Showalter and others (1984)--Continued | | | | | | | |
| 14S/2E-08M2 | 1 | M | 2,3,4,13 | 15S/3E-26H2 | 2 | M,N,Z | 2,4,12,13 |
| 9L2 | 1 | M | 2,3,4,13 | 27J1 | 2 | M,N,Z | 2,4,12,13 |
| 9N1 | 1 | M | 2,3,4,13 | 28G1 | 1 | M,N,Z | 2,4,12,13 |
| 10R1 | 4 | M | 2,3,4,13 | 35B5 | 2 | M,N,Z | 2,4,12,13 |
| 12E1 | 2 | M | 2,3,4,13 | 15S/4E-06D4 | 2 | M | 2,4,13 |
| 12Q1 | 2 | M | 2,3,4,13 | 7A1 | 2 | M,N | 2,4,10,13 |
| 13P1 | 2 | M | 2,3,4,13 | 16E2 | 3 | M,N | 2,4,10,13 |
| 16E2 | 4 | M | 2,3,4,13 | 17P2 | 2 | M,N | 2,4,10,13 |
| 16H1 | 1 | M | 2,3,4,13 | 19H3 | 1 | M,N | 2,4,10,13 |
| 17B2 | 2 | M | 2,3,4,13 | 22L2 | 3 | M,N | 2,4,10,13 |
| 21L1 | 4 | M | 2,3,4,13 | 27G1 | 3 | M,N | 2,4,10,13 |
| 22P2 | 2 | M | 2,3,4,13 | 29Q1 | 3 | M,N | 2,4,10,13 |
| 23F1 | 4 | M | 2,3,4,13 | 33A1 | 2 | M,N | 2,4,10,13 |
| 24E1 | 2 | M | 2,3,4,13 | 15S/5E-30G1 | 4 | M,N | 2,4,10,12 |
| 24P2 | 2 | M | 2,3,4,13 | 30P† | 4 | M | 2,4,13 |
| 25D3 | 2 | M | 2,3,4,13 | 16S/3E-01A† | 4 | M,N | 2,4,10,13 |
| 34A1 | 2 | M | 2,3,4,13 | 1G† | 4 | M,N | 2,4,10,13 |
| 34B3 | 2 | M | 2,3,4,13 | 16S/4E-01G† | 4 | M,N | 2,4,10,13 |
| 35L2 | 1 | M | 2,3,4,13 | 8J1 | 3 | M,N | 2,4,10 |
| 36E1 | 3 | M | 2,3,4,13 | 13K1 | 2 | M,N | 2,4,10 |
| 36G1 | 2 | M | 2,3,4,13 | 14M2 | 2 | M,N | 2,4,10 |
| 14S/3E-10F3 | 2 | M | 2,4,13 | 15D1 | 2 | M,N | 2,4,10 |
| 11H1 | 2 | M | 2,4,13 | 24A1 | 1 | M,N | 2,4,10 |
| 16K3 | 4 | M | 2,4,13 | 25K1 | 1 | M,N | 2,4,10 |
| 18J1 | 2 | M | 2,4,13 | 27F† | 4 | M,N | 2,4,10 |
| 19H1 | 4 | M | 2,4,13 | 28H† | 4 | M,N | 2,4,10 |
| 24C† | 4 | M | 2,4,13 | 28Q† | 4 | P | 2,4 |
| 25L2 | 2 | M | 2,4,13 | 36B1 | 3 | M,N | 2,4,10 |
| 28B2 | 2 | M | 2,4,13 | 16S/5E-08F1 | 4 | M,N | 2,4,12 |
| 28F2 | 2 | M | 2,4,13 | 8H† | 4 | M,N | 2,4,12 |
| 30E1 | 3 | M | 2,4,13 | 9P† | 4 | M,N | 2,4,12 |
| 30N1 | 3 | M | 2,4,13 | 14N† | 4 | M,N | 2,4,12 |
| 31F2 | 2 | M | 2,4,13 | 15L† | 4 | M,N | 2,4,12 |
| 31Q2 | 2 | M | 2,4,13 | 17G† | 4 | M,N | 2,4,10,12,13 |
| 33G1 | 1 | M | 2,4,13 | 17R1 | 2 | M,N | 2,4,12 |
| 35H3 | 2 | P | 2,4 | 27E† | 4 | M,N | 2,4,12 |
| 14S/4E-30L† | 4 | P | 2,4 | 32B2 | 4 | M,N | 2,4,12 |
| 32G† | 4 | P | 2,4 | 35C1 | 1 | M | 2,4 |
| 15S/2E-01A3 | 1 | M | 2,4,13 | 17S/5E-01Q1 | 1 | M,N | 2,4,12 |
| 2A2 | 4 | M | 2,3,4,13 | 3B1 | 2 | M,N | 2,4,12 |
| 3C1 | 4 | M,Z | 2,3,4,12,13 | 4C1 | 2 | M,N | 2,4,10 |
| 3C3 | 4 | M,Z | 2,3,4,12,13 | 6Q1 | 2 | M,N | 2,4,10 |
| 9G† | 4 | M,Z | 2,3,4,12,13 | 9Q1 | 2 | P | 2,4 |
| 12C2 | 4 | M,Z | 2,3,4,13 | 10Q1 | 2 | P | 2,4 |
| 14A† | 4 | M,Z | 2,3,4,13 | 12P3 | 1 | M,N | 2,4,12 |
| 25B2 | 1 | P | 2,4 | 22K† | 4 | P | 2,4 |
| 15S/3E-03C1 | 2 | P,Z | 2,4,13 | 24G† | 4 | M,N | 2,4,12 |
| 4H4 | 4 | M,N,Z | 2,4,10,12,13 | 25L1 | 3 | P | 2,4 |
| 5C2 | 1 | M | 2,4,13 | 36F2 | 2 | P | 2,4 |
| 5Q4 | 4 | M,N | 2,4,10,13 | 17S/6E-08N† | 4 | P | 2,4 |
| 6F2 | 1 | M,N | 2,4,10,13 | 20Q3 | 2 | M,N,HM,C | 2,4,10,12 |
| 7G1 | 3 | M,N | 2,4,10,13 | 21N2 | 4 | M,N,HM,C | 2,4,10,12 |
| 8F5 | 1 | M,N,Z | 2,4,10,12,13 | 27K1 | 4 | M,N,HM,C | 2,4,12 |
| 12F2 | 2 | M,N | 2,4,10,13 | 28N1 | 3 | M,N,HM,C | 2,4,10,12 |
| 13J2 | 2 | M,N | 2,4,10,13 | 29C1 | 2 | M,N,HM,C | 2,4,10,12 |
| 14H1 | 2 | M,N | 2,4,10,13 | 32G1 | 3 | M,N,HM,C | 2,4,10,12 |
| 15B1 | 2 | M,N | 2,4,10,13 | 18S/6E-07A1 | 4 | M,N,HM,C | 2,4,10,12 |
| 18F1 | 2 | M,N,Z | 2,4,10,13 | | | | |

TABLE 10.--*Inventory of ground-water-quality monitoring networks*--Continued

| Well No. | Well class | Monitoring Type | Monitoring Reason | Well No. | Well class | Monitoring Type | Monitoring Reason |
|---|---|---|---|---|---|---|---|
| Network Q9. Burau and others (1981) Monterey Basin Pilot Monitoring Project [Total well count, 63] | | | | | | | |
| 13S/2E-28L2 | 2 | M,N,HM,Z | 1,2,10 | 14S/3E-31L1 | 1 | M,N,HM,Z | 1,2,10 |
| 33A1 | 4 | M,N,HM,Z | 1,2,10 | 32B1 | 4 | M,N,HM,Z | 1,2,10 |
| 33A2 | 4 | M,N,HM,Z | 1,2,10 | 32N4 | 1 | M,N,HM,Z | 1,2,10 |
| 14S/2E-08M2 | 1 | M,N,HM,Z | 1,2,10 | 33G1 | 1 | M,N,HM,Z | 1,2,10 |
| 12Q1 | 2 | M,N,HM,Z | 1,2,10 | 33Q1 | 1 | M,N,HM,Z | 1,2,10 |
| 13P1 | 2 | M,N,HM,Z | 1,2,10 | 34C1 | 1 | M,N,HM,Z | 1,2,10 |
| 36G1 | 2 | M,N,HM,Z | 1,2,10 | 35C2 | 2 | M,N,HM,Z | 1,2,10 |
| 14S/3E-04E1 | 3 | M,N,HM,Z | 1,2,10 | 35H2 | 2 | M,N,HM,Z | 1,2,10 |
| 9B1 | 2 | M,N,HM,Z | 1,2,10 | 35N1 | 2 | M,N,HM,Z | 1,2,10 |
| 9E1 | 2 | M,N,HM,Z | 1,2,10 | 15S/3E-03C1 | 2 | M,N,HM,Z | 1,2,10 |
| 9G2 | 4 | M,N,HM,Z | 1,2,10 | 3N2 | 1 | M,N,HM,Z | 1,2,10 |
| 9P3 | 1 | M,N,HM,Z | 1,2,10 | 3R2 | 1 | M,N,HM,Z | 1,2,10 |
| 10E3 | 2 | M,N,HM,Z | 1,2,10 | 5C2 | 1 | M,N,HM,Z | 1,2,10 |
| 10E4 | 2 | M,N,HM,Z | 1,2,10 | 5Q5 | 1 | M,N,HM,Z | 1,2,10 |
| 19J1 | 1 | M,N,HM,Z | 1,2,10 | 13N1 | 2 | M,N,HM,Z | 1,2,10 |
| 19R1 | 2 | M,N,HM,Z | 1,2,10 | 17P1 | 4 | M,N,HM,Z | 1,2,10 |
| 20F2 | 1 | M,N,HM,Z | 1,2,10 | 25F1 | 1 | M,N,HM,Z | 1,2,10 |
| 20L1 | 1 | M,N,HM,Z | 1,2,10 | 15S/4E-26G1 | 2 | M,N,HM,Z | 1,2,10 |
| 21E3 | 1 | M,N,HM,Z | 1,2,10 | 16S/4E 2 wells | 4 | M,N,HM,Z | 1,2,10 |
| 21L1 | 4 | M,N,HM,Z | 1,2,10 | 3Q1 | 4 | M,N,HM,Z | 1,2,10 |
| 22D1 | 1 | M,N,HM,Z | 1,2,10 | 16S/5E-17P1 | 2 | M,N,HM,Z | 1,2,10 |
| 22E1 | 1 | M,N,HM,Z | 1,2,10 | 29H1 | 1 | M,N,HM,Z | 1,2,10 |
| 25L2 | 2 | M,N,HM,Z | 1,2,10 | 29M1 | 4 | M,N,HM,Z | 1,2,10 |
| 26D2 | 4 | M,N,HM,Z | 1,2,10 | 17S/5E-14D1 | 4 | M,N,HM,Z | 1,2,10 |
| 26M1 | 2 | M,N,HM,Z | 1,2,10 | 36F2 | 2 | M,N,HM,Z | 1,2,10 |
| 26Q3 | 2 | M,N,HM,Z | 1,2,10 | 17S/6E-07Q1 | 4 | M,N,HM,Z | 1,2,10 |
| 26Q4 | 2 | M,N,HM,Z | 1,2,10 | 21P1 | 4 | M,N,HM,Z | 1,2,10 |
| 27G3 | 4 | M,N,HM,Z | 1,2,10 | 28C1 | 3 | M,N,HM,Z | 1,2,10 |
| 28M2 | 1 | M,N,HM,Z | 1,2,10 | 28G5 | 1 | M,N,HM,Z | 1,2,10 |
| 28M3 | 1 | M,N,HM,Z | 1,2,10 | 28G6 | 4 | M,N,HM,Z | 1,2,10 |
| 28N1 | 4 | M,N,HM,Z | 1,2,10 | | | | |
| 30R2 | 1 | M,N,HM,Z | 1,2,10 | | | | |

[1]No wells were sampled as of 1987 by the U.S. Geological Survey (Gail Keeter, U.S. Geological Survey, oral commun., 1987).

[2]Well shown on the California Department of Health Services (CDHS) retrieval dated November 21, 1983, which was received from the California State Water Resources Control Board, Data Management Department which maintains the computer files for CDHS. All other wells in Networks Q4-Q7 came from C.D. Farrar and F.M. Glenn (U.S. Geological Survey, written commun., 1980).

## TABLE 11.--*Well summary and cross-reference to wells in ground-water networks*

[Complete well number is given where available. Dagger (†) indicates that area within section has been proposed for the location of a monitoring well. An inspection of well-log files and a field canvass are needed to determine if suitable wells exist in these locations. Network numbers starting with "L" indicate ground-water-level networks from table 8. Network numbers starting with "Q" indicate ground-water-quality networks from table 10. Well classes were determined for each well based on the availability of information for each well (see table 7). All official State well numbers in Monterey County are assigned by Monterey County Flood Control and Water Conservation District. --, no data available]

Monterey County Flood Control and Water Conservation District autumn water-level networks:
- L1a, Pressure area, 180-foot aquifer
- L1b, Pressure area, 400-foot aquifer
- L1c, East Side area
- L1d, Forebay area
- L1e, Pressure area, deep aquifer
- L1f, El Toro Creek basin

Monterey County Flood Control and Water Conservation District monthly water-level networks:
- L2a, Pressure area, 180-foot aquifer
- L2b, Pressure area, 400-foot aquifer
- L2c, East Side area
- L2d, Forebay area
- L2e, Pressure area, deep aquifer
- L2f, El Toro Creek basin

Monterey County Flood Control and Water Conservation District August water-level networks:
- L3a, Pressure area, 180-foot aquifer
- L3b, Pressure area, 400-foot aquifer

U.S. Geological Survey:
- L4, Stream channel/aquifer response network
- Q1, Baseline data network, part of Statewide network

U.S. Army Health Service:
- Q2, Public supply network

Monterey County Flood Control and Water Conservation District water-quality networks:
- Q3a, Summer network, monthly analyses
- Q3b, Summer network, annual analyses
- Q4, California Department of Health Services

Department of Health Services public supply networks:
- Q5, Monterey County Department of Environmental Health, public health network
- Q6, California Regional Water Quality Control Board, Central Coast Region, discharger network
- Q7, California Water Service Company, public supply network
- Q8, Showalter and others (1984) Salinas Valley network
- Q9, Burau and others (1981) Monterey Basin Pilot Monitoring Project

| Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification | Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification |
|---|---|---|---|---|---|---|---|
| 13S/1E-36J1 | 1 | L1e,L2e,Q3b | Moss Landing Harbor District well | 13S/2E-32E3 | 2 | L1b,Q3a,Q3b,Q8 | -- |
| | | | | 32E5 | 1 | L1e,L2e,Q3b | -- |
| | | | | 32J3 | 1 | L1b,L3b,Q3a,Q3b | -- |
| 13S/2E-15M1 | 4 | Q3b | -- | 32M2 | 1 | Q3b | -- |
| 16D1 | 4 | Q3b | -- | 32N1 | 1 | Q3a,Q3b,Q8 | -- |
| 17H3 | 4 | Q3a,Q3b | -- | 32Q3 | 1 | Q8 | -- |
| 17J1 | 2 | Q3a,Q3b | -- | 33A1 | 4 | Q4,Q9 | No. 1 |
| 19H1 | 2 | L1b,L3b | -- | 33A2 | 4 | Q4,Q9 | No. 2 |
| 19Q3 | 1 | L1e,L2e,Q3a,Q3b | -- | 33H3 | 2 | Q3b,Q8 | -- |
| 19R1 | 1 | L1b,L3b | -- | 33N3 | 3 | L1b,L3b,Q3b | -- |
| 20J1 | 3 | L1b,L3b,Q3a,Q3b | -- | 33R1 | 3 | L1a,L2a,L3a,Q1,Q3a,Q3b | -- |
| 20M2 | 1 | Q3a | -- | 34G1 | 1 | L3b | -- |
| 20N1 | 1 | Q5 | -- | 34M1 | 1 | L3b | -- |
| 20P2 | 1 | Q3a | -- | 35L1 | 3 | L1a,L3a,Q3b | -- |
| 21N1 | 1 | L1b,L2b,L3b,Q3a | -- | 36F1 | 3 | L1c | -- |
| 26L1 | 3 | L3b | -- | 36J1 | 1 | Q8 | -- |
| 27L1 | 4 | L1a,L3a,Q3b | -- | 13S/3E-02N1 | 4 | Q3b | -- |
| 27M1 | 3 | L1a,L3a,Q3b | -- | 15R1 | 4 | Q6 | -- |
| 27P1 | 2 | L1b,Q3b | -- | 27D1 | 2 | Q6 | -- |
| 28B1 | 1 | Q3b | -- | 30E1 | 2 | Q5 | -- |
| 28L2 | 2 | L3a,Q4,Q9 | No. 3 | 30P1 | 4 | Q8 | -- |
| 28M1 | 3 | Q3b | -- | 33Q† | 4 | Q8 | -- |
| 29C2 | 1 | L1b,L3b,Q3a,Q3b | -- | 35N1 | 2 | L1c | -- |
| 29C4 | 1 | Q3a,Q3b | -- | 14S/2E-01H1 | 2 | Q5 | -- |
| 29D3 | 1 | L1b,Q3a,Q3b | -- | 2M1 | 4 | Q3b,Q8 | -- |
| 29F2 | 1 | L1b,L3b,Q3a,Q3b | -- | 3C1 | 4 | L1a,L3a | -- |
| 29H1 | 1 | Q3b | -- | 3F1 | 3 | L1a,L3a,Q3b | -- |
| 29J1 | 2 | Q3b | -- | 3K1 | 4 | L1a,L3a | -- |
| 29M2 | 1 | L1b,Q1,Q3b | -- | 3K2 | 1 | L1b,L3b | -- |
| 29R1 | 4 | L1a,Q3b | -- | 3L1 | 4 | L3a | -- |
| 30A1 | 1 | L1b,L2b,L3b | -- | 3M2 | 1 | L1b,L3b,Q3b,Q8 | -- |
| 30H1 | 4 | L1b,L3b,Q3a,Q3b | -- | 3R1 | 4 | L1a,L2a,L3a,Q3a,Q3b | -- |
| 30J1 | 4 | Q3a,Q3b | -- | 4A1 | 3 | L1a,L3a | -- |
| 30Q2 | 2 | L1b | -- | 4B1 | 2 | L1b,L3b,Q3b | -- |
| 31A2 | 1 | L2e | -- | 4E2 | 4 | Q3b | -- |
| 31D2 | 1 | L1b,L3b,Q3a,Q3b | -- | 4H1 | 1 | L1b,L3b | -- |
| 31G4 | 1 | L1b,L3b | -- | 4R1 | 3 | L1a,L3a | -- |
| 31N2 | 1 | L1b,L2b,L3b,Q3a,Q3b,Q8 | -- | 5C2 | 2 | L1b,L3b,Q3b | -- |
| 31P1 | 2 | L1b,L3b,Q3a,Q3b | -- | 5F4 | 1 | L1b,L3b,Q3b,Q8 | -- |
| 32A1 | 3 | Q3a,Q3b | -- | 5G2 | 2 | Q3b | -- |
| 32A2 | 2 | L1b,L2b,L3b,Q3a,Q3b | -- | 5K1 | 1 | L1b,L3b,Q3b | -- |
| 32C1 | 1 | L1b,Q3a,Q3b | -- | 5K2 | 2 | Q3b | -- |
| | | | | 5P2 | 1 | L1b,L3b,Q3b,Q8 | -- |

## TABLE 11.--*Well summary and cross-reference to wells in ground-water networks*--Continued

| Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification | Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification |
|---|---|---|---|---|---|---|---|
| 14S/2E-06B1 | 4 | Q3b | -- | 14S/2E-35N1 | 4 | Q6 | -- |
| 6J3 | 1 | L1b,L3b,Q3b,Q8 | -- | 35Q1 | 4 | Q3b | -- |
| 6L1 | 1 | L1e,L2e,Q3a | -- | 36E1 | 3 | L1a,L3a,Q3b,Q8 | -- |
| 6R2 | 1 | Q3b,Q8 | -- | 36G1 | 2 | L1b,Q3b,Q8,Q9 | -- |
| 7F2 | 1 | Q3b,Q8 | -- | 36H1 | 4 | Q3b | -- |
| 7K1 | 3 | L1b,L3b,Q3b | -- | 36J2 | 2 | Q3b | -- |
| 7L3 | 4 | L1b | -- | 36R1 | 4 | Q3b | -- |
| 8A1 | 1 | Q3b | -- | 14S/3E-02E3 | 3 | L1c,Q3b | -- |
| 8C3 | 1 | L1b,L3b,Q3b,Q8 | -- | 3K1 | 3 | L1c,Q3b | -- |
| 8M2 | 1 | L1b,L2b,L3b,Q3a,Q3b | -- | 4E1 | 3 | L1c,Q3b,Q9 | -- |
| | | Q8,Q9 | | 4N1 | 3 | L1c,Q3b | -- |
| 9L2 | 1 | Q3b,Q8 | -- | 4Q1 | 4 | L1c | -- |
| 9N1 | 1 | Q3b,Q8 | -- | 5B2 | 3 | L1c,Q3b | -- |
| 10C1 | 1 | L1b,L3b,Q3b | -- | 6L1 | 3 | L1c,Q3b | -- |
| 10K1 | 3 | L1a,L3a | -- | 6L2 | 2 | L1c,Q3b | -- |
| 10P1 | 4 | L1a,L3a | -- | 6R1 | 3 | L1c,L2c,Q3a | -- |
| 10R1 | 4 | L1a,L3a,Q3a,Q3b,Q8 | -- | 7A1 | 2 | L1c,Q3b | -- |
| 11D1 | 3 | Q3b | -- | 8C1 | 3 | L1c | -- |
| 11G1 | 3 | L1a,L3a,Q3b | -- | 8R1 | 4 | Q5 | -- |
| 12E1 | 2 | Q8 | -- | 9B1 | 2 | Q4,Q9 | -- |
| 12Q1 | 2 | L1b,L2b,Q3a,Q3b,Q8,Q9 | -- | 9E1 | 2 | Q4,Q9 | -- |
| 13B2 | 1 | L1a,L3a,Q3b | -- | 9F3 | 2 | L2c | -- |
| 13P1 | 2 | Q3b,Q8,Q9 | -- | 9G2 | 4 | Q4,Q9 | -- |
| 14E1 | 2 | L1a,L3a | -- | 9P3 | 1 | Q4,Q9 | -- |
| 14J1 | 4 | Q3b | -- | 10E3 | 2 | Q4,Q9 | -- |
| 14L1 | 4 | L1a,L2a,L3a,Q3a | -- | 10E4 | 2 | Q4,Q9 | -- |
| 14N2 | 2 | Q3b | -- | 10F2 | 3 | Q3b | -- |
| 15A1 | 1 | L3b,Q3b | -- | 10F3 | 2 | L1c,Q3b,Q8 | -- |
| 15B1 | 1 | L1b | -- | 10P1 | 3 | Q3b | -- |
| 15G1 | 4 | L1a,L3a | -- | 10Q1 | 2 | L1c,Q3b | -- |
| 15H1 | 4 | L3a | -- | 10R2 | 2 | L1c,Q3b | -- |
| 15P1 | 2 | L1b,L3b,Q3b | -- | 11H1 | 2 | L1c,Q3b,Q8 | -- |
| 16E2 | 4 | L1a,L3a,Q3a,Q8 | -- | 12E1 | 2 | L1c,Q3b | -- |
| 16H1 | 1 | Q3b,Q8 | -- | 14C1 | 3 | L1c | -- |
| 16L1 | 3 | Q6 | -- | 14D1 | 3 | Q3b | -- |
| 16Q1 | 3 | Q6 | -- | 14N1 | 3 | L1c | -- |
| 17A1 | 4 | L1a,L3a | -- | 15C1 | 3 | L1c | -- |
| 17B2 | 2 | L1b,L3b,Q3b,Q8 | -- | 15H3 | 2 | L1c,L2c,Q3a | -- |
| 17J1 | 3 | Q6 | -- | 16D1 | 3 | L1c | -- |
| 17J2 | 3 | Q6 | -- | 16E1 | 2 | L1c,Q3b | -- |
| 18E1 | 4 | L1e | -- | 16G1 | 2 | Q3b | -- |
| 21J1 | 4 | L1a,L3a,Q3b | -- | 16K2 | 4 | Q3b | -- |
| 21L1 | 4 | L1a,Q8 | -- | 16K3 | 4 | Q8 | -- |
| 22F1 | 3 | L1a,L3a,Q3b | -- | 17D1 | 4 | Q3b | -- |
| 22N1 | 3 | L1a,Q3b | -- | 18J1 | 2 | L1b,L2b,Q1,Q3a,Q3b,Q8 | -- |
| 22P2 | 2 | L1a,L3a,Q3b,Q8 | -- | 19G1 | 3 | L1a,L3a | -- |
| 22Q1 | 4 | Q3b | -- | 19H1 | 4 | Q8 | -- |
| 23A1 | 3 | L1a,L3a,Q3b | -- | 19J1 | 1 | Q4,Q9 | -- |
| 23F1 | 4 | Q8 | -- | 19Q2 | 3 | L1a,L3a,Q3b | -- |
| 23L1 | 3 | L1a | -- | 19R1 | 2 | Q4,Q9 | No. 1 |
| 23P1 | 3 | Q3b | -- | 20D1 | 2 | Q3b | -- |
| 24E1 | 2 | Q3b,Q8 | -- | 20F2 | 1 | Q7,Q9 | -- |
| 24J1 | 3 | L1a,L3a,Q3b | -- | 20L1 | 1 | Q7,Q9 | -- |
| 24P2 | 2 | Q3b,Q8 | -- | 21E3 | 1 | Q7,Q9 | -- |
| 24Q1 | 3 | Q3b | -- | 21L1 | 4 | Q7,Q9 | -- |
| 25D3 | 2 | Q3b,Q8 | -- | 22A1 | 2 | L1c,Q3b | -- |
| 25F1 | 3 | Q3b | -- | 22D1 | 1 | Q7,Q9 | -- |
| 26C1 | 3 | Q3b | -- | 22E1 | 1 | Q7,Q9 | -- |
| 26J3 | 4 | L1b,L3b,Q3b | -- | 24C† | 4 | Q8 | -- |
| 26N3 | 2 | Q3b | -- | 24H1 | 2 | L1c,Q3b | -- |
| 26P1 | 3 | L1a,L3a,Q3b | -- | 24N1 | 3 | L1c,Q3b | -- |
| 27G2 | 3 | L1a,L3a | -- | 24R1 | 4 | L1c,L2c,Q3a | -- |
| 27G3 | 1 | L1b | -- | 25L1 | 3 | L1c | -- |
| 27K1 | 1 | Q3b | -- | 25L2 | 2 | L1c,L2c,Q3a,Q8,Q9 | -- |
| 28H2 | 2 | L1a,Q3b | -- | 26D2 | 4 | Q9 | Rider Street |
| 34A1 | 2 | L1b,L2b,L3b,Q3a,Q3b,Q8 | -- | 26G3 | 1 | Q4 | -- |
| 34B1 | 3 | L1a,L3a | -- | 26M1 | 2 | Q4,Q9 | Alma Street |
| 34B3 | 2 | L1b,Q3b,Q8 | -- | 26Q3 | 2 | Q4,Q9 | Wiren Street front |
| 35G1 | 3 | Q3b | -- | | | | |
| 35L2 | 1 | L1b,Q3b,Q8 | -- | 26Q4 | 2 | Q4,Q9 | Wiren Street rear |

## TABLE 11.--*Well summary and cross-reference to wells in ground-water networks*--Continued

| Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification |
|---|---|---|---|
| 14S/3E-27G2 | 3 | L1c | -- |
| 27G3 | 4 | Q4,Q9 | East Laurel Drive |
| 28B2 | 2 | Q3b,Q8 | -- |
| 28F2 | 2 | Q3b,Q8 | -- |
| 28M1 | 1 | Q7 | -- |
| 28M2 | 1 | Q7,Q9 | -- |
| 28M3 | 1 | Q7,Q9 | -- |
| 28N1 | 4 | Q7,Q9 | 1-04 |
| 29G2 | 1 | Q3b | -- |
| 29L4 | 1 | Q3b | -- |
| 29P1 | 1 | Q7 | -- |
| 30E1 | 3 | Q3b,Q8 | -- |
| 30E3 | 2 | Q3b | -- |
| 30F1 | 4 | Q3b | -- |
| 30F2 | 2 | Q3b | -- |
| 30N1 | 3 | L1a,L3a,Q3b,Q8 | -- |
| 30R2 | 1 | Q7,Q9 | -- |
| 31B1 | 3 | Q3b | -- |
| 31F1 | 3 | L1a,L2a,L3a,Q3a,Q3b | -- |
| 31F2 | 2 | L1b,L2b,Q3a,Q3b,Q8 | -- |
| 31L1 | 1 | Q7,Q9 | -- |
| 31Q2 | 2 | Q3b,Q8 | -- |
| 32B1 | 4 | Q7,Q9 | -- |
| 32N4 | 1 | Q7,Q9 | -- |
| 33G1 | 1 | Q7,Q8,Q9 | -- |
| 33Q1 | 1 | Q7,Q9 | -- |
| 34C1 | 1 | Q7,Q9 | -- |
| 35C2 | 2 | Q4,Q9 | Williams Road |
| 35H2 | 2 | Q4,Q9 | Bardin Road |
| 35H3 | 2 | Q8 | -- |
| 35N1 | 2 | Q7,Q9 | -- |
| 36A1 | 3 | L1c,Q3b | -- |
| 36P2 | 2 | L1c | -- |
| 14S/4E-30L† | 4 | Q8 | -- |
| 30N1 | 2 | L1c,Q3b | -- |
| 30R1 | 3 | L1c | -- |
| 31F1 | 3 | L1c,Q3b | -- |
| 32G† | 4 | Q8 | -- |
| 15S/1E-23G2 | 1 | Q4 | -- |
| 15S/2E-01A3 | 1 | L1b,Q3b,Q8 | -- |
| 1K1 | 3 | Q3b | -- |
| 1Q1 | 3 | L1a,L2a,L3a,Q1,Q3a | -- |
| 2A2 | 4 | Q8 | -- |
| 2B1 | 4 | Q6 | -- |
| 2G1 | 2 | L1b,Q3b | -- |
| 2J1 | 4 | L1a,L2a,L3a,Q3a | -- |
| 2N1 | 4 | Q2 | -- |
| 2Q1 | 3 | Q3b | -- |
| 3C1 | 4 | Q8 | -- |
| 3C3 | 4 | Q8 | -- |
| 9G† | 4 | Q8 | -- |
| 10A1 | 4 | Q2 | -- |
| 12A1 | 2 | L1b,Q3b | -- |
| 12C1 | 3 | Q3b | -- |
| 12C2 | 4 | Q8 | -- |
| 12E2 | 2 | L1a,Q3b | -- |
| 14A† | 4 | Q8 | -- |
| 24J1 | 4 | Q3b | -- |
| 24J3 | 4 | Q4 | S-1 |
| 25B1 | 4 | Q4 | Toro Park |
| 25B2 | 1 | Q4,Q8 | -- |
| 25F1 | 1 | Q4 | -- |
| 15S/3E-01L1 | 3 | Q3b | -- |
| 2Q1 | 3 | L1c | -- |
| 3C1 | 2 | Q7,Q8,Q9 | -- |
| 3N2 | 1 | Q7,Q9 | -- |
| 3R2 | 1 | Q7,Q9 | -- |
| 4H4 | 4 | Q8 | -- |
| 4K3 | 2 | L1b,Q3b | -- |
| 4N3 | 2 | Q3b | -- |
| 5C2 | 1 | Q7,Q8,Q9 | -- |
| 15S/3E-05N1 | 4 | Q3b | -- |
| 5Q4 | 4 | Q8 | -- |
| 5Q5 | 1 | Q7,Q9 | -- |
| 5R1 | 3 | Q3b | -- |
| 6A3 | 4 | Q3b | -- |
| 6D2 | 2 | L1b,L3b,Q3b | -- |
| 6F2 | 1 | Q3b,Q8 | -- |
| 6K1 | 3 | L1b,Q3b | -- |
| 7C1 | 2 | L2a | -- |
| 7D2 | 3 | Q3b | -- |
| 7E1 | 4 | Q3b | -- |
| 7G1 | 3 | L1b,Q3b,Q8 | -- |
| 7N1 | 3 | Q3b | -- |
| 8B4 | 1 | Q3b | -- |
| 8C1 | 3 | Q3b | -- |
| 8C6 | 2 | Q3b | -- |
| 8F1 | 2 | L1b,Q3b | -- |
| 8F5 | 1 | Q8 | -- |
| 8F7 | 1 | Q3b | -- |
| 8N3 | 2 | L1b,Q3b | -- |
| 9B1 | 3 | Q3b | -- |
| 9C1 | 4 | Q3b | -- |
| 9E3 | 2 | L1a | -- |
| 9H1 | 3 | Q3b | -- |
| 9H2 | 3 | Q3b | -- |
| 9K1 | 3 | Q3b | -- |
| 10P1 | 3 | Q3b | -- |
| 10P3 | 3 | Q3b | -- |
| 10R2 | 3 | Q3b | -- |
| 12E2 | 2 | L1c,L2c,Q3a,Q3b | -- |
| 12F2 | 2 | L1c,Q8 | -- |
| 13G4 | 4 | L1c | -- |
| 13J2 | 2 | Q3b,Q8 | -- |
| 13N1 | 2 | L1a,Q3b,Q6,Q9 | -- |
| 13P1 | 4 | Q6 | -- |
| 14C1 | 3 | L1a,Q3b | -- |
| 14G1 | 3 | Q3b | -- |
| 14H1 | 2 | Q3b,Q8 | -- |
| 14R1 | 3 | Q3b | -- |
| 15B1 | 2 | L1b,Q3b,Q8 | -- |
| 15L1 | 3 | Q3b | -- |
| 16B3 | 1 | L1b,L2b,Q3a,Q3b | -- |
| 16M1 | 3 | L1a,L2a,Q3a,Q3b | -- |
| 17B1 | 3 | Q3b | -- |
| 17B2 | 4 | Q3b | -- |
| 17G1 | 3 | Q3b | -- |
| 17P1 | 4 | Q9 | -- |
| 18B1 | 3 | L1a,Q3b | -- |
| 18C2 | 2 | L1a | -- |
| 18F1 | 2 | L1b,Q3b,Q8 | -- |
| 18M2 | 2 | L1b | -- |
| 21A1 | 2 | Q3b | -- |
| 22F1 | 3 | Q3b | -- |
| 22G1 | 4 | L1a,Q3b | -- |
| 23E1 | 3 | Q3b | -- |
| 24C1 | 4 | Q6 | -- |
| 25F1 | 1 | Q7,Q9 | -- |
| 25L1 | 2 | Q3b | -- |
| 25Q1 | 4 | L1a,L2a,Q3b | -- |
| 26A1 | 1 | Q3b | -- |
| 26D1 | 4 | Q3b | -- |
| 26F1 | 2 | L1a | -- |
| 26H2 | 2 | Q3b,Q8 | -- |
| 26P1 | 2 | Q3b | -- |
| 27J1 | 2 | Q3b,Q8 | -- |
| 28B1 | 4 | L1b | -- |
| 28B2 | 4 | Q3b | -- |
| 28G1 | 1 | Q3b,Q8 | -- |
| 35B5 | 2 | Q3b,Q8 | -- |
| 15S/4E-05C1 | 2 | L1c | -- |
| 5K1 | 2 | Q3b | -- |
| 5M1 | 3 | L1c,Q3b | -- |

# TABLE 11.--*Well summary and cross-reference to wells in ground-water networks*--Continued

| Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification |
|---|---|---|---|
| 15S/4E-06D4 | 2 | Q3b,Q8 | -- |
| 6R1 | 2 | L1c,L2c,Q3a,Q3b | -- |
| 7A1 | 2 | L1c,Q3b,Q8 | -- |
| 7E2 | 1 | Q3b | -- |
| 7R1 | 3 | L1c,L2c,Q3a,Q3b | -- |
| 7R2 | 2 | L2c | -- |
| 8C1 | 3 | L1c,Q3b | -- |
| 8L1 | 3 | L1c,Q3b | -- |
| 8N1 | 3 | L1c,Q3b | -- |
| 8Q1 | 3 | L1c | -- |
| 9D1 | 3 | L1c | -- |
| 9J1 | 3 | L1c | -- |
| 9L1 | 4 | Q6 | -- |
| 9M1 | 2 | L1c | -- |
| 9N1 | 4 | Q3b | -- |
| 14N1 | 2 | L1c | -- |
| 15D2 | 1 | L1c,Q3b | -- |
| 15P2 | 4 | L1c,Q3b | -- |
| 16D1 | 3 | L1c,Q3b | -- |
| 16E2 | 3 | L1c,Q8 | -- |
| 17B1 | 3 | Q3b | -- |
| 17P2 | 2 | L1c,Q3b,Q8 | -- |
| 18L1 | 4 | Q3b | -- |
| 19D2 | 2 | L1b,Q3b | -- |
| 19H3 | 1 | Q3b,Q8 | -- |
| 20B2 | 2 | L1c,Q3b | -- |
| 21B1 | 4 | Q3b | -- |
| 21F4 | 2 | L1c | -- |
| 21L2 | 3 | L1c,L2c | -- |
| 22J1 | 3 | Q3b | -- |
| 22L2 | 3 | L1c,L2c,Q3a,Q3b,Q8 | -- |
| 23M1 | 3 | Q3b | -- |
| 24N3 | 2 | L1c | -- |
| 26G1 | 2 | Q3b,Q9 | -- |
| 27G1 | 3 | L1c,Q3b,Q8 | -- |
| 28C1 | 3 | Q3b | -- |
| 29D1 | 3 | L1b,Q3b | -- |
| 29Q1 | 3 | L1b,L2b,Q3a,Q3b,Q8 | -- |
| 29R1 | 2 | L1b | -- |
| 31A2 | 2 | L1a | -- |
| 32D2 | 2 | Q3b | -- |
| 32E1 | 4 | Q3b | -- |
| 33A1 | 2 | L1c,Q3b,Q8 | -- |
| 34G1 | 4 | Q3b | -- |
| 34L1 | 2 | L1c | -- |
| 36H1 | 2 | L1c,Q3b | -- |
| 36P1 | 4 | L1c,L2c,Q3b | -- |
| 36R2 | 2 | L1c,Q3b | -- |
| 15S/5E-30G1 | 4 | Q8 | -- |
| 30P† | 4 | Q8 | -- |
| 16S/2E-01E1 | 2 | L1f,Q3b | -- |
| 1L1 | 1 | L1f,Q3b | -- |
| 1M1 | 1 | L1f,Q3b | -- |
| 2D1 | 1 | L1f,L2f,Q3b | -- |
| 2D2 | 2 | L1f | -- |
| 2D3 | 3 | L1f | -- |
| 2D5 | 1 | L1f | -- |
| 2G1 | 1 | L1f,L2f,Q3b | -- |
| 2H1 | 1 | L1f,L2f,Q3b | -- |
| 3A1 | 2 | L1f,Q3b,Q5 | -- |
| 3G1 | 1 | L1f,Q3b | -- |
| 3H1 | 2 | L1f,Q3b | -- |
| 3J1 | 3 | L1f,Q3b | -- |
| 3J3 | 4 | Q3b | -- |
| 4H1 | 1 | L1f,Q3b | -- |
| 4L1 | 1 | L1f,Q3b,Q5 | -- |
| 9H1 | 4 | L1f | -- |
| 9J1 | 1 | L1f,Q5 | -- |
| 10B1 | 2 | L1f | -- |
| 10H1 | 2 | L1f,Q3b | -- |
| 16S/2E-10Q1 | 2 | L1f,L2f,Q3b | -- |
| 10Q2 | 4 | L1f,Q3b | -- |
| 10Q3 | 4 | Q3b | -- |
| 12G1 | 2 | Q3b,Q5 | -- |
| 12J1 | 3 | Q5 | -- |
| 14Q1 | 1 | Q5 | -- |
| 14R1 | 1 | Q5 | -- |
| 15F2 | 2 | L1f,Q3b | -- |
| 15J1 | 2 | L1f,L2f,Q3b | -- |
| 15L1 | 1 | Q5 | -- |
| 15L2 | 1 | Q5 | -- |
| 15P1 | 2 | L1f,Q3b | -- |
| 15R1 | 2 | Q5 | -- |
| 17N1 | 2 | L2f | -- |
| 23H1 | 4 | L1f | -- |
| 24C1 | 3 | L1f,Q3b | -- |
| 24G1 | 1 | Q5 | -- |
| 24G2 | 2 | Q5 | -- |
| 24J1 | 1 | Q3b | -- |
| 16S/3E-01A† | 4 | Q8 | -- |
| 1G† | 4 | Q8 | -- |
| 7L1 | 2 | L1f,Q3b | -- |
| 7N1 | 1 | L1f,Q3b,Q5 | -- |
| 7N2 | 2 | Q3b | -- |
| 17F2 | 3 | L1f,Q3b | -- |
| 17N1 | 2 | L1f,Q3b | -- |
| 19L1 | 4 | L1f | -- |
| 19L2 | 4 | L1f,Q3b | -- |
| 16S/4E 2 wells | 4 | Q9 | Chualar wells |
| 1G† | 4 | Q8 | -- |
| 1L1 | 1 | L1c,Q3b | -- |
| 2Q3 | 2 | L1b,Q3b | -- |
| 3Q1 | 4 | Q9 | -- |
| 4C1 | 2 | L1b,Q3b | -- |
| 5M2 | 2 | L1a | -- |
| 8B1 | 4 | L1a | -- |
| 8J1 | 3 | L1a,Q3b,Q8 | -- |
| 9A1 | 2 | L1a,Q3b | -- |
| 10K1 | 2 | Q3b | -- |
| 10R2 | 2 | L1b,L2b,Q3a,Q3b | -- |
| 11E2 | 2 | Q3b | -- |
| 12M1 | 3 | Q3b | -- |
| 13D1 | 2 | Q3b | -- |
| 13H1 | 3 | L1a | -- |
| 13K1 | 2 | Q3b,Q8 | -- |
| 13R2 | 2 | L1a | -- |
| 14A1 | 4 | Q3b | -- |
| 14M1 | 2 | Q3b | -- |
| 14M2 | 2 | Q3b,Q8 | -- |
| 15D1 | 2 | L1a,Q3b,Q8 | -- |
| 15H2 | 2 | Q3b | -- |
| 15R2 | 2 | L1a | -- |
| 16E1 | 3 | L1a | -- |
| 24A1 | 1 | Q3b,Q6,Q8 | -- |
| 24C1 | 3 | L1a | -- |
| 24R1 | 4 | Q3b | -- |
| 25A1 | 2 | Q3b | -- |
| 25C1 | 4 | L1a | -- |
| 25G1 | 4 | L1b | -- |
| 25K1 | 1 | Q3b,Q6,Q8 | -- |
| 25P1 | 3 | L1a | -- |
| 25Q1 | 3 | Q3b | -- |
| 27B2 | 3 | L1a | -- |
| 27F† | 4 | Q8 | -- |
| 27G1 | 3 | Q3b | -- |
| 28H† | 4 | Q8 | -- |
| 28Q† | 4 | Q8 | -- |
| 36B1 | 3 | Q3b,Q8 | -- |
| 16S/5E-05N1 | 2 | L1c,Q3b | -- |
| 7G1 | 2 | L1c,Q3b | -- |
| 8F1 | 4 | Q3b,Q8 | -- |

TABLE 11.--*Well summary and cross-reference to wells in ground-water networks*--Continued

| Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification | Well No. | Well class | Network Nos. (tables 8 and 10) | Local identification |
|---|---|---|---|---|---|---|---|
| 16S/5E-08H† | 4 | Q8 | -- | 17S/5E-12E1 | 1 | L1d,Q3b | -- |
| 8Q1 | 4 | L1c,L2c,Q3b | -- | 12P3 | 1 | Q3b,Q8 | -- |
| 9P† | 4 | Q8 | -- | 13A1 | 1 | Q5 | -- |
| 14N† | 4 | Q8 | -- | 13B1 | 3 | Q5 | -- |
| 15L† | 4 | Q8 | -- | 13E1 | 4 | L1d | -- |
| 17G† | 4 | Q8 | -- | 14D1 | 4 | L1d,Q3b,Q6,Q9 | -- |
| 17P1 | 2 | L1c,Q3b,Q9 | -- | 14G1 | 2 | Q3b | -- |
| 17R1 | 3,2 | L1c,Q1,Q3b,Q8 | -- | 21A1 | 2 | L1d,Q3b | -- |
| 19F1 | 4 | L1a,Q3b | -- | 22K† | 4 | Q8 | -- |
| 19R1 | 3 | Q3b | -- | 23F† | -- | L4 (5 wells) | -- |
| 20G2 | 3 | L1c,Q3b | -- | 23L1 | 2 | Q3b | -- |
| 20R1 | 2 | L1c,L2c | -- | 24G† | 4 | Q8 | -- |
| 21R1 | 3 | L1c,Q3a | -- | 24G1 | 4 | L1d | -- |
| 26R1 | 4 | Q6 | -- | 25L1 | 3 | L1d,Q3b,Q8 | -- |
| 27E† | 4 | Q8 | -- | 27A1 | 2 | L1d | -- |
| 27G1 | 2 | Q3b | -- | 36F2 | 2 | L1d,Q3b,Q8,Q9 | -- |
| 27Q1 | 4 | L1c,L2c,Q3b | -- | 36J1 | 4 | L1d,L2d,Q3b | -- |
| 28D1 | 2 | L1c,L2c,Q3a,Q3b | -- | 17S/6E-07Q1 | 4 | Q9 | -- |
| 28P1 | 4 | L1c,Q3b | -- | 08N† | 4 | Q8 | -- |
| 29H1 | 1 | Q4,Q9 | -- | 16N1 | 2 | L1d,L2d,Q3a,Q3b | -- |
| 29L1 | 1 | Q4 | -- | 17R1 | 4 | Q3b | -- |
| 29M1 | 4 | Q4,Q9 | -- | 18G1 | 2 | L1d,Q3b | -- |
| 30C1 | 3 | Q3b | -- | 19D1 | 3 | L1d,L2d,Q3a,Q3b | -- |
| 30E1 | 4 | L1a,L2a,Q3b | -- | 20E2 | 2 | L1d | -- |
| 30G1 | 3 | Q3b | -- | 20K1 | 2 | Q3b | -- |
| 30J2 | 4 | L1b,Q3b | -- | 20Q2 | 2 | Q3b | -- |
| 31A1 | 4 | L1a,Q3b | -- | 20Q3 | 2 | Q3b,Q8 | -- |
| 31M1 | 4 | L1a | -- | 21N2 | 4 | Q8 | -- |
| 31Q1 | 3 | L1a,Q3b | -- | 21P1 | 4 | Q4,Q9 | -- |
| 32B2 | 2 | L1a,Q3b,Q8 | -- | 21R1 | 4 | Q6 | -- |
| 32C1 | 4 | L1a,Q3b | -- | 27E3 | 2 | L1d,Q3b | -- |
| 32E1 | 4 | L1a,Q3b | -- | 27K1 | 4 | L1d,Q8 | -- |
| 32H2 | 2 | L1d | -- | 28B1 | 4 | L1d,L2d,Q3b | -- |
| 32M1 | 3 | L1d,Q3b | -- | 28C1 | 3 | Q4,Q9 | -- |
| 33F1 | 2 | Q3b | -- | 28G5 | 1 | Q4,Q9 | -- |
| 33Q1 | 3 | L1d,Q3b | -- | 28G6 | 4 | Q4,Q9 | -- |
| 35C1 | 1 | Q3b,Q8 | -- | 28K1 | 3 | L1d | -- |
| 17S/4E-01D1 | 3 | L1a,Q3b | -- | 28N1 | 3 | Q3b,Q8 | -- |
| 17S/5E-01Q1 | 1 | L1d,Q3b,Q8 | -- | 29C1 | 2 | L1d,Q3b,Q8 | -- |
| 2N2 | 2 | L1d | -- | 29K1 | 3 | L1d,Q3b | -- |
| 2N4 | 4 | L1d,L2d,Q3b | -- | 29Q1 | 2 | L1d,Q3b | -- |
| 3B1 | 2 | Q3b,Q8 | -- | 30F1 | 3 | L1d,Q3b | -- |
| 3L1 | 2 | L1d,L2d | -- | 32G1 | 3 | Q8 | -- |
| 4C1 | 2 | Q3b,Q8 | -- | 32J2 | 2 | Q3b | -- |
| 4K1 | 4 | L1d,Q3b | -- | 34E1 | 4 | L1d | -- |
| 4N1 | 2 | L1d,Q3b | -- | 35F1 | 4 | L1d,Q3b | -- |
| 4R1 | 2 | L1d | -- | 35J1 | 4 | Q3b | -- |
| 5G1 | 4 | L1d,L2d,Q3b | -- | 18S/6E-02N1 | 2 | L2d | -- |
| 6Q1 | 2 | L1d,Q3b,Q8 | -- | 5H1 | 4 | Q3b | -- |
| 8L1 | 3 | L1d | -- | 5R2 | 4 | L1d | -- |
| 9G1 | 3 | Q3b | -- | 6M1 | 4 | L1d,L2d,Q3b | -- |
| 9Q1 | 2 | Q3b,Q8 | -- | 7A1 | 4 | L1d,Q3b,Q8 | -- |
| 9R1 | 3 | L1d | -- | 8R1 | 4 | L1d,Q3b | -- |
| 10A1 | 3 | Q3b | -- | 9M1 | 3 | L1d | -- |
| 10Q1 | 2 | L1d,Q3b,Q8 | -- | 9M2 | 2 | L1d | -- |

The ground-water-quality monitoring program of the Monterey County Flood Control and Water Conservation District consists of a network of wells sampled monthly during the summer months (usually May to September) and a network of wells sampled annually during the summer. In the northern Salinas River drainage basin, saltwater intrusion has become an immediate and serious threat to ground-water use. Each year, samples are collected and a partial mineral analysis (for specific conductance, nitrogen nitrite, and chloride) is done monthly during the irrigation season to provide information on short-term trends in the water quality of this area (table 10). The Pressure area 400-foot aquifer near Castroville is sampled as part of the monthly-summer network, as are areas in the north-county part of the phase 2 study area. The coordination of water-level measurement along with water-quality sampling is important so the analyst of these data can better interpret their meaning. Well locations are shown in figure 9.

Additional water samples for complete mineral analyses are collected from some of these wells each summer to obtain a complete analysis on each well once every 5 years. The data from this network are used to provide information on the historical long-term trends in ground-water quality as shown by concentrations of chlorides, nitrates, and other water-quality characteristics. The Monterey County Flood Control and Water Conservation District relies on the California Department of Water Resources Title 22 classification system which indicates the limitations of ground water for domestic and agricultural purposes; this system is based on dissolved solids, chloride, percent sodium, and boron concentration ranges (Bruce LaClergue, Monterey County Flood Control and Water Conservation District, written commun., 1988). The quality of ground water is represented by the Monterey County Flood Control and Water Conservation District (1978, p. 17) in graphs of the mean changes in specific conductance concentrations from all wells in each aquifer or ground-water basin.

The approach used by Monterey County Flood Control and Water Conservation District (1978, p. 20) has some limitations. For example, average water quality in the Pressure area, measured in specific conductance, depends on the specific wells sampled and may not reflect real trends. As saltwater moves inland, specific conductance in wells increases at a higher than normal rate until the wells become unusable. Sampling of abandoned, salty wells is discontinued, and graphs of average water quality may indicate an improvement. The apparent improvement, however, merely reflects the exclusion of wells with high specific conductance which thereby lowers the average specific conductance for the area.

Averages of water-quality characteristics, therefore, cannot be relied on by themselves to indicate water quality for an area. The range of values of water-quality characteristics and the history of wells removed from the networks also needs to be indicated in order to have adequate knowledge of the regional quality of ground water for that specific characteristic. The data published prior to Monterey County Flood Control and Water Conservation District's (1978) report used electrical conductivity (EC) to indicate dissolved solids. The relation between electrical conductivity and dissolved solids varies with space and time, depending on their local relation. Determination of electrical conductivity also varies with the temperature of the water at the time of measurement; for this reason, the U.S. Geological Survey measures specific conductance (which is electrical conductivity adjusted to 25 °C) to obtain a more standard indicator of water quality. Until 1978, these factors had not been addressed in Monterey County Flood Control and Water Conservation District annual data reports, and pre-1978 historical EC data may not be comparable to post-1978 specific conductance data. Use of the proper instruments and methodology, therefore, is extremely important in obtaining and analyzing the results of water-quality samples. The District staff are aware of the importance of proper use of instruments and analytical procedures and are working to improve all aspects of their operations.

## Possible Additional Monitoring

At present, the Monterey County Flood Control and Water Conservation District monitors 379 wells for a limited range of water-quality constituents on a monthly or annual basis. This study identified 135 additional wells that have been monitored or recommended by other networks. The saltwater-intrusion areas near Castroville (fig. 3) have the densest distribution of wells. In these areas, a few of the currently monitored wells may be selected for the baseline network, and sampling at these wells may be expanded to include constituents needed for the baseline network. The distribution of wells in other areas is more sparse. For the baseline networks, wells could be added to provide an even spatial distribution; the 54 sections presently lacking wells for such a distribution are shown in table 12. An evenly spaced grid would require additional wells to be monitored in these sections. Additional wells also would improve the accuracy of a statistical evaluation of networks. Replacing wells having lower classifications (less information available about them) with higher class wells will improve the reliability of the resultant information.

Historic data are available for many of the constituents of concern. A thorough analysis of these data may make it be unnecessary to establish additional wells in all areas. The baseline network, however, is intended to identify temporal as well as spatial variations in the quality of the area's ground water, so that at least some key wells (as suggested by Showalter and Hoffard, 1986) could be established that have good water-quality correlations with unmonitored wells in these areas. Periodically, the correlations between those wells would be rechecked to retain confidence in network adequacy. Other factors to consider are the constituents to monitor and the frequency of sampling. The ideal network calls for monitoring a broad range of water-quality constituents on a quarterly basis. In reality, these requirements may not be financially feasible, but unless historic data or adequate well correlations are available, the ideal networks should be approximated as closely as possible.

An approach similar to the one by Karubian (1974) may be a valuable supplement to conventional ground-water-quality monitoring by sampling from wells. Further research would be helpful if done to see if Karubian was correct in hypothesizing that trends in ground-water pollution may be more easily deduced and predicted with greater confidence and lower cost by analyzing human activities than by extrapolating data from water-well sampling.

TABLE 12.--*Network locations that presently do not have wells monitored for ambient water-quality conditions by the Monterey County Flood Control and Water Conservation District*

| Township/Range | Section |
|---|---|
| T13S/R2E | 8,34 |
| T13S/R3E | 31,32,34,35 |
| T14S/R3E | 1,13,23 |
| T15S/R2E | 4,11,13,26,35,36 |
| T15S/R3E | 2,11,19,20,34,36 |
| T15S/R4E | 14,24,25,30,31,35 |
| T16S/R4E | 5,6,16,21,22,23,26,34,35 |
| T16S/R5E | 6,16,18,22,23,34 |
| T17S/R5E | 7,8,11,15,16,26,27 |
| T17S/R6E | 8,9,10,22,31 |

## SUMMARY AND CONCLUSIONS

This report presents an evaluation of water-resources data-collection networks for precipitation, surface water and ground water in the northern Salinas River drainage basin of Monterey County, California. The evaluation includes an inventory of active data-collection networks and a description of possible additional monitoring. A set of ideal networks is described that would meet the data needs for water management in the study area.

The study identified 34 precipitation gages in the study area, of which 20 are active. The stations are concentrated in the northwestern part of the study area. Data are lacking for the eastern and southern parts of the study area as well as the southwestern slopes of the Gabilan Range. No precipitation-quality networks were identified. Possible data-collection efforts for precipitation quality include monitoring for acid rain and for pesticides in precipitation.

The study identified 10 streamflow-gaging stations, of which 6 are active. To meet the objectives for streamflow networks that are outlined in the report, all sites could be reactivated, and two of the inactive sites could be relocated to improve the record.

The Monterey County Flood Control and Water Conservation District samples one surface-water site for suspended sediment, specific conductance, and chlorides. Several other agencies have done water-quality sampling in the past, but only five sites are active, counting the District's sites. Reactivation of the 45 inactive sites would help to meet the various surface-water-quality objectives described in the report. Development of a stream-reach rating system also could help to identify parts of the study area most in need of sampling.

The Monterey County Flood Control and Water Conservation District maintains three networks to measure ground-water levels on a monthly basis, during peak irrigation, and at the end of the irrigation season. The only other network identified for this report was run by the U.S. Geological Survey, and none of its five wells are active. The District measures water levels in 318 wells. An ideal network would have evenly spaced wells throughout the study area. The study identified 128 sections in which no ground-water-level monitoring presently is done. Well coverage is densest in the saltwater-intrusion areas near Castroville, California. Wells in the rest of the study area are more sparsely distributed, but they are concentrated down the center of the drainage in the alluvial ground-water basin.

At present, the Monterey County Flood Control and Water Conservation District monitors 379 wells for a limited range of water-quality constituents on a monthly or annual basis. This study identified 135 additional wells that have been monitored or recommended by other networks. For the baseline networks, wells could be added to provide an even spatial distribution; the 54 sections presently lacking wells for such a distribution are shown in table 12. Replacing wells having lower classifications (less information available about them) with higher class wells will improve the reliability of the resultant information.

To develop a water-resources information system that would meet the objectives outlined in tables 1 and 3, a regional computerized data base could be created for each of the six categories of hydrologic data evaluated in this report to bring together historic information with new information obtained from active monitoring. Additional historic and new data could be gathered about specific existing and potential problems. These data could be collected from historic reports as well as monitoring networks established for each of the objectives identified in table 3.

Computer software packages are readily available that include statistical applications (such as analysis of variance, multivariate linear regression, and cluster analysis) for use in analyzing data adequacy. More specialized analyses (such as kriging and regional analysis with semivariograms) also can be made to evaluate cost effectiveness and "worth" of data, but that would include adapting existing computer programs to fit the specific computer hardware being used. The combination of temporal and financial constraints with the absence of a coordinated data base prohibited use of these tools in this study.

The computerized Geographic Information System (GIS) that is planned for Monterey County could easily use the information in this report for the needed initial analysis of network adequacy. The feasibility of management and analysis of large complicated data bases (such as the ground-water networks identified in this report) is substantially improved through the use of state-of-the-art GIS tools now available.

The ability to plot mechanically all data-collection sites from a computer file for each specific network objective within each basin or study area provides spatial analysis capabilities that are often too time consuming and costly to be done routinely by hand. The acquisition and application of computer geographic information system (GIS) software and hardware that allow manipulation of data files is a requirement of modern hydrologic data-network evaluation that needs to be considered by the Monterey County Flood Control and Water Conservation District.

In conclusion, hydrologic data network evaluation requires that data are organized properly, contain adequate information on the specific sites, and are maintained routinely. The existing hydrologic networks will need to be reevaluated when the above criteria are met.

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