# CHEMICAL QUALITY OF GROUND WATER IN YOLO AND SOLANO COUNTIES, CALIFORNIA

By Kristin D. Evenson

---

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 84-4244

Prepared in cooperation with the
CALIFORNIA DEPARTMENT OF WATER RESOURCES



Sacramento, California
January 1985

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

---

For additional information
write to:

District Chief
U.S. Geological Survey
Federal Building, Room W-2235
2800 Cottage Way,
Sacramento, CA 95825

Copies of this report can
be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225
(Telephone: (303) 236-7476)

CONTENTS

## CONVERSION FACTORS

For readers who prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

| Multiply | By | To obtain |
|---|---|---|
| acres | 0.4047 | square hectometers |
| ft (feet) | 0.3048 | meters |
| mi (miles) | 1.609 | kilometers |
| $mi^2$ (square miles) | 2.590 | square kilometers |
| micromhos per centimeter at 25° Celsius (µmho/cm at 25°C) | 1.000 | microsiemen per centimeter at 25° Celsius |

Water temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F=1.8(°C)+32.$$

Air temperature is given in degrees Fahrenheit (°F), which can be converted to degrees Celsius (°C) by the following equation:

$$°C=(°F-32)/1.8.$$

Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is about the same as for concentrations in parts per million.

Chemical concentration is terms of ionic interacting values is given in milli-equivalents per liter (meq/L). Milliequivalents per liter is numerically equal to equivalents per million.

Chemical abbreviations used in the report are listed below.

Hardness and noncarbonate hardness, $CaCO_3$.

# CHEMICAL QUALITY OF GROUND WATER IN YOLO AND SOLANO COUNTIES, CALIFORNIA

By Kristin D. Evenson

## ABSTRACT

Chemical quality of ground water was investigated in Yolo and Solano Counties during the summers of 1980 and 1981. Most of the ground water discussed in this report comes from the low alluvial plains and fans of the western Sacramento Valley. Chemical analyses of water from 188 representative samples indicate that the ground water is suitable for domestic and most agricultural uses. Water from wells near the Sacramento River generally had lower concentrations of dissolved solids and higher concentrations of trace elements than the rest of the study area. Dissolved-solids concentrations in 57 percent of the water sampled were less than 500 milligrams per liter. Chemical water types varied; however, 72 percent of the wells had sodium bicarbonate, magnesium bicarbonate, sodium magnesium bicarbonate, or magnesium sodium bicarbonate type water. Boron concentrations in ground water exceeded tolerance levels for many crops in a large part of the study area. Other toxic trace elements were present in negligible amounts.

# 1.0 INTRODUCTION

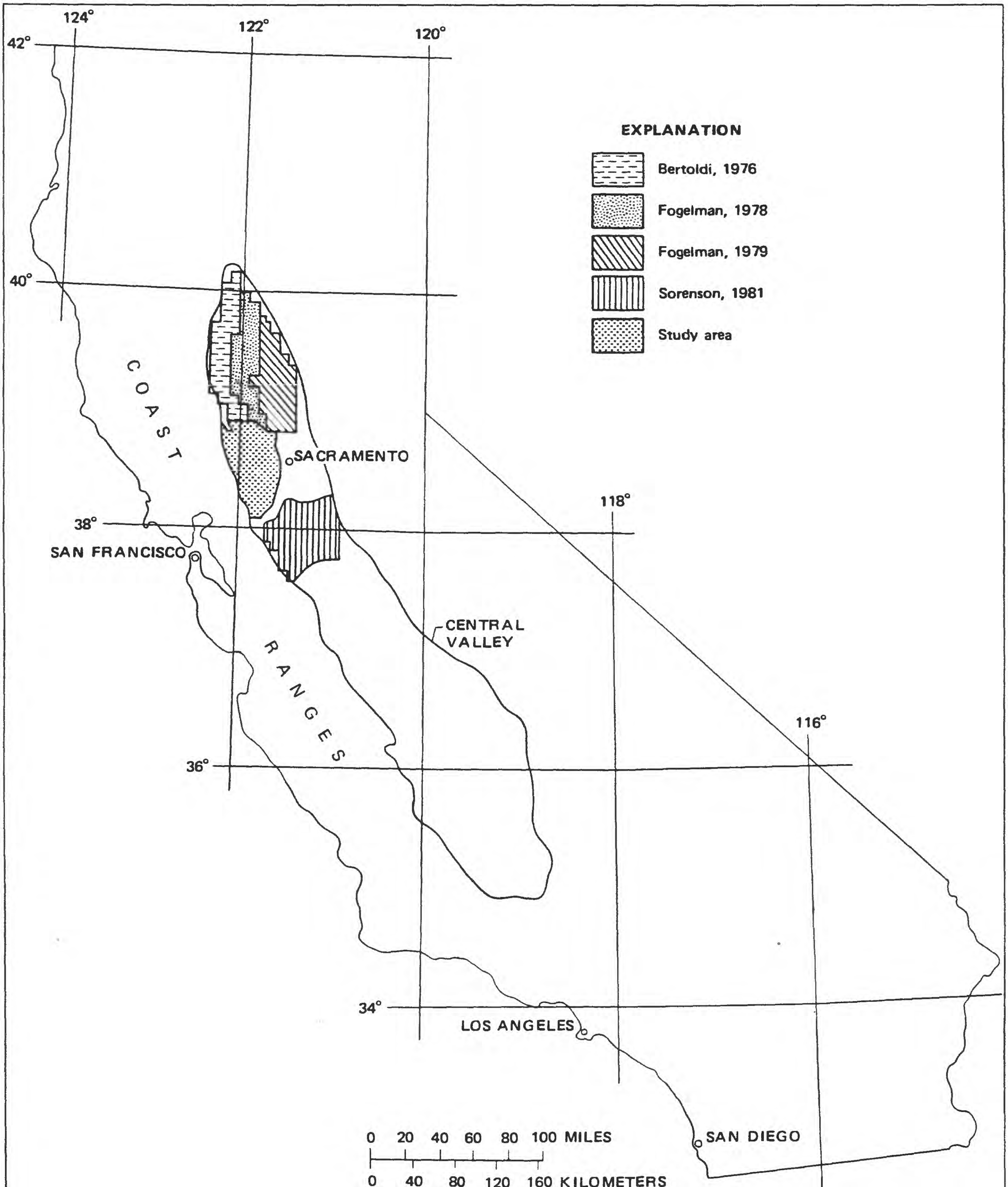
## 1.1 Purpose and Scope, and Previous Studies

### This Report Describes Chemical Quality of Ground Water in Yolo and Solano Counties

**Wells were selectively inventoried in Yolo and Solano Counties. Wells that would be representative of ground-water conditions were sampled and data were analyzed for this report.**

This report is the fifth in a series of reports, prepared by the U.S. Geological Survey in cooperation with the California Department of Water Resources, which describes chemical quality of ground water in the Sacramento Valley. The Sacramento Valley is the northern one-third of the Central Valley. The purpose of this report is to describe ground-water quality in Yolo and Solano Counties as of 1981.

The scope of the study included (1) collection of well data, mainly from drillers' reports; (2) a selective field inventory of wells chosen from data collected; (3) collection and analyses of ground-water samples from wells selected as representative of the ground water in the study area; (4) classification of ground water into water types; and (5) detection of areas or individual well sites where specific chemical constituents in ground water exceed recommended limits for agricultural or domestic uses.



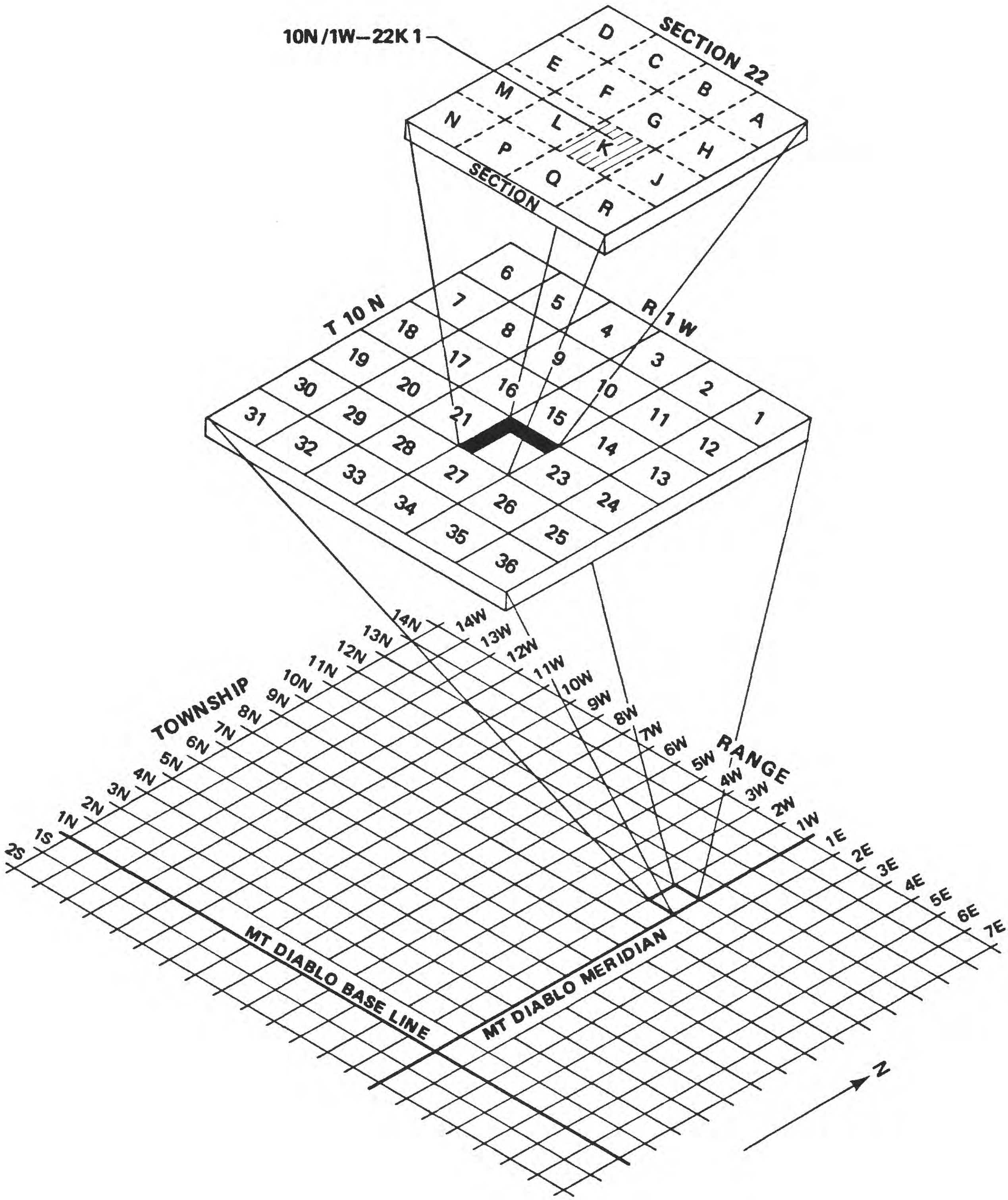

Areas included in reports of ground-water quality in Sacramento Valley.

## 1.2 Well-Numbering System

### Wells Are Numbered According to Their Location Within a Township

**The well-numbering system is based on the rectangular subdivision of public lands.**

Wells are identified according to their location in the rectangular system for the subdivision of public lands. Section lines have been projected into unsurveyed areas for reference only. The identification consists of the township number, north or south; the range number, east or west; and the section number. Each section is further divided into sixteen 40-acre tracts lettered consecutively (except 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 sequentially numbered in the order they are inventoried. The final letter refers to the base line and meridian. Because all wells in the study area are referenced to Mount Diablo base line and meridian (M), the final letter will be omitted.




Well-numbering system.

## 2.0 DESCRIPTION OF STUDY AREA

### 2.1 Location and General Features

**The Study Area Lies Within the Lower Sacramento Valley**

**The study area includes 1,270 $mi^2$ of the lower Sacramento Valley. The economy is based on agriculture and the climate is a Mediterranean subtropical type.**

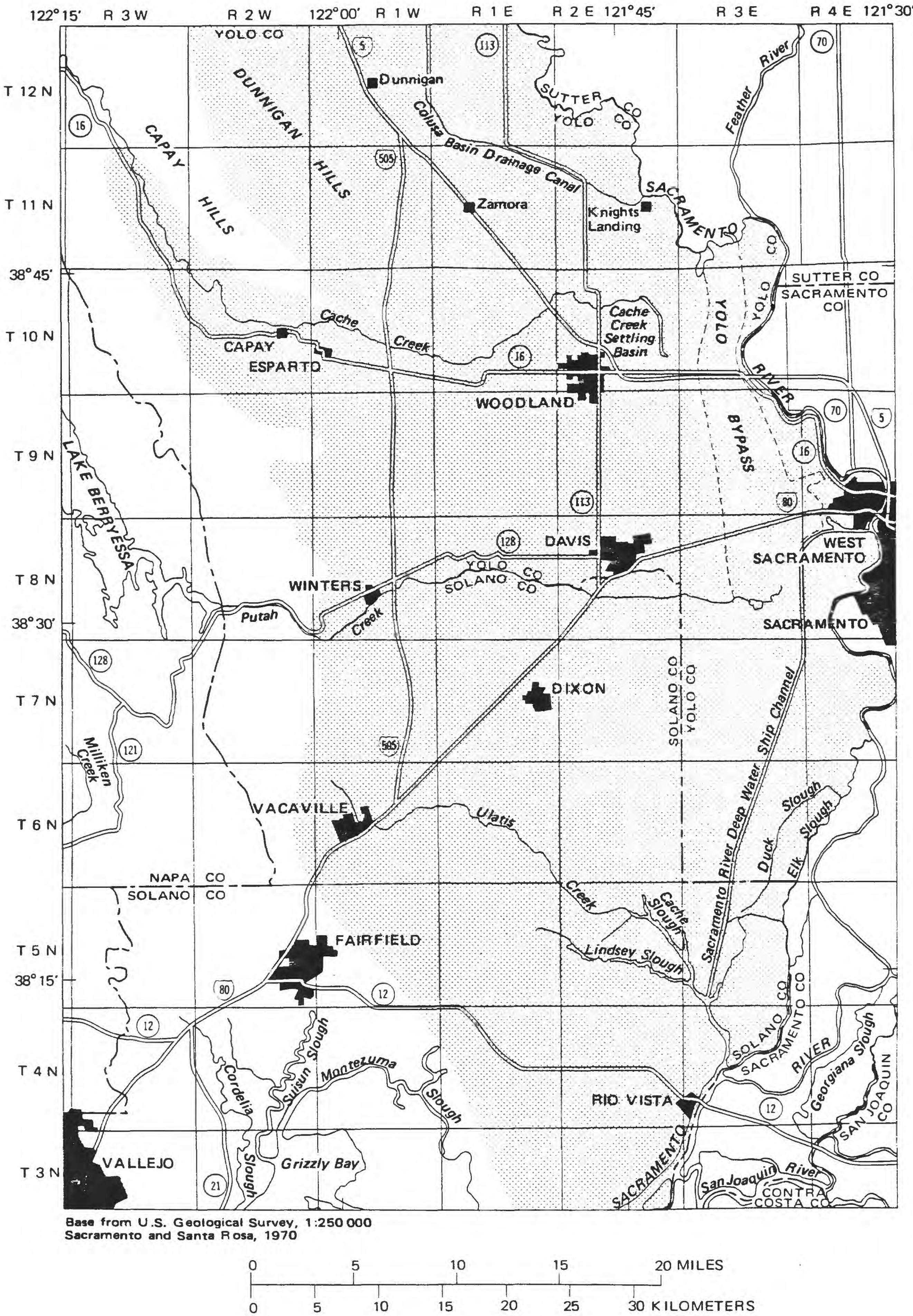
This report is confined to those parts of Yolo and Solano Counties that lie within the Sacramento Valley. The 500-ft elevation in the Coast Ranges is used as the western boundary line, the Yolo-Colusa County line is the northern boundary, and the Sacramento River forms the eastern and southern boundaries.

Except for an isolated area of low rolling hills in the north and southwest, the valley area is a broad, almost flat, alluvial plain. Cache and Putah Creeks are two major streams that flow eastward through the study area. At present, most of the water from these creeks is diverted into various irrigation canals.

Most of the land is occupied by various field crops, orchards, and pastures, leaving a small percentage for urban development. The main population centers are the towns of Vacaville, Dixon, Davis, Woodland, and West Sacramento. Because of the predominance of agriculture, the principal industry is food processing.

Ground water supplies most of the water used for industrial and domestic uses. Water used for irrigation is derived from both surface water and ground water.

The study area has a Mediterranean subtropical climate. Precipitation, about 90 percent of which occurs in winter, consists almost entirely of rainfall. Winter temperatures are moderate and seldom fall below freezing. Summer temperatures are usually high. The mean annual temperature is about 60°F and the growing season is normally over 8 months.




**Location of study area (screened).**

## Five Geomorphic Units Are Described

The geology and geomorphology of the Sacramento Valley have been described in detail by Olmsted and Davis (1961). Five geomorphic units in the study area are the Coast Ranges, low hills and dissected uplands, low alluvial plains and fans, flood basins, and Sacramento River flood plains and natural levees.

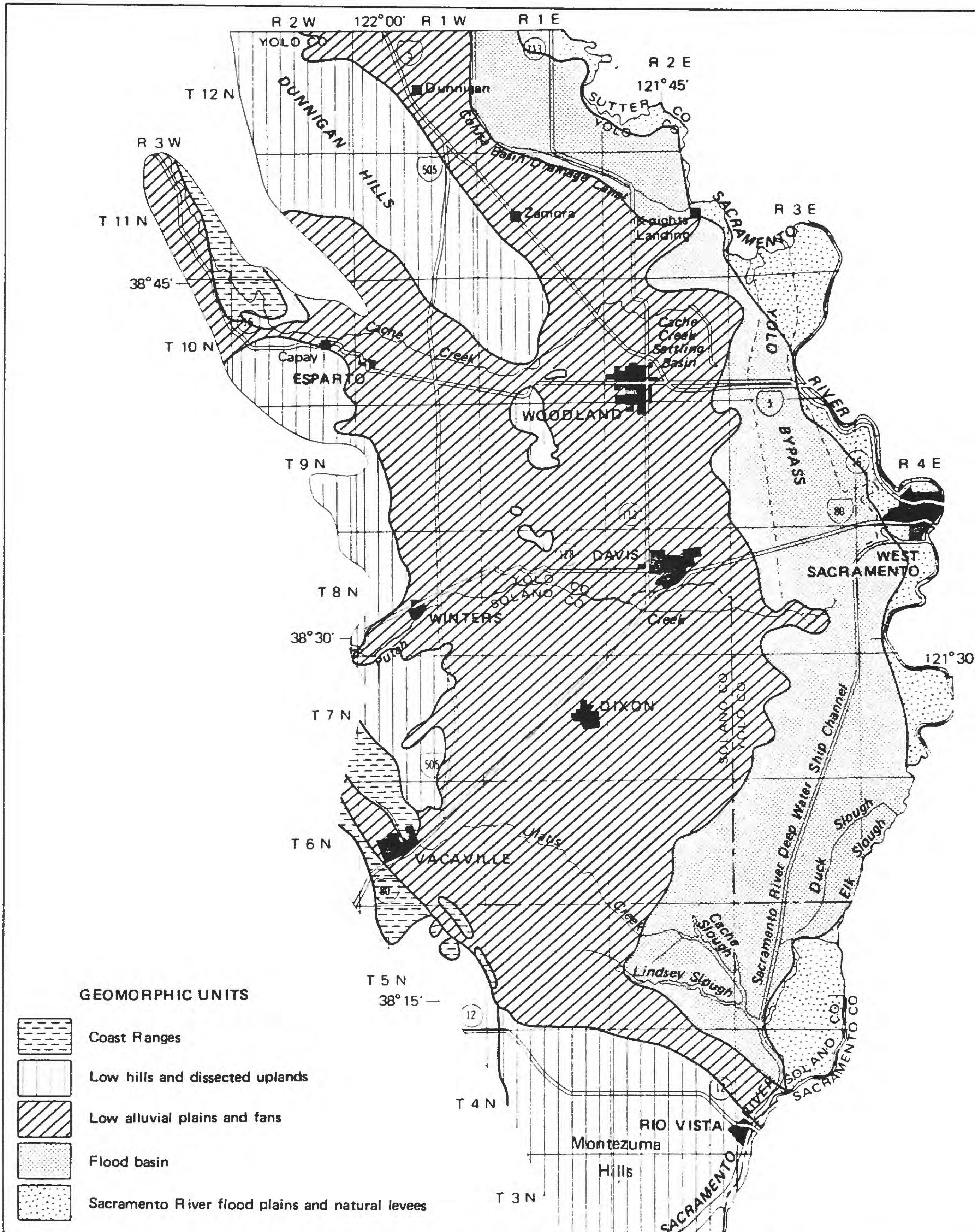
The Coast Ranges, bordering the west side of the study area, are a northward-trending belt of marine shale, siltstone, and sandstone of Cretaceous age. They are carved by streams that follow north-south strike patterns for considerable distances then cut eastward and flow into the valley. The Coast Ranges contain small amounts of oil and saline water and may be the source of some of the high concentrations of soluble salts found in water from wells.

The low hills and dissected uplands are to the east of the Coast Ranges. Where they extend into the valley in the north, they are known as the Dunnigan Hills, and in the south they are known as the Montezuma Hills. These areas are underlain by unconsolidated and semiconsolidated silt, sand, and gravel of Pliocene and Pleistocene age with variable permeability. Drainage in these areas is generally eastward. Although there has been some domestic use of ground water in some of the foothill locations, its use is almost nonexistent in the Dunnigan and Montezuma Hills. Information from this unit is therefore limited.

Low alluvial plains and fans comprise the central part of the study area. This unit is composed of Pleistocene and Holocene unconsolidated sediments and, although it varies greatly in permeability, it is generally more permeable here than in the low hills and dissected uplands to the west. With the exception of a few streams that have cut through this area, it is almost topographically featureless. Movement of ground water is generally southeast. Most of the water discussed in this report comes from this unit.

The flood basins lie adjacent to the Sacramento River flood plains and natural levees and are composed of Holocene deposits of mostly fine silt and clays deposited by the river. This area is generally low in permeability. Ground-water development in this area is limited mostly to shallow domestic wells.

The Sacramento River flood plains and natural levees extend along the Sacramento River throughout the study area. This unit is composed of Holocene unconsolidated deposits of gravel, sand, silt, and clay. These deposits are highly permeable. Ground-water development in in this area, as in the flood basins, is also mostly from shallow domestic wells.




Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

0 5 10 15 MILES

0 5 10 15 20 KILOMETERS

**Areal distribution of geomorphic units.**

## 3.0 APPROACH

### 3.1 Methods

#### Collection of Water-Quality Data

From January to August 1980, 349 wells were selectively inventoried in Solano County. During August and September 1980, samples were collected from 75 of these wells. From November 1980 to August 1981, 630 samples were selectively inventoried in Yolo County. During August and September 1981, samples were collected from 113 of these wells.

To establish a network of wells for sampling in Yolo and Solano Counties, information was gathered on as many wells in the area as possible. The information was examined to determine the probability of locating the well in the field. Criteria used for this determination were:

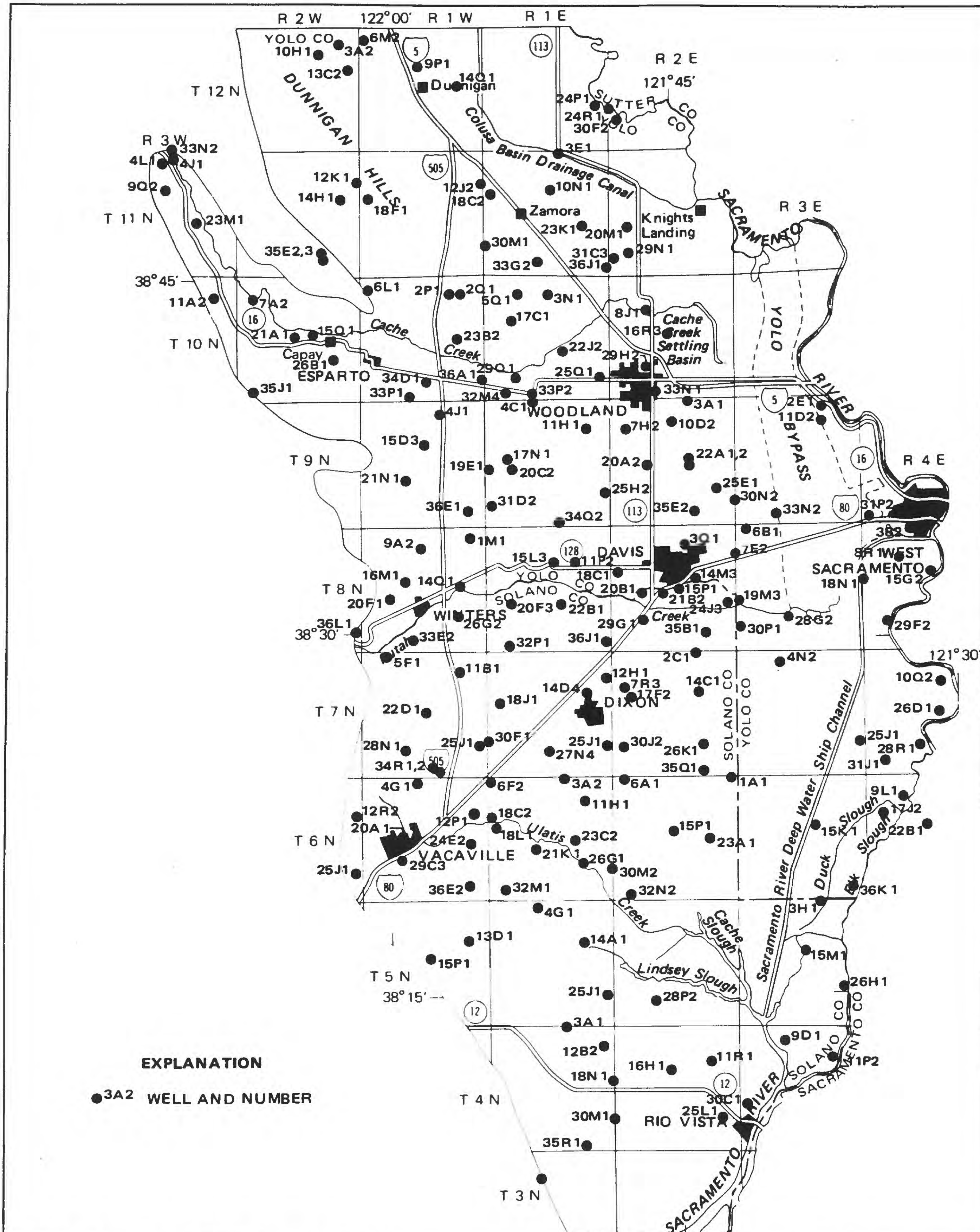
1. Age of the well--25 years or less. (Some wells more than 25 years old are still active.)
2. Description of location--street address (or rural route number), owners' name, township, range, and section, and distance from the nearest intersection.
3. Well-identifying features--well use, depth, casing size, and size and serial numbers of pump and motor.

When a well was located, the fieldperson determined whether or not the well could be sampled, obtained the owner's permission, recorded the point at which the sample should be collected, and updated construction information.

The resulting network was further refined to include 188 of the wells inventoried that would be representative of the study area. Criteria used for this determination were well location and depth, depth of perforated intervals, and suitability for sampling.

Temperature, specific conductance, pH, and alkalinity were measured at the time the sample was collected. Temperature of the sample was taken with a handheld thermometer, specific conductance and pH were taken with portable meters, and the alkalinity was determined by the electrometric titration process described by Brown and others (1970, p. 42). In an attempt to reduce error, all measurements were made twice. At each sampling site, water also was processed for shipment to the U.S. Geological Survey Central Laboratory. Samples that required filtration were filtered through a 0.45-micrometer cellulose acetate filter. At the end of each day, the samples were mailed to the laboratory.

At the Central Laboratory, all samples were analyzed for dissolved concentrations of boron, calcium, chloride, fluoride, magnesium, nitrite plus nitrate as nitrogen, potassium, dissolved solids, silica, sodium, and sulfate. Hardness values were calculated for all samples. Of the 188 samples, 101 were also analyzed for aluminum, arsenic, iron, and manganese. In addition, 22 samples were analyzed for cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Seventeen of these samples were analyzed for cobalt, lithium, strontium, and vanadium.




Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

0 5 10 15 MILES

0 5 10 15 20 KILOMETERS

**Location of wells sampled.**

## Comparison of Water-Quality Data to Recommended Limits

Water quality in this report is discussed in terms of potential effects on irrigated agriculture and humans. Concentrations are compared to governmental regulations for public drinking water supplies and irrigation. Limits given are for total concentration of constituents.

Chemical constituents considered are limited to those for which government agencies have established recommended limits and which are indicative of degraded water quality. These constituents are discussed in terms of human toxicity or annoyance, and agricultural toxicity.

Distinction is made between primary drinking water regulations and secondary drinking water regulations. The primary drinking water regulations (U.S. Environmental Protection Agency [EPA], 1977) pertains to constituents that may present a health hazard. These regulations are the same as the maximum contaminant levels outlined in California Department of Health, Sanitary Engineering Division (1977). The secondary drinking water regulations (U.S. Environmental Protection Agency, 1979) pertains to constituents that may be objectionable to the esthetic qualities but do not necessarily present a health hazard. These regulations are the same as the secondary maximum contaminant levels outlined in California Department of Health, Sanitary Engineering Division (1977). Comparisons are made to values established by various government agencies which represent statutory limitations on public-water supplies.

Ayers and Branson (1975) and the National Academy of Sciences and National Academy of Engineering (1973) provide recommendations for maximum concentrations of certain elements in water to be used for irrigation. There are no regulations on irrigation water and recommendations vary with type of soil and different farming practices.

Distributions of chemical concentrations are shown on maps along with their discussion. Throughout the area, these distributions are related to the availability of wells qualified for sampling. Two areas within the study area lack ground-water development and therefore lack data. These areas are parts of Tps. 6-10 N., R. 3 E.; and the Dunnigan and Capay Hills which include parts of Tps. 11-12 N., Rs. 1-2 W.

Recommended limits for selected chemical constituents in drinking and irrigation water

[For irrigation water, the lower value is the maximum recommended for use continuously on all soils. The upper value is the maximum recommended for use on fine textured, neutral to alkaline soils for up to 20 years]

| | Concentrations, in milligrams per liter | | |
|---|---|---|---|
| | Environmental Protection Agency drinking water regulations | | |
| Constituent | Primary | Secondary | Irrigation water |
| Arsenic | 0.05 | --- | 0.1-2.0 |
| Chloride | --- | 250 | --- |
| Fluoride | [1]1.6 | --- | 1.0-15.0 |
| Iron | --- | 0.3 | 5.0-20.0 |
| Manganese | --- | 0.5 | 0.2-10.0 |
| Nitrate nitrogen | 10 | --- | --- |
| Sulfate | --- | 250 | --- |
| Dissolved solids | --- | 500 | ([2]) |

[1] Concentration based on mean annual maximum daily air temperature in the study area.

[2] Refer to section 4.1.

## 4.0 CHEMICAL QUALITY OF GROUND WATER

### 4.1 Dissolved Solids

Dissolved Solids in Ground Water

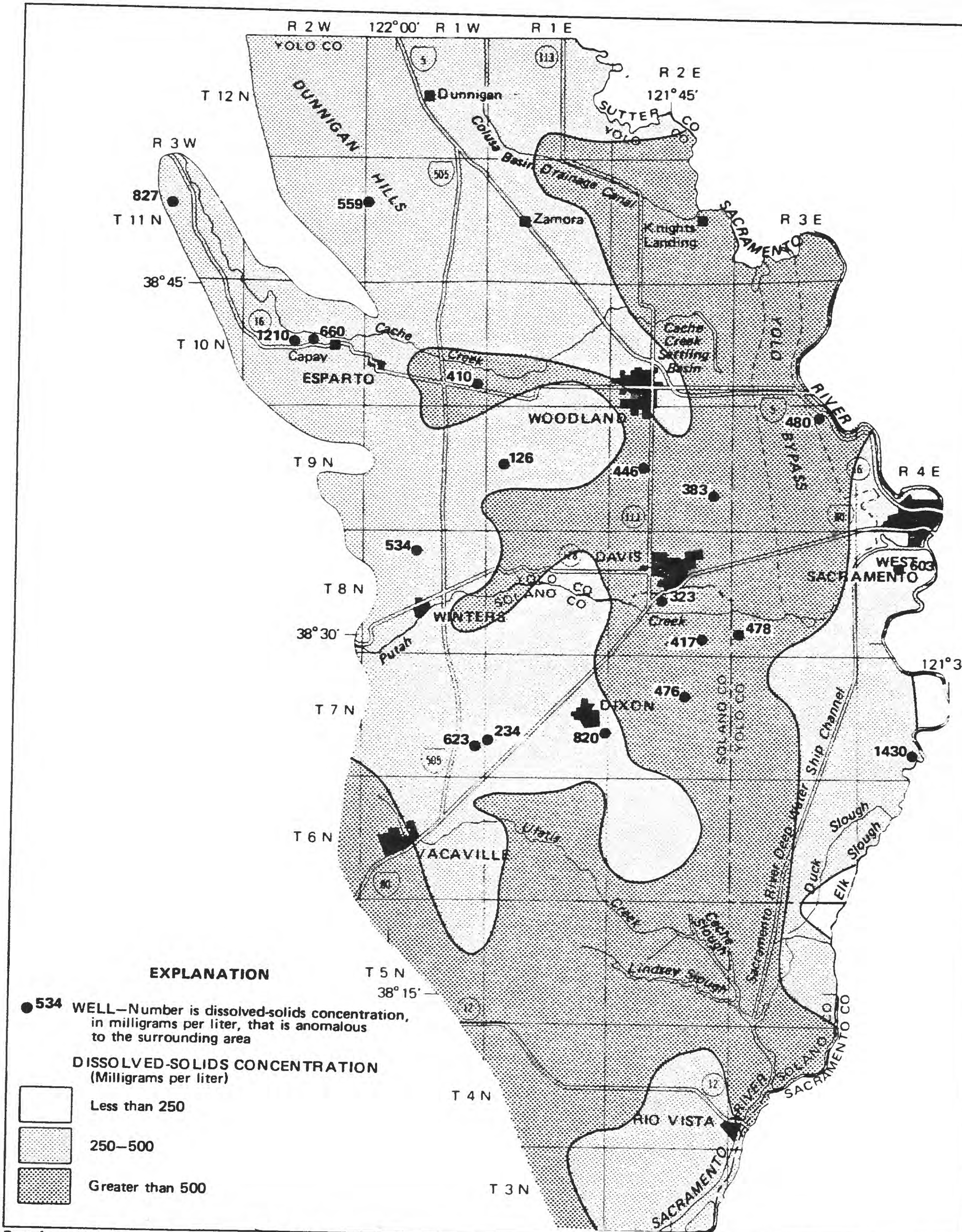
Dissolved-solids concentrations in the study area were high with respect to recommended limits. Concentrations ranged from 126 to 2,130 mg/L with a mean of 537 mg/L and a median of 457 mg/L.

High dissolved-solids concentrations in water may be objectionable to users because of odor, taste, and staining. With higher concentrations of dissolved solids there also may be excessive concentrations of specific substances that can be physiologically harmful to humans. The U.S. Environmental Protection Agency (1979) secondary drinking water regulations recommended a limit of 500 mg/L if other sources are available. Drinking water exceeding 500 mg/L can be used without ill effects; therefore, the usability of water should be evaluated according to the concentration of each chemical constituent.

No detrimental effects will be noticed on crops irrigated with water containing less than 500 mg/L of dissolved solids. Chapman and others (1949, p. 136) suggested that 1,000 mg/L is near maximum for best crop growth in California.

Suggested guidelines for dissolved solids in irrigation water (National Academy of Sciences and National Academy of Engineering, 1973) and their percent distribution are shown on the table below. About one-half of the area has dissolved-solids concentrations greater than 500 mg/L.

| Crop response | Dissolved-solids concentration (mg/L) | Distribution (percent of wells) |
|---|---|---|
| No detrimental effects noticed | 500 | 57 |
| Can affect sensitive crops | 500-1,000 | 37 |
| Can affect most crops | 1,000-2,000 | 5 |
| Can be applied to tolerant crops on permeable soils. | 2,000-5,000 | 1 |




Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

0 5 10 15 MILES

0 5 10 15 20 KILOMETERS

**Areal distribution of dissolved-solids concentrations.**

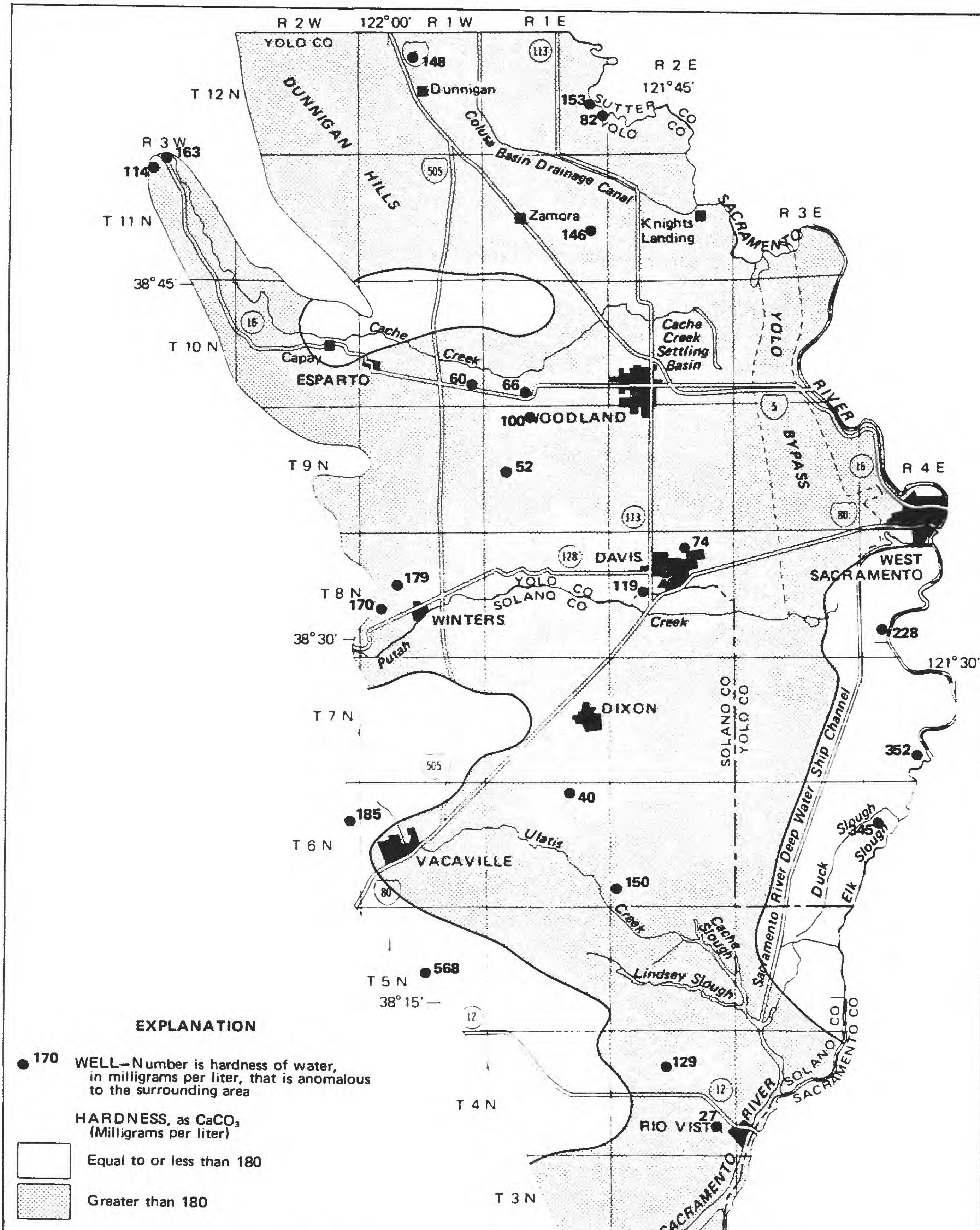
## Hardness in Ground Water

**Hardness ranged from 27 to 1,159 mg/L with a mean of 297 mg/L and a median of 256 mg/L.**

Hardness is mainly a reflection of the amount of calcium and magnesium in water. The adjectives--hard and soft--used to describe water become defined by people's experiences and are inexact, therefore the following classification (Hem, 1970) is used to quantify the terms. From a practical standpoint, hardness is a reflection of the amount of soap needed in washing. There are no water-quality standards for hardness of water; however, hardness (as $CaCO_3$) in excess of 180 mg/L may be objectionable because of soap consumption, scaling of utensils, and incrustation in water pipes (Hem, 1970).

| Classification | Hardness range (mg/L) | Distribution (percent of wells) |
|---|---|---|
| Soft | 0-60 | 2.6 |
| Moderately hard | 60-120 | 11.8 |
| Hard | 121-180 | 11.8 |
| Very hard | Greater than 180 | 73.8 |

Hardness values were generally greater than 180 mg/L. Water samples from wells east of the deep water ship channel tended to have the lowest hardness values. In this area, the average hardness was 144 mg/L. In two small areas, one north and east of Esparto and the other along the western edge of the study area south of Winters, hardness also was lower than average. In these areas, hardness ranged from 39 to 360 mg/L.




Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

0 5 10 15 MILES
0 5 10 15 20 KILOMETERS

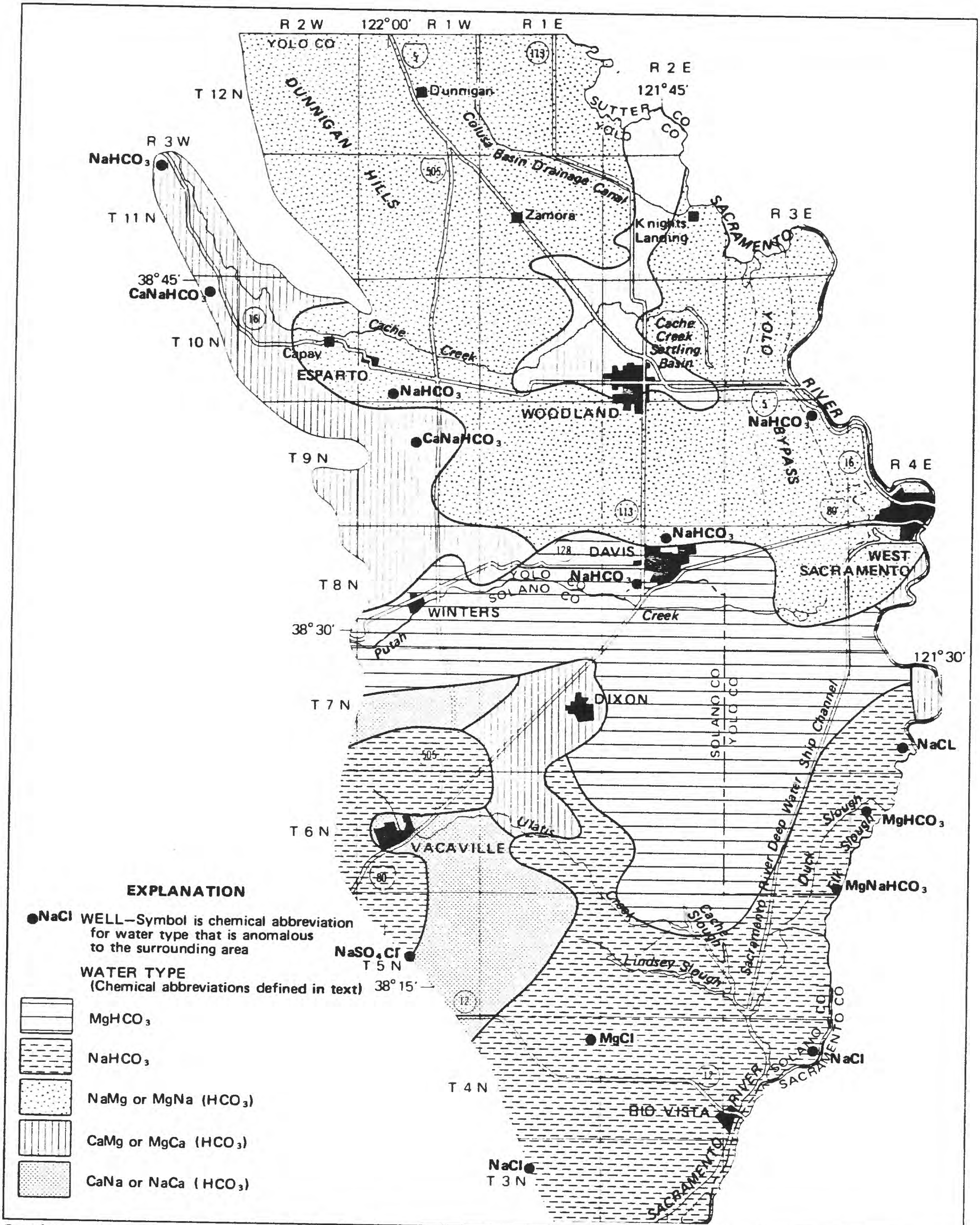
Areal distribution of the hardness of water.

## Chemical Water Types of Ground Water

Water types varied throughout the area. Eighty-eight percent of the wells sampled contained water that was a bicarbonate type; of that, 72 percent was a sodium, magnesium, sodium magnesium, or magnesium sodium bicarbonate.

The classification of water into general chemical types is based on the relative concentration, in chemical equivalents, of cations and anions in the water. A magnesium bicarbonate type refers to water in which magnesium amounts to at least 50 percent of the cations and bicarbonate amounts to at least 50 percent of the anions. If no one cation or anion accounts for 50 percent of the total, the water is designated by the two largest percentages such as sodium magnesium bicarbonate (Piper, Garrett, and others, 1953, p. 26). Eight water types were predominant in the study area: Magnesium bicarbonate ($MgHCO_3$), sodium bicarbonate ($NaHCO_3$), sodium magnesium bicarbonate ($NaMgHCO_3$), magnesium sodium bicarbonate ($MgNaHCO_3$), calcium magnesium bicarbonate ($CaMgHCO_3$), magnesium calcium bicarbonate ($MgCaHCO_3$), calcium sodium bicarbonate ($CaNaHCO_3$), and sodium calcium bicarbonate ($NaCaHCO_3$).

Wells along Putah Creek, and extending south in the center of the study area, contain water that is mainly a magnesium bicarbonate type. Historical analyses of water from Putah Creek also shows that the water type is a magnesium bicarbonate (California Division of Water Resources, 1955). This seems to indicate that the surface water from Putah Creek may be a factor in the chemical makeup of the ground water both near the creek and following the flow of the ground water south into the center of Solano County. South and east of this area, the water is mostly sodium bicarbonate. To the north of Putah Creek, the water is a sodium magnesium bicarbonate or a magnesium sodium bicarbonate type. Bertoldi (1976) also found this chemical water type in wells sampled in the Zamora area. Along the western edge of the study area, north of Putah Creek, the water type is a calcium magnesium and magnesium calcium bicarbonate. This type water also was found in the vicinity of Dixon, West Sacramento, and Woodland. Calcium sodium and sodium calcium bicarbonate type water was found in two small areas in Solano County. One of these areas is west of Dixon and the other south of Vacaville.




**EXPLANATION**

●NaCl WELL—Symbol is chemical abbreviation for water type that is anomalous to the surrounding area

WATER TYPE
(Chemical abbreviations defined in text)

- $MgHCO_3$
- $NaHCO_3$
- NaMg or MgNa ($HCO_3$)
- CaMg or MgCa ($HCO_3$)
- CaNa or NaCa ($HCO_3$)

Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

Scale: 0 5 10 15 MILES; 0 5 10 15 20 KILOMETERS

Areal distribution of water types.

## Chloride in Ground Water

**Chloride concentrations are as much as 720 mg/L with a mean of 75 mg/L and a median of 43 mg/L.**

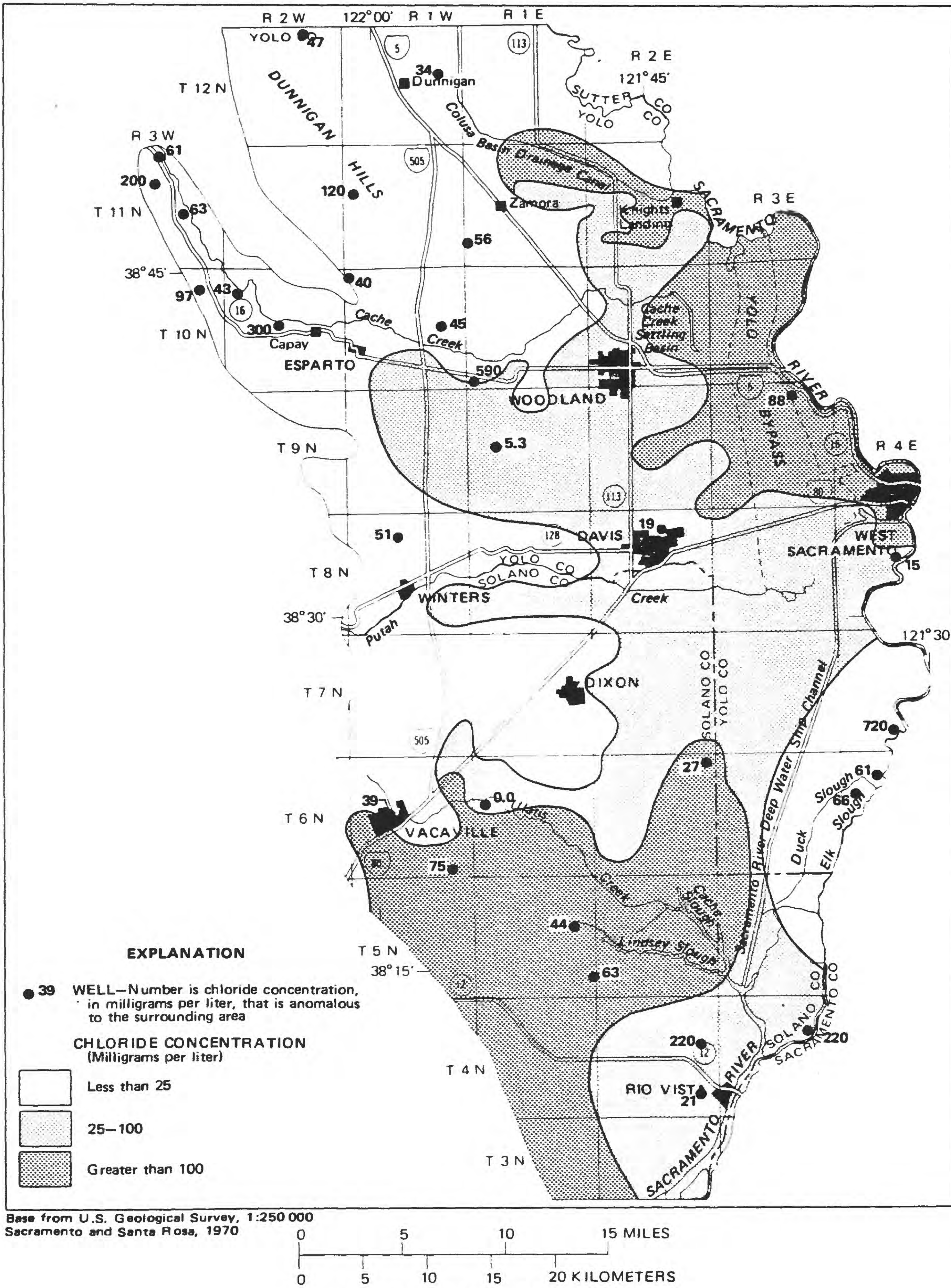
High chloride concentrations, although corrosive to water pipes and salty to the taste, are not a health hazard. On the basis of taste preference, the U.S. Environmental Protection Agency (1979) recommends a maximum concentration of 250 mg/L for drinking water.

Chloride in high concentrations can be toxic to plants; however, salinity usually impairs growth before chloride concentrations can reach toxic levels. Chloride concentrations as much as 700 mg/L can be used on most crops without incurring toxic effects (National Academy of Sciences and National Academy of Engineering, 1973).

The southwestern part of the study area and the area along the Sacramento River between Cache and Putah Creeks have chloride concentrations that are high for the study area. Even in these areas, 250 mg/L was rarely exceeded. Chloride concentrations in 10 wells were greater than than 250 mg/L; one well exceeded 700 mg/L. Of these wells, two are industrial wells, and the remaining eight are domestic wells.

Wells with water exceeding chloride concentrations of 250 milligrams per liter

| Well No. | Use | Chloride concentration (mg/L) |
|---|---|---|
| 3N/1E-9H1 | Domestic | 520 |
| 4N/1E-12B2 | Industrial | 340 |
| 5N/1E-4G1 | Domestic | 280 |
| 5N/1W-15P1 | do. | 360 |
| 6N/2E-23A1 | do. | 280 |
| 6N/2E-32N2 | do. | 570 |
| 7N/4E-28R1 | do. | 720 |
| 9N/3E-30N2 | Industrial | 500 |
| 10N/1E-32M4 | Domestic | 590 |
| 10N/2W-21A1 | do. | 300 |




Areal distribution of chloride concentrations.

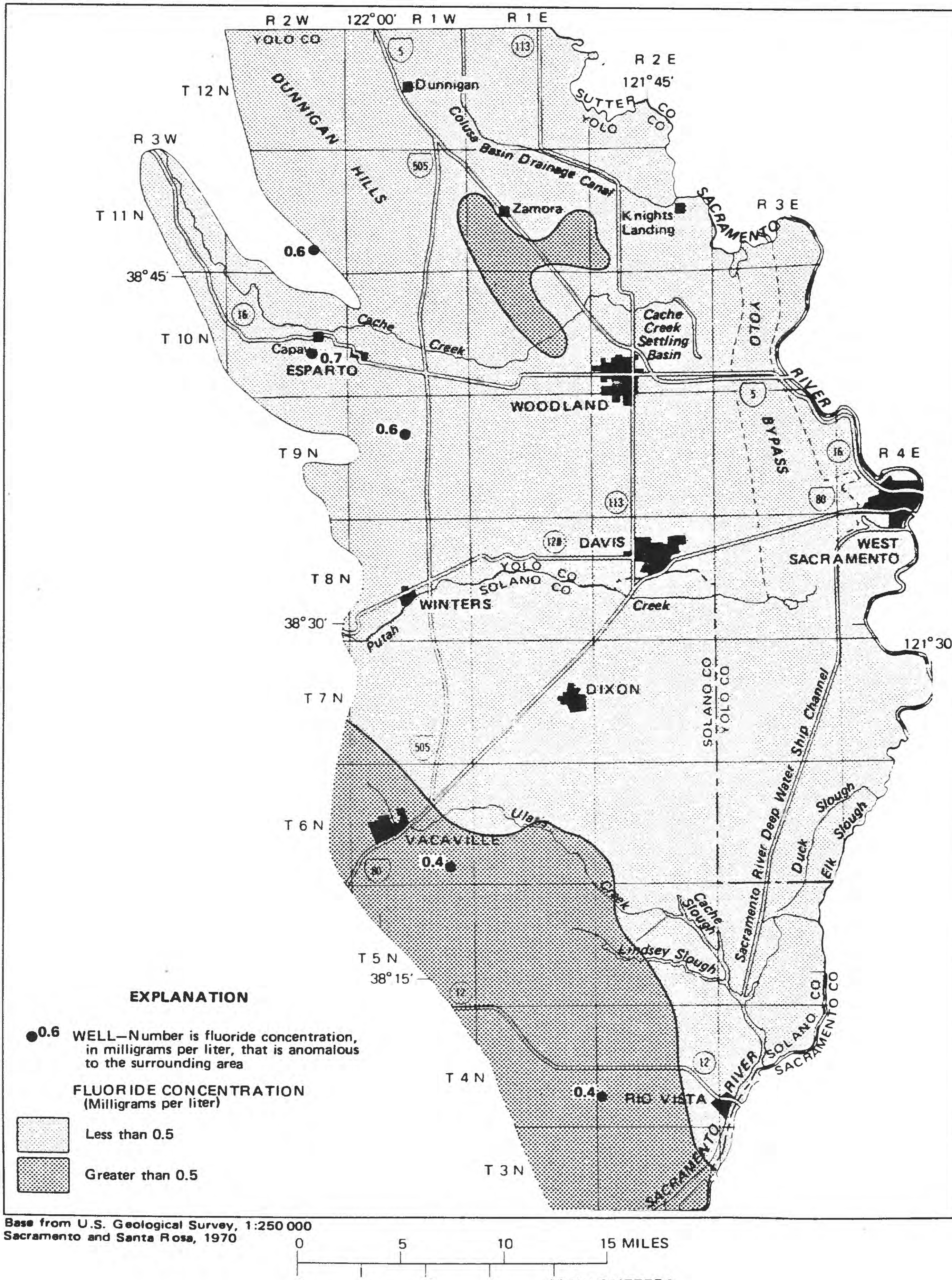
## Fluoride in Ground Water

**Fluoride concentrations in Yolo and Solano Counties were as high as 1.6 mg/L, and had a mean of 0.3 mg/L and a median of 0.3 mg/L.**

In small amounts, fluoride has some beneficial effects; however, excessive fluoride can produce dental fluorosis (mottled enamel) that increases with fluoride consumption. Because the amount of water an individual consumes (and therefore the amount of fluoride consumed) is primarily influenced by air temperature, the recommended maximum fluoride concentrations have been adjusted according to mean maximum daily air temperature. The U.S. Environmental Protection Agency primary drinking water limit (1977) for fluoride is 1.6 mg/L; in this study area 0.8 mg/L is considered the optimum fluoride concentration.

Soluble fluoride salt can be applied to neutral or alkaline soils without harmful effects to crop production; however, application on acidic soils can result in plant toxicity. The National Academy of Sciences and the National Academy of Engineering (1973) recommend that fluoride not exceed 1.0 mg/L in irrigation water.

None of the wells in the study area exceeded the U.S. Environmental Protection Agency drinking water limit of 1.6 mg/L. Two wells in the study area exceeded 1.0 mg/L. An irrigation well, 5N/1E-14A1, had a concentration of 1.6 mg/L, and a domestic well, 4N/1E-35R1, had a concentration of 1.1 mg/L. The southwestern part of the study area and a small area between Woodland and Zamora had high concentrations of fluoride. Here the concentrations ranged from 0.6 to 1.6 mg/L and averaged 0.8 mg/L.




**Areal distribution of fluoride concentrations.**

## Sulfate in Ground Water

Sulfate concentrations ranged from 0.3 to 720 mg/L with a mean of 57.5 mg/L and a median of 39 mg/L.

High sulfate concentrations in drinking water may have a cathartic effect on persons accustomed to low sulfate concentrations. Acclimatization to high sulfate water is such that sulfate is not usually considered a health hazard. On the basis of taste, and because of its cathartic effect, the U.S. Environmental Protection Agency (1979) secondary drinking water regulations recommend that sulfate not exceed 250 mg/L.

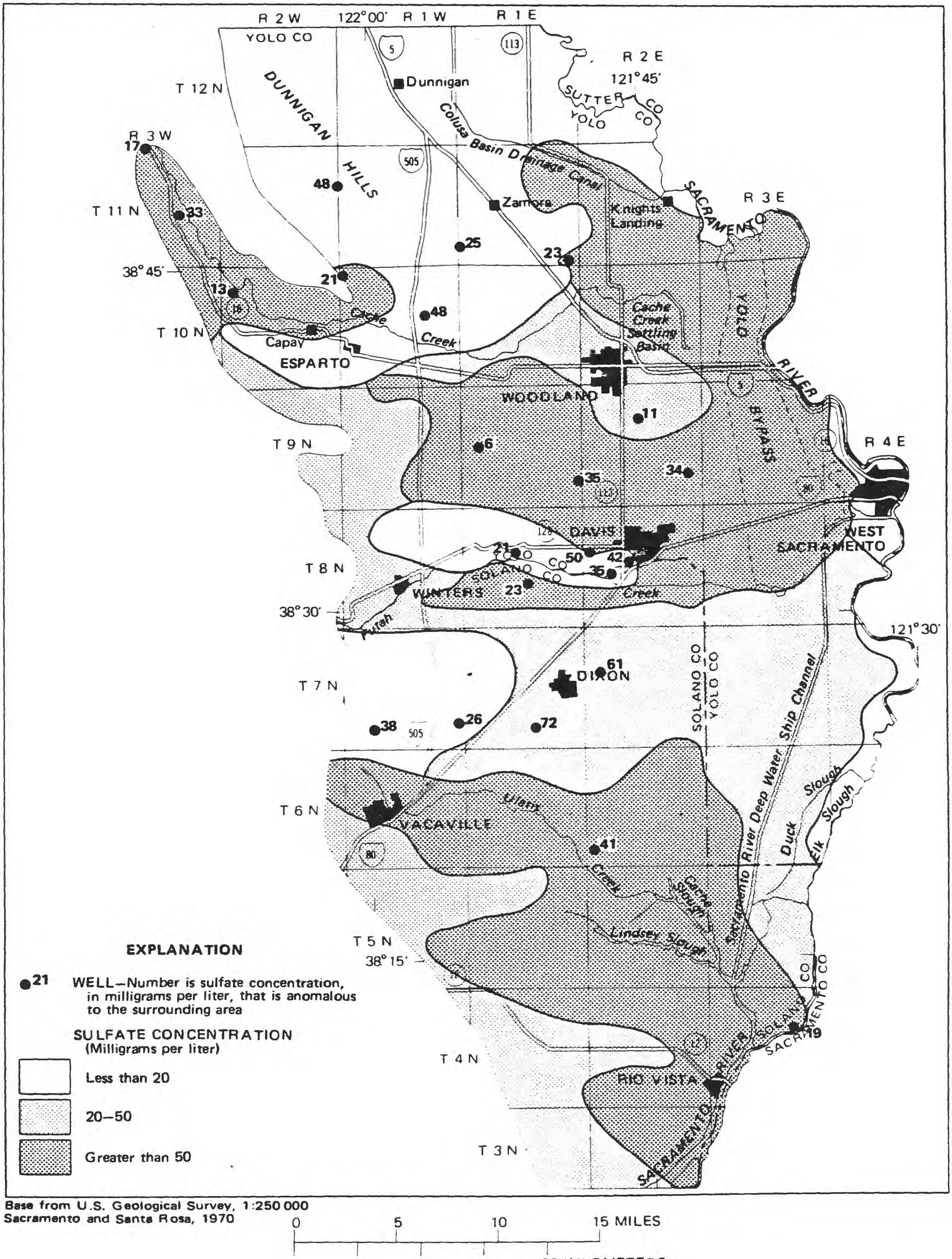
Because high sulfate concentrations can limit plant uptake of calcium, therefore disturbing cationic balance within plant cells, it can be a detriment in irrigation water. Detrimental effects are dependent on calcium content, soil type, drainage, and plant variety. The table below is a general guideline for sulfate concentrations in irrigation water (modified from California State Water Resources Control Board, 1951).

| Description | Maximum concentration (mg/L) | Distribution (percent of wells) |
|---|---|---|
| Excellent to good | 480 | 98 |
| Good to injurious | 480-960 | 2 |
| Injurious to unsatisfactory | 960 | 0 |

Sulfate concentrations were low over the study area with respect to the recommended limits. The north central part of the study area had the lowest sulfate concentrations in the area from Zamora to Dunnigan. Low sulfate concentrations also were found along Putah Creek west of Davis, west of Dixon, and along the Sacramento River in Tps. 6 and 7N. Ground water sampled in these areas had less than 2 mg/L of sulfate. Five wells in the study area contained more than 250 mg/L of sulfate. Four of these wells are domestic wells and one is an industrial well.

| Well No. | Use | Sulfate concentration (mg/L) |
|---|---|---|
| 5N/1W-15P1 | Domestic | 530 |
| 6N/2E-23A1 | do. | 510 |
| 6N/2E-32N2 | do. | 340 |
| 8N/3E-6B1 | do. | 500 |
| 9N/3E-30N2 | Industrial | 720 |

None of the irrigation wells contained water with sulfate in concentrations high enough to present problems. The highest sulfate levels were found in the central part of Yolo County and the southern part of Solano County.




**Areal distribution of sulfate concentrations.**

## Nitrogen in Ground Water

Nitrogen concentrations varied over the study area. They were as much as 45 mg/L with a mean of 3.3 mg/L and a median of 1.6 mg/L.

Water samples were analyzed for total nitrate plus nitrite as nitrogen. Nitrate is the most abundant form of nitrogen found in ground water (Hem, 1970); therefore, these nitrogen values were assumed to be about equivalent to nitrate concentrations.

Nitrate in ground water most commonly originates from land surface sources and is not associated with the chemical composition of the water-bearing formation. Most cases of nitrate toxicity in the United States are associated with private, shallow domestic wells which are subject to localized pollution sources such as leachates from fertilizers used in agriculture, septic tanks, and percolation from sewage ponds, and livestock feedlots.

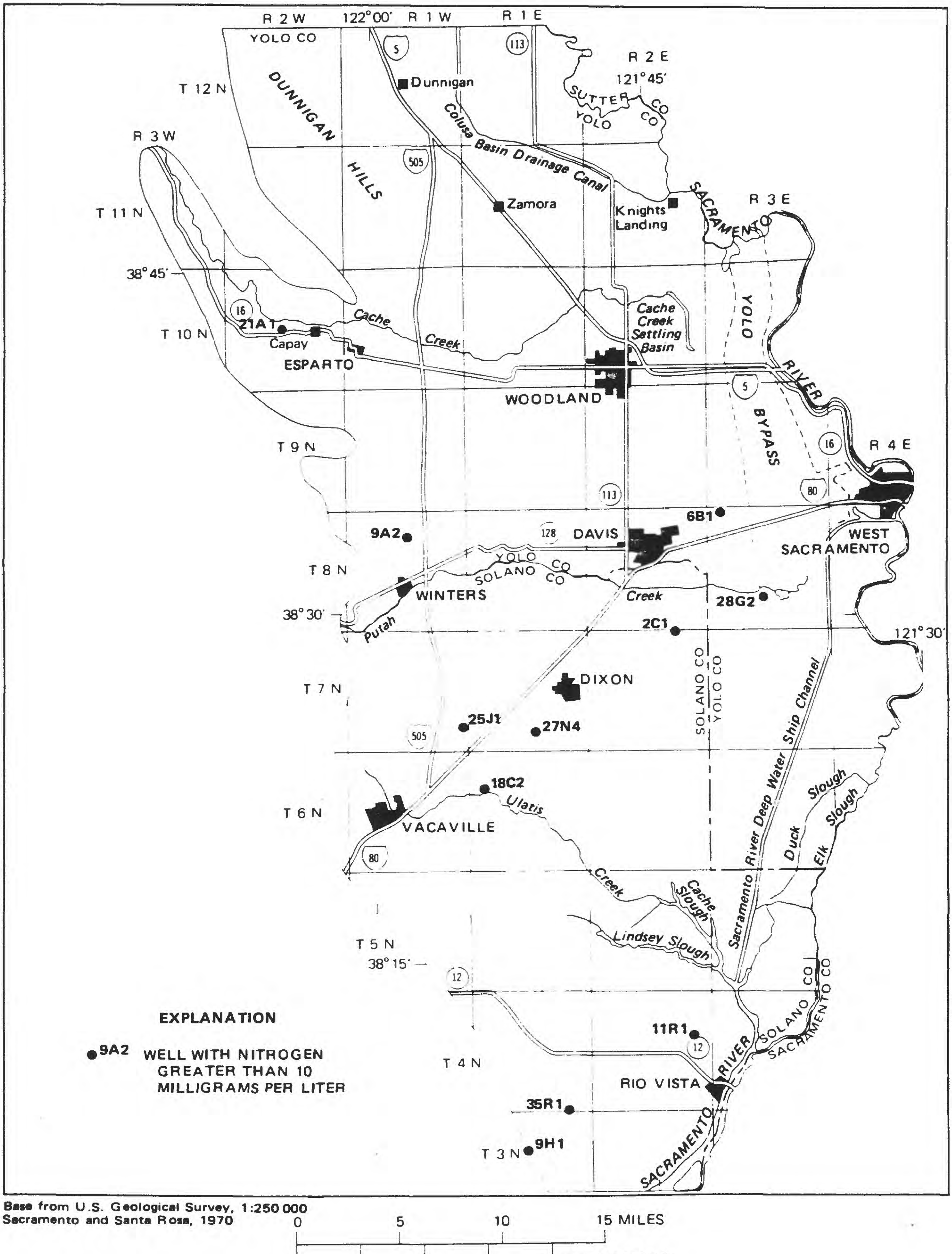
The primary drinking water regulation set by the U.S. Environmental Protection Agency (1977) is 10 mg/L of nitrate as nitrogen. High nitrate concentrations usually do not affect adults and older children, but can lead to a blood disorder known as methemoglobinemia which can be fatal in infants under about 4 months old.

For most agricultural uses, nitrate is considered an asset because of its value as a fertilizer. High concentrations of nitrate may have adverse effects on certain crops such as sugar beets, apricots, grapes, citrus, and avocados. Increasing problems can be detected from about 5 mg/L with severe problems occurring in concentrations above 30 mg/L (Ayers, 1977).

Eleven wells in the study area exceeded 10 mg/L nitrogen. These tended to be shallow and are scattered throughout the study area. Of these, 10 are used for domestic use and 1 is used for irrigation.

Wells with water exceeding nitrogen concentrations of 10 milligrams per liter

| Well No. | Use | Nitrogen concentration (mg/L) |
|---|---|---|
| 3N/1E-9H1 | Domestic | 45 |
| 4N/1E-35R1 | do. | 11 |
| 4N/2E-11R1 | do. | 16 |
| 6N/1E-18C2 | do. | 15 |
| 7N/1W-25J1 | do. | 18 |
| 7N/1E-27N4 | Irrigation | 12 |
| 7N/2E-2C1 | Domestic | 12 |
| 8N/1W-9A2 | do. | 14 |
| 8N/3E-6B1 | do. | 24 |
| 8N/3E-28G2 | do. | 23 |
| 10N/2W-21A1 | do. | 16 |



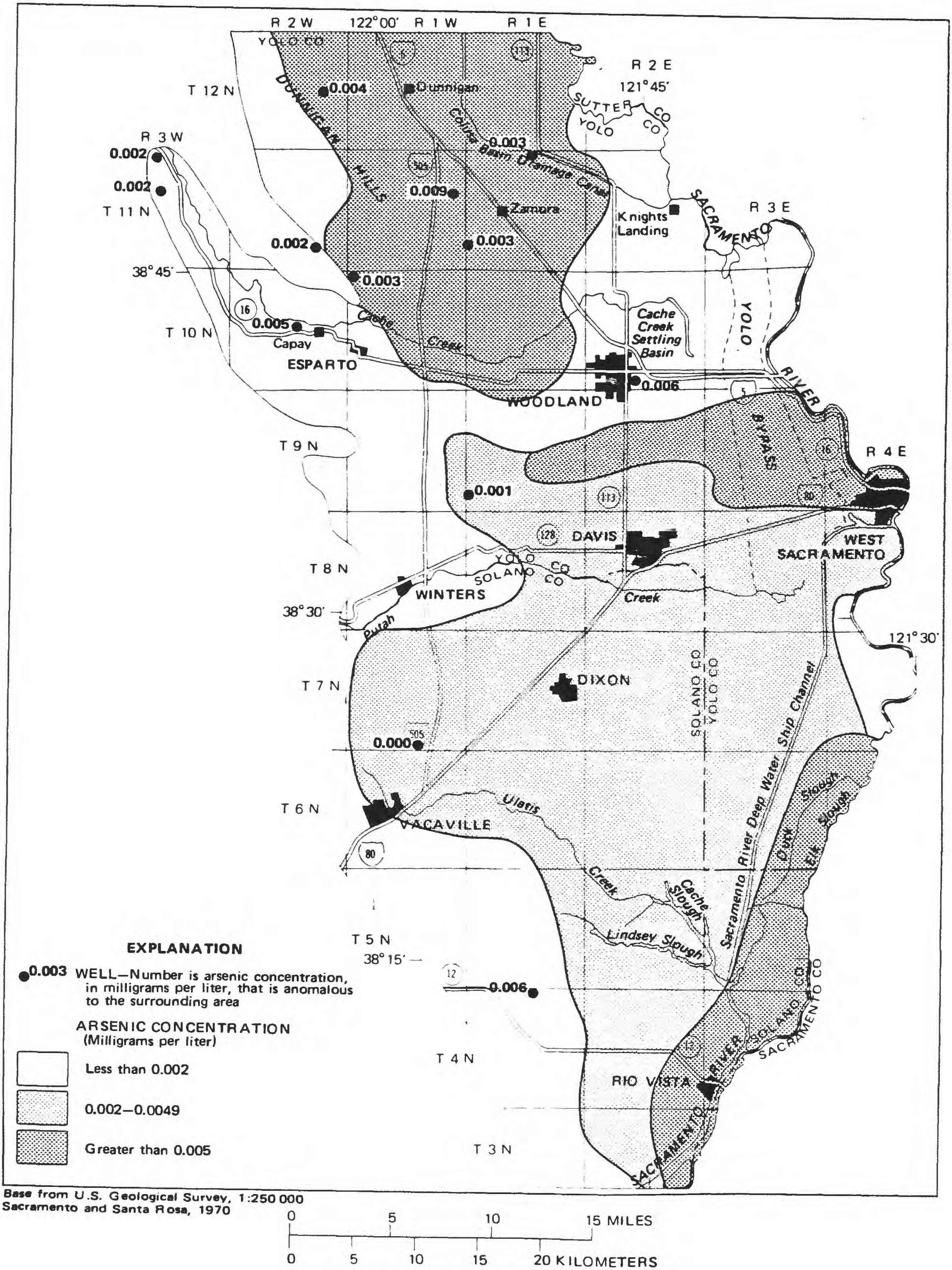

Location of wells exceeding 10 milligrams per liter of nitrogen.

## Arsenic in Ground Water

**Arsenic concentrations were less than the U.S. Environmental Protection Agency (1977) primary drinking water regulations throughout the study area. Values are as much as 0.022 mg/L with a mean of 0.004 mg/L and a median of 0.003 mg/L.**

Arsenic can be toxic to both plants and animals. The U.S. Environmental Protection Agency (1977) has established a primary drinking water regulation of 0.05 mg/L for arsenic and has recommended 0.1 mg/L arsenic not be exceeded in water used for irrigation. Although arsenic has not been found essential to animals, small amounts have been added to animal feed as a growth stimulant. The National Academy of Sciences and National Academy of Engineering (1973) recommend concentrations of arsenic in water used for livestock not exceed 0.2 mg/L.

Arsenic concentrations varied slightly throughout the study area. Values tend to be lower on the western side of the study area and slightly higher in the north, central, and southeast parts of the study area.




Areal distribution of arsenic concentrations.

## Boron in Ground Water

**Boron concentrations varied in Yolo and Solano Counties and are as much as 7.9 mg/L with a mean of 0.94 mg/L and a median of 0.63 mg/L.**

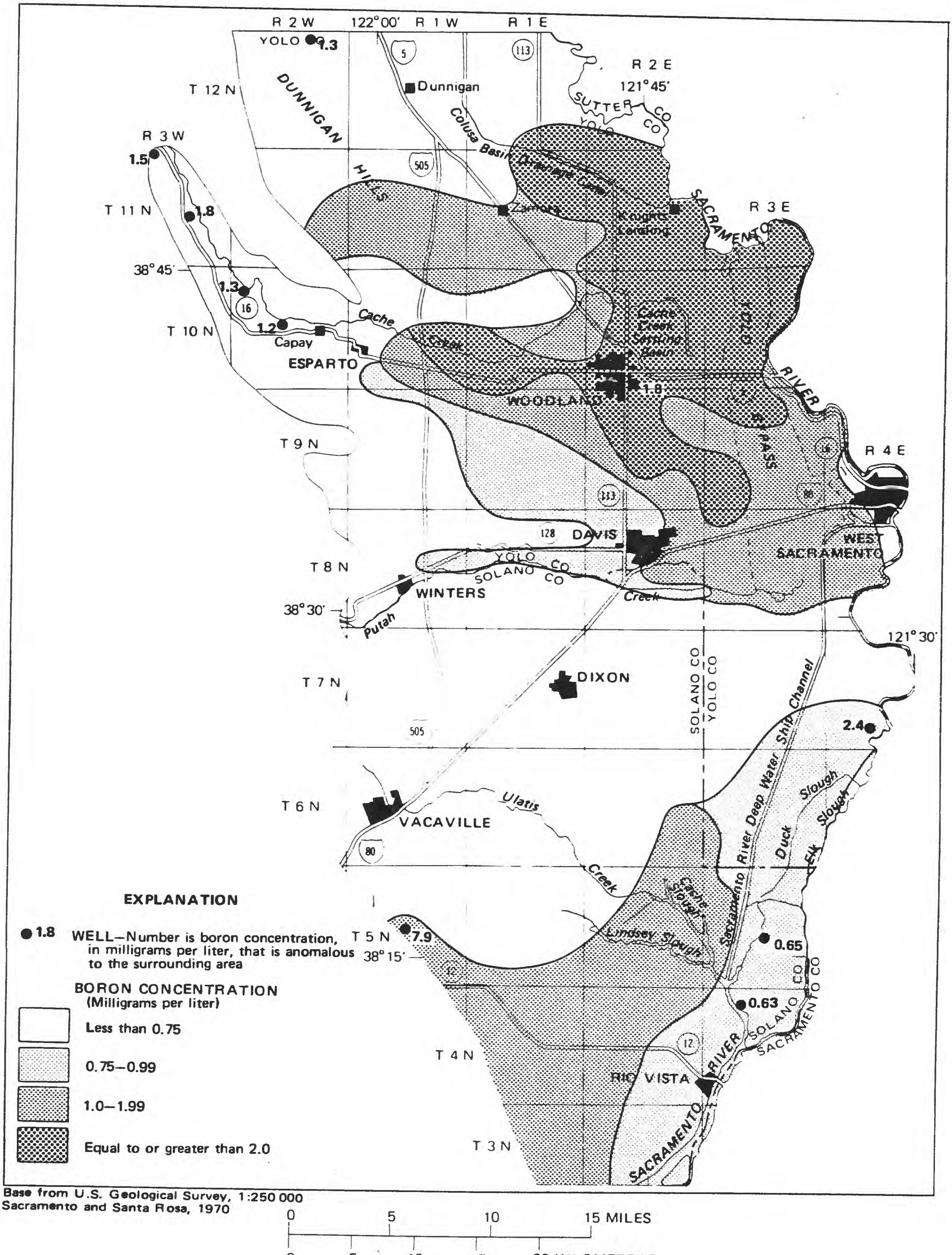
Although no Federal concentration limits exist for boron in drinking water, it is a critical element in irrigation water. In concentrations up to 0.5 mg/L, boron is considered an essential micronutrient in irrigation water; however, concentrations of more than 0.75 mg/L can be toxic to some plants. Crops have been classified into three categories of boron tolerance: sensitive, with toxicities of 1 mg/L or less, semitolerant at 1 to 2 mg/L, and tolerant at 2 to 4 mg/L (National Academy of Sciences and National Academy of Engineering, 1973). A listing of some of these crops is shown below. Water containing boron in concentrations greater than 4.0 mg/L and used continuously is considered unsatisfactory for most all crops.

Wells sampled in the western part of the study area north of Fairfield, and in two areas extending east to the Sacramento River at the latitudes of the towns of Dunnigan and Dixon, and in a narrow strip bordering the Sacramento River extending for about 3 mi south of West Sacramento were found to contain water with boron concentrations below 0.75 mg/L. However, ground water in the greater part of Yolo County and the southern part of Solano County contains boron in values greater than 1 mg/L with concentrations exceeding 2 mg/L in the Woodland-Zamora area. The highest concentrations are found east of Zamora where values ranged from 3.3 to 6.8 mg/L. Previous studies by Bertoldi (1976) and Fogelman (1978) also show boron concentrations exceeding 0.75 mg/L in the Zamora-Knights Landing area.

In Yolo County, the pattern of boron exceeding 0.75 mg/L follows a southeastern course from the foothills of the Coast Ranges toward the Sacramento River. Surface-water analyses from Cache Creek near Capay have a mean boron concentration of 1.5 mg/L (Sorenson and Elliott, 1981). High boron concentrations in water from wells sampled adjacent to Cache Creek indicate that surface water from the creek may be a source for high boron concentrations in the surrounding ground water. In these areas of high concentrations, where much of the water used for irrigation is ground water, boron can be a hazard to even tolerant crops. In Solano County, boron concentrations are high along the Sacramento River and seem to increase in a southwest direction.

Relative tolerance of some plants to boron
(Modified from U.S. Salinity Laboratory Staff, 1954. In each group, the plants first named are considered as being more sensitive and the last named more tolerant)

| Sensitive (<1.0 mg/L) | Semitolerant (1.0-2.0 mg/L) | Tolerant (>2.0 to 4 mg/L) |
|---|---|---|
| Almond | Lima bean | Carrot |
| Apricot | Sweet potato | Cabbage |
| Peach | Bell pepper | Turnip |
| Cherry | Tomato | Onion |
| Pear | Milo | Alfalfa |
| Prune | Corn | Sugar beet |
| Plum | Wheat | Asparagus |
| Persian (English) walnut | Barley | |
| Black walnut | Olive | |
| | Radish | |
| | Sunflower (native) | |



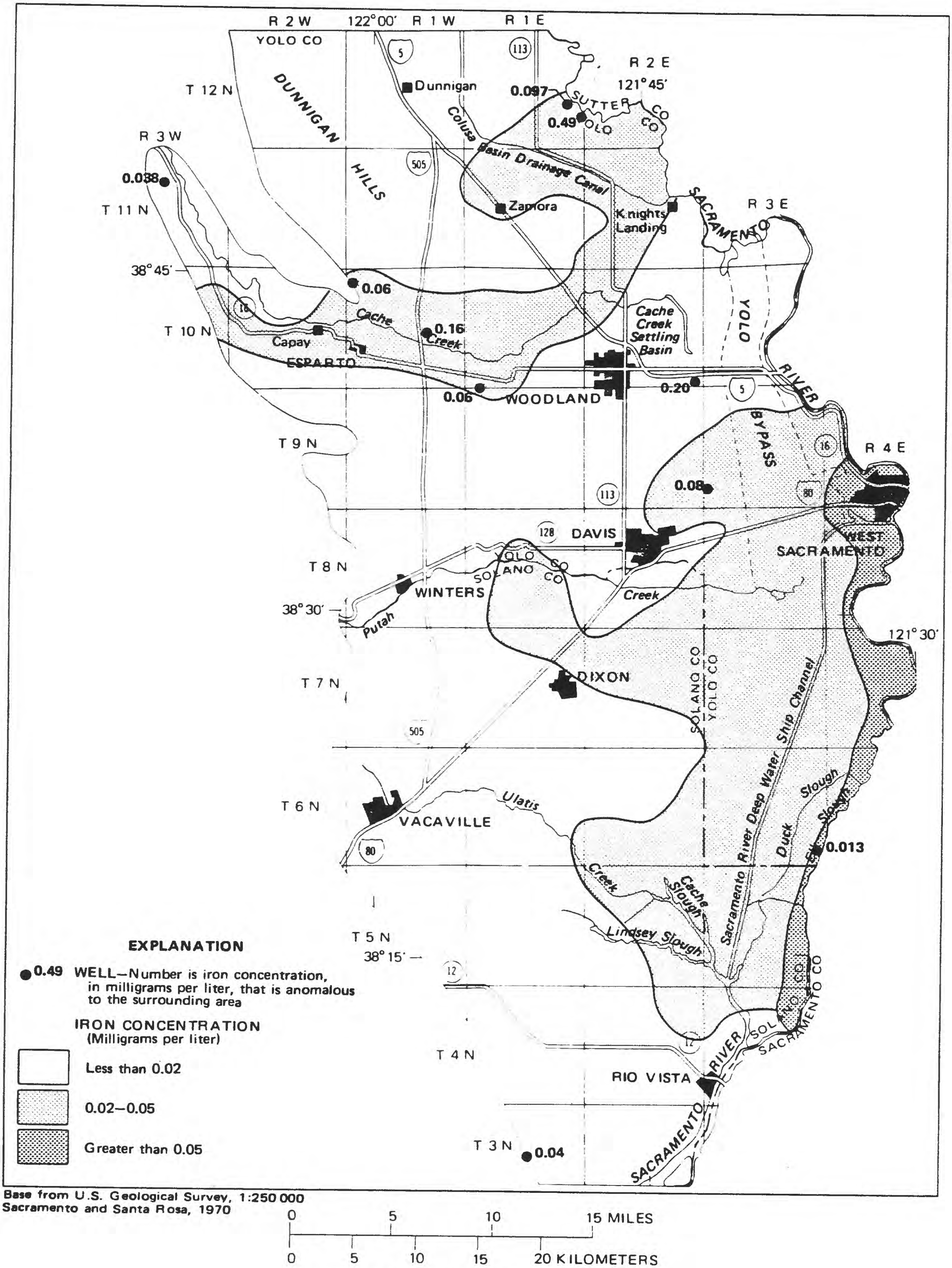

Areal distribution of boron concentrations.

## Iron in Ground Water

**With respect to Federal standards, iron concentrations throughout the study area are low and range from 0.01 to 0.49 mg/L with a mean of 0.03 mg/L and a median of 0.01 mg/L.**

Iron can be objectionable in public-water supplies if concentrations are great enough to stain plumbing fixtures and laundry, accumulate in distribution systems, and affect the taste. Based on these considerations, the U.S. Environmental Protection Agency (1979) secondary drinking water regulations for iron in public-water supplies is 0.3 mg/L.

With the exception of the area bordering Cache Creek, concentrations of iron were uniformly low over the western part of the study area; all the wells sampled contained less than 0.02 mg/L. Along Cache Creek and in the eastern part of the study area, values ranged from 0.02 to 0.49 mg/L. One well, 12N/1E-24R1, having a concentration of 0.49 mg/L, exceeded the 0.3 mg/L limit and is used for irrigation.




Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

Areal distribution of iron concentrations.

## Manganese in Ground Water

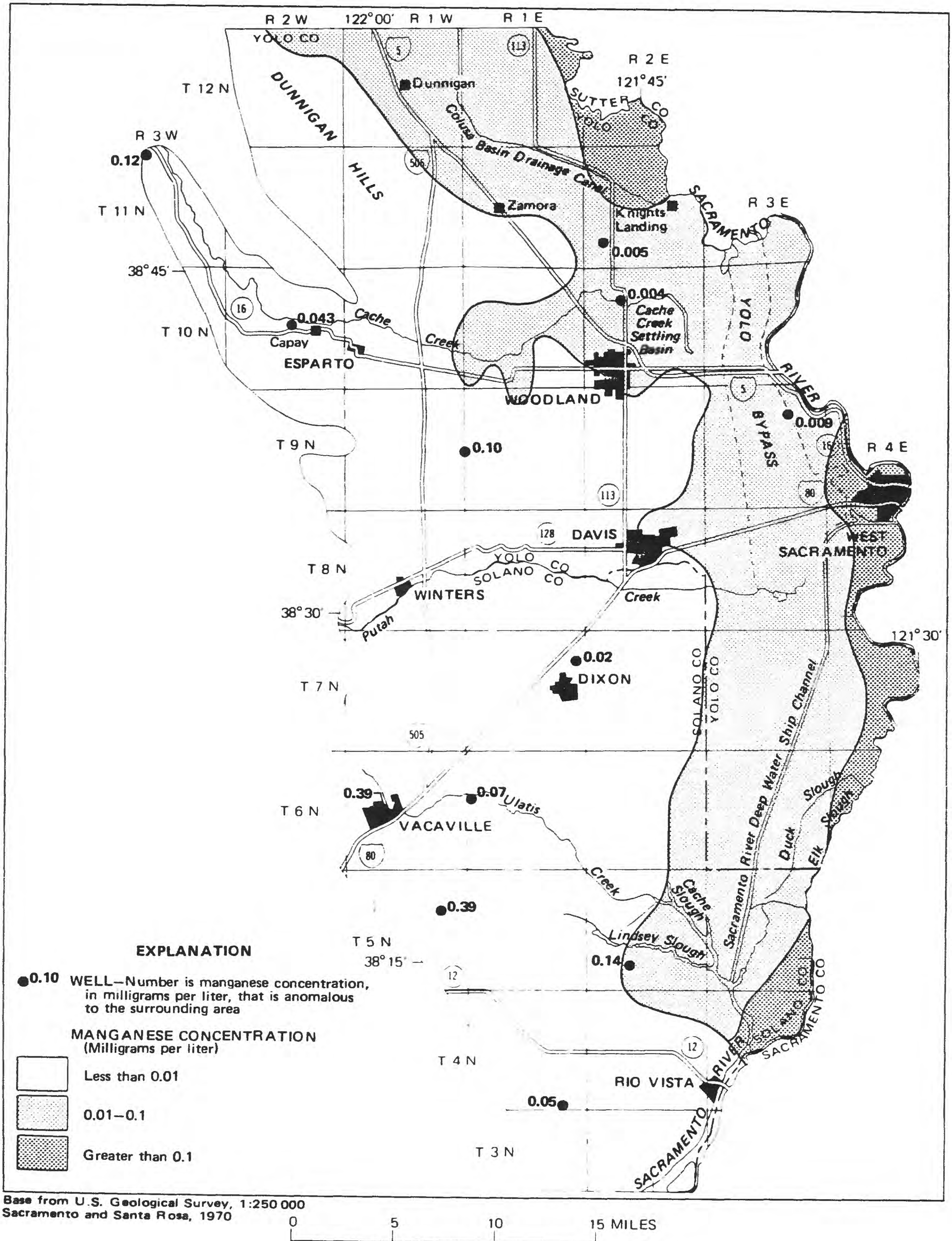
**Manganese concentrations are generally low with respect to the recommended limits, and range from 0.00 to 1.2 mg/L with a mean of 0.057 mg/L and a median of 0.004 mg/L.**

Manganese is not considered a human health hazard, but high concentrations in drinking water can affect taste, stain clothing and plumbing fixtures, and accumulate in distribution systems. On these criteria, the U.S. Environmental Protection Agency (1979) recommended a maximum manganese concentration of 0.05 mg/L in public-water supplies. The National Academy of Science and National Academy of Engineering (1973) recommend a maximum manganese value of 0.2 mg/L for irrigation water.

Wells sampled in the area bordering the Sacramento River contained water with the highest concentrations of manganese. In this area, concentrations ranged from 0.18 to 1.2 mg/L. Manganese concentrations decreased as the distance from the Sacramento River increased. Water samples from wells near the Sacramento River and west about 10 mi had manganese concentrations ranging from 0.02 to 0.18 mg/L, and samples from wells in the western half of the study area rarely exceeded 0.01 mg/L. Seventeen wells throughout the study area exceeded the 0.05 mg/L limit for drinking water, and of these, eight wells also exceeded the 0.2 mg/L limit for irrigation water.

Wells with water exceeding manganese concentrations of 0.05 milligram per liter

| Well No. | Use | Manganese concentration (mg/L) |
|---|---|---|
| 4N/3E-9D1 | Domestic | 0.23 |
| 4N/3E-11P2 | do. | .18 |
| 5N/1W-13D1 | Irrigation | .39 |
| 5N/2E-28P2 | Domestic | .14 |
| 6N/1E-1811 | do. | .07 |
| 6N/1W-20A1 | Irrigation | .39 |
| 6N/4E-17J2 | Domestic | 1.20 |
| 7N/4E-10Q2 | Irrigation | .72 |
| 7N/4E-31J1 | Domestic | .07 |
| 8N/4E-8R1 | do. | .23 |
| 8N/4E-15G2 | do. | .28 |
| 9N/1E-4C1 | do. | .09 |
| 9N/1E-19E1 | do. | .10 |
| 9N/4E-31P2 | Industrial | .18 |
| 11N/3W-4L1 | Domestic | .12 |
| 12N/1E-24P1 | Domestic | .17 |
| 12N/1E-24R1 | Irrigation | .43 |




Areal distribution of manganese concentrations.

## 5.0 IRRIGATION WATER CLASSIFICATION

### 5.1 Sodium

**Sodium, Salinity, and Irrigation Water Classification**

**Most of the wells sampled in Yolo and Solano Counties contained water that is considered to be low in sodium hazard but medium to high in salinity hazard.**

Salinity (often measured as electrical conductance or dissolved solids), sodium, and phytotoxic substances are the three most important constituents when considering water for irrigation use.

Sodium in drinking water can adversely affect individuals who must restrict sodium in their diets. The amount of sodium that can cause these effects varies so greatly that no standards for sodium in drinking water have been established.

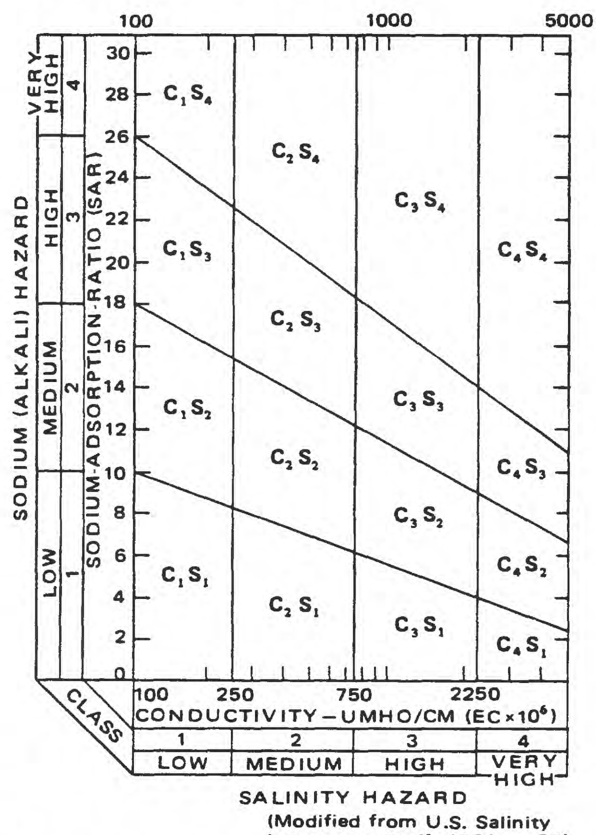
High sodium concentrations relative to calcium and magnesium decrease the permeability of soil which in turn makes it difficult to supply crops with water. As a measure of sodium hazard, the U.S. Salinity Laboratory Staff (1954) defined the SAR (Sodium Adsorption Ratio) by the equation:

$$SAR = \frac{Na^{+1}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}}$$

where all concentrations are expressed as milliequivalents per liter (meq/L).

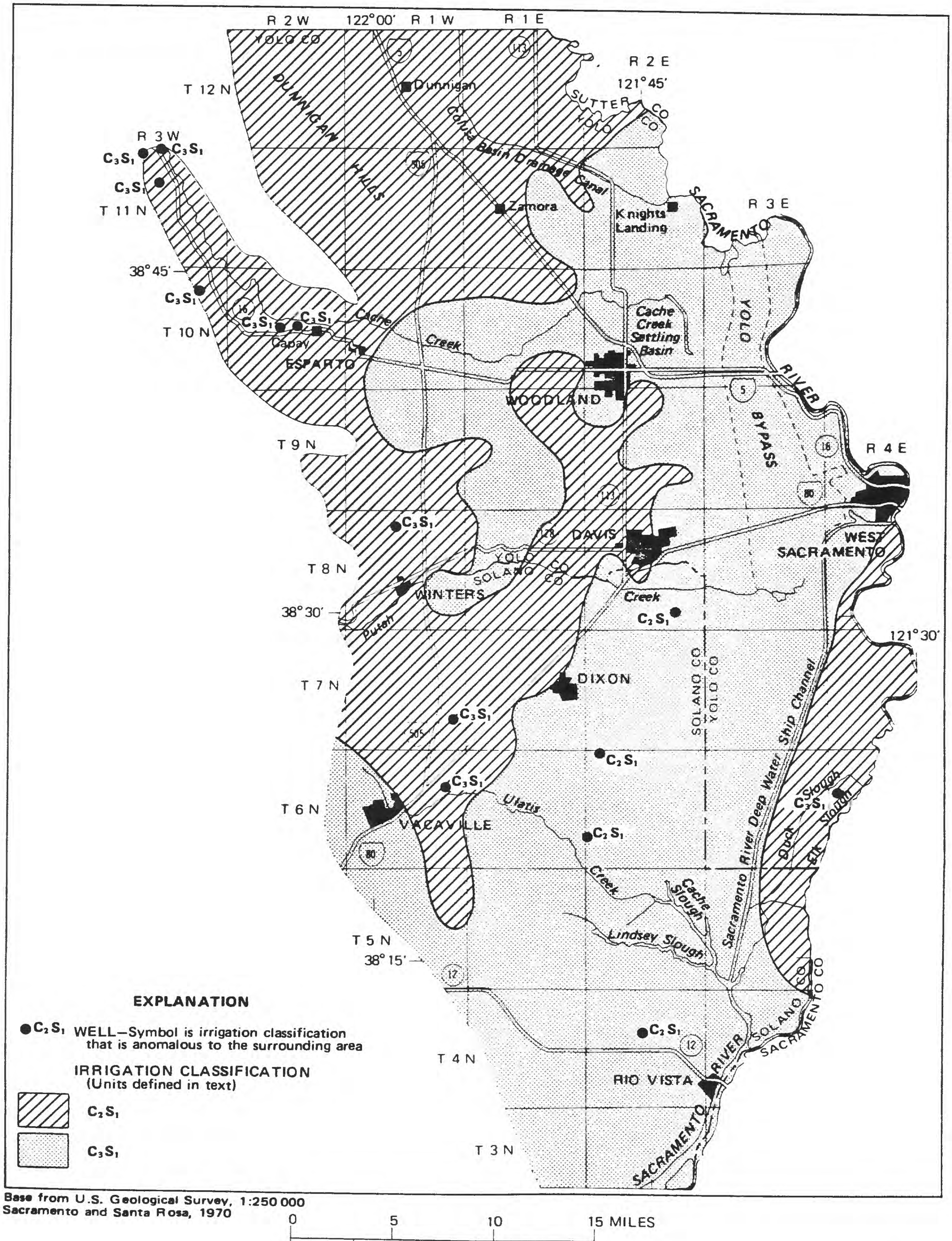
The Salinity Laboratory presented a method of classification to evaluate the interrelationship of salinity and SAR if both the SAR and conductivity are known.

Forty-nine percent of the wells sampled in the study area contain water classified $C_3S_1$ (high salinity, low sodium hazard). In the water in the western part of the study area and along the Sacramento River, the salinity hazard was medium and the sodium hazard was low ($C_2S_1$). Wells in the southern and eastern parts of the study area (except along the Sacramento River) were high in salinity hazard and low in sodium hazard ($C_3S_1$). Two wells, 4N/2E-30M1 and 10N/2W-15Q1, contain water with a high salinity hazard and medium sodium hazard ($C_3S_2$). Both of these wells are used for domestic purposes.




(Modified from U.S. Salinity Laboratory Staff, 1954, p. 80)

**Method of classifying irrigation water based on dissolved-solids concentration and sodium hazards.**




Areal distribution of irrigation water classes.

## Potential for an Increase of Sodium Hazard in Irrigation Water

**The potential for an increase of sodium hazard exists in 25 percent of the wells sampled in the study area.**

High concentrations of bicarbonate ions cause precipitation of calcium and magnesium as carbonates, thereby increasing the proportion of sodium ions and, consequently, the sodium hazard. The RSC (Residual Sodium Carbonate) is an estimate of the potential increase of sodium hazard and can be calculated by the following equation:

$$RSC = (CO_3^{-2} + HCO_3^{-1}) - (Ca^{+2} + Mg^{+2})$$

where all constituents are in milliequivalents per liter (Eaton, 1950).

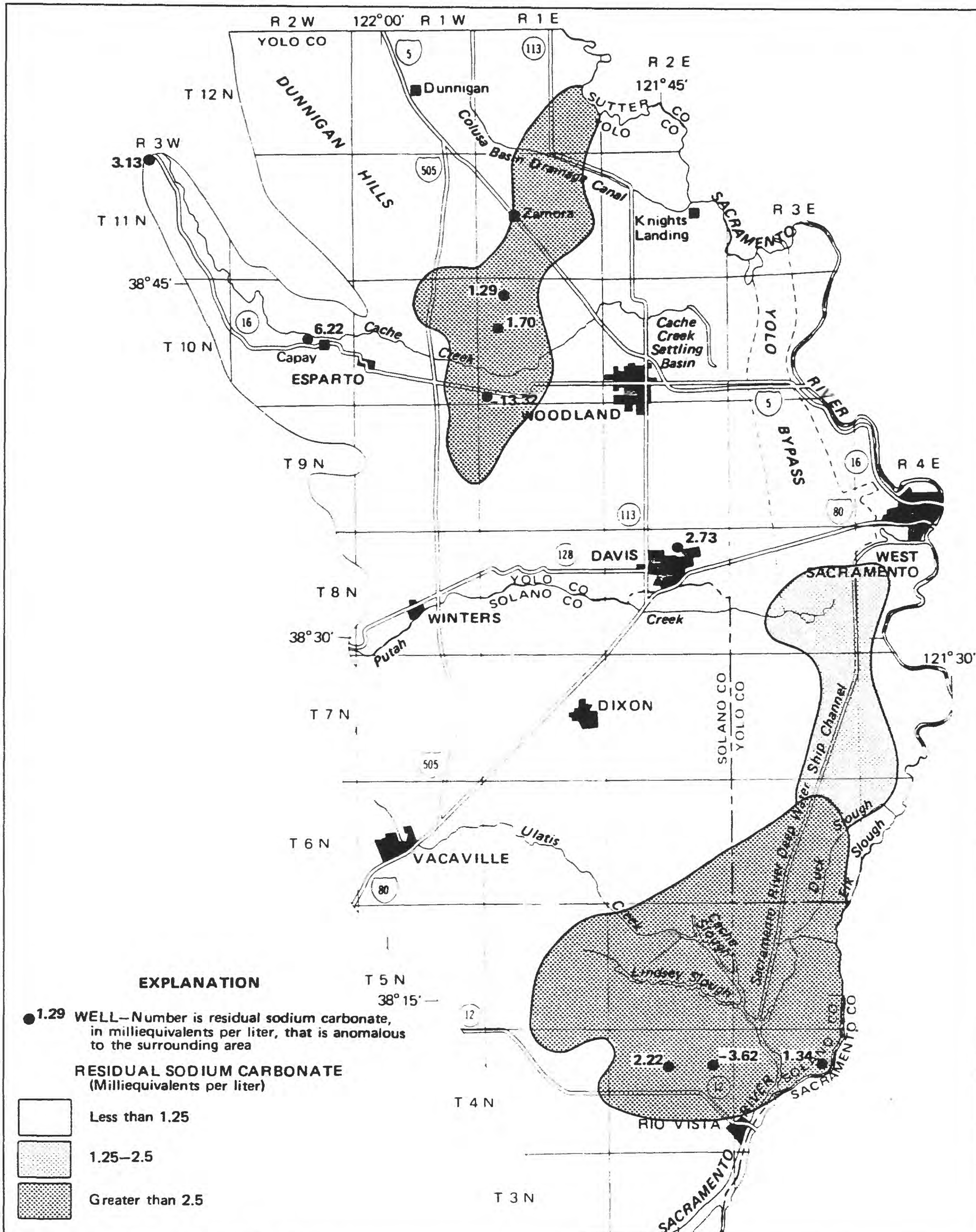
Generally, an RSC value less than 1.25 meq/L will not change SAR values, values between 1.25 and 2.5 meq/L are marginal, and values greater than 2.5 meq/L will increase sodium hazard.

The RSC values generally were low except for an area north and west of Rio Vista along the Sacramento River and the small creeks and sloughs in the southeastern area, and an area in north central Yolo County extending from the Sacramento River to just southwest of the town of Woodland. In these two areas, the potential for an increase of sodium hazard exists.

Twenty-three wells had RSC values exceeding 2.5 meq/L. Overall, the mean RSC value was 0.218 meq/L.

Wells with water exceeding 2.5 milliequivalents per liter residual sodium carbonate

| Well No. | Use | Residual sodium carbonate (meq/L) |
|---|---|---|
| 4N/1E-3A1 | Stock | 4.54 |
| 4N/2E-18N1 | Domestic | 3.17 |
| 4N/3E-9D1 | do. | 3.76 |
| 4N/3E-30C1 | Public | 3.17 |
| 5N/1E-14A1 | Irrigation | 3.08 |
| 5N/1E-25J1 | Domestic | 2.65 |
| 5N/2E-28P2 | do. | 3.18 |
| 5N/3E-3H1 | do. | 3.32 |
| 5N/3E-15M1 | do. | 3.85 |
| 5N/3E-26H1 | do. | 2.83 |
| 6N/2W-12R2 | do. | 3.71 |
| 6N/3E-15K1 | do. | 3.18 |
| 7N/3E-25J1 | do. | 2.54 |
| 8N/2E-3Q1 | Industrial | 2.73 |
| 9N/1E-4C1 | Domestic | 3.60 |
| 10N/1E-33P2 | do. | 4.49 |
| 10N/1W-2P1 | do. | 2.65 |
| 10N/1W-36A1 | do. | 4.39 |
| 10N/2W-15Q1 | do. | 6.22 |
| 11N/1E-3E2 | do. | 2.86 |
| 11N/1E-10N1 | do. | 3.40 |
| 11N/3W-4L1 | do. | 3.13 |
| 12N/1E-24R1 | do. | 3.16 |




Base from U.S. Geological Survey, 1:250 000
Sacramento and Santa Rosa, 1970

0 5 10 15 MILES

0 5 10 15 20 KILOMETERS

**Areal distribution of potential sodium hazards.**

## 5.3 Phytotoxic Trace Elements

### Trace Elements in Ground Water

None of the wells sampled in the study area contained water in which trace elements exceeded the recommended limits for continuous use in irrigation water (except those previously discussed).

Recommended limits for potentially phytotoxic trace elements in irrigation water (modified from National Academy of Sciences, and National Academy of Engineering, 1973, p. 339), and the range of concentrations of those elements in the study area are shown below. Boron, fluoride, and manganese exceeded suggested limits for irrigation use and have been previously discussed in detail.

| Trace elements | Recommended limits for continuous use in irrigation water | U.S. Environmental Protection Agency drinking water regulations 1977 | U.S. Environmental Protection Agency drinking water regulations 1979 | Range of concentration | Number of wells sampled |
|---|---|---|---|---|---|
| | (milligrams per liter) | | | | |
| Aluminum | 5.0 | --- | --- | 0.00-0.10 | 101 |
| Arsenic | 0.1 | 0.05 | --- | 0.00-0.022 | 101 |
| Boron | 0.75 | --- | --- | 0.00-7.90 | 177 |
| Cadmium | 0.01 | 0.01 | --- | 0.001-0.003 | 22 |
| Chromium | 0.1 | 0.05 | --- | 0.00-0.037 | 22 |
| Cobalt | 0.05 | --- | --- | 0.00-0.003 | 17 |
| Copper | 0.2 | --- | 1.0 | 0.00-0.026 | 22 |
| Fluoride | 1.0 | [1]1.6 | --- | 0.0-1.6 | 187 |
| Iron | 5.0 | --- | 0.3 | 0.01-0.49 | 100 |
| Lead | 5.0 | 0.05 | --- | 0.00-0.007 | 22 |
| Lithium | [2]2.5 | --- | --- | 0.004-0.090 | 17 |
| Manganese | 0.2 | --- | 0.05 | 0.00-1.20 | 101 |
| Mercury | --- | 0.002 | --- | 0.00-0.0008 | 22 |
| Molybdenum | 0.01 | --- | --- | 0.00-0.010 | 22 |
| Nickel | 0.2 | --- | --- | 0.00-0.004 | 22 |
| Selenium | 0.02 | 0.01 | --- | 0.00-0.009 | 22 |
| Strontium | --- | --- | --- | 0.13-2.00 | 17 |
| Vanadium | 0.1 | --- | --- | 0.00-0.024 | 17 |
| Zinc | 2.0 | --- | 5.0 | 0.003-0.600 | 22 |

[1]Concentration based on mean annual mimimum daily air temperature in the study area.

[2]Recommended maximum concentration for citrus is 0.075 mg/L.

## 6.0 SUMMARY

Analyses of water from 188 wells in Yolo and Solano Counties showed that ground-water-quality conditions ranged from good quality, low in dissolved solids and trace constituents, to marginal quality, high in dissolved solids and (or) exceeding established standards for one or more constituents.

Most of the area is underlain with water that is classified as hard to very hard and is low in sodium and moderate to high in salinity hazard. Dissolved-solids concentration ranged from 126 to 2,130 mg/L. Concentrations of chloride, fluoride, sulfate, nitrogen, arsenic, and iron were generally below recommended limits for drinking and irrigation water; however, one well exceeded fluoride limits for irrigation water.

Boron in concentrations large enough to be damaging to some crops was found in a large part of the study area. The area of high boron concentrations defined in Yolo County agrees with analytical results presented by Bertoldi (1976) and Fogelman (1978) which show boron in concentrations greater than 0.75 mg/L to be present from Zamora to Knights Landing.

Manganese was found in concentrations high enough to be an annoyance in domestic uses in water from wells adjacent to the Sacramento River. Concentrations of manganese decrease with increasing distance from the Sacramento River, implying that the Sacramento River is the source of higher manganese values in this area. Other trace elements were present in negligible amounts.

## 7.0 REFERENCES


Ayers, R. S., 1977, Quality of water for irrigation: Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, v. 103, no. IR2, p. 135-154.

Ayers, R. S., and Branson, R. L., 1975, Guidelines for interpretation of water quality for agriculture: Davis, University of California Cooperative Extension Circular, 11 p.

Bertoldi, G. L., 1976, Chemical quality of ground water in the Tehama-Colusa Canal service area, Sacramento Valley, California: U.S. Geological Survey Water-Resources Investigations 76-92, 44 p.

Brown, Eugene, Skougstad, M. W., and Fishman, M. J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques Water-Resources Investigations Report, Book 5, Chapter A1, 160 p. [Superseded by Skougstad, M. W., Fishman, M. J., Friedman, L. C., Erdmann, D. E., and Duncan, S. S., eds., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 626 p.].

California Department of Health, Sanitary Engineering Section, 1977, California domestic water quality and monitoring regulations: California Health and Safety Code and California Administrative Code, Title 22, p. 1701-1719.

California Division of Water Resources, 1955, Report to the California State Legislature on Putah Creek Cone Investigation: 211 p.

California State Water Resources Control Board, 1951, Water resources of California: California State Water Resources Control Board, 1951, Bulletin 1, 648 p.

Chapman, H. D., Wilcox, L. V., and Hayward, H. F., 1949, Water quality from an agricultural point of view: Report of Interim Fact-Finding Committee on Water Pollution, California State Assembly, 172 p.

Eaton, F. M., 1950, Significance of carbonates in irrigation waters: Soil Science, v. 69, p. 127-128.

Eaton, F. M., and Wilcox, L. V., 1939, The behavior of boron in soils: U.S. Department of Agriculture Technical Bulletin 696, 57 p.

Fogelman, R. P., 1975, Description and chemical analyses for selected wells in the Tehama-Colusa Canal service area, Sacramento Valley, California: U.S. Geological Survey Open-File Report, 52 p.

----- 1976, Descriptions and chemical analyses for selected wells in the central Sacramento Valley, California: U.S. Geological Survey Open-File Report 76-472, 71 p.

----- 1978, Chemical quality of ground water in the central Sacramento Valley, California: U.S. Geological Survey Water-Resources Investigations 77-133, 49 p.

----- 1979, Chemical quality of ground water in the eastern Sacramento Valley, California: U.S. Geological Survey Water-Resources Investigations 78-124, 45 p.

Fogelman, R. P., and Rockwell, G. L., 1977, Description and chemical analyses for selected wells in the eastern Sacramento Valley, California: U.S. Geological Survey Open-File Report 77-486, 82 p.

Hem, J. D., 1970, Study and interpretation of chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 1473, 363 p.

Keeter, G. L., 1980, Chemical analysis for selected wells in San Joaquin County and part of Contra Costa County, California: U.S. Geological Survey Open-File Report 80-420, 70 p.

National Academy of Sciences and National Academy of Engineering, 1973 [1974], Water-quality criteria, 1972: U.S. Environmental Protection Agency, EPA R3-73-033, 594 p.

Olmsted, F. H., and Davis, G. H., 1961, Geologic features and ground-water storage capacity of the Sacramento Valley, California: U.S. Geological Survey Water-Supply Paper 1497, 241 p.

Piper, A. M., Garrett, A. A., and others, 1953, Native and contaminated ground waters in the Long Beach-Santa Ana area, California: U.S. Geological Survey Water-Supply Paper 1136, 320 p.

Sorenson, S. K., 1981, Chemical quality of ground water in San Joaquin and part of Contra Costa Counties, California: U.S. Geological Survey Water-Resources Investigations 81-26, 32 p.

Sorenson, S. K., and Elliott, A. L., 1981, Water-quality assessment of Cache Creek, Yolo, Lake, and Colusa Counties, California: U.S. Geological Survey Open-File Report 81-677, 41 p.

Thomasson, H. G., Olmsted, F. H., and Le Roux, E. F., 1960, Geology, water resources, and usable ground-water storage capacity of part of Solano County, California: U.S. Geological Survey Water-Supply Paper 1464, 693 p.

U.S. Environmental Protection Agency, 1977, National interim primary drinking water regulations: U.S. Environmental Protection Agency, Office of Water Supply, EPA-570/9-76-003, 159 p.

----- 1979, National secondary drinking water regulations: Federal Register, v. 44, no. 140, July 19, 1979, p. 42195-42202.

U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkali soils: U.S. Department of Agriculture Handbook no. 60, 160 p.

## 8.0 CHEMICAL ANALYSES OF WATER FROM WELLS

[Station No. is based on the grid system of latitude and longitude. The system provides the geographic location of the well. The number consists of 15 digits. The first 6 digits denote the degrees, minutes, and seconds of longitude, and the last 2 digits (assigned sequentially) identify the wells or other sites within a 1-second grid. <, actual value is less than the value shown]

| WELL NO. | STATION NO. | DATE OF SAMPLE | SPECIFIC CONDUCTANCE (UMHOS) | PH (STANDARD UNITS) | TEMPERATURE (DEG C) | HARDNESS (MG/L AS CACO3) | HARDNESS, NONCARBONATE (MG/L CACO3) | CALCIUM DISSOLVED (MG/L AS CA) | MAGNESIUM, DISSOLVED (MG/L AS MG) | SODIUM, DISSOLVED (MG/L AS NA) | PERCENT SODIUM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 003N001E09H01M | 380708121515001 | 80-09-22 | 2,470 | 7.7 | 22.5 | 389 | 69 | 65 | 55 | 380 | 68 |
| 004N001E03A01M | 381324121504401 | 80-09-17 | 1,200 | 8.0 | 21.5 | 123 | 0 | 18 | 19 | 230 | 80 |
| 004N001E12B02M | 381244121484401 | 80-09-17 | 1,620 | 7.5 | 18.0 | 572 | 332 | 64 | 100 | 100 | 28 |
| 004N001E35R01M | 380831121491801 | 80-09-22 | 1,390 | 7.5 | 19.5 | 350 | 31 | 53 | -- | 160 | 50 |
| 004N002E11R01M | 381155121425201 | 80-09-17 | 1,370 | 7.5 | 21.5 | 451 | 181 | 62 | 72 | 100 | 32 |
| 004N002E16H01M | 381129121450301 | 80-09-17 | 700 | 8.3 | 19.5 | 129 | 0 | 17 | 21 | 110 | 65 |
| 004N002E18N01M | 381111121481301 | 80-09-17 | 991 | 7.8 | 19.5 | 182 | 0 | 25 | 29 | 140 | 62 |
| 004N002E25L01M | 380935121421601 | 80-09-23 | 661 | 8.6 | 21.0 | 27 | 0 | 5.5 | 3.2 | 140 | 91 |
| 004N002E30M01M | 380931121481401 | 80-09-17 | 1,100 | 8.5 | 21.0 | 55 | 0 | 9.2 | 7.7 | 250 | 91 |
| 004N003E09D01M | 381232121391101 | 80-09-23 | 1,040 | 7.6 | 18.0 | 202 | 0 | 20 | 37 | 170 | 64 |
| 004N003E11P02M | 381203121364201 | 80-09-23 | 1,230 | 7.9 | 19.5 | 193 | 0 | 28 | 30 | 180 | 67 |
| 004N003E30C01M | 381007121410501 | 80-09-23 | 1,100 | 7.8 | 19.5 | 212 | 0 | 27 | 35 | 170 | 63 |
| 005N001E04G01M | 381832121515601 | 80-09-11 | 1,410 | 7.4 | 20.0 | 434 | 194 | 98 | 46 | 120 | 38 |
| 005N001E14A01M | 381706121492801 | 80-09-11 | 878 | 7.6 | 21.0 | 186 | 0 | 30 | 27 | 130 | 60 |
| 005N001E25J01M | 381448121483001 | 80-09-11 | 1,200 | 8.0 | 21.0 | 178 | 0 | 25 | 28 | 210 | 72 |
| 005N001W13D01M | 381703121555301 | 80-09-16 | 648 | 7.1 | 21.0 | 141 | 31 | 30 | 16 | 65 | 49 |
| 005N001W15P01M | 381632121573701 | 80-09-16 | 2,650 | 7.3 | 20.0 | 568 | 216 | 150 | 47 | 390 | 60 |
| 005N002E28P02M | 381443121454501 | 80-09-11 | 1220 | 7.8 | 19.0 | 261 | 0 | 37 | 41 | 190 | 60 |
| 005N003E03H01M | 381827121371001 | 80-09-23 | 521 | 8.1 | 19.0 | 64 | 0 | 9.9 | 9.6 | 99 | 77 |
| 005N003E15M01M | 381633121381101 | 80-09-23 | 617 | 8.1 | 17.0 | 88 | 0 | 12 | 14 | 120 | 74 |
| 005N003E26H01M | 381501121360801 | 80-09-23 | 691 | 8.1 | 17.5 | 117 | 0 | 17 | 18 | 110 | 67 |
| 006N001E03A02M | 382403121504101 | 80-09-04 | 582 | 8.5 | 23.0 | 40 | 0 | 9.0 | 4.3 | 130 | 87 |
| 006N001E06F02M | 382345121542501 | 80-09-09 | 588 | 7.4 | 19.5 | 212 | 22 | 52 | 20 | 35 | 26 |
| 006N001E11H01M | 382259121492001 | 80-09-03 | 1,130 | 7.5 | 19.0 | 463 | 0 | 47 | 84 | 76 | 26 |
| 006N001E18C02M | 382214121541901 | 80-09-04 | 1,400 | 7.4 | 19.5 | 538 | 188 | 120 | 58 | 110 | 31 |
| 006N001E18L01M | 382157121540401 | 80-09-04 | 644 | 7.6 | 19.5 | 216 | 0 | 52 | 21 | 59 | 37 |
| 006N001E21K01M | 382103121515001 | 80-09-14 | 888 | 7.6 | 20.5 | 294 | 54 | 55 | 38 | 80 | 37 |
| 006N001E23C02M | 382128121500001 | 80-09-04 | 929 | 7.7 | 19.0 | 368 | 48 | 55 | 56 | 62 | 27 |
| 006N001E26G01M | 382013121494401 | 80-09-04 | 1,350 | 7.7 | 19.0 | 307 | 0 | 29 | 57 | 190 | 57 |
| 006N001E32M01M | 381921121533401 | 80-09-04 | 1,010 | 7.6 | 18.0 | 327 | 117 | 83 | 29 | 83 | 36 |
| 006N001W04G01M | 382346121583501 | 80-09-09 | 430 | 7.7 | 22.0 | 138 | 0 | 37 | 11 | 39 | 38 |
| 006N001W12P01M | 382232121554001 | 80-09-09 | 1,090 | 7.2 | 18.5 | 334 | 174 | 86 | 29 | 75 | 33 |
| 006N001W20A01M | 382131121592601 | 80-09-09 | 986 | 7.5 | 21.0 | 364 | 0 | 88 | 35 | 77 | 31 |
| 006N001W24E02M | 382114121555801 | 80-09-03 | 695 | 7.1 | 18.0 | 350 | 97 | -- | -- | -- | 25 |
| 006N001W29C03M | 382028121595001 | 80-09-12 | 1,400 | 7.2 | 21.0 | 331 | 0 | 75 | 35 | 190 | 55 |
| 006N001W36E02M | 381929121555101 | 80-09-16 | 683 | 7.3 | 19.5 | 188 | 8 | 49 | 16 | 73 | 45 |
| 006N002E01A01M | 382404121413601 | 80-09-02 | 893 | 7.7 | 18.5 | 380 | 0 | 32 | 73 | 63 | 26 |
| 006N002E06A01M | 382355121471101 | 80-09-02 | 676 | 7.8 | 18.5 | 275 | 0 | 36 | 45 | 41 | 24 |
| 006N002E15P01M | 382135121442501 | 80-09-02 | 790 | 8.0 | 19.5 | 325 | 55 | 28 | 62 | 48 | 24 |
| 006N002E23A01M | 382127121424201 | 80-09-03 | 2,260 | 7.7 | 19.5 | 891 | 501 | 60 | 180 | 200 | 33 |
| 006N002E30M02M | 382012121481101 | 80-09-02 | 693 | 8.0 | 18.5 | 150 | 0 | 20 | -- | 110 | 61 |
| 006N002E32N02M | 381856121470001 | 80-09-11 | 3,090 | 7.6 | 18.5 | 1,058 | 518 | 61 | 220 | 310 | 39 |
| 006N002W12R02M | 382228122012701 | 80-09-22 | 1,010 | 7.7 | 19.5 | 185 | 0 | 46 | 17 | 160 | 5 |
| 006N002W25J01M | 382009122013801 | 80-09-22 | 882 | 7.2 | 22.5 | 177 | 0 | 38 | 20 | 130 | 61 |
| 006N003E15K01M | 382152121373001 | 81-08-31 | 482 | 8.0 | 20.0 | 61 | 0 | 11 | 8.2 | 92 | 76 |
| 006N003E36K01M | 381914121352501 | 81-08-06 | 295 | 7.8 | 17.5 | 92 | 0 | 7.1 | 18 | 30 | 41 |
| 006N004E09L01M | 382259121324501 | 81-08-31 | 498 | 7.6 | 17.5 | 177 | 7 | 23 | 29 | 36 | 30 |
| 006N004E17J02M | 382215121332901 | 81-08-31 | 791 | 7.3 | 18.0 | 345 | 35 | 21 | 71 | 36 | 18 |
| 006N004E22B01M | 382140121312201 | 81-08-31 | 278 | 7.8 | 20.0 | 84 | 0 | 18 | 9.5 | 29 | 42 |
| 007N001E12H01M | 382808121482101 | 80-08-26 | 1,110 | 7.8 | 19.5 | 504 | 0 | 65 | 83 | 35 | 13 |
| 007N001E14D04M | 382736121501101 | 80-09-03 | 646 | 7.7 | 20.5 | 255 | 0 | 38 | 39 | 40 | 25 |
| 007N001E18J01M | 382703121534801 | 80-08-26 | 553 | 7.8 | 21.0 | 170 | 0 | 40 | 17 | 45 | 36 |
| 007N001E25J01M | 382517121481401 | 80-08-28 | 1,010 | 7.7 | 20.0 | 328 | 0 | 7.8 | 75 | 47 | 24 |
| 007N001E27N04M | 382514121513001 | 80-09-03 | 869 | 7.4 | 18.0 | 341 | 21 | 49 | 53 | 53 | 25 |
| 007N001E30F01M | 382538121543101 | 80-08-26 | 313 | 7.4 | 21.5 | 111 | 0 | 28 | 10 | 22 | 30 |
| 007N001W05F01M | 382905121595901 | 80-09-10 | 537 | 7.7 | 20.5 | 245 | 0 | 34 | 39 | 10 | 8 |
| 007N001W11B01M | 382826121561901 | 80-09-10 | 416 | 8.0 | 22.0 | 182 | 0 | 20 | 32 | 22 | 21 |
| 007N001W22D01M | 382633121575901 | 80-09-10 | 406 | 7.6 | 23.0 | 139 | 0 | 40 | 9.4 | 32 | 33 |
| 007N001W25J01M | 382515121550501 | 80-09-10 | 918 | 7.2 | 19.5 | 348 | 58 | 80 | 36 | 45 | 22 |
| 007E001W28N01M | 382504121591001 | 80-09-10 | 546 | 7.4 | 23.0 | 171 | 0 | 37 | 19 | 45 | 36 |

| SODIUM AD-SORP-TION RATIO | POTAS-SIUM, DIS-SOLVED (MG/L AS K) | ALKA-LINITY FIELD (MG/L AS CACO3) | SULFATE DIS-SOLVED (MG/L AS SO4) | CHLO-RIDE, DIS-SOLVED (MG/L AS CL) | FLUO-RIDE, DIS-SOLVED (MG/L AS F) | SILICA, DIS-SOLVED (MG/L AS SIO2) | SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) | SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) | NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) | ALUM-INUM, DIS-SOLVED (UG/L AS AL) | ARSENIC DIS-SOLVED (UG/L AS AS) | BORON, DIS-SOLVED (UG/L AS B) | IRON, DIS-SOLVED (UG/L AS FE) | MANGA-NESE, DIS-SOLVED (UG/L AS MN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.6 | 1.3 | 320 | 46 | 520 | 0.9 | 20 | 1,460 | 1,280 | 45 | 20 | 1 | -- | 40 | 0 |
| 9.2 | 1.3 | 350 | 100 | 110 | .7 | 26 | 750 | 715 | 3.5 | 20 | 6 | -- | 10 | 2 |
| 1.8 | .9 | 240 | 82 | 340 | .7 | [illegible] | [illegible] | [illegible] | [illegible] | -- | -- | -- | -- | -- |
| 3.7 | .9 | 320 | 34 | 230 | 1.1 | 31 | 822 | 317 | 11 | -- | -- | -- | -- | 53 |
| 2.1 | 1.4 | 270 | 70 | 220 | .4 | 38 | 708 | 726 | 16 | 30 | 5 | -- | 20 | 2 |
| 4.3 | 2.0 | 240 | 15 | 69 | .7 | 26 | 403 | 405 | 3.8 | -- | -- | -- | -- | -- |
| 4.6 | 1.9 | 340 | 14 | 97 | .8 | 28 | 573 | 540 | 5.7 | 50 | 3 | -- | 10 | 1 |
| 12 | 1.1 | 250 | 51 | 21 | .2 | 26 | 391 | 399 | .06 | 30 | 8 | 980 | 10 | 8 |
| 15 | 1.4 | 380 | 72 | 94 | .4 | 21 | 660 | 684 | .01 | -- | -- | -- | -- | -- |
| 5.3 | 3.0 | 390 | 100 | 46 | .3 | 52 | 646 | 664 | .10 | 30 | 9 | 630 | 10 | 230 |
| 5.7 | 2.7 | 260 | 19 | 220 | .1 | 46 | 650 | 684 | .00 | 10 | 7 | 870 | 50 | 180 |
| 5.2 | 2.6 | 370 | 61 | 100 | .3 | 41 | 660 | 660 | .88 | -- | -- | 840 | -- | -- |
| 2.6 | .9 | 240 | 27 | 280 | .8 | 23 | 845 | 740 | 5.9 | 10 | 2 | 300 | 10 | 1 |
| 4.2 | .4 | 340 | 50 | 44 | 1.6 | 25 | 566 | 513 | .29 | -- | -- | 650 | -- | -- |
| 7.0 | 1.8 | 310 | 210 | 63 | .6 | 32 | 706 | 758 | .00 | -- | -- | 1,800 | -- | -- |
| 2.5 | 5.6 | 110 | 36 | 110 | .7 | 49 | 418 | 379 | .00 | 0 | 1 | 360 | -- | 390 |
| 7.4 | 1.8 | 350 | 530 | 360 | .8 | 17 | 1,650 | 1,714 | 4.4 | -- | -- | 7,900 | -- | -- |
| 5.2 | 9.0 | 420 | 74 | 110 | .7 | 32 | 740 | 747 | 2.7 | 10 | 4 | 1,200 | 10 | 140 |
| 5.5 | 1.5 | 230 | 33 | 13 | .1 | 28 | 304 | 334 | .00 | 20 | 17 | 890 | 20 | 50 |
| 5.7 | 2.1 | 280 | 33 | 22 | .1 | 31 | 397 | 403 | .40 | -- | -- | 650 | -- | -- |
| 4.5 | 1.9 | 258 | 35 | 37 | .1 | 24 | 415 | 399 | .06 | -- | -- | 970 | -- | -- |
| 9.2 | 1.1 | 250 | 36 | 16 | .2 | 28 | 385 | 375 | .88 | -- | -- | 430 | -- | -- |
| 1.1 | .3 | 190 | 27 | 43 | .3 | 48 | 370 | 340 | .00 | 10 | 4 | 50 | 10 | 3 |
| 1.6 | .7 | 478 | 66 | 24 | .4 | 30 | 671 | 615 | 5.0 | -- | -- | 340 | -- | -- |
| 2.1 | .5 | 350 | 240 | 91 | .2 | 40 | 1,130 | 870 | 15 | 10 | 2 | 200 | 10 | 1 |
| 1.8 | 1.2 | 250 | 64 | .0 | .2 | 32 | 610 | 380 | 1.1 | 10 | 2 | 110 | 10 | 70 |
| 2.1 | .6 | 240 | 72 | 110 | .7 | 30 | 534 | 531 | .15 | -- | -- | 310 | -- | -- |
| 1.4 | .5 | 320 | 59 | 72 | .3 | 39 | 550 | 536 | 4.8 | 10 | 3 | 160 | 10 | 1 |
| 4.8 | .6 | 380 | 80 | 190 | 1.0 | 25 | 760 | 801 | .04 | -- | -- | 630 | -- | -- |
| 2.1 | .5 | 210 | 110 | 130 | .7 | 23 | 592 | 586 | 3.1 | 20 | 1 | 530 | 10 | 1 |
| 1.5 | 2.4 | 210 | 10 | 8.1 | .5 | 36 | 268 | 270 | 1.2 | -- | -- | 40 | -- | -- |
| 1.8 | .3 | 160 | 110 | 170 | .3 | 50 | 581 | 617 | 2.3 | -- | -- | 60 | -- | -- |
| 1.8 | .6 | 390 | 83 | 39 | .8 | 20 | 539 | 578 | 1.3 | 10 | 2 | 260 | 10 | 390 |
| 1.2 | .5 | 260 | 73 | 14 | .3 | 41 | 425 | 451 | 3.2 | -- | -- | 260 | -- | -- |
| 4.7 | .8 | 340 | 45 | 230 | .8 | 21 | 786 | 802 | .92 | -- | -- | 540 | -- | -- |
| 2.4 | 2.0 | 180 | 54 | 75 | .4 | 33 | 413 | 411 | 4.9 | 10 | 1 | 470 | 10 | 1 |
| 1.4 | 1.1 | 420 | 47 | 27 | .2 | 32 | 515 | 528 | 1.3 | -- | -- | 740 | -- | -- |
| 1.1 | 1.2 | 290 | 40 | 34 | .1 | 29 | 383 | 401 | 1.5 | 10 | 3 | 460 | 10 | 1 |
| 1.2 | .7 | 270 | 58 | 72 | .2 | 30 | 449 | 462 | .21 | 20 | 4 | 450 | 10 | 1 |
| 2.9 | 1.7 | 390 | 510 | 280 | .2 | 23 | 1,520 | 1,491 | 2.5 | 20 | 3 | 1,600 | 30 | 30 |
| 3.9 | .9 | 290 | 41 | 30 | .4 | 28 | 414 | 434 | .20 | -- | -- | 410 | 25 | -- |
| 4.2 | 1.0 | 540 | 340 | 570 | .6 | 22 | 2,000 | 1,849 | 5.6 | -- | -- | 630 | -- | -- |
| 5.3 | 1.8 | 370 | 78 | 70 | 1.0 | 21 | 600 | 617 | 2.7 | 30 | 0 | -- | 10 | 2 |
| 4.4 | 1.2 | 290 | 49 | 81 | .6 | 27 | 526 | 521 | 5.0 | -- | -- | -- | -- | -- |
| 5.2 | 2.0 | 220 | 26 | 21 | .1 | 35 | 307 | 328 | .12 | -- | -- | 910 | -- | -- |
| 1.4 | 1.0 | 140 | <1.0 | 13 | .1 | 48 | 191 | 203 | .11 | 50 | 22 | 290 | 13 | 10 |
| 1.2 | 2.2 | -- | <1.0 | 61 | .1 | 40 | 288 | -- | .10 | -- | -- | 360 | -- | -- |
| .9 | 1.3 | 310 | 1.0 | 66 | .2 | 47 | 452 | 432 | 1.7 | 50 | 5 | 430 | 82 | 1,200 |
| 1.4 | 1.2 | 140 | <1.0 | 8.2 | .2 | 34 | 176 | 186 | .11 | -- | -- | 70 | -- | -- |
| .7 | 1.7 | 510 | 38 | 16 | .2 | 36 | 613 | 581 | .16 | 20 | 3 | 710 | 40 | 20 |
| 1.1 | 2.0 | 290 | 26 | 14 | .2 | 28 | 363 | 362 | 4.1 | -- | -- | 500 | -- | -- |
| 1.5 | .9 | 220 | 18 | 13 | .1 | 35 | 319 | 301 | .20 | 10 | 4 | 90 | 10 | 1 |
| 1.1 | 1.2 | 360 | 41 | 21 | .2 | 40 | 820 | 450 | 10 | -- | -- | 530 | -- | -- |
| 1.3 | .9 | 320 | 72 | 13 | .3 | 40 | 519 | 473 | 12 | 10 | 3 | 230 | 10 | 1 |
| .9 | .3 | 120 | 5.0 | 20 | .2 | 58 | 234 | 215 | 4.9 | -- | -- | 20 | -- | -- |
| .3 | 1.0 | 250 | 18 | 6.8 | .4 | 52 | 312 | 311 | .28 | 0 | 3 | 20 | 10 | 1 |
| .7 | .50 | 210 | .3 | 11 | .3 | 49 | 246 | 261 | 1.6 | -- | -- | 7 | -- | -- |
| 1.2 | 1.2 | 200 | 1.4 | 7.3 | .4 | 35 | 279 | 247 | 1.7 | -- | -- | 40 | -- | -- |
| 1.1 | .4 | 290 | 26 | 62 | .2 | 57 | 623 | 480 | 18 | -- | -- | 0 | -- | -- |
| 1.5 | 2.5 | 190 | 38 | 22 | .5 | 56 | 346 | 334 | 3.7 | 20 | 3 | 30 | 10 | 1 |

| WELL NO. | STATION NO. | DATE OF SAMPLE | SPECIFIC CONDUCTANCE (UMHOS) | PH (STANDARD UNITS) | TEMPERATURE (DEG C) | HARDNESS (MG/L AS CACO3) | HARDNESS, NONCARBONATE (MG/L CACO3) | CALCIUM DISSOLVED (MG/L AS CA) | MAGNESIUM, DISSOLVED (MG/L AS MG) | SODIUM, DISSOLVED (MG/L AS NA) | PERCENT SODIUM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 007N001W34R01M | 382414121571201 | 80-09-12 | 440 | 7.9 | 21.5 | 153 | 0 | 40 | 13 | 41 | 37 |
| 007N001W34R02M | 382413121570201 | 80-09-12 | 437 | 8.0 | 24.0 | 153 | 0 | 38 | 14 | 38 | 34 |
| 007N002E02C01M | 382913121431801 | 80-08-27 | 1,270 | 7.7 | 20.5 | 553 | 13 | 40 | 110 | 60 | 19 |
| 007N002E07R03M | 382747121471001 | 80-08-27 | 1,050 | 7.6 | 20.0 | 497 | 7 | 64 | 82 | 39 | 15 |
| 007N002E14C01M | 382734121432901 | 80-08-27 | 917 | 7.8 | 18.5 | 372 | 0 | 40 | 66 | 46 | 21 |
| 007N002E17F02M | 382710121464501 | 80-08-28 | 1,360 | 7.4 | 19.0 | 660 | 30 | 83 | 110 | 51 | 14 |
| 007N002E26K01M | 382513121431201 | 80-08-27 | 1,040 | 7.8 | 18.0 | 411 | 1 | 41 | 75 | 60 | 24 |
| 007N002E30J02M | 382524121471001 | 80-08-27 | 951 | 7.7 | 18.5 | 434 | 14 | 50 | 75 | 40 | 17 |
| 007N002E35Q01M | 382408121425801 | 80-09-09 | 1,180 | 7.8 | 18.0 | 472 | 130 | 34 | 94 | 61 | 22 |
| 007N003E04N02M | 382831121391901 | 81-08-26 | 816 | 7.9 | 19.0 | 342 | 0 | 28 | 66 | 52 | 25 |
| 007N003E25J01M | 382519121345801 | 81-08-27 | 485 | 7.8 | 18.5 | 113 | 0 | 14 | 19 | 66 | 55 |
| 007N004E10Q02M | 382813121312801 | 81-08-27 | 255 | 7.6 | 21.0 | 108 | 8 | 20 | 14 | 9.8 | 16 |
| 007N004E26D01M | 382610121305301 | 81-08-27 | 195 | 7.4 | 17.5 | 80 | 0 | 18 | 8.4 | 9.3 | 20 |
| 007N004E28R01M | 382535121322501 | 81-08-27 | 2,450 | 7.6 | 20.0 | 352 | 132 | 85 | 34 | 370 | 69 |
| 007N004E31J01M | 382451121343801 | 81-08-31 | 480 | 7.1 | 17.5 | 92 | 0 | 12 | 15 | 79 | 65 |
| 008N001E11P02M | 383302121500001 | 81-08-20 | 552 | 7.8 | 21.0 | 244 | 0 | 27 | 43 | 34 | 23 |
| 008N001E15L03M | 383216121510801 | 81-08-20 | 559 | 7.9 | 20.5 | 234 | 0 | 31 | 38 | 32 | 23 |
| 008N001E20F03M | 383142121531101 | 80-08-25 | 1,110 | 7.6 | 20.5 | 510 | 40 | 69 | 82 | 39 | 14 |
| 008N001E22B01M | 383147121504201 | 80-08-25 | 512 | 8.1 | 21.0 | 211 | 0 | 30 | 33 | 28 | 22 |
| 008N001E32P01M | 382924121532101 | 80-09-03 | 566 | 7.7 | 19.0 | 252 | 2 | 35 | 40 | 21 | 15 |
| 008N001E36J01M | 382944121481301 | 80-08-25 | 1,070 | 7.8 | 21.5 | 473 | 0 | 51 | 84 | 40 | 16 |
| 008N001W01M01M | 383408121555701 | 81-08-28 | 502 | -- | 22.0 | 187 | 0 | 32 | 26 | 35 | 29 |
| 008N001W09A02M | 383336121582001 | 81-08-28 | 896 | -- | 19.5 | 378 | 208 | 92 | 36 | 51 | 23 |
| 008N001W14Q01M | 383208121562101 | 81-08-28 | 548 | 7.6 | 18.0 | 250 | 20 | 39 | 37 | 24 | 17 |
| 008N001W16M01M | 383215121555701 | 81-08-20 | 443 | 7.8 | 21.5 | 179 | 9 | 29 | 26 | 25 | 23 |
| 008N001W20F01M | 383145121595401 | 81-08-28 | 441 | 7.6 | 20.0 | 170 | 0 | 32 | 22 | 26 | 25 |
| 008N001W26G02M | 383050121561701 | 80-08-26 | 1,110 | 7.4 | 18.5 | 567 | 57 | 64 | 99 | 28 | 10 |
| 008N001W33E02M | 382951121585801 | 80-08-26 | 563 | 7.9 | 18.5 | 258 | 0 | 34 | 42 | 21 | 15 |
| 008N002E03Q01M | 383349121441701 | 81-08-25 | 500 | 8.1 | 26.0 | 74 | 0 | 16 | 8.2 | 92 | 72 |
| 008N002E14M03M | 383218121435001 | 81-08-25 | 1,160 | 7.6 | 19.0 | 516 | 6 | 45 | 98 | 79 | 25 |
| 008N002E15P01M | 383204121442401 | 80-08-25 | 1,530 | 7.8 | 19.5 | 553 | 0 | 40 | 110 | 120 | 32 |
| 008N002E18C01M | 383246121475501 | 81-08-24 | 542 | 7.4 | 19.5 | 523 | 3 | 56 | 93 | 53 | 18 |
| 008N002E20B01M | 383155121462401 | 81-08-25 | 952 | 7.5 | 19.5 | 416 | 0 | 41 | 76 | 66 | 26 |
| 008N002E21B02M | 383155121452001 | 81-08-26 | 515 | 8.1 | 25.0 | 119 | 0 | 16 | 19 | 82 | 60 |
| 008N002E24J03M | 383121121414101 | 80-08-25 | 1,010 | 7.8 | 25.5 | 389 | 0 | 42 | 69 | 76 | 30 |
| 008N002E29G01M | 383042121463401 | 80-08-25 | 1,110 | 7.8 | 19.5 | 488 | 0 | 57 | 84 | 47 | 17 |
| 008N002E35B01M | 383010121431101 | 80-08-25 | 661 | 7.8 | 21.0 | 334 | 0 | 33 | 61 | 45 | 23 |
| 008N002W36L01M | 382939122015301 | 80-08-26 | 559 | 7.8 | 18.5 | 257 | 0 | 32 | 43 | 27 | 19 |
| 008N003E06B01M | 383429121405601 | 81-08-25 | 2,640 | 7.5 | 20.5 | 878 | 218 | 22 | 200 | 310 | 43 |
| 008N003E07E02M | 383324121413301 | 81-08-25 | 1,150 | 7.7 | 19.0 | 415 | 35 | 31 | 82 | 110 | 36 |
| 008N003E19M03M | 383114121413801 | 81-08-26 | 1,220 | 7.8 | 19.0 | 382 | 0 | 26 | 77 | 95 | 35 |
| 008N003E28G02M | 383032121383801 | 81-08-26 | 885 | 7.8 | 19.5 | 252 | 0 | 20 | 49 | 110 | 49 |
| 008N003E30P01M | 383008121410801 | 81-08-26 | 812 | 7.8 | 19.5 | 337 | 0 | 31 | 63 | 58 | 27 |
| 008N004E03B02M | 383425121305501 | 81-08-27 | 756 | 7.7 | 18.5 | 209 | 59 | 44 | 24 | 66 | 40 |
| 008N004E08R01M | 383247121324401 | 81-08-27 | 1,130 | 8.0 | 17.0 | 178 | 0 | 20 | 31 | 170 | 67 |
| 008N004E15G02M | 383228121305401 | 81-08-27 | 335 | 7.9 | 18.0 | 137 | 0 | 30 | 15 | 17 | 21 |
| 008N004E18N01M | 383203121345001 | 81-08-27 | 612 | 8.1 | 19.0 | 89 | 0 | 19 | 10 | 100 | 70 |
| 008N004E29F02M | 383042121332101 | 81-08-27 | 521 | 7.7 | 17.0 | 228 | 48 | 32 | 36 | 22 | 17 |
| 009N001E04C01M | 383947121520601 | 81-08-24 | 697 | 8.0 | 21.5 | 100 | 0 | 12 | 17 | 120 | 72 |
| 009N001E11H01M | 383836121491401 | 81-08-24 | 759 | 7.8 | 21.0 | 235 | 0 | 25 | 42 | 76 | 41 |
| 009N001E17N01M | 383707121334501 | 81-09-01 | 182 | 8.2 | 16.0 | 52 | 0 | 9.1 | 7.2 | 18 | 42 |
| 009N001E19E01M | 383651121544801 | 81-08-24 | 663 | 7.9 | 20.0 | 202 | 0 | 23 | 35 | 110 | 54 |
| 009N001E20C02M | 383708121530601 | 81-08-24 | 767 | 8.0 | 19.5 | 238 | 0 | 29 | 40 | 79 | 42 |
| 009N001E25H02M | 383553121482301 | 81-08-24 | 655 | 7.7 | 19.5 | 402 | 0 | 54 | 65 | 65 | 26 |
| 009N001E31D02M | 383526121544001 | 81-08-20 | 1,160 | 7.5 | 19.0 | 345 | 0 | 62 | 46 | 120 | 43 |
| 009N001E34Q02M | 383443121505001 | 81-08-24 | 838 | 7.7 | 22.0 | 298 | 0 | 40 | 48 | 76 | 36 |
| 009N001W04J01M | 383913121581401 | 81-09-03 | 976 | 7.4 | 21.0 | 392 | 42 | 96 | 37 | 56 | 24 |
| 009N001W15D03M | 383806121581101 | 81-09-08 | 795 | 7.4 | 19.5 | 281 | 9 | 73 | 24 | 67 | 34 |
| 009N001W21N01M | 383630121591601 | 81-09-08 | 612 | 7.3 | 19.0 | 246 | 0 | 59 | 24 | 39 | 26 |
| 009N001W36E01M | 383508121555101 | 81-08-20 | 584 | 7.7 | 18.5 | 240 | 0 | 43 | 32 | 57 | 34 |
| 009N002E03A01M | 383945121434301 | 81-08-11 | 855 | 7.4 | 20.5 | 313 | 23 | 56 | 42 | 55 | 28 |
| 009N002E07H02M | 383829121470601 | 81-08-12 | 981 | 7.5 | 20.0 | 374 | 0 | 54 | 58 | 80 | 32 |
| 009N002E10D02M | 383843121444501 | 81-08-12 | 578 | 7.9 | 19.0 | 205 | 0 | 31 | 31 | 50 | 34 |
| 009N002E20A02M | 383709121455701 | 81-08-12 | 1,560 | 7.4 | 22.0 | 615 | 36 | 65 | 110 | 110 | 28 |
| 009N002E22A01M | 383705121434701 | 81-08-12 | 1,270 | 7.6 | 22.0 | 485 | 0 | 49 | 88 | 100 | 31 |

| SODIUM AD-SORP-TION RATIO | POTAS-SIUM, DIS-SOLVED (MG/L AS K) | ALKA-LINITY FIELD (MG/L AS CACO3) | SULFATE DIS-SOLVED (MG/L AS SO4) | CHLO-RIDE, DIS-SOLVED (MG/L AS CL) | FLUO-RIDE, DIS-SOLVED (MG/L AS F) | SILICA, DIS-SOLVED (MG/L AS SIO2) | SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) | SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) | NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) | ALUM-INUM, DIS-SOLVED (UG/L AS AL) | ARSENIC DIS-SOLVED (UG/L AS AS) | BORON, DIS-SOLVED (UG/L AS B) | IRON, DIS-SOLVED (UG/L AS FE) | MANGA-NESE, DIS-SOLVED (UG/L AS MN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.4 | 200 | 15 | 14 | 0.3 | 31 | 270 | 276 | 1.2 | 10 | 0 | 60 | 10 | 1 |
| 1.4 | 3.6 | 200 | 20 | 9.5 | .4 | 55 | 311 | 299 | 1.3 | 10 | 3 | 60 | 10 | 1 |
| 1.1 | 1.0 | 540 | 43 | 57 | .2 | 33 | 731 | 669 | 12 | -- | -- | 690 | -- | -- |
| .8 | 1.3 | 490 | 40 | 25 | .2 | 37 | 598 | 583 | 6.2 | 20 | 5 | 630 | 30 | 1 |
| 1.1 | 1.2 | 380 | 39 | 43 | .1 | 29 | 476 | 493 | 2.9 | -- | -- | 540 | -- | -- |
| .9 | 1.4 | 630 | 61 | 44 | .2 | 36 | 585 | 765 | 9.4 | 10 | 3 | 690 | 10 | 1 |
| 1.3 | 1.3 | 410 | 45 | 36 | .2 | 30 | 530 | 535 | 8.8 | 10 | 4 | 740 | 10 | 2 |
| .8 | 1.2 | 420 | 38 | 34 | .2 | 35 | 547 | 526 | 5.7 | -- | -- | 490 | -- | -- |
| 1.2 | .80 | 340 | 86 | 130 | .2 | 27 | 659 | 637 | 4.2 | -- | -- | 540 | -- | -- |
| 1.2 | 1.2 | 380 | 37 | 36 | .2 | 34 | 457 | 483 | 1.7 | -- | -- | 640 | -- | -- |
| 2.7 | 2.0 | 240 | 29 | 22 | .1 | 37 | 297 | 334 | .04 | -- | -- | 890 | -- | -- |
| .4 | 1.7 | 100 | 4.0 | 17 | .1 | 43 | 170 | 171 | .03 | 30 | 0 | 50 | 290 | 720 |
| .5 | 1.8 | 99 | 3.0 | 10 | .1 | 28 | 131 | 138 | .05 | -- | -- | 40 | -- | -- |
| 8.9 | 9.3 | 220 | 1.0 | 720 | .1 | 33 | 1,430 | 1,387 | .03 | -- | -- | 2,400 | -- | -- |
| 3.7 | 1.9 | 180 | 31 | 12 | .1 | 40 | 302 | 300 | .10 | 50 | 13 | 880 | 43 | 68 |
| 1.0 | 1.5 | 270 | 18 | 18 | .2 | 33 | 329 | 337 | 1.5 | -- | -- | 470 | -- | -- |
| .9 | 1.1 | 260 | 21 | 21 | .4 | 35 | 322 | 336 | 1.2 | 10 | 3 | 880 | 34 | 8 |
| .8 | .7 | 470 | 58 | 44 | .3 | 39 | 651 | 614 | .53 | -- | -- | 580 | -- | -- |
| .9 | 2.2 | 240 | 23 | 18 | .2 | 33 | 288 | 312 | .00 | 20 | 3 | 400 | 20 | 2 |
| .6 | 1.4 | 250 | 29 | 16 | .2 | 29 | 308 | 322 | .79 | 10 | 2 | 540 | 20 | 2 |
| .8 | .8 | 480 | 43 | 15 | .3 | 40 | 590 | 563 | .24 | 10 | 4 | 560 | 10 | 1 |
| 1.1 | .7 | -- | 19 | 20 | .4 | 41 | 297 | 300 | 2.4 | -- | -- | 200 | -- | -- |
| 1.2 | .6 | -- | 12 | 51 | .3 | 30 | 534 | 375 | 14 | 100 | 1 | 270 | <10 | 2 |
| .7 | .4 | -- | 22 | 22 | .2 | 33 | 342 | 316 | 7.3 | 30 | 1 | 880 | 18 | 4 |
| .8 | 1.0 | 170 | 27 | 20 | .3 | 36 | 265 | 266 | 1.8 | -- | -- | 160 | -- | -- |
| .9 | 1.1 | 180 | 21 | 18 | .3 | 30 | 263 | 259 | 3.2 | -- | -- | 230 | -- | -- |
| .5 | 1.3 | 510 | 53 | 29 | .1 | 33 | 626 | 614 | 8.6 | -- | -- | 600 | -- | -- |
| .6 | 1.2 | 260 | 27 | 9.3 | .2 | 27 | 328 | 318 | 2.2 | 10 | 1 | 580 | 10 | 1 |
| 4.8 | 2.0 | 210 | 37 | 19 | .1 | 33 | 325 | 334 | .00 | 10 | 9 | 830 | 23 | 44 |
| 1.5 | 1.1 | 510 | 78 | 49 | .3 | 35 | 699 | 692 | 6.1 | 20 | 4 | 630 | <10 | 2 |
| 2.2 | .9 | 610 | 120 | 64 | .5 | 31 | 785 | 854 | 1.2 | -- | -- | 1,600 | -- | -- |
| 1.0 | .6 | 520 | 50 | 51 | .3 | 39 | 666 | 665 | 7.4 | -- | -- | 530 | -- | -- |
| 1.4 | 1.0 | 480 | 35 | 25 | .3 | 37 | 568 | 571 | 5.5 | 10 | 3 | 810 | <10 | 1 |
| 3.3 | 1.8 | 220 | 42 | 25 | .1 | 30 | 323 | 349 | .45 | 30 | 4 | 720 | <10 | 2 |
| 1.7 | 1.5 | 420 | 69 | 53 | .3 | 34 | 613 | 597 | 1.6 | -- | -- | 710 | -- | -- |
| .9 | 1.1 | 490 | 51 | 29 | .4 | 36 | 637 | 600 | .97 | -- | -- | 540 | -- | -- |
| 1.1 | 1.0 | 360 | 39 | 26 | .3 | 37 | 417 | 459 | .00 | 20 | 5 | 570 | 40 | 3 |
| .7 | 1.2 | 280 | 24 | 9.8 | .2 | 32 | 327 | 338 | .19 | -- | -- | 540 | -- | -- |
| 4.6 | .7 | 660 | 500 | 190 | .5 | 26 | 1,710 | 1,648 | 24 | -- | -- | 3,100 | -- | -- |
| 2.4 | 1.8 | 380 | 150 | 75 | .2 | 32 | 700 | 711 | 1.5 | 10 | 4 | 1,000 | <10 | 30 |
| 2.1 | 1.1 | -- | 88 | 40 | .3 | 34 | 602 | 626 | 3.9 | -- | -- | 860 | -- | -- |
| 3.0 | .7 | 360 | 58 | 38 | .5 | 27 | 514 | 520 | 23 | -- | -- | 1,100 | -- | -- |
| 1.4 | 1.3 | 360 | 52 | 37 | .3 | 38 | 478 | 497 | 2.8 | -- | -- | 590 | -- | -- |
| 2.0 | 5.9 | 150 | <1.0 | 160 | .1 | 53 | 457 | 444 | .05 | -- | -- | 310 | -- | -- |
| 5.6 | 3.1 | 220 | <1.0 | 230 | .1 | 42 | 603 | 629 | .02 | 30 | 1 | 1,500 | 29 | 230 |
| .7 | 3.6 | 170 | <1.0 | 15 | .1 | 41 | 206 | 224 | .01 | 30 | 1 | 70 | 98 | 280 |
| 4.8 | 2.3 | 210 | 43 | 46 | .1 | 37 | 384 | 385 | .01 | -- | -- | 1,200 | -- | -- |
| .6 | 1.7 | 180 | 38 | 40 | .1 | 48 | 327 | 326 | .86 | -- | -- | 230 | -- | -- |
| 5.3 | 1.8 | 280 | 66 | 26 | .3 | 38 | 437 | 451 | .03 | 10 | 8 | 1,700 | 40 | 87 |
| 2.2 | 1.4 | 290 | 52 | 51 | .3 | 31 | 383 | 454 | .67 | -- | -- | 1,300 | -- | -- |
| 1.1 | 1.2 | -- | 6.0 | 5.3 | .1 | 40 | 126 | 136 | .11 | -- | -- | 100 | -- | -- |
| 3.4 | 1.3 | 280 | 72 | 64 | .3 | 25 | 463 | 500 | .02 | 20 | 4 | 970 | 18 | 100 |
| 2.3 | 1.2 | 270 | 68 | 51 | .5 | 32 | 453 | 464 | .42 | 30 | 4 | 760 | <10 | 6 |
| 1.4 | .5 | 450 | 35 | 43 | .3 | 31 | 579 | 564 | 2.7 | -- | -- | 800 | -- | -- |
| 2.9 | .5 | 350 | 120 | 81 | .5 | 29 | 704 | 672 | 7.9 | 10 | 1 | 1,100 | <10 | 2 |
| 2.0 | .4 | 310 | 78 | 58 | .5 | 35 | 508 | 523 | 1.8 | 20 | 3 | 830 | 14 | 1 |
| 1.3 | .3 | 350 | 44 | 59 | .5 | 25 | 576 | 528 | 9.8 | -- | -- | 380 | -- | -- |
| 1.8 | .5 | 272 | 47 | 68 | .6 | 24 | 474 | 468 | 3.8 | -- | -- | 420 | -- | -- |
| 1.1 | .3 | -- | 23 | 27 | .3 | 29 | 380 | 358 | 4.9 | 50 | 1 | 180 | <10 | 3 |
| 1.6 | .7 | 250 | 53 | 42 | .5 | 35 | 398 | 414 | 2.0 | 10 | 1 | 310 | 11 | 2 |
| 1.4 | 2.1 | 290 | 27 | 78 | .1 | 23 | 464 | 459 | 3.1 | 0 | 2 | 2,000 | <10 | 3 |
| 1.8 | 1.1 | -- | 37 | 72 | .2 | 30 | 592 | 563 | 5.1 | 0 | 2 | 2,300 | <10 | 2 |
| 1.5 | 1.5 | 240 | 11 | 43 | .1 | 25 | 331 | 338 | .27 | -- | -- | 1,500 | -- | -- |
| 2.0 | 1.0 | 580 | 69 | 140 | .2 | 31 | 900 | 877 | 5.7 | 0 | 3 | 2,500 | <10 | 8 |
| 2.0 | 1.1 | 510 | 56 | 93 | .2 | 27 | 713 | 723 | 2.0 | -- | -- | 2,600 | -- | -- |

| WELL NO. | STATION NO. | DATE OF SAMPLE | SPE-CIFIC CON-DUCT-ANCE (UMHOS) | PH (STAND-ARD UNITS) | TEMPER-ATURE (DEG C) | HARD-NESS (MG/L AS CACO3) | HARD-NESS, NONCAR-BONATE (MG/L CACO3) | CALCIUM DIS-SOLVED (MG/L AS CA) | MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) | SODIUM, DIS-SOLVED (MG/L AS NA) | PERCENT SODIUM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 009N002E22A02M | 383705121434601 | 81-08-12 | 1,270 | 7.8 | 24.0 | 303 | 0 | 39 | 50 | 61 | 30 |
| 009N002E25E01M | 383600121423701 | 81-08-12 | 650 | 7.8 | 21.0 | 191 | 0 | 22 | 33 | 70 | 44 |
| 009N002E35E02M | 383458121433801 | 81-08-12 | 1,000 | 7.7 | 19.5 | 350 | 0 | 38 | 62 | 80 | 33 |
| 009N003E02E01M | 383926121365901 | 81-09-01 | 806 | 8.0 | 19.5 | 192 | 0 | 29 | 29 | 110 | 55 |
| 009N003E11D02M | 383845121370501 | 81-09-01 | 1,380 | 7.4 | 17.5 | 413 | 73 | 45 | 73 | 130 | 40 |
| 009N003E30N02M | 383530121412401 | 81-08-26 | 3,200 | 7.8 | 20.0 | 1,159 | 799 | 85 | 230 | 280 | 34 |
| 009N003E33N02M | 383431121390501 | 81-08-26 | 906 | 7.9 | 19.0 | 278 | 0 | 24 | 53 | 93 | 42 |
| 009N004E31P02M | 383431121342401 | 81-09-01 | 745 | -- | 22.5 | 197 | 0 | 21 | 35 | 94 | 51 |
| 010N001E03N01M | 384412121511401 | 81-08-10 | 469 | 7.5 | 19.5 | 159 | 0 | 19 | 27 | 46 | 38 |
| 010N001E05Q01M | 384416121525401 | 81-08-10 | 479 | 7.6 | 18.5 | 146 | 0 | 22 | 22 | 42 | 38 |
| 010N001E17C01M | 384314121530901 | 81-08-13 | 349 | 8.2 | 19.5 | 95 | 0 | 15 | 14 | 40 | 47 |
| 010N001E22J02M | 384146121502101 | 81-08-10 | 693 | 7.4 | 18.5 | 270 | 30 | 47 | 37 | 44 | 26 |
| 010N001E25Q01M | 384041121482901 | 81-08-10 | 1,090 | 7.4 | 20.5 | 421 | 71 | 73 | 58 | 59 | 23 |
| 010N001E29Q01M | 384048121524301 | 81-08-13 | 1,054 | 7.3 | 19.0 | 438 | 68 | 75 | 61 | 65 | 24 |
| 010N001E32M04M | 384009121530701 | 81-08-13 | 2,720 | 7.3 | 21.0 | 1,119 | 669 | 200 | 150 | 150 | 23 |
| 010N001E33P02M | 383951121521001 | 81-08-13 | 719 | 8.2 | 22.5 | 66 | 0 | 9.8 | 10 | 150 | 83 |
| 010N001W02P01M | 384414121565201 | 81-09-03 | 479 | 8.0 | 26.0 | 88 | 0 | 17 | 11 | 79 | 66 |
| 010N001W02Q01M | 384416121562501 | 81-09-03 | 389 | 7.9 | 22.5 | 105 | 0 | 17 | 15 | 48 | 50 |
| 010N001W06L01M | 384439122005701 | 81-08-19 | 643 | 7.7 | 20.0 | 239 | 0 | 48 | 29 | 47 | 30 |
| 010N001W23B02M | 384214121561101 | 81-08-19 | -- | 7.6 | 22.0 | 282 | 0 | 52 | 37 | 68 | 34 |
| 010N001W33P01M | 384001121590401 | 81-08-19 | 775 | 7.6 | 20.0 | 193 | 0 | 41 | 22 | 100 | 53 |
| 010N001W34D01M | 384003121565801 | 81-09-08 | 1,150 | 7.3 | 18.5 | 396 | 46 | 71 | 53 | 93 | 34 |
| 010N001W36A01M | 384027121545401 | 81-08-19 | 654 | 8.1 | 20.0 | 60 | 0 | 7.7 | 10 | 130 | 82 |
| 010N002E08J01M | 384338121460101 | 81-08-11 | 851 | 7.3 | 19.5 | 364 | 34 | 65 | 49 | 45 | 21 |
| 010N002E16R03M | 384232121445701 | 81-08-11 | 1,470 | 7.2 | 19.0 | 703 | 193 | 100 | 110 | 72 | 18 |
| 010N002E29H02M | 384113121455501 | 81-08-11 | 820 | 7.6 | 20.0 | 309 | 9 | 56 | 41 | 54 | 27 |
| 010N002E33N01M | 383947121453901 | 81-08-11 | 748 | 7.6 | 21.0 | 248 | 0 | 45 | 33 | 63 | 35 |
| 010N002W07A02M | 384406122071001 | 81-08-18 | 805 | 7.2 | 20.5 | 324 | 0 | 67 | 38 | 61 | 29 |
| 010N002W15Q01M | 384233122040601 | 81-09-03 | 1,030 | 7.9 | 22.5 | 39 | 0 | 11 | 2.8 | 220 | 92 |
| 010N002W21A01M | 384228122050301 | 81-09-03 | 1,940 | 7.5 | 20.5 | 381 | 91 | 94 | 35 | 280 | 62 |
| 010N002W26B01M | 384230122060001 | 81-08-18 | 568 | 7.3 | 21.5 | 257 | 0 | 55 | 29 | 33 | 22 |
| 010N002W35J01M | 384016122023801 | 81-08-28 | 497 | 7.3 | 22.0 | 217 | 0 | 59 | 17 | 22 | 18 |
| 010N003W11A02M | 384403122091501 | 81-08-18 | 825 | 7.1 | 24.0 | 260 | 40 | 66 | 23 | 75 | 39 |
| 011N001E03E02M | 384951121512201 | 81-08-06 | 1,900 | 7.3 | 23.0 | 598 | 0 | 58 | 110 | 220 | 44 |
| 011N001E10N01M | 384833121511701 | 81-08-03 | 1,440 | 7.5 | 19.0 | 480 | 0 | 44 | 90 | 160 | 42 |
| 011N001E18C02M | 384828121541701 | 81-08-06 | 690 | 7.5 | 20.5 | 300 | 0 | 46 | 45 | 39 | 22 |
| 011N001E23K01M | 384658121494801 | 81-08-04 | 502 | 7.7 | 20.5 | 146 | 0 | 27 | 19 | 57 | 45 |
| 011N001E30M01M | 384711121500501 | 81-08-03 | 798 | 7.7 | 20.0 | 275 | 0 | 46 | 39 | 58 | 31 |
| 011N001E33G02M | 384535121515701 | 81-08-10 | 793 | 7.4 | 19.0 | 303 | 0 | 52 | 42 | 55 | 28 |
| 011N001E36J01M | 384518121481101 | 81-08-04 | 693 | 7.5 | 18.0 | 267 | 0 | 51 | 34 | 42 | 25 |
| 011N001W12J02M | 384858121545101 | 81-09-02 | 496 | 8.0 | 20.0 | 215 | 0 | 30 | 34 | 29 | 23 |
| 011N001W18F01M | 384822122010201 | 81-09-02 | 976 | 8.0 | 21.5 | 183 | 0 | 19 | 33 | 150 | 64 |
| 011N002E20M01M | 384659121465901 | 81-08-04 | 1,720 | 7.4 | 21.0 | 584 | 0 | 92 | 86 | 180 | 40 |
| 011N002E29N01M | 384552121465901 | 81-08-04 | 1,730 | 7.2 | 21.0 | 669 | 119 | 103 | 100 | 120 | 28 |
| 011N002E31C03M | 384549121474701 | 81-08-04 | 1,130 | 7.6 | 19.5 | 495 | 55 | 86 | 68 | 73 | 24 |
| 011N002W12K01M | 384858122020001 | 81-09-02 | 564 | 7.8 | 21.0 | 257 | 0 | 22 | 49 | 33 | 22 |
| 011N002W14H01M | 384812122023501 | 81-09-02 | 459 | 7.9 | 19.5 | 209 | 0 | 21 | 38 | 21 | 18 |
| 011N002W35E02M | 384535122031201 | 81-09-02 | 488 | 7.8 | 22.0 | 186 | 0 | 20 | 33 | 39 | 31 |
| 011N002W35E03M | 384535122033301 | 81-08-10 | 793 | 7.4 | 19.0 | 303 | 0 | 52 | 42 | 55 | 28 |
| 011N003W04J01M | 384947122112601 | 81-08-17 | 776 | 8.1 | 19.0 | 305 | 75 | 66 | 34 | 43 | 23 |
| 011N003W04L01M | 384940122115401 | 81-08-17 | 647 | 7.7 | 22.0 | 114 | 0 | 24 | 13 | 110 | 67 |
| 011N003W09Q02M | 384839122115201 | 81-08-17 | 1,320 | 8.0 | 24.5 | 556 | 236 | 122 | 61 | 61 | 19 |
| 011N003W23M01M | 384711122100901 | 81-08-18 | 654 | 7.7 | 20.0 | 254 | 34 | 49 | 32 | 46 | 28 |
| 012N001E24P01M | 385211121484101 | 81-08-06 | 566 | 7.3 | 19.0 | 153 | 0 | 28 | 20 | 79 | 52 |
| 012N001E24R01M | 385206121481101 | 81-08-06 | 251 | 7.1 | 15.0 | 82 | 0 | 13 | 12 | 21 | 35 |
| 012N001W06M02M | 385454122012401 | 81-07-30 | 506 | 7.7 | 23.0 | 229 | 0 | 21 | 43 | 26 | 20 |
| 012N001W09P02M | 385849121584501 | 81-07-31 | 370 | 7.5 | 21.0 | 148 | 0 | 33 | 16 | 18 | 21 |
| 012N001W14Q01M | 385256121561501 | 81-08-03 | 557 | 7.6 | 19.5 | 222 | 0 | 28 | 37 | 42 | 29 |
| 012N002E30F02M | 385142121474201 | 81-08-06 | 493 | 6.9 | 18.5 | 239 | 0 | 43 | 32 | 13 | 10 |
| 012N002W03A02M | 385532122035101 | 81-07-30 | 632 | 7.3 | 21.5 | 205 | 0 | 36 | 28 | 61 | 39 |
| 012N002W10H01M | 385430122033801 | 81-07-30 | 771 | 7.6 | 27.0 | 270 | 40 | 45 | -- | -- | -- |
| 012N002W13C02M | 385349122021101 | 81-08-03 | 487 | 7.6 | 22.0 | 224 | 0 | 19 | 43 | 21 | 17 |
| 012N003W33N02M | 385039122121201 | 81-08-17 | 397 | -- | 20.0 | 163 | 33 | 34 | 19 | 17 | 18 |

| SODIUM AD-SORP-TION RATIO | POTAS-SIUM, DIS-SOLVED (MG/L AS K) | ALKA-LINITY FIELD (MG/L AS CACO3) | SULFATE DIS-SOLVED (MG/L AS SO4) | CHLO-RIDE, DIS-SOLVED (MG/L AS CL) | FLUO-RIDE, DIS-SOLVED (MG/L AS F) | SILICA, DIS-SOLVED (MG/L AS SIO2) | SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L) | SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) | NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) | ALUM-INUM, DIS-SOLVED (UG/L AS AL) | ARSENIC DIS-SOLVED (UG/L AS AS) | BORON, DIS-SOLVED (UG/L AS B) | IRON, DIS-SOLVED (UG/L AS FE) | MANGA-NESE, DIS-SOLVED (UG/L AS MN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.1 | 320 | 25 | 51 | 0.2 | 33 | 446 | 454 | 1.0 | -- | -- | 1,400 | -- | -- |
| 2.2 | 2.0 | 250 | 34 | 42 | .2 | 43 | 383 | 398 | .46 | 0 | 16 | 1,200 | 20 | 4 |
| 1.9 | 1.0 | 350 | 70 | 78 | .3 | 34 | 567 | 574 | 1.3 | -- | -- | 1,100 | -- | -- |
| 3.5 | 2.6 | 250 | 58 | 88 | .1 | 37 | 480 | 506 | .18 | 20 | 20 | 1,700 | 11 | 48 |
| 2.8 | 2.8 | -- | 140 | 180 | .2 | 39 | 790 | 817 | .31 | 30 | 6 | 3,000 | 24 | 9 |
| 3.6 | 1.4 | 360 | 720 | 500 | .3 | 27 | 2,130 | 2,062 | .79 | 40 | 3 | 2,400 | 80 | 40 |
| 2.5 | 2.2 | 280 | 110 | 69 | .2 | 38 | 535 | 559 | .26 | 40 | 7 | 1,300 | 40 | 53 |
| 3.0 | 2.4 | -- | 54 | 70 | .2 | 41 | 446 | 458 | .32 | 30 | 8 | 1,400 | 150 | 180 |
| 1.6 | 1.3 | -- | 4.0 | 10 | .5 | 37 | 285 | 283 | 1.3 | 10 | 14 | 460 | 14 | 4 |
| 1.5 | 1.7 | 210 | <1.0 | 8.7 | .6 | 29 | 252 | 256 | .79 | -- | -- | 180 | -- | -- |
| 1.8 | 1.4 | 180 | 4.0 | 5.8 | .1 | 24 | 207 | 213 | .20 | 0 | 16 | 290 | 20 | 45 |
| 1.2 | 2.6 | 240 | 39 | 49 | .6 | 15 | 390 | 380 | 2.8 | 10 | 2 | 1,500 | 17 | 4 |
| 1.3 | 2.1 | 350 | 25 | 120 | .1 | 26 | 572 | 575 | 6.4 | -- | -- | 1,900 | -- | -- |
| 1.4 | 2.5 | -- | 67 | 79 | .1 | 21 | 596 | 595 | 6.8 | -- | -- | 2,300 | -- | -- |
| 2.0 | 2.5 | 450 | 150 | 590 | .0 | 28 | 1,660 | 1,547 | .00 | 0 | 2 | 3,700 | 60 | 0 |
| 8.2 | 1.7 | 290 | 63 | 22 | .1 | 29 | 441 | 462 | .04 | 0 | 10 | 1,600 | <10 | 33 |
| 3.8 | .9 | 220 | 17 | 9.0 | .1 | 21 | 300 | 289 | .16 | 20 | 5 | 1,600 | <10 | 2 |
| 2.1 | .8 | 180 | 6.0 | 8.7 | .2 | 22 | 236 | 227 | 2.0 | 20 | 7 | 490 | <10 | 2 |
| 1.4 | 1.0 | 240 | 21 | 40 | .4 | 25 | 386 | 356 | 4.9 | 10 | 3 | 290 | 60 | 0 |
| 1.8 | 2.8 | 310 | 48 | 45 | .2 | 20 | 495 | 463 | 6.1 | 90 | 2 | 2,500 | 160 | 0 |
| 3.2 | .7 | 300 | 81 | 30 | .5 | 24 | 478 | 480 | .19 | -- | -- | 810 | -- | -- |
| 2.1 | 1.9 | -- | 91 | 99 | .4 | 23 | 651 | 644 | 4.7 | 20 | 1 | 1,500 | <10 | <1 |
| 7.4 | 1.0 | 280 | 49 | 17 | .3 | 23 | 410 | 409 | .13 | 10 | 12 | 2,300 | 20 | 50 |
| 1.1 | 2.4 | 330 | 50 | 53 | .1 | 20 | 497 | 484 | 4.7 | 10 | 2 | 2,000 | 18 | 4 |
| 1.2 | 2.0 | 510 | 69 | 150 | .1 | 28 | 884 | 840 | 10 | -- | -- | 2,900 | -- | -- |
| 1.4 | 2.4 | 300 | 32 | 73 | .1 | 25 | 459 | 465 | 2.2 | -- | -- | 1,800 | -- | -- |
| 1.8 | 2.5 | 290 | 28 | 55 | .1 | 31 | 423 | 434 | 1.6 | 10 | 6 | 1,800 | <10 | 28 |
| 1.5 | 1.0 | 350 | 13 | 43 | .3 | 30 | 483 | 464 | .85 | -- | -- | 1,300 | -- | -- |
| 16 | 2.8 | 350 | 130 | 18 | .2 | 39 | 660 | 635 | .33 | 20 | 5 | 690 | 11 | 43 |
| 6.5 | .6 | -- | 180 | 300 | .4 | 26 | 1,210 | 1,093 | 16 | 20 | 1 | 1,200 | <10 | 4 |
| .9 | .7 | 280 | 7.0 | 15 | .7 | 25 | 351 | 334 | 1.8 | 0 | 1 | 90 | 40 | 10 |
| .7 | .8 | -- | 1.0 | 10 | .4 | 35 | 287 | 289 | 1.1 | 50 | 1 | 50 | <10 | 6 |
| 2.1 | .9 | 220 | 67 | 97 | .3 | 25 | 495 | 487 | 1.3 | 10 | 1 | 650 | 30 | 10 |
| 4.0 | .8 | 740 | 130 | 120 | .5 | 30 | 1,040 | 1,120 | .01 | 30 | 3 | 6,800 | 34 | 4 |
| 3.2 | 1.2 | 650 | 57 | 71 | .5 | 28 | 879 | 844 | 6.6 | -- | -- | 2,700 | -- | -- |
| 1.0 | .6 | 340 | 15 | 9.8 | .6 | 36 | 415 | 396 | 6.3 | -- | -- | 270 | -- | -- |
| 2.1 | 3.2 | 240 | 2.0 | 18 | .6 | 37 | 218 | 308 | .56 | 30 | 7 | 580 | <10 | 13 |
| 1.6 | 2.1 | 290 | 25 | 56 | .1 | 32 | 435 | 434 | 1.9 | 30 | 3 | 1,500 | <10 | 2 |
| 1.4 | 1.6 | -- | 3.0 | 24 | .6 | 24 | 442 | 419 | 4.0 | -- | -- | 1,400 | -- | -- |
| 1.1 | 2.3 | 270 | 23 | 46 | .6 | 17 | 396 | 379 | 2.0 | -- | -- | 1,300 | -- | -- |
| .9 | 1.0 | 260 | <1.0 | 6.9 | .2 | 34 | 284 | 317 | 5.7 | 20 | 4 | 150 | <10 | 1 |
| 4.9 | 1.4 | 300 | 48 | 120 | .2 | 29 | 559 | 582 | 1.0 | 20 | 9 | 1,100 | 11 | 3 |
| 3.3 | 2.6 | -- | 94 | 150 | .6 | 24 | 1,050 | 1,030 | 7.5 | 20 | 1 | 5,100 | 11 | 5 |
| 2.1 | 2.2 | -- | 7.3 | 230 | .1 | 28 | 966 | 924 | -- | -- | -- | 3,500 | -- | -- |
| 1.5 | 2.2 | 440 | 53 | 84 | .6 | 23 | 671 | 655 | 7.6 | 30 | 1 | 1,800 | 25 | 11 |
| .9 | 1.7 | 300 | <5.0 | 9.8 | .1 | 38 | 409 | 345 | 1.6 | 30 | 5 | 210 | <10 | 2 |
| .6 | .6 | 220 | <1.0 | 8.8 | .3 | 33 | 266 | 276 | 4.7 | -- | -- | -- | -- | -- |
| 1.3 | 1.5 | 240 | 13 | 6.5 | .5 | 31 | 282 | 289 | 2.8 | 20 | 2 | 170 | 12 | 2 |
| 1.4 | 1.6 | -- | 3.0 | 24 | .6 | 24 | 442 | 419 | 4.0 | -- | -- | 1,400 | -- | -- |
| 1.1 | .2 | -- | 79 | 61 | .1 | 28 | 456 | 456 | 1.3 | 10 | 1 | 500 | <10 | 2 |
| 4.6 | 1.6 | 270 | 51 | 22 | .3 | 36 | 413 | 422 | .15 | 0 | 2 | 1,500 | 12 | 120 |
| 1.2 | .9 | -- | 95 | 200 | .1 | 28 | 827 | 771 | 2.3 | 20 | 2 | 500 | 38 | 8 |
| 1.3 | 2.5 | 220 | 33 | 63 | .1 | 14 | 381 | 373 | 1.0 | -- | -- | 1,800 | -- | -- |
| 2.9 | 3.9 | 310 | <1.0 | 9.3 | .5 | 54 | 376 | 382 | .11 | 20 | 8 | 400 | 97 | 170 |
| 1.0 | 1.2 | 120 | 2.0 | 4.3 | .5 | 42 | 166 | 170 | .14 | 30 | 9 | 150 | 490 | 430 |
| .8 | 1.5 | 260 | 1.0 | 12 | .2 | 36 | 283 | 397 | 1.7 | -- | -- | 150 | -- | -- |
| .7 | .9 | 150 | <1.0 | 19 | .2 | 31 | 219 | 219 | 2.2 | -- | -- | 60 | -- | -- |
| 1.2 | 2.0 | 250 | 14 | 34 | .3 | 48 | 358 | 355 | .85 | -- | -- | 200 | -- | -- |
| .4 | 2.5 | 240 | 19 | 5.2 | .1 | 46 | 300 | 305 | .13 | -- | -- | 80 | -- | -- |
| 1.9 | .9 | 240 | 7.0 | 47 | .2 | 31 | 372 | 356 | 4.3 | -- | -- | 1,300 | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | 426 | 428 | 3.3 | 10 | 4 | 580 | -- | -- |
| .6 | 1.7 | 260 | <1.0 | 5.2 | .3 | 33 | 281 | 282 | 1.8 | 20 | 5 | 140 | <10 | <1 |
| .6 | .8 | -- | 17 | 27 | .1 | 28 | 237 | 236 | 3.4 | -- | -- | 130 | -- | -- |

## 9.0 RESULTS OF ANALYSES FOR SELECTED TRACE ELEMENTS

[Station No. is based on the grid system of latitude and longitude. The system provides the geographic location of the well. The number consists of 15 digits. The first 6 digits denote the degrees, minutes, and seconds of longitude, and the last 2 digits (assigned sequentially) identify the wells or other sites within a 1-second grid. <, actual value is less than the value shown]

| WELL NO. | STATION NO. | DATE OF SAMPLE | CADMIUM DIS-SOLVED (UG/L AS CD) | CHRO-MIUM, DIS-SOLVED (UG/L AS CR) | COBALT, DIS-SOLVED (UG/L AS CO) | COPPER, DIS-SOLVED (UG/L AS CU) | LEAD, DIS-SOLVED (UG/L AS PB) | LITHIUM DIS-SOLVED (UG/L AS LI) | MERCURY DIS-SOLVED (UG/L AS HG) |
|---|---|---|---|---|---|---|---|---|---|
| 006N001E18C02M | 382214121541901 | 80-09-04 | <1 | 1 | -- | 1 | 1 | -- | 0.0 |
| 006N001E18L01M | 382157121540401 | 80-09-04 | <1 | .00 | -- | 0 | 0 | -- | .0 |
| 006N001W36E02M | 381929121555101 | 80-09-16 | <1 | .00 | -- | 4 | 1 | -- | .0 |
| 007N001W34R01M | 382414121571201 | 80-09-12 | <1 | 4 | -- | 26 | 4 | -- | .0 |
| 007N001W34R02M | 382413121570201 | 80-09-12 | <1 | 6 | -- | 4 | 4 | -- | .0 |
| 008N002E20B01M | 383155121462401 | 81-08-25 | <1 | 40 | <3 | 5 | 4 | 39 | .0 |
| 008N002E21B02M | 383155121452001 | 81-08-26 | <1 | 9 | <3 | 3 | 0 | 29 | .0 |
| 008N004E15G02M | 383228121305401 | 81-08-27 | <1 | .00 | <3 | 3 | 1 | <4 | .0 |
| 009N001E19E01M | 383651121544801 | 81-08-24 | <1 | .00 | <3 | 2 | 4 | 28 | .0 |
| 009N001E20C02M | 383708121530601 | 81-08-24 | <1 | 5 | <3 | 3 | 5 | 41 | .0 |
| 009N001E31D02M | 383526121544001 | 81-08-20 | <1 | 2 | <3 | 21 | 7 | 44 | .0 |
| 009N001W36E01M | 383508121555101 | 81-08-20 | <1 | 9 | <3 | 2 | 2 | 27 | .0 |
| 010N001E32M04M | 384009121530701 | 81-08-13 | 1 | 8 | 0 | 3 | 3 | 90 | .0 |
| 010N001E33P02M | 383951121521001 | 81-08-13 | <1 | .00 | <3 | 2 | 2 | 23 | .5 |
| 010N001W02P01M | 384414121565201 | 81-09-03 | <1 | 2 | <3 | 2 | 2 | 10 | .6 |
| 010N001W02Q01M | 384416121562501 | 81-09-03 | 1 | 9 | <3 | 2 | 6 | 19 | .0 |
| 010N002W15Q01M | 384233122040601 | 81-09-03 | <1 | 1 | <3 | 1 | 5 | 22 | .2 |
| 010N002W21A01M | 384228122050201 | 81-09-03 | 3 | 30 | <3 | 1 | 5 | 39 | .8 |
| 011N003W04J01M | 384947122112601 | 81-08-17 | 1 | 2 | <3 | 6 | 2 | 26 | .0 |
| 011N003W04L01M | 384940122115401 | 81-08-17 | <1 | .00 | <3 | 4 | 2 | 45 | .0 |
| 012N001E24P01M | 385211121484101 | 81-08-06 | <1 | .00 | <3 | 1 | 1 | 17 | .0 |
| 012N001E24R01M | 385206121481101 | 81-08-06 | <1 | .00 | <3 | 0 | 1 | 11 | .0 |

| WELL NO. | DATE OF SAMPLE | MOLYB-DENUM, DIS-SOLVED (UG/L AS MO) | NICKEL, DIS-SOLVED (UG/L AS NI) | SELE-NIUM, DIS-SOLVED (UG/L AS SE) | STRON-TIUM, DIS-SOLVED (UG/L AS SR) | VANA-DIUM, DIS-SOLVED (UG/L AS V) | ZINC, DIS-SOLVED (UG/L AS ZN) |
|---|---|---|---|---|---|---|---|
| 006N001E18C02M | 80-09-04 | <10 | 0 | 6 | -- | -- | 60 |
| 006N001E18L01M | 80-09-04 | <10 | 0 | 3 | -- | -- | 30 |
| 006N001W36E02M | 80-09-16 | <10 | 0 | 2 | -- | -- | 10 |
| 007N001W34R01M | 80-09-12 | <10 | 0 | 0 | -- | -- | 50 |
| 007N001W34R02M | 80-09-12 | <10 | 0 | 0 | -- | -- | 7 |
| 008N002E20B01M | 81-08-25 | <10 | 1 | 9 | 690 | 9 | <3 |
| 008N002E21B02M | 81-08-26 | <10 | 3 | 1 | 280 | 20 | <3 |
| 008N004E15G02M | 81-08-27 | <10 | 3 | 0 | 350 | 0 | 5 |
| 009N001E19E01M | 81-08-24 | <10 | 2 | 0 | 570 | 4 | 17 |
| 009N001E20C02M | 81-08-24 | <10 | 2 | 1 | 550 | 6 | 43 |
| 009N001E31D02M | 81-08-20 | <10 | 4 | 2 | 1100 | 4 | 600 |
| 009N001W36E01M | 81-08-20 | <10 | 2 | 2 | 730 | 4 | 81 |
| 010N001E32M04M | 81-08-13 | 0 | 1 | 1 | 1900 | 15 | 470 |
| 010N001E33P02M | 81-08-13 | <10 | 2 | 0 | 200 | 0 | 29 |
| 010N001W02P01M | 81-09-03 | <10 | 1 | 0 | 370 | 3 | 39 |
| 010N001W02Q01M | 81-09-03 | <10 | 0 | 0 | 370 | 24 | 73 |
| 010N002W15Q01M | 81-09-03 | <10 | 1 | 0 | 370 | 1 | 92 |
| 010N002W21A01M | 81-09-03 | <10 | 3 | 2 | 2000 | 10 | 52 |
| 011N003W04J01M | 81-08-17 | <10 | 1 | 0 | 480 | 0 | 58 |
| 011N003W04L01M | 81-08-17 | <10 | 0 | 1 | 130 | 1 | 100 |
| 012N001E24P01M | 81-08-06 | <10 | 1 | 0 | 330 | 2 | 20 |
| 012N001E24R01M | 81-08-06 | <10 | 2 | 0 | 140 | 1 | <3 |