
Kern County Water Agency
Water Supply Report
1994

January 1996



Kern County Water Agency
WATER SUPPLY REPORT
1994

Thomas N. Clark
General Manager

January 1996

Table of Contents

Definitions, 3

1994: Another Dry Year, 4

Water Supplies, 7

- State Water Project, 7
- Kern River, 15
- Central Valley Project, 16
- Minor Streams, 16
- Effective Precipitation, 24
- Waste Water Reuse, 31
- Oil Field Produced Water, 31
- Ground Water Extractions, 31

Water Requirements, 42

- Agricultural, 42
- Municipal and Industrial, 50
- Exports, 50
- Water Surface Evaporation, 50

Change in Ground Water Storage, 53

Basin-Wide Water Use Efficiency, 58

Intertie Activity, 58

Ground Water Conditions, 60

- Ground Water Recharge, 60
- Ground Water Banking, 60
- Shallow Ground Water, 71
- Ground Water Quality, 71
- Ground Water Levels, 73
- Indian Wells Valley, 79

Focus: Kern Delta Water District, 80

Outlook: 1995, 82

Bay-Delta Accord, 83

Monterey Principles, 83

Tables

| | |
|-----|--|
| 1 | Sacramento River Indices, Historic, 5 |
| 2a | State Water Project Article 12(d) Account, 8 |
| 2b | Member Units Contract Entitlements for 1990-2035, 9 |
| 3 | State Water Project Deliveries, Historic, 11 |
| 4 | State Water Project Deliveries by Contract, 1994, 12 |
| 5 | Kern River Flows, Historic, 18 |
| 6 | Kern River Water Diversions by Entity, 1994, 20 |
| 7 | Central Valley Project Deliveries by Entity, 1994, 21 |
| 8 | Central Valley Project Deliveries, Historic, 22 |
| 9 | Minor Stream Flows, Historic, 25 |
| 10 | Monthly Rainfall at Selected Stations, 1994, 28 |
| 11 | Effective Precipitation, Historic, 32 |
| 12 | Waste Water Treatment Plant Volumes, 1994, 34 |
| 13 | Oil Field Produced Water Flows, Historic, 35 |
| 14 | Water Reuse, Historic, 37 |
| 15 | Ground Water Pumping, Historic, 40 |
| 16 | Irrigated Acreage, Historic, 43 |
| 17 | Monthly Evaporation for Three San Joaquin Valley Climatic Stations, 1994, 47 |
| 18 | Irrigated Acreage, 1994, 49 |
| 19 | Average Applied Water Requirements for Various Crops, 51 |
| 20 | Urban Water Use, 1994, 52 |
| 21 | Surface and Ground Water Usage or Availability, Historic, 57 |
| 22 | Kern River-California Aqueduct Intertie Activity, Historic, 59 |
| 23 | Ground Water Recharge Activities, 61 |
| 24a | Ground Water Banking Activities, 62 |
| 24b | Ground Water Banking Summary, City of Bakersfield 2,800 Acres, 64 |
| 24c | Ground Water Banking Summary, Berrenda Mesa Spreading Grounds, 66 |
| 24d | Ground Water Banking Summary, Kern River Channel within Improvement District No. 4, 67 |
| 24e | Ground Water Banking Summary, Kern Water Bank, 68 |
| 24f | Ground Water Banking Summary, Other, 69 |
| 24g | Ground Water Banking Summary, Semitropic Water Storage District, 70 |
| 25 | Areal Extent of Shallow Ground Water, Historic, 72 |
| 26 | Kern Delta Water District Irrigated Acreage, 1994, 80 |

Figures

| | |
|----|--|
| 1 | The Hydrologic Cycle, 3 |
| 2 | Sacramento River Indices, Historic, 6 |
| 3 | State Water Project Deliveries, Historic, 10 |
| 4 | Kern River Flows at First Point, Historic, 17 |
| 5 | Central Valley Project Deliveries, Historic, 23 |
| 6 | Minor Stream Flows, Historic, 26 |
| 7a | Poso Creek Hydrograph, 1994, 27 |
| 7b | Poso Creek Cumulative Runoff, 1994, 27 |
| 8 | Annual Precipitation at Three Stations, Historic, 30 |
| 9 | Effective Precipitation, Historic, 33 |
| 10 | Oil Field Produced Water, Historic, 36 |
| 11 | Water Reuse, Historic, 38 |
| 12 | Ground Water Pumping, Historic, 41 |

Figures (continued)

- 13 Irrigated Acreage, Historic, 44
- 14 Summary of Irrigated Acreage, 1994, 45
- 15 Monthly Evaporation Percent of Normal, 1994, 48
- 16 Water Resources Inventory, 1994, 54
- 17 Gross Water Supplies and Net Water Requirements, Historic, 55
- 18 Cumulative Change in Ground Water Storage, 56
- 19a Water Well Hydrograph, Wildlife Refuge Area (West of Delano), 75
- 19b Water Well Hydrograph, Wasco Area, 76
- 19c Water Well Hydrograph, Southwest Bakersfield Area, 77
- 19d Water Well Hydrograph, Arvin Area, 78

Plates

- 1 Depth to Shallow Ground Water
- 2 Ground Water Quality of Unconfined Aquifer
- 3 Ground Water Quality of Confined Aquifer
- 4 Depth to Ground Water
- 5 Ground Water Surface Elevations
- 6 Change in Ground Water Surface Elevations, 1994-95
- 7 Depth to Ground Water, Indian Wells Valley
- 8 Ground Water Surface Elevations, Indian Wells Valley
- 9 Ground Water Quality, Indian Wells Valley
- 10 Major Surface Water Supplies and Intermediate Transmission Facilities

Definitions

Acre-Foot (AF) The quantity of water required to cover one acre of land to a depth of one foot (325,872 gallons). This amount of water is normally used by a family of five during a one-year period for residential use (not including water used for food or clothing).

Agency Kern County Water Agency (KCWA).

Aquifer Geologic formations or parts of formations containing sufficient saturated permeable material able to yield sufficient quantities of water.

cfs Cubic feet per second, a rate of flow.
1 cfs = 450 gallons per minute
= 646,360 gallons per day
= 1.983 acre-feet per day

Change in Ground Water Storage The change in volume of water retained by subsurface aquifers within the ground water basin. A negative change reflects the fact that extractions have exceeded recharge.

Confined Aquifer A ground water bearing stratum constrained at its upper surface by an impervious unit, such as a regional clay.

Corcoran Clay A thick, impermeable layer of clay which lies under much of the San Joaquin Valley. This clay layer separates the ground water basin into two distinct aquifers. One region, referred to as the "unconfined" aquifer, lies above the Corcoran Clay. The other region, referred to as the "confined" aquifer, lies entirely below the Corcoran Clay.

CVC The Cross Valley Canal.

CVP The federal Central Valley Project. The Friant-Kern Canal is its major feature in Kern County.

DWR California Department of Water Resources. The operators of the State Water Project (California Aqueduct).

Electrical Conductance (EC) A measure of the ability of water to conduct an electrical current, which can be related to the concentration of total dissolved solids. The normal unit of measurement is micromhos per centimeter.

Ground Water Basin An area underlain by one or more permeable formations (aquifers) capable of furnishing a substantial and beneficial water supply. The basin referred to in this report is within the San Joaquin Valley portion of Kern County but is connected hydrologically and geologically to a larger basin.

Ground Water Recharge Any act of nature or man which replenishes or adds water to that supply which is stored within the natural subsurface aquifer system.

In-lieu Recharge The process of recharging ground water supplies by substituting surface water for ground water that would otherwise be extracted.

Irrigation Efficiency The amount of applied irrigation water that actually goes to satisfy net crop water demands, expressed as a percent.

Metric Conversions Acre-feet (x) 1233.5 = cubic meters
Acre-feet (x) 0.0012335 = cubic hectometers
Feet (x) 0.0348 = meters
Inches (x) 2.54 = centimeters
Million gallons per day (x) 0.043813 = cubic meters per second

Overdraft A long-term condition in which ground water extractions exceed ground water recharge.

Sacramento River Index An index used by the California Department of Water Resources to forecast available water supplies and SWP delivery capabilities. The index consists of the forecasted or computed unimpaired flows of the Sacramento River near Red Bluff, Feather River at Oroville Reservoir, Yuba River at Smartville and American River at Folsom Reservoir.

SWP The State Water Project. In Kern County, its major feature is the Edmund G. Brown California Aqueduct.

TDS Total dissolved solids. A measurement of the dissolved matter in water, consisting mainly of inorganic salts, and small amounts of organic matter and gases. Usually measured in parts per million (ppm).

Unconfined Aquifer A ground water bearing stratum that is not constrained at its upper surface by an impervious or semi-impervious unit, such as a regional clay.

USBR United States Bureau of Reclamation. The operators of the Federal Central Valley Project.

Introduction

The Kern County Water Agency was created by the California Legislature in July, 1961 and ratified by the electorate of Kern County in September, 1961. The Agency was granted the primary power to acquire and contract for water supplies for Kern County, with additional powers to control flood and storm waters, to drain and reclaim land, to store and reclaim water, to protect the quality of underground waters, and to conduct investigations relative to water resources. The primary focus of the Agency, working with other water entities, is to coordinate management of the water supplies of Kern County, with particular emphasis on State Water Project supplies, in order to enhance our local economy.

Since its beginning in 1961, the Agency has been building a base of information on the water supply and demand characteristics of the San Joaquin Valley portion of Kern County. Since 1977, the Agency has published the annual Water Supply Report in order to present these statistics in one document and to assist water leaders and users in making water management decisions.

The Water Supply Report attempts to identify and quantify the interrelationships of the hydrologic cycle (see Figure 1) with man's activities in Kern County. For instance, the natural pattern of evapotranspiration has been altered by the planting and harvesting of crops. Ground water storage has been affected by ground water pumping and recharge, as the agricultural, municipal and industrial sectors attempt to meet their expanding needs. Local surface storage facilities and contracts for imported surface supplies have lessened our dependence upon ground water supplies. Also, coordinated ground water recharge efforts have had a positive effect upon ground water storage.

The net result of the interactions between the available water supplies and the various demands for that water is a change in ground water storage and ground water quality. The Water Supply Report documents these changes and their causes.

All supporting data and calculations used to prepare this report are on file at the Agency and are open to public review.

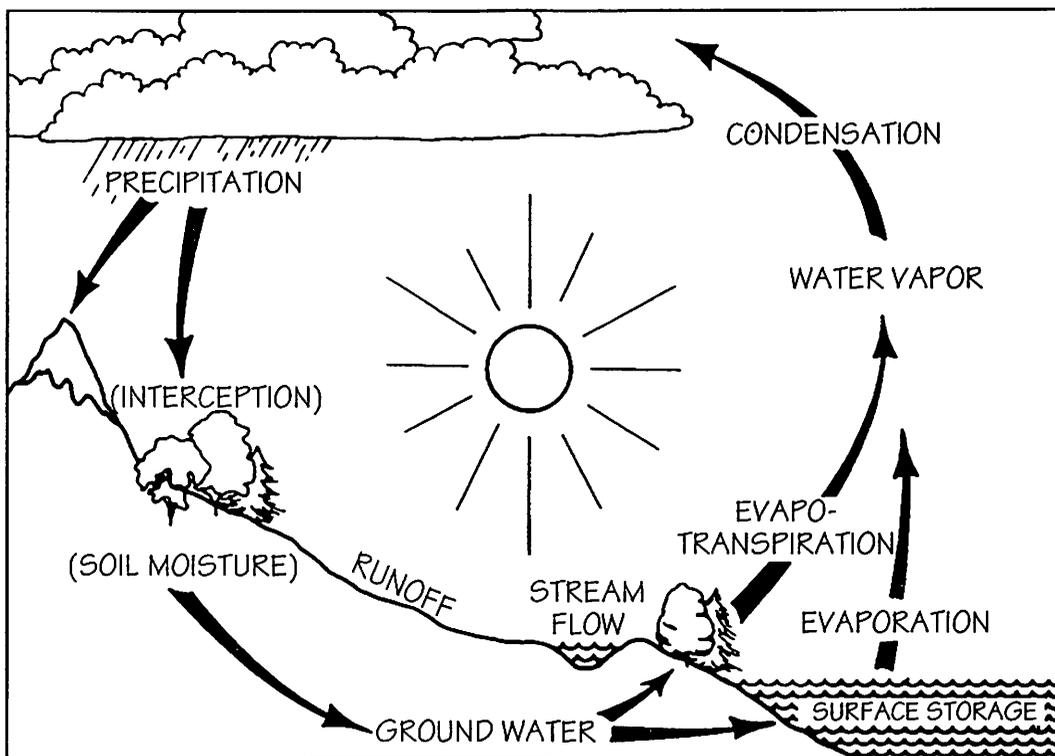


Figure 1. The Hydrologic Cycle

1994: Another Dry Year

Fears of another prolonged drought loomed during the end of 1993, when extremely dry conditions again returned to the state. While 1993 was a wet year, 1994 ended up being critically dry. The return of drought conditions meant that only 50 percent of State Water Project (SWP) supplies were available. Likewise, only 80 percent of Class I entitlements were available for federal Friant-Kern contractors. No Class II entitlement was available. Federal contractors served from the Delta received only 43 percent of Class I entitlements. Federal Delta export contractors have not received full entitlements since 1989.

The Sacramento River Index (SRI) is used to reflect SWP water supply conditions. The average SRI over 89 years of record is 17.6 million acre-feet (MAF). Any year with an index less than 10.2 MAF is classified as critically dry. Any year with an index greater than 19.6 MAF is classified as wet. Thus, 1994 was officially a critical year with an SRI of 7.8 MAF. In terms of rainfall, 1994 was the fourth driest year of record, with lower rainfall than any year during the 1987-92 drought. Table 1 is a history of Sacramento River Indices. Figure 2 shows the same information graphically.

Kern County surface water supplies from all sources during 1994 were about 1,537,800 acre-feet. Normal

supplies are about 2,200,000 acre-feet. Therefore, water availability in 1994 was about 70 percent of normal. SWP entitlement deliveries from all sources totaled 668,577 acre-feet, or about 53 percent of entitlement. Kern River supplies were 425,053 acre-feet, or 59 percent of average. Central Valley Project deliveries totaled 186,303 acre-feet, or 51 percent of the 1975-94 average.

Because of the dry conditions, about 144,500 acres of farm land (mostly west side lands) remained idle during 1994. Total irrigated acreage was 802,400 acres, only slightly more than in 1993.

The change in ground water storage in 1994 was a decrease of about 1,054,500 acre-feet. This more than wiped out the 215,400 acre-feet added to storage in 1993. The total withdrawals since 1970 have been about 12,955,000 acre-feet. The total additions to storage over the same period have been about 5,551,000 acre-feet. The net change in storage since 1970 has been a loss of about 7,404,000 acre-feet, or about 296,000 acre-feet per year. In terms of volume of water stored, the ground water basin is at a level below the last drought. During the six years of the 1987-92 drought, ground water storage was reduced by about 5,390,000 acre-feet, or about 898,000 acre-feet per year.

Table 1
Historic Sacramento River Indices *
(in million acre-feet)

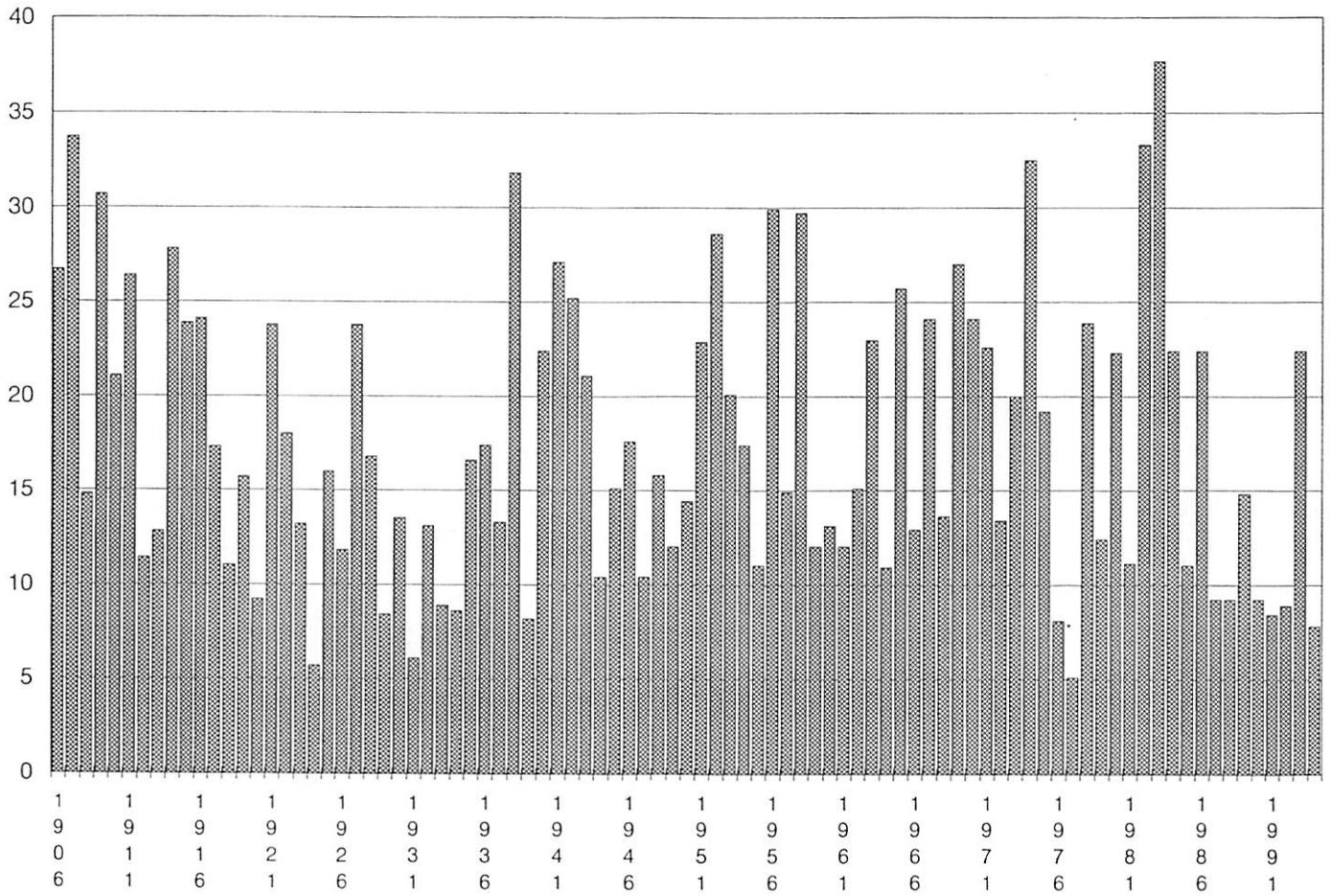
| Descending Order by Year | | | | Ascending Order by Index | | | |
|--------------------------|-------|------|-------|--------------------------|-------|------|-------|
| Year | Index | Year | Index | Year | Index | Year | Index |
| 1994 | 7.8 | | | | | | |
| 1993 | 22.4 | | | | | | |
| 1992 | 8.9 | | | | | | |
| 1991 | 8.4 | | | | | | |
| 1990 | 9.2 | 1945 | 15.1 | 1977 | 5.1 | 1925 | 16.0 |
| 1989 | 14.8 | 1944 | 10.4 | 1924 | 5.7 | 1935 | 16.6 |
| 1988 | 9.2 | 1943 | 21.1 | 1931 | 6.1 | 1928 | 16.8 |
| 1987 | 9.2 | 1942 | 25.2 | 1994 | 7.8 | 1917 | 17.3 |
| 1986 | 22.4 | 1941 | 27.1 | 1976 | 8.1 | 1954 | 17.4 |
| 1985 | 11.0 | 1940 | 22.4 | 1939 | 8.2 | 1936 | 17.4 |
| 1984 | 22.4 | 1939 | 8.2 | 1929 | 8.4 | 1922 | 18.0 |
| 1983 | 37.7 | 1938 | 31.8 | 1991 | 8.4 | 1975 | 19.2 |
| 1982 | 33.3 | 1937 | 13.3 | 1934 | 8.6 | 1973 | 20.0 |
| 1981 | 11.1 | 1936 | 17.4 | 1992 | 8.9 | 1953 | 20.1 |
| 1980 | 22.3 | 1935 | 16.6 | 1933 | 8.9 | 1943 | 21.1 |
| 1979 | 12.4 | 1934 | 8.6 | 1990 | 9.2 | 1946 | 17.6 |
| 1978 | 23.9 | 1933 | 8.9 | 1988 | 9.2 | 1910 | 21.1 |
| 1977 | 5.1 | 1932 | 13.1 | 1987 | 9.2 | 1980 | 22.3 |
| 1976 | 8.1 | 1931 | 6.1 | 1920 | 9.2 | 1993 | 22.4 |
| 1975 | 19.2 | 1930 | 13.5 | 1947 | 10.4 | 1984 | 22.4 |
| 1974 | 32.5 | 1929 | 8.4 | 1944 | 10.4 | 1940 | 22.4 |
| 1973 | 20.0 | 1928 | 16.8 | 1964 | 10.9 | 1986 | 22.4 |
| 1972 | 13.4 | 1927 | 23.8 | 1985 | 11.0 | 1971 | 22.6 |
| 1971 | 22.6 | 1926 | 11.8 | 1955 | 11.0 | 1951 | 22.9 |
| 1970 | 24.1 | 1925 | 16.0 | 1918 | 11.0 | 1963 | 23.0 |
| 1969 | 27.0 | 1924 | 5.7 | 1981 | 11.1 | 1927 | 23.8 |
| 1968 | 13.6 | 1923 | 13.2 | 1912 | 11.4 | 1921 | 23.8 |
| 1967 | 24.1 | 1922 | 18.0 | 1926 | 11.8 | 1978 | 23.9 |
| 1966 | 12.9 | 1921 | 23.8 | 1961 | 12.0 | 1915 | 23.9 |
| 1965 | 25.7 | 1920 | 9.2 | 1959 | 12.0 | 1970 | 24.1 |
| 1964 | 10.9 | 1919 | 15.7 | 1949 | 12.0 | 1967 | 24.1 |
| 1963 | 23.0 | 1918 | 11.0 | 1979 | 12.4 | 1916 | 24.1 |
| 1962 | 15.1 | 1917 | 17.3 | 1913 | 12.8 | 1942 | 25.2 |
| 1961 | 12.0 | 1916 | 24.1 | 1966 | 12.9 | 1965 | 25.7 |
| 1960 | 13.1 | 1915 | 23.9 | 1960 | 13.1 | 1911 | 26.4 |
| 1959 | 12.0 | 1914 | 27.8 | 1932 | 13.1 | 1906 | 26.7 |
| 1958 | 29.7 | 1913 | 12.8 | 1923 | 13.2 | 1969 | 27.0 |
| 1957 | 14.9 | 1912 | 11.4 | 1937 | 13.3 | 1941 | 27.1 |
| 1956 | 29.9 | 1911 | 26.4 | 1972 | 13.4 | 1914 | 27.8 |
| 1955 | 11.0 | 1910 | 21.1 | 1930 | 13.5 | 1952 | 28.6 |
| 1954 | 17.4 | 1909 | 30.7 | 1968 | 13.6 | 1958 | 29.7 |
| 1953 | 20.1 | 1908 | 14.8 | 1950 | 14.4 | 1956 | 29.9 |
| 1952 | 28.6 | 1907 | 33.7 | 1989 | 14.8 | 1909 | 30.7 |
| 1951 | 22.9 | 1906 | 26.7 | 1908 | 14.8 | 1938 | 31.8 |
| 1950 | 14.4 | | | 1957 | 14.9 | 1974 | 32.5 |
| 1949 | 12.0 | | | 1962 | 15.1 | 1982 | 33.3 |
| 1948 | 15.8 | | | 1945 | 15.1 | 1907 | 33.7 |
| 1947 | 10.4 | | | 1919 | 15.7 | 1983 | 37.7 |
| 1946 | 17.6 | | | 1948 | 15.8 | | |

| | |
|--------------------|------|
| 89 years of record | |
| Average SRI | 17.6 |
| Median SRI | 15.8 |

* An index used by the California Department of Water Resources to forecast available water supplies and SV delivery capabilities. The index consists of the forecasted or computed unimpaired flows of the Sacramento River near Red Bluff, Feather River at Oroville Reservoir, Yuba River at Smartville and American River at Folsom Reservoir. Formerly called Four-basin Index.

Figure 2
 Historic Sacramento River Indices

Million
 Acre-Feet



Water Supplies

State Water Project (SWP)

On December 9, 1993 the Department of Water Resources (DWR) announced their initial allocation of State Water Project supplies for 1994. Expectations were that the allocation would be 40-50 percent, since the snowpack was only 40-50 percent of normal. However, SWP reservoir carryover storage was high because of the previous wet year. DWR made an initial allocation of 50 percent of requested 1994 SWP entitlement. For Kern County Water Agency (KCWA), this amounted to 517,000 feet for agricultural use and 60,000 acre-feet for urban uses. DWR's low initial allocation reflected not only the dry conditions, but the uncertainty of the SWP's water delivery capabilities. Pumping restrictions to protect winter salmon and Delta smelt (both protected under the federal Endangered Species Act) served to complicate DWR's operational planning.

The chronology of 1994 allocations follows:

| | |
|-------------------|---|
| December 9, 1993 | 50% |
| | (initial allocation, original requests) |
| February 16, 1994 | 53% (revised requests) |
| May 18, 1994 | 53% (final allocation) |

The low initial allocation left local water users again facing the problem of dealing with inadequate surface water supplies. Anticipating another low water supply year, in December 1993 KCWA began planning for a 1994 emergency water supply program. Emphasis was placed on purchasing any available surface supplies to offset shortages. Specifically, DWR was developing a 1994 State Drought Water Bank (Drought Bank), which local districts could draw upon if needed. Ground water bank accounts would only be pumped as a last resort. A total of 45,563 acre-feet of Drought Bank water was purchased by Kern County water users. Only a small amount of ground water (8,280 acre-feet) was pumped from ground water banking accounts to meet irrigation needs for west side districts.

Article 12(d) of the master contract between DWR and KCWA provides for future repayment of entitlement water that DWR is unable to deliver because of causes beyond its control. Such "12(d) water" will be delivered in succeeding years on an as-available basis. Article 12(d) was triggered in 1990-92, and again in

1994. At the end of 1994, KCWA had a 12(d) credit of 2,810,499 acre-feet, equal to more than 2 1/2 years of full entitlement. Terms under which 12(d) water will be delivered have not yet been decided. Furthermore, since the State Water Project is only half-completed, it is unlikely that the balance will ever be fully repaid.

A detailed summary of present member unit balances of 12(d) water is shown in Table 2a. Member units' contract entitlement for 1990 and after are shown on Table 2b. The table also breaks down entitlement between municipal and industrial (M&I) and agricultural uses. While the M&I entitlement is small compared to the agricultural, KCWA is the third-largest M&I contractor with the SWP, and is the largest agricultural contractor.

A total of 668,577 acre-feet of SWP water was delivered during 1994, including 610,103 acre-feet of SWP entitlement and 58,474 acre-feet was so-called "Interruptible Entitlement." Interruptible Entitlement water is available during short periods when water is available for export that is not needed to meet Delta water quality criteria and DWR's reservoir storage targets. Another 45,563 acre-feet of water was purchased and delivered from the 1994 Drought Bank. The Agency pumped an additional 8,280 acre-feet of banked ground water for west side water districts. Since the first deliveries in 1968, a total of over 20 million acre-feet of SWP water has been brought into Kern County. A graph of historic SWP deliveries is provided in Figure 3. Table 3 provides a history of SWP deliveries, with annual and cumulative deliveries and imports shown. Table 4 shows 1994 SWP deliveries by contract type.

The federal Environmental Protection Agency (EPA) released its draft water quality protection plan for the Sacramento-San Joaquin Delta on December 15, 1993. From its onset the December 15 announcement was controversial. The proposed standards were developed by EPA under authority of the federal Clean Water Act, and to settle a lawsuit filed by environmental interests aimed at forcing EPA to develop federal standards for the Delta. A group of federal agencies, the Bureau of Reclamation, U.S. Fish and Wildlife Service, National Marine Fisheries Service and EPA, dubbed collectively as "Club Fed," developed the December 15 draft plan. On the same day, Club Fed announced the listing of the Sacramento Splittail min-

Table 2a
Kern County Water Agency
State Water Project
Article 12(d) Account
(in acre-feet)

| Member Unit | Article 12(d) Account | | | | | Article 12(d) Delivered | Balance |
|----------------------------------|-----------------------|------------------|----------------|----------------|------------------|----------------------------|------------------|
| | 1990 | 1991 | 1992 | 1994 | Total | | |
| Berrenda Mesa WD | 77,505 | 155,073 | 85,091 | 73,058 | 390,727 | 0 | 390,727 |
| Lost Hills WD | 70,159 | 140,376 | 77,027 | 66,134 | 353,696 | 0 | 353,696 |
| Belridge WSD | 81,453 | 162,972 | 89,426 | 76,780 | 410,631 | 0 | 410,631 |
| Buttonwillow ID | 41,476 | 82,986 | 45,536 | 39,096 | 209,094 | 0 | 209,094 |
| Pond Poso ID | 33,480 | 66,988 | 36,758 | 31,560 | 168,786 | 0 | 168,786 |
| Semitropic WSD | 3,998 | 7,999 | 4,389 | 3,768 | 20,154 | 0 | 20,154 |
| Cawelo WD | 19,089 | 38,193 | 20,957 | 17,994 | 96,233 | 0 | 96,233 |
| Improvement District No. 4 (Ag) | 5,135 | 10,274 | 5,638 | 4,840 | 25,887 | 0 | 25,887 |
| Improvement District No. 4 (M&I) | 0 | 53,900 | 42,244 | 36,270 | 132,414 | 0 | 132,414 |
| Rosedale-Rio Bravo WSD | 14,941 | 29,895 | 16,404 | 14,084 | 75,324 | 0 | 75,324 |
| Buena Vista WSD | 10,644 | 21,296 | 11,685 | 10,033 | 53,658 | 0 | 53,658 |
| Kern Delta WD | 12,742 | 25,495 | 13,990 | 12,012 | 64,239 | 0 | 64,239 |
| Henry Miller WD | 17,740 | 35,494 | 19,476 | 16,722 | 89,432 | 0 | 89,432 |
| West Kern WD (M&I) | 0 | 17,500 | 13,716 | 11,776 | 42,992 | 0 | 42,992 |
| Wheeler Ridge-Maricopa WSD | 126,389 | 252,880 | 138,760 | 119,137 | 637,166 | 0 | 637,166 |
| Tehachapi-Cummings CWD (Ag) | 2,149 | 4,299 | 2,359 | 2,025 | 10,832 | 0 | 10,832 |
| Tehachapi-Cummings CWD (M&I) | 0 | 10,500 | 8,229 | 7,066 | 25,795 | 0 | 25,795 |
| Tejon-Castac WD (M&I) | 0 | 1,400 | 1,097 | 942 | 3,439 | 0 | 3,439 |
| Total | 516,900 | 1,117,520 | 632,782 | 543,297 | 2,810,499 | 0 | 2,810,499 |

Table 2b
Kern County Water Agency
Member Unit Contract Entitlements
for 1990-2035

| Member Unit | Firm | Surplus (1) | Total | M&I | Ag | Total |
|----------------------------|------------------|--------------------|------------------|----------------|------------------|------------------|
| Berrenda Mesa WD | 155,100 | 8,100 | 163,200 | | 163,200 | 163,200 |
| Lost Hills WD | 140,400 | 0 | 140,400 | 2,000 (2) | 138,400 | 140,398 |
| Belridge WSD | 163,000 | 0 | 163,000 | 15,000 (2) | 148,000 | 162,998 |
| Buttonwillow ID | 83,000 | 13,100 | 96,100 | | 96,100 | 96,100 |
| Pond Poso ID | 67,000 | 11,100 | 78,100 | | 78,100 | 78,100 |
| Semitropic WSD | 8,000 | 900 | 8,900 | | 8,900 | 8,900 |
| Cawelo WD | 38,200 | 6,800 | 45,000 | | 45,000 | 45,000 |
| Improvement District No. 4 | 87,276 | 1,554 | 88,830 | 77,000 | 11,830 | 88,830 |
| Rosedale-Rio Bravo WSD | 29,900 | 5,100 | 35,000 | | 35,000 | 35,000 |
| Buena Vista WSD | 21,300 | 3,750 | 25,050 | | 25,050 | 25,050 |
| Kern Delta WD | 25,500 | 4,500 | 30,000 | | 30,000 | 30,000 |
| Henry Miller WD | 35,500 | 6,250 | 41,750 | | 41,750 | 41,750 |
| West Kern WD | 25,000 | 0 | 25,000 | 25,000 | | 25,000 |
| Wheeler Ridge-Maricopa WSD | 252,924 | 38,146 | 291,070 | | 291,070 | 291,070 |
| Tehachapi-Cummings CWD | 19,300 | 700 | 20,000 | 15,000 | 5,000 | 20,000 |
| Tejon-Castac WD | 2,000 | 0 | 2,000 | 2,000 | | 2,000 |
| Total | 1,153,400 | 100,000 | 1,253,400 | 136,000 | 1,117,400 | 1,253,400 |

Note: Maximum annual entitlement is reached in 1990.

(1) Surplus water is part of Kern County Water Agency's contracts with its member units, but is not provided as part of KCWA's master contract with the state Department of Water Resources. It is only delivered on an as-available basis, and reached its minimum in 1990.

(2) Agricultural entitlement converted to M&I use; retains agricultural delivery priority.

Figure 3
California State Water Project Deliveries
to Kern County Water Agency

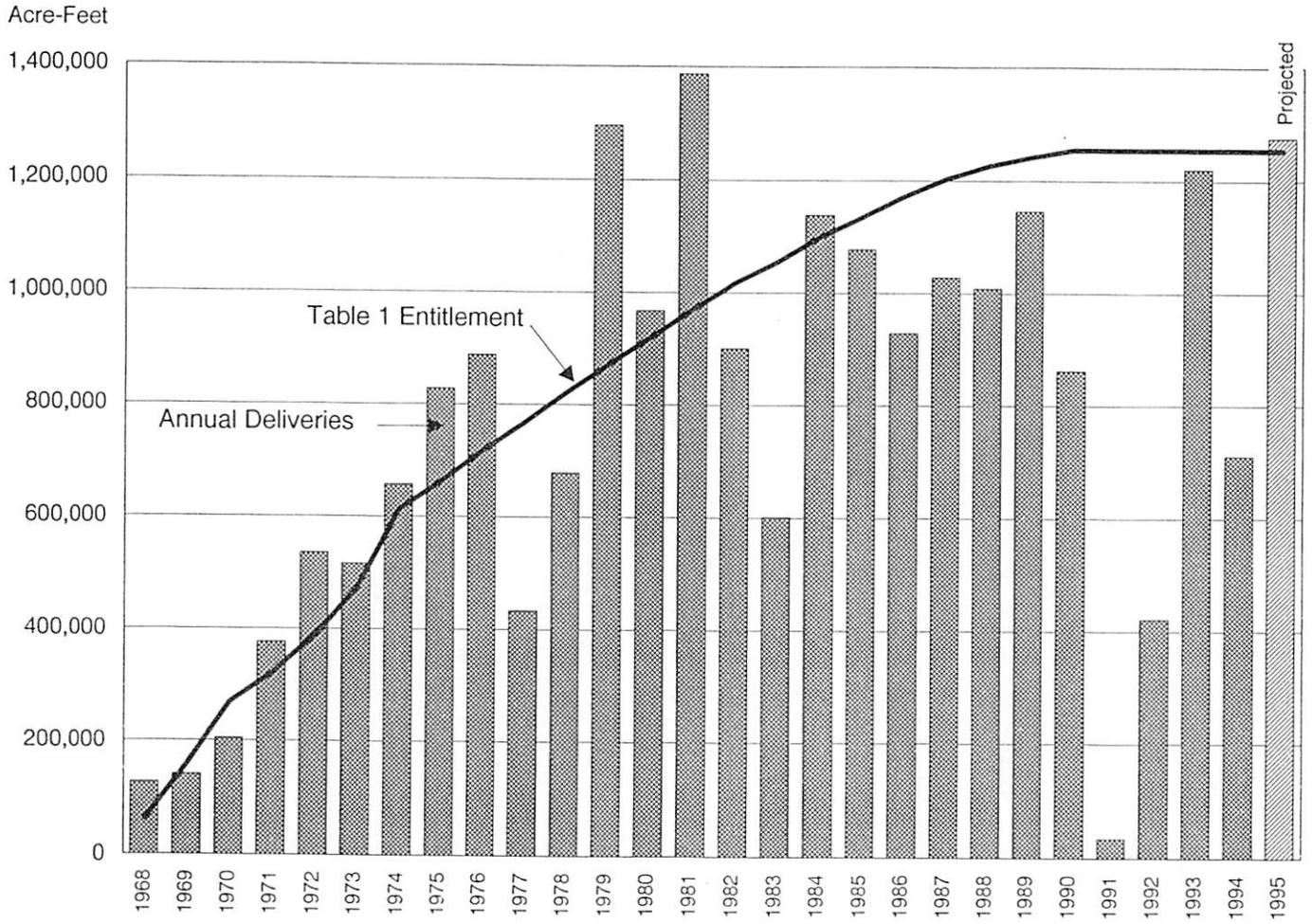


Table 3
SWP Water Deliveries to the
San Joaquin Valley Portion of Kern County
(in acre-feet)

| Year | Annual (1) Deliveries | Cumulative Deliveries | Intertie Deliveries | Deliveries (2) Outside SJV | Annual Importations | Cumulative Importations |
|-------------|----------------------------------|----------------------------------|--------------------------------|---------------------------------------|--------------------------------|------------------------------------|
| 1968 | 127,384 | 127,384 | | | 127,384 | 127,384 |
| 1969 | 141,265 | 268,649 | | | 141,265 | 268,649 |
| 1970 | 204,634 | 473,283 | | | 204,634 | 473,283 |
| 1971 | 375,505 | 848,788 | | | 375,505 | 848,788 |
| 1972 | 535,573 | 1,384,361 | | | 535,573 | 1,384,361 |
| 1973 | 515,546 | 1,899,907 | | 25 | 515,521 | 1,899,882 |
| 1974 | 656,773 | 2,556,680 | | 4,992 | 651,781 | 2,551,663 |
| 1975 | 828,437 | 3,385,117 | | 6,699 | 821,738 | 3,373,401 |
| 1976 | 888,112 | 4,273,229 | | 4,755 | 883,357 | 4,256,758 |
| 1977 | 432,837 | 4,706,066 | | 3,424 | 429,413 | 4,686,171 |
| 1978 | 678,400 | 5,384,466 | 64,100 | 2,826 | 611,474 | 5,297,645 |
| 1979 | 1,295,388 | 6,679,854 | | 3,630 | 1,291,758 | 6,589,403 |
| 1980 | 968,092 | 7,647,946 | 64,792 | 3,041 | 900,259 | 7,489,662 |
| 1981 | 1,386,641 | 9,034,587 | | 1,897 | 1,384,744 | 8,874,406 |
| 1982 | 900,973 | 9,935,560 | 13,679 | 2,791 | 884,503 | 9,758,909 |
| 1983 | 601,183 | 10,536,743 | 365,505 | 724 | 234,954 | 9,993,863 |
| 1984 | 1,138,040 | 11,674,783 | 13,639 | 1,360 | 1,123,041 | 11,116,904 |
| 1985 | 1,078,147 | 12,752,930 | | 4,015 | 1,074,132 | 12,191,036 |
| 1986 | 929,178 | 13,682,108 | 12,701 | 2,916 | 913,561 | 13,104,597 |
| 1987 | 1,028,124 | 14,710,232 | | 2,217 | 1,025,907 | 14,130,504 |
| 1988 | 1,009,520 | 15,719,752 | | 3,307 | 1,006,213 | 15,136,717 |
| 1989 | 1,146,062 | 16,865,814 | | 48,833 | 1,097,229 | 16,233,946 |
| 1990 | 862,448 | 17,728,262 | | 21,643 | 840,805 | 17,074,751 |
| 1991 | 34,865 (4) | 17,763,127 (4) | | 2,213 | 32,656 | 17,107,407 |
| 1992 | 421,520 | 18,184,647 | | 3,508 | 418,012 | 17,525,419 |
| 1993 | 1,219,653 | 19,404,300 | | 14,139 | 1,205,514 | 18,730,933 |
| 1994 | 711,002 (3) | 20,115,302 | | 15,616 | 695,386 | 19,426,319 |

| | |
|---------------------|------------|
| Mean Deliveries | 745,012 AF |
| Median Deliveries | 828,437 AF |
| Mean Importations | 720,225 AF |
| Median Importations | 821,738 AF |

(1) Includes Pre-consolidation water deliveries, 1977 Dry Year Pool, 1991 State Bank water.

(2) Includes Tehachapi-Cummings CWD and other deliveries outside the San Joaquin Valley portion of Kern County. Beginning in 1990, also includes local ground water programs.

(3) From Table 4.

Table 4
1994 State Water Project Deliveries by Contract
(in acre-feet)

| District | No.1 | No.2 | No.3 | No.4 | No.5 | No.6 | No.7 |
|----------------------------|------------------------------|--------------------------------------|------------------------|-----------------------|----------------------------------|--|--|
| | State Water Project Supplies | | | | | | |
| | Table 1 Entitlement | Interrupt. Entitlement Program | Landowner Transfers | Long-Term M&I Pool | Misc. Exchanges/ Transfers | 1994-95 SWP Entitlement Exchange | Banking for Entitlement Exchange |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Berrenda Mesa WD | 82,042 | 6,359 | | | 294 (6) | | |
| Lost Hills WD | 74,266 | 3,954 | (2,002) (2) | | 266 (6) | (5,909) | (1,500) |
| Belridge WSD | 86,220 | 344 | | | | (1,000) | (325) |
| Semitropic WSD | 83,576 | 11,119 | 902 (3) | | | 785 | 181 |
| Cawelo WD | 20,206 | | | | (22,171) (7) | 4,390 | 44 |
| Improvement Dist. No. 4 Ag | 5,436 | | | | | | |
| M&I | 40,730 | 17,233 | | 2,325 | (12,002) (8) | 2,095 | 100 |
| Rosedale-Rio Bravo WSD | 15,816 | 378 | (626) (4) | | (6,666) (9) | | |
| Buena Vista WSD | 11,267 | 5,403 | | | 67,455 (10) | 639 | |
| Kern Delta WD | 13,488 | 3,961 | | | (17,449) (11) | | |
| Henry Miller WD | 18,778 | 1,065 | | | 6,666 (9) | | |
| West Kern WD | 13,224 | 5,387 | | 2,325 | (20,474) (12) | | |
| Wheeler Ridge-Maricopa WSD | 133,787 | 3,169 | | | 479 (6) | (1,000) | 1,500 |
| Tehachapi-Cummings CWD Ag | 2,275 | | | | | | |
| M&I | 7,934 | 51 | | (4,650) | | | |
| Tejon-Castac WD | 1,058 | 51 | | | (1,039) (6) | | |
| Arvin-Edison WSD | | | | | 4,641 (13) | | |
| Dudley Ridge WD | | | 1,726 (5) | | | | |
| Total | 610,103 | 58,474 | 0 | 0 | 0 | 0 | 0 |

Note: This table shows contracted deliveries for calendar year 1994. District deliveries may vary from amounts shown, due to: a) current year SWP/Kern River exchanges, b) payback of SWP water from prior year exchanges, and c) conjunctive use agreements.

- (1) Program offered by DWR whereby excess Delta flows are offered to SWP Contractors who can put them to beneficial use; offered during the periods of Jan 25 through Jan 31 and Feb 7 through Feb 28.
- (2) Includes 1,100 AF transfer to Dudley Ridge WD in lieu of a like transfer from Paramount to Westlands WD (Shannon = 1,000 AF ; Chandler = 100 AF); includes 16 AF (Adelaida) and 886 AF (various duck clubs as mitigation) transfer to Semitropic WSD.
- (3) Includes 16 AF (Adelaida) and 886 AF (various duck clubs as mitigation for LHWD evaporation ponds) from Lost Hills WD.
- (4) Transfer of 626 AF to Dudley Ridge WD from Rosedale-Rio Bravo WSD on behalf of Paramount Farming Company.
- (5) Includes transfer of 1,100 AF from Lost Hills WD in lieu of a like transfer from Paramount Farming Company to Westlands WD; includes transfer of 626 AF from Rosedale-Rio Bravo WSD on behalf of Paramount Farming Company.
- (6) Tejon-Castac WD sale of 1,039 AF of SWP entitlement to Berrenda Mesa WD (294 AF), Lost Hills (266 AF) and Wheeler Ridge Maricopa WSD (479 AF); sale price of \$80 per acre-foot.
- (7) Includes 20,173 AF long-term exchange to Buena Vista WSD (Cawelo WD to receive a like amount of Kern River water from Buena Vista); includes Kern River exchange paybacks to Improvement District No. 4 (Sep = 1,053 AF; Oct = 552 AF; Nov = 393 AF).
- (8) Includes 4,000 AF prior year exchange payback to Buena Vista WSD; includes 10,000 AF exchange to Buena Vista WSD (in exchange for a like amount of Kern River water from BVWSD); includes 1,998 AF Kern River exchange payback from Cawelo WD.
- (9) Partial payback of 6,666 AF to Henry Miller WD associated with the 1993 banking program between Rosedale-Rio Bravo WSD and Henry Miller WD.
- (10) Includes long-term exchange amount from CWD (20,173 AF), KDWD (12,808 AF) and WKWD (20,474 AF); includes 4,000 AF prior year exchange payback from ID4; includes 10,000 AF exchange from ID4 (in exchange for a like amount of Kern River water).
- (11) Includes 12,808 AF long-term exchange amount to Buena Vista WSD; includes 4,641 AF exchange to Arvin-Edison WSD.
- (12) Long-term exchange amount of 20,474 AF to Buena Vista WSD.
- (13) Exchange amount from Kern Delta WD pursuant to the water exchange agreement between Kern Delta WD and Arvin-Edison WSD; payback from Arvin-Edison WSD to Kern Delta WD to be made in a future year.
- (14) Exchange of 1994 SWP entitlement for a like amount of 1995 SWP entitlement.
- (15) Exchange of 1994 SWP entitlement for a like amount of water banked in the City of Bakersfield's 2800 Acre Spreading Facility.
- (16) Carried over for delivery in 1995.

Table 4 (continued)
1994 State Water Project Deliveries by Contract
(in acre-feet)

| District | No.8 | No.9 | No.10 | No.11 | No.12 | No.13 | No.14 | No.15 | No.16 | |
|----------------------------|---------------|---------------|----------------|----------------|----------------|--------------|----------------|----------------|---------------|------------------------|
| | State Bank | | Other Supplies | | Total Supplies | | | Deliveries | | |
| | 1994 | 1994 | Agency | SWP | State Bank | Ground | Grand | Total | Total | Supply ⁽¹⁶⁾ |
| | Water | Drought | Ground | | | | | | | |
| Purchase | Water | Water | Water | Water | Water | Total | Deliveries | Not | | |
| Agreement | Bank | Recovery | | | | | | Delivered | | |
| Berrenda Mesa WD | 5,541 | | 200 | 88,695 | 5,541 | 200 | 94,436 | 89,871 | 4,565 | |
| Lost Hills WD | 8,375 | 7,288 | | 69,075 | 15,663 | 0 | 84,738 | 83,650 | 1,088 | |
| Belridge WSD | 5,541 | 4,748 | 2,029 | 85,239 | 10,289 | 2,029 | 97,557 | 95,543 | 2,014 | |
| Semitropic WSD | | | | 96,563 | 0 | 0 | 96,563 | 96,563 | 0 | |
| Cawelo WD | | | | 2,469 | 0 | 0 | 2,469 | 2,469 | 0 | |
| Improvement Dist. No. 4 Ag | | | | 5,436 | 0 | 0 | 5,436 | 5,436 | 0 | |
| M&I | | | | 50,481 | 0 | 0 | 50,481 | 50,481 | 0 | |
| Rosedale-Rio Bravo WSD | | | | 8,902 | 0 | 0 | 8,902 | 8,902 | 0 | |
| Buena Vista WSD | | | | 84,764 | 0 | 0 | 84,764 | 84,764 | 0 | |
| Kern Delta WD | | | | 0 | 0 | 0 | 0 | | 0 | |
| Henry Miller WD | | | | 26,509 | 0 | 0 | 26,509 | 26,509 | 0 | |
| West Kern WD | | | | 462 | 0 | 0 | 462 | 462 | 0 | |
| Wheeler Ridge-Maricopa WSD | 7,923 | 6,147 | 6,051 | 137,935 | 14,070 | 6,051 | 158,056 | 154,629 | 3,427 | |
| Tehachapi-Cummings CWD Ag | | | | 2,275 | 0 | 0 | 2,275 | 2,275 | 0 | |
| M&I | | | | 3,335 | 0 | 0 | 3,335 | 3,011 | 324 | |
| Tejon-Castac WD | | | | 70 | 0 | 0 | 70 | 70 | 0 | |
| | | | | 4,641 | 0 | 0 | 4,641 | 4,641 | 0 | |
| | | | | 1,726 | 0 | 0 | 1,726 | 1,726 | 0 | |
| Total | 27,380 | 18,183 | 8,280 | 668,577 | 45,563 | 8,280 | 722,420 | 711,002 | 11,418 | |

now as a threatened species, and changed the status of winter run Chinook salmon from threatened to endangered.

Club Fed representatives portrayed their actions as necessary to "save the biologically troubled" estuary after the state refused to do so, and would end water supply uncertainty for Delta water users. The water quality standards outlined three broad criteria. The first would require releasing more fresh water from dams to allegedly reduce salinity in Suisun Marsh, an important nursery area for young fish. The second would set survivability targets for young winter run salmon migrating through the Delta to the ocean. The third would attempt to improve water quality in the lower San Joaquin River to provide a better environment for striped bass.

Club Fed expected their new standards would cost water users about 570,000 acre-feet in normal years and up to 1.1 million acre-feet in drought years. Federal officials maintained that the water deficit could be made up with additional water conservation and water sales between existing users. However, those same officials conceded that the federal Endangered Species Act could require them to take much more water than the new standards proposed. A Club Fed-sponsored assessment of the economic impacts from implementation of the standards indicated that the cost to California's economy would be about \$45 million in average years (\$20 million from agriculture and \$25 million from cities). The worst-case drought scenario would take \$450 million from California's economy.

Subsequent analyses of the water supply impacts from Club Fed's draft plan estimated that the average water loss could be closer to 800,000 acre-feet, and could reach 1.6 million acre-feet or more in drought years. An independent analysis of Club Fed's economic assessment showed that it was seriously flawed and grossly underestimated the economic costs associated with reallocating water supplies. The true costs of water shortages caused by Club Fed's proposed plan could have reached \$600 million annually. As much as 155,000 acres of prime farm land would have been permanently lost from production and 12,000 farm jobs lost, adding about two percent to unemployment rates in the southern San Joaquin Valley.

The federal plan was ostensibly designed to provide certainty about water supplies. In reality, the plan would have resulted in water shortages in nine years

out of ten. Severe water shortages would be experienced in four years out of ten. The increased risk of water shortages would have caused a complete restructuring and downsizing of agriculture in Kern County and the southern San Joaquin Valley. Ground water overdraft would have accelerated as pumping lifts increased.

The federal water quality plan created a furor in the southern San Joaquin Valley because of its high water costs and severe impact on the Valley's economy. In a major breakthrough, the state and federal governments agreed on an arrangement whereby the state and federal governments would both develop Bay-Delta protection standards on parallel tracks. It was hoped that the two standard setting efforts, both scheduled for completion by the end of 1994, would be coordinated and harmonious. Then the federal government could accept the state's plan and avert the need to impose its own plan, as was done December 15, 1993. New Delta standards were developed and announced December 15, 1994. The State Water Resources Control Board has adopted the so-called Bay-Delta Accord and is now implementing them via a water rights hearing process.

DWR's caution in allocating water supplies during 1994 was partly due to the uncertainty as to how the federal plan would affect SWP operations. Particularly troublesome was how winter run salmon and Delta smelt "take limits" would effect the SWP's operations.

A take limit of one percent of the estimated number of out migrating salmon smolts was imposed on the SWP, or 905 smolts. The wildlife agencies use a sliding size scale to determine whether a salmon smolt caught at the SWP's fish screens is a winter run. As yet there is no reliable method of determining by sight whether a salmon is a winter run, or some other race (such as fall run or spring run). However, since 1991 some winter run salmon have been captured and bred in a hatchery as part of a captive breeding program. Coded wire tags are inserted into hatchery-raised smolts. (Coded wire tags are microscopic pieces of wire with unique markings that are inserted into a bony structure in the head of the fish. The tag contains information on which hatchery raised the fish, when it was released, and what race of fish it is. Upon removal, this tag can be read under a microscope, and a positive identification of the fish can be made.) Wire tags were also inserted into about 1 million other non-winter run salmon.

During 1994 a total of 97 smolts in the winter run size range were actually caught by the fish screens in Clifton Court Forebay. Of these fish, 20 had clipped adipose fins (fleshy fin on the underside near the tail), indicating they were hatchery raised. Of these 20, 19 fish had coded wire tags; one fish was missing its tag. The coded wire tags proved that none of the 19 smolts were winter run. The fish missing its tag was assumed to be a winter run and counted against the take limit. The other 77 untagged smolts were all assumed to be winter run and counted against the take limit. Yet, none of these fish were proved to be winter run. The experience with winter run takes during 1994 shows the unreliability of the size scale used by the wildlife agencies to identify winter run smolts.

By comparison, during the 1994 fishing season 19 adult winter run salmon were caught with coded wire tags, six by commercial fishing boats and 13 by sport fishermen. While the SWP has a take limit imposed, there are no corresponding limits on the commercial or sport fishing industries. Biologists estimate that a pair of winter run salmon that successfully spawn will produce four adults. Two of these will be caught by fishermen and two will return to spawn. Accordingly, in 1994 the fishing industry may have impacted the winter run salmon more than the SWP.

The SWP Delta pumps were essentially shut down for five days in early April when calculations showed that the take limit was nearly reached, and operated at only about five percent of capacity over the entire month. Combined SWP/CVP water supply impacts from winter run restrictions during 1994 were estimated to be about 200,000 acre-feet.

Delta smelt caused more problems for the SWP operators in 1994 than did the winter run salmon. The take limit imposed on the SWP by the U.S. Fish and Wildlife Service (USFWS) was 755 smelt per day computed on a 14-day running average. The USFWS had imposed outflow limitations on the state and federal water projects aimed at moving the young smelt to Suisun Bay and away from the project's export pumps. However, in May the smelt moved into the south Delta area and began to show up in greater numbers at the state and federal export pumps. Over a five day period in late May an estimated 164,000 smelt were taken by the combined operation of the state and federal pumps.

Because of the swarm of smelt on May 23 the pumps

were slowed to a combined 1,250 cubic feet per second (cfs). Normally, they would have operated at 2,500 to 3,500 cfs. During parts of June the SWP pumps were shut down entirely, and experienced restrictions even into July. Finally, in early July the smelt had moved away from the pumps and into the western Delta. DWR estimated that the SWP and CVP together were not able to pump 120,000 acre-feet of water because of problems with Delta smelt during 1994. However, water deliveries were not adversely affected by the presence of Delta smelt at the pumps because of sufficient water storage in downstream reservoirs.

The swarm of juvenile Delta smelt in the south Delta was unusual. Even though the water projects did everything required of them to move the smelt into Suisun Bay, still a large number found their way into the south Delta. Some government biologists believed that the San Joaquin River side of the Delta had become a suitable nursery because of the previous drought. Others felt that they were only a small part of a larger population of smelt. The state Department of Fish and Game's summer population survey supported the latter. The summer townt survey showed that the population of Delta smelt was at its highest since 1981, and the second year in a row the survey has shown a relatively healthy abundance of smelt. In spite of this, nine environmental and fishing organizations sued the USFWS, claiming the smelt was threatened with extinction because of inadequate government protections.

Kern River

The 1994 water year was one of the driest of record. April through July is the primary runoff period for the Kern River watershed. During 1994, April-July runoff was 41 percent of normal, compared to 127 percent of normal the prior year. For the 1987-94 period, April-July runoff averaged 53 percent of normal, second only to the 1924-31 period. A comparison of the snow pack in the Kern River watershed during 1992-94 with the historic average (inches of water content) is shown as follows:

| | <u>Apr 1</u> <u>1992</u> | <u>Apr 1</u> <u>1993</u> | <u>Apr 1</u> <u>1994</u> | <u>Apr 1</u> <u>Avg</u> | <u>1994</u> <u>% of</u> <u>Avg</u> |
|-------------------|-----------------------------|-----------------------------|-----------------------------|----------------------------|--|
| Upper Tyndall Cr. | 12.7 | 34.0 | 15.5 | 27.7 | 56% |
| Crabtree Meadow | 9.0 | 22.7 | 10.3 | 19.8 | 52% |
| Chagoopa | 17.0 | 32.7 | 13.7 | 21.8 | 63% |

| (continued) | Apr 1 1992 | Apr 1 1993 | Apr 1 1994 | Apr 1 Avg | 1994 % of Avg |
|--------------------|---------------|---------------|---------------|--------------|---------------------|
| Pascoe | 22.2 | 40.0 | 18.7 | 24.9 | 75% |
| Wet Meadow | 16.1 | 37.3 | 7.5 | 30.3 | 25% |
| Tunnel Guard | 8.2 | 21.6 | 4.4 | 15.6 | 28% |
| Casa Vieja Meadows | 13.7 | 28.1 | 10.5 | 20.9 | 50% |
| Beach Meadows | 3.9 | 12.6 | 0.4 | 11.0 | 4% |
| Average | 12.9 | 28.6 | 10.1 | 21.5 | 47% |

The outlook for Kern River supplies during the April-July snow melt period deteriorated as the water year progressed, as shown below:

| | |
|----------------|--------------------|
| February, 1994 | 43% of average |
| March | 56" |
| April | 44" |
| May | 44" |
| Final | 42" (final runoff) |

Table 5 shows historic Kern River runoff and cumulative runoff for the 101 years of complete record, including diversions above First Point. In 1994 a total of 422,361 acre-feet of Kern River water flowed past First Point of Measurement. An additional 2,692 acre-feet was diverted above First Point. Total 1994 Kern River flows were 425,053 acre-feet, about 59 percent of average. During the last 101 years, the Kern River has yielded over 72 million acre-feet of runoff. Since Isabella Dam began regulating flows in 1954, nearly 30 million acre-feet of runoff has occurred. Figure 4 is a histogram of annual Kern River flows at First Point. Table 6 gives a summary of Kern River deliveries by entity in 1994. Plate 10 shows the major canal distribution facilities operated by water districts that receive Kern River entitlement.

Central Valley Project (CVP)

Like the SWP, water available from the CVP in 1994 reflected the dry year conditions. In 1994 deliveries of CVP water to Kern County totaled 186,303 acre-feet, less than half as much as in 1993. Original Friant-Kern and CVP Delta allocations on February 15, 1994 were: Friant-Kern contractors - 60 percent Class I and no Class II water; CVP Delta contractors - 35 percent of Class I water. By June the allocation had improved to 80 percent of Class I for Friant-Kern supplies. CVP Delta supplies were not increased until June 17, when the United States Bureau of Reclamation made available "Critical Needs" water. This amounted to an additional 7.5 percent of water. Following is a chronology of 1994 CVP allocations.

| | Friant-Kern Supplies | CVP Delta Supplies |
|--------------|-----------------------------------|---------------------------------------|
| Feb 15, 1994 | 60% Class I 0% Class II | 35% Class I |
| Mar 15 | 60% Class I 0% Class II | (no change) |
| Apr 12 | 65% Class I 0% Class II | (no change) |
| May 20 | 70% Class I 0% Class II | (no change) |
| Jun 6 | 80% Class I 0% Class II | (no change) |
| Jun 17 | (no change) | 42.5% Class I * (final allocation) |
| Jul 12 | (no change) | |
| Aug 18 | (no change) | |
| Sept 13 | (no change) (final allocation) | |

* On June 17, 1994 the USBR made available "Critical Needs" water to its CVP Delta contractors. This amounted to an additional 7.5 percent of water. The final allocation of Class I water remained at 35 percent.

Table 7 shows 1994 deliveries of CVP water by entity. As shown, 180,758 acre-feet of Class I entitlement and 5,545 acre-feet of CVC Pump-In water was delivered. Table 8 shows annual and cumulative deliveries of CVP water since 1950, when the first importations were made to Kern County. Figure 5 is a histogram of CVP deliveries since 1970. From 1950 to 1994, 12.6 million acre-feet of CVP water had been imported into Kern County.

Minor Streams

Local "minor stream" watersheds are the second largest local source of water, after the Kern River. Streams which yield measurable runoffs are grouped into four watershed areas; the Poso group (including Poso Creek), the Caliente group (including Caliente and Tehachapi Creeks), the El Paso group (including El Paso Creek), and the San Emigdio group (including San Emigdio Creek). Grouping of minor streams is based upon hydrologic similarity of the watersheds and representative gaging records. Minor stream flows can be substantial during above-average precipitation years, such as 1982, 1983 and 1986.

Runoff for ungauged streams is estimated by statistical methods based on historic relationships of the watershed area, precipitation and runoff for similar gauged streams. Gauges are in place on Poso and Tehachapi Creeks, and therefore actual measurements can usually be used for these watersheds. (KCWA, in coop-

Figure 4
Kern River Flows at First Point of Measurement

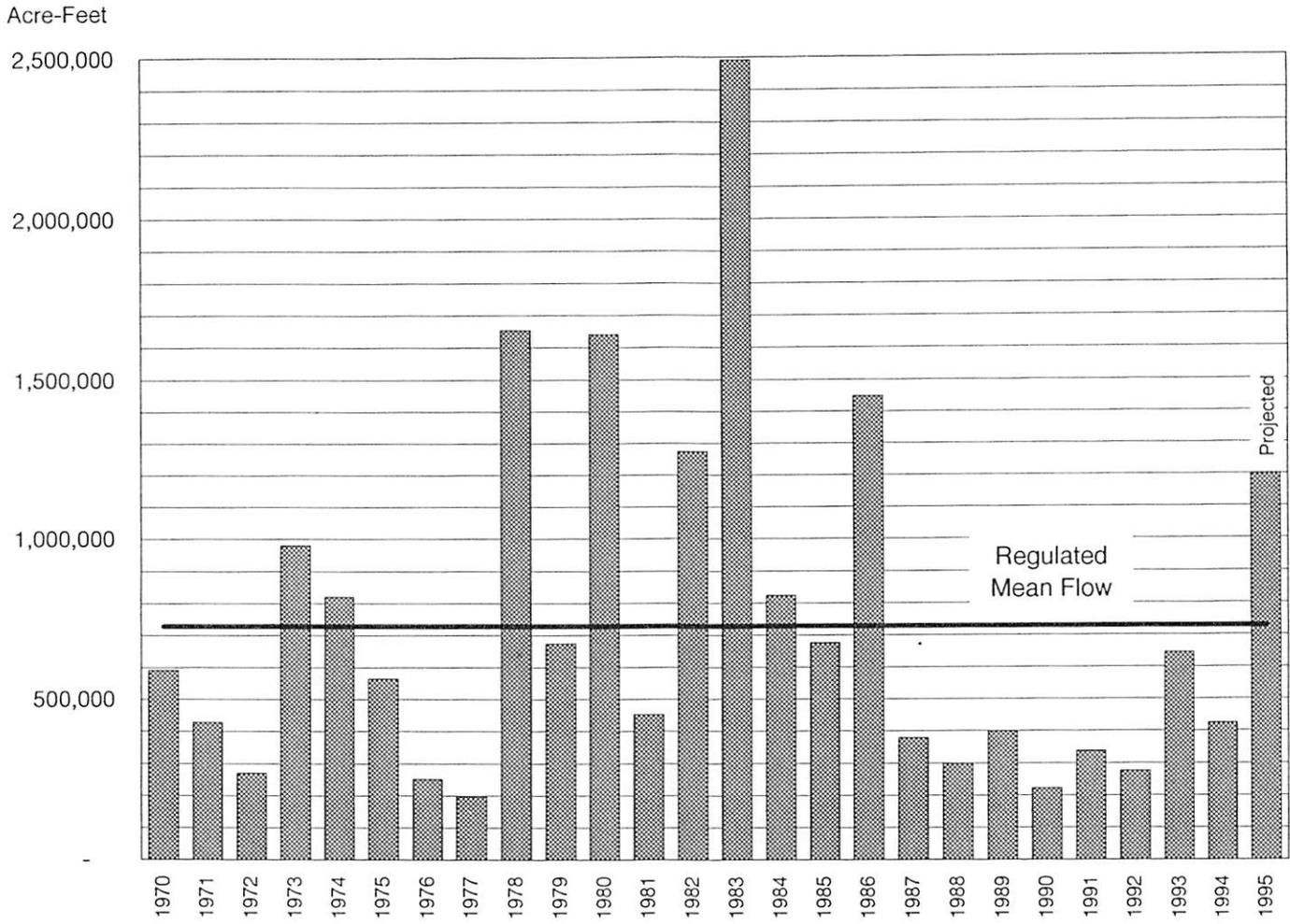


Table 5
Historic Kern River Flows ⁽¹⁾
(in acre-feet)

| Calendar Year | Annual Flows | Cumulative Unregulated Flows | Calendar Year | Annual Flows | Cumulative Flows | |
|---------------|------------------------|------------------------------|---------------|------------------------|------------------|-----------|
| | | | | | Unregulated | Regulated |
| 1894 | 533,326 | 533,326 | | | | |
| 1895 | 1,023,052 | 1,556,378 | | | | |
| 1896 | 619,692 | 2,176,070 | 1931 | 185,645 | 26,249,601 | |
| 1897 | 893,434 | 3,069,504 | 1932 | 737,727 | 26,987,328 | |
| 1898 | 251,827 | 3,321,331 | 1933 | 441,086 | 27,428,414 | |
| 1899 | 338,872 | 3,660,203 | 1934 | 227,665 | 27,656,079 | |
| 1900 | 332,373 | 3,992,576 | 1935 | 474,128 | 28,130,207 | |
| 1901 | 880,089 | 4,872,665 | 1936 | 796,447 | 28,926,654 | |
| 1902 | 552,539 | 5,425,204 | 1937 | 1,260,182 | 30,186,836 | |
| 1903 | 546,395 | 5,971,599 | 1938 | 1,358,685 | 31,545,521 | |
| 1904 | 492,949 | 6,464,548 | 1939 | 461,073 | 32,006,594 | |
| 1905 | 531,809 | 6,996,357 | 1940 | 789,098 | 32,795,692 | |
| 1906 | 1,900,540 | 8,896,897 | 1941 | 1,401,076 | 34,196,768 | |
| 1907 | 990,900 ⁽²⁾ | 9,887,797 | 1942 | 771,966 | 34,968,734 | |
| 1908 | 498,503 ⁽²⁾ | 10,386,300 | 1943 | 1,220,827 | 36,189,561 | |
| 1909 | 1,838,643 | 12,224,943 | 1944 | 625,537 | 36,815,098 | |
| 1910 | 658,911 | 12,883,854 | 1945 | 938,055 | 37,753,153 | |
| 1911 | 1,013,384 | 13,897,238 | 1946 | 650,683 | 38,403,836 | |
| 1912 | 387,432 | 14,284,670 | 1947 | 406,698 | 38,810,534 | |
| 1913 | 367,840 | 14,652,510 | 1948 | 329,506 | 39,140,040 | |
| 1914 | 1,113,513 | 15,766,023 | 1949 | 302,870 | 39,442,910 | |
| 1915 | 646,287 | 16,412,310 | 1950 | 601,360 | 40,044,270 | |
| 1916 | 2,520,149 | 18,932,459 | 1951 | 442,222 | 40,486,492 | |
| 1917 | 823,082 | 19,755,541 | 1952 | 1,500,999 | 41,987,491 | |
| 1918 | 538,503 | 20,294,044 | 1953 | 548,833 | 42,536,324 | |
| 1919 | 499,124 | 20,793,168 | 1954 | 528,357 ⁽³⁾ | 43,064,681 | 528,357 |
| 1920 | 600,643 | 21,393,811 | 1955 | 444,300 | 43,508,981 | 972,657 |
| 1921 | 509,519 | 21,903,330 | 1956 | 840,862 | 44,349,843 | 1,813,519 |
| 1922 | 861,426 | 22,764,756 | 1957 | 444,338 | 44,794,181 | 2,257,857 |
| 1923 | 500,515 | 23,265,271 | 1958 | 1,104,730 | 45,898,911 | 3,362,587 |
| 1924 | 187,727 | 23,452,998 | 1959 | 257,978 | 46,156,889 | 3,620,565 |
| 1925 | 465,913 | 23,918,911 | 1960 | 300,037 | 46,456,926 | 3,920,602 |
| 1926 | 366,706 | 24,285,617 | 1961 | 177,642 | 46,634,568 | 4,098,244 |
| 1927 | 792,580 | 25,078,197 | 1962 | 697,704 | 47,332,272 | 4,795,948 |
| 1928 | 312,828 | 25,391,025 | 1963 | 801,450 | 48,133,722 | 5,597,398 |
| 1929 | 322,958 | 25,713,983 | 1964 | 339,266 | 48,472,988 | 5,936,664 |
| 1930 | 349,973 | 26,063,956 | 1965 | 720,362 | 49,193,350 | 6,657,026 |

⁽¹⁾ Includes deliveries above First Point.

⁽²⁾ Data incomplete. Flow extrapolated from available data.

⁽³⁾ Isabella Dam in operation. All subsequent flows are controlled releases.

Table 5 (continued)
Historic Kern River Flows ⁽¹⁾
(in acre-feet)

| Calendar Year | Annual Flows | Cumulative Flows | | | |
|---------------|--------------|------------------|------------|-----------------------------------|------------|
| | | Unregulated | Regulated | | |
| 1966 | 678,595 | 49,871,945 | 7,335,621 | 101 Year Mean First Point Flow | 716,807 AF |
| 1967 | 1,396,227 | 51,268,172 | 8,731,848 | 101 Year Median First Point Flow | 552,539 AF |
| 1968 | 453,760 | 51,721,932 | 9,185,608 | Regulated Mean First Point Flow | 728,321 AF |
| 1969 | 2,461,370 | 54,183,302 | 11,646,978 | Regulated Median First Point Flow | 565,367 AF |
| 1970 | 590,274 | 54,773,576 | 12,237,252 | | |
| 1971 | 428,254 | 55,201,830 | 12,665,506 | | |
| 1972 | 269,227 | 55,471,057 | 12,934,733 | | |
| 1973 | 980,452 | 56,451,509 | 13,915,185 | | |
| 1974 | 819,408 | 57,270,917 | 14,734,593 | | |
| 1975 | 565,367 | 57,836,284 | 15,299,960 | | |
| 1976 | 250,268 | 58,086,552 | 15,550,228 | | |
| 1977 | 197,798 | 58,284,350 | 15,748,026 | | |
| 1978 | 1,654,295 | 59,938,645 | 17,402,321 | | |
| 1979 | 673,451 | 60,612,096 | 18,075,772 | | |
| 1980 | 1,640,852 | 62,252,948 | 19,716,624 | | |
| 1981 | 452,152 | 62,705,100 | 20,168,776 | | |
| 1982 | 1,273,630 | 63,978,730 | 21,442,406 | | |
| 1983 | 2,491,313 | 66,470,043 | 23,933,719 | | |
| 1984 | 824,302 | 67,294,345 | 24,758,021 | | |
| 1985 | 675,419 | 67,969,764 | 25,433,440 | | |
| 1986 | 1,447,939 | 69,417,703 | 26,881,379 | | |
| 1987 | 378,335 | 69,796,038 | 27,259,714 | | |
| 1988 | 297,685 | 70,093,723 | 27,557,399 | | |
| 1989 | 399,151 | 70,492,874 | 27,956,550 | | |
| 1990 | 221,267 | 70,714,141 | 28,177,817 | | |
| 1991 | 338,332 | 71,052,473 | 28,516,149 | | |
| 1992 | 275,041 | 71,327,514 | 28,791,190 | | |
| 1993 | 644,921 | 71,972,435 | 29,436,111 | | |
| 1994 | 425,053 | 72,397,488 | 29,861,164 | | |

Table 6
1994 Summary of Kern River Water
Diversions by Entity
(in acre-feet)

| Area of Use | Deliveries |
|---|-----------------------|
| Above First Point | |
| Kern Valley Golf Course (Kernville) | 186 |
| La Hacienda, Inc. | 131 |
| Lake Ming | 790 |
| Olcese WD | 1,583 |
| Other | 2 |
| Subtotal | 2,692 |
| Below First Point | |
| Arvin-Edison WSD | 401 |
| Buena Vista WSD | 24,634 |
| Cawelo WD | 50,090 |
| City of Bakersfield, Irrigation and Spreading Improvement District No. 4 | 38,606 ⁽¹⁾ |
| Kern Delta WD | 175,390 |
| North Kern WSD | 105,741 |
| Rosedale Ranch Improvement District | 659 |
| Rosedale-Rio Bravo WSD | 145 |
| South Fork | 972 |
| Subtotal | 422,361 |
| Total | 425,053 |

⁽¹⁾ Includes Kern River Canal & Irrigating Company deliveries, Truxton Lakes deliveries, Carrier Canal losses and percolation, Kern River channel losses and percolation.

Table 7
1994 Central Valley Project
Deliveries by Entity
(in acre-feet)

| | Class I | Class II | CVC Pump-In Water | Total |
|--|----------------|----------|----------------------|----------------|
| Arvin-Edison WSD | 28,172 | | | 28,172 |
| Delano-Earlimart ID | 15,793 | | | 15,793 |
| Kern County Water Agency | 875 | | | 875 |
| Kern National Wildlife Refuge ⁽¹⁾ | 3,500 | | | 3,500 |
| Kern-Tulare WD ⁽²⁾ | 18,212 | | 5,525 | 23,737 |
| Rag Gulch WD ⁽²⁾ | 7,289 | | 20 | 7,309 |
| Shafter-Wasco ID | 33,172 | | | 33,172 |
| So. San Joaquin MUD | 73,745 | | | 73,745 |
| Total | 180,758 | - | 5,545 | 186,303 |

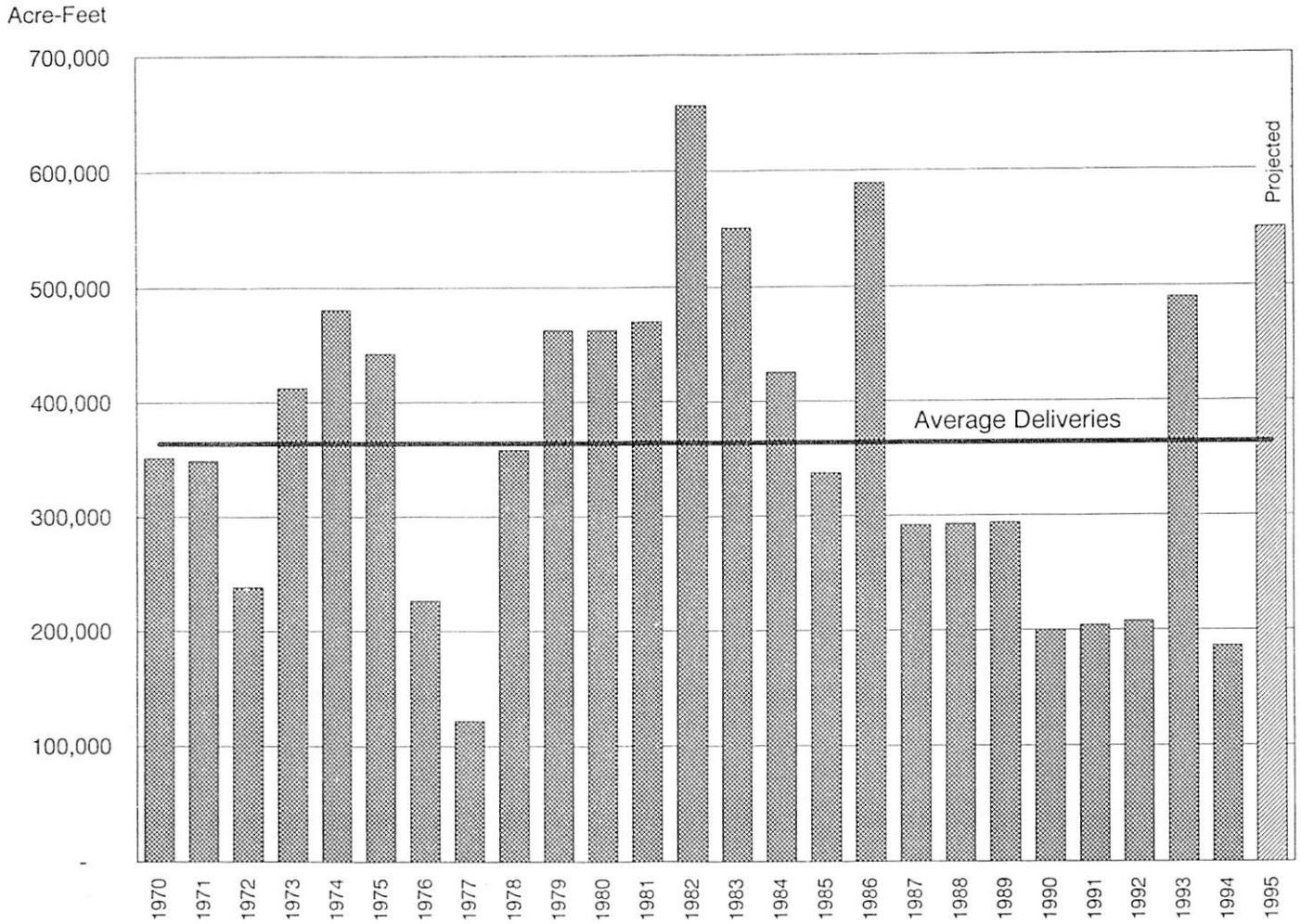
⁽¹⁾ Delivered via the San Luis Canal.

⁽²⁾ Per exchange of Cross Valley Canal water with Arvin-Edison WSD.

**Table 8
Annual and Cumulative
Central Valley Project Deliveries
to Kern County
(in acre-feet)**

| Year | Annual Delivery | Cumulative Delivery | Year | Annual Delivery | Cumulative Delivery |
|-------------|----------------------------|--------------------------------|-------------------------|----------------------------|--------------------------------|
| 1950 | 762 | 762 | | | |
| 1951 | 27,005 | 27,767 | 1981 | 469,966 | 7,899,255 |
| 1952 | 49,500 | 77,267 | 1982 | 656,608 | 8,555,863 |
| 1953 | 83,558 | 160,825 | 1983 | 550,874 | 9,106,737 |
| 1954 | 112,093 | 272,918 | 1984 | 425,371 | 9,532,108 |
| 1955 | 126,238 | 399,156 | 1985 | 337,514 | 9,869,622 |
| 1956 | 279,134 | 678,290 | 1986 | 589,262 | 10,458,884 |
| 1957 | 141,684 | 819,974 | 1987 | 291,981 | 10,750,865 |
| 1958 | 223,830 | 1,043,804 | 1988 | 292,828 | 11,043,693 |
| 1959 | 166,099 | 1,209,903 | 1989 | 293,865 | 11,337,558 |
| 1960 | 156,978 | 1,366,881 | 1990 | 200,141 | 11,537,699 |
| 1961 | 126,412 | 1,493,293 | 1991 | 204,396 | 11,742,095 |
| 1962 | 231,045 | 1,724,338 | 1992 | 208,021 | 11,950,116 |
| 1963 | 234,283 | 1,958,621 | 1993 | 489,783 | 12,439,899 |
| 1964 | 189,330 | 2,147,951 | 1994 | 186,303 | 12,626,202 |
| 1965 | 245,482 | 2,393,433 | | | |
| 1966 | 232,084 | 2,625,517 | | | |
| 1967 | 319,706 | 2,945,223 | Mean Delivery | | 280,582 AF |
| 1968 | 206,499 | 3,151,722 | Median Delivery | | 238,475 AF |
| 1969 | 372,826 | 3,524,548 | Mean Delivery 1975-94 | | 363,508 AF |
| 1970 | 351,392 | 3,875,940 | Median Delivery 1975-94 | | 347,681 AF |
| 1971 | 348,865 | 4,224,805 | | | |
| 1972 | 238,475 | 4,463,280 | | | |
| 1973 | 412,178 | 4,875,458 | | | |
| 1974 | 480,575 | 5,356,033 | | | |
| 1975 | 442,130 | 5,798,163 | | | |
| 1976 | 226,512 | 6,024,675 | | | |
| 1977 | 121,469 | 6,146,144 | | | |
| 1978 | 357,847 | 6,503,991 | | | |
| 1979 | 462,526 | 6,966,517 | | | |
| 1980 | 462,772 | 7,429,289 | | | |

Figure 5
Central Valley Project Deliveries to Kern County



eration with local water districts, monitors stream flows on Poso and Tehachapi Creeks). However, in very dry years the flow on Tehachapi Creek is too small for the gauge to record. In this report, flows are assumed to occur at the foothill line before they disappear into the valley alluvium. Total minor stream volumes in 1994 were estimated to be about 36,800 acre-feet as follows;

| <u>Stream Group</u> | <u>Acre-feet</u> |
|---------------------|------------------|
| Poso | 19,400 |
| Caliente | 6,200 |
| El Paso | 3,600 |
| San Emigdio | <u>7,600</u> |
| Total | 36,800 |

Some minor stream water is used for irrigation by farmers in the North Kern Water Storage District and Pond-Poso Improvement District. Much of the remaining water percolates to the underlying aquifer. Some of this recharge probably contributes to shallow ground water in the Kern Lake Bed area and near the Kern National Wildlife Refuge. KCWA estimated that about 35,000 acre-feet of the minor stream flows during 1994 contributed to ground water recharge. Table 9 shows annual minor stream runoffs, along with cumulative runoff since 1970. The variability of minor stream flows is shown by the accompanying statistics, and shown graphically in Figure 6. Figure 7a shows the hydrograph for Poso Creek in 1994. Figure 7b shows cumulative runoff for Poso Creek for the year.

Effective Precipitation

Rainfall that occurs during the growing season of a crop, or is otherwise stored in the soil for later use, provides water that would otherwise be applied by the farmer. By reducing the total crop water needs that the farmer must fulfill, rainfall can reduce the total volume of water that needs to be imported or withdrawn from ground water supplies. So, rainfall can provide an alternate water supply, called effective precipitation

Not all rainfall contributes to crop water needs. Only the portion that satisfies crop water requirements can properly be called effective precipitation. A large portion of rainfall evaporates from the soil surface and profile before it can be used by the crop. The timing of the rainfall is also an important factor determining its

effectiveness. During years of extremely heavy rainfall, a small amount may percolate past the crop root zone and recharge the underlying ground water, particularly during early stages of growth. In addition, heavy rain immediately after an irrigation cycle may not be usable by the crop.

Most urban storm runoff is captured in unlined sumps and allowed to percolate. It is not usually measured. A small amount of storm runoff is diverted into the Kern River, where it becomes available for delivery or recharge. About 100 acre-feet of urban storm runoff was diverted into the Kern River system in 1994.

KCWA gathers monthly rainfall data for most of the measuring stations in the San Joaquin Valley portion of Kern County and some mountain stations. This rainfall data is subsequently used to compute effective precipitation and minor stream runoff. Table 10 gives monthly rainfall for every measuring station gathered by KCWA. Rainfall in 1994 contributed 169,100 acre-feet of effective precipitation, with 148,600 acre-feet occurring over the usable ground water basin. This excludes the urban storm water diverted into the Kern River. Rainfall at Meadows Field in 1994 was 116 percent of normal, slightly less than 1993. Following is a tabulation of 1991-94 and average monthly rainfall for Meadows Field near Bakersfield. KCWA estimates that rainfall provided about 2.5 inches of usable water for crops grown during 1994. This is about average for Kern County.

Rainfall at Meadows Field, Bakersfield (inches)

| | <u>1991</u> | <u>1992</u> | <u>1993</u> | <u>1994</u> | <u>Avg</u> | <u>1994</u> <u>% of Avg</u> |
|--------------|-------------|-------------|-------------|-------------|-------------|--------------------------------|
| Jan | 0.62 | 1.56 | 2.33 | 0.57 | 1.02 | 56% |
| Feb | 0.13 | 2.14 | 2.02 | 1.34 | 1.00 | 134% |
| Mar | 4.33 | 1.86 | 1.76 | 0.97 | 0.94 | 103% |
| Apr | 0.66 | 0 | 0 | 1.06 | 0.65 | 163% |
| May | 0 | 0.08 | 0 | 0.27 | 0.30 | 90% |
| Jun | 0 | 0 | 0.48 | 0 | 0.07 | 0% |
| Jul | 0 | 0.03 | 0 | 0 | 0.01 | 0% |
| Aug | 0 | 0 | 0 | 0.01 | 0.02 | 50% |
| Sep | 0.01 | 0 | 0 | 0.09 | 0.10 | 90% |
| Oct | 0.30 | 0.92 | 0.17 | 0.08 | 0.31 | 26% |
| Nov | 0.01 | 0 | 0.79 | 0.98 | 0.52 | 188% |
| Dec | 1.04 | 1.81 | 0.62 | 1.32 | 0.80 | 165% |
| Total | 6.50 | 8.40 | 8.17 | 6.69 | 5.74 | 116% |

Figure 8 shows annual rainfall recorded at three selected climatic stations in Kern County. Rainfall in the

Table 9
Annual and Cumulative
Minor Stream Flows in the
San Joaquin Valley Portion of Kern County
(in acre-feet)

| Year | Annual Stream Flows | Cumulative Stream Flows |
|-------------|------------------------|----------------------------|
| 1970 | 132,400 | 132,400 |
| 1971 | 63,200 | 195,600 |
| 1972 | 21,600 | 217,200 |
| 1973 | 22,900 | 240,100 |
| 1974 | 104,900 | 345,000 |
| 1982 | 39,400 | 384,400 |
| 1976 | 42,700 | 427,100 |
| 1977 | 32,900 | 460,000 |
| 1978 | 429,200 | 889,200 |
| 1979 | 96,700 | 985,900 |
| 1980 | 65,200 | 1,051,100 |
| 1981 | 63,600 | 1,114,700 |
| 1982 | 91,700 | 1,206,400 |
| 1983 | 273,300 | 1,479,700 |
| 1984 | 14,300 | 1,494,000 |
| 1985 | 20,200 | 1,514,200 |
| 1986 | 32,600 | 1,546,800 |
| 1987 | 28,600 | 1,575,400 |
| 1988 | 22,900 | 1,598,300 |
| 1989 | 26,300 | 1,624,600 |
| 1990 | 17,000 | 1,641,600 |
| 1991 | 34,600 | 1,676,200 |
| 1992 | 52,200 | 1,728,400 |
| 1993 | 72,900 | 1,801,300 |
| 1994 | 36,800 | 1,838,100 |
| Mean Flow | | 73,500 AF |
| Median Flow | | 39,400 AF |

Figure 6
 Minor Stream Flows in Kern County

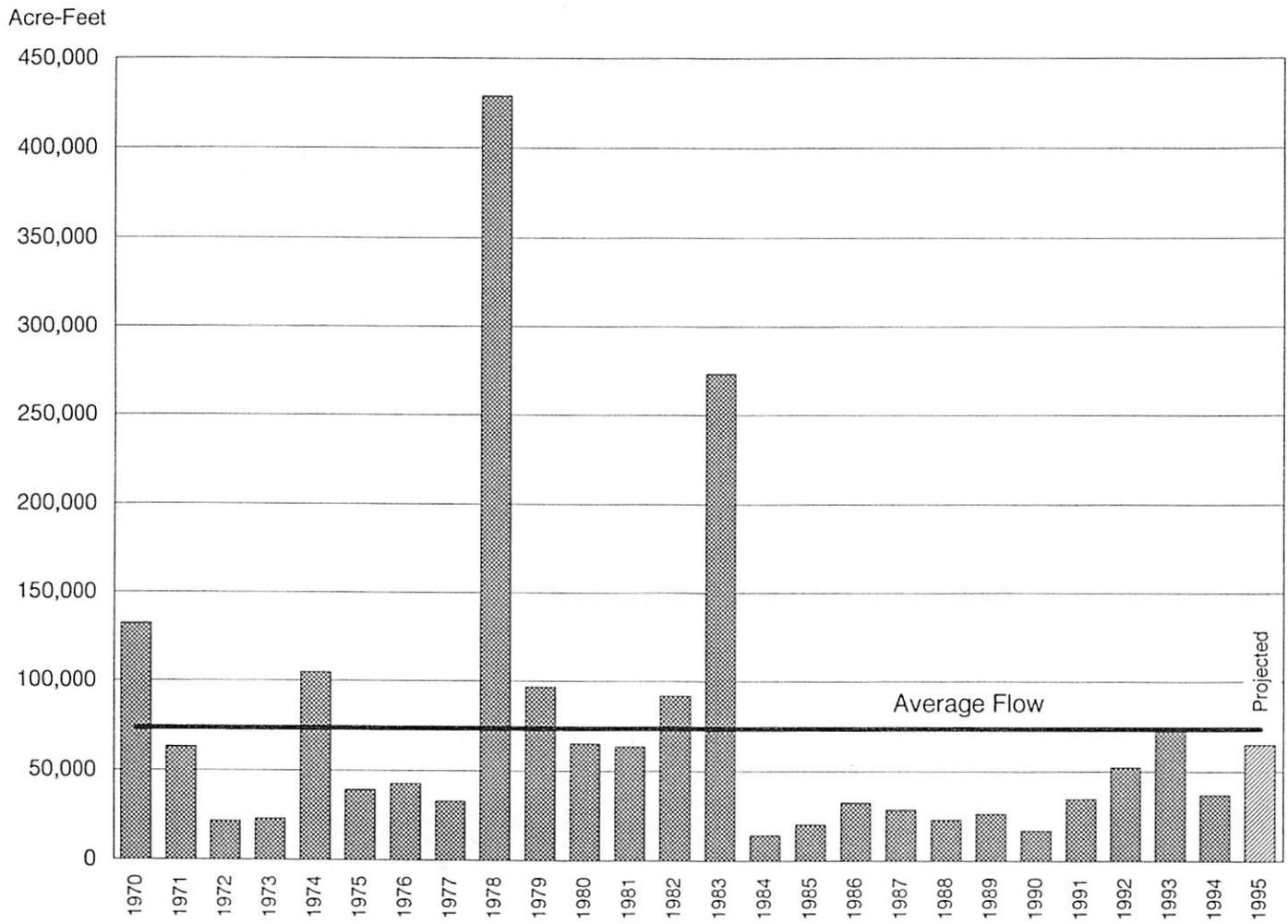
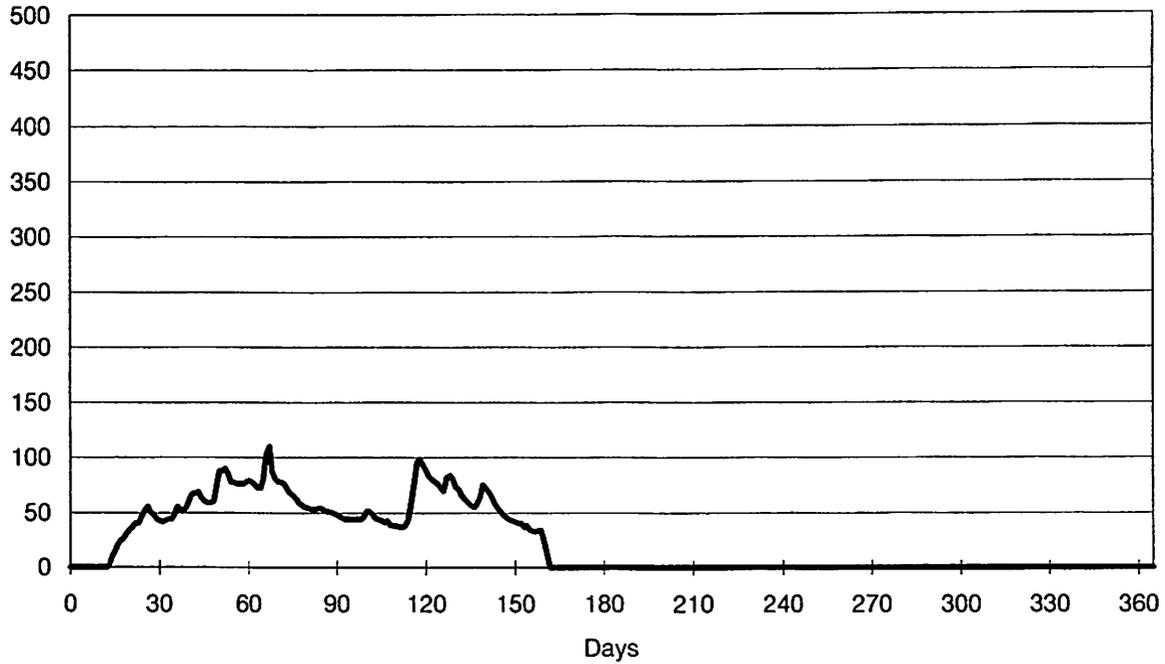


Figure 7a
Poso Creek
Hydrograph, 1994

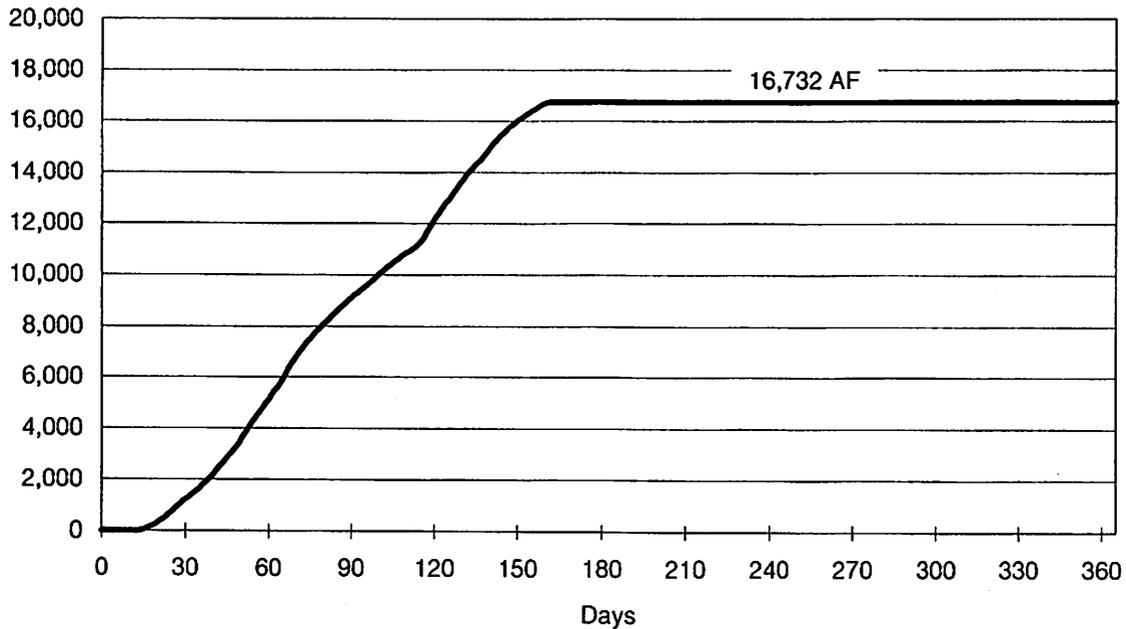
Mean Daily Flow (cfs)



- Note:
1. Hydrograph began 0000 hrs on 1/1/94 and ended at 2400 hrs on 12/31/1994.
 2. Located at Lat.35 30' 49", Long. 118 54' 17", SW 1/4, SW 1/4, Sec. 6, T.28S., R.29E. Kern County.
 3. Peak Discharge, 110.4 cfs, 3/8/94.

Figure 7b
Poso Creek
Cumulative Volumes, 1994

Cumulative Volumes (AF)



| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|------------------------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Volume (AF) | 1,312 | 3,669 | 4,137 | 3,059 | 3,926 | 629 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cumulative Volume (AF) | 1,312 | 4,981 | 9,118 | 12,177 | 16,103 | 16,732 | 16,732 | 16,732 | 16,732 | 16,732 | 16,732 | 16,732 |

Table 10
1994 Monthly Rainfall at Selected Stations (in inches)

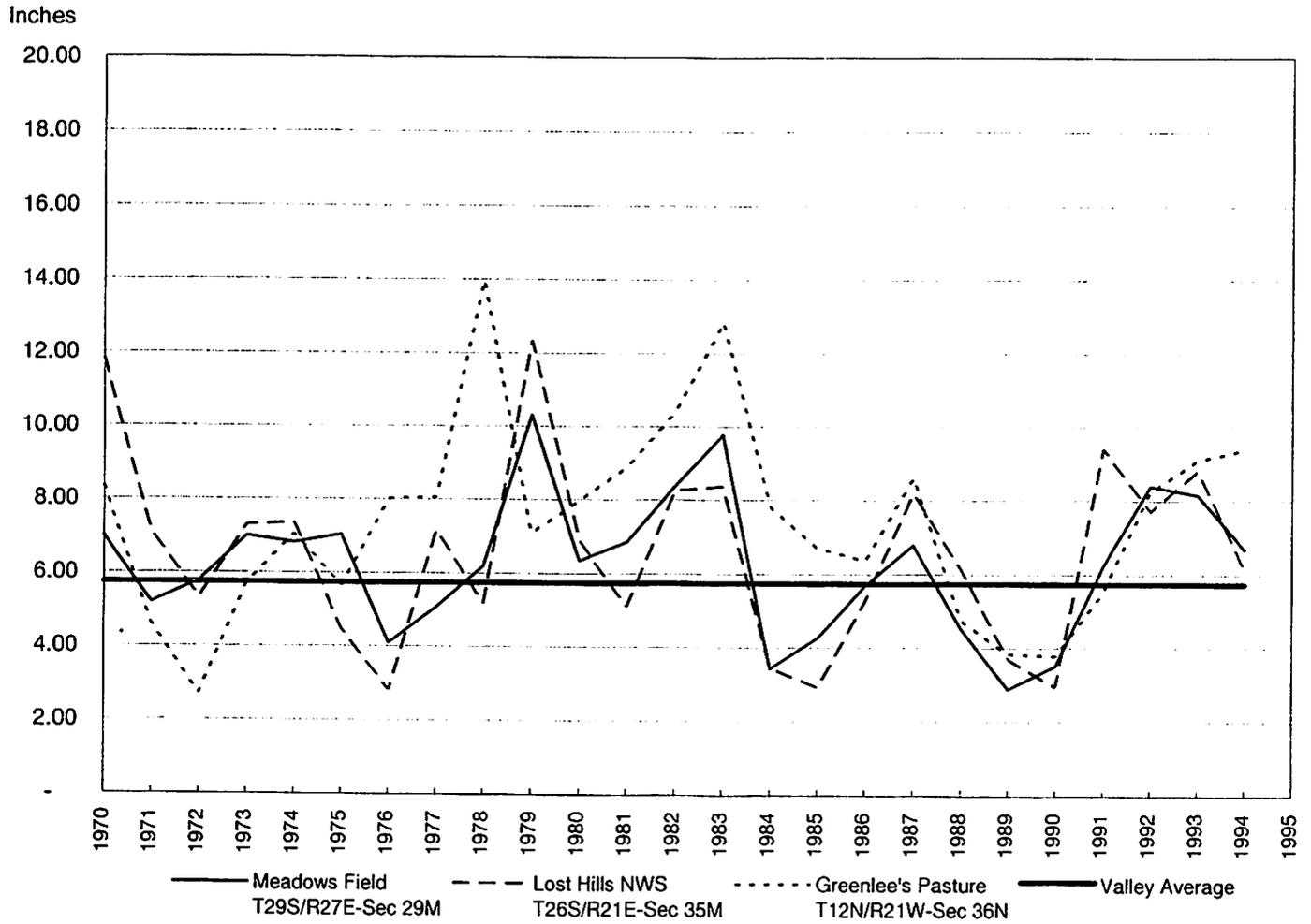
| OPERATOR/Station | Elev. (ft) | Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|--|---------------|-------------|------|------|------|------|------|-----|-----|-------------------|------|------|------|------|-------|
| ARVIN-EDISON WATER STORAGE DISTRICT | | | | | | | | | | | | | | | |
| District Headquarters | 500 | 31S/30E-29 | 0.84 | 1.44 | 0.60 | 1.07 | 0.45 | 0 | 0 | 0 | 0.17 | 0.15 | 2.03 | 1.94 | 8.69 |
| Sycamore | 420 | 31S/30E-20 | 0.98 | 1.44 | 0.60 | 1.12 | 0.48 | 0 | 0 | 0 | 0.16 | 0.01 | 1.80 | 1.99 | 8.58 |
| Tejon | 480 | 32S/29E-15 | 0.70 | 0.98 | 0.82 | 1.01 | 0.37 | 0 | 0 | 0 | 0.11 | 0.10 | 1.58 | 2.62 | 8.29 |
| CALIFORNIA DEPARTMENT OF WATER RESOURCES | | | | | | | | | | | | | | | |
| Lost Hills O&M Center | 300 | 27S/21E-03 | 0.90 | 0.83 | 0.63 | 0.13 | 1.56 | 0 | 0 | 0 | 0.29 | 0.30 | 1.27 | 0.90 | 6.81 |
| Wind Gap O&M Center | 780 | 11N/20W-26 | 0.67 | 1.00 | 0.55 | 1.09 | 0.45 | 0 | 0 | 0 | 0.23 | 0.02 | 1.46 | 2.53 | 8.00 |
| Bakersfield 12S | 300 | 31S/27E-36D | 0.67 | 1.14 | 1.67 | 0.92 | 0.47 | 0 | 0 | 0 | 0.10 | 0.03 | 1.11 | 1.33 | 7.44 |
| Bakersfield 14W | 310 | 30S/25E-04R | 0.88 | 1.00 | 0.61 | 0.98 | 0.66 | 0 | 0 | 0 | 0.39 | 0.07 | 1.08 | 1.61 | 7.28 |
| J.G. BOSWELL COMPANY | | | | | | | | | | | | | | | |
| Kern Lake Shop | 280 | 32S/28E-18 | 0.82 | 1.12 | 0.99 | 1.17 | 0.44 | 0 | 0 | 0 | 0.25 | 0.05 | 1.02 | 2.38 | 8.24 |
| Paloma | 290 | 32S/24E-02 | 0.95 | 1.25 | 1.44 | 1.04 | 0.45 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 2.29 | 7.42 |
| Kern Lake Time Room | 280 | 32S/27E-16 | 0.88 | 1.29 | 1.13 | 0.72 | 0.37 | 0 | 0 | 0 | 0.31 | 0.04 | 0.90 | 2.28 | 7.92 |
| Buena Vista Gin | 300 | 32S/25E-12 | 0.84 | 1.13 | 1.20 | 0.38 | 0.30 | 0 | 0 | 0 | 0.15 | 0.01 | 0.97 | 2.18 | 7.16 |
| Buena Vista #4 | 300 | 32S/25E-06 | 0.87 | 0.86 | 1.11 | 0.50 | 0.49 | 0 | 0 | 0 | 0.24 | 0.00 | 0.94 | 1.76 | 6.77 |
| Buena Vista Office | 290 | 31S/25E-25 | 0.83 | 0.90 | 1.16 | 0.77 | 0.37 | 0 | 0 | 0 | 0.08 | 0.00 | 0.94 | 1.69 | 6.74 |
| KERN COUNTY PLANNING DEPARTMENT | | | | | | | | | | | | | | | |
| Edmonston Pump Station | 1,310 | 10N/18W-17M | 0.82 | 1.99 | 2.00 | 0.50 | 1.14 | 0 | 0 | 0 | 0.57 | 0.33 | 3.00 | 2.37 | 12.72 |
| Arvin Fire Station | 450 | 31S/29E-28 | 0.45 | 0.93 | 1.02 | 1.06 | 0.08 | 0 | 0 | 0 | 0.05 | 0.05 | 0.93 | 1.77 | 6.34 |
| Buttonwillow Fire Station | 270 | 29S/23E-14 | 0.76 | 0.99 | 0.37 | 0.52 | 0.81 | 0 | 0 | 0 | 0.18 | 0.15 | 0.91 | 1.03 | 5.72 |
| Buena Vista Aquatic Rec Area | 300 | 31S/25E-15 | 0.68 | 0.72 | 1.52 | 0.75 | 0.27 | 0 | 0 | 0 | 0.27 | 0.03 | 0.75 | 1.32 | 6.31 |
| Communications Center | 770 | 29S/28E-16 | 0.34 | 1.23 | 0.57 | 1.87 | 0.13 | 0 | 0 | 0 | 0.09 | 0.16 | 0.77 | 1.48 | 6.64 |
| McFarland Fire Station | 350 | 26S/25E-10 | 0.97 | 1.35 | 0.72 | 0.52 | 0.59 | 0 | 0 | 0 | 0.13 | 0.60 | 1.05 | 1.33 | 7.26 |
| Rio Bravo Fire Station | 610 | 29S/29E-04 | 0.27 | 1.61 | 0.78 | 1.23 | 0.00 | 0 | 0 | 0 | 0.14 | 0.24 | 0.94 | 1.31 | 6.52 |
| Pine Mountain | 520 | 09N/21W-19 | 1.84 | 3.85 | 0.75 | 1.82 | 1.06 | 0 | 0 | 0 | 0.67 | 0.39 | 1.51 | 1.56 | 13.45 |
| NATIONAL WEATHER SERVICE | | | | | | | | | | | | | | | |
| Piute | 4,290 | 29S/33E-36 | 0.14 | 1.82 | 0.87 | 2.29 | 0.28 | 0 | 0 | 0 | 0.02 | 0.40 | 1.49 | 0.99 | 8.30 |
| Maricopa | 700 | 10N/24W-11 | 1.05 | 1.39 | 1.24 | 0.54 | 0.36 | 0 | 0 | 0 | 0.05 | 0.03 | 1.07 | 2.22 | 7.95 |
| Bakersfield NWS | 380 | 30S/28E-08 | 0.57 | 1.34 | 0.97 | 1.06 | 0.27 | 0 | 0 | 0.01 | 0.09 | 0.08 | 0.98 | 1.32 | 6.69 |
| Wasco | 300 | 27S/24E-11 | 1.11 | 1.37 | 0.75 | 0.42 | 0.98 | 0 | 0 | 0 | 0.20 | 0.44 | 0.93 | 0.90 | 7.10 |
| Woody | 1,600 | 25S/29E-35 | 0.53 | 2.40 | 1.23 | 2.32 | 0.52 | 0 | 0 | 0 | 0.26 | 0.63 | 2.29 | 1.81 | 11.99 |
| Keene | 2,900 | 31S/32E-20 | 0.84 | 2.84 | 0.70 | 2.58 | 0.85 | 0 | 0 | 0 | 0.11 | 0.39 | 2.26 | 1.61 | 12.18 |
| Tehachapi | 3,980 | 32S/33E-21 | 0.41 | 1.75 | 0.54 | 1.49 | 1.06 | 0 | 0 | 0 | 0.01 | 0.71 | 1.02 | 1.24 | 8.23 |
| Lost Hills | 280 | 26S/21E-35 | 0.80 | 1.02 | 0.86 | 0.14 | 0.62 | 0 | 0 | 0 | 0.10 | 0.31 | 1.26 | 1.02 | 6.13 |
| Glennville | 3,100 | 25S/30E-25 | 1.46 | 3.25 | 1.23 | 2.95 | 1.72 | 0 | 0 | 0 | 0.30 | 1.05 | 2.51 | 1.70 | 16.17 |
| Bear Valley | 4,100 | 32S/31E-03 | 0.78 | 2.97 | 1.01 | 3.27 | 0.88 | 0 | 0 | 0 | 0.07 | 0.47 | 2.95 | 2.00 | 14.40 |
| Lebec | 3,600 | 09N/19W-26 | | | | | | | | | | | | | |
| | | | | | | | | | | Record Incomplete | | | | | |
| TEHACHAPI-CUMMINGS COUNTY WATER DISTRICT | | | | | | | | | | | | | | | |
| Station 6 | 4,890 | 12N/15W-01 | 0.55 | 2.10 | 0.70 | 1.70 | 0.70 | 0 | 0 | 0 | 0.10 | 0.40 | 1.80 | 1.60 | 9.65 |
| Station 20 | 5,730 | 12N/15W-12 | 0.80 | 3.10 | 1.30 | 2.15 | 0.85 | 0 | 0 | 0 | 0.15 | 0.55 | 2.30 | 2.15 | 13.35 |
| WHEELER RIDGE-MARICOPA WATER STORAGE DISTRICT | | | | | | | | | | | | | | | |
| District Headquarters | 480 | 11N/12W-11 | 0.91 | 1.27 | 1.28 | 1.26 | 0.79 | 0 | 0 | 0.02 | 0.32 | 0.05 | 1.55 | 2.49 | 9.94 |
| PA-2 | 960 | 11N/19W-30 | 0.78 | 1.23 | 0.96 | 1.21 | 0.71 | 0 | 0 | 0 | 0.22 | 0.11 | 1.45 | 2.17 | 8.84 |
| WRM-2 | 510 | 32S-24E-35 | 0.86 | 1.00 | 1.02 | 0.89 | 0.48 | 0 | 0 | 0 | 0.19 | 0.00 | 1.70 | 2.13 | 8.27 |
| 5P-P2 | 590 | 11N/22W-09 | 0.72 | 1.19 | 2.11 | 0.45 | 0.63 | 0 | 0 | 0 | 0.12 | 0.00 | 1.71 | 2.46 | 9.39 |
| Spill Basin | 850 | 11N/18W-31 | 1.03 | 1.26 | 1.48 | 0.58 | 0.57 | 0 | 0 | 0.02 | 0.25 | 0.00 | 0.92 | 2.34 | 8.45 |
| Greenlee's Pasture | 380 | 12N/21W-36 | 1.06 | 1.24 | 2.30 | 0.09 | 0.60 | 0 | 0 | 0.02 | 0.23 | 0.05 | 1.61 | 2.20 | 9.40 |

Table 10 (continued)
1994 Monthly Rainfall at Selected Stations (in inches)

| OPERATOR/Station | Elev. (ft) | Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|-------------------------------|------------|-------------|------|------|------|------|------|-----|-----|-----|------|------|------|------|-------|
| OTHER OPERATORS | | | | | | | | | | | | | | | |
| City of Bakersfield Corp. Yd. | 400 | 30S/27E-06 | 0.58 | 1.12 | 1.12 | 1.20 | 0.22 | 0 | 0 | 0 | 0.19 | 0.13 | 0.98 | 1.80 | 7.34 |
| Del Kern Station (KDWD) | 350 | 31S/28E-06C | 0.63 | 1.12 | 0.66 | 1.04 | 0.21 | 0 | 0 | 0 | 0.18 | 0.14 | 0.92 | 1.67 | 6.57 |
| Delano Fire Station | 320 | 25S/25E-11A | 2.80 | 1.69 | 0.58 | 1.03 | 1.20 | 0 | 0 | 0 | 0.23 | 0.66 | 1.00 | 1.31 | 10.50 |
| Belridge WSD Office | 550 | 28S/21E-34 | 1.50 | 1.25 | 0.45 | 0.25 | 0.69 | 0 | 0 | 0 | 0.10 | 0.00 | 1.10 | 1.15 | 6.49 |
| Blackwell's Corner (BMWD) | 630 | 27S/20E-06 | 0.55 | 1.24 | 1.34 | 0.08 | 0.54 | 0 | 0 | 0 | 0.63 | 0.38 | 1.23 | 0.98 | 6.97 |
| Shafter Cotton Research Sta. | 370 | 27S/25E-33J | 1.08 | 1.36 | 0.67 | 0.79 | 0.80 | 0 | 0 | 0 | 0.21 | 0.26 | 1.25 | 1.76 | 8.18 |
| So. Belridge (Cal Resources) | 600 | 28S/21E-33 | 1.18 | 1.07 | 0.43 | 0.17 | 0.44 | 0 | 0 | 0 | 0.19 | 0.14 | 1.18 | 2.09 | 6.89 |

Note: Boxed numbers are estimated values.

Figure 8
 Annual Precipitation at Three Stations
 in the San Joaquin Valley Portion of Kern County



Wheeler Ridge area is normally higher than on the valley floor. Orographic uplift associated with the mountains at the southern end of the valley account for the higher rainfall in the Wheeler Ridge area. Table 11 lists the annual amounts of effective precipitation, expressed as total acre-feet and inches per acre, along with cumulative amounts and descriptive statistics. Figure 9 is a graphic depiction of the same information.

Waste Water Reuse

The reuse of municipal and industrial waste water provides a minor source of water for Kern County agriculture. There are 14 active waste water sewage treatment plants in the valley portion of Kern County. Waste water treatment processes are classified as primary, secondary or tertiary. Primary treatment removes most of the suspended matter from the sewage (usually via settling ponds), but little or no colloidal or dissolved matter. Secondary treatment provides some biological action or filtration to remove any remaining organic matter from the sewage. Tertiary treatment removes harmful chemicals (such as heavy metals) and nutrients. Nearly all of the waste water treatment facilities in Kern County provide secondary treatment of sewage. Most of the effluent from these treatment plants is used to irrigate some salt-tolerant crops on bordering lands, such as cotton, pasture and some grains. A small amount is directly recharged to the ground water basin. The remainder is evaporated. In 1994 about 49,700 acre-feet of waste water was treated (see Table 12). KCWA estimated that about 45,900 acre-feet was used by agriculture, 100 acre-feet evaporated and 3,700 acre-feet percolated to the underlying aquifer.

Another source of waste water reuse results from agricultural tail water return systems. Many farming operations have installed these systems to intercept water that would normally run off the field during irrigation. This recovered water is either transported back to the main irrigation system or it is applied on an adjacent field (from the foot of one field to the head of another). Tail water return systems are widely used on fields that are furrow or border irrigated. Their efficiency lies in the saving of energy required to recover the water from wells, or by reducing the need to import additional surface supplies. From a basin balance standpoint, these two water reuse activities are internal

and do not add to the hydrologic system.

Oil Field Produced Water

Another source of waste water is a by-product of oil field production. Unlike treated municipal effluent or tail water, oil field produced waters are a true addition to the hydrologic system, being drawn from deep, connate waters that are intermixed with oil deposits. In the Kern Front oil field, which lies astride the Kern River northeast of Bakersfield, substantial quantities of water are removed with each barrel of oil. The chemical quality of this water is generally within acceptable limits for agriculture. Thus, much of this water is discharged into irrigation canals. A total of 16,800 acre-feet of produced water from the Kern Front oil field was reused in 1994. This was nearly twice what was produced during 1993. Table 13 shows historic oil field produced water flows. Figure 10 show the same information as a graph.

In other areas, some oil companies discharge their produced waters into plastic lined and unlined sumps, some of which recharges the underlying aquifer, probably degrading it in the process. These amounts cannot be quantified, since accurate records of such discharges are seldom kept.

Total water reuse was estimated to be about 66,500 acre-feet in 1994, excluding any tail water reuse, which was not estimated. Table 14 gives a historical summary of water reuse in the San Joaquin Valley portion of Kern County since 1970. Figure 11 shows the same information as a hydrograph. Note that water production stays fairly constant.

Ground Water Extractions

Most of the ground water extractions in Kern County are not recorded. In the past, agricultural power records from the utility companies were matched with calculations for ground water production. However, the accuracy of power record calculations was unsatisfactory. In this report ground water extractions are estimated by backing in, or solving for the missing number in the ground water change-in-storage equation (see Figure 16).

Total ground water extractions in 1994 were calcu-

Table 11
Annual and Cumulative Effective Precipitation
in the San Joaquin Valley Portion of Kern County
(in acre-feet)

| | Annual Effective Precipitation | Unit Rate (inches per acre) | Cumulative Effective Precipitation |
|------|---|---|---|
| 1970 | 380,200 | 5.72 | 380,200 |
| 1971 | 148,300 | 2.13 | 528,500 |
| 1972 | 264,900 | 3.78 | 793,400 |
| 1973 | 131,900 | 1.84 | 925,300 |
| 1974 | 220,200 | 2.88 | 1,145,500 |
| 1975 | 240,500 | 3.17 | 1,386,000 |
| 1976 | 175,300 | 2.25 | 1,561,300 |
| 1977 | 198,400 | 2.74 | 1,759,700 |
| 1978 | 612,500 | 8.08 | 2,372,200 |
| 1979 | 152,600 | 1.97 | 2,524,800 |
| 1980 | 281,200 | 3.58 | 2,806,000 |
| 1981 | 255,400 | 3.21 | 3,061,400 |
| 1982 | 332,300 | 4.18 | 3,393,700 |
| 1983 | 438,100 | 6.15 | 3,831,800 |
| 1984 | 139,300 | 1.72 | 3,971,100 |
| 1985 | 160,700 | 2.04 | 4,131,800 |
| 1986 | 162,600 | 2.40 | 4,294,400 |
| 1987 | 168,200 | 2.57 | 4,462,600 |
| 1988 | 144,200 | 2.08 | 4,606,800 |
| 1989 | 106,100 | 1.49 | 4,712,900 |
| 1990 | 90,500 | 1.29 | 4,803,400 |
| 1991 | 171,700 | 2.82 | 4,975,100 |
| 1992 | 142,300 | 2.16 | 5,117,400 |
| 1993 | 168,700 | 2.53 | 5,286,100 |
| 1994 | 169,100 | 2.53 | 5,455,200 |

| | |
|----------------------|------------------|
| Mean EP (total) | 218,200 AF |
| Median EP (total) | 169,100 AF |
| Mean EP (per acre) | 3.01 Inches/Acre |
| Median EP (per acre) | 2.53 Inches/Acre |

Figure 9
 Effective Precipitation in the San Joaquin Valley Portion of Kern County

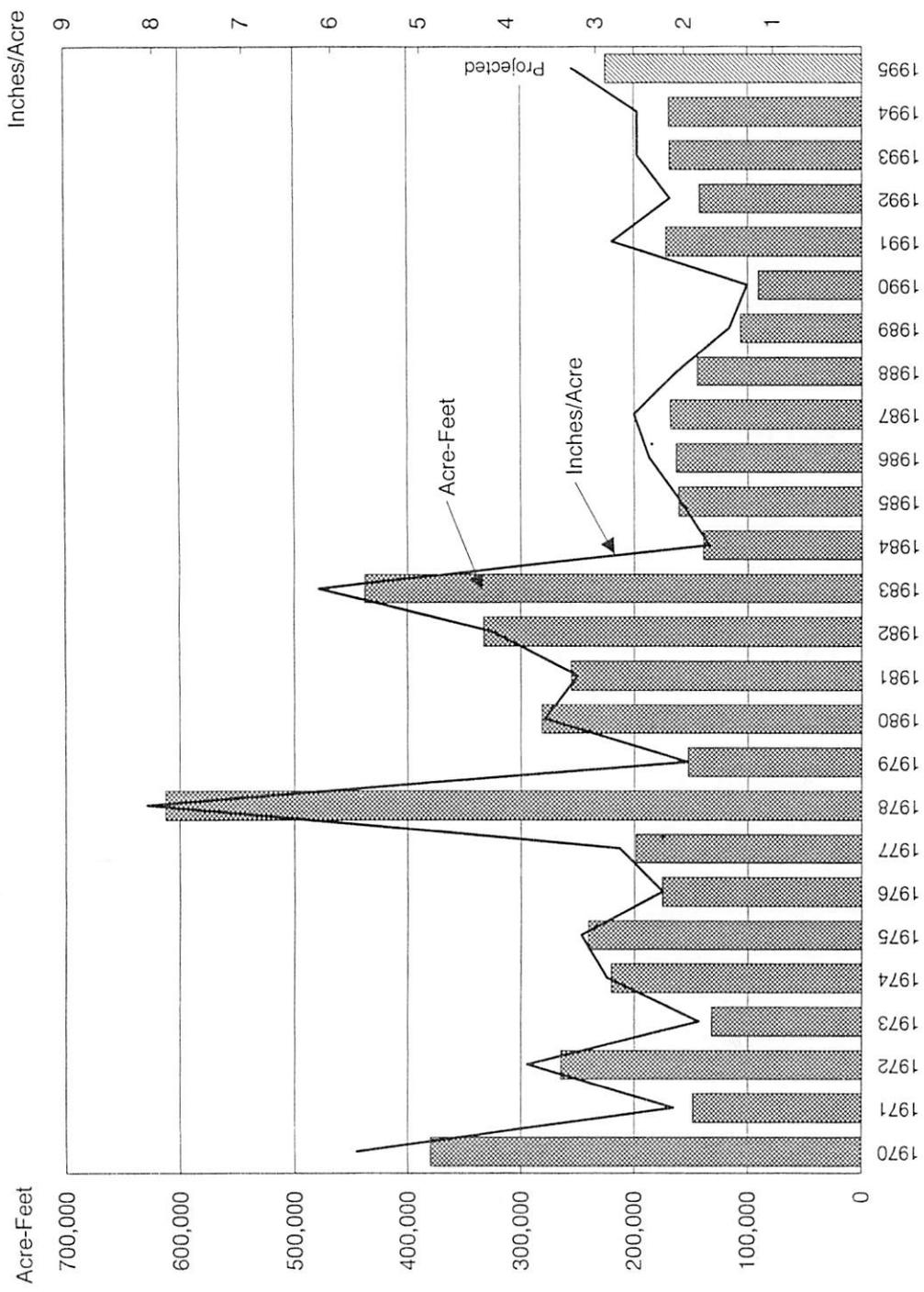


Table 12
1994 Waste Water Treatment Plant Volumes

| Facility | Volume | | Influent Source | Treatment System | Effluent Use |
|---|---------------|---------------|-----------------|------------------------------|---------------------------------------|
| | (MG) | (AF) | | | |
| City of Arvin | 346 | 1,063 | Dom | Secondary | Agriculture |
| City of Bakersfield | | | | | |
| #2 | 6,271 | 19,245 | Dom/Ind | Secondary | Restricted Agriculture |
| #3 | 3,462 | 10,624 | Dom/Ind | Secondary | Restricted Agriculture |
| Kern County Waste Management Department | | | | | |
| KSA (Mt. Vernon) | 1,646 | 5,051 | Dom | 1/2 Primary 1/2 Secondary | Agriculture Evaporation |
| BVARA * | 7 | 20 | Agr | Secondary | Percolation |
| Sheriff's Lerdo Facility * | 100 | 307 | Dom | Secondary | Same |
| Reeder Tract * | 12 | 35 | Dom | Secondary | Same |
| NOR Sanitary District #1 | 1,278 | 3,920 | Dom/Ind | Secondary | Restricted Agriculture Percolation |
| City of Delano | 1,185 | 3,636 | Dom | Secondary | Restricted Agriculture |
| Lamont Public Utilities District | 657 | 2,016 | Dom | Primary | Agriculture |
| City of McFarland | 268 | 822 | Dom | Secondary | Agriculture |
| City of Shafter | 415 | 1,275 | Dom/Ind | Secondary | Agriculture |
| Shafter Airport | 56 | 171 | Ind | Secondary | Percolation |
| City of Wasco | 505 | 1,550 | Dom/Ind | Secondary | Agriculture |
| Total | 16,207 | 49,735 | | | |

For influent source:

- Dom - domestic
- Ind - industrial
- Agr - agricultural

* No information available for 1994; 1993 data used as an estimation.

Table 13
Historic Oil Field Produced Water
(in acre-feet)

| Year | Annual Flows | Cumulative Flows |
|-------------------------------|-----------------|---------------------|
| 1970 | 5,300 | 5,300 |
| 1971 | 5,600 | 10,900 |
| 1972 | 6,100 | 17,000 |
| 1973 | 6,400 | 23,400 |
| 1974 | 6,900 | 30,300 |
| 1975 | 7,400 | 37,700 |
| 1976 | 7,700 | 45,400 |
| 1977 | 8,100 | 53,500 |
| 1978 | 8,500 | 62,000 |
| 1979 | 9,400 | 71,400 |
| 1980 | 10,100 | 81,500 |
| 1981 | 10,100 | 91,600 |
| 1982 | 10,600 | 102,200 |
| 1983 | 11,600 | 113,800 |
| 1984 | 11,700 | 125,500 |
| 1985 | 11,700 | 137,200 |
| 1986 | 11,800 | 149,000 |
| 1987 | 10,000 | 159,000 |
| 1988 | 12,700 | 171,700 |
| 1989 | 9,100 | 180,800 |
| 1990 | 5,300 | 186,100 |
| 1991 | 14,100 | 200,200 |
| 1992 | 8,700 | 208,900 |
| 1993 | 9,600 | 218,500 |
| 1994 | 16,800 | 235,300 |
| Mean Oil Field Flows | | 9,400 AF |
| Median Oil Field Flows | | 9,400 AF |

Figure 10
Oil Field Produced Water in Kern County

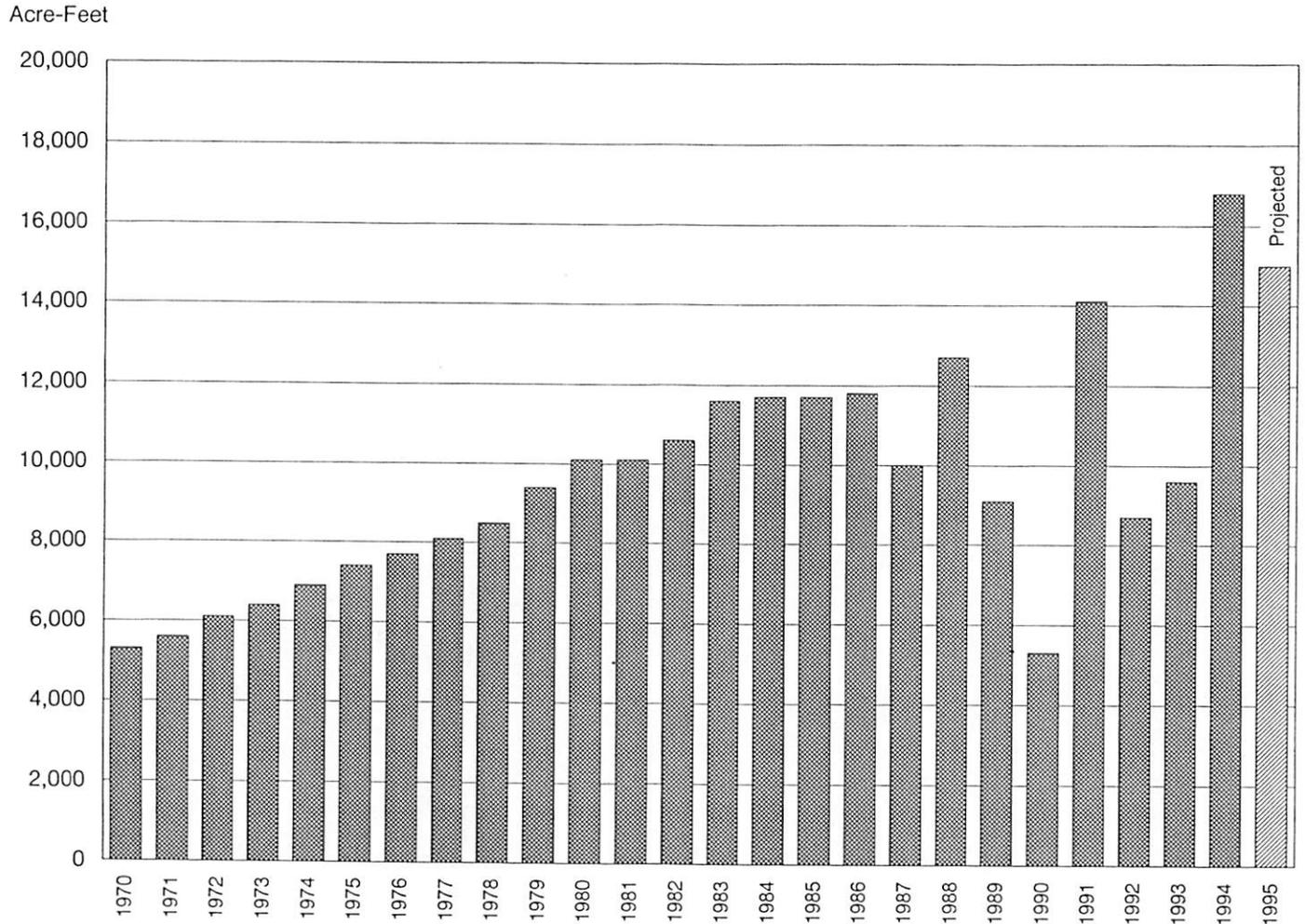
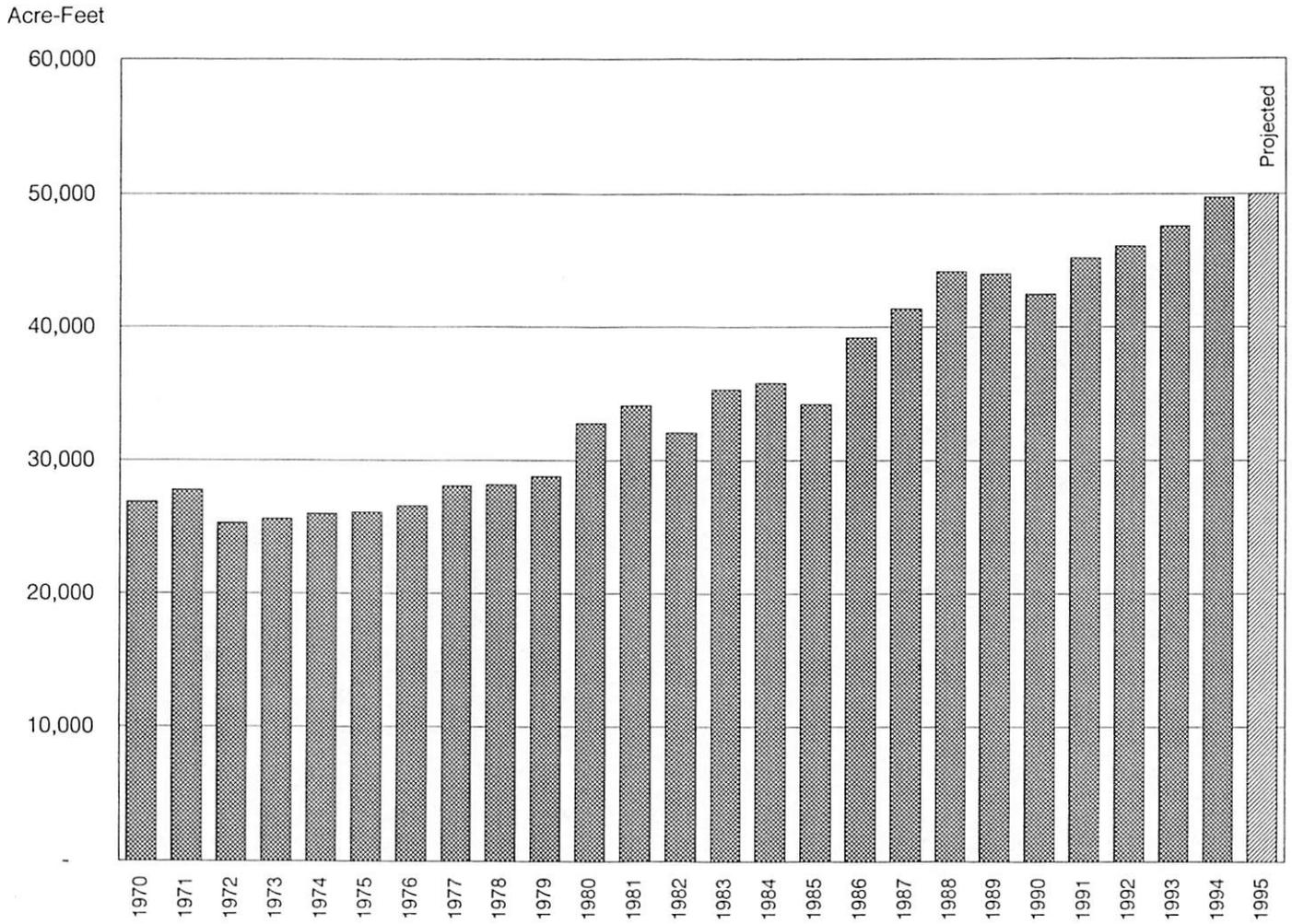


Table 14
Historic Water Reuse
(in acre-feet)

| Year | Annual Flows | Cumulative Flows |
|-------------|-------------------------|-----------------------------|
| 1970 | 26,900 | 26,900 |
| 1971 | 27,800 | 54,700 |
| 1972 | 25,300 | 80,000 |
| 1973 | 25,600 | 105,600 |
| 1974 | 26,000 | 131,600 |
| 1975 | 26,100 | 157,700 |
| 1976 | 26,600 | 184,300 |
| 1977 | 28,100 | 212,400 |
| 1978 | 28,200 | 240,600 |
| 1979 | 28,800 | 269,400 |
| 1980 | 32,800 | 302,200 |
| 1981 | 34,100 | 336,300 |
| 1982 | 32,100 | 368,400 |
| 1983 | 35,300 | 403,700 |
| 1984 | 35,800 | 439,500 |
| 1985 | 34,200 | 473,700 |
| 1986 | 39,200 | 512,900 |
| 1987 | 41,400 | 554,300 |
| 1988 | 44,200 | 598,500 |
| 1989 | 44,000 | 642,500 |
| 1990 | 42,500 | 685,000 |
| 1991 | 45,200 | 730,200 |
| 1992 | 46,100 | 776,300 |
| 1993 | 47,600 | 823,900 |
| 1994 | 49,700 | 873,600 |

| | |
|--------------------|-----------|
| Mean Water Reuse | 34,900 AF |
| Median Water Reuse | 34,100 AF |

Figure 11
Water Reuse in Kern County



lated to be about 1,895,800 acre-feet. This is about 908,000 acre-feet (almost double) more than was extracted in 1993. The obvious reason for this increase was the smaller amount of surface water available.

Ground water is pumped for a variety of uses in the valley. Agriculture, the largest user of ground water, used about 1,757,600 acre-feet in 1994. Municipal and industrial uses of ground water were about 138,200 acre-feet. During the 1987-92 drought about 9,809,900 acre-feet of ground water were pumped. Water level declines of 40-90 feet have resulted.

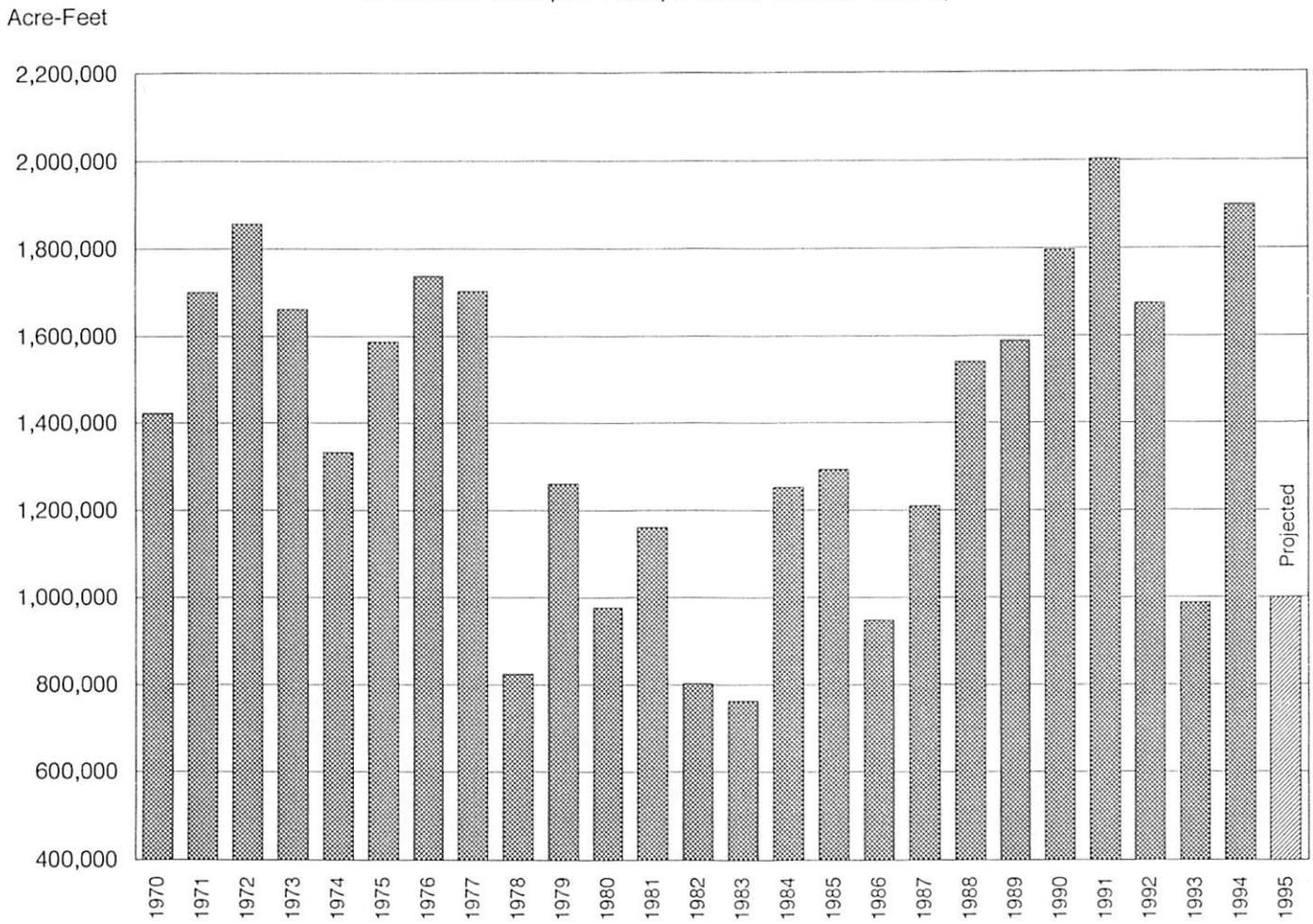
Table 15 gives historic ground water pumping in the San Joaquin Valley portion of Kern County since 1970. Both annual and cumulative amounts are tabulated, along with descriptive statistics. Figure 12 provides a histogram of ground water pumping, graphically displaying the relative variations.

Table 15
Historic Ground Water Pumping
(in acre-feet)

| Year | Annual Ground Water Pumped | Cumulative Ground Water Pumped |
|-------------|---|---|
| 1970 | 1,422,000 | 1,422,000 |
| 1971 | 1,700,000 | 3,122,000 |
| 1972 | 1,857,000 | 4,979,000 |
| 1973 | 1,662,000 | 6,641,000 |
| 1974 | 1,333,000 | 7,974,000 |
| 1975 | 1,587,000 | 9,561,000 |
| 1976 | 1,738,000 | 11,299,000 |
| 1977 | 1,703,000 | 13,002,000 |
| 1978 | 825,000 | 13,827,000 |
| 1979 | 1,260,000 | 15,087,000 |
| 1980 | 977,000 | 16,064,000 |
| 1981 | 1,161,000 | 17,225,000 |
| 1982 | 802,200 | 18,027,200 |
| 1983 | 762,700 | 18,789,900 |
| 1984 | 1,252,200 | 20,042,100 |
| 1985 | 1,293,800 | 21,335,900 |
| 1986 | 947,600 | 22,283,500 |
| 1987 | 1,208,700 | 23,492,200 |
| 1988 | 1,540,200 | 25,032,400 |
| 1989 | 1,588,500 | 26,620,900 |
| 1990 | 1,796,500 | 28,417,400 |
| 1991 | 2,002,400 | 30,419,800 |
| 1992 | 1,673,600 | 32,093,400 |
| 1993 | 987,700 | 33,081,100 |
| 1994 | 1,895,800 | 34,976,900 |

| | |
|-----------------------------|--------------|
| Mean Ground Water Pumping | 1,399,100 |
| Median Ground Water Pumping | 1,422,000 AF |
| Minimum Pumping in 1983 | 762,700 AF |
| Maximum Pumping in 1991 | 2,002,400 AF |

Figure 12
 Ground Water Pumping
 in the San Joaquin Valley Portion of Kern County



Water Requirements

Agricultural

Gross irrigated acreage in the San Joaquin Valley portion of Kern County was about 802,400 acres in 1994. Since about 12,700 acres were double-cropped, total gross cropped acreage in 1993 was about 789,700 acres. About 696,600 acres (including double-cropping) were irrigated over the usable ground water basin, and 105,800 acres were irrigated on lands outside the usable ground water basin. Total irrigated acreage was barely increased over 1993.

Cotton acreage decreased about 6,400 acres from 1993, reflecting the dry year conditions. Wheat also decreased about 1,700 acres from 1993, likely reflecting the reduction in cotton acreage. (Wheat is a common rotation crop with cotton.) Carrots decreased about 7,300 acres from 1993, likely because of the low water supply. Kern County produces about 30 percent of the nation's carrots, and has been called the "carrot capital of the world." Alfalfa increased about 4,900 acres from 1993. Almonds and pistachios increased by 3,500 acres and 2,500 acres respectively. A total of about 144,500 acres were idled during 1994. Most of this land was idled during the drought, and has remained out of production because of the late SWP water allocation in 1993 and dry conditions in 1994. Much of this reduction (about 82,000 acres) came from the west side areas, which are entirely dependent upon surface water for irrigation. A historical summary of irrigated acreage is provided on Table 16, along with descriptive statistics. Figure 13 shows historic irrigated acreage plotted as a bar graph. Figure 14 breaks down irrigated acreage into major categories. Permanent crops account for one-third of Kern County's total acreage. Cotton is an important crop to Kern County's economy, also accounting for about one-third of Kern's total acreage. Vegetables account for seven percent of irrigated acreage. Before the drought, vegetable plantings began increasing. This trend will likely resume when water supply conditions improve. Thousands of acres of vegetables are usually grown on the west side of the valley. This area has suffered the worst water supply reductions during the drought. Green feeds (alfalfa and pasture) represent about 11 percent of total acreage. Alfalfa grown in Kern County supports the local dairy industry and pleasure horses in Kern County and southern Califor-

nia. Several new dairy operations have recently relocated to Kern County. This will likely cause a slight increase in alfalfa plantings over the next few years.

Crops grown in Kern County are consumed throughout the United States. Indeed, Kern County grows 60 percent of the nation's supply of pistachios, 58 percent of its kiwis, about 30 percent of its carrots, 17 percent of the nation's almonds and 16 percent of the nation's grapes.

Exports of Kern's agricultural commodities are made to countries all over the world. The top ten exports are almonds, carrots, cotton, grapes, nursery stock, oranges, peaches, pistachios, plums and potatoes. Nearly every continent of the world receives some agricultural products from Kern County. Some 100 different countries obtain part of their food supplies from Kern County. These include Canada, Mexico, countries in both Central and South America, Africa, Europe, the Middle East, China and the Far East, Australia, and island countries scattered throughout the world's oceans. Experts predict that demand for Kern County's agricultural products will increase in Pacific Rim countries in the coming years.

The Kern County Agricultural Commissioner's annual crop report shows that in 1994 the agricultural products of Kern County had a market value of \$1,947,218,000. This was up about three percent from 1993's value. The slight increase can be attributed to small jumps in value for permanent, field and nursery crops. The slight gains for these groups was partially offset by a decrease in value for vegetable crops. A comparison of 1994 to 1993 gross crop values shows:

| | <u>1994</u> | <u>1993</u> | <u>Change</u> |
|--------------|------------------------|-------------------------|---------------------|
| Trees, Vines | \$976,139,000 | \$950,416,000* | \$25,723,000 |
| Cotton | 312,006,000 | 301,177,000 | 10,829,000 |
| Field crops | 33,057,000 | 24,236,000* | 8,821,000 |
| Green Feeds | 96,717,000 | 76,987,000* | 19,730,000 |
| Vegetables | 311,128,000 | 320,215,000 | -9,087,000 |
| Grains | 22,350,000 | 16,338,000 | 6,012,000 |
| Other | 195,821,000 | 195,441,000* | 62,408,000 |
| Total | \$1,947,218,000 | \$1,884,810,000* | \$62,408,000 |

* Modified from 1993 Kern County Agricultural Commissioner's Crop Report

Table 16
Historic Irrigated Acreage *
in the San Joaquin Valley Portion of Kern County
(in Acres)

| Year | Total Irrigated Acreage | | |
|------|----------------------------|-----------------------------------|---------------|
| 1970 | 797,300 | Mean Irrigated Acreage | 867,100 |
| 1971 | 834,800 | Maximum Irrigated Acreage in 1984 | 972,800 Acres |
| 1972 | 841,000 | Minimum Irrigated Acreage in 1991 | 729,400 Acres |
| 1973 | 858,700 | | |
| 1974 | 919,000 | | |
| 1975 | 909,600 | | |
| 1976 | 934,800 | | |
| 1977 | 868,100 | | |
| 1978 | 909,400 | | |
| 1979 | 928,700 | | |
| 1980 | 943,500 | | |
| 1981 | 955,400 | | |
| 1982 | 954,100 | | |
| 1983 | 854,200 | | |
| 1984 | 972,800 | | |
| 1985 | 945,100 | | |
| 1986 | 813,900 | | |
| 1987 | 786,800 | | |
| 1988 | 831,100 | | |
| 1989 | 856,100 | | |
| 1990 | 842,400 | | |
| 1991 | 729,400 | | |
| 1992 | 789,600 | | |
| 1993 | 800,100 | | |
| 1994 | 802,400 | | |

* Double-cropped acreage is counted twice, since it is irrigated twice. Double-cropping is generally a small percentage of total irrigated acreage, on the order of 5,000 to 8,000 acres annually.

Figure 13
Irrigated Acreage in the
San Joaquin Valley Portion of Kern County

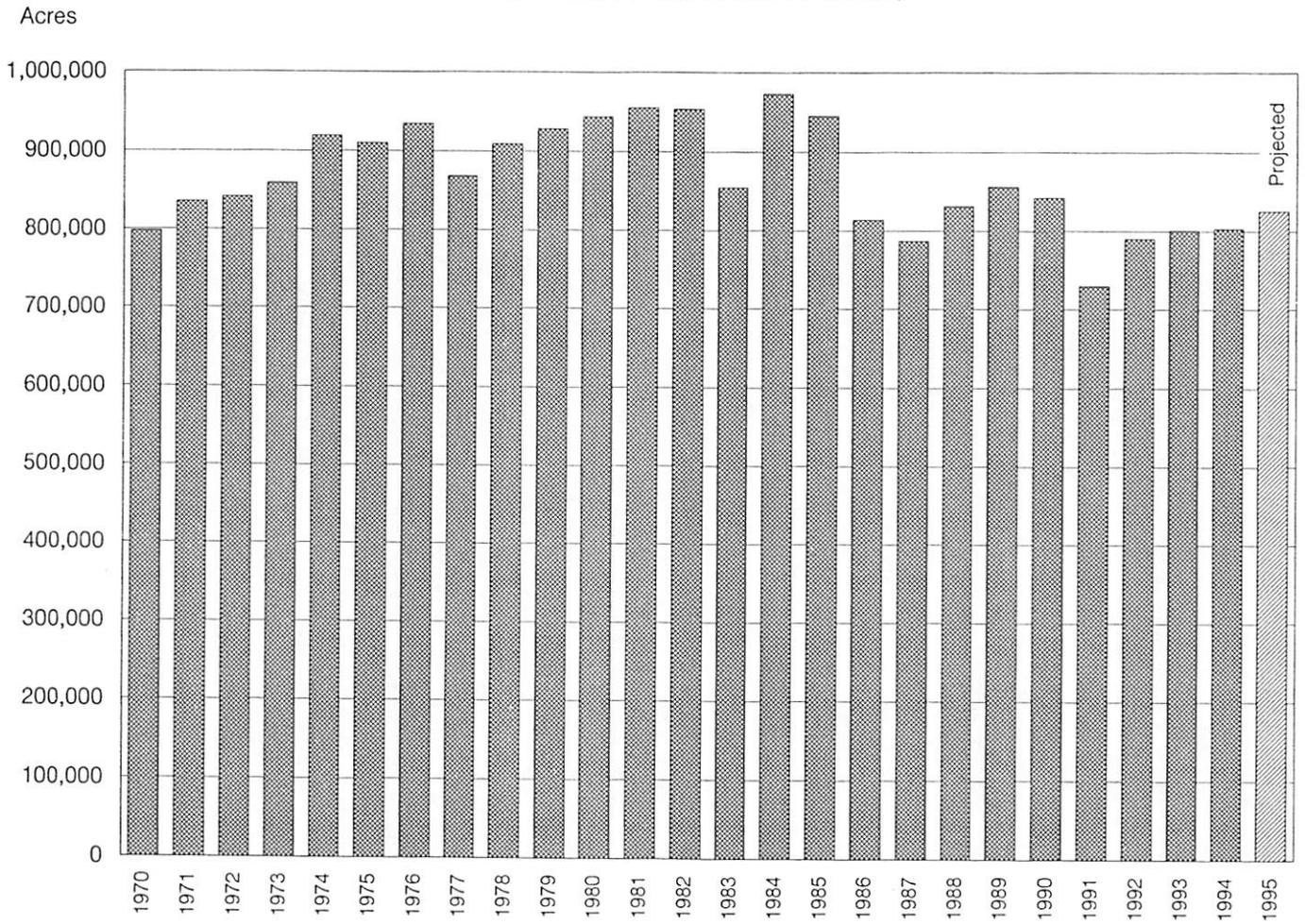
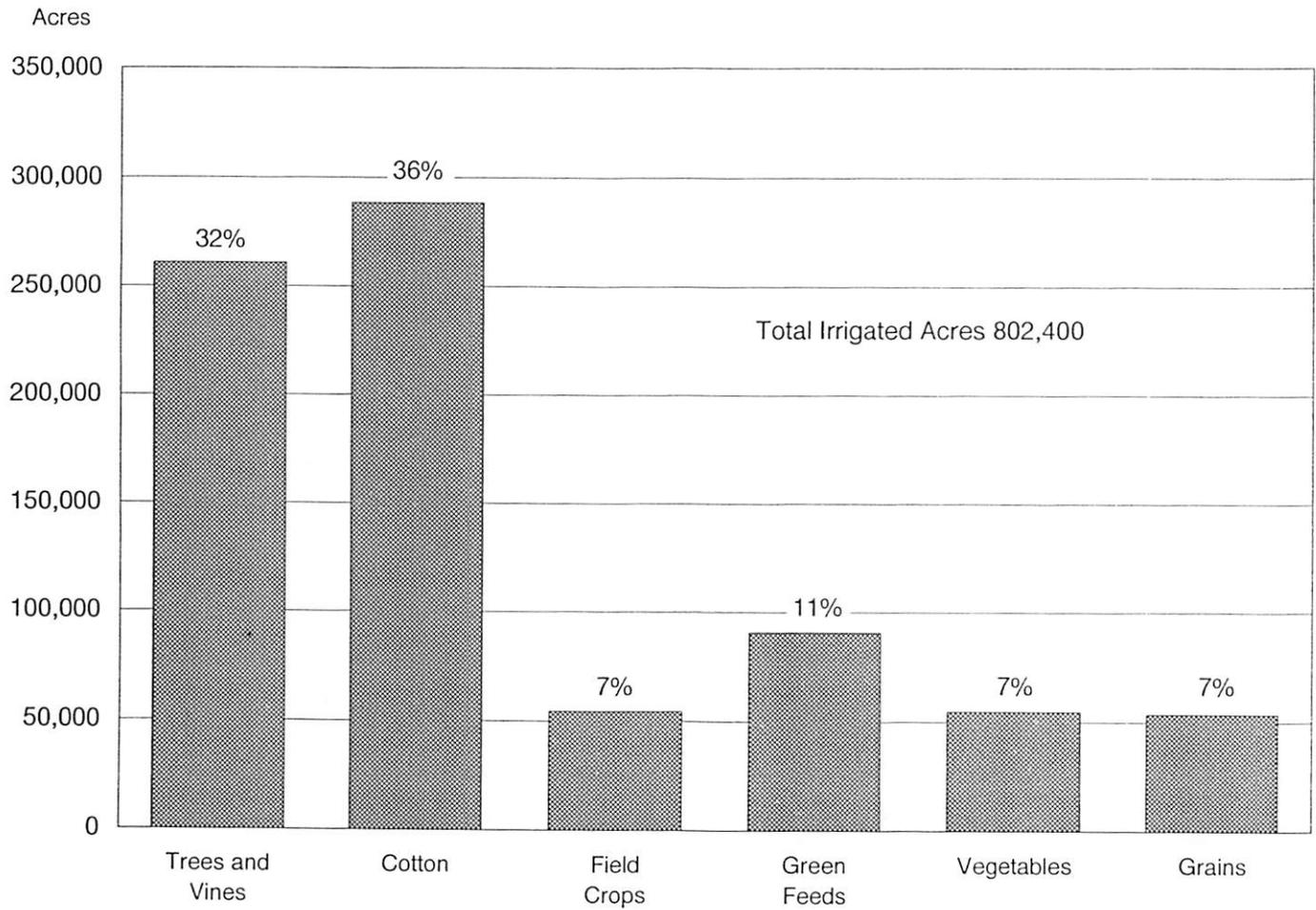


Figure 14
Summary of Irrigated Acreage, 1994



Note that trees and vines accounted for 50 percent of Kern County's gross agricultural value, reflecting the importance these crops hold in the local economy.

Agriculture is a major employer in Kern County. About 25 percent of all jobs within the county are agricultural or agriculture related. For some smaller communities, agriculture is the overwhelming employer, such as:

| <u>Agriculture's Share of Employment</u> | |
|--|-----|
| Arvin | 92% |
| Buttonwillow | 77% |
| Delano | 80% |
| Lost Hills | 94% |
| Shafter | 64% |
| Wasco | 75% |

Source: 1992 Agricultural Statistics

Per unit crop water demands in 1994 were slightly higher than normal. Table 17 is a summary of monthly evaporation as measured at three climatic stations in the county. Evaporation is a key parameter for measuring crop water use. The Bakersfield 12S and Bakersfield 14W stations (operated by the state Department of Water Resources) typify evaporation on the valley floor. Figure 15 displays monthly evaporation for these stations as a percent of normal.

Following are some crops that experienced significant yield increases over 1993.

| <u>Crop</u> | <u>Yield increase over 1993</u> |
|----------------|---------------------------------|
| Almonds | + 42% |
| Apples | + 27% |
| Watermelons | + 24% |
| Alfalfa | + 18% |
| Onions (fresh) | + 18% |

KCWA uses data from the California Irrigation Management and Information Service (CIMIS) to compute crop consumptive use on a district-by-district and crop-by-crop basis. CIMIS is a statewide computerized irrigation scheduling system that can help farmers to schedule their irrigations based upon soil moisture budgets. This method affords the opportunity to reduce total applied water requirements. There are four CIMIS weather stations in Kern County. CIMIS is

funded and operated by the DWR Office of Water Conservation. Approximate crop water use, as computed using the CIMIS data for 1994, is summarized on Table 18 along with total irrigated acreage.

It is difficult to quantify applied water requirements over the valley. Areal differences, soil differences, cultural practices, leaching requirements (typically 5-10 percent) and irrigation technologies employed across the valley result in very different applied water rates on specific crops. For instance, farmers in areas suffering from shallow ground water will usually apply less water on their crops than they would if the soil were well drained. The intent is to manage the shallow ground water problem. In addition, the crop may consumptively use some shallow ground water, reducing the amount the farmer needs to apply. Also, sprinkler or low-volume irrigation typically requires less water than furrow or flood irrigation. Many factors govern the type of irrigation system chosen by a farmer. Furrow or flood irrigation systems are not necessarily less efficient than other systems. Under some conditions (such as level slopes and heavy soils), furrow irrigation may be as efficient as sprinklers. The efficiency of any given irrigation system is determined by how well the system is managed.

Gross agricultural water requirements in 1994 were estimated to be about 2,948,500 acre-feet with 2,647,300 acre-feet occurring over the usable ground water basin. This was about 237,000 acre-feet more than was applied in 1993. Net agricultural requirements in 1994 were about 2,350,400 acre-feet with about 2,061,200 acre-feet occurring over the ground water basin. The difference between gross and net water requirements over the basin is an estimate of agricultural return flows to ground water. Not all return flows return to usable ground water. Some is lost to saline sinks (such as shallow ground water areas). Over moisture deficient soils, return flows are absorbed by the soils and are irrecoverable. About 116,800 acre-feet of water was lost to saline sinks during 1994, and about 15,400 acre-feet was lost to moisture deficient soils. About 469,200 acre-feet of agricultural applied water in 1994 returned to usable ground water storage.

Quite a large amount of applied water data has been collected over the years by many entities. The amount of water applied on a crop is affected by several factors: the slope and texture of the soil, the type of irrigation system and the age of the crop (for trees and

Table 17
1994 Monthly Evaporation for
San Joaquin Valley Climatic Stations
(in inches)

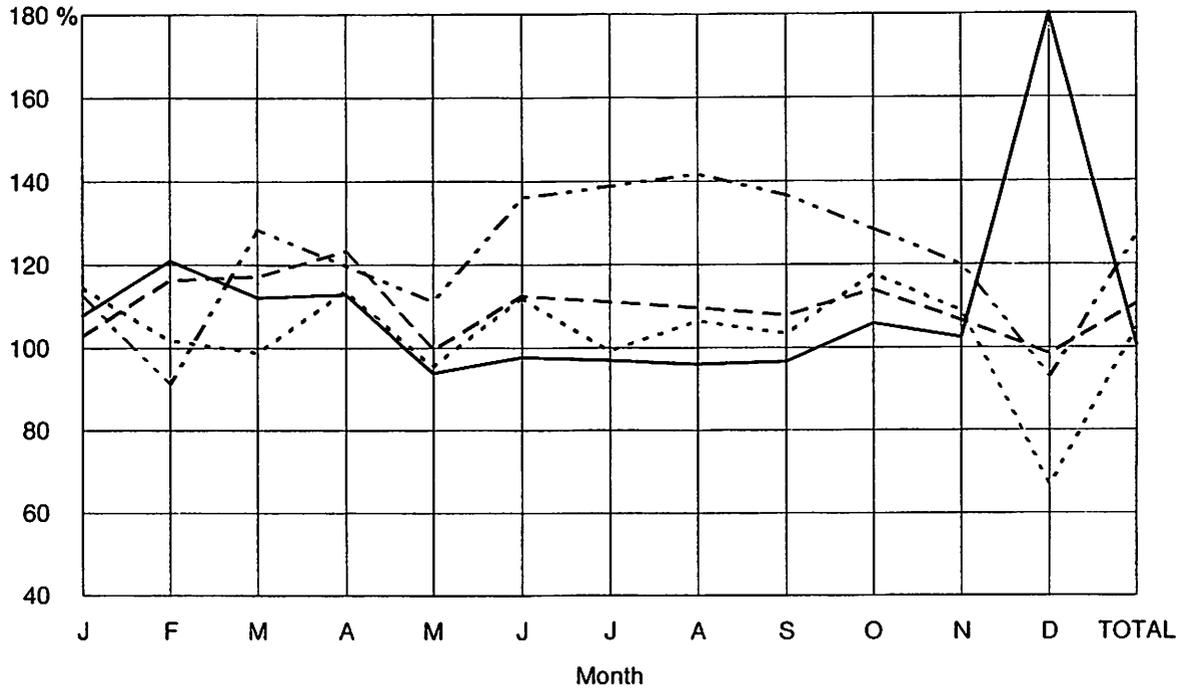
| | Bakersfield 12S | Bakersfield 14W | USDA Cotton Station | Greenlee's Pasture | Avg. All Stations |
|--------------------------|--------------------|--------------------|---------------------------|-----------------------|----------------------|
| January | 1.52 | 1.45 | 1.51 | 1.42 | 1.48 |
| February | 2.65 | 2.55 | 2.54 | 2.45 | 2.55 |
| March | 4.45 | 4.65 | 5.05 | 3.88 | 4.51 |
| April | 6.56 | 7.16 | 6.96 | 6.98 | 6.92 |
| May | 7.78 | 8.26 | 8.84 | 8.21 | 8.27 |
| June | 9.33 | 10.76 | 11.29 | 9.98 | 10.34 |
| July | 9.37 | 10.75 | 11.88 | 9.17 | 10.29 |
| August | 8.16 | 9.33 | 11.17 | 8.75 | 9.35 |
| September | 6.17 | 6.89 | 8.25 | 6.51 | 6.96 |
| October | 4.57 | 4.92 | 5.52 | 5.22 | 5.06 |
| November | 2.20 | 2.29 | 2.71 | 2.40 | 2.40 |
| December | 2.18 | 1.19 | 1.21 | 0.87 | 1.36 |
| Total | 64.94 | 70.20 | 76.93 | 65.84 | 69.48 |
| Percent of Normal | 101 | 111 | 127 | 105 | 111 |

Station Locations

| | |
|----------------------------|--|
| Bakersfield 12S | Section 36D, T31S, R27E, MDB&M. Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment. |
| Bakersfield 14W | Section 4R, T30S, R25E, MDB&M. Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment. |
| USDA Cotton Station | Section 33F, T27S, R25E, MDB&M. Equipment: USWB Class "A" evaporation pan in an irrigated grass turf environment. |
| Greenlee's Pasture | Section 36N, T12N, R21W, SBB&M. Equipment: USWB Class "A" evaporation pan in an irrigated pasture environment. |

Figure 15

1994
Percent of Normal Evaporation



—— Bakersfield 12S - - - Bakersfield 14W ····· Greenlee's Pasture - · - · - USDA Cotton Station

Percent of Normal, Total:

| | |
|----------------------------|--------------|
| Bakersfield 12S | 100.5 |
| Bakersfield 14W | 110.6 |
| Greenlee's Pasture | 104.6 |
| USDA Cotton Station | 127.2 |

Bakersfield 12S

1994 observed monthly EP, Bakersfield 12S (irrigated pasture) compared to long-term average for pasture pans in the San Joaquin Valley. This station is indicative of EP on the valley floor.

Bakersfield 14W

1994 observed monthly EP, Bakersfield 14W (irrigated pasture) compared to long-term average for pasture pans in the San Joaquin Valley. This station is indicative of EP on the valley floor.

Greenlee's Pasture

1994 observed monthly EP, Greenlee's Pasture (irrigated pasture - Wheeler Ridge area) compared to long-term average for pasture pans in the San Joaquin Valley. This station is indicative of EP in the foothill regions of the valley.

USDA Cotton Station

1994 observed monthly EP, USDA Cotton Station (irrigated turf) compared to long-term average for long-term average for USDA Cotton Station in the San Joaquin Valley. This station is indicative of EP for cotton in Kern County.

Table 18
1994 Irrigated Acreage
in the San Joaquin Valley Portion of Kern County, California

| Crop | Acres | Percent of Total | Consumptive Water Use (AF/Acre) |
|------------------------------|----------------|------------------|---------------------------------------|
| Alfalfa (including seed) | 84,247 | 10.5 | 3.88 |
| Almonds | 77,247 | 9.6 | 3.67 |
| Apples | 4,121 | 0.5 | 3.48 |
| Apricots | 634 | - | 3.47 |
| Asparagus | 393 | - | 3.70 |
| Avocado | 0 | - | - |
| Barley | 13,597 | 1.7 | 1.74 |
| Beans | 6,466 | 0.8 | 1.99 |
| Broccoli | 0 | - | - |
| Carrots | 14,957 | 1.9 | 0.69 |
| Citrus | 41,016 | 5.1 | 3.34 |
| Corn, Field | 6,501 | 0.8 | 2.84 |
| Cotton | 288,395 | 35.9 | 3.03 |
| Figs | 480 | - | - |
| Grapes | 87,007 | 10.8 | 2.55 |
| Guayale and Jojoba | 400 | - | 1.00 |
| Idle and Fallow Lands | 144,486 | - | - |
| Kiwi | 319 | - | 2.55 |
| Lettuce | 2,765 | 0.3 | 0.21 |
| Melons, Squash, Cucumbers | 7,200 | 0.9 | 1.78 |
| Misc. Deciduous Trees | 8,813 | 1.1 | 3.48 |
| Misc. Field Crop | 2,335 | 0.3 | 3.03 |
| Misc. Hay/Grain | 11,104 | 1.4 | 2.36 |
| Misc. Subtropical Trees | 273 | - | 2.68 |
| Misc. Truck Crop | 4,371 | 0.5 | 0.42 |
| Nursery | 4,454 | 0.6 | 2.60 |
| Oats | 2,507 | 0.3 | 1.67 |
| Olives | 1,936 | 0.2 | 3.34 |
| Onions, Garlic | 11,649 | 1.5 | 3.62 |
| Pasture, Turf | 6,548 | 0.8 | 4.85 |
| Peaches, Nectarines | 6,045 | 0.8 | 3.43 |
| Pears | 72 | - | 3.67 |
| Peas | 415 | - | 1.60 |
| Peppers | 1,238 | 0.2 | 2.11 |
| Pistachios | 28,013 | 3.5 | 3.34 |
| Plums, Prunes | 3,161 | 0.4 | 3.50 |
| Potatoes | 22,687 | 2.8 | 1.95 |
| Rice | 0 | - | - |
| Safflower | 6,910 | 0.9 | 2.60 |
| Sorghum/Milo | 1,431 | 0.2 | 2.37 |
| Sudan Grass | 327 | - | - |
| Sugar Beets | 9,291 | 1.2 | 3.58 |
| Tomatoes | 4,964 | 0.6 | 2.60 |
| Turnips | 452 | - | - |
| Walnuts | 1,623 | 0.2 | 2.93 |
| Wheat | 25,993 | 3.2 | 2.36 |
| Total Irrigated Lands | 802,357 | 100.0 | 2.96* |

Note: Double-cropped acreage is counted twice, since it is irrigated twice.

* Weighted average consumptive use of all crops.

vines). Table 19 provides a basin-wide average applied water requirement for some major crops grown in Kern County.

Municipal and Industrial (M&I)

Gross M&I requirements in 1994 were estimated to be about 181,800 acre-feet, with about 167,400 acre-feet required over the usable ground water basin. Of the total amount used over the usable basin, 27,500 acre-feet was supplied by KCWA's Henry C. Garnett Water Purification Plant. The Olcese Water District, which serves the Rio Bravo area, used about 800 acre-feet of Kern River water. East Niles Community Services District used about 900 acre-feet of CVP water obtained from the Arvin-Edison Water Storage District. The remainder, about 138,200 acre-feet, was drawn from ground water. Table 20 gives a breakdown of urban water deliveries by water purveyor service area. The total production of these purveyors, as listed on Table 20, is less than the gross M&I requirements. Many rural families and businesses maintain their own water systems, and as such, their volumes of production are not recorded. In addition, some small water companies do not keep accurate records of their water production. The gross M&I requirements reflect this fact and include an estimate of the needs of these rural areas and small water companies.

The average municipal and industrial water use over the ground water basin in 1994 was 326 gallons per capita per day (gpcd), slightly higher than in 1993. Long-term, average M&I water use is about 250 gpcd. Residential water use is about 200 gpcd. Industrial, commercial and public authority water use accounts for the difference. It should be noted that domestic water uses by the west side towns (Taft, Maricopa, Lost Hills) are quite low when compared to the domestic water use over the ground water basin. The average domestic water usage during 1994 was about 196 gallons per capita per day for the west side towns.

Net M&I consumptive use in 1994 was about 51,300 acre-feet over the ground water basin. Gross return flows from M&I uses over the ground water basin were about 116,100 acre-feet. About 49,700 acre-feet of M&I return flows were treated in sewage treatment facilities and evaporated, percolated or reused for agriculture. The remaining 66,400 acre-feet returned to ground water supplies. Most of the M&I water used

outside the ground water basin is for oil field operations (only about 30 percent is used domestically), and is all consumptively used. Any water not consumptively used outside the ground water basin is lost to moisture deficient soils.

Exports

During periods of high runoff, some water may be introduced into the California Aqueduct via the Kern River-California Aqueduct Intertie and exported over the Tehachapi Mountains. Some water may be spilled into the Kern River Flood Channel, where it may flow north into Tulare Lake in Kings County. Essentially, this is not a usable surface supply in Kern County. No water was exported from Kern County during 1994 via the Intertie nor the Kern River Flood Channel.

Water Surface Evaporation

Water surface evaporation normally accounts for a small amount of water lost from the valley portion of Kern County. In 1994 about 42,200 acre-feet of evaporation losses occurred, with about 41,600 acre-feet occurring over the ground water basin. This was slightly higher than in 1993. Any water lost in this manner is lost from this regional hydrologic system.

Table 19
Average Applied Water Requirements for Various Crops
in Kern County
(in acre-feet per acre)

| Crop | Drip ⁽¹⁾ | Sprinkler ⁽²⁾ | Row/Border ⁽³⁾ |
|---------------------------|----------------------------|---------------------------------|----------------------------------|
| Alfalfa | | 3.45-4.35 | 3.5-5.15 |
| Almonds | 2.85-4.10 | 2.85-4.50 | 2.85-4.50 |
| Apples | 1.95-3.80 | 3.40-4.75 | |
| Beans (dry) | | | 2.00-2.75 |
| Carrots | | 1.75-2.45 | |
| Citrus | 2.05-3.75 | 2.75-4.40 | 3.50-4.50 |
| Corn (field) | | | 3.00-5.00 |
| Cotton | | 2.25-3.75 | 2.45-3.75 |
| Grapes | 2.00-4.00 | 2.15-4.50 | 2.35-4.85 |
| Lettuce | | | 1.50-2.50 |
| Onions, Garlic | | 1.00-2.65 | 1.25-4.25 |
| Melons, Squash, Cucumbers | | | 2.00-3.40 |
| Misc. Deciduous Trees | 2.75-3.35 | 3.00-4.00 | 3.00-4.50 |
| Nursery | | | 2.25-3.50 |
| Pasture, Irrigated | | 3.50-4.50 | 3.50-6.00 |
| Pistachios | 2.65-4.40 | 2.35-3.35 | 3.00-3.50 |
| Potatoes | | 1.10-2.30 | |
| Small Grains | | 1.00-2.50 | 1.00-2.50 |
| Tomatoes | | | 2.50-3.50 |
| Walnuts | | | 3.50-5.00 |

⁽¹⁾ Includes emitters, misters, mini-sprinklers and fan jets.

⁽²⁾ Includes portables, solid-sets, linear moves, sprinkler-guns.

⁽³⁾ Border includes border strip, level basin, contour strip.

Note: A blank entry indicates that an irrigation system is generally not utilized on a crop.

Table 20
1994 Urban Water Use, San Joaquin Valley Portion of Kern County

| Water Purveyor Service area | Metered Connections | Non-metered Connections | Annual Water Use | | Permanent Population | GPCD (1) |
|--|------------------------|----------------------------|------------------|----------------|-------------------------|----------------|
| | | | Million Gals. | Acre Feet | | |
| <u>Arvin</u> | | | | | | |
| Arvin CSD | 2,200 | -- | 666 | 2,044 | 10,500 | 174 |
| <u>Bakersfield Metro Area</u> | | | | | | |
| Airport Mutual WC | -- | -- | 18 | 55 | -- | -- |
| California Water Service | 15,661 | 38,732 | 23,402 | 71,813 | 182,670 | 351 |
| Casa Loma WC | -- | 215 | 401 | 1,231 | 2,000 | 549 |
| <u>City of Bakersfield</u> | | | | | | |
| Ashe Water Division | 18,694 | 178 | 7,497 | 23,006 | 57,740 | 356 |
| East Niles CSD | 6,150 | -- | 3,409 | 10,461 | 21,500 | 434 |
| Fairfax WC | -- | -- | 2 | 6 | -- | -- |
| Greenfield CWD | 678 | 368 | 351 | 1,077 | 6,000 | 160 |
| North of the River MWD | 439 | 1,470 | 886 | 2,719 | 5,500 | 441 |
| Oildale MWC | 341 | 5,881 | 2,216 | 6,800 | 20,000 | 304 |
| Rancho Verdugo WC | -- | 289 | 132 | 405 | 1,156 | 313 |
| Stockdale MWC | -- | 80 | 43 | 132 | 236 | 499 |
| Stockdale Annex MWC | -- | 138 | 98 | 301 | 163 | 1,647 |
| Vaughn WC | 3,235 | 1,002 | 2,153 | 6,607 | 11,906 | 495 |
| Victory MWC | -- | 155 | 55 | 169 | 620 | 243 |
| Metro Area Subtotal | 45,198 | 48,508 | 40,663 | 124,782 | 319,991 | 354 |
| <u>Buttonwillow</u> | | | | | | |
| Buttonwillow CWD (5) | -- | 415 | 158 | 486 | 1,278 | 340 |
| <u>Delano</u> | | | | | | |
| City of Delano | 2,392 | 3,706 | 2,300 | 7,058 | 29,944 | 210 |
| <u>Lamont</u> | | | | | | |
| Lamont PUD and ID#1 | 260 | 3,074 | 1,708 | 5,241 | 12,690 | 369 |
| <u>Lost Hills</u> | | | | | | |
| Lost Hills Utility District | 223 | -- | 105 | 322 | 800 | 360 (2) |
| <u>McFarland</u> | | | | | | |
| McFarland MWC | 1,602 | 5 | 410 | 1,258 | 7,000 | 160 |
| <u>Rio Bravo</u> | | | | | | |
| Olcese WD | 333 | -- | 266 | 817 | 832 | 877 (3) |
| <u>Shafter</u> | | | | | | |
| City of Shafter | 24 | 3,408 | 921 | 2,826 | 11,139 | 227 |
| <u>Taft-Maricopa-McKittrick</u> | | | | | | |
| West Kern WD | 7,155 | -- | 3,811 | 11,695 | 17,300 | 604 (2) |
| <u>Wasco</u> | | | | | | |
| City of Wasco | 665 | 2,908 | 1,161 | 3,563 | 13,774 | 231 |
| Wasco State Prison | 2 | -- | 198 | 608 | 4,500 | 121 |
| Total | 60,054 | 62,024 | 52,368 | 160,700 | 429,748 | 326 (4) |

(1) Gallons per capita per day. Note that the computed GPCD on this table includes residential, commercial, industrial and public authority water use. Residential use is about 200 GPCD.

(2) Includes significant quantities of water used by oil companies.

(3) Includes significant quantities of water used to irrigate a golf course.

(4) Weighted average gpcd, excluding Rio Bravo, Lost Hills and Taft-Maricopa-McKittrick.

(5) 1994 data not available; estimated using 1994 data.

Change in Ground Water Storage

Figure 16 shows a total gross water demand for the San Joaquin Valley portion of Kern County of 3,433,600 acre-feet in 1994. About 3,113,900 acre-feet occurred over the ground water basin. About 257,600 acre-feet of water was used for direct recharge or delivery system losses. Total net water use was about 2,590,600 acre-feet, with about 2,270,900 acre-feet used over the ground water basin. Gross available surface water supplies were about 1,537,800 acre-feet. Therefore, there was a net decrease in ground water storage of about 1,052,800 acre-feet. This was consistent with the fact that 1994 was a dry year.

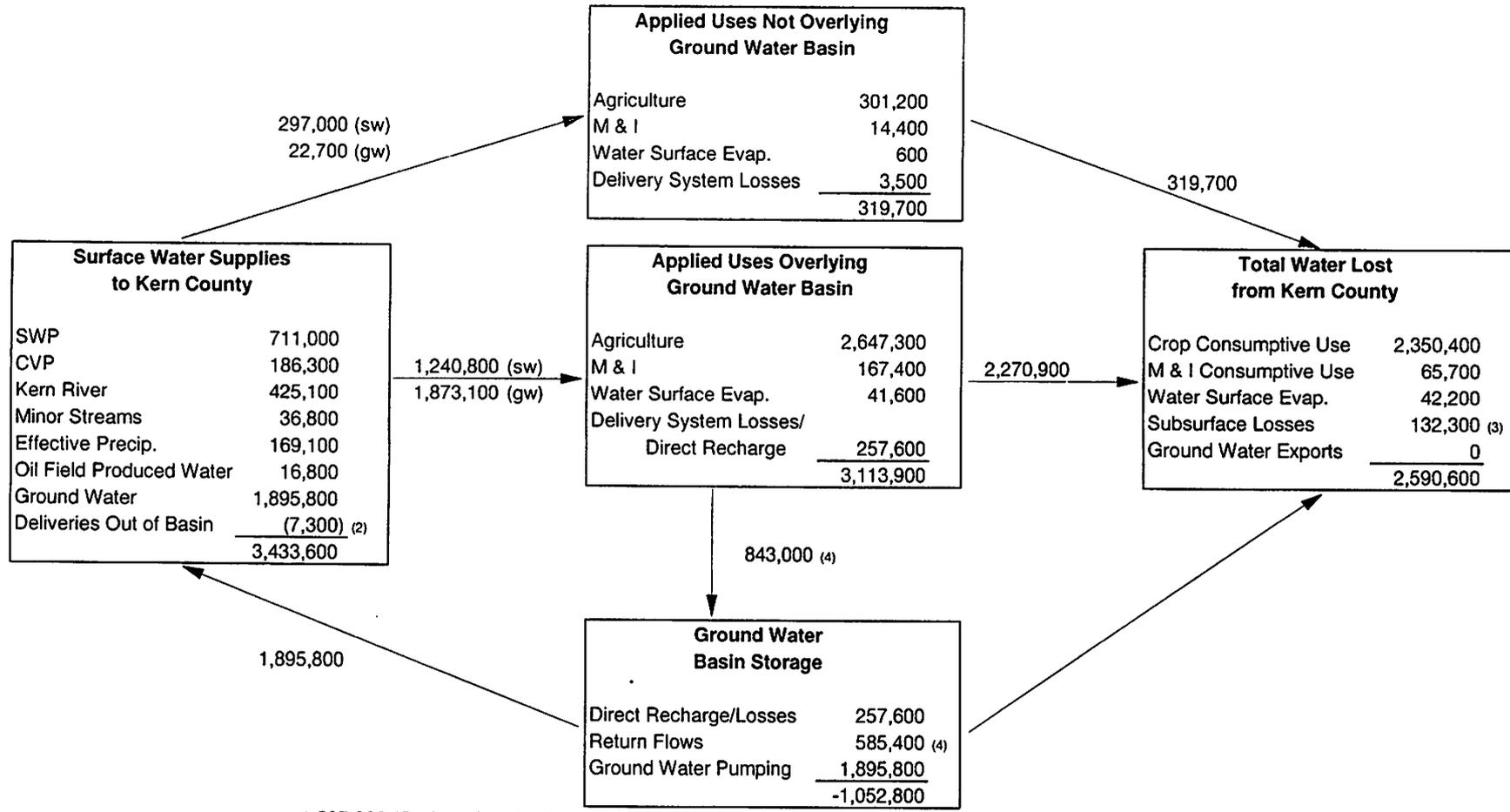
Figure 17 graphically displays the water supplies and demands of the San Joaquin Valley portion of Kern County since 1970 (when SWP water was first introduced over the ground water basin). During 1970-75 delivery systems were being developed, and the Cross Valley Canal had not been completed. During 1976-77 drought conditions restricted surface water supplies.

During 1970-94 about 12,955,000 acre-feet of water was withdrawn from ground water storage. Over the same period the balance of additions over extractions has replenished about 5,551,000 acre-feet. The average change in storage since 1970 is about 296,000

acre-feet per year. Figure 18 shows the cumulative ground water balance since 1970 when SWP water was first introduced over the Kern County ground water basin. In volume of ground water storage, the basin now stands below 1977 drought levels. Improvements achieved during the 1978-86 and 1993 wet period have been erased.

Kern County's ground water management plans depend upon the sustained delivery of water from all three major sources: Kern River, State Water Project and Central Valley Project. A reduction in one supply, unless accompanied by an increase in another, can have a serious impact upon the ground water basin. Table 21 provides a summary of supplies from these sources and shows this relative dependence. The dependence is especially illustrated by comparing the year 1986 with 1987. During 1986 surface water supplies were ample. Therefore, ground water comprised only 25 percent of the total water supply. In 1987 the reverse was true, and ground water pumping increased to make up for the dry-year conditions. Conditions during the ongoing drought have shown this dependence; as surface water sources were reduced, ground water pumping increased to make up the shortfall.

Figure 16
 1994 Water Resources Inventory
 San Joaquin Valley Portion of Kern County
 (in acre-feet)



1,537,800 (Surface Supplies) minus 2,590,600 (Consumptive Use) equals -1,052,800 (Change in Storage)

Notes:

- (1) Includes 13,500 AF Drought Bank water and 500 AF other imports.
- (2) Delivered to other SWP contractors and Tehachapi-Cummings WD (3,500 AF).
- (3) Includes 116,900 AF to saline sinks, and 15,400 AF losses to moisture deficient soils.
- (4) Of this, 49,700 AF was treated in waste water facilities and reused.

(sw) Surface Water
 (gw) Ground Water

Figure 17
 Gross Water Supplies and Net Water Requirements
 San Joaquin Valley Portion of Kern County, California

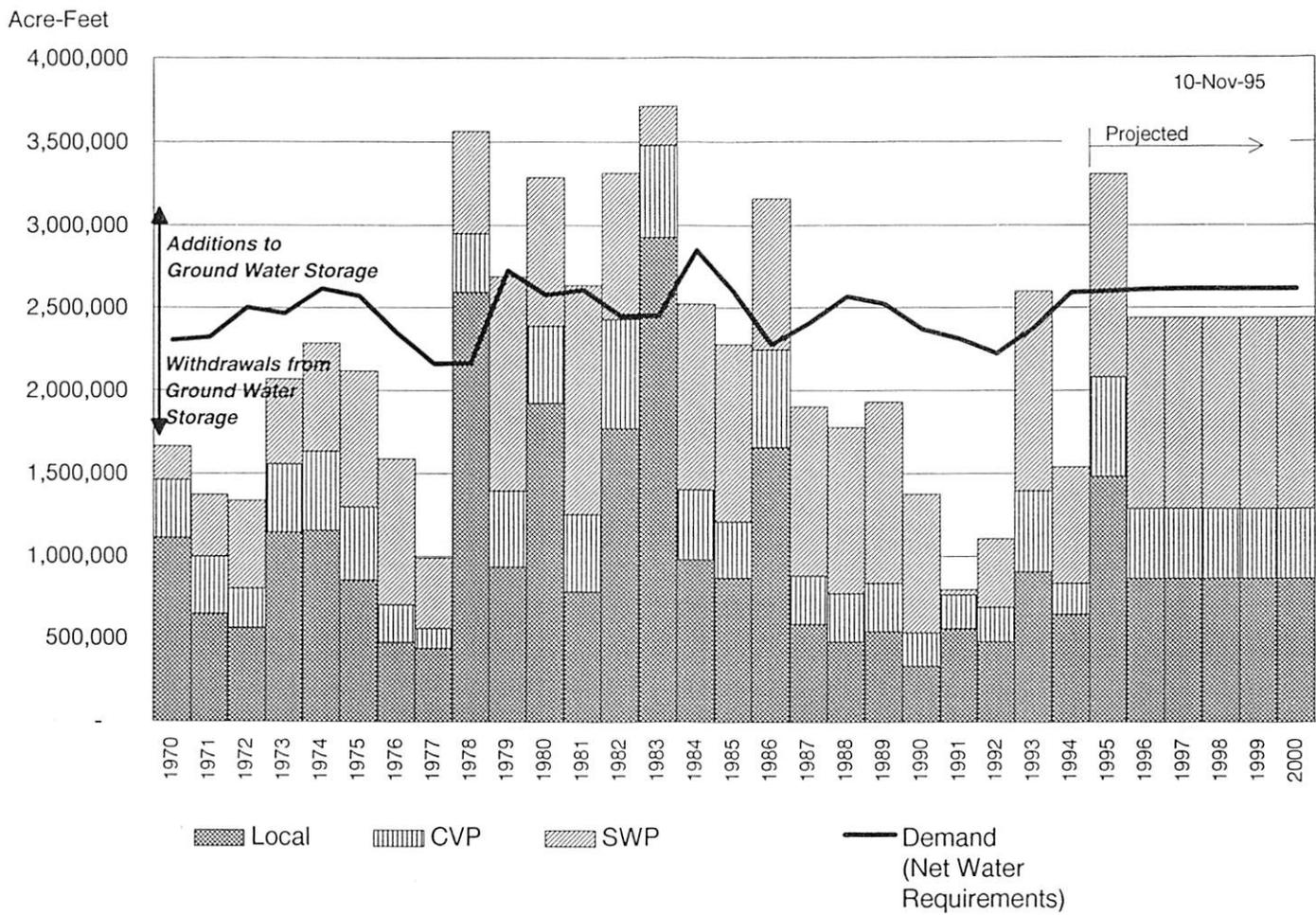


Figure 18
 Cumulative Change in Ground Water Storage
 in the San Joaquin Valley Portion of Kern County

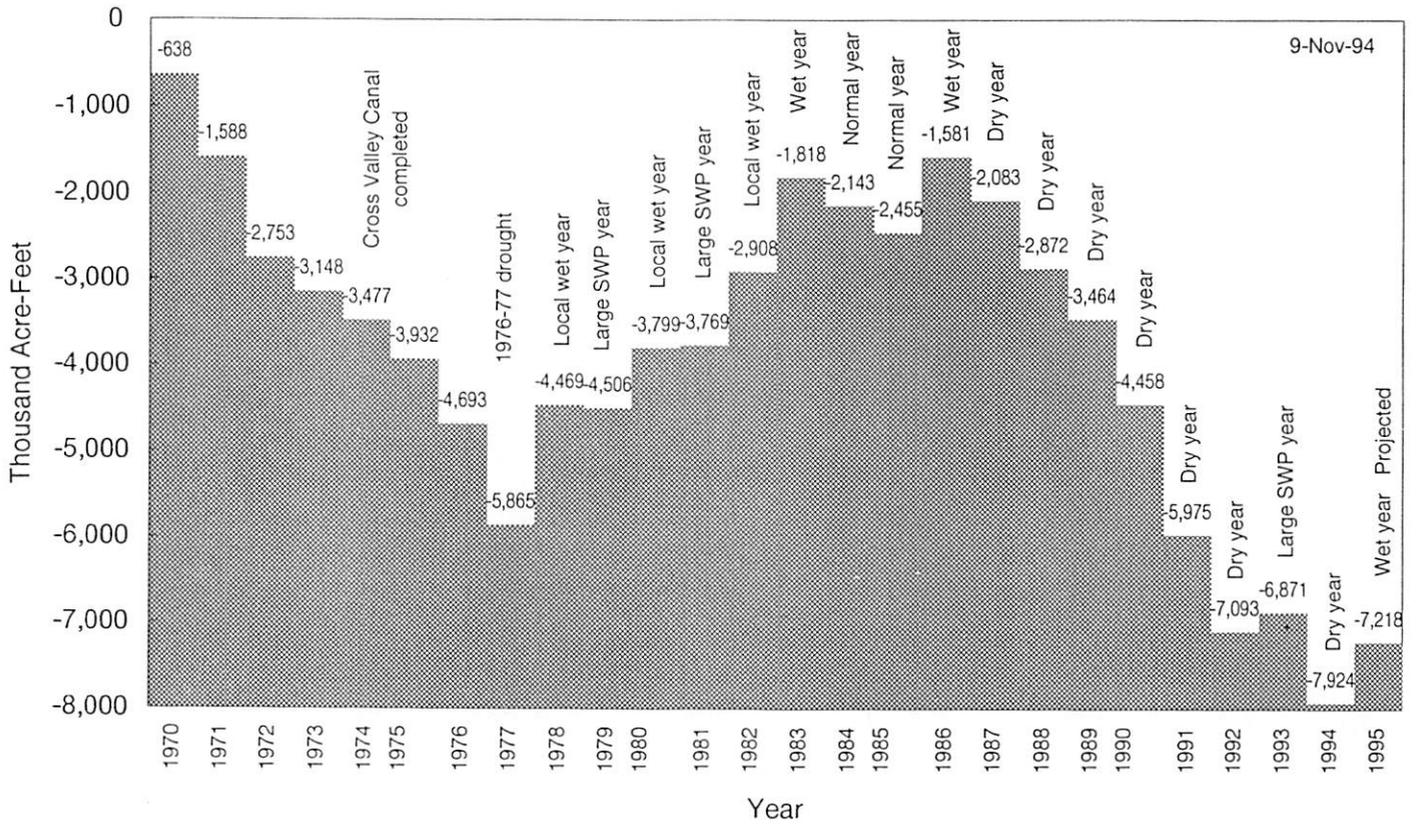


Table 21
Historic Surface* and Ground Water Usage or Availability
in the San Joaquin Valley Portion of Kern County
(in acre-feet)

| | <u>Kern River</u> | | <u>Other Local Water</u> | | <u>Central Valley Project</u> | | <u>State Water Project</u> | | <u>Ground Water</u> | | <u>Total Supplies</u> |
|-------------|-------------------|-------------------|--------------------------|-------------------|-------------------------------|-------------------|----------------------------|-------------------|---------------------|-------------------|-----------------------|
| | <u>Available</u> | <u>% of Total</u> | <u>Available</u> | <u>% of Total</u> | <u>Usage</u> | <u>% of Total</u> | <u>Usage</u> | <u>% of Total</u> | <u>Usage</u> | <u>% of Total</u> | |
| 1970 | 590,300 | 19.1 | 517,900 | 16.8 | 351,400 | 11.4 | 204,600 | 6.6 | 1,422,000 | 46.1 | 3,086,200 |
| 1971 | 428,300 | 14.0 | 217,100 | 7.1 | 348,900 | 11.4 | 375,500 | 12.2 | 1,700,000 | 55.4 | 3,069,800 |
| 1972 | 269,200 | 8.4 | 292,600 | 9.2 | 238,500 | 7.5 | 535,600 | 16.8 | 1,857,000 | 58.2 | 3,192,900 |
| 1973 | 980,500 | 26.3 | 161,200 | 4.3 | 412,200 | 11.0 | 515,500 | 13.8 | 1,662,000 | 44.5 | 3,731,400 |
| 1974 | 819,400 | 22.7 | 332,000 | 9.2 | 480,600 | 13.3 | 651,800 | 18.0 | 1,333,000 | 36.9 | 3,616,800 |
| 1975 | 565,400 | 15.3 | 287,300 | 7.8 | 442,100 | 11.9 | 821,700 | 22.2 | 1,587,000 | 42.9 | 3,703,500 |
| 1976 | 250,300 | 7.5 | 225,700 | 6.8 | 226,500 | 6.8 | 883,400 | 26.6 | 1,738,000 | 52.3 | 3,323,900 |
| 1977 | 197,800 | 7.4 | 239,400 | 8.9 | 121,500 | 4.5 | 429,400 | 16.0 | 1,703,000 | 63.3 | 2,691,100 |
| 1978 | 1,654,300 | 36.8 | 1,050,200 | 23.3 | 357,800 | 8.0 | 611,500 | 13.6 | 825,000 | 18.3 | 4,498,800 |
| 1979 | 673,500 | 17.1 | 258,700 | 6.6 | 462,500 | 11.7 | 1,291,800 | 32.7 | 1,260,000 | 31.9 | 3,946,500 |
| 1980 | 1,640,900 | 37.8 | 356,500 | 8.2 | 462,800 | 10.7 | 900,300 | 20.8 | 977,000 | 22.5 | 4,337,500 |
| 1981 | 452,200 | 11.9 | 329,100 | 8.7 | 470,000 | 12.4 | 1,384,700 | 36.5 | 1,161,000 | 30.6 | 3,797,000 |
| 1982 | 1,273,600 | 31.4 | 434,600 | 10.7 | 656,600 | 16.2 | 884,500 | 21.8 | 802,200 | 19.8 | 4,051,500 |
| 1983 | 2,491,300 | 52.3 | 723,000 | 15.2 | 550,900 | 11.6 | 238,200 | 5.0 | 762,700 | 16.0 | 4,766,100 |
| 1984 | 824,300 | 21.7 | 165,300 | 4.4 | 425,400 | 11.2 | 1,123,000 | 29.6 | 1,252,200 | 33.0 | 3,790,200 |
| 1985 | 675,400 | 18.9 | 192,600 | 5.4 | 337,500 | 9.4 | 1,074,100 | 30.1 | 1,293,800 | 36.2 | 3,573,400 |
| 1986 | 1,447,900 | 35.3 | 207,000 | 5.0 | 589,300 | 14.4 | 913,600 | 22.3 | 947,600 | 23.1 | 4,105,400 |
| 1987 | 378,300 | 12.2 | 206,800 | 6.6 | 292,000 | 9.4 | 1,025,900 | 33.0 | 1,208,700 | 38.8 | 3,111,700 |
| 1988 | 297,700 | 9.0 | 179,800 | 5.4 | 292,800 | 8.8 | 1,006,200 | 30.3 | 1,540,200 | 46.4 | 3,316,700 |
| 1989 | 399,200 | 11.3 | 141,500 | 4.0 | 293,900 | 8.3 | 1,097,200 | 31.2 | 1,588,500 | 45.1 | 3,520,300 |
| 1990 | 221,300 | 6.9 | 112,800 | 3.5 | 200,100 | 6.3 | 857,300 | 26.9 | 1,796,500 | 56.4 | 3,188,000 |
| 1991 | 338,300 | 12.1 | 220,400 | 7.9 | 204,400 | 7.3 | 32,700 | 1.2 | 2,002,400 | 71.6 | 2,798,200 |
| 1992 | 275,000 | 9.9 | 203,200 | 7.3 | 208,000 | 7.5 | 418,000 | 15.0 | 1,673,600 | 60.2 | 2,777,800 |
| 1993 | 644,900 | 18.0 | 251,200 | 7.0 | 489,800 | 13.7 | 1,205,500 | 33.7 | 987,700 | 27.6 | 3,579,100 |
| 1994 | 425,100 | 12.4 | 222,700 | 6.5 | 186,300 | 5.4 | 695,400 | 20.3 | 1,895,800 | 55.3 | 3,425,300 |
| Avg. | 728,600 | 20.5 | 301,100 | 8.5 | 364,100 | 10.2 | 767,100 | 21.5 | 1,399,100 | 39.3 | 3,560,000 |

* Adjusted for deliveries within Kern County. SWP includes Intertie deliveries.

Basin-Wide Water Use Efficiency

Water applied to a crop that is over its evapotranspiration requirements percolates past the root zone and returns to ground water supplies, where it is available for reuse. Sometimes the deep percolation is intercepted by shallow clay lenses in the soil. This condition is called shallow ground water. In some areas the deep percolation may return to unusable saline ground water. In the western portion of Kern County, most of the soils are moisture-deficient. That is, the water held in the soil is less than the amount of water the soil would normally retain after gravity drainage. Any deep percolation occurring over these moisture-deficient soils will be absorbed until the water holding capacity of the soils is satisfied. Geologists estimate it would take over three million acre-feet of water to satisfy the holding capacity of these moisture-deficient soils.

Over the entire San Joaquin Valley portion of Kern County, gross water uses were about 3,433,600 acre-feet during 1994 (2,948,500 for agriculture, 181,800 for M&I, 42,200 of evaporation losses, 257,600 for ground water recharge, and 3,500 of unrecoverable delivery

system losses). The total consumption of water was about 2,590,600 acre-feet (2,350,400 by agriculture, 65,700 by M&I, 42,200 of evaporation losses). Effective precipitation was about 169,100 acre-feet. The agricultural irrigation efficiency, therefore, was about 74 percent. A total of 49,700 acre-feet of M&I water was treated and reused, mostly by agriculture. The difference between gross and net requirements is an estimate of ground water returns, which amounted to 717,700 acre-feet. However, about 116,900 acre-feet of deep percolation was intercepted by shallow ground water. Another 15,400 acre-feet was absorbed by moisture-deficient soils. Therefore, net ground water returns were 585,400 acre-feet in 1994. Expressed another way, of the 3,433,600 acre-feet of gross water demand during 1994, 3,261,000 acre-feet was beneficially used or available for reuse (via net deep percolation). As a percent, 95 percent of the water uses during 1994 were put to beneficial use or available for reuse. This percentage is termed basin-wide water use efficiency. Kern County is among the most efficient areas of the state in terms of basin-wide water use efficiency.

Intertie Activity

The Kern River-California Aqueduct Intertie is a structure connecting the Kern River to the California Aqueduct near Tupman. Built by the Army Corps of Engineers in 1977, its basic purpose is to dispose of flood water, preventing damages downstream of the Kern River flood plain. Flows into the California Aqueduct through the Intertie may contain water from the Kern, Kaweah, San Joaquin or Tule Rivers, or a combination of these. Generally, Kern River flows must exceed about 200 percent of normal before the Intertie gates need to be opened. Water from the Kern River channel first passes through a sedimentation basin to remove sand and silt. Water then passes through trash racks to remove floating debris before it enters the aqueduct. The structure has a capacity of 3,500 cfs. However, downstream aqueduct demands can become the limiting factor in wet years when demands are low.

When it enters the California Aqueduct, Intertie water becomes the property of the State Department of

Water Resources and is used to meet SWP system needs. During periods of extremely heavy runoff (such as in 1983), temporary pumps may be installed to pump the water to aqueduct reaches north (upstream) of the Intertie as well. Such water displaces an equal amount of SWP water that would have been pumped from the Sacramento-San Joaquin River Delta, producing a power cost saving for the SWP users.

The Intertie has not operated since 1986. Through the end of 1986, a total cumulative flow of 1,143,081 acre-feet of water has passed through its gates into the California Aqueduct. About 47 percent of this was used in Kern County, the remainder went to southern California. Table 22 is a historical summary of Intertie activity to date, showing the inflow by source, and amounts exported and retained in the County. It is expected that water banking programs operated by KCWA and DWR will reduce this loss in the future.

Table 22
Summary of Kern River-California Aqueduct Intertie Activity
(in acre-feet)

| | <u>Intertie Inflow</u> | | | <u>Amount Exported</u> | | | <u>Retained in County</u> | | |
|--------------|------------------------|--------------------|------------------|------------------------|--------------------|----------------|---------------------------|--------------------|----------------|
| | Kern River | Friant-Kern | Total | Kern River | Friant-Kern | Total | Kern River | Friant-Kern | Total |
| 1978 | 168,818 | 9,113 | 177,931 | n/a* | n/a* | 113,831 | n/a* | n/a* | 64,100 |
| 1980 | 138,816 | 0 | 138,816 | 74,024 | 0 | 74,024 | 64,792 | 0 | 64,792 |
| 1982 | 10,339 | 11,968 | 22,307 | 5,928 | 2,700 | 8,628 | 4,411 | 9,268 | 13,679 |
| 1983 | 662,856 | 96,200 | 759,056 | n/a* | n/a* | 393,551 | n/a* | n/a* | 365,505 |
| 1984 | 27,524 | 0 | 27,524 | 13,885 | 0 | 13,885 | 13,639 | 0 | 13,639 |
| 1986 | 1,867 | 15,580 | 17,447 | 0 | 4,746 | 4,746 | 1,867 | 10,834 | 12,701 |
| Total | 1,010,220 | 132,861 | 1,143,081 | | | 608,665 | | | 534,416 |

* A breakdown between sources was not available.

Source: State Department of Water Resources and City of Bakersfield Kern River Annual Reports.

Ground Water Conditions

Ground Water Recharge

Several entities in Kern County are actively engaged in ground water replenishment operations. Semitropic WSD, Rosedale-Rio Bravo WSD, North Kern WSD, Arvin-Edison WSD, City of Bakersfield and KCWA all operate recharge facilities. Kern River water is recharged by a combination of deliberate spreading in recharge areas, by losses in unlined canals, or by percolation in the Kern River channel. Central Valley Project water is recharged in spreading ponds operated by the Arvin-Edison WSD or in the Kern River and Poso Creek channels. State Water Project water is recharged by KCWA and several water districts in the Kern River channel via the Cross Valley Canal, in unlined irrigation canals, or in district operated recharge sites. During wet periods, every effort is made to deliver water through unlined canals to maximize ground water recharge.

Many water districts in Kern County utilize conjunctive use and banking programs to help balance their supplies. A correctly managed conjunctive use or banking program is an effective water management tool that allows a district to smooth over periods when surface water is unavailable. The intent is to store water during times when the available supply exceeds demand, and recover the water when the opposite is true. Also, a correctly managed program monitors the effects of water withdrawals in any year, so adverse local and regional impacts are minimized. A tremendous amount of ground water recharge in Kern County is accomplished as part of these programs. Table 23 shows major conjunctive use and banking programs since 1971, listing the amounts of water by source. About 257,600 acre-feet of water was recharged in 1994, both deliberately and incidentally. The approximate breakdown between sources was:

| | |
|---------------|----------------|
| Kern River | 144,700 |
| SWP | 58,900 |
| CVP | 13,000 |
| Waste Water | 3,700 |
| Minor Streams | 35,000 |
| Combined | 2,300 |
| Total | 257,600 |

These numbers should only be considered as best estimates since often the supplies are intermixed in the same canal systems. Therefore, any differentiation becomes impossible. The amount of recharge shown on Table 23 is more than the amount of recharge listed here. This is because Table 23 includes in lieu recharge, but excludes incidental recharge and minor stream flows that have naturally recharged the ground water basin. In lieu recharge is accomplished by delivering surface water to users who would normally pump ground water.

Such recharge efforts show the importance attached to reducing ground water overdraft in Kern County, and conserving water. Since 1970 a total of about 8,566,000 acre-feet of water has been recharged (both deliberately and incidentally) to replenish ground water supplies. The effectiveness of such recharge activities is apparent in Figure 17. KCWA estimates that the 8,566,000 acre-feet of recharged water results in a gross basin-wide ground water pumping lift difference of about 85 feet, or about one foot for every 100,000 acre-feet.

Ground Water Banking

Ground water banking is a water management tool that has increased in use during recent years, corresponding to the decreasing ability of the SWP and CVP to provide a dependable water supply. Because of limitations of existing surface storage facilities coupled with regulatory restraints DWR cannot presently meet its long-term contractual obligations. Since ground water storage is now more environmentally acceptable and financially feasible, DWR, KCWA and local water districts are expanding the development of water banking programs. The purpose of banking programs is to store surface water in the underground when it is available and recover it during times of need. Therefore, available surface water supplies are used conjunctively with ground water.

The Kern Water Bank is a planned banking/recovery program that will ultimately provide as much as 100,000 acre-feet of annual dry-year yield for the State Water Project. On the local level, the City of Bakersfield has maintained its 2,800-acre recharge area as a banking

Table 23
Summary of Ground Water Recharge Activities *
(in acre-feet)

| Entity/Location | Source | 1971-89 | 1990 | 1991 | 1992 | 1993 | 1994 | Total |
|--------------------------------------|----------|---------------------------------|----------------|---------------|----------------|----------------|----------------|--------------------------|
| BANKING | | | | | | | | |
| City of Bakersfield ** | | | | | | | | |
| 2,800 Acre Spreading Area | Kern | 525,132 ⁽²⁾ | 0 | 0 | 0 | 865 | 0 | 525,997 |
| | SWP | 21,010 | 0 | 0 | 0 | 0 | 0 | 21,010 |
| | F-K | 68,681 ⁽²⁾ | 0 | 0 | 0 | 7,016 | 0 | 75,697 |
| Subtotal COB | | 614,823 | 0 | 0 | 0 | 7,881 | 0 | 622,704 |
| Kern County Water Agency | | | | | | | | |
| Berrenda Mesa Spreading Area | Combined | 33,960 ⁽¹⁾ | 0 | 0 | 0 | 7,563 | 2,333 | 43,856 ⁽¹⁾ |
| Kern River Channel (in ID4) | SWP | 33,552 | 0 | 0 | 0 | 0 | 0 | 33,552 |
| 2,800 Acre Spreading Area | SWP | 82,733 | 0 | 0 | 0 | 168,709 | 20,551 | 271,993 |
| Subtotal KCWA | | 150,245 | 0 | 0 | 0 | 176,272 | 22,884 | 349,401 |
| DWR-Kern Water Bank | | | | | | | | |
| 2800 Acre Spreading Area | SWP | 7,379 | 0 | 0 | 0 | 0 | 0 | 7,379 |
| Local Elements*** In-lieu Rechg. | SWP | 0 | 136,300 | 0 | 0 | 0 | 0 | 136,300 |
| Local Elements*** Direct Rechg. | SWP | 0 | 4,200 | 0 | 0 | 0 | 0 | 4,200 |
| Subtotal DWR | | 7,379 | 140,500 | 0 | 0 | 0 | 0 | 147,879 |
| Total Banking | | 772,447 | 140,500 | 0 | 0 | 184,153 | 22,884 | 1,119,984 |
| CONJUNCTIVE USE | | | | | | | | |
| Arvin-Edison WSD | F-K | 752,323 | 0 | 170 | 9,253 | 122,917 | 12,839 | 897,502 |
| Buena Vista WSD Direct Rechg. | Kern | 245,169 | 0 | 0 | 0 | 11,949 | 34,806 | 291,924 |
| | SWP | 29,709 | 0 | 0 | 0 | 16,965 | 9,233 | 55,907 |
| | F-K | 0 | 0 | 0 | 0 | 1,818 | 0 | 1,818 |
| Semitropic WSD Direct Rechg. | SWP | 36,272 | 16,400 | 6,800 | 9,326 | 9,738 | 8,960 | 87,496 |
| In-Lieu Rechg. | SWP | 601,404 | 34,870 | 697 | 1,531 | 31,728 | 34,638 | 704,868 |
| | Combined | 7,289 ⁽¹⁾ | -- | -- | -- | -- | -- | 7,289 ⁽¹⁾ |
| I.D. No. 4 Direct Rechg. | Kern | 411,580 | 3,116 | 6,279 | 4,437 | 30,319 | 15,250 | 470,981 |
| | SWP | 246,894 | 10,713 | 1,651 | 2,574 | 44,557 | 14,030 | 320,419 |
| | F-K | 18,835 | 0 | 0 | 0 | 8,084 | 193 | 27,112 |
| Kern Delta WD Direct Rechg. | Combined | 1,024,908 | 33,246 | 42,614 | 37,740 | 57,428 | 47,675 | 1,243,611 |
| North Kern WSD Direct Rechg. | Kern | 1,381,176 | 0 | 4,038 | 26,017 | 61,482 | 4,829 | 1,477,542 |
| In-Lieu Rechg. | Kern | 459,505 | 0 | 1,326 | 26,739 | 45,218 | 108,167 | 640,955 |
| Rosedale-Rio Bravo WSD Direct Rechg. | Kern | 508,904 | 0 | 9,076 | 1,041 | 26,890 | 0 | 545,911 |
| | SWP | 514,643 | 0 | 0 | 8,282 | 55,636 | 6,119 | 584,680 |
| | F-K | 161,807 | 0 | 62 | 0 | 6,859 | 0 | 168,728 |
| | Combined | 279,800 ⁽¹⁾ | -- | -- | -- | -- | -- | 279,800 ⁽¹⁾ |
| In-Lieu Rechg. | SWP | -- | -- | -- | -- | -- | 2,657 | 2,657 |
| Wheeler Ridge-Maricopa WSD | | | | | | | | |
| In-Lieu Recharge | SWP | 86,563 | 9,000 | 0 | 0 | 6,882 | 0 | 102,445 |
| Total Conjunctive Use | | 6,766,781 | 107,345 | 72,713 | 126,940 | 538,470 | 299,396 | 7,911,645 |
| OVERDRAFT CORRECTION | | | | | | | | |
| Ground Water Replenishment Programs | | | | | | | | |
| Direct Rechg. | Kern | 188,185 | 0 | 0 | 0 | 521 | 0 | 188,706 |
| | SWP | 257,920 | 0 | 0 | 0 | 0 | 0 | 257,920 |
| | F-K | 7,723 | 0 | 0 | 0 | 0 | 0 | 7,723 |
| In Lieu Rechg. | Kern | 0 | 0 | 0 | 0 | 573 | 0 | 573 |
| | SWP | 96,871 | 0 | 0 | 0 | 573 | 0 | 97,444 |
| Total Overdraft Correciton | | 550,699 | 0 | 0 | 0 | 1,667 | 0 | 552,366 |
| GRAND TOTALS | | | | | | | | |
| | Kern | 3,719,651 | 3,116 | 20,719 | 58,234 | 177,817 | 163,052 | 4,142,589 |
| | SWP | 2,014,950 | 211,483 | 9,148 | 21,713 | 334,788 | 96,188 | 2,688,270 |
| | F-K | 1,009,369 | 0 | 232 | 9,253 | 146,694 | 13,032 | 1,178,580 |
| | Combined | 1,345,957 | 33,246 | 42,614 | 37,740 | 64,991 | 50,008 | 1,574,556 ⁽¹⁾ |
| Total | | 8,089,927 ⁽¹⁾ | 247,845 | 72,713 | 126,940 | 724,290 | 322,280 | 9,583,995 |

* Includes direct and in-lieu recharge.

** Includes banking by Olcese WD, Hacienda WD, Buena Vista WSD, City of Bakersfield; for breakdown between districts see Table 23.

*** Includes 1990 Kern Water Bank Demonstration Program deliveries.

(1) Breakdown between sources not available.

(2) Revised from 1992 Water Supply Report.

Note: For a breakdown of 1971 to 1989, see prior Water Supply Reports.

Table 24a
Kern County Water Agency
Summary of Ground Water Banking Activities

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|--------------------------------------|---------|---------|----------|-----------|---------|---------|---------|---------|---------|
| Belridge WSD | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| Buena Vista WSD | | | | | | | | | |
| Recharge/Purchase | 6,056 | 9,913 | | | 24,465 | | | | 10,000 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | 6,056 | 15,969 | 15,969 | 15,969 | 40,434 | 40,434 | 40,434 | 40,434 | 50,434 |
| Berrenda Mesa WD | | | | | | | | | |
| Recharge/Purchase | | | | 9,500 | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | 9,500 | 9,500 | 9,500 | 9,500 | 9,500 | 9,500 |
| Cawelo WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| City of Bakersfield | | | | | | | | | |
| Recharge/Purchase | 104,587 | 4,505 | 68,804 | 2,603 | 37,913 | 113,380 | 16,058 | 402 | 64,168 |
| Recovery/Sale | | | (13,772) | (100,837) | | | (472) | (1,615) | |
| Storage Balance | 104,587 | 109,092 | 164,124 | 65,890 | 103,803 | 217,183 | 232,769 | 231,556 | 295,724 |
| Improvement District No. 4 | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | 12,766 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | 12,766 |
| Kern County Water Agency | | | | | | | | | |
| Recharge/Purchase | | | | 63,364 | | 14,155 | 416 | 15,055 | 29,389 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | 63,364 | 63,364 | 77,519 | 77,935 | 92,990 | 122,379 |
| Lost Hills WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| Metropolitan WD of So. Calif. | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| OlceseWD/Hacienda WD | | | | | | | | | |
| Recharge/Purchase | 24,328 | | 52,604 | 4,465 | 14,266 | | | | 56,197 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | 24,328 | 24,328 | 76,932 | 81,397 | 95,663 | 95,663 | 95,663 | 95,663 | 151,860 |
| Semitropic WSD | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| State of California | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| Tejon-Castac WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | | |
| Wheeler Ridge-Maricopa WSD | | | | | | | | | |
| Recharge/Purchase | | | | 5,600 | | | | | |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 |
| Total of All Accounts | | | | | | | | | |
| Recharge/Purchase | 134,971 | 14,418 | 121,408 | 85,532 | 76,644 | 127,535 | 16,474 | 15,457 | 172,520 |
| Recovery/Sale | | | (13,772) | (100,837) | | | (472) | (1,615) | |
| Storage Balance | 134,971 | 149,389 | 257,025 | 241,720 | 318,364 | 445,899 | 461,901 | 475,743 | 648,263 |

Table 24a (continued)
Kern County Water Agency
Summary of Ground Water Banking Activities

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | Total |
|--------------------------------------|---------|----------|----------|-----------|-----------|-----------|---------|----------|-----------|
| Belridge WSD | | | | | | | | | |
| Recharge/Purchase | | | | | | | 14,204 | 325 | 14,529 |
| Recovery/Sale | | | | | | | | (2,029) | (2,029) |
| Storage Balance | | | | | | | 14,204 | 12,500 | 12,500 |
| Buena Vista WSD | | | | | | | | | |
| Recharge/Purchase | | | | | | | 7,849 | | 58,283 |
| Recovery/Sale | (6,000) | (5,000) | (3,138) | (2,242) | (4,410) | (4,004) | | | (24,794) |
| Storage Balance | 44,434 | 39,434 | 36,296 | 34,054 | 29,644 | 25,640 | 33,489 | 33,489 | 33,489 |
| Berrenda Mesa WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | 7,936 | 6,568 | 24,004 |
| Recovery/Sale | | | | (9,500) | | | | (200) | (9,700) |
| Storage Balance | 9,500 | 9,500 | 9,500 | | | | 7,936 | 14,304 | 14,304 |
| Cawelo WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | 14,068 | | 14,068 |
| Recovery/Sale | | | | | | | | (44) | (44) |
| Storage Balance | | | | | | | 14,068 | 14,024 | 14,024 |
| City of Bakersfield | | | | | | | | | |
| Recharge/Purchase | 109 | | | | | | 32 | | 412,561 |
| Recovery/Sale | (656) | (5,432) | (2,859) | (23,318) | (57,159) | (30,266) | | (8,311) | (244,697) |
| Storage Balance | 295,177 | 289,745 | 286,886 | 263,568 | 206,409 | 176,143 | 176,175 | 167,864 | 167,864 |
| Improvement District No. 4 | | | | | | | | | |
| Recharge/Purchase | | | 3,500 | | | | 23,007 | 10,641 | 49,914 |
| Recovery/Sale | | | | | | (3,500) | | (100) | (3,600) |
| Storage Balance | 12,766 | 12,766 | 16,266 | 16,266 | 16,266 | 12,766 | 35,773 | 46,314 | 46,314 |
| Kern County Water Agency | | | | | | | | | |
| Recharge/Purchase | | | | | 44,131 | 6,450 | 5,542 | | 178,502 |
| Recovery/Sale | | | (16,105) | | (66,775) | (22,684) | | | (105,564) |
| Storage Balance | 122,379 | 122,379 | 106,274 | 106,274 | 83,630 | 67,396 | 72,938 | 72,938 | 72,938 |
| Lost Hills WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | 31,153 | 5,280 | 36,433 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | 31,153 | 36,433 | 36,433 |
| Metropolitan WD of So. Calif. | | | | | | | | | |
| Recharge/Purchase | | | | | | | 50,000 | | 50,000 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | 50,000 | 50,000 | 50,000 |
| OlceseWD/Hacienda WD | | | | | | | | | |
| Recharge/Purchase | 5,344 | 3,214 | | | 22,096 | 6,450 | | | 188,964 |
| Recovery/Sale | | | (873) | (99,405) | (23,496) | (6,450) | | (1,160) | (131,384) |
| Storage Balance | 157,204 | 160,418 | 159,545 | 60,140 | 58,740 | 58,740 | 58,740 | 57,580 | 57,580 |
| Semitropic WSD | | | | | | | | | |
| Recharge/Purchase | | | | | | | 19,972 | | 19,972 |
| Recovery/Sale | | | | | | | | (181) | (181) |
| Storage Balance | | | | | | | 19,972 | 19,791 | 19,791 |
| State of California | | | | | | | | | |
| Recharge/Purchase | 7,379 | | | 248,006 | | | | | 255,385 |
| Recovery/Sale | | | | | | (72,049) | | (12,458) | (84,507) |
| Storage Balance | 7,379 | 7,379 | 7,379 | 255,385 | 255,385 | 183,336 | 183,336 | 170,878 | 170,878 |
| Tejon-Castac WD | | | | | | | | | |
| Recharge/Purchase | | | | | | | | 70 | 70 |
| Recovery/Sale | | | | | | | | | |
| Storage Balance | | | | | | | | 70 | 70 |
| Wheeler Ridge-Maricopa WSD | | | | | | | | | |
| Recharge/Purchase | | | 15,019 | | | | 58,290 | | 78,909 |
| Recovery/Sale | | | | | | | | (7,551) | (7,551) |
| Storage Balance | 5,600 | 5,600 | 20,619 | 20,619 | 20,619 | 20,619 | 78,909 | 71,358 | 71,358 |
| Total of All Accounts | | | | | | | | | |
| Recharge/Purchase | 12,832 | 3,214 | 18,519 | 248,006 | 66,227 | 12,900 | 232,053 | 22,884 | 1,381,594 |
| Recovery/Sale | (6,656) | (10,432) | (22,975) | (134,465) | (151,840) | (138,953) | | (32,034) | (614,051) |
| Storage Balance | 654,439 | 647,221 | 642,765 | 756,306 | 670,693 | 544,640 | 776,693 | 767,543 | 767,543 |

Table 24b
Kern County Water Agency
City of Bakersfield 2,800 Acre Recharge Facility
Ground Water Banking Summary
Recharge/Purchase or Recovery/Sale by Year and Contracting Entity
(in acre-feet)

| Calendar Year | KCWA General Account | | | Wheeler Ridge-Maricopa WSD | | | Berrenda Mesa WD | | |
|---------------|-----------------------|-------------------|------------------------|----------------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
| | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance |
| 1981 | 29,812 | 0 | 29,812 | 5,600 | 0 | 5,600 | 9,500 | 0 | 9,500 |
| 1982 | 0 | 0 | 29,812 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1983 | 0 | 0 | 29,812 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1984 | 0 | 0 | 29,812 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1985 | 15,055 | 0 | 44,867 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1986 | 10,000 | 0 | 54,867 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1987 | 0 | 0 | 54,867 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1988 | 0 | 0 | 54,867 | 0 | 0 | 5,600 | 0 | 0 | 9,500 |
| 1989 | 0 | <i>16,105</i> (1) | 38,762 | <i>15,019</i> | 0 | 20,619 | 0 | 0 | 9,500 |
| 1990 | 0 | 0 | 38,762 | 0 | 0 | 20,619 | 0 | <i>9,500</i> (3) | 0 |
| 1991 | <i>42,096</i> | 33,316 | 47,542 | 0 | 0 | 20,619 | 0 | 0 | 0 |
| 1992 | <i>6,450</i> | 9,953 | 44,039 | 0 | 0 | 20,619 | 0 | 0 | 0 |
| 1993 | 5,542 | 0 | 49,581 | 50,273 | 0 | 70,892 | 2,224 | 0 | 2,224 |
| 1994 | 0 | 0 | 49,581 | 0 | 6,261 | 64,631 | 4,593 | 0 | 6,817 |
| | 108,955 | 59,374 | 49,581 | 70,892 | 6,261 | 64,631 | 16,317 | 9,500 | 6,817 |

| Calendar Year | Improvement District No. 4 | | | State of California | | | Cawelo WD | | |
|---------------|----------------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
| | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 12,766 | 0 | 12,766 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 0 | 0 | 12,766 | 7,379 | 0 | 7,379 | 0 | 0 | 0 |
| 1988 | <i>3,500</i> (2) | 0 | 16,266 | 0 | 0 | 7,379 | 0 | 0 | 0 |
| 1989 | 0 | 0 | 16,266 | 0 | 0 | 7,379 | 0 | 0 | 0 |
| 1990 | 0 | 0 | 16,266 | <i>107,505</i> | 0 | 114,884 | 0 | 0 | 0 |
| 1991 | 0 | 0 | 16,266 | 0 | 0 | 114,884 | 0 | 0 | 0 |
| 1992 | 0 | <i>3,500</i> | 12,766 | 0 | 14,878 | 100,006 | 0 | 0 | 0 |
| 1993 | 23,007 | 0 | 35,773 | 0 | 0 | 100,006 | 14,068 | 0 | 14,068 |
| 1994 | 10,641 | 100 | 46,314 | 0 | 12,458 | 87,548 | 0 | 44 | 14,024 |
| | 49,914 | 3,600 | 46,314 | 114,884 | 27,336 | 87,548 | 14,068 | 44 | 14,024 |

(1) Total of 1,086 AF owed by ID4 to KCWA General and delivered in 1991; 15,019 AF transferred to Wheeler Ridge-Maricopa WSD's account.

(2) Assignment of 3,500 AF from City of Bakersfield ground water storage to ID4 on behalf of Kern-Tulare WD (2,800 AF) and Rag Gulch WD (700 AF).

(3) Transferred to DWR as part of 1990 Demonstration Program.

Note: Purchases and sales are shown as italicized and larger.

Table 24b (continued)
Kern County Water Agency
City of Bakersfield 2,800 Acre Recharge Facility
Ground Water Banking Summary
Recharge/Purchase or Recovery/Sale by Year and Contracting Entity
(in acre-feet)

| Calendar Year | Lost Hills WD | | | Belridge WSD | | | Tejon-Castac WD | | |
|---------------|-----------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
| | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 2,035 | 0 | 2,035 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 0 | 0 | 2,035 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 26,705 | 0 | 28,740 | 10,437 | 0 | 10,437 | 0 | 0 | 0 |
| 1994 | 4,922 | 0 | 33,662 | 325 | 1,197 | 9,565 | 70 | 0 | 70 |
| | 33,662 | 0 | 33,662 | 10,762 | 1,197 | 9,565 | 70 | 0 | 70 |

| Calendar Year | Semitropic WSD | | | Total of All Accounts | | |
|---------------|-----------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
| | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance |
| 1981 | 0 | 0 | 0 | 44,912 | 0 | 44,912 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 44,912 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 44,912 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 44,912 |
| 1985 | 0 | 0 | 0 | 15,055 | 0 | 59,967 |
| 1986 | 0 | 0 | 0 | 22,766 | 0 | 82,733 |
| 1987 | 0 | 0 | 0 | 7,379 | 0 | 90,112 |
| 1988 | 0 | 0 | 0 | 3,500 | 0 | 93,612 |
| 1989 | 0 | 0 | 0 | 15,019 | 16,105 | 92,526 |
| 1990 | 0 | 0 | 0 | 107,505 | 9,500 | 190,531 |
| 1991 | 0 | 0 | 0 | 44,131 | 33,316 | 201,346 |
| 1992 | 0 | 0 | 0 | 6,450 | 28,331 | 179,465 |
| 1993 | 19,972 | 0 | 19,972 | 152,228 | 0 | 353,574 |
| 1994 | 0 | 181 | 19,791 | 20,551 | 20,241 | 179,775 |
| | 19,972 | 181 | 19,791 | 439,496 | 107,493 | 179,775 |

Table 24c
Kern County Water Agency
Berrenda Mesa Spreading Grounds
Ground Water Banking Summary
Recharge/*Purchase* or Recovery/*Sale* by Year and Contracting Entity
(in acre-feet)

| Calendar Year | KCWA General Account | | | Wheeler Ridge-Maricopa WSD | | | Berrenda Mesa WD | | |
|---------------|-------------------------------|---------------------------|------------------------|-------------------------------|---------------------------|------------------------|-------------------------------|---------------------------|------------------------|
| | <i>Recharge/ Purchase</i> | <i>Recovery/ Sale</i> | Recoverable Balance | <i>Recharge/ Purchase</i> | <i>Recovery/ Sale</i> | Recoverable Balance | <i>Recharge/ Purchase</i> | <i>Recovery/ Sale</i> | Recoverable Balance |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 14,155 | 0 | 14,155 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 416 | 0 | 14,571 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 0 | 0 | 14,571 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 19,389 | 0 | 33,960 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 0 | 0 | 33,960 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 0 | 0 | 33,960 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 0 | 0 | 33,960 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0 | 0 | 33,960 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0 | 15,298 | 18,662 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 0 | 0 | 18,662 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | 18,662 | 8,017 | 0 | 8,017 | 5,712 | 0 | 5,712 |
| 1994 | 0 | 0 | 18,662 | 0 | 1,290 | 6,727 | 1,975 | 200 | 7,487 |
| | 33,960 | 15,298 | 18,662 | 8,017 | 1,290 | 6,727 | 7,687 | 200 | 7,487 |

| Calendar Year | Lost Hills WD | | | Belridge WSD | | | Total of All Accounts | | |
|---------------|-------------------------------|---------------------------|------------------------|-------------------------------|---------------------------|------------------------|-------------------------------|---------------------------|------------------------|
| | <i>Recharge/ Purchase</i> | <i>Recovery/ Sale</i> | Recoverable Balance | <i>Recharge/ Purchase</i> | <i>Recovery/ Sale</i> | Recoverable Balance | <i>Recharge/ Purchase</i> | <i>Recovery/ Sale</i> | Recoverable Balance |
| 1981 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 14,155 | 0 | 14,155 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 416 | 0 | 14,571 |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14,571 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 19,389 | 0 | 33,960 |
| 1987 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33,960 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33,960 |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33,960 |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33,960 |
| 1991 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15,298 | 18,662 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18,662 |
| 1993 | 4,448 | 0 | 4,448 | 3,767 | 0 | 3,767 | 21,944 | 0 | 40,606 |
| 1994 | 358 | 0 | 4,806 | 0 | 832 | 2,935 | 2,333 | 2,322 | 18,673 |
| | 4,806 | 0 | 4,806 | 3,767 | 832 | 2,935 | 58,237 | 17,620 | 18,673 |

Note: Purchases and sales are shown as italicized and larger.

Table 24d
Kern County Water Agency
Kern River Channel Within Improvement District No. 4
Ground Water Banking Summary
Recharge and Recovery Accounting
(in acre-feet)

| Calendar Year | Recharge | | | Recovery | | | Recoverable Balance | | |
|---------------|---------------|---------------------|---------------|---------------|---------------------|---------------|---------------------|---------------------|--------------|
| | SWP | Imported Floodwater | Total | SWP | Imported Floodwater | Total | SWP | Imported Floodwater | Total |
| 1981 | 33,552 | 0 | 33,552 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1984 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1985 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1986 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1987 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | 33,552 | 0 | 33,552 |
| 1991 | 0 | 0 | 0 | 18,161 | 0 | 18,161 | 15,391 | 0 | 15,391 |
| 1992 | 0 | 0 | 0 | 12,731 | 0 | 12,731 | 2,660 | 0 | 2,660 |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 2,660 | 0 | 2,660 |
| 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 2,660 | 0 | 2,660 |
| | 33,552 | 0 | 33,552 | 30,892 | 0 | 30,892 | 2,660 | 0 | 2,660 |

Table 24e
Department of Water Resources, Kern Water Bank
Ground Water Banking Summary
Recharge and Recovery Accounting
(in acre-feet)

| Calendar Year | Contracting Entity or Location | | | | | | | | | | Total |
|---------------|--------------------------------|---------------------------------|-----------|---------------|------------------|----------------|----------------|------------------------|----------------|--------------|----------------|
| | Buena Vista WSD | City of Bakersfield 2,800 Acres | KCWA ID#4 | Kern Delta WD | Kern Fan Element | La Hacienda WD | North Kern WSD | Rosedale-Rio Bravo WSD | Semitropic WSD | West Kern WD | |
| 1987 | 0 | 7,379 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,379 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 20,000 | 9,500 ## | 0 | 7,500 | 0 | 98,005 | 0 | 7,500 | 105,500 | 0 | 248,006 |
| 1991 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | (9,300) | 0 | 0 | (2,814) | 0 | (14,878) | 0 | (3,558) | (41,499) | 0 | (72,049) |
| 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 0 | 0 | (12,458) | 0 | 0 | 0 | 0 | (12,458) |
| | 10,700 | 16,879 | 0 | 4,686 | 0 | 70,669 | 0 | 3,942 | 64,001 | 0 | 170,878 |

(1) Transfer of storage account from Berrenda Mesa WD to DWR as a result of 1990 Demonstration Program.
Source: KCWA records.

Table 24f
Ground Water Banking Summary
City of Bakersfield 2,800 Acre Recharge Facility*
Contracting Entities Other Than KCWA or DWR
Recharge/Purchase and Recovery/Sale
(in acre-feet)

| Calendar Year | City of Bakersfield | | Olcese/Hacienda WD | | Buena Vista WSD | | Total Banking | | Storage Balance |
|------------------|---------------------|------------------|--------------------|------------------|-----------------|-----------------|----------------|------------------|--------------------|
| | Recharge | Extraction | Recharge | Extraction | Recharge | Extraction | Recharge | Extraction | |
| 1978 | 104,587 | | 24,328 | | 6,056 | | 134,971 | 0 | 134,971 |
| 1979 | 4,505 | | | | 9,913 | | 14,418 | 0 | 149,389 |
| 1980 | 68,804 | (13,772) | 52,604 | | | | 121,408 | (13,772) | 257,025 |
| 1981 | 2,603 | (100,837) | 4,465 | | | | 7,068 | (100,837) | 163,256 |
| 1982 | 37,913 | | 14,266 | | 24,465 | | 76,644 | 0 | 239,900 |
| 1983 | 113,380 | | | | | | 113,380 | 0 | 353,280 |
| 1984 | 16,058 | (472) | | | | | 16,058 | (472) | 368,866 |
| 1985 | 402 | (1,615) | | | | | 402 | (1,615) | 367,653 |
| 1986 | 64,168 | | 56,197 | | 10,000 | | 130,365 | 0 | 498,018 |
| 1987 | 109 | (656) | 5,344 | | | (6,000) | 5,453 | (6,656) | 496,815 |
| 1988 | | (5,432) | 3,214 | | | (5,000) | 3,214 | (10,432) | 489,597 |
| 1989 | | (2,859) | | (873) | | (3,138) | 0 | (6,870) | 482,727 |
| 1990 | | (23,318) | | (104,305) | | (2,242) | 0 | (129,865) | 352,862 |
| 1991 | | (57,159) | 22,096 | (23,496) | | (4,410) | 22,096 | (85,065) | 289,893 |
| 1992 | 0 | (30,266) | 6,450 | (6,450) | 0 | (4,004) | 6,450 | (40,720) | 318,592 |
| 1993 | 32 | 0 | 0 | 0 | 7,849 | 0 | 7,881 | 0 | 360,743 |
| 1994 | 0 | (8,311) | 0 | (1,160) | 0 | 0 | 0 | (9,471) | 280,422 |
| | 412,561 | (244,697) | 188,964 | (136,284) | 58,283 | (24,794) | 659,808 | (405,775) | 280,422 |

* A more detailed breakdown is provided in the City of Bakersfield 2,800 Acre Recharge Facility Report.

Source: City of Bakersfield 2,800 Acre Recharge Facility 1991 Report.

Table 24g
Ground Water Banking Summary
Semitropic Water Storage District
Recharge/Purchase and Recovery/Sale
(in acre-feet)

| Calendar Year | Department of Water Resources | | | Metropolitan WD of So. California | | | Total of All Accounts | | |
|---------------|-------------------------------|-------------------|------------------------|-----------------------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
| | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance | Recharge/ Purchase | Recovery/ Sale | Recoverable Balance |
| 1978 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1979 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1980 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1981 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1982 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1983 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1984 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1985 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1986 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1987 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1988 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1989 | | | 0 | | | 0 | 0 | 0 | 0 |
| 1990 | 105,500 | | 105,500 | | | 0 | 105,500 | 0 | 105,500 |
| 1991 | | | 105,500 | | | 0 | 0 | 0 | 105,500 |
| 1992 | | 41,499 | 64,001 | | | 0 | 0 | 41,499 | 64,001 |
| 1993 | | | 105,500 | 50,000 | | 50,000 | 50,000 | 0 | 155,500 |
| 1994 | 0 | | 64,001 | 0 | | 0 | 0 | 0 | 64,001 |
| | 105,500 | 41,499 | 64,001 | 50,000 | 0 | 50,000 | 155,500 | 41,499 | 114,001 |

and recovery site for many years, where KCWA and others have deposited water.

During 1992 KCWA purchased 2,400 acres of land to develop additional water recharge and banking facilities. Named the Pioneer Spreading Grounds, the property comprises two parcels located southwest of Bakersfield. One parcel lies just north of the Kern River, and the other lies just south. Once completed, the Pioneer Spreading Grounds will increase Kern County's ground water recharge capacity by about 170,000 acre-feet annually.

Tables 24a-24g outline the banking account balances for those entities who are involved in various banking programs. These tables are detailed summaries of the banking portion of Table 23, and include recharge, extractions and transfer/sales of banking accounts.

Shallow Ground Water

When the downward movement of water is intercepted by shallow clay beds or strata of low permeability, shallow ground water accumulations result. These accumulations generally are undesirable in farming operations if the water reaches the crop root zone. Poor crop yield, soil salt buildup and farm equipment bogging in poorly drained fields are all symptoms of shallow ground water problems.

The areas suffering from shallow ground water in Kern County follow the historic lower-elevation trace of the Kern River channel. Increases in shallow ground water area appear after a year of high Kern River runoff. Similarly, contractions seem to occur during years when runoff is low. In this sense, shallow ground water may be a natural phenomenon. Table 25 lists historic areas with shallow ground water problems, categorized into five foot increments, along with the number of monitoring wells measured. At first glance, it may seem that an enormous increase in shallow water area occurred between 1979 and 1980, and again in 1993. It is likely that these increases reflect the expansion of the monitoring grids of KCWA and cooperating districts rather than a true expansion of the shallow ground water area. During 1992-93 the Buena Vista Water Storage District and Lost Hills Water District both expanded their shallow ground water monitoring programs. As a result, the number of data points increased from 344 (in 1992) to 518 (in 1993). As

shown on Table 25 and Plate 1, expanding the grid has now allowed the eastern and western boundaries of the shallow ground water areas to be fairly well defined. Monitoring wells located in these areas are consistently dry. The expanded grid has also resulted in better definition of the 0-5 feet interval.

Depth to shallow ground water as measured in shallow monitoring wells is contoured on Plate 1. In the summer of 1994 water within five feet of the ground surface was found under an area of about 19,000 acres. This was a 24 percent decrease from the summer of 1993 area. The area of shallow ground water between 5-10 feet of the ground surface was about 107,000 acres, about nine percent more than the previous year. The area with shallow ground water between 10-15 feet of the surface was 69,000 acres in 1994, a 48 percent increase over 1993. The total area with shallow ground water between ground surface and 15 feet of depth increased about 15 percent from 1993. Likely this increase reflects the lingering effects of the wet 1993 winter.

Ground Water Quality

The ground water basin in the Kern County portion of the San Joaquin Valley is a basin of interior drainage. It has no appreciable surface or subsurface outflow, except in extremely wet years. Therefore, new salts introduced into the basin with imported water supplies are retained in the basin. The ground water is the recipient of these salts via recharge waters or return flows from irrigation and urban users.

Surface water supplies over the usable ground water basin in 1994 (some 1,240,400 acre-feet) carried about 321,300 tons of new salts into the ground water basin. This quantity of salt was about half the amount that was introduced in 1993, reflecting the lower delivery of surface water. It should be noted that SWP water carries about twice as much salt as local supplies. Following is a table of salt loads by surface water source for 1994:

Table 25
Areal Extent of Shallow Ground Water
(in acres)

| Year | Summer Measurements | | | | | | Winter Measurements | | | | | |
|------|---------------------|----------|-----------|-------------|---------------------|----------------|---------------------|----------|-----------|------------|---------------------|----------------|
| | 0-5 ft. | 5-10 ft. | 10-15 ft. | 15-20 ft. | Total Within 20 ft. | No. of Piezo's | 0-5 ft. | 5-10 ft. | 10-15 ft. | 15-20 ft. | Total Within 20 ft. | No. of Piezo's |
| 1976 | 27,940 | 64,700 | -- | 79,680 (1) | 172,320 | -- | -- | -- | -- | -- | -- | -- |
| 1977 | 19,320 | 68,980 | -- | 95,960 (1) | 184,260 | 180 | 16,930 | 52,530 | -- | 67,300 (3) | 136,760 | 143 |
| 1978 | 27,680 | 65,760 | -- | 87,920 (1) | 181,360 | 174 | 9,600 | 59,520 | -- | 86,400 (3) | 155,520 | -- |
| 1979 | 30,270 | 67,310 | -- | 95,870 (1) | 193,450 | -- | 15,320 | 83,200 | -- | 80,640 (3) | 179,160 | 126 |
| 1980 | 74,357 | 82,787 | -- | 125,883 (1) | 283,027 | -- | 45,882 | 92,998 | 126,665 | 62,578 | 328,123 | 154 |
| 1981 | 62,002 | 85,556 | -- | 128,323 (1) | 275,881 | 178 | 46,746 | 75,318 | 36,736 | 104,200 | 263,000 | 168 |
| 1982 | 78,725 | 95,615 | 76,271 | 30,226 | 280,837 | 259 | 90,658 | 85,541 | 55,392 | 43,181 | 274,772 | 199 |
| 1983 | 109,915 | 90,090 | 63,510 | 48,980 | 312,495 | 227 | -- | -- | -- | -- | -- | -- |
| 1984 | 110,500 | 57,650 | 45,400 | 47,649 | 261,199 | 246 | -- | -- | -- | -- | -- | -- |
| 1985 | 49,396 | 120,396 | 123,776 | 90,323 | 383,891 | 290 | -- | -- | -- | -- | -- | -- |
| 1986 | 84,160 | 79,774 | 73,698 | 83,264 | 320,896 | 330 | -- | -- | -- | -- | -- | -- |
| 1987 | 57,600 | 84,864 | 89,816 | 76,672 | 308,952 | 261 | 90,800 | 74,100 | 61,200 | 72,200 | 298,300 | -- |
| 1988 | 82,700 | 86,500 | 83,900 | 93,400 | 346,500 | 288 | -- | -- | -- | -- | -- | -- |
| 1989 | 65,536 | 95,949 | 83,558 | 85,760 | 330,803 | 328 | -- | -- | -- | -- | -- | -- |
| 1990 | 67,561 | 91,257 | 82,823 | -- (2) | 241,641 | 350 | -- | -- | -- | -- | -- | -- |
| 1991 | 40,363 | 101,888 | 45,141 | -- (2) | 187,392 | 351 | -- | -- | -- | -- | -- | -- |
| 1992 | 9,954 | 102,114 | 46,287 | -- (2) | 158,355 | 344 | -- | -- | -- | -- | -- | -- |
| 1993 | 25,184 | 97,357 | 46,893 | -- (2) | 169,434 | 518 | -- | -- | -- | -- | -- | -- |
| 1994 | 19,176 | 106,506 | 69,362 | -- (2) | 195,044 | 422 | -- | -- | -- | -- | -- | -- |

(1) 10-20 ft. measurement.

(2) Data insufficient to establish a 20 foot contour. Total is area within 15 feet.

(3) No 15 foot contour established. Total is within 20 feet.

-- Data not available.

Note: Annual changes in shallow ground water area may be perceived rather than real, due to increases in the number of monitoring wells used to prepare the maps. More monitoring wells may have provided better coverage, allowing for a more accurate map to be produced.

Surface Water Salt Loads, 1994

| <u>Source</u> | <u>Volume</u> (AF) | <u>Avg. TDS</u> (ppm) | <u>Salt Load</u> (Tons) |
|-----------------------|-----------------------|--------------------------|----------------------------|
| SWP Over GW Basin | 426,800 | 371 | 215,100 |
| Kern River | 425,100 | 79 | 45,900 |
| Minor Streams | 36,800 | 364 | 18,200 |
| Other Local Supplies* | 165,400 | 142 | 31,900 |
| CVP | 186,300 | 40 | 10,200 |
| Total | 1,240,400 | 191 | 321,300 |

* Includes effective rainfall, oil field waste water.

Ground water pumped and used for irrigation becomes degraded as salts are leached from the crop root zones. A portion (averaging about 25 percent in this basin) of applied water percolates through the soil profile to the ground water. This smaller volume of water carries the salts once held by the total volume applied. The result is a concentration of the salts. The construction of local drainage projects would help reduce this buildup of salts by removing some near-surface accumulations in the shallow ground water areas. In areas of interior drainage such as Kern County the sustained large-scale importation of water and large-scale agriculture, unless properly managed, will eventually result in the degradation of ground water supplies. This is a normal by-product of water use, whether for agricultural or urban purposes. A great challenge for water leaders is to relieve the contamination of our precious ground water by improved water management, including salt management.

Chemical analyses of well water samples collected over the years have been used as a basis for drafting the water quality maps in this report. Plate 2 illustrates the variations in ground water quality samples taken from the unconfined water system, as revealed by the total dissolved solids (TDS) obtained. TDS are shown in parts per million (ppm). These are generally shallow wells, usually less than 400 feet. Higher salt contents are prevalent in the west side areas and in an area west of Delano.

Plate 3 is a compilation of data from water wells producing from the confined or lower aquifer system, as the system was understood in 1989. Data from many recent studies strongly suggests that the area of confinement is smaller than what was understood in 1989. The lower system is partially protected from surface contaminants by the Corcoran Clay. Contours on this map show the ground water quality of the lower aquifer

to be superior to that of the unconfined zone.

Agricultural water well drilling increased during 1994 compared to activity in 1993. A total of 61 agricultural water well permits were issued by the Kern County Environmental Health Services Department during 1994. Comparatively, a total of 32 permits were issued during 1993. The increase in drilling activity was largely due to the decreased allocations of surface water in 1994. Wells were drilled in the following water districts:

| | <u>No. of Wells</u> |
|------------------------------|---------------------|
| Arvin-Edison WSD | 1 |
| Antelope Valley-East Kern WA | 1 |
| Belridge WSD | 1 |
| Buena Vista WSD | 6 |
| Cawelo WD | 1 |
| Kern Delta WD | 3 |
| North Kern WSD | 2 |
| Rosedale-Rio Bravo WSD | 1 |
| Semitropic WSD | 27 |
| Shafter-Wasco ID | 2 |
| Southern San Joaquin MUD | 6 |
| Wheeler Ridge-Maricopa WSD | 1 |
| Unorganized areas | 9 |
| Total | 61 |

Annular seals were required in six of the new wells to prevent degradation of lower ground water zones. Annular seals are plugs of cement between the well casing and the drilled hole next to a regional stratum of low permeability. From the origin of the Kern County Water Well Ordinance in 1981 to the end of 1994 a total of 674 agricultural water wells have been constructed, of which 212 required annular seals.

Ground Water Levels

Plate 4, "Depth to Ground Water, Spring 1995" was prepared by KCWA using hundreds of well measurements taken by KCWA and others. The water depths are plotted and contoured to aid in the evaluation of ground water trends. Control wells include unconfined and some composite aquifer wells throughout most the basin. In areas north of Wasco water levels in confined wells are used for contouring because they best represent the aquifer most utilized. The "Depth to Ground

Water” map shows the distances in feet from the ground surface to the water surface.

A “Ground Water Surface Elevation” map (Plate 5) was prepared based on the same measured wells as the “Depth to Ground Water” map. This map implies the horizontal movement of ground water from higher to lower elevations. The major direction of ground water movement is away from the sources of recharge.

Plate 5 shows what appears to be steep gradients between Semitropic Water Storage District and neighboring Buena Vista Water Storage District, Lost Hills Water District and Southern San Joaquin Municipal Utility District. Contours in these areas are based on both unconfined and confined wells. These apparent steep gradients are explained by the differences in water level between the unconfined and confined aquifers.

Historically, the Kern River has been the major ground water recharge source. Mounding of water occurs along the Kern River channel, and ground water moves away from this area. In this area, the rate of horizontal ground water flow in the upper portions of the aquifer is 70-500 feet per year. Another high area is along the northeastern edge of the valley. Also, some local mounding is attributed to local water district’s recharge efforts.

Generally, ground water level lows are associated with areas of higher ground water pumping. The largest of these areas is in the central portion of the valley (west/northwest of Wasco). Other low areas are in the extreme south end of the valley and in the Arvin area.

Plate 6 depicts ground water level changes from Spring 1994 to Spring 1995. Differences were plotted and contoured to show areas of relative improvement or decline. Color was added to emphasize significant level changes.

Unless the annual change exceeds 10 feet, little impact (either losses or gains) to storage can be inferred. The potential error related to the timing of ground water level measurements and simple measuring errors preclude more precision.

Ground water level declines greater than 10 feet exist throughout much of Semitropic Water Storage District, with the largest declines surrounding the Wasco area. Declines were also noted in the Shafter-Wasco

Irrigation District, North Kern Water Storage District and Cawelo Water District. South of the Kern River, in areas served by the Kern Island canal, ground water levels improved by more than 10 feet.

Water level changes in eight key water wells are displayed on hydrographs as Figures 19a, 19b, 19c and 19d. Each hydrograph represents water levels for a pair of wells, one unconfined and the other confined. One well pair is located in the Pond-Poso area. Another pair is between Shafter and Rosedale-Rio Bravo. A third pair of wells is southwest of Bakersfield. The fourth pair of wells is in the Arvin area.

The two wells in the Pond-Poso area represent the unconfined and confined aquifer systems in the area. The hydrographs are plotted together to compare water level changes in both aquifers. The unconfined well reflects an upward trend since the 1977 drought. This trend is probably a continuation of a long-term rise in water levels, caused by surface water deliveries from the Friant-Kern system. During 1990-92 drought conditions were more severe, with an increased dependence on ground water. The recent decline in water levels reflects the expanded use of ground water during the drought. The confined well shows a steady rise of water levels from the 1977 drought up through 1987. This confined well shows a more rapid and marked response to the recent drought than did the unconfined well.

The Shafter/Rosedale-Rio Bravo area hydrographs represent the unconfined aquifer. The Rosedale-Rio Bravo well (T29S/R26E-34Q) is near the Kern River channel. The hydrograph reflects a long-term decline in water levels from 1960 through the 1977 drought, with transient rises during years when Kern River flows were above normal. Since these wells are situated close to the Kern River channel and ground water recharge facilities, the hydrographs show rapid water level rises during the 1978-86 wet period and dramatic declines during the 1987-92 drought.

The more moderate ground water level changes in the Shafter well (T28S/R25S-32F1) reflect the greater distance from the main area of ground water recharge. The Shafter well appears to be at the southeastern terminus of the Corcoran Clay. Present water level data suggests that no confined aquifer exists easterly and southerly of this location. Deep wells in these areas show annual ground water levels and fluctuations that are consistent with the shallow wells. Con-

Figure 19a
Water Well Hydrograph
Pond-Poso Area

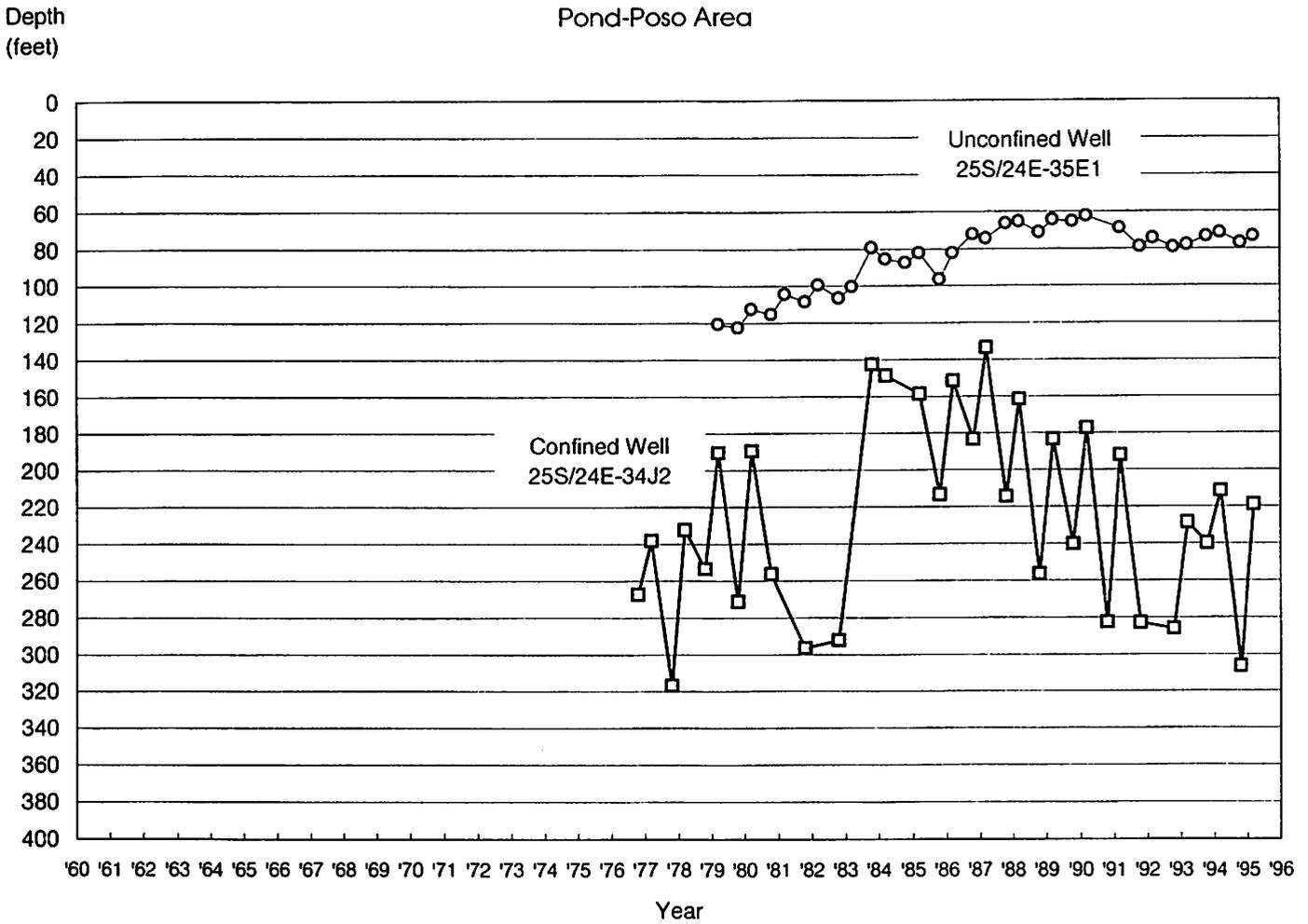


Figure 19b
 Water Well Hydrograph
 Shaffer/Rosedale-Rio Bravo Area

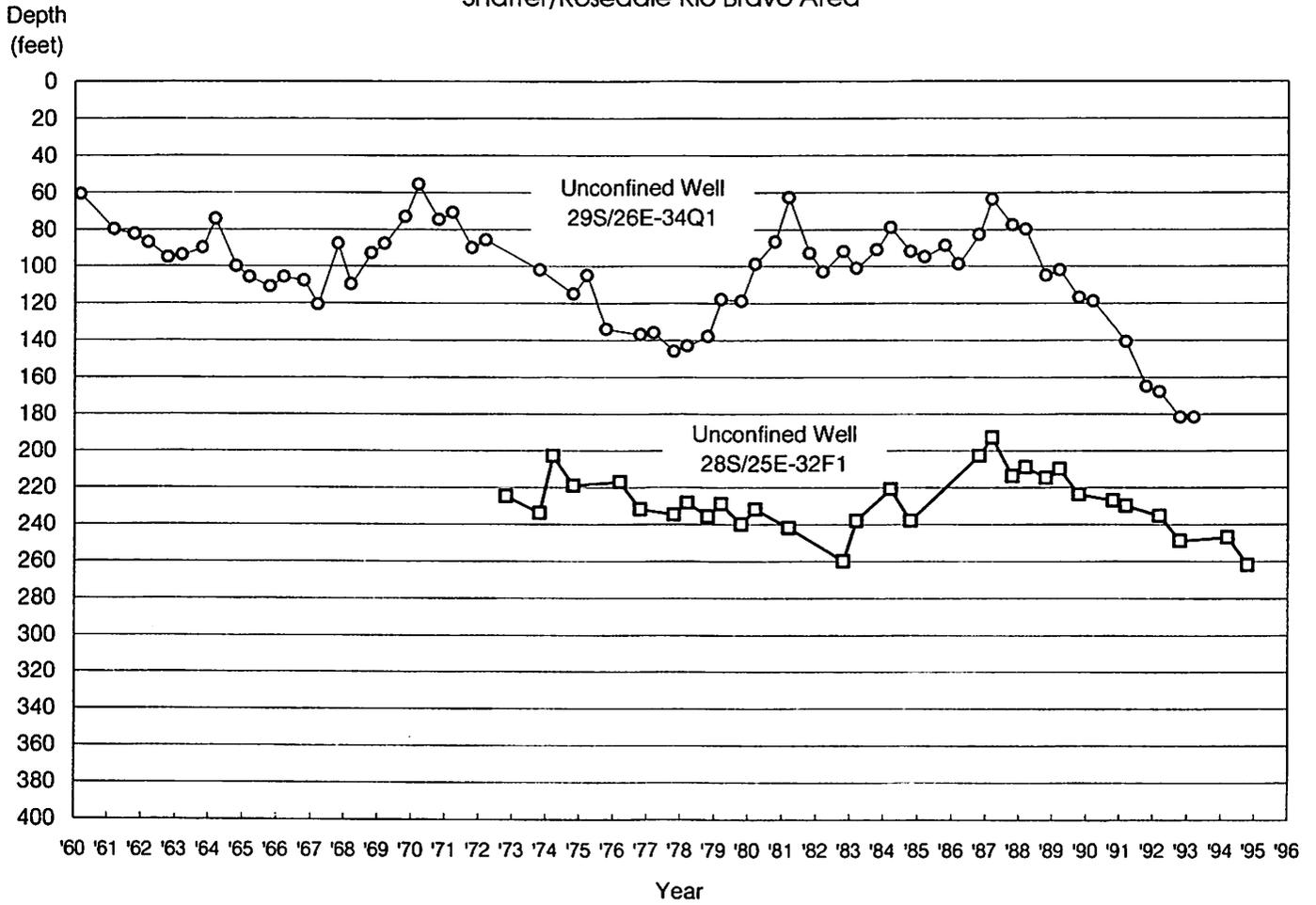


Figure 19c
 Water Well Hydrograph
 Southwest Bakersfield Area

Depth
 (feet)

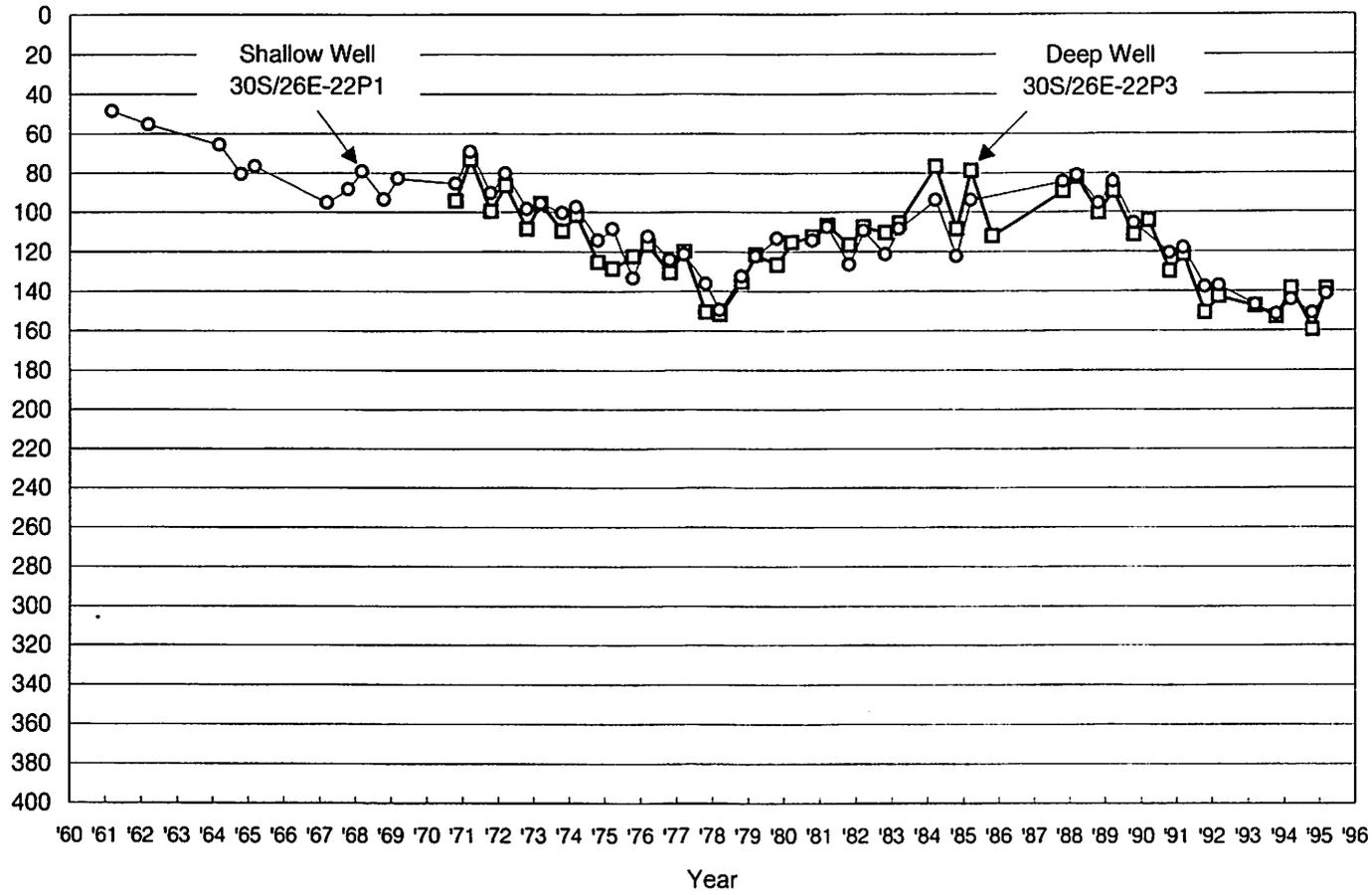
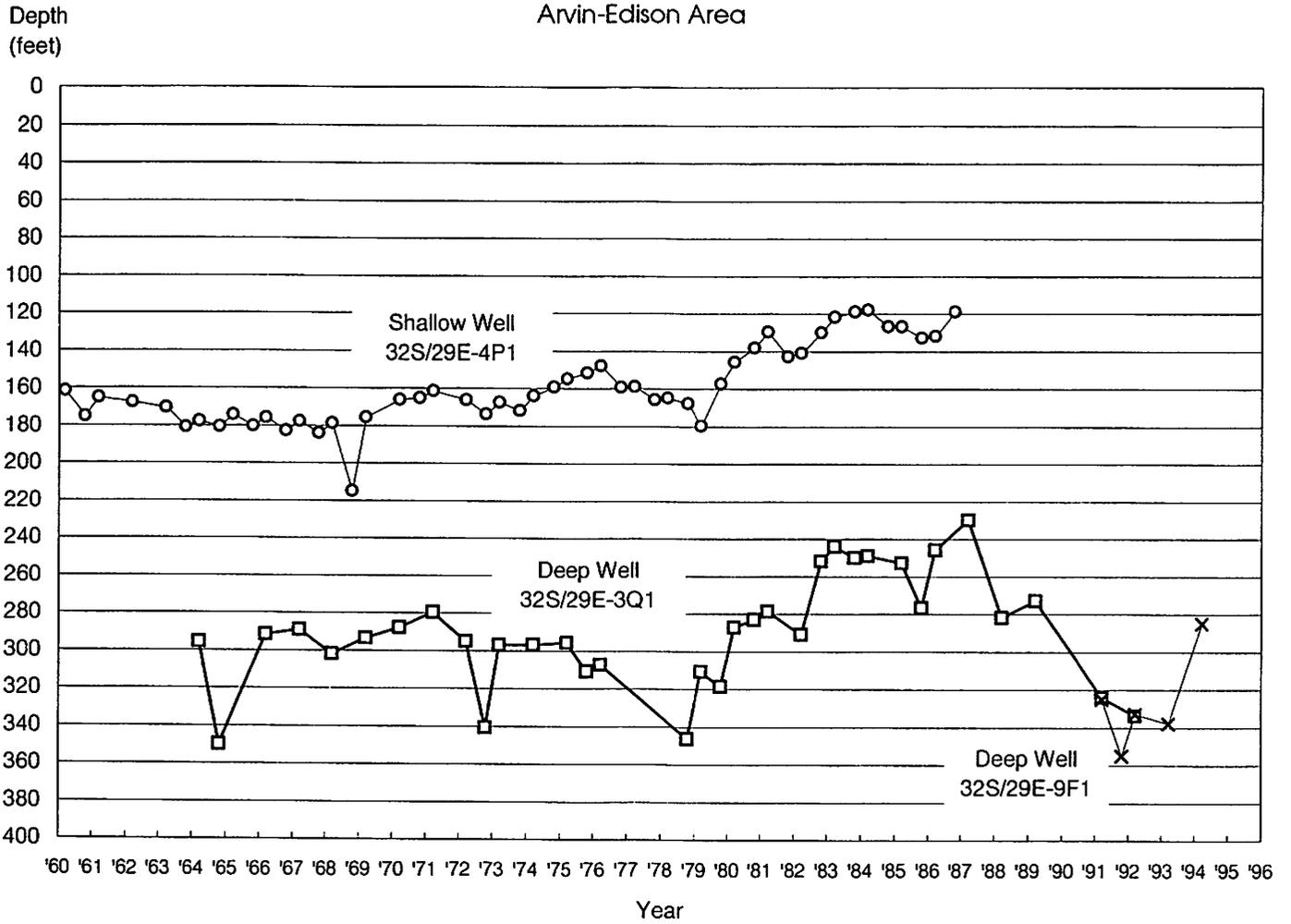


Figure 19d
Water Well Hydrograph
Arvin-Edison Area



fined and unconfined aquifers usually exhibit characteristic differences in seasonal ground water level changes.

The southwest Bakersfield hydrograph shows continual declines until 1978. The wet period of 1978-86 shows up as a rise in water level. The 1987-92 drought shows a dramatic rate of water level decline.

In prior years these two wells were designated as unconfined and confined, respectively. However, similar ground water levels in both wells over a long period suggests that a classic confined aquifer may not exist in this area. Analysis of wells to the north seems to corroborate this interpretation. On Figure 19c these wells are simply called the shallow well and deep well.

The Arvin-Edison area wells are similarly designated as shallow (T32S/R29E-04P1) and deep (T32S/R29E-03Q1). The Arvin-Edison deep well may be confined. It has shown annual variabilities of ground water levels more consistent with a confined aquifer than unconfined. The large difference in ground water levels in the two wells also suggests that a minimum of two aquifers exist in this area.

The delivery of CVP water to Arvin-Edison in the mid-1960s caused ground water levels to rise, as seen in the shallow well hydrograph. During the drought of 1977 ground water levels declined. The deep well showed rising ground water levels from 1978-86. The recent six-year drought has resulted in ground water levels declining to near 1977 levels in this well.

Indian Wells Valley

Indian Wells Valley is located in the northeast corner of Kern County. The valley floor encompasses about 300 square miles. The valley is surrounded by the southern Sierra Nevada Mountains on the west, the Coso Range on the north, the Argus Mountains on the east and the El Paso Mountains on the south. Elevations on the valley floor are around 2,300 feet above sea level, while surrounding mountains may reach 9,000 feet. The largest community in the valley is the city of Ridgecrest, with a population of about 30,000. The valley is an arid desert, with rainfall of only 3-4 inches per year. Little rainfall reaches the ground water table; it is rapidly evaporated by the high winds or transpired by desert plants. Presently, the only source

of potable water is ground water. Most of the contributions to the ground water basin come from the higher elevation Sierra Nevada mountains to the west.

Water level measurements for wells throughout the valley were the basis for Plate 7, "Depth to Ground Water, Indian Wells Valley" and Plate 8, "Ground Water Elevation, Indian Wells Valley." Plate 8 shows a broad pumping depression extending from Ridgecrest to beyond Inyokern (called the Ridgecrest-Inyokern pumping corridor). The depression has expanded by 29,000 acres since 1946. Comparatively, the population of the valley was about 15,000 in 1946, and about 63,000 today. At the center of the pumping depression ground water levels have declined as much as 45 feet since 1965. Presently the water table is declining by about 1.5 feet per year within the pumping depression, and 0.5 to 1.0 feet per year at the edges of the ground water basin.

Plate 9, "Ground Water Quality, Indian Wells Valley" shows the distribution of total dissolved solids (TDS) throughout the basin. The map represents a compilation of data acquired between 1980 and 1994 by the U.S. Geological Survey, KCWA, U.S. Bureau of Reclamation, Indian Wells Valley Water District and private well owners. The distribution of relatively good quality water (TDS less than 500 ppm) reflects the areas of recharge from adjacent mountains. The map shows the existence of very poor quality ground water (TDS greater than 2,000 ppm) in large portions of T25S/R39E and T25S/R40E, and in the eastern portion of T26S/R40E. To the southeast, south and southwest of Ridgecrest there is poor quality ground water (TDS greater than 1,000 ppm).

Focus: Kern Delta Water District

The Kern Delta Water District was formed in December 1965 to provide a public entity that could contract with KCWA for SWP water, and to protect the area's existing Kern River water rights. The district is located south of Bakersfield, and encompasses the historic Kern River delta and Kern Lake bed. The gross area of the district is 128,958 acres, with about 96,800 acres under cultivation in 1994. The potential irrigable area is estimated to be 106,800 acres. Elevations range from 415 feet above sea level in the east to 280 feet in the west part of the district, with the land gently sloping to the west and south. Soils in the area are excellent for agriculture. About 44 percent of the soils are Class I, 34 percent are Class II and 22 percent are Class III. The entire Kern Lake bed area and the historic south fork of the Kern River trace are underlain by shallow (perched) ground water in varying degrees of poor quality, requiring careful management practices to maintain agricultural productivity. The district's delivery facilities consist of 136 miles of unlined canals. Because they are unlined, the district's canals also serve as a primary ground water recharge source.

Kern Delta Water District encompasses the service areas of the Buena Vista, Stine, Farmers and Kern Island (including East Side) Canals, each of which has an appropriative right to Kern River flows. In 1967 these service areas were combined into the Kern Island Water Company. In 1976 all of the assets of the Kern Island Water Company were acquired by the district.

By virtue of the Kern River water rights acquired from the Kern Island Water Company, Kern Delta has high priorities for Kern River flows. On average, the Kern River rights provide the district with about 185,000 acre-feet of deliverable water. The district also has a contract with KCWA for 25,500 acre-feet annually of SWP Table 1 "Firm" water and 4,500 acre-feet of Table 1 "Surplus." To avoid the expense of new facilities to physically deliver its SWP water into the district, an agreement was reached with Buena Vista Water Storage District to exchange Kern Delta's SWP entitlement for an equal amount of Buena Vista's Kern River water. A small amount of SWP water is occasionally delivered to lands on the western edge of Kern Delta through Buena Vista's Maples Canal.

About 75,400 acres are capable of receiving surface water from the district's canals. The remaining lands

are served entirely with ground water. Recharge from the canals is a principle source of water for these ground water lands. On average, about 27 percent of Kern Delta's canal water infiltrates to ground water, or about 53,000 acre-feet annually. This makes Kern Delta one of the largest contributors to ground water recharge in Kern County. Average annual ground water pumping in the district is about 220,000 acre-feet.

The crops grown in Kern Delta can be grouped as follows:

| | |
|--------------|---------------------|
| Field Crops | 90% |
| Orchards | 1% |
| Vegetables | 4% |
| Vineyards | 5% |
| Total | 96,825 acres |

Table 26 shows irrigated acreage in Kern Delta Water District during 1994. The total gross value of the crops grown during 1994 is about \$138 million, which translates into about \$350 million for the regional economy. Cotton makes up half the irrigated acreage in the district, and accounts for about 35 percent of the gross crop value. The gentle slope and heavier soils make the area near-perfect for cotton production.

Table 26
1994 Irrigated Acreage
Kern Delta Water District

| Annual Crops | Acres |
|---------------------------|--------|
| Alfalfa | 19,997 |
| Carrots | 1,358 |
| Corn | 4,178 |
| Cotton | 48,323 |
| Dry Beans | 504 |
| Grains | 9,787 |
| Melons, Squash, Cucumbers | 550 |
| Misc. Annual Crops | 264 |
| Onions, Garlic | 1,529 |
| Pasture, Turf | 969 |
| Potatoes | 1,500 |
| Safflower | 1,214 |
| Sugar Beets | 781 |
| Tomatoes | 399 |
| Subtotal | 91,353 |

| | |
|------------------------|---------------|
| Permanent Crops | |
| Almonds | 287 |
| Apples | 192 |
| Grapes | 4,704 |
| Misc. Trees, Vines | 289 |
| Subtotal | 5,472 |
| Total | 96,825 |

In recent years the northern portion of the district has become more urbanized as the Bakersfield metropolitan area continues to expand. The loss of agricultural land is of concern to both Kern Delta and KCWA, but efforts continue to accommodate urban growth, monitor and avoid adverse impacts and meet the challenges of urban/ag coexistence.

Outlook: 1995

Things can change fast with California's water supply. After one of the driest years this century, it seemed as though another drought was developing in 1995. In December 1994 the state Department of Water Resources announced allocations of 40 percent of SWP entitlement for 1995. Federal CVP contractors were expecting 50 percent allocations. The Kern River was forecast to produce 81 percent of average runoff. Then an El Niño condition in the Pacific Ocean began to bombard the state with storms, dropping a record rainfall and snowpack.

During normal weather conditions, the winds and currents in the tropical south Pacific flow westward from South America to Australia. As the warm surface water is moved toward the western Pacific, nutrient-rich cold water from the Humboldt Current wells up along the coasts of Peru and Ecuador, producing one of the most abundant fisheries in the world. During El Niño conditions the winds and currents die or reverse direction, altering the food chain for fish and seabirds. Unusual amounts of heat energy are released into the atmosphere, evaporating huge amounts of water that later falls as rain or snow.

El Niño-spawned storms battered the entire state with torrential rains. Storage reservoirs seemingly filled overnight, and widespread flooding occurred in some northern and southern California areas. Particularly hard-hit was the Salinas Valley, the so-called "salad bowl" of California. Much of California's winter lettuce crop, grown in Salinas Valley, was destroyed by flooding. On January 11, 1995 Governor Pete Wilson declared 34 of the state's counties emergency areas, including Kern County. Statewide estimates of flood damage were more than \$2 billion, with \$360 million damage to the state's crops alone. In Kern County, high winds combined with saturated soils to blow over thousands of mature almond trees. Total damage in Kern County was estimated to be \$32 million, with \$22 million from crop losses. While this pales in comparison to the \$220 million crop loss in Monterey County, Kern County had the second worst crop loss in the state.

On March 10, 1995 a powerful storm system drenched the already-soaked state with rain. Flows on the rain-swollen Arroyo Pasajero Creek washed out two bridges over Interstate 5 in Fresno County, killing seven people

and nearly wiping out the California Aqueduct. The Aqueduct was breached by flood flows from Salt and Cantua Creeks. It was nearly swamped by water entering through the breach. Over 100 thick concrete panels lining the Aqueduct were washed away by the flood flows. About 27,000 acre-feet of water cascaded into the aqueduct, which quickly flowed downstream into Kern County. Water officials were gravely concerned that the water would overflow out of the canal in Kern County, wash away the dirt embankment and collapse the aqueduct. To deal with this emergency the Kern River Intertie gates were opened, and 15,000 acre-feet of water was allowed to reverse flow into the Kern River flood channel. (The Intertie was designed and built to introduce Kern River floodwaters into the California Aqueduct. In this emergency, the opposite was done.) Additionally, the Cross Valley Canal was purposefully breached near the Kern Water Bank to create a temporary turnout. The first reach of the CVC was allowed to fill to the top of its lining with the flood water and spill onto Kern Water Bank property, further reducing the emergency threat. All of this work took place in the middle of the night. Absent these quick actions by state and local water managers, portions of the California Aqueduct would have been destroyed and serious flood damages would have occurred in Kern County.

By the end of January 1995 SWP allocations were increased to 100 percent, or 1,153,400 acre-feet. CVP allocations were raised to 100 percent of Class I and Class II entitlements by March. Additionally, it is expected that some "Section 215" floodwater will be available. Total CVP deliveries are expected to be about 700,000 acre-feet. The Kern River is expected to yield 150 percent of normal supplies, or about 1,100,000 acre-feet. Minor stream flows are expected to be 65,000 acre-feet. Effective precipitation is expected to be about 300,000 acre-feet. Accordingly, total surface supplies in 1995 are expected to be about 3,300,000 acre-feet, over twice what was available in 1994. Much of this water is expected to be recharged to ground water.

Total water demands during 1994 are projected to be about 2,900,000 acre-feet. Irrigated acreage is expected to increase somewhat over 1994 because of ample water supplies received early in the growing season. Hence, irrigated acreage is projected to rise to

about 840,000 acres. Consumption or losses for all types of uses are estimated to be about 2,600,000 acre-feet. Thus, KCWA projects that a net increase in

ground water storage of about 700,000 acre-feet will occur in 1995. Such an increase will recover much of the negative change in storage that occurred in 1994.

Bay-Delta Accord

On December 15, 1994 the Bay-Delta Accord was signed by federal and state agencies that had been working to develop new Delta water quality standards. Also signing the historic Accord were public interest organizations, agricultural and urban water agencies that depend on Delta water. The three-year Accord provides an average of 300,000 acre-feet of additional Delta outflow, which could go up to as much as 900,000 acre-feet of additional outflow during dry years. Major benefits of the Accord are the elimination of so-called "take" limits (which have plagued the SWP and CVP for the past several years) in favor of operational guarantees, a moratorium on listing of additional Delta species as threatened or endangered

during the Accord's three-year life, a guarantee that no additional water will be taken from the SWP and CVP for fish and wildlife, and creation of a "Category III" process for resolving non-flow related factors that impact fish and wildlife.

The Bay-Delta Accord also established a program for defining a long-term comprehensive plan to restore ecological health and to improve water management and beneficial uses in the Bay-Delta system. This so-called CALFED Bay-Delta program is now under development. A more detailed discussion of the progress of this important program will be included in the 1995 Water Supply Report.

Monterey Principles

A second significant development during December 1994 was agreement on the Monterey Principles. The Monterey Principles resulted from protracted negotiations between urban and agricultural water suppliers and the state Department of Water Resources regarding various problems which had arisen in administration of the SWP due to environmental constraints. These Principles will substantially amend the water service contracts between the state Department of Water Resources and the SWP contractors. The Monterey Principles will provide for increased water supply reliability, lower costs, water transfers and more flexible operation of the SWP. Highlights of the

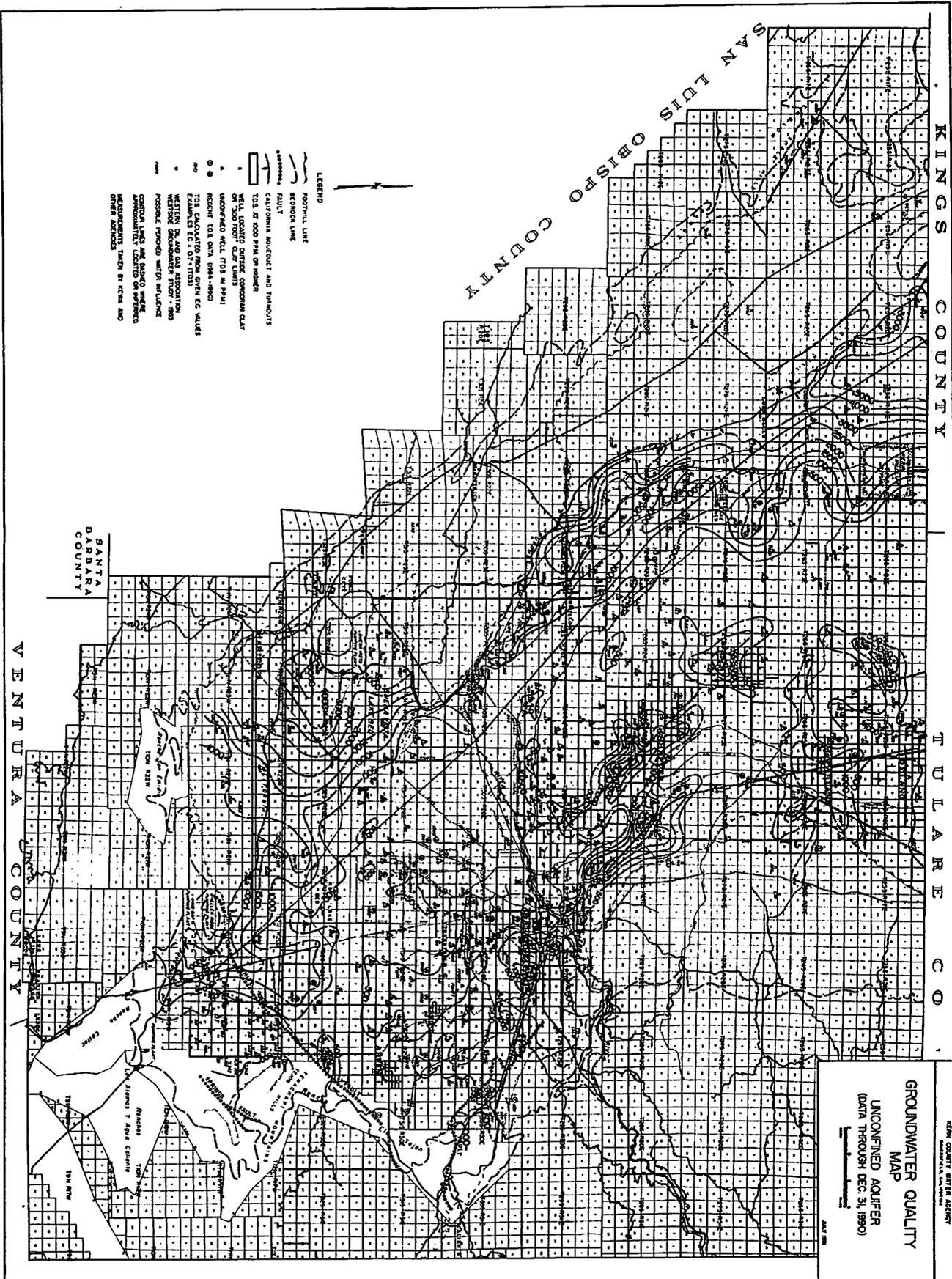
Principles are: the elimination of a provision which required agricultural users to take disproportionate shortages in certain years, creation of a mechanism for reducing urban and agricultural water costs, transfer to local control of the Kern Water Bank, and approval for use of SWP reservoirs by the SWP contractors.

Contract amendments and agreements to implement the Monterey Principles are being developed during 1995. More details of the benefits of this important agreement will be included in the 1995 Water Supply Report.

GROUNDWATER QUALITY
MAP

UNCONFINED AQUIFER
DATA THROUGH DEC. 31, 1990

1:50,000



LEGEND

- FOOTPRINT LINE
- FOOTPRINT LINE
- REVERSE LINE
- CAUTION: CALIFORNIA AUTOREG. AND TOWNSHIPS
- WELL LOCATED OUTSIDE COMPASSION CLAY
- ON 300 FOOT CLAY LIMITS
- UNCOVERED WELLS (TDS IN PPM)
- RECOVER WELLS DATA (1984-1990)
- TDS CALCULATED FROM GRESH EC WELLS
- EXAMPLES (E.C.: 07+1102)
- WESTERN DR. AND GAS ASSOCIATION
- WESTSIDE SUBSEQUENT FROM 1989
- POSSIBLE PIONEER WELLS IN PLAINS
- CENTRAL LINES ARE LATEST WHERE
- APPROXIMATELY LOCATED ON REVERSE
- MEASUREMENTS TAKEN BY KICWA AND
- OTHER AGENCIES

KINGS COUNTY

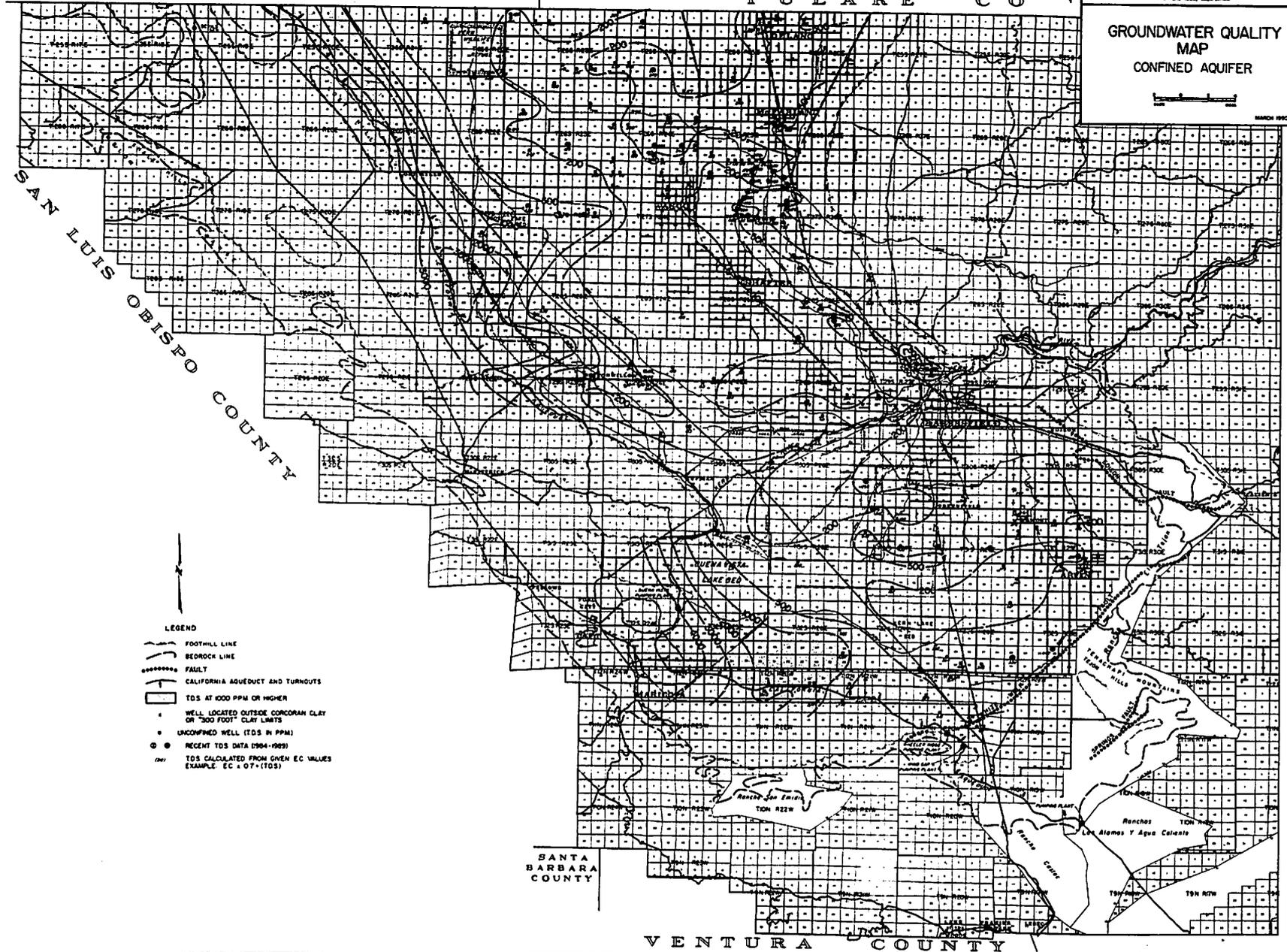
TULARE CO

KERN COUNTY WATER AGENCY
BANDERITA, CALIFORNIA

GROUNDWATER QUALITY MAP CONFINED AQUIFER



MARCH 1990



LEGEND

-  FOOTHILL LINE
-  BEDROCK LINE
-  FAULT
-  CALIFORNIA AQUEDUCT AND TURNOUTS
-  TDS AT 1000 PPM OR HIGHER
-  WELL LOCATED OUTSIDE CORCORAN CLAY OR 300 FOOT CLAY LIMITS
-  UNCONFINED WELL (TDS IN PPM)
-  RECENT TDS DATA (1984-1989)
-  TDS CALCULATED FROM GIVEN EC VALUES
EXAMPLE: EC x 0.7 = (TDS)

SANTA
BARBARA
COUNTY

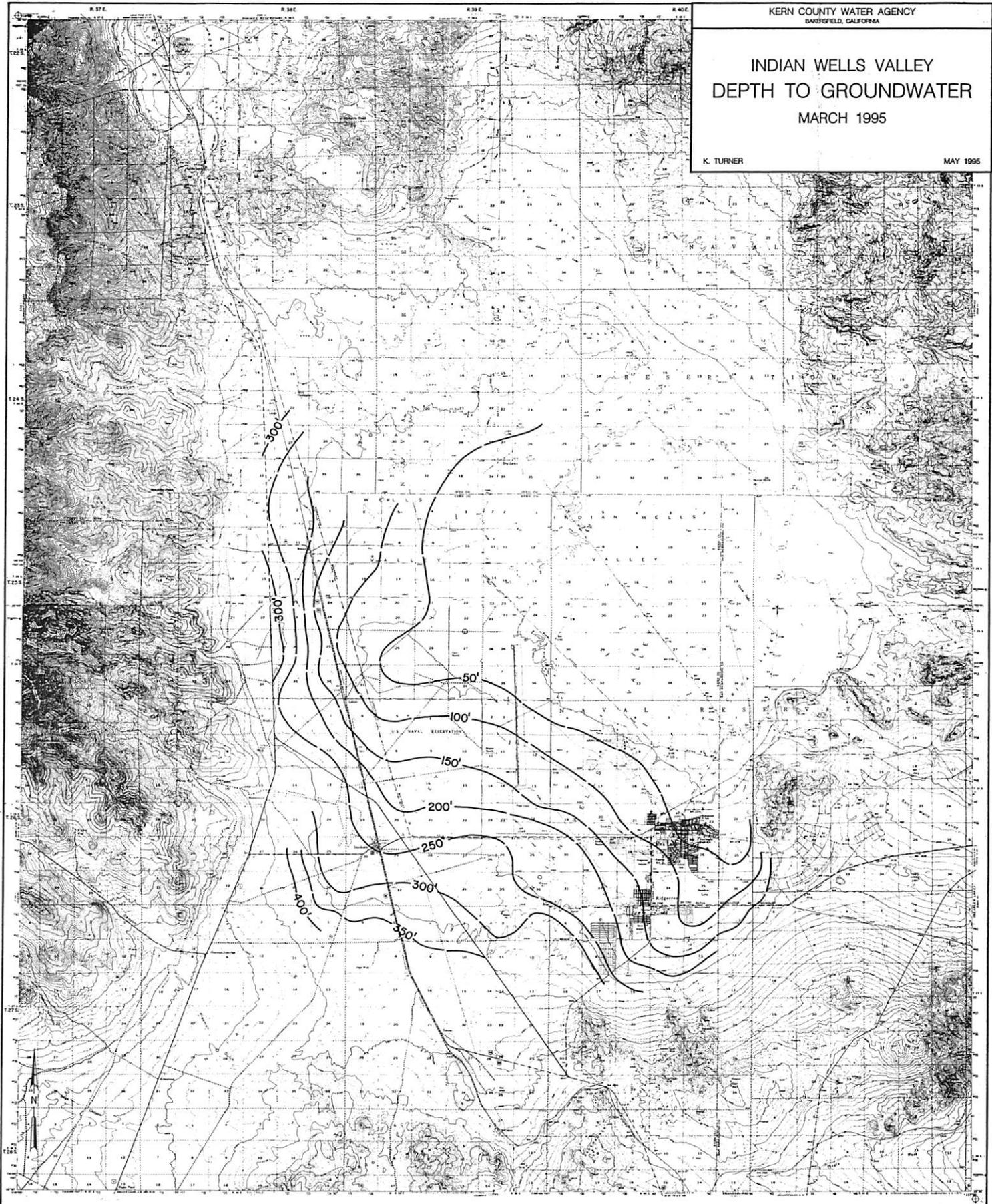
VENTURA COUNTY

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

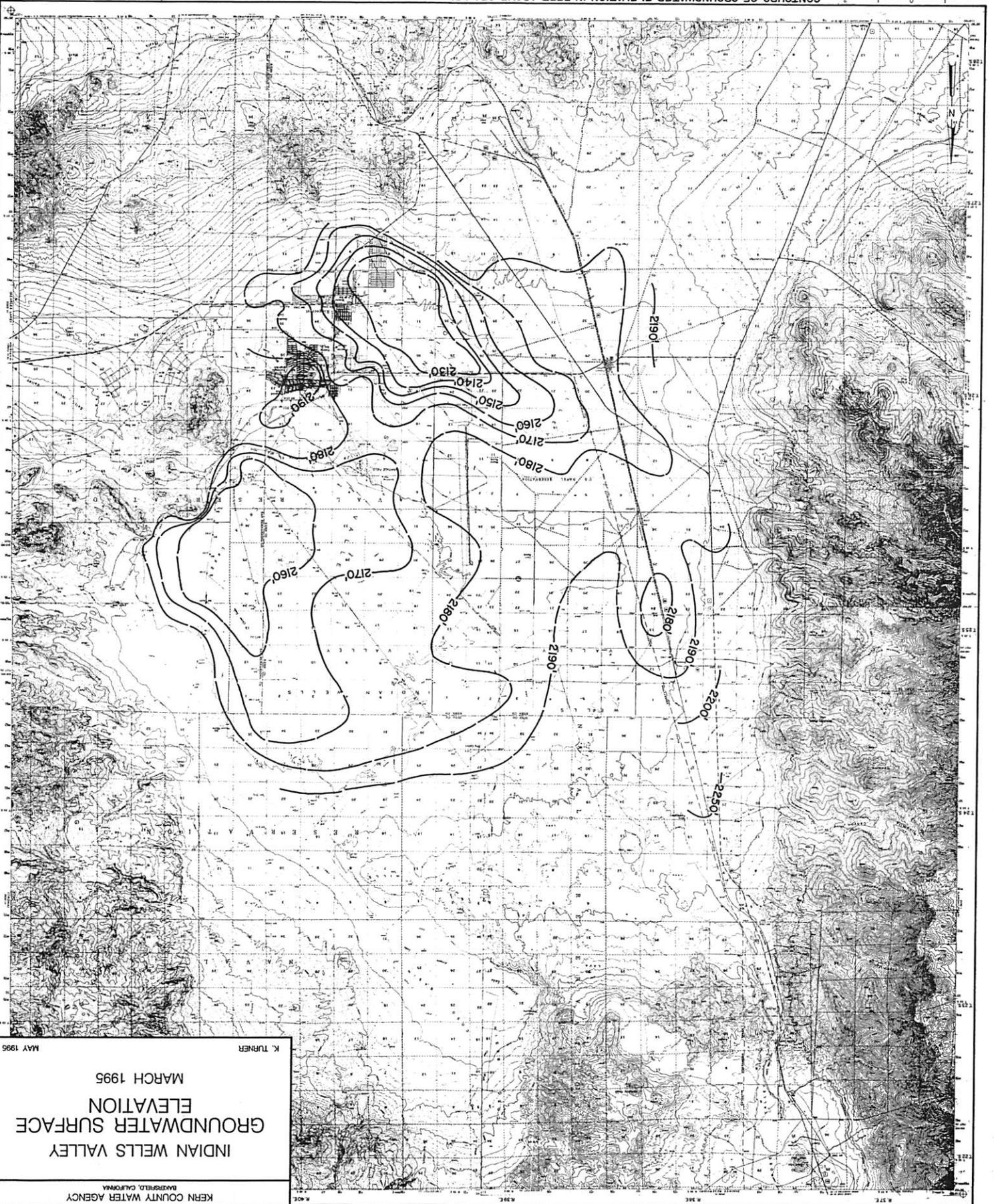
INDIAN WELLS VALLEY DEPTH TO GROUNDWATER MARCH 1995

K. TURNER

MAY 1995



CONTOURS OF DEPTH TO GROUNDWATER IN FEET BELOW GROUND SURFACE.



INDIAN WELLS VALLEY
GROUNDWATER SURFACE
ELEVATION
MARCH 1995
K. TURNER
MAY 1995

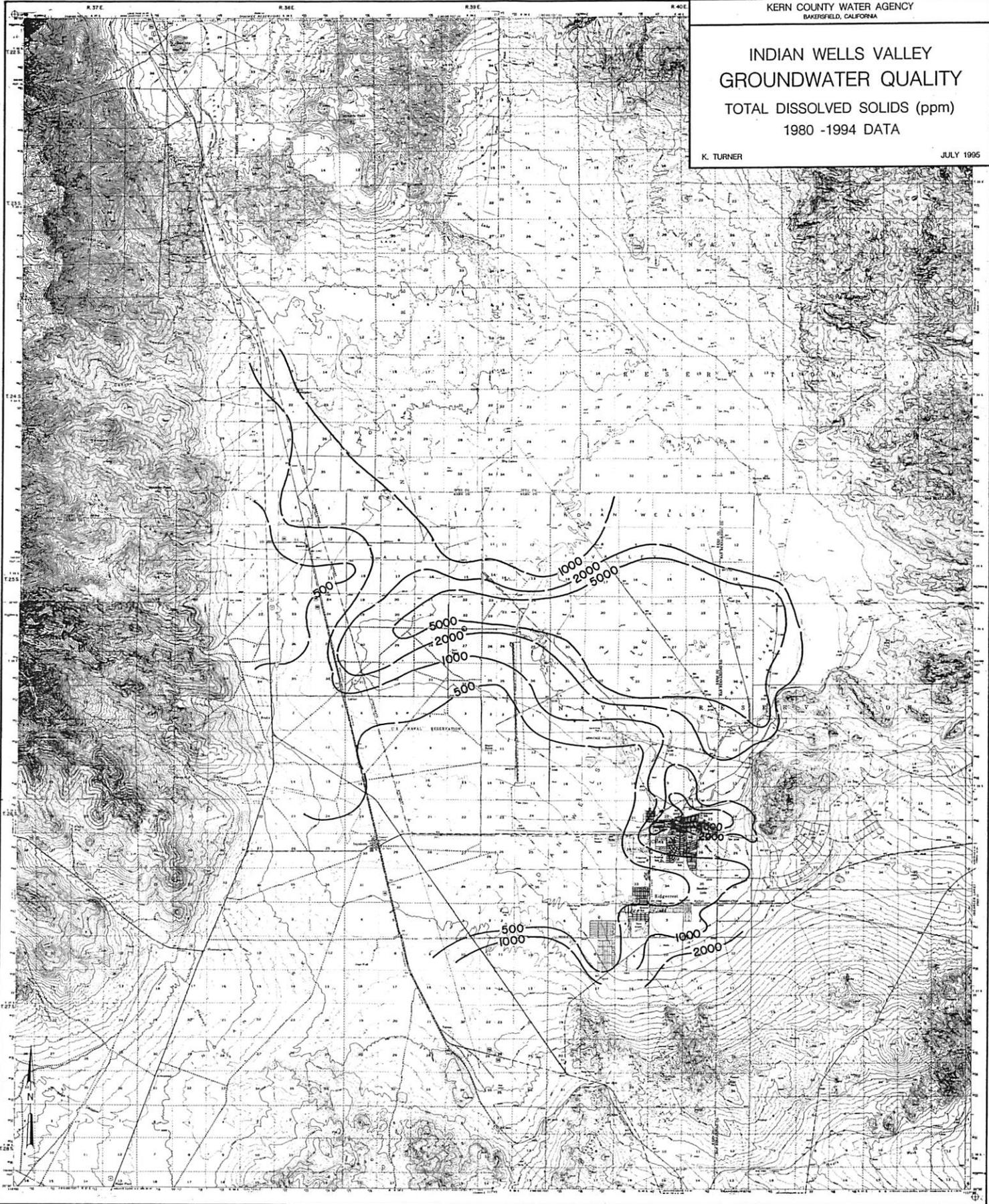
KERN COUNTY WATER AGENCY
BANGSFIELD, CALIFORNIA

KERN COUNTY WATER AGENCY
BAKERSFIELD, CALIFORNIA

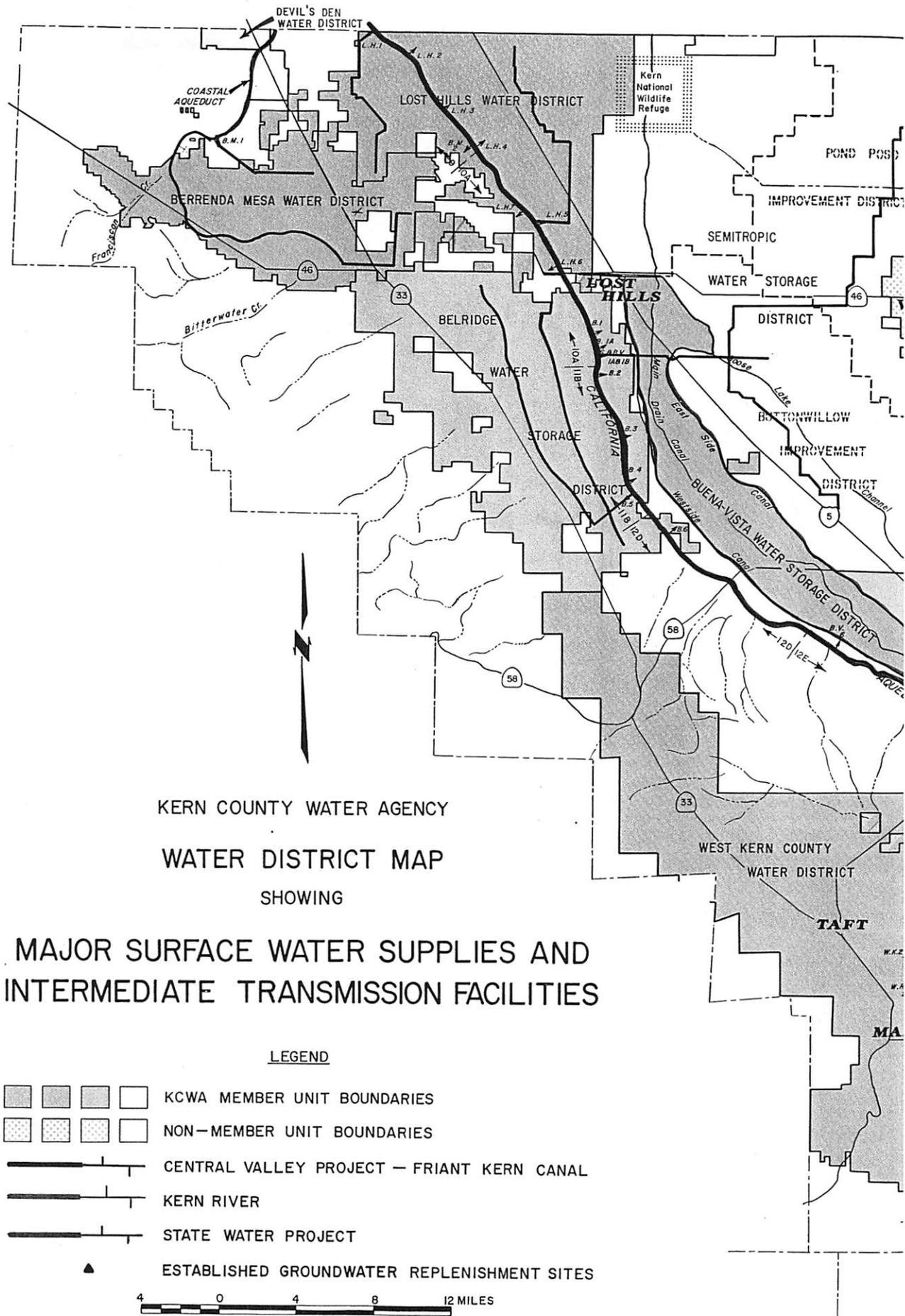
INDIAN WELLS VALLEY
GROUNDWATER QUALITY
TOTAL DISSOLVED SOLIDS (ppm)
1980 -1994 DATA

K. TURNER

JULY 1995



□ T.D.S. AT 1000 p.p.m. OR HIGHER



KERN COUNTY WATER AGENCY
 WATER DISTRICT MAP
 SHOWING

MAJOR SURFACE WATER SUPPLIES AND
 INTERMEDIATE TRANSMISSION FACILITIES

LEGEND

-   KCWA MEMBER UNIT BOUNDARIES
-   NON-MEMBER UNIT BOUNDARIES
-  CENTRAL VALLEY PROJECT - FRIANT KERN CANAL
-  KERN RIVER
-  STATE WATER PROJECT
-  ESTABLISHED GROUNDWATER REPLENISHMENT SITES



