

KERN COUNTY WATER AGENCY

**WATER SUPPLY REPORT  
1995**

THOMAS N. CLARK  
GENERAL MANAGER

JANUARY 1998

ARDEN

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## 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 four 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

1 cfs = 646,360 gallons per day

1 cfs = 1.983 acre-feet per day

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

**Confined Aquifer** A groundwater-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 groundwater 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.

**Groundwater 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.

**Groundwater 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 groundwater supplies by substituting surface water for groundwater 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 groundwater extractions exceed groundwater 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 groundwater 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.

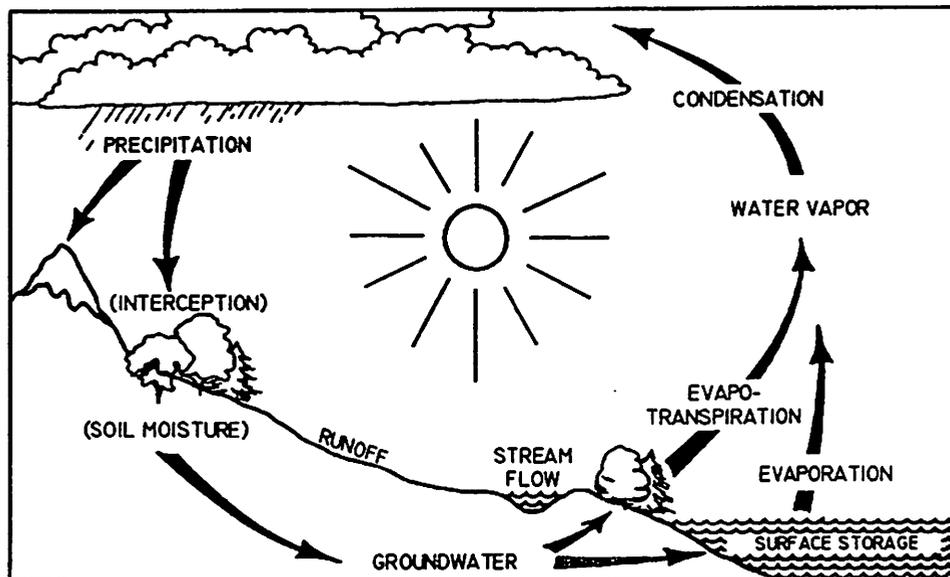
Since its beginning in 1961, the Agency has been building a base of information on the water supply and demand characteristics of the San Joaquin Valley portion of Kern County. Since 1977, the Agency has published the annual Water Supply Report in order to present these statistics in one document and 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 human activities in Kern County. For instance, the planting and harvesting of crops has altered the natural pattern of evapotranspiration. Groundwater storage has been affected by the groundwater 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 groundwater supplies. Also, coordinated groundwater recharge efforts have had a positive effect on groundwater.

The net result of the interactions between the available water supplies and the various demands for that water is a change in groundwater storage and groundwater 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



## 1995: AN ABOUT-FACE

After 1994, 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 80 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; an about-face from 1994.

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 Peru and Ecuador, producing one of the most abundant fisheries in the world. During El Niño conditions the winds and currents reverse direction, altering the food chain for fish and seabirds. Unusual amounts of heat energy are released into the atmosphere, which evaporates huge amounts of water that later falls as rain or snow in the eastern north Pacific region.

Beginning in late December 1994, El Niño-spawned storms battered the entire state with torrential rains. Storage reservoirs filled seemingly 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. Flooding destroyed much of California's winter lettuce crop, grown in Salinas Valley. On January 11, 1995 Governor Pete Wilson declared 34 of the state's counties emergency areas, including Kern County.

Another series of El Niño storms in March 1995 caused another round of extensive flooding. High winds combined with saturated ground to blow over more than 750,000 mature almond trees throughout the state (about 100,000 trees in Kern County were blown over). Statewide estimates of flood damage from the March storms were more than \$2 billion, with \$519 million damage to the state's crops alone. Total damage in Kern County was estimated to be \$33 million, with \$22 million from crop losses (mostly almonds that blew down). While this pales in comparison to the \$238 million crop loss in Monterey County, Kern County had the second worst crop loss in the state.

On March 9-11, 1995 a particularly powerful storm system drenched the already-soaked state with rain. Flows on the rain-swollen Arroyo Pasajero Creek washed out two bridges on Interstate 5 in Fresno County, killing seven people. It also eroded a 50 feet wide by 10 feet deep gap behind the California Aqueduct, and combined with flood inflows from Salt and Cantua Creeks to nearly wipe out the aqueduct. Over 100 thick concrete panels lining the aqueduct were washed away and the aqueduct was nearly swamped by the breach. Peak flows of about 4,000 to 5,000 cfs cascaded into the aqueduct, which quickly filled the aqueduct to the top of the concrete panels and flowed downstream into Kern County. Within Kern County, the water level peaked at 1-2 feet above the concrete lining. Officials were gravely concerned that the water would pond against the Buena Vista Pumping Plant in Kern County, overtop the canal and erode away the dirt supporting embankment, thus collapsing the aqueduct. To deal with this emergency the Kern River Intertie gates were opened, and a peak of about 5,200 cfs of water was allowed to flow from the aqueduct in reverse into the Kern River flood channel. A total of about 13,000 acre-feet of water flowed into the flood channel. (The Intertie was designed and built to introduce Kern River floodwater into the California Aqueduct. In this emergency, the opposite was done.) Additionally, the Cross Valley Canal (CVC) was purposely 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 floodwater allowed to 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, the California Aqueduct would have been severely damaged and serious flood damage would have occurred in Kern County. As it was, water levels at the Buena Vista Pumping Plant came within inches of overtopping the aqueduct.

In addition to nearly destroying the aqueduct, nearly 1 million cubic yards of sand, silt and other fine grained sediments were introduced into the aqueduct, which settled out in a plume that now stretches from the entry point to Edmonston Pumping Plant. The fine-grained particles remained in suspension, creating extremely high turbidity. Normally, water in the Kern County portion of the aqueduct has a turbidity-unit reading of about 15 ntu. During the summer peak delivery season turbidity readings ranged as high as 150 ntu.

Rows of submerged concrete block barriers were installed in numerous locations in the aqueduct in an attempt to contain the sediment for later removal. In some reaches the aqueduct's carrying capacity was reduced by 40 percent. High water flows during the summer caused the silt to re-suspend, raising the turbidity to unacceptable levels for groundwater recharge programs.

KCWA and member units had planned to deliver about 200,000 acre-feet of SWP water for groundwater recharge during 1995. However the high turbidity prevented the use of SWP water for this purpose. It was feared that the extremely fine-grained sediments could permanently damage prime recharge areas by plugging and sealing the overlying soils. To overcome this, purchases and exchanges were obtained for east-side Friant water supplies. These exchanges were made possible because KCWA delivered SWP water to users north of the aqueduct damage and silt problem, and delivered like amounts of clean Friant water via the Friant-Kern Canal.

Additionally, the high turbidity caused major problems with pumps and pressurized irrigation systems in Kern County. Sediment created a constant plugging problem for low volume drip irrigation systems, and rapidly eroded pumps and other metal components of delivery systems. Pumps that would normally run 10,000 hours before needing an overhaul would be literally worn out after 1,500 hours. It is estimated that pump and irrigation system damage caused by the suspended sediment ran in the millions of dollars for Kern County water users.

The return of wet conditions meant that 100 percent of State Water Project (SWP) supplies were available. Likewise, 100 percent of Class I and II contract amounts were available for federal Friant-Kern contractors. Federal contractors served from the Delta also received 100 percent of Class I entitlement. This was the first time since 1989 that federal Delta export contractors received full entitlement.

The Sacramento River Index (SRI) is used to reflect SWP water supply conditions. The average SRI over 90 years of record is 17.8 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 1995 was officially an extremely wet year with an SRI of 33.9 MAF, the second wettest year of record. Table 1 is a history of Sacramento River Indices. Figure 2 shows the same information graphically.

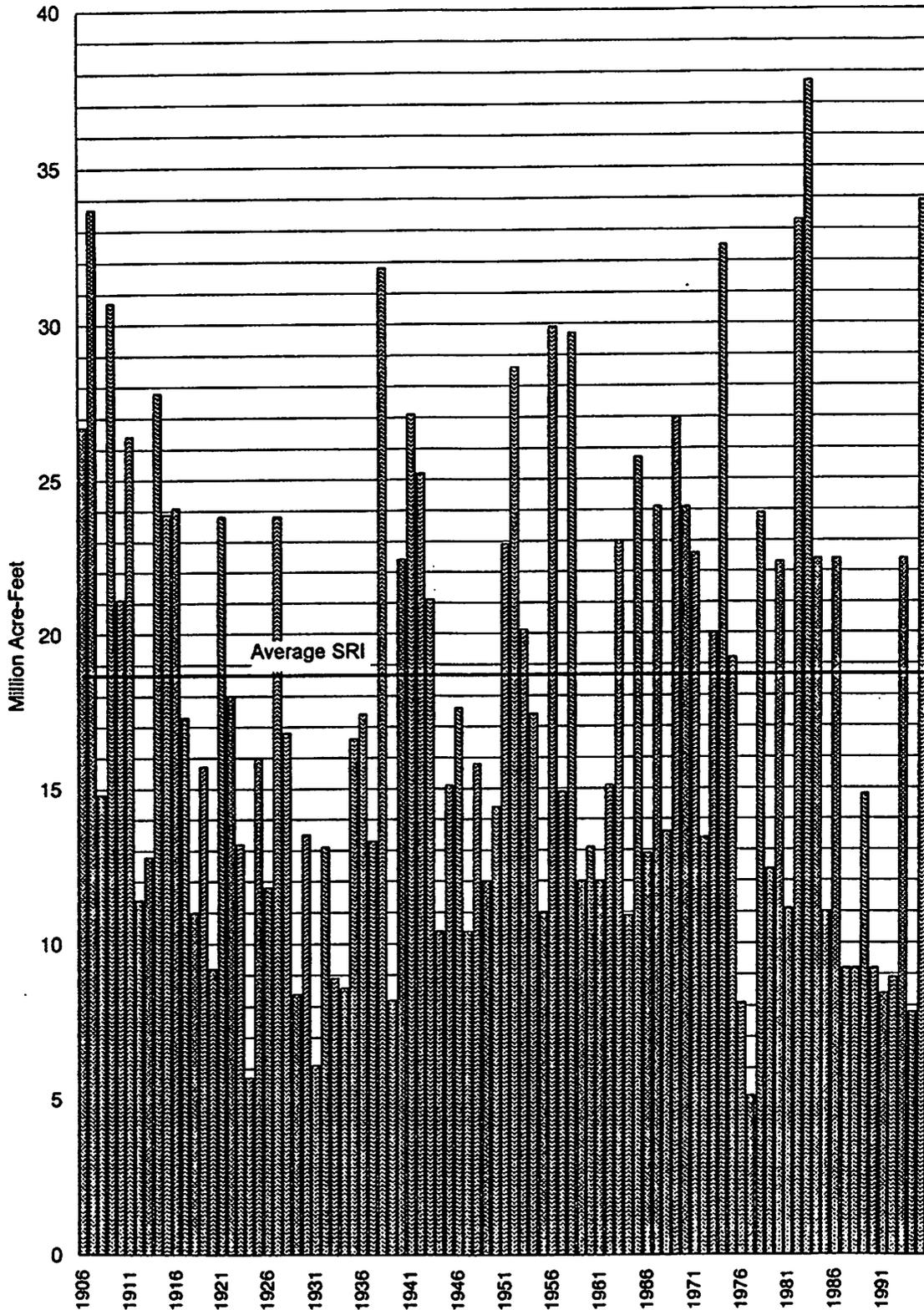
Kern County's surface water supplies from all sources during 1995 were about 3,332,800 acre-feet. Normal supplies are about 2,200,000 acre-feet. Therefore, water availability in 1995 was about 150 percent of normal. SWP deliveries from all sources totaled 1,219,146 acre-feet. Kern River supplies were 1,200,684 acre-feet, or 166 percent of average. Central Valley Project deliveries totaled 647,077 acre-feet, or 170 percent of the 1975-95 average.

**Table 1. Sacramento River Indices\* (In million acre-feet)**

| Descending Order by Year |       |      |       | Ascending Order by Index |       |      |       |
|--------------------------|-------|------|-------|--------------------------|-------|------|-------|
| Year                     | Index | Year | Index | Year                     | Index | Year | Index |
| 1995                     | 33.9  | 1950 | 14.4  | 1977                     | 5.1   | 1925 | 16.0  |
| 1994                     | 7.8   | 1949 | 12.0  | 1924                     | 5.7   | 1935 | 16.6  |
| 1993                     | 22.4  | 1948 | 15.8  | 1931                     | 6.1   | 1928 | 16.8  |
| 1992                     | 8.9   | 1947 | 10.4  | 1994                     | 7.8   | 1917 | 17.3  |
| 1991                     | 8.4   | 1946 | 17.6  | 1976                     | 8.1   | 1954 | 17.4  |
| 1990                     | 9.2   | 1945 | 15.1  | 1939                     | 8.2   | 1936 | 17.4  |
| 1989                     | 14.8  | 1944 | 10.4  | 1929                     | 8.4   | 1946 | 17.6  |
| 1988                     | 9.2   | 1943 | 21.1  | 1991                     | 8.4   | 1922 | 18.0  |
| 1987                     | 9.2   | 1942 | 25.2  | 1934                     | 8.6   | 1975 | 19.2  |
| 1986                     | 22.4  | 1941 | 27.1  | 1992                     | 8.9   | 1973 | 20.0  |
| 1985                     | 11.0  | 1940 | 22.4  | 1933                     | 8.9   | 1953 | 20.1  |
| 1984                     | 22.4  | 1939 | 8.2   | 1990                     | 9.2   | 1943 | 21.1  |
| 1983                     | 37.7  | 1938 | 31.8  | 1988                     | 9.2   | 1910 | 21.1  |
| 1982                     | 33.3  | 1937 | 13.3  | 1987                     | 9.2   | 1980 | 22.3  |
| 1981                     | 11.1  | 1936 | 17.4  | 1920                     | 9.2   | 1993 | 22.4  |
| 1980                     | 22.3  | 1935 | 16.6  | 1947                     | 10.4  | 1986 | 22.4  |
| 1979                     | 12.4  | 1934 | 8.6   | 1944                     | 10.4  | 1984 | 22.4  |
| 1978                     | 23.9  | 1933 | 8.9   | 1964                     | 10.9  | 1940 | 22.4  |
| 1977                     | 5.1   | 1932 | 13.1  | 1985                     | 11.0  | 1971 | 22.6  |
| 1976                     | 8.1   | 1931 | 6.1   | 1955                     | 11.0  | 1951 | 22.9  |
| 1975                     | 19.2  | 1930 | 13.5  | 1918                     | 11.0  | 1963 | 23.0  |
| 1974                     | 32.5  | 1929 | 8.4   | 1981                     | 11.1  | 1927 | 23.8  |
| 1973                     | 20.0  | 1928 | 16.8  | 1912                     | 11.4  | 1921 | 23.8  |
| 1972                     | 13.4  | 1927 | 23.8  | 1926                     | 11.8  | 1978 | 23.9  |
| 1971                     | 22.6  | 1926 | 11.8  | 1961                     | 12.0  | 1915 | 23.9  |
| 1970                     | 24.1  | 1925 | 16.0  | 1959                     | 12.0  | 1970 | 24.1  |
| 1969                     | 27.0  | 1924 | 5.7   | 1949                     | 12.0  | 1967 | 24.1  |
| 1968                     | 13.6  | 1923 | 13.2  | 1979                     | 12.4  | 1916 | 24.1  |
| 1967                     | 24.1  | 1922 | 18.0  | 1913                     | 12.8  | 1942 | 25.2  |
| 1966                     | 12.9  | 1921 | 23.8  | 1966                     | 12.9  | 1965 | 25.7  |
| 1965                     | 25.7  | 1920 | 9.2   | 1960                     | 13.1  | 1911 | 26.4  |
| 1964                     | 10.9  | 1919 | 15.7  | 1932                     | 13.1  | 1906 | 26.7  |
| 1963                     | 23.0  | 1918 | 11.0  | 1923                     | 13.2  | 1969 | 27.0  |
| 1962                     | 15.1  | 1917 | 17.3  | 1937                     | 13.3  | 1941 | 27.1  |
| 1961                     | 12.0  | 1916 | 24.1  | 1972                     | 13.4  | 1914 | 27.8  |
| 1960                     | 13.1  | 1915 | 23.9  | 1930                     | 13.5  | 1952 | 28.6  |
| 1959                     | 12.0  | 1914 | 27.8  | 1968                     | 13.6  | 1958 | 29.7  |
| 1958                     | 29.7  | 1913 | 12.8  | 1950                     | 14.4  | 1956 | 29.9  |
| 1957                     | 14.9  | 1912 | 11.4  | 1989                     | 14.8  | 1909 | 30.7  |
| 1956                     | 29.9  | 1911 | 26.4  | 1908                     | 14.8  | 1938 | 31.8  |
| 1955                     | 11.0  | 1910 | 21.1  | 1957                     | 14.9  | 1974 | 32.5  |
| 1954                     | 17.4  | 1909 | 30.7  | 1962                     | 15.1  | 1982 | 33.3  |
| 1953                     | 20.1  | 1908 | 14.8  | 1945                     | 15.1  | 1907 | 33.7  |
| 1952                     | 28.6  | 1907 | 33.7  | 1919                     | 15.7  | 1995 | 33.9  |
| 1951                     | 22.9  | 1906 | 26.7  | 1948                     | 15.8  | 1983 | 37.7  |
| 90 year average          |       | 17.8 |       |                          |       |      |       |
| 90 year median           |       | 90.0 |       |                          |       |      |       |
| Minimum (1977)           |       | 5.1  |       |                          |       |      |       |
| Maximum (1983)           |       | 37.7 |       |                          |       |      |       |

\* 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.

Figure 2. Sacramento River Indices



Because of the favorable water supply conditions, irrigated acreage increased over 1994 by about 45,000 acres. A total of about 126,000 acres of farmland (mostly west-side lands) remained idle during 1995. Total irrigated acreage was 848,400 acres, a 6 percent increase over 1994.

The change in groundwater storage in 1995 was an increase of about 763,000 acre-feet. This made up for most of the 1,052,800 acre-feet removed from storage in 1994. 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 6,313,000 acre-feet. The net change in storage since 1970 has been a loss of about 6,644,400 acre-feet, or about 250,000 acre-feet per year. In terms of volume of water stored, the groundwater basin is at a level below the last drought in 1976-77. During the six years of the 1987-92 drought, about 5,390,000 acre-feet of groundwater was withdrawn, averaging about 898,000 acre-feet per year.

## MONTEREY PRINCIPLES

A 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 (DWR) regarding various problems which had arisen in administration of the SWP due to contracts, shortages caused by environmental constraints in the Sacramento-San Joaquin Delta and incomplete SWP facilities. These Principles substantially amended the water service contracts between the DWR and its SWP contractors.

The state's failure to complete the State Water Project combined with escalating imposition of environmental regulations upon the SWP, impact Kern County's water supply reliability while at the same time increasing the costs for the available water. The SWP appears to be able to deliver full contractual amounts only half the time. In the original contracts with the state for SWP supplies, urban areas received a priority over agriculture for water deliveries during drought years. Because of the incomplete SWP and increasing environmental regulations, agricultural contractors bore the major burden of so-called "ag first" shortages. SWP agricultural contractors had endured serious financial hardship during the prolonged drought of 1987-92. KCWA objected to "ag first" shortages to the extent such shortages were caused by incomplete SWP facilities or by regulatory Delta pumping restrictions and water quality criteria. KCWA maintained that such non-drought shortages should be borne by all state water contractors. Unsuccessful in resolving this issue since discussions began in 1986, in 1993 KCWA threatened litigation. This resulted in serious discussions among DWR and SWP contractors to explore the means by which elements of the SWP Master Contract could be renegotiated to provide greater equity, recognizing the changed realities faced by the SWP today as opposed to when the SWP contracts were signed in the 1960s.

The negotiations resulted in agreement to a set of principles (signed December 1, 1994) that were the basis for an amendment to the Master Contract and were referred to as the "Monterey Agreement," because the final negotiations were completed in Monterey, California.

The Monterey Agreement will provide for increased agricultural water supply reliability, lower costs, water transfers and more flexible operation of the SWP. Highlights of the Principles are:

- Elimination of the contract provision which required agricultural users to take disproportionate shortages in certain years. In addition, water allocations will be based on proportionate shares of entitlement, up to requests, rather than based on requests and priorities of use.

- Creation of a mechanism for reducing urban and agricultural water costs. An agricultural trust fund will provide for buffering of price swings to stabilize the unit cost of water in shortage years. Whereas fixed payments used to be required even when no agricultural water was delivered, payments will now be more closely related to the amount of water actually received. Urban contractors will see similar benefits in routine credits on a yearly basis.
- Transfer of the Kern Water Bank to local control. Participating agricultural contractors will permanently reduce their entitlement by a combined total of 45,000 acre-feet in exchange for the Kern Fan Element of the Kern Water Bank. KCWA Member Units are the largest participants in the Kern Water Bank Authority (90 percent), along with Dudley Ridge Water District (10 percent). The Kern Water Bank Authority is a consortium of local public water entities that own and operate the Kern Water Bank.
- Use of SWP reservoirs by the SWP contractors. SWP contractors will gain greater operational flexibility by being able to store and transport both Project and non-Project water in DWR facilities for the benefit of the contractor (when space is available).
- Allowing the sale of up to 130,000 acre-feet of agricultural entitlement between willing buyers and willing sellers.

Kern County Water Agency approved and signed the Monterey Amendments on Tuesday, November 14, 1995.

## BAY-DELTA ACCORD

The Sacramento-San Joaquin Delta is the water hub for more than 40 percent of the state's total stream runoff. It provides some or all of the drinking water for two-thirds of all Californians and irrigation water for 7.5 million acres of farmland. Some 120 species of fish live in the Delta system for at least part of their lives, including commercially important salmon species and striped bass. Both the SWP and CVP pump water from the southern end of the Delta.

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 environmental public advocacy organizations, agricultural and urban water agencies that depend on Delta water. The Accord, which has a three-year term, provides an average of 300,000 acre-feet of additional Delta outflow. This could go up to as much as 1,100,000 acre-feet during critically dry years. The Accord is an unprecedented agreement that is a giant step toward ending one of California's biggest water wars.

Major elements of the water agreement are:

- Relaxation of so-called "take" limits in favor of operational guarantees. Implementation of the federal Endangered Species Act (ESA) had plagued the SWP and CVP for several years. Particularly troublesome were take limits on fish species, which caused the export pumps to be slowed and even shut down, with serious impacts on water users. Operational guarantees include a real-time monitoring program to better track fish movements, and establishing an operations group

which can make scientifically sound decisions on project operations based on information provided by the real-time monitoring.

- A moratorium on listing of additional Delta species as threatened or endangered during the Accord's three-year life. This provision will eliminate the "stacking" of ESA impacts upon water users from new species or changes in the needs of species already listed. If for some reason additional water is needed for ESA purposes, it will be purchased from willing sellers and paid for in full by the federal government.
- Creation of a process and fund for resolving non-flow related factors that impact fish and wildlife, such as toxic drainage into the Delta system, urban and agricultural non point source pollution, introduced species, fishing pressure, loss of spawning habitat and fish screening problems. Implementation of the federal ESA was heavily weighted toward altering water flows by controlling the water projects, even though other non-flow factors may have as much or more impact on fish and wildlife.
- Establishing a program for defining a long-term plan to improve ecological health and to improve water management and beneficial uses in the Bay-Delta system. This so-called CALFED Bay-Delta Program will develop a programmatic environmental impact report that will analyze alternatives for the Bay-Delta. CALFED is guided by four "solution principles": (1) Water Quality — Provide adequate water quality for all beneficial uses; (2) Ecosystem Quality — Improve and increase aquatic and terrestrial habitats and ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species; (3) Water Supply Reliability — Improve the ability of the Bay-Delta system to meet current and projected water supply beneficial uses; (4) System Vulnerability — Reduce the risk to land use and associated economic activities, water supply, infrastructure and the ecosystem from catastrophic inundation of Delta islands. CALFED is a consortium of state and federal agencies with jurisdiction in the Bay-Delta which was established as part of the Bay-Delta Accord.

The Bay-Delta Accord provides a three-year window of opportunity to craft a long-term program that reduces the conflicts between Bay-Delta water users and the Bay-Delta environment. CALFED is now gathering policy input from stakeholders and performing technical analyses of various options. CALFED expects to have its draft programmatic environmental impact report completed by late 1997.

## **WATER SUPPLIES**

### **State Water Project (SWP)**

On December 8, 1994 the Department of Water Resources announced their initial allocation of State Water Project supplies for 1995. Expectations were that the allocation would be 40-50 percent, since the snowpack was only 40-50 percent of normal and carryover storage was low because of the previous dry year. DWR made an initial allocation of 40 percent of requested 1995 SWP entitlement. For KCWA, this amounted to 406,960 feet for agricultural use and 54,400 acre-feet for urban uses. Because the Bay-Delta Accord was implemented in 1995 DWR was able to make its initial allocation with more certainty. Since pumping restrictions to protect winter run

salmon and Delta smelt (both protected under the federal Endangered Species Act) were spelled out in the Accord, they could be factored into SWP operations studies.

Heavy rain and snowfall in December and early January filled SWP storage reservoirs to maximum carryover capacity. A huge snowpack accumulated in northern California watersheds, assuring an extremely wet year. SWP allocations were increased to 100 percent on January 24, 1995. The 1995 Sacramento River Index was 33.9 MAF, the second wettest year of record.

The chronology of 1995 allocations follows:

|                  |                          |
|------------------|--------------------------|
| December 8, 1994 | 40% (initial allocation) |
| January 13, 1995 | 60%                      |
| January 24, 1995 | 100% (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 1994 KCWA began planning for a 1995 emergency water supply program. Emphasis was placed on purchasing any available surface supplies to offset shortages. Specifically, DWR was developing a 1995 State Drought Water Bank (Drought Bank), which local districts could draw upon if needed. Groundwater bank accounts would only be pumped as a last resort. A total of 96,470 acre-feet of Drought Bank water was scheduled for purchase by Kern County water users. However the 100 percent allocation eliminated the need for Drought Bank water.

Member Units' contract entitlement for 1990 and after are shown on Table 2. 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 SWP supply of 1,283,483 acre-feet was available during 1995, including 1,153,400 acre-feet of SWP entitlement, 2,795 acre-feet of 1994 entitlement carried forward into 1995, 59,671 acre-feet of "Interruptible Water," 13,117 acre-feet of SWP flood releases and 54,500 acre-feet of SWP water transferred into Kern County by other entities. A total of 1,219,146 acre-feet of SWP water was actually delivered during 1995. Since the first deliveries in 1968, a total of over 21 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 1995 SWP deliveries by contract type.

KCWA and Member Units had planned to deliver some 200,000 acre-feet of SWP water for groundwater programs during 1995. However high turbidity problems associated with the Arroyo Pasajero breach of the aqueduct prevented the use of SWP water for this purpose. It was feared that the extremely fine-grained sediments could plug and seal overlying soils of the County's prime recharge areas. To overcome this, exchanges were obtained with Friant water users and Kern River interests. In the latter part of August SWP turbidity dropped to levels low enough to permit SWP water to be recharged through the remainder of the year. KCWA and its member units recharged a total of about 450,000 acre-feet during 1995.

## Kern River

The 1995 Kern River water year was about twice normal, due to the El Niño-influenced storms in January and March 1995. April through July is the primary runoff period for the Kern River watershed. During 1995 April-July runoff was 191 percent of normal, compared to 41 percent of

**Table 2. Kern County Water Agency, Member Unit Contract Entitlements for 1990-2035**

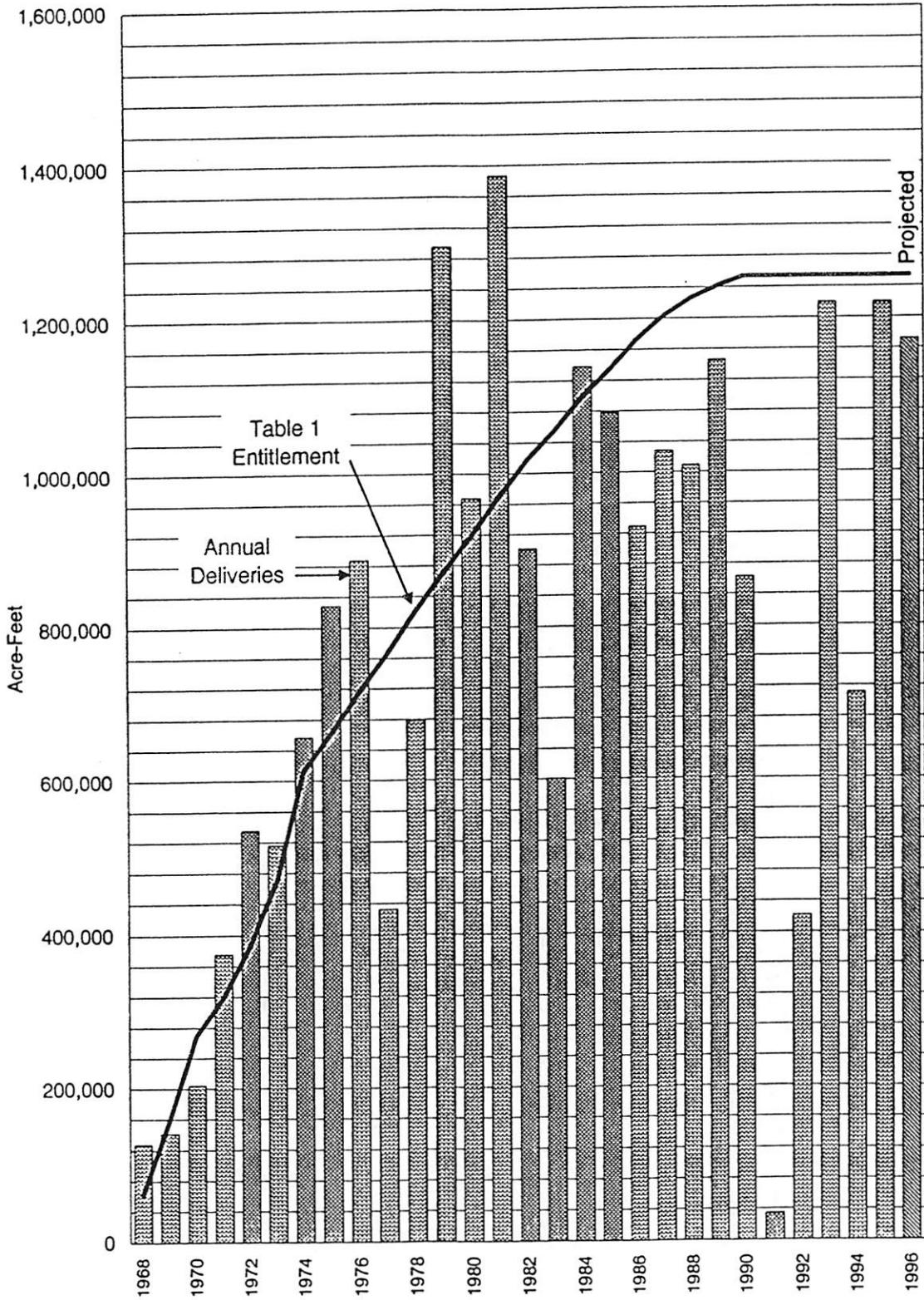
| Member Unit                | Firm             | Surplus <sup>(1)</sup> | Total            | M&I                   | Ag               | Total            |
|----------------------------|------------------|------------------------|------------------|-----------------------|------------------|------------------|
| Berrenda Mesa WD           | 155,100          | 8,100                  | 163,200          |                       | 163,200          | 163,200          |
| Lost Hills WD              | 140,400          | 0                      | 140,400          | 2,000 <sup>(2)</sup>  | 138,400          | 140,398          |
| Belridge WSD               | 163,000          | 0                      | 163,000          | 15,000 <sup>(2)</sup> | 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          |
| Tebachapi-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            |
| <b>Total</b>               | <b>1,153,400</b> | <b>100,000</b>         | <b>1,253,400</b> | <b>136,000</b>        | <b>1,117,400</b> | <b>1,253,400</b> |

**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. State Water Project Deliveries to Kern County Water Agency



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

| Year                       | Annual <sup>(1)</sup><br>Deliveries | Cumulative<br>Deliveries | Intertie<br>Deliveries | Deliveries <sup>(2)</sup><br>Outside SJV | Annual<br>Importations | Cumulative<br>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                              | 17,763,127               |                        | 2,213                                    | 32,652                 | 17,107,403                 |
| 1992                       | 421,520                             | 18,184,647               |                        | 3,508                                    | 418,012                | 17,525,415                 |
| 1993                       | 1,219,653                           | 19,404,300               |                        | 14,139                                   | 1,205,514              | 18,730,929                 |
| 1994                       | 711,002                             | 20,115,302               |                        | 15,616                                   | 695,386                | 19,426,315                 |
| 1995                       | 1,219,146                           | 21,334,448               |                        | 107,950                                  | 1,111,196              | 20,537,511                 |
| <b>Mean Deliveries</b>     |                                     |                          | <b>761,945 AF</b>      | <b>Minimum Deliveries (1991)</b>         |                        | <b>34,886 AF</b>           |
| <b>Median Deliveries</b>   |                                     |                          | <b>845,443 AF</b>      | <b>Maximum Deliveries (1981)</b>         |                        | <b>1,386,641 AF</b>        |
| <b>Mean Importations</b>   |                                     |                          | <b>734,188 AF</b>      | <b>Minimum Importations (1991)</b>       |                        | <b>32,673 AF</b>           |
| <b>Median Importations</b> |                                     |                          | <b>839,537 AF</b>      | <b>Maximum Importations (1981)</b>       |                        | <b>1,384,744 AF</b>        |

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

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

**Table 4. 1995 State Water Project Deliveries by Contract (in acre-feet)**

| District                      | No. 1                  | No. 2  | No. 3                          | No. 4   | No. 5                   | No. 6                  |
|-------------------------------|------------------------|--|--------------------------------|---|-------------------------|------------------------|
|                               | SWP Water Supplies     |  |                                |   |                         |                        |
|                               | Table 1<br>Entitlement | Carryover<br>of 1994<br>Entitlement<br>into 1995 <sup>(16)</sup> | Total<br>Entitlement<br>Supply | Interruptable<br>Water<br>Program<br>Allocation <sup>(17)</sup> | SWP<br>Flood<br>Release | Total<br>SWP<br>Supply |
| Berrenda Mesa WD              | 155,100                |  | 155,100                        |   |                         | 155,100                |
| Lost Hills WD                 | 140,400                | 1,088  | 141,488                        | 6,000   | 126                     | 147,614                |
| Belridge WSD                  | 163,000                | 1,383  | 164,383                        | 1,864   |                         | 166,247                |
| Semitropic WSD                | 158,000                |  | 158,000                        | 15,034  | 267                     | 173,301                |
| Cawelo WD                     | 38,200                 |  | 38,200                         |   |                         | 38,200                 |
| Improvement Dist. No. 4 Ag    | 10,276                 |  | 10,276                         |   |                         | 10,276                 |
| Improvement Dist. No. 4 M&I   | 77,000                 |  | 77,000                         | 17,776  | 874                     | 95,650                 |
| Rosedale-Rio Bravo WSD        | 29,900                 |  | 29,900                         | 7,858   |                         | 37,758                 |
| Buena Vista WSD               | 21,300                 |  | 21,300                         |   |                         | 21,300                 |
| Kern Delta WD                 | 25,500                 |  | 25,500                         |   |                         | 25,500                 |
| Henry Miller WD               | 35,500                 |  | 35,500                         |   |                         | 35,500                 |
| West Kern WD                  | 25,000                 |  | 25,000                         | 10,929  |                         | 35,929                 |
| Wheeler Ridge-Maricopa WSD    | 252,924                |  | 252,924                        |   |                         | 252,924                |
| Tehachapi-Cummings CWD Ag     | 4,300                  |  | 4,300                          |   |                         | 4,300                  |
| Tehachapi-Cummings CWD M&I    | 15,000                 | 324  | 15,324                         | 210   |                         | 15,534                 |
| Tejon-Castac WD               | 2,000                  |  | 2,000                          |   |                         | 2,000                  |
| Kern River Interlie           |                        |  |                                |   | 11,850                  | 11,850                 |
| Westlands WD                  |                        |  | -                              |   |                         | -                      |
| Tulare Lake Basin WSD         |                        |  | -                              |   |                         | -                      |
| Dudley Ridge WD               |                        |  | -                              |   |                         | -                      |
| TLBWSD (Transfer in)          |                        |  | -                              |   |                         | -                      |
| MWD (Transfer in)             |                        |  | -                              |   |                         | -                      |
| Dudley Ridge WD (Transfer in) |                        |  | -                              |   |                         | -                      |
| <b>Total</b>                  | <b>1,153,400</b>       | <b>2,795</b>   | <b>1,156,195</b>               | <b>59,671</b>   | <b>13,117</b>           | <b>1,228,983</b>       |

Note: This table shows contracted deliveries for calendar year 1995. 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) Landowner transfers to Westlands WD (Vista Verde Farms: 1,520 AF; Woolf Enterprises: 11,500 AF).
- (2) Includes transfers to Westlands WD (Shannon: 5,000 AF; Woolf Enterprises: 4,500 AF); Includes transfer from Dudley Ridge WD of 1,000 AF (banked in COB 2,800 Acres); Includes transfers to Semitropic WSD (Lost Hills Utility District: 210 AF; Adelaida Farms: 400 AF; Buttonwillow Farms: 117 AF).
- (3) Landowner transfer to Westlands WD (Woolf Enterprises: 5,000 AF).
- (4) Landowner transfer from Tulare Lake Basin WSD (J.G. Boswell Co.).
- (5) Exchange of SWP entitlement to ID4 for a like amount of groundwater banked in the COB 2,800 Acres.
- (6) Includes the remainder (28 AF) of a 1994 transfer (930 AF) to Semitropic WSD (note that 16 AF was not transferred); Includes 1,500 AF transfer to Tulare Lake Basin WSD; Includes 245 AF transfer to Dudley Ridge WD; Includes 3,228 AF from Rosedale-Rio-Bravo WSD for Paramount Farming Co.
- (7) Transfer of 11,141 AF of SWP entitlement to Westlands WD for future payback.
- (8) Includes the remainder (28 AF) of a 1994 transfer (930 AF) from Lost Hills WD; Includes 50,000 AF from Metropolitan WD pursuant to MWD/ST Banking Program.
- (9) Exchange of SWP entitlement to Buena Vista WSD for a like amount of Kern River water pursuant to long-term exchange agreement.
- (10) Includes 1,500 AF from Berrenda Mesa WD (see (5)); Includes SWP/Kern River exchange paybacks to Buena Vista WSD (4,098 AF) and Rosedale-Rio Bravo WSD (6,478 AF); Includes 10,000 AF and 875 AF paybacks to Westlands WD for Friant-Kern exchange; Includes 3,174 AF to Wheeler Ridge-Maricopa WSD for Friant-Kern exchange; Includes 632 AF to Rosedale-Rio Bravo WSD.

Table 4 (continued). 1995 State Water Project Deliveries by Contract (in acre-feet)

| District                      | No.7                  | No. 8                  | No. 9   | No. 10                                     | No. 11                                 | No. 12                                  |
|-------------------------------|-----------------------|------------------------|---|--|--|---|
|                               | Approved Transfers    |                        |   |  |  |   |
|                               | Long-Term<br>M&I Pool | Landowner<br>Transfers | Misc.<br>Transfers,<br>Exchanges,<br>Paybacks | 1995-95<br>SWP Ent.<br>Exchange<br>Payback | Kern River<br>For SWP<br>Exchange (14) | Friant-Kern<br>For SWP<br>Exchange (15) |
| Berrenda Mesa WD              |                       | (13,020) (1)           | (1,500) (5)                                   |  | (14,479)                               | (6,857)                                 |
| Lost Hills WD                 |                       | (9,227) (2)            | 1,453 (6)                                     | 5,909                                      | (7,241)                                | (5,879)                                 |
| Behridge WSD                  |                       | (5,000) (3)            | (11,141) (7)                                  | 1,000                                      | (3,699)                                | (6,812)                                 |
| Semitropic WSD                |                       | 727                    | 50,028 (8)                                    | (785)                                      |  |   |
| Cawelo WD                     |                       |                        | (33,803) (9)                                  | (4,390)                                    |  |   |
| Improvement Dist. No. 4 Ag    |                       |                        | (5)   |  |  |   |
| Improvement Dist. No. 4 M&I   | 5,050                 |                        | (23,757) (10)                                 | (2,095)                                    | (6,692)                                | (3,894)                                 |
| Rosedale-Rio Bravo WSD        |                       |                        | 3,884 (11)                                    |  |  | (1,287)                                 |
| Buena Vista WSD               |                       |                        | 103,780 (12)                                  | (639)                                      | 41,369                                 |   |
| Kern Delta WD                 |                       |                        | (25,500)                                      |  |  |   |
| Henry Miller WD               |                       | 3,500 (4)              |   |  |  | (4,000)                                 |
| West Kern WD                  | 5,050                 |                        | (40,379)                                      |  |  |   |
| Wheeler Ridge-Maricopa WSD    |                       |                        | (7,968) (13)                                  | 1,000                                      | (8,904)                                | (11,182)                                |
| Tehachapi-Cummings CWD Ag     |                       |                        |   |  |  |   |
| Tehachapi-Cummings CWD M&I    | (10,100)              |                        |   |  |  |   |
| Tejon-Castac WD               |                       |                        |   |  | (354)                                  | (89)                                    |
| Kern River Intertie           |                       |                        |   |  |  |   |
| Westlands WD                  |                       | 27,520                 | 33,158  |  |  |   |
| Tulare Lake Basin WSD         |                       |                        | 1,500   |  |  | 40,000                                  |
| Dudley Ridge WD               |                       |                        | 245   |  |  |   |
| TLBWSD (Transfer in)          |                       | (3,500)                |   |  |  |   |
| MWD (Transfer in)             |                       |                        | (50,000)                                      |  |  |   |
| Dudley Ridge WD (Transfer in) |                       | (1,000)                |   |  |  |   |
| <b>Total</b>                  | <b>0</b>              | <b>0</b>               | <b>0</b>                                      | <b>0</b>                                   | <b>0</b>                               | <b>0</b>                                |

(11) Includes Kern River water to ID4 for a like amount of SWP entitlement (6,478 AF); Includes 3,226 AF of SWP entitlement to Lost Hills WD (Paramount Farming Co.) for a like amount of Kern River water; Includes 632 AF from ID4 in exchange for future Kern River payback.

(12) Includes long-term exchange amounts from Kern Delta WD (25,500 AF), West Kern WD (40,179 AF) and Cawelo WD (33,803 AF); Includes SWP/Kern River exchange payback from ID4 (see (6)).

(13) Includes transfer of 11,142 AF to Westlands WD for future payback; includes 3,174 AF from ID4 in exchange for a Friant-Kern delivery to Arvin-Edison WSD.

(14) Exchange of Kern River water to requesting member units for a like amount of SWP entitlement delivered to Buena Vista WSD.

(15) Exchange of Friant-Kern water to requesting member units for a like amount of SWP entitlement delivered to Tulare Lake Basin WSD.

(16) Reflects member unit requests to reclassify 8,623 AF of 1994 SWP Carryover entitlement as 1995 SWP entitlement (Berrenda Mesa WD: 4,565 AF; Behridge WSD: 631 AF; Wheeler Ridge-Maricopa WSD: 3,427 AF).

(17) Reflects member unit requests to reclassify 22,387 AF of 1995 interruptible water as 1995 SWP entitlement (Berrenda Mesa WD: 4,320 AF; Lost Hills WD: 4,217 AF; Buena Vista WSD: 10,929 AF; Wheeler Ridge-Maricopa WSD: 2,921 AF).

**Table 4 (continued). 1995 State Water Project Deliveries by Contract (in acre-feet)**

| District                      | No. 13                    | No. 14                 | No. 15              | No. 16           | No. 17                  |
|-------------------------------|---------------------------|------------------------|---------------------|------------------|-------------------------|
|                               | Total SWP Water Available | In-District Deliveries | Recharge Deliveries | Total Deliveries | Balance to be Delivered |
| Berrenda Mesa WD              | 119,244                   | 88,140                 | 23,425              | 111,565          | 7,679                   |
| Lost Hills WD                 | 132,629                   | 95,121                 | 28,588              | 123,709          | 8,920                   |
| Berbridge WSD                 | 140,595                   | 112,951                | 14,062              | 127,013          | 13,582                  |
| Semitropic WSD                | 223,271                   | 223,800                |                     | 223,800          | (529)                   |
| Cawelo WD                     | 7                         | 7                      |                     | 7                | 0                       |
| Improvement Dist. No. 4 Ag    | 10,276                    |                        | 10,276              | 10,276           | 0                       |
| Improvement Dist. No. 4 M&I   | 64,262                    | 39,399                 | 22,845              | 62,244           | 2,018                   |
| Rosedale-Rio Bravo WSD        | 40,355                    | 40,355                 |                     | 40,355           | 0                       |
| Buena Vista WSD               | 165,810                   | 164,650                |                     | 164,650          | 1,160                   |
| Kern Delta WD                 | 0                         |                        |                     | 0                | 0                       |
| Henry Miller WD               | 35,000                    | 35,000                 |                     | 35,000           | 0                       |
| West Kern WD                  | 600                       | 3                      |                     | 3                | 597                     |
| Wheeler Ridge-Maricopa WSD    | 225,870                   | 158,747                | 40,420              | 199,167          | 26,703                  |
| Tehachapi-Cummings CWD Ag     | 4,300                     | 2,339                  |                     | 2,339            | 1,961                   |
| Tehachapi-Cummings CWD M&I    | 5,434                     | 3,188                  |                     | 3,188            | 2,246                   |
| Tejon-Castac WD               | 1,557                     |                        | 1,557               | 1,557            | 0                       |
| Kern River Intertie           | 11,850                    |                        | 11,850              | 11,850           | 0                       |
| Westlands WD                  | 60,678                    | 60,678                 |                     | 60,678           | 0                       |
| Tulare Lake Basin WSD         | 41,500                    | 41,500                 |                     | 41,500           | 0                       |
| Dudley Ridge WD               | 245                       | 245                    |                     | 245              | 0                       |
| TLBWSD (Transfer in)          |                           |                        |                     | 0                | 0                       |
| MWD (Transfer in)             |                           |                        |                     | 0                | 0                       |
| Dudley Ridge WD (Transfer in) |                           |                        |                     | 0                | 0                       |
| <b>Total</b>                  | <b>1,283,483</b>          | <b>1,066,123</b>       | <b>153,023</b>      | <b>1,219,146</b> | <b>64,337</b>           |

normal the prior year. A comparison of the snowpack in the Kern River watershed during 1993-95 with the historic average (inches of water content) is shown as follows:

|                    | <u>Apr 1</u><br><u>1993</u> | <u>Apr 1</u><br><u>1994</u> | <u>Apr 1</u><br><u>1995</u> | <u>Apr 1</u><br><u>Avg.</u> | <u>1995 %</u><br><u>of Avg.</u> |
|--------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------------|
| Upper Tyndall Cr.  | 34.0                        | 15.5                        | 34.0                        | 27.7                        | 123                             |
| Crabtree Meadow    | 22.7                        | 10.3                        | 27.7                        | 19.8                        | 140                             |
| Chagoopa           | 32.7                        | 13.7                        | 34.6                        | 21.8                        | 159                             |
| Pascoe             | 40.0                        | 18.7                        | 53.8                        | 24.9                        | 216                             |
| Wet Meadow         | 37.3                        | 7.5                         | 43.2                        | 30.3                        | 143                             |
| Tunnel Guard       | 21.6                        | 4.4                         | 27.1                        | 15.6                        | 174                             |
| Casa Vieja Meadows | 28.1                        | 10.5                        | 29.5                        | 20.9                        | 141                             |
| Beach Meadows      | 12.6                        | 0.4                         | 13.2                        | 11.0                        | 120                             |
| Average            | 28.6                        | 10.1                        | 32.9                        | 21.5                        | 153                             |

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

|               |                      |
|---------------|----------------------|
| February 1995 | 119% of average      |
| March         | 106%                 |
| April         | 174%                 |
| May           | 178%                 |
| Final         | 191% (actual runoff) |

Table 5 shows historic Kern River runoff and cumulative runoff for the 102 years of complete record, including diversions above First Point of Measurement. In 1995 a total of 1,197,100 acre-feet of Kern River water flowed past First Point of Measurement. An additional 3,584 acre-feet was diverted above First Point. Total 1995 Kern River flows were 1,200,684 acre-feet, about 166 percent of average. During the last 102 years, the Kern River has yielded over 73 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 1995.

### Central Valley Project (CVP)

Like the SWP, water available from the CVP in 1995 reflected the wet year conditions. Full supplies of Class I and II contract amounts were available. Beginning in February 1995 "Section 215" floodwater became available, and remained available for several months in order to relieve flooding in the Central Valley. Large amounts of floodwater were delivered for groundwater recharge and banking.

In 1995 deliveries of CVP water to Kern County totaled 647,077 acre-feet, about 350 percent more than in 1994. Original Friant-Kern and CVP Delta allocations on February 15, 1995 were: Friant-Kern contractors - 100 percent Class I and Class II water; CVP Delta contractors - 60 percent of Class I water. By April the allocation had improved to 100 percent of Class I for CVP Delta contractors. Following is a chronology of CVP water allocations:

Figure 4. Kern River Regulated Flows at First Point of Measurement

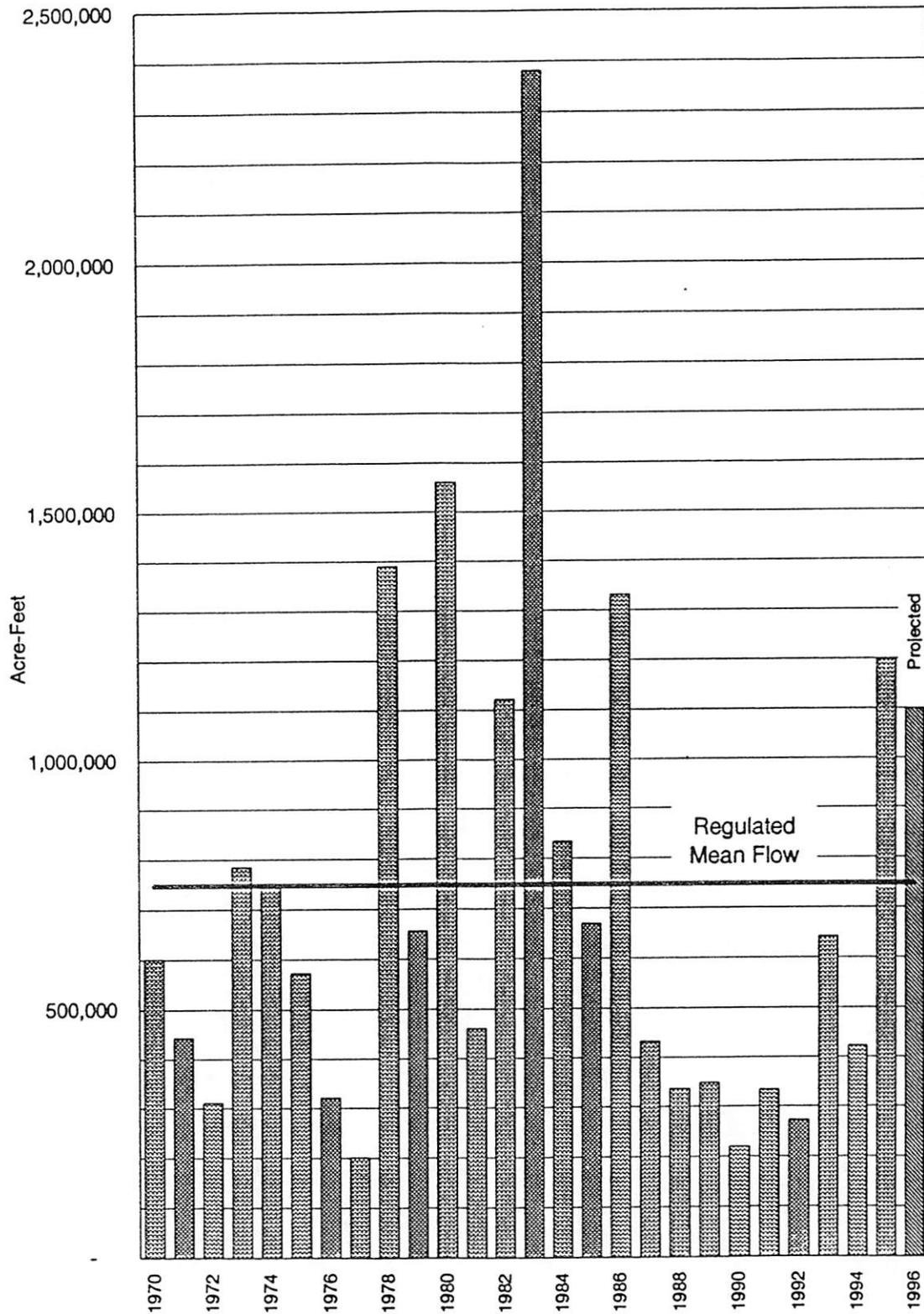


Table 5. Kern River Flows (in acre-feet)

| Calendar Year | Natural Flows | Cumulative Natural Flows | Calendar Year | Natural Flows | Regulated (1) Flows | Cumulative Flows |           |
|---------------|---------------|--------------------------|---------------|---------------|---------------------|------------------|-----------|
|               |               |                          |               |               |                     | Natural          | 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       | 9,887,797                | 1942          | 771,966       |                     | 34,968,734       |           |
| 1908          | 498,503       | 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       | 510,320 (2)         | 43,064,681       | 510,320   |
| 1920          | 600,643       | 21,393,811               | 1955          | 444,300       | 367,783             | 43,508,981       | 878,103   |
| 1921          | 509,519       | 21,903,330               | 1956          | 840,862       | 755,500             | 44,349,843       | 1,633,603 |
| 1922          | 861,426       | 22,764,756               | 1957          | 444,338       | 445,859             | 44,794,181       | 2,079,462 |
| 1923          | 500,515       | 23,265,271               | 1958          | 1,104,730     | 967,511             | 45,898,911       | 3,046,973 |
| 1924          | 187,727       | 23,452,998               | 1959          | 257,978       | 353,165             | 46,156,889       | 3,400,138 |
| 1925          | 465,913       | 23,918,911               | 1960          | 300,037       | 324,088             | 46,456,926       | 3,724,226 |
| 1926          | 366,706       | 24,285,617               | 1961          | 177,642       | 177,063             | 46,634,568       | 3,901,289 |
| 1927          | 792,580       | 25,078,197               | 1962          | 697,704       | 607,848             | 47,332,272       | 4,509,137 |
| 1928          | 312,828       | 25,391,025               | 1963          | 801,450       | 676,237             | 48,133,722       | 5,185,374 |
| 1929          | 322,958       | 25,713,983               | 1964          | 339,266       | 361,624             | 48,472,988       | 5,546,998 |
| 1930          | 349,973       | 26,063,956               | 1965          | 720,362       | 634,303             | 49,193,350       | 6,181,301 |

(1) Regulated flows do not include deliveries above First Point.

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

**Table 5 (continued). Kern River Flows (in acre-feet)**

| Calendar Year | Natural Flows | Regulated (1) Flows | Cumulative Flows |            |
|---------------|---------------|---------------------|------------------|------------|
|               |               |                     | Natural          | Regulated  |
| 1966          | 678,595       | 504,506             | 49,871,945       | 6,685,807  |
| 1967          | 1,396,227     | 1,465,855           | 51,268,172       | 8,151,662  |
| 1968          | 453,760       | 497,026             | 51,721,932       | 8,648,688  |
| 1969          | 2,461,370     | 2,313,769           | 54,183,302       | 10,962,457 |
| 1970          | 589,474       | 601,254             | 54,772,776       | 11,563,711 |
| 1971          | 427,454       | 442,651             | 55,200,230       | 12,006,362 |
| 1972          | 268,427       | 311,291             | 55,468,657       | 12,317,653 |
| 1973          | 979,652       | 785,133             | 56,448,309       | 13,102,786 |
| 1974          | 818,608       | 745,903             | 57,266,917       | 13,848,689 |
| 1975          | 564,567       | 572,091             | 57,831,484       | 14,420,780 |
| 1976          | 249,468       | 320,784             | 58,080,952       | 14,741,564 |
| 1977          | 196,998       | 200,702             | 58,277,950       | 14,942,266 |
| 1978          | 1,653,505     | 1,390,675           | 59,931,455       | 16,332,941 |
| 1979          | 672,661       | 656,068             | 60,604,116       | 16,989,009 |
| 1980          | 1,639,957     | 1,560,652           | 62,244,073       | 18,549,661 |
| 1981          | 449,263       | 460,469             | 62,693,336       | 19,010,130 |
| 1982          | 1,271,139     | 1,121,088           | 63,964,475       | 20,131,218 |
| 1983          | 2,489,128     | 2,381,575           | 66,453,603       | 22,512,793 |
| 1984          | 821,797       | 834,036             | 67,275,400       | 23,346,829 |
| 1985          | 672,431       | 668,971             | 67,947,831       | 24,015,800 |
| 1986          | 1,444,939     | 1,331,561           | 69,392,770       | 25,347,361 |
| 1987          | 375,935       | 432,309             | 69,768,705       | 25,779,670 |
| 1988          | 294,685       | 335,473             | 70,063,390       | 26,115,143 |
| 1989          | 397,038       | 348,773             | 70,460,428       | 26,463,916 |
| 1990          | 203,571       | 219,501             | 70,663,999       | 26,683,417 |
| 1991          | 406,289       | 333,494             | 71,070,288       | 27,016,911 |
| 1992          | 296,829       | 272,822             | 71,367,117       | 27,289,733 |
| 1993          | 853,760       | 642,339             | 72,220,877       | 27,932,072 |
| 1994          | 336,456       | 422,361             | 72,557,333       | 28,354,433 |
| 1995          | 1,385,160     | 1,197,100           | 73,942,493       | 29,551,533 |

|   |            |   |              |
|---|------------|---|--------------|
| 102 Year Mean Natural First Point Flow    | 724,900 AF | Minimum Natural First Point Flow (1961)   | 177,642 AF   |
| 102 Year Median Natural First Point Flow  | 564,600 AF | Maximum Natural First Point Flow (1916)   | 2,520,149 AF |
| 42 Year Mean Regulated First Point Flow   | 703,600 AF | Minimum Regulated First Point Flow (1961) | 177,063 AF   |
| 42 Year Median Regulated First Point Flow | 572,100 AF | Maximum Regulated First Point Flow (1983) | 2,381,575 AF |

**Table 6. 1995 Kern River Water Diversions by Entity (in acre-feet)**

| Area of Use  | Diversions       |
|--|------------------|
| <b>Above First Point</b>                                     |                  |
| Kern Valley Golf Course (Kernville)                          | 177              |
| La Hacienda, Inc.  | 1,142            |
| Lake Ming  | 790              |
| Olcese WD  | 1,475            |
| <b>Subtotal</b>  | <b>3,584</b>     |
| <b>Below First Point</b>                                     |                  |
| Arvin-Edison WSD   | 10,601           |
| Buena Vista WSD  | 152,867          |
| Cawelo WD  | 68,967           |
| City of Bakersfield, Irrigation and Spreading <sup>(1)</sup> | 97,870           |
| County of Kern (at Second Point)                             | 3,060            |
| Hacienda WD/Paramount Farming Co.                            | 79,232           |
| Improvement District No. 4                                   | 69,486           |
| Kern County Water Agency                                     | 35,000           |
| Kern Delta WD  | 221,102          |
| North Kern WSD   | 339,558          |
| Olcese WD  | 6,028            |
| Rosedale Ranch Improvement District                          | 16,360           |
| Rosedale-Rio Bravo WSD                                       | 96,089           |
| South Fork   | 880              |
| <b>Subtotal</b>  | <b>1,197,100</b> |
| <b>Total</b>   | <b>1,200,684</b> |

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<sup>(1)</sup> Includes Kern River Canal & Irrigating Company deliveries, Truxtun Lakes deliveries, Carrier Canal losses and percolation, Kern River channel losses and percolation.

|                   | <u>Friant-Kern Supplies</u>                  | <u>CVP Delta Supplies</u>                 |
|-------------------|--|---|
| February 15, 1995 | 100 percent Class I,<br>100 percent Class II | 60 percent Class I                        |
| March 7           | (no change)                                  | (no change)                               |
| April 11          | (no change)                                  | 100 percent Class I<br>(final allocation) |

Table 7 shows 1995 deliveries of CVP water by entity. As shown, 100,662 acre-feet of Class I entitlement and 347,232 acre-feet of Class II water was delivered. A total of 136,081 acre-feet of "Section 215" water was delivered, most of which was delivered by Kern County Water Agency for groundwater recharge and banking programs. Another 63,102 acre-feet of other CVP water was delivered, again mostly by KCWA for groundwater programs.

High turbidity problems on the California Aqueduct made SWP water undesirable for groundwater recharge. Nearly 1 million cubic yards of fine-grained silt were washed into the California Aqueduct during the March 9-11, 1995 flood event. Two bridges on Interstate 5 in Fresno County were washed out by flows on Arroyo Pasajero Creek, killing seven people. The same creek breached the California Aqueduct, washing tons of silt and sediment into the Aqueduct.

Since 1995 was an extremely wet year, Kern County water users wanted to maximize groundwater recharge programs. In order to move forward with recharge programs, KCWA arranged an exchange of SWP water for Friant-Kern supplies, which did not have high turbidities. SWP supplies were delivered to CVP contractors above the California Aqueduct breach (where turbidity was not a problem), and a like amount of Friant-Kern water was delivered via the Friant-Kern Canal into the Kern River channel, and hence to groundwater recharge areas. This program demonstrated the ingenuity of local water managers, as well as the synergy that exists between the two water supply projects. Delivering large amounts of water into Kern County from the Friant-Kern system alleviated potential flooding problems in the Central Valley, and also allowed an important groundwater program to continue.

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 1995, 13.2 million acre-feet of CVP water was imported into Kern County.

## Minor Streams

Local "minor stream" watersheds are the second largest local source of surface 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 gauging 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 cooperation 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

**Table 7. 1995 Central Valley Project Deliveries by Entity<sup>(1)</sup> (in acre-feet)**

|   | Class I        | Class II       | 215 Water      | Other <sup>(3)</sup><br>Water | Total          |
|---|----------------|----------------|----------------|-------------------------------|----------------|
| Arvin-Edison WSD                        | 12,315         | 209,212        | 2,889          | 11,732                        | 236,148        |
| Cawelo WD                               |                |                | 2,000          |                               | 2,000          |
| Delano-Earlimart ID                     | 8,895          | 4,884          | 10,401         | 336                           | 24,516         |
| Kern County Water Agency <sup>(4)</sup> | 1,460          | 28,300         | 78,862         | 48,128                        | 156,750        |
| Kern-Tulare WD <sup>(2)</sup>           | 64             | 4,667          |                | 107                           | 4,837          |
| North Kern WSD                          |                |                | 9,989          |                               | 9,989          |
| Rag Gulch WD <sup>(2)</sup>             |                | 1,863          |                | 11                            | 1,874          |
| Rosedale-Rio Bravo WSD                  |                | 19,515         |                |                               | 19,515         |
| Semitropic WSD                          | 2,400          | 2,452          | 894            |                               | 5,746          |
| Shafter-Wasco ID                        | 30,164         | 26,339         | 10,399         | 1,760                         | 68,662         |
| So. San Joaquin MUD                     | 45,365         | 50,000         | 20,647         | 1,028                         | 117,040        |
| <b>Total</b>                            | <b>100,662</b> | <b>347,232</b> | <b>136,081</b> | <b>63,102</b>                 | <b>647,077</b> |

<sup>(1)</sup> Quantities for water year March 1995 - February 1996.

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

<sup>(3)</sup> Includes M&I water, operational spill water and non-project water delivered via CVP.

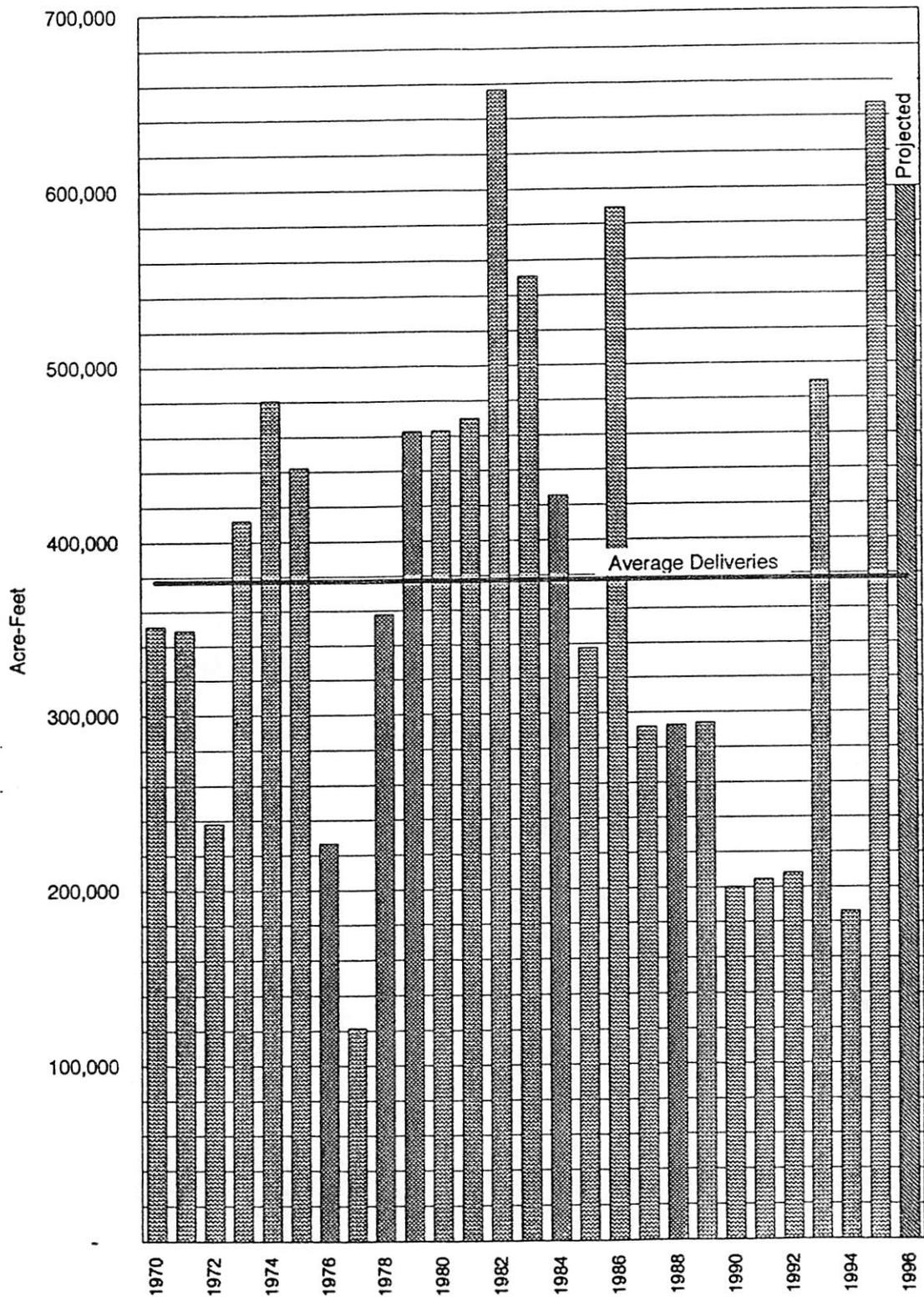
<sup>(4)</sup> Deliveries for KCWA are in dispute.

**Table 8. 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           | 1995 | 647,077         | 13,273,279          |
| 1966 | 232,084         | 2,625,517           |      |                 |                     |
| 1967 | 319,706         | 2,945,223           |      |                 |                     |
| 1968 | 206,499         | 3,151,722           |      |                 |                     |
| 1969 | 372,826         | 3,524,548           |      |                 |                     |
| 1970 | 351,392         | 3,875,940           |      |                 |                     |
| 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           |      |                 |                     |

|                       |            |                              |            |
|-----------------------|------------|------------------------------|------------|
| Mean Delivery         | 288,550 AF | Median Delivery 1975-95      | 357,847 AF |
| Median Delivery       | 241,979 AF | Min. Delivery 1975-95 (1977) | 121,469 AF |
| Mean Delivery 1975-95 | 377,012 AF | Max. Delivery 1975-95 (1982) | 656,608 AF |

Figure 5. Central Valley Project Deliveries to Kern County



gauge to record. Total minor stream volumes in 1995 were estimated to be about 161,900 acre-feet as follows;

| <u>Stream Group</u> | <u>Acre-feet</u> |
|---------------------|------------------|
| Poso                | 62,300           |
| Caliente            | 2,800            |
| El Paso             | 20,300           |
| San Emigdio         | <u>36,500</u>    |
| Total               | 161,900          |

Farmers in the North Kern Water Storage District and Semitropic Water Storage District occasionally use some minor stream water for irrigation. Much of the remaining water percolates to the underlying aquifer. Some of this recharge probably contributes to shallow groundwater in the Kern Lake Bed area and near the Kern National Wildlife Refuge. KCWA estimated that about 153,800 acre-feet of the minor stream flows during 1995 contributed to groundwater recharge. The remainder was mostly lost to evaporation. Table 9 shows annual minor stream runoff, 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 1995. Figure 7b shows cumulative runoff for Poso Creek for the year. Normally, hydrographs for Tehachapi Creek would also be included. However problems with the flow gauge prevented KCWA from developing hydrographs for Tehachapi Creek.

## 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 groundwater 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 the soil profile before the crop can use it. 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 groundwater, particularly during early stages of crop growth. In addition, heavy rain immediately after an irrigation cycle may not be usable by the crop.

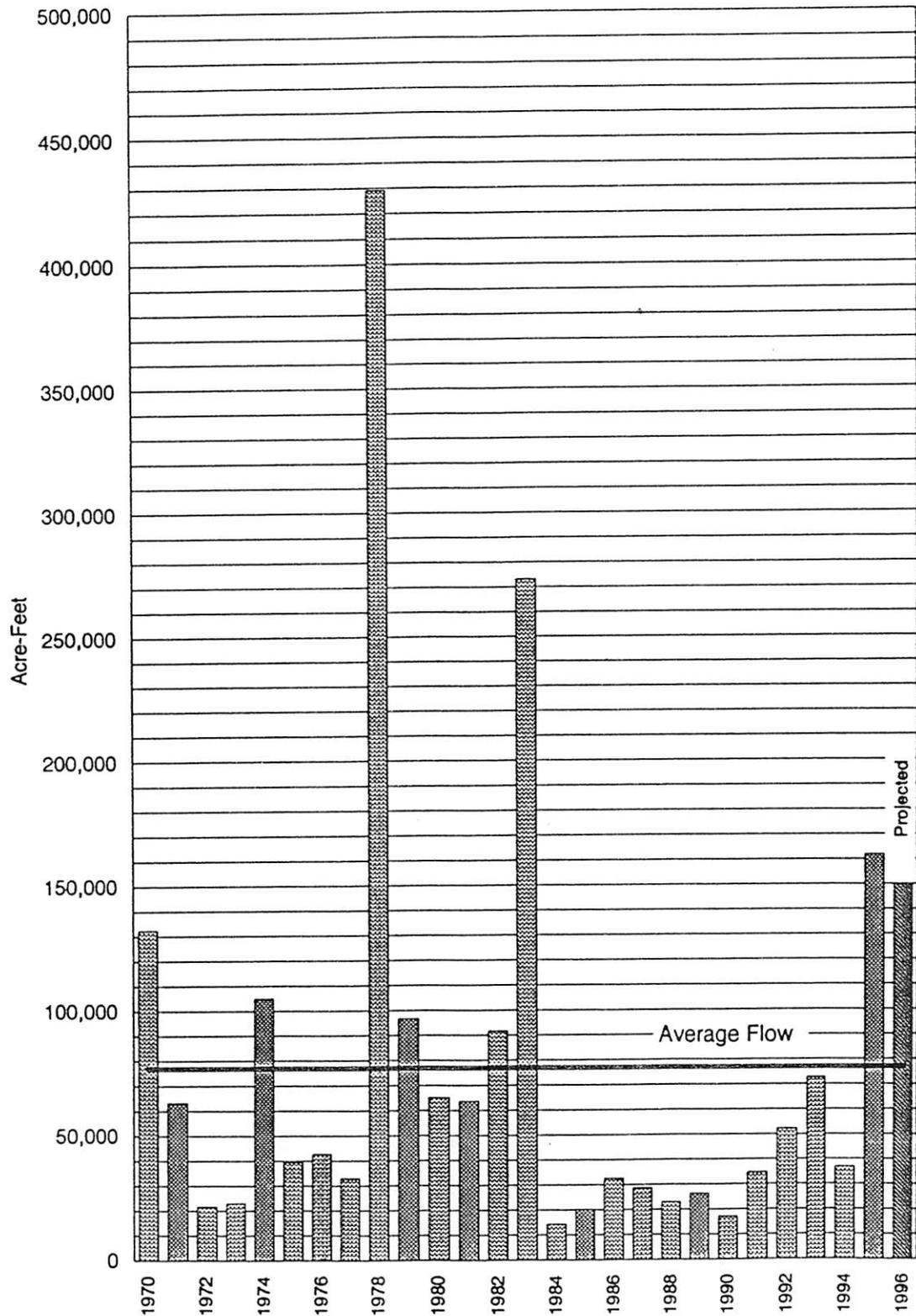
Most urban storm runoff is captured in unlined sumps and allowed to percolate. It is not usually measured. A small amount of storm runoff is diverted into the Kern River, where it becomes available for delivery or recharge. About 200 acre-feet of urban storm runoff was diverted into the Kern River system in 1995.

KCWA gathers monthly rainfall data for most of the measuring stations in the San Joaquin Valley portion of Kern County. Data for some mountain stations are also gathered. This rainfall data is subsequently used to compute effective precipitation and minor stream runoffs. Table 10 gives monthly rainfall for every measuring station gathered by KCWA. Rainfall in 1995 contributed 192,400 acre-feet of effective precipitation, with 170,500 acre-feet occurring over the usable groundwater basin. This excludes the urban storm water diverted into the Kern River. Rainfall at

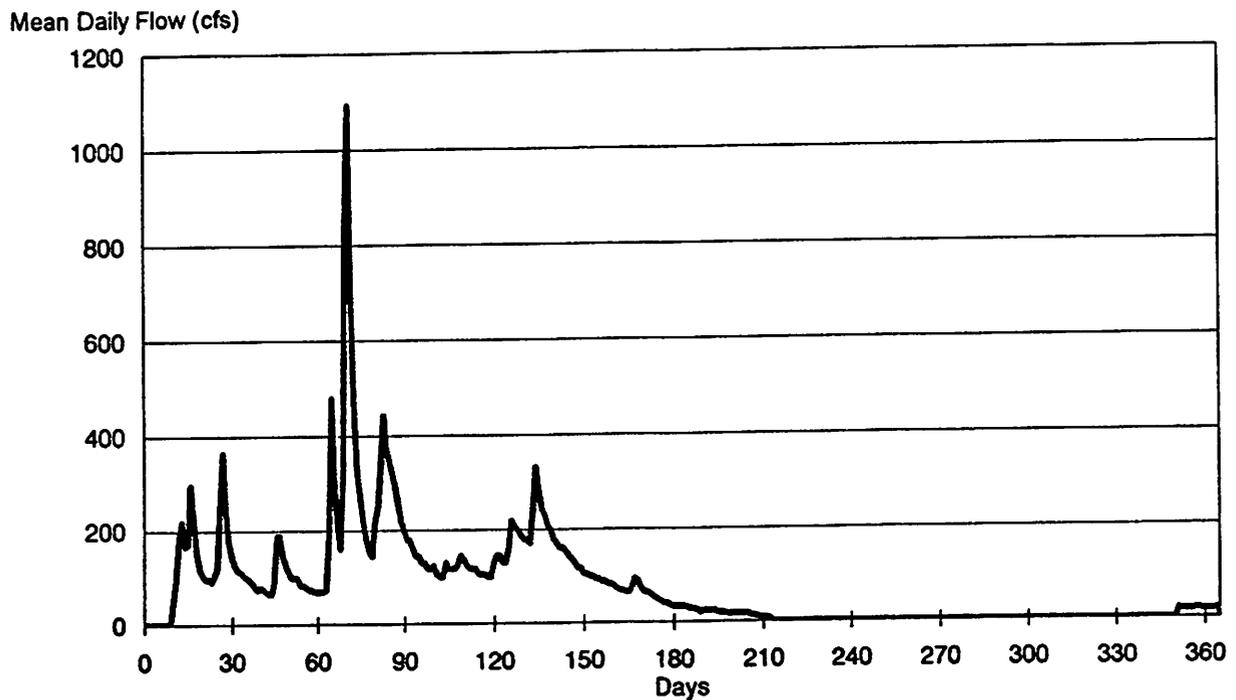
**Table 9. Minor Stream Flows in the San Joaquin Valley Portion of Kern County (in acre-feet)**

| <b>Year</b>                | <b>Annual Stream Flows</b> | <b>Cumulative Stream Flows</b> |
|----------------------------|----------------------------|--------------------------------|
| 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                     | 1,765,200                      |
| 1995                       | 161,900                    | 1,963,200                      |
| <b>Mean Flow</b>           |                            | <b>76,900 AF</b>               |
| <b>Median Flow</b>         |                            | <b>41,100 AF</b>               |
| <b>Minimum Flow (1984)</b> |                            | <b>14,300 AF</b>               |
| <b>Maximum Flow (1978)</b> |                            | <b>429,200 AF</b>              |

Figure 6. Minor Stream Flows in the San Joaquin Valley Portion of Kern County

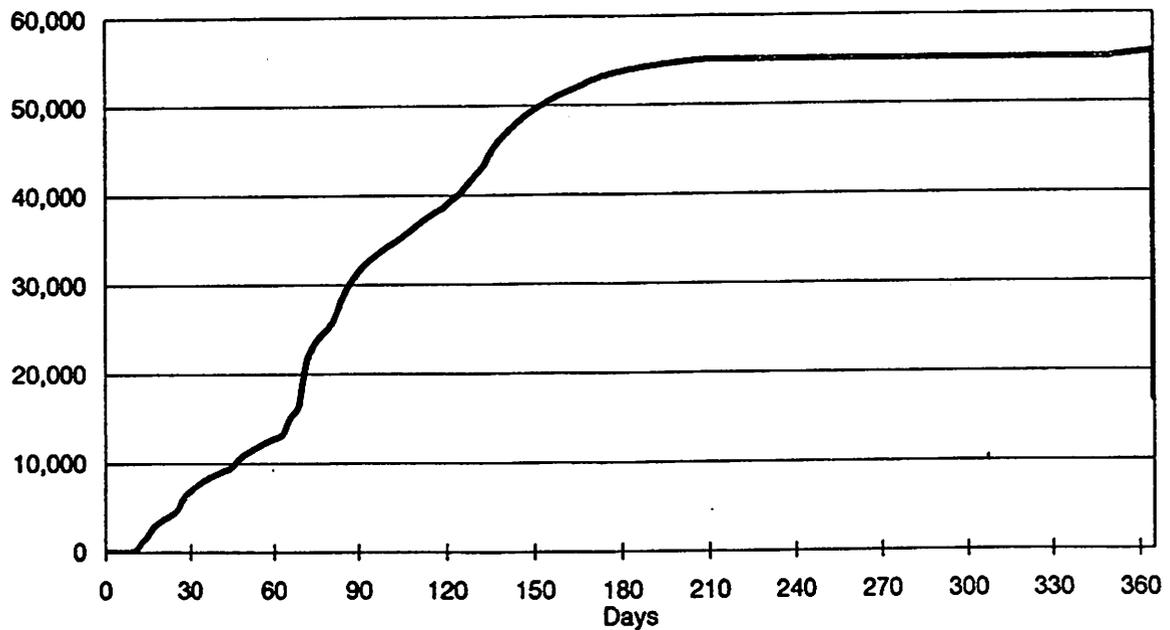


**Figure 7a. Poso Creek Hydrograph, 1995**



- Note:
1. Hydrograph began 0000 hrs on 1/1/95 and ended at 2400 hrs on 12/31/1995.
  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, 1,093 cfs, 3/12/95.

**Figure 7b. Poso Creek Cumulative Volumes, 1995**



|                        | Jan   | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec    |
|------------------------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Volume (AF)            | 7,112 | 5,435  | 18,885 | 7,440  | 10,838 | 4,114  | 1,284  | 6      | 0      | 0      | 0      | 571    |
| Cumulative Volume (AF) | 7,112 | 12,548 | 31,433 | 38,872 | 49,711 | 53,825 | 55,108 | 55,114 | 55,108 | 55,108 | 55,108 | 55,879 |

**Table 10. 1995 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 |
|--|-------------|-------------|-------|------|-------|------|------|------|------|------|-----|------|------|------|-------|
| <b>ARVIN-EDISON WATER STORAGE DISTRICT</b>           |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| District Headquarters                                | 500         | 31S/30E-29  | 3.33  | 1.53 | 4.56  | 1.54 | 0.79 | 0.16 | 0    | 0    | 0   | 0    | 0.04 | 1.79 | 13.74 |
| Sycamore   | 420         | 31S/30E-20  | 2.98  | 1.37 | 4.11  | 1.28 | 0.63 | 0.14 | 0    | 0    | 0   | 0    | 0.05 | 1.73 | 12.29 |
| Tejon  | 480         | 32S/29E-15  | 2.82  | 1.50 | 3.40  | 1.64 | 0.54 | 0.08 | 0    | 0    | 0   | 0    | 0.07 | 0.86 | 10.91 |
| <b>CALIFORNIA DEPARTMENT OF WATER RESOURCES</b>      |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| Lost Hills O&M Center                                | 300         | 27S/21E-03  | 3.58  | 0.61 | 4.65  | 0.35 | 0.25 | 0.15 | 0    | 0    | 0   | 0    | 0    | 0.30 | 9.89  |
| Wind Gap O&M Center                                  | 780         | 11N/20W-26  | 2.72  | 1.17 | 5.21  | 1.56 | 0.40 | 0.02 | 0    | 0    | 0   | 0    | 0    | 0.76 | 11.84 |
| Bakersfield 12S                                      | 300         | 31S/27E-36D | 2.39  | 1.26 | 3.37  | 0.97 | 0.21 | 0    | 0    | 0    | 0   | 0.05 | 0.05 | 0.91 | 9.21  |
| Bakersfield 14W                                      | 310         | 30S/25E-04R | 2.77  | 1.18 | 3.74  | 0.88 | 0.34 | 0.10 | 0    | 0    | 0   | 0.07 | 0.08 | 1.03 | 10.19 |
| <b>J.G. BOSWELL COMPANY</b>                          |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| Kern Lake Shop                                       | 280         | 32S/28E-18  | 2.31  | 1.67 | 3.45  | 0.88 | 0.17 | 0    | 0    | 0    | 0   | 0    | 0.07 | 0.78 | 9.33  |
| Paloma   | 290         | 32S/24E-02  | 2.04  | 1.11 | 3.51  | 0.64 | 0.17 | 0.18 | 0    | 0    | 0   | 0    | 0.12 | 0.79 | 8.56  |
| Kern Lake Time Room                                  | 280         | 32S/27E-16  | 2.38  | 1.44 | 3.55  | 0.85 | 0.16 | 0    | 0    | 0    | 0   | 0    | 0.13 | 0.89 | 9.40  |
| Buena Vista Gin                                      | 300         | 32S/25E-12  | 2.69  | 1.29 | 3.47  | 0.44 | 0.27 | 0.14 | 0    | 0    | 0   | 0    | 0.11 | 0.63 | 9.04  |
| Buena Vista #4                                       | 300         | 32S/25E-06  | 3.20  | 1.74 | 4.05  | 0.62 | 0.22 | 0.10 | 0    | 0    | 0   | 0    | 0.10 | 0.69 | 10.72 |
| Buena Vista Office                                   | 290         | 31S/25E-25  | 2.33  | 2.01 | 3.31  | 0.71 | 0.23 | 0.08 | 0    | 0    | 0   | 0    | 0.07 | 0.87 | 9.61  |
| <b>KERN COUNTY PLANNING DEPARTMENT</b>               |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| Edmonston Pump Station                               | 1,310       | 10N/18W-17M | 10.53 | 1.10 | 7.41  | 2.99 | 1.01 | 0.33 | 0    | 0.03 | 0   | 0    | 0.08 | 1.61 | 25.09 |
| Arvin Fire Station                                   | 450         | 31S/29E-28  | 2.37  | 1.23 | 3.35  | 0.75 | 0.35 | 0.13 | 0    | 0    | 0   | 0    | 0.01 | 1.04 | 9.23  |
| Buttonwillow Fire Station                            | 270         | 29S/23E-14  | 2.92  | 0.88 | 3.86  | 0.43 | 0.19 | 0.08 | 0    | 0    | 0   | 0    | 0    | 0.43 | 8.79  |
| Buena Vista Aquatic Rec Area                         | 300         | 31S/25E-15  | 1.88  | 1.10 | 3.31  | 0.41 | 0.24 | 0.08 | 0    | 0    | 0   | 0    | 0.10 | 0.83 | 7.95  |
| Communications Center                                | 770         | 29S/28E-16  | 2.40  | 1.00 | 3.15  | 0.62 | 0.28 | 0.20 | 0    | 0.02 | 0   | 0    | 0    | 1.96 | 9.63  |
| McFarland Fire Station                               | 350         | 26S/25E-10  | 3.19  | 0.55 | 4.24  | 0.52 | 0.52 | 0.05 | 0    | 0.02 | 0   | 0    | 0    | 1.73 | 10.82 |
| Rio Bravo Fire Station                               | 610         | 29S/29E-04  | 3.01  | 0.77 | 3.14  | 0.73 | 0.35 | 0.12 | 0    | 0    | 0   | 0    | 0    | 1.97 | 10.09 |
| Pine Mountain  | 520         | 09N/21W-19  | 14.96 | 1.66 | 10.01 | 1.64 | 1.04 | 0.41 | 0.11 | 0.04 | 0   | 0    | 0.14 | 2.92 | 32.93 |
| <b>NATIONAL WEATHER SERVICE</b>                      |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| Piute  | 4,290       | 29S/33E-36  | 6.94  | 0.73 | 4.17  | 0.76 | 0.92 | 0.33 | 0    | 0.32 | 0   | 0    | 0.02 | 2.55 | 16.74 |
| Maricopa   | 700         | 10N/24W-11  |       |      |       |      |      |      |      |      |     |      |      |      | 0     |
| Bakersfield NWS                                      | 380         | 30S/28E-08  | 2.29  | 0.87 | 3.39  | 0.79 | 0.35 | 0.12 | 0    | 0    | 0   | 0    | 0    | 2.03 | 9.84  |
| Wasco  | 300         | 27S/24E-11  | 3.02  | 0.67 | 4.26  | 0.53 | 0.59 | 0.08 | 0    | 0    | 0   | 0    | 0    | 0.83 | 9.98  |
| Woody  | 1,600       | 25S/29E-35  | 5.75  | 1.50 | 5.94  | 1.74 | 1.49 | 0.47 | 0    | 0    | 0   | 0.02 | 0    | 2.32 | 19.23 |
| Keene  | 2,900       | 31S/32E-20  | 8.17  | 0.79 | 5.88  | 2.15 | 1.71 | 0.33 | 0    | 0.26 | 0   | 0    | 0    | 2.06 | 21.35 |
| Tehachapi  | 3,980       | 32S/33E-21  | 9.09  | 0.49 | 6.24  | 1.31 | 0.86 | 0.14 | 0.05 | 0.63 | 0   | 0    | 0.05 | 1.05 | 19.91 |
| Lost Hills   | 280         | 26S/21E-35  | 3.27  | 0.59 | 4.61  | 0.36 | 0.25 | 0.20 | 0    | 0    | 0   | 0    | 0    | 0.31 | 9.59  |
| Glenville  | 3,100       | 25S/30E-25  | 8.46  | 2.35 | 7.70  | 2.40 | 1.81 | 0.47 | 0    | 0    | 0   | 0    | 0    | 1.51 | 24.70 |
| Bear Valley  | 4,100       | 32S/31E-03  | 9.02  | 1.28 | 6.65  | 3.40 | 2.44 | 0.52 | 0    | 0.25 | 0   | 0    | 0.05 | 3.29 | 26.90 |
| Lebec  | 3,600       | 09N/19W-26  | 12.53 | 0.54 | 5.85  | 2.05 | 1.27 | 0    | 0    | 0    | 0   | 0    | 0    | 2.05 | 24.29 |
| Delano   | 320         | 25S/25E-S11 | 2.67  | 0.83 | 4.57  | 0.60 | 1.11 | 0.28 | 0    | 0    | 0   | 0    | 0    | 0.87 | 10.93 |
| <b>TEHACHAPI-CUMMINGS COUNTY WATER DISTRICT</b>      |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| Station 6  | 4,890       | 12N/15W-01  | 14.37 | 0.70 | 7.50  | 2.53 | 1.35 | 0.23 | 0.15 | 0.95 | 0   | 0    | 0.15 | 1.50 | 29.43 |
| Station 20   | 5,730       | 12N/15W-12  | 14.68 | 0.83 | 9.10  | 3.13 | 2.05 | 0.35 | 0.20 | 1.13 | 0   | 0    | 0.20 | 2.15 | 33.82 |
| <b>WHEELER RIDGE-MARICOPA WATER STORAGE DISTRICT</b> |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| District Headquarters                                | 480         | 11N/12W-11  | 2.72  | 1.11 | 4.37  | 1.12 | 0.52 | 0.05 | 0    | 0    | 0   | 0.17 | 0    | 0.46 | 10.52 |
| PA-2   | 960         | 11N/19W-30  | 2.59  | 0.72 | 4.59  | 1.50 | 0.84 | 0.68 | 0    | 0    | 0   | 0.16 | 0    | 1.11 | 12.19 |
| WRM-2  | 510         | 32S-24E-35  | 1.91  | 1.16 | 3.50  | 0.81 | 0.64 | 0.10 | 0    | 0    | 0   | 0.23 | 0    | 0.52 | 8.87  |
| SP-P2  | 590         | 11N/22W-09  | 2.34  | 1.34 | 4.23  | 1.24 | 0.22 | 0.08 | 0    | 0    | 0   | 0.17 | 0    | 0.52 | 10.14 |
| Spill Basin  | 850         | 11N/18W-31  | 3.18  | 0.91 | 4.68  | 1.74 | 0.58 | 0.12 | 0    | 0    | 0   | 0.13 | 0    | 0.58 | 11.92 |
| Greenlee's Pasture                                   | 380         | 12N/21W-36  | 2.60  | 1.18 | 3.99  | 0.96 | 0.65 | 0.09 | 0    | 0    | 0   | 0.17 | 0    | 0.46 | 10.10 |
| <b>OTHER OPERATORS</b>                               |             |             |       |      |       |      |      |      |      |      |     |      |      |      |       |
| City of Bakersfield DWR Yd.                          | 400         | 30S/27E-06  | 2.17  | 1.17 | 3.81  | 0.64 | 0.46 | 0.16 | 0    | 0    | 0   | 0.03 | 0    | 1.16 | 9.60  |
| Del Kern Station (KDWD)                              | 350         | 31S/28E-06C | 2.52  | 1.30 | 4.44  | 0.65 | 0.31 | 0.04 | 0    | 0.04 | 0   | 0    | 0.04 | 1.16 | 10.50 |
| Belridge WSD Office                                  | 550         | 28S/21E-34  | 3.55  | 0.70 | 4.60  | 0.80 | 0.30 | 0    | 0    | 0    | 0   | 0    | 0    | 0.45 | 10.40 |
| Blackwell's Corner (BMWD)                            | 630         | 27S/20E-06  | 4.42  | 0.47 | 4.59  | 0.39 | 0.19 | 0.30 | 0    | 0    | 0   | 0    | 0    | 0.46 | 10.82 |
| Shafter Cotton Research Sta.                         | 370         | 27S/25E-33J | 3.06  | 1.32 | 4.76  | 0.65 | 0.65 | 0.18 | 0    | 0    | 0   | 0    | 0.01 | 1.45 | 12.08 |
| So. Belridge (Cal Resources)                         | 600         | 28S/21E-33  | 4.14  | 0.52 | 5.26  | 0.31 | 0.13 | 0    | 0    | 0    | 0   | 0.06 | 0    | 0.71 | 11.13 |

Note: Boxed numbers are estimated values.

Meadows Field in 1995 was 171 percent of normal, about 50 percent higher than 1994. Following is a tabulation of 1992-95 and average monthly rainfall for Meadows Field near Bakersfield. KCWA estimates that rainfall provided about 2.7 inches of usable water for crops grown during 1995.

#### Rainfall at Meadows Field, Bakersfield

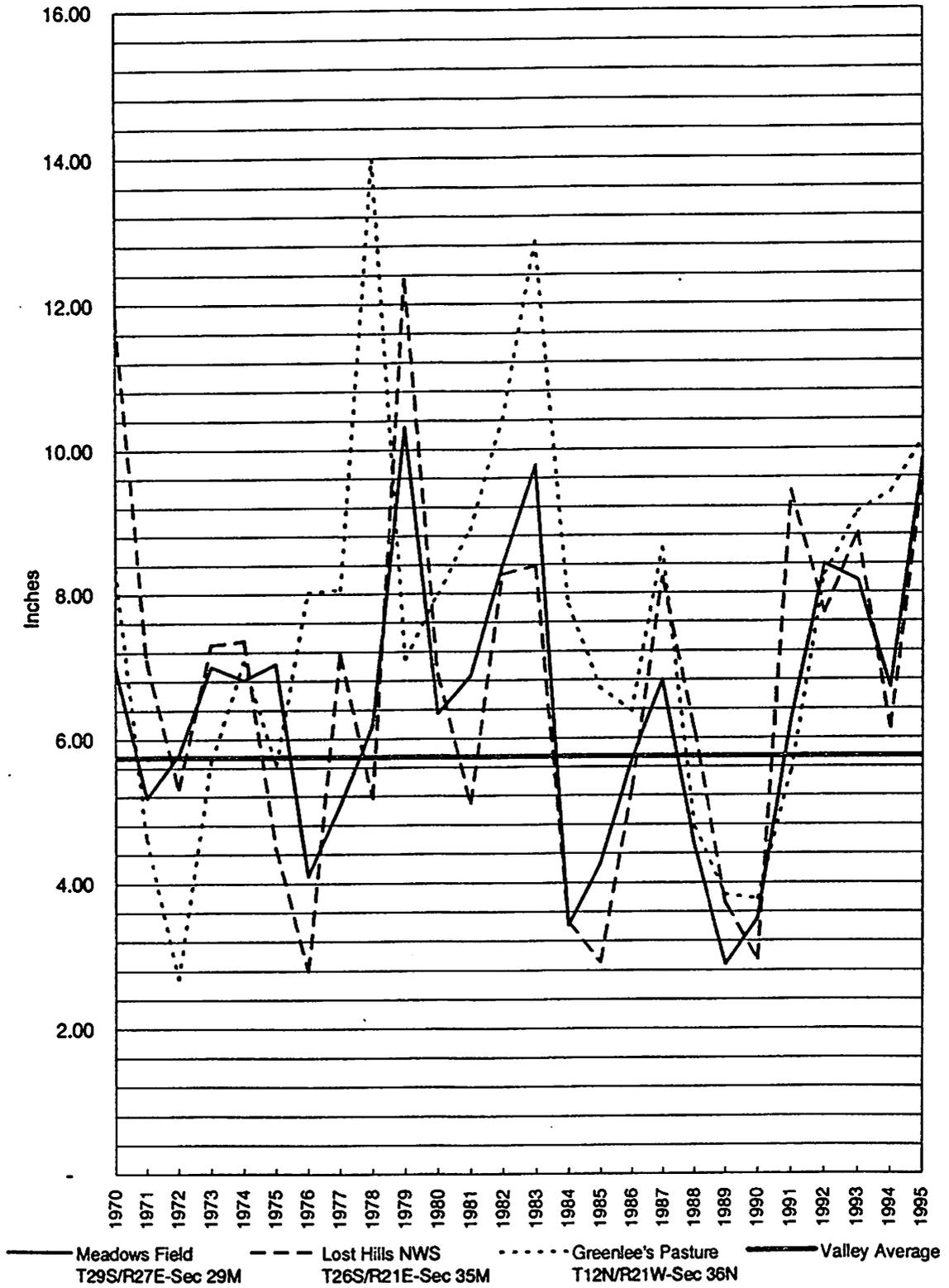
|              | <u>1992</u> | <u>1993</u> | <u>1994</u> | <u>1995</u> | <u>Avg.</u> | <u>1995</u><br><u>% of Avg</u> |
|--------------|-------------|-------------|-------------|-------------|-------------|--------------------------------|
| Jan          | 1.56        | 2.33        | 0.57        | 2.29        | 1.02        | 225                            |
| Feb          | 2.14        | 2.02        | 1.34        | 0.87        | 1.00        | 87                             |
| Mar          | 1.86        | 1.76        | 0.97        | 3.39        | 0.94        | 360                            |
| Apr          | 0           | 0           | 1.06        | 0.79        | 0.65        | 122                            |
| May          | 0.08        | 0           | 0.27        | 0.35        | 0.30        | 117                            |
| Jun          | 0           | 0.48        | 0           | 0.12        | 0.07        | 171                            |
| Jul          | 0.03        | 0           | 0           | 0           | 0.01        | 0                              |
| Aug          | 0           | 0           | 0.01        | 0           | 0.02        | 0                              |
| Sep          | 0           | 0.09        | 0.09        | 0           | 0.10        | 0                              |
| Oct          | 0.92        | 0.17        | 0.08        | 0           | 0.31        | 0                              |
| Nov          | 0           | 0.79        | 0.98        | 0           | 0.52        | 0                              |
| Dec          | 1.81        | 0.62        | 1.32        | 2.03        | 0.80        | 254                            |
| <b>Total</b> | <b>8.40</b> | <b>8.17</b> | <b>6.69</b> | <b>9.84</b> | <b>5.74</b> | <b>171</b>                     |

The severity of the March storms shows clearly, with 360 percent of normal rainfall for that month. Normally, March rainfall accounts for about 16 percent of the year's total. In March 1995 about 60 percent of the long-term annual rainfall fell. Figure 8 shows annual rainfall recorded at three selected climatic stations in Kern County. Rainfall in the 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 this 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.

## Wastewater Reuse

The reuse of municipal and industrial wastewater provides a source of water for Kern County agriculture. There are 14 active wastewater sewage treatment plants in the valley portion of Kern County. Wastewater 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 removes little or no colloidal or dissolved matter. Secondary treatment provides some biological action or filtration to remove any remaining colloidal or dissolved substances from the sewage. Tertiary treatment involves further filtration and disinfection to inactivate pathogens. Nearly all of the wastewater 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 groundwater basin. The remainder is evaporated. In 1995 about 49,700 acre-feet of wastewater 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. Table 13 shows historic treated wastewater amounts. Figure 10 shows the same information as a graph.

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

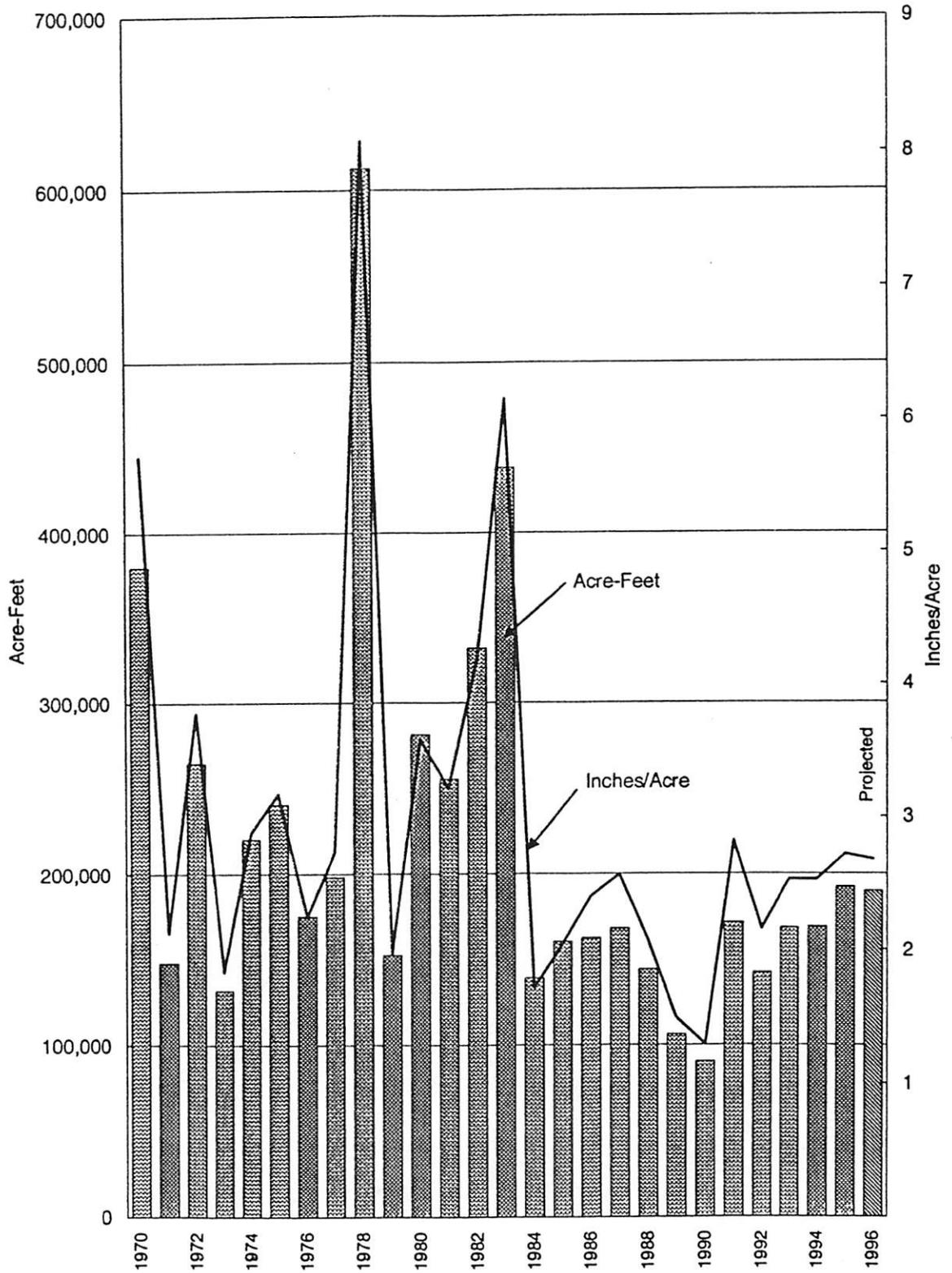


**Table 11. Effective Precipitation in the San Joaquin Valley Portion of Kern County (in acre-feet)**

|      | <b>Annual Effective<br/>Precipitation</b> | <b>Unit Rate<br/>( inches per acre)</b> | <b>Cumulative<br/>Effective<br/>Precipitation</b> |
|------|---|---|---|
| 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   |
| 1995 | 192,400                                   | 2.72                                    | 5,647,600   |

|                      |                  |
|----------------------|------------------|
| Mean EP (total)      | 217,200 AF       |
| Median EP (total)    | 170,400 AF       |
| Mean EP (per acre)   | 3.00 Inches/Acre |
| Median EP (per acre) | 2.55 Inches/Acre |

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



**Table 12. 1995 Wastewater 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             | Secondary        | Agriculture                           |
| BVARA <sup>(1)</sup>                    | 7             | 20            | Agr             | Secondary        | Percolation                           |
| Sheriff's Lerdo Facility <sup>(1)</sup> | 100           | 307           | Dom             | Secondary        | Percolation                           |
| Reeder Tract <sup>(1)</sup>             | 12            | 35            | Dom             | Secondary        | Percolation                           |
| NOR Sanitary District #1                | 1,278         | 3,920         | Dom/Ind         | Secondary        | Restricted Agriculture<br>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                           |
| <b>Total</b>                            | <b>16,207</b> | <b>49,735</b> |                 |                  |                                       |

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For influent source:  
 Dom - domestic  
 Ind - industrial  
 Agr - agricultural

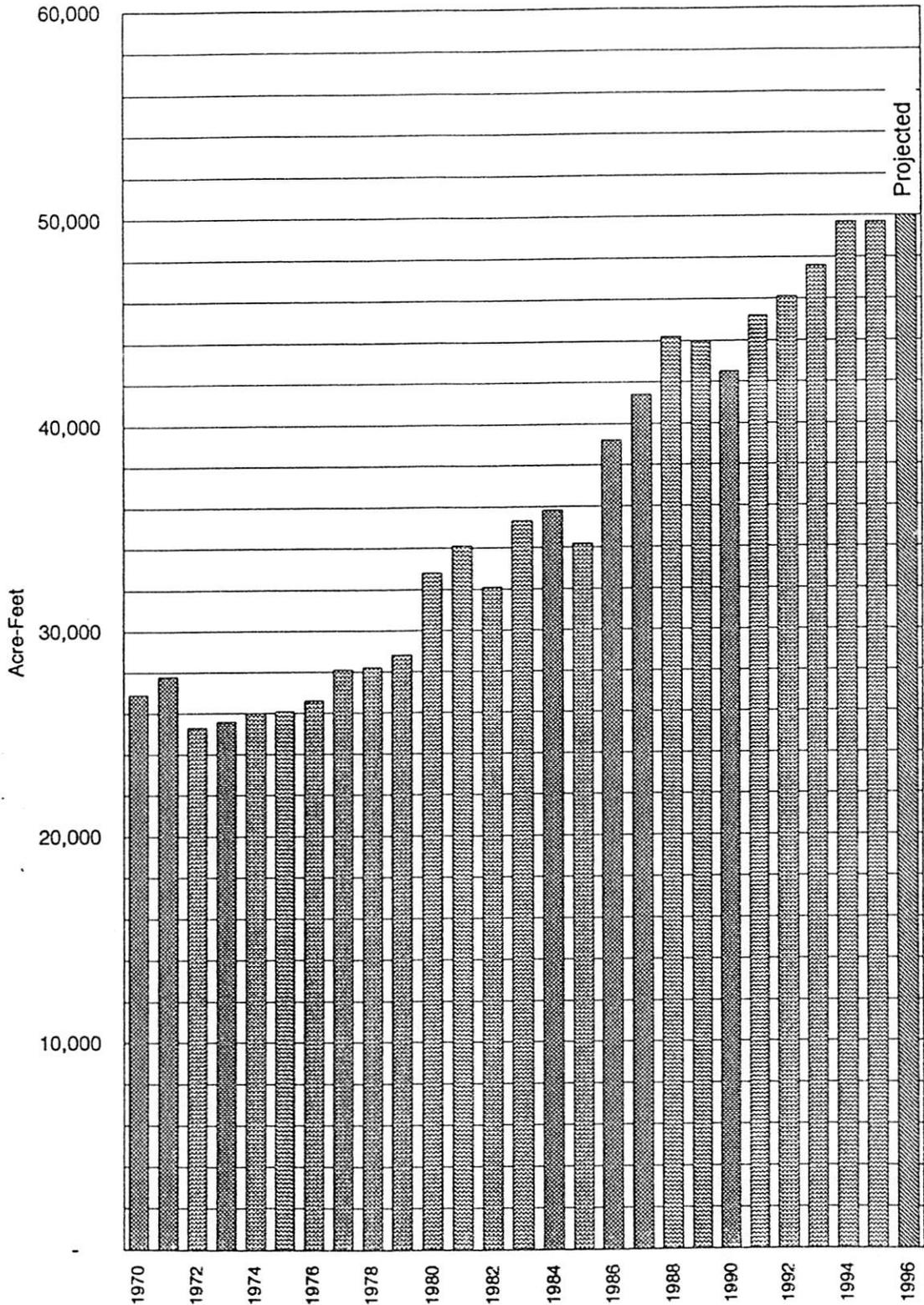
Primary treatment removes settleable solids.  
 Secondary treatment involves further oxidation of waste water to remove dissolved and biologically degradable substances.  
 Tertiary treatment involves further filtration and disinfection to inactivate pathogens.

<sup>(1)</sup> No information available for 1995; 1994 data used as an estimation.

**Table 13. Wastewater Reuse (in acre-feet)**

| <b>Year</b>                       | <b>Annual<br/>Flows</b> | <b>Cumulative<br/>Flows</b> |
|-----------------------------------|-------------------------|-----------------------------|
| 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                     |
| 1995                              | 49,700                  | 923,300                     |
| <b>Mean Water Reuse</b>           |                         | <b>35,500 AF</b>            |
| <b>Median Water Reuse</b>         |                         | <b>34,200 AF</b>            |
| <b>Minimum Water Reuse (1972)</b> |                         | <b>25,300 AF</b>            |
| <b>Maximum Water Reuse (1995)</b> |                         | <b>49,700 AF</b>            |

Figure 10. Wastewater Reuse in Kern County



Another source of wastewater 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 wastewater is a byproduct 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 east 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 19,800 acre-feet of production water from the Kern Front oil field was reused in 1995, with 11,900 acre-feet used for irrigation and 7,900 acre-feet recharged. Table 14 shows historic oil field produced water flows. Figure 11 shows the same information as a graph.

## **Groundwater Extractions**

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

Total groundwater extractions in 1995 were calculated to be about 1,394,500 acre-feet. This is about 500,000 acre-feet, almost 25 percent, less than was extracted in 1994. The obvious reason for this decrease was the larger amount of surface water supplies available.

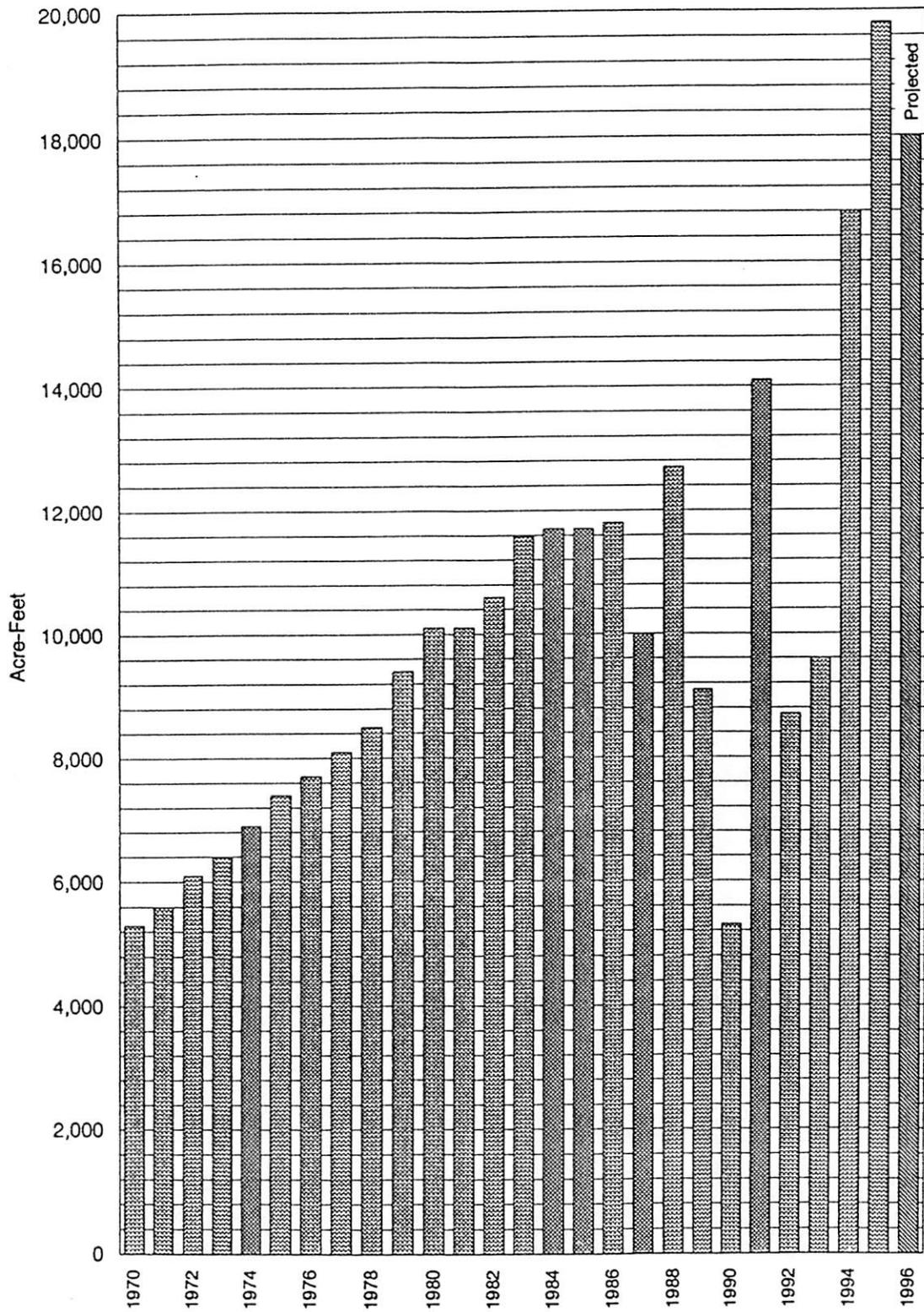
Groundwater is pumped for a variety of uses in the San Joaquin Valley portion of Kern County. Agriculture, the largest user of groundwater, used about 1,239,200 acre-feet in 1995. Municipal and industrial uses of groundwater were about 155,300 acre-feet. (During the 1987-92 drought about 9,809,900 acre-feet of groundwater was pumped. Water level declines of 40-90 feet resulted.)

Table 15 gives historic groundwater 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 groundwater pumping, graphically displaying the relative variations.

**Table 14. Oil Field Produced Water (in acre-feet)**

| <b>Year</b>                            | <b>Annual Flows</b> | <b>Cumulative Flows</b> |
|--|---------------------|-------------------------|
| 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                 |
| 1995                                   | 19,800              | 255,100                 |
| <b>Mean Oil Field Water</b>            |                     | <b>9,800 AF</b>         |
| <b>Median Oil Field Water</b>          |                     | <b>9,500 AF</b>         |
| <b>Minimum Oil Field Water (1990)</b>  |                     | <b>5,300 AF</b>         |
| <b>Maximum Oilf Field Water (1995)</b> |                     | <b>19,800 AF</b>        |

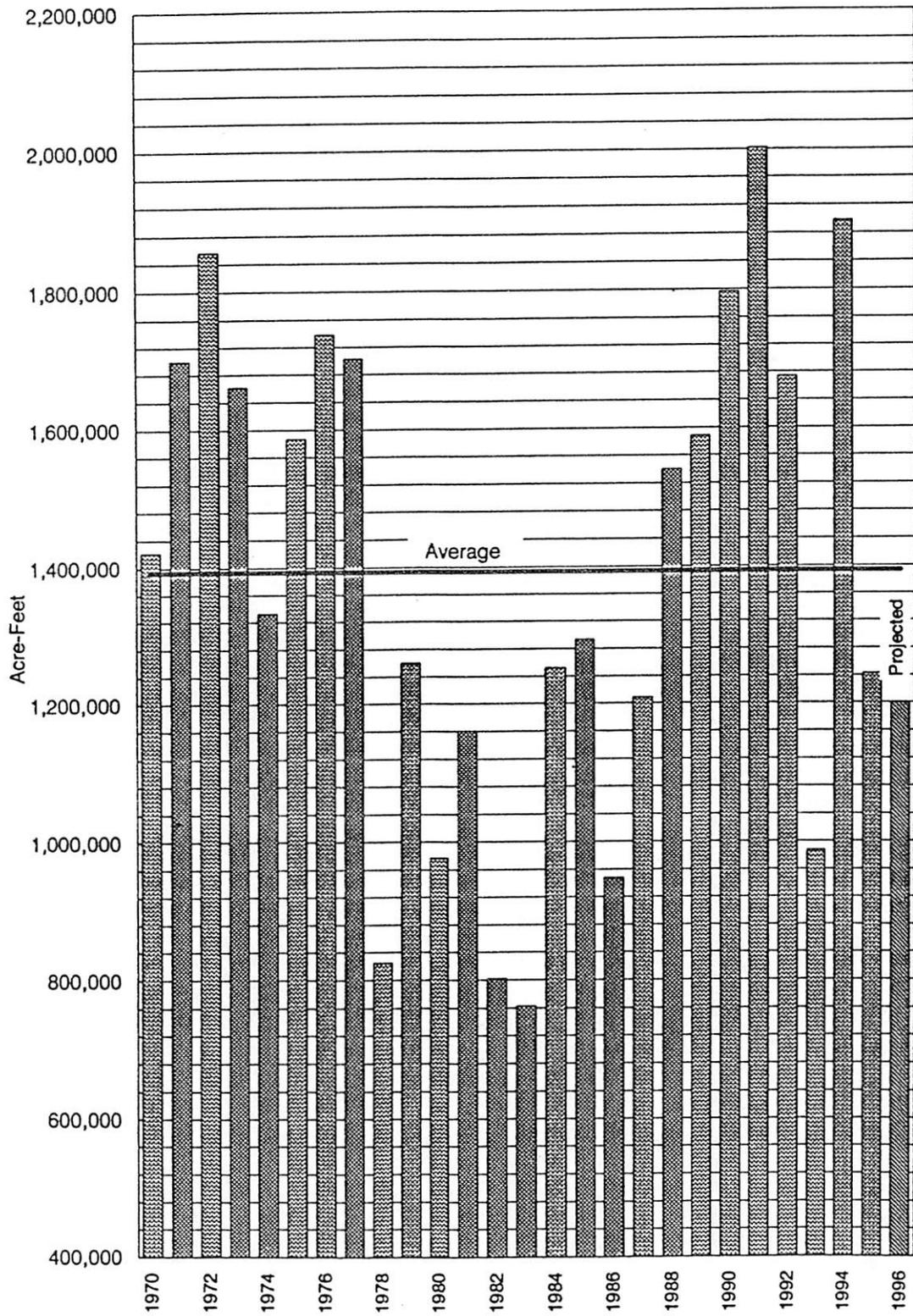
Figure 11. Oil Field Produced Water in Kern County



**Table 15. Groundwater Pumping in the San Joaquin Valley Portion of Kern County (in acre-feet)**

| <b>Year</b>                       | <b>Annual<br/>Groundwater<br/>Pumped</b> | <b>Cumulative<br/>Groundwater<br/>Pumped</b> |
|-----------------------------------|--|--|
| 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                              | 1,897,700                                | 34,978,800                                   |
| 1995                              | 1,242,800                                | 36,221,600                                   |
| <b>Mean Groundwater Pumping</b>   |  | <b>1,393,100 AF</b>                          |
| <b>Median Groundwater Pumping</b> |  | <b>1,377,500 AF</b>                          |
| <b>Minimum Pumping (1983)</b>     |  | <b>762,700 AF</b>                            |
| <b>Maximum Pumping (1991)</b>     |  | <b>2,002,400 AF</b>                          |

Figure 12. Groundwater 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 848,400 acres in 1995. Since 19,100 acres were double-cropped, total gross cropped acreage in 1995 was 829,300 acres. Some 727,000 acres (including double cropping) were irrigated over the usable groundwater basin, and 121,400 acres were irrigated on lands outside the usable groundwater basin. Total irrigated acreage increased 5 percent over 1994.

Cotton acreage increased 17,800 acres from 1994, reflecting the excellent water supply situation. Carrots also increased 12,000 acres from 1994. Kern County produces about 30 percent of the nation's carrots, and has been called the "carrot capital of the world." Almonds and pistachios collectively increased by 3,200 acres. Apples increased 1,000 acres. Grapes of all varieties increased 3,000 acres over 1994. Overall, fresh market vegetable plantings increased almost 14,000 acres over 1994 and grains increased 4,200 acres. Irrigated pasture showed a decrease of about 1,000 acres, and sugar beets were reduced by 1,600 acres. A total of 126,000 acres were idled during 1995. Most of this land was idled during the drought, and has remained out of production. This was about 18,400 acres less than was idled during 1994.

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 (trees and vines) 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 7 percent of irrigated acreage. Green feeds (alfalfa and pasture) represent about 11 percent of total acreage (the same as in 1994). Alfalfa grown in Kern County supports the local dairy industry, as well as pleasure horses in Kern County and southern California. 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 by Pacific Rim countries will increase in the coming years.

The Kern County Agricultural Commissioner's annual crop report shows that in 1995 the agricultural products of Kern County had a market value of \$1,978,951,000. This was up about 1.6 percent from 1994's value. The slight increase can be attributed to the increased irrigated acreage. A comparison of 1995 to 1994 gross crop values shows:

**Table 16. Irrigated Acreage<sup>(1)</sup> in the San Joaquin Valley Portion of Kern County (in acres)**

| Year | Total Irrigated Acreage |                                  |            |
|------|-------------------------|----------------------------------|------------|
| 1970 | 797,300                 | Mean Irrigated Acreage           | 866,400 AF |
|      |                         | Minimum Irrigated Acreage (1991) | 729,400 AF |
|      |                         | Maximum Irrigated Acreage (1984) | 972,800 AF |
| 1971 | 834,800                 |                                  |            |
| 1972 | 841,000                 |                                  |            |
| 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 | 803,100                 |                                  |            |
| 1995 | 848,400                 |                                  |            |

<sup>(1)</sup> Double-cropped acreage is counted twice, since it is irrigated twice. Double-cropping is generally a small percentage of total irrigated acreage, in the order of 10,000 to 20,000 acres annually.

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

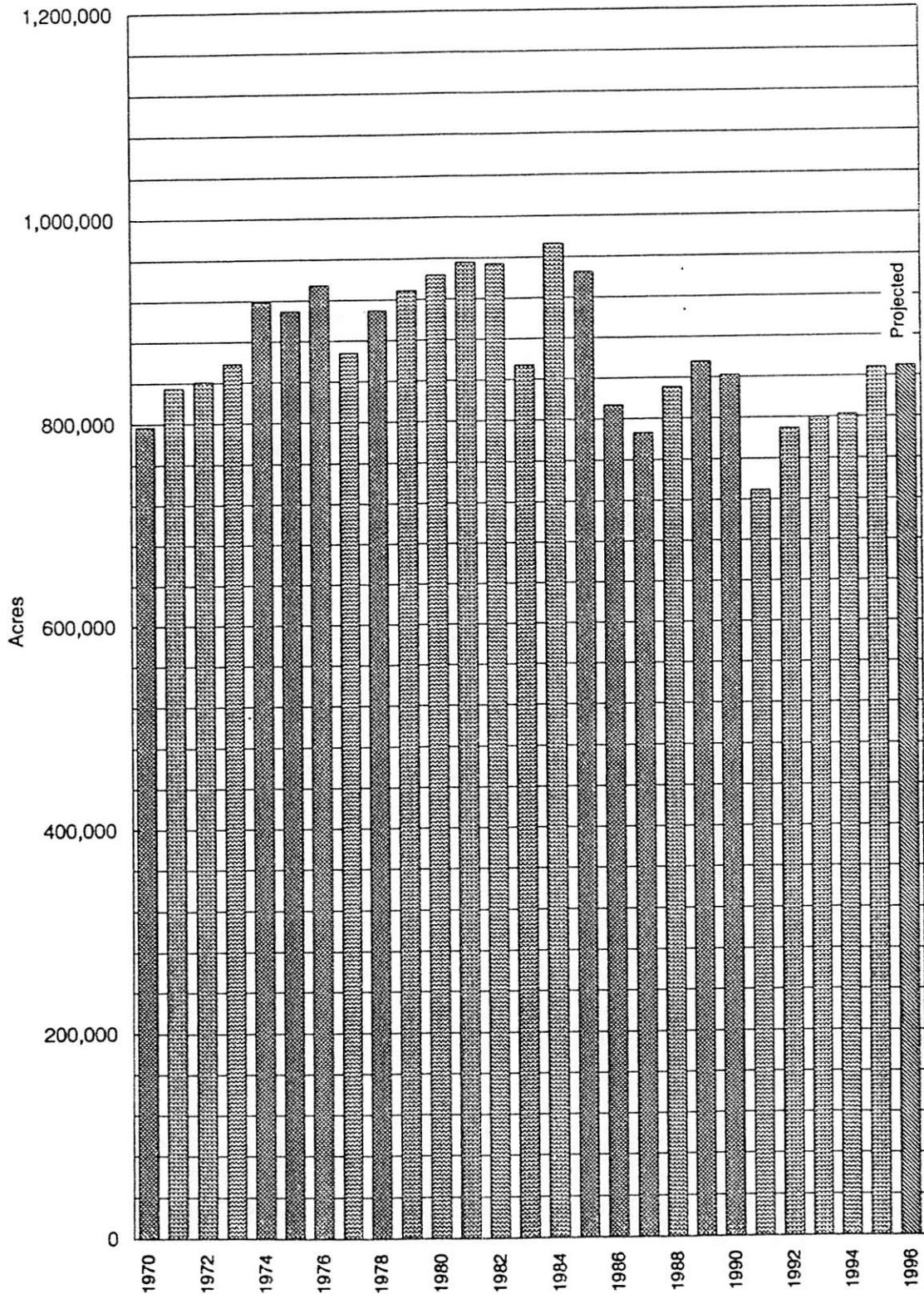
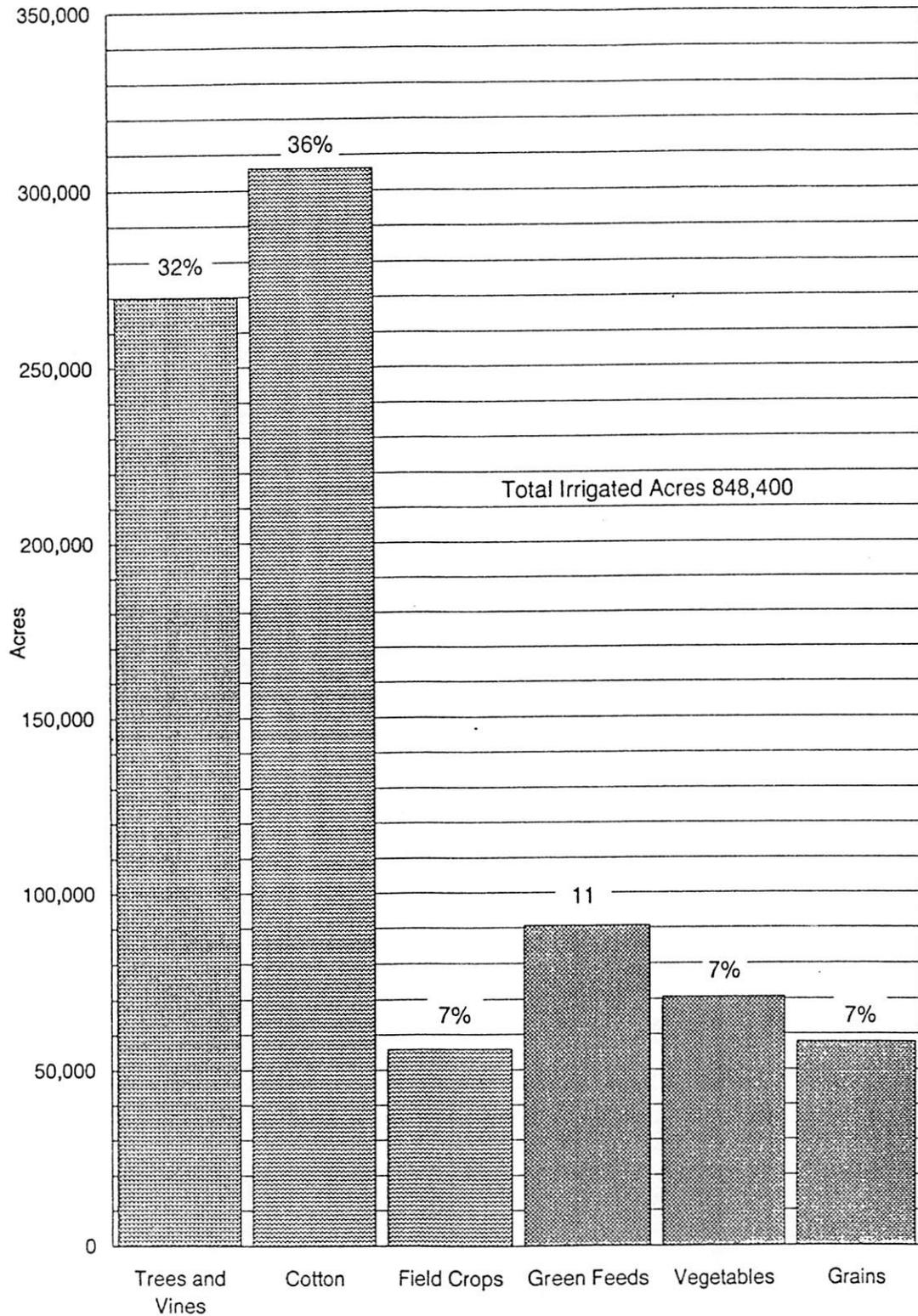


Figure 14. 1995 Summary of Irrigated Acreage



|                 | <u>1995</u>            | <u>1994</u>            | <u>Change</u>       |
|-----------------|------------------------|------------------------|---------------------|
| Trees and Vines | \$1,005,502,000        | \$976,139,000          | \$29,363,000        |
| Cotton          | 296,764,000            | 312,006,000            | -15,242,000         |
| Field crops     | 37,810,000             | 33,057,000             | 4,753,000           |
| Green Feeds     | 68,983,000             | 96,717,000             | -27,734,000         |
| Vegetables      | 329,777,000            | 311,128,000            | 18,649,000          |
| Grains          | 20,387,000             | 22,350,000             | -1,963,000          |
| Other           | 219,728,000            | 195,821,000            | 23,907,000          |
| <b>Total</b>    | <b>\$1,978,951,000</b> | <b>\$1,947,218,000</b> | <b>\$31,733,000</b> |

Note that trees and vines accounted for over 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:

|              | <u>Agriculture's Share<br/>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 1995 were very 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.

Many crops experienced yield declines over 1994, due to the extremely wet spring conditions. A wet spring encourages prolific growth of grasses in the hills surrounding the valley, which creates excellent breeding conditions for insects. When the hillside vegetation dies in the summer heat, the insects move down from the hills into the irrigated croplands of the valley. Cotton is one crop that suffered from such insect infestations, as well as the late rains (through May) which prevented the crop from establishing well during the early part of the growing season before the summer heat. Following are some crops that experienced large yield reductions.

| <u>Crop</u>            | <u>Yield decline from 1994</u> |
|------------------------|--------------------------------|
| Almonds                | 49 %                           |
| Bell Peppers           | 26 %                           |
| Cotton, Acala          | 24 %                           |
| Cotton, Pima           | 34 %                           |
| Spring Potatoes        | 16 %                           |
| Watermelons (seedless) | 28 %                           |

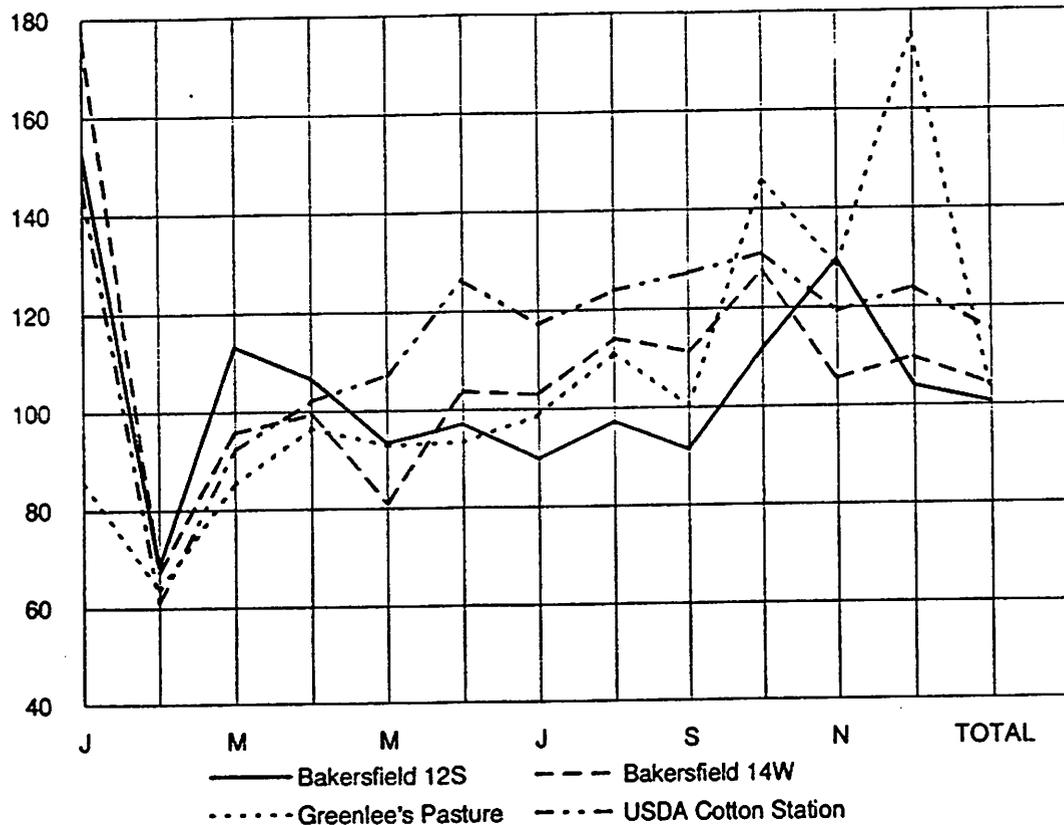
**Table 17. 1995 Monthly Evaporation for San Joaquin Valley Climatic Station (in inches)**

|                          | Bakersfield<br>12S | Bakersfield<br>14W | USDA<br>Cotton<br>Station | Greenlee's<br>Pasture | Avg. All<br>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                 |
| <b>Total</b>             | <b>64.94</b>       | <b>70.20</b>       | <b>76.93</b>              | <b>65.84</b>          | <b>69.48</b>         |
| <b>Percent of Normal</b> | <b>101</b>         | <b>111</b>         | <b>127</b>                | <b>105</b>            | <b>111</b>           |

**Station Locations**

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

**Figure 15. 1995 Percent of Normal Evaporation**



**Percent of Normal, Total:**

|                            |              |
|----------------------------|--------------|
| <b>Bakersfield 12S</b>     | <b>100.5</b> |
| <b>Bakersfield 14W</b>     | <b>104.1</b> |
| <b>Greenlee's Pasture</b>  | <b>102.5</b> |
| <b>USDA Cotton Station</b> | <b>115.2</b> |

**Bakersfield 12S**

1995 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**

1995 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**

1995 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**

1995 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.

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 state-wide-computerized irrigation scheduling system that can help farmers to schedule their irrigation 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 Water Conservation Office. Approximate crop water use, as computed using the CIMIS data for 1995, 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 groundwater will usually apply less water on their crops than they would if the soil were well drained. The intent is to manage the shallow groundwater problem. In addition, the crop may consumptively use some shallow groundwater, 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 1995 were estimated to be about 2,909,600 acre-feet with 2,581,300 acre-feet occurring over the usable groundwater basin. Net agricultural requirements in 1995 were about 2,337,800 acre-feet with about 2,021,100 acre-feet occurring over the groundwater basin. The difference between gross and net water requirements over the basin is an estimate of agricultural return flows to groundwater. Not all return flows return to usable groundwater. Some is lost to saline sinks (such as shallow groundwater areas). Over moisture deficient soils, return flows are absorbed by the soils and are irrecoverable. About 112,900 acre-feet of water was lost to saline sinks during 1995, and about 11,700 acre-feet was lost to moisture deficient soils. About 447,300 acre-feet of agricultural applied water in 1995 returned to usable groundwater storage.

Quite a large amount of applied water data has been collected over the years by many entities. 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 1995 were estimated to be about 176,400 acre-feet, with about 162,300 acre-feet required over the usable groundwater basin. Of the total amount used over the usable basin, 31,600 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 1,700 acre-feet of CVP water obtained from the Arvin-Edison Water Storage District. The remainder, about 128,200 acre-feet, was drawn from groundwater. 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 their volumes of production are not recorded. The gross M&I requirements include an estimate of the needs of these rural areas.

The average municipal and industrial water use over the groundwater basin in 1995 was 311 gallons per capita per day (gpcd), slightly lower than in 1994. Long-term, average M&I water use

**Table 18. 1995 Irrigated Acreage, San Joaquin Valley Portion of Kern County**

| Crop                         | Acres <sup>(1)</sup> | Percent of Total | Consumptive Water Use <sup>(2)</sup><br>(af/acre) |
|------------------------------|----------------------|------------------|---|
| Alfalfa (including seed)     | 85,061               | 8.5              | 3.73  |
| Almonds                      | 79,930               | 8.0              | 5.28  |
| Apples                       | 5,212                | 0.5              | 5.00  |
| Apricots                     | 651                  | -                | 3.36  |
| Asparagus                    | 393                  | -                | 3.64  |
| Avocado                      | -                    | -                | -   |
| Barley                       | 17,351               | 1.7              | 1.47  |
| Beans                        | 8,375                | 0.8              | 1.86  |
| Broccoli                     | 40                   | -                | 0.62  |
| Carrots                      | 27,489               | 2.8              | 1.12  |
| Citrus                       | 42,426               | 4.2              | 4.77  |
| Corn, Field & Sweet          | 6,497                | 0.7              | 5.30  |
| Cotton                       | 306,205              | 30.7             | 2.94  |
| Dry Farmed Grains, Pasture   | 24,480               | 2.5              | -   |
| Figs                         | 498                  | -                | 3.75  |
| Grapes                       | 90,144               | 9.0              | 3.65  |
| Guayale, Jojoba              | 209                  | -                | 1.00  |
| Idle, Fallow Lands           | 126,046              | 12.6             | -   |
| Kiwi                         | 291                  | -                | 2.54  |
| Lettuce                      | 3,040                | 0.3              | 0.30  |
| Melons, Squash, Cucumbers    | 8,196                | 0.8              | 1.65  |
| Misc. Deciduous Trees        | 9,665                | 1.0              | 5.28  |
| Misc. Field Crops            | 887                  | -                | 2.65  |
| Misc. Hay/Grain              | 12,884               | 1.3              | 2.10  |
| Misc. Subtropical Trees      | 62                   | -                | 0.41  |
| Misc. Vegetables             | 3,530                | 0.4              | 6.19  |
| Nursery                      | 4,429                | 0.4              | 3.25  |
| Oats                         | 2,631                | 0.3              | 1.42  |
| Olives                       | 1,879                | 0.2              | 3.40  |
| Onions, Garlic               | 12,194               | 1.2              | 3.25  |
| Pasture, Turf                | 5,589                | 0.6              | 4.63  |
| Peaches, Nectarines          | 6,321                | 0.6              | 4.98  |
| Pears                        | 78                   | -                | 3.52  |
| Peas                         | 431                  | -                | 1.35  |
| Peppers                      | 2,181                | 0.2              | 1.98  |
| Pistachios                   | 28,565               | 2.9              | 5.01  |
| Plums, Prunes                | 2,674                | 0.3              | 5.09  |
| Potatoes                     | 22,918               | 2.3              | 3.44  |
| Rice                         | -                    | -                | -   |
| Safflower                    | 9,580                | 1.0              | 2.42  |
| Sorghum/Milo                 | 200                  | -                | 2.28  |
| Sudan Grass                  | 728                  | -                | 2.28  |
| Sugar Beets                  | 7,636                | 0.8              | 3.35  |
| Tomatoes                     | 5,421                | 0.5              | 2.42  |
| Turnips                      | 71                   | -                | 3.44  |
| Walnuts                      | 1,660                | 0.2              | 4.34  |
| Wheat                        | 24,194               | 2.4              | 2.10  |
| <b>Total Irrigated Lands</b> | <b>848,416</b>       | <b>100.0</b>     | <b>2.79</b>                                       |
| <b>Total Harvested Lands</b> | <b>872,896</b>       |                  |   |
| <b>Double Cropped</b>        | <b>19,067</b>        |                  |   |

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

(1) Excludes acreage in Arvin-Edison WSD/Wheeler Ridge-Maricopa WSD overlap area.

(2) Weighted average consumptive use of all crops.

**Table 19. Average Applied Water Requirements for Various Crops, San Joaquin Valley Portion of Kern County (in acre-feet per acre)**

| Crop                      | Drip <sup>(1)</sup> | Sprinkler <sup>(2)</sup> | Row/Border <sup>(3)</sup> |
|---------------------------|---------------------|--------------------------|---------------------------|
| 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                 |

<sup>(1)</sup> Includes emitters, misters, mini-sprinklers and fan jets.

<sup>(2)</sup> Includes portables, solid-sets, linear moves, sprinkler guns.

<sup>(3)</sup> 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. 1995 Urban Water Use, San Joaquin Valley Portion of Kern County

| Water Purveyor<br>Service area             | Metered<br>Connections | Non-metered<br>Connections | Million<br>Gals. | Acre<br>Feet   | Permanent<br>Population | GPCD <sup>(1)</sup>       |
|--|------------------------|----------------------------|------------------|----------------|-------------------------|---------------------------|
| <b>Arvin</b>                               |                        |                            |                  |                |                         |                           |
| Arvin CSD                                  | 2,265                  | -                          | 638              | 1,959          | 10,700                  | 163                       |
| <b>Bakersfield Metro Area</b>              |                        |                            |                  |                |                         |                           |
| Airport Mutual WC                          | Unknown                | Unknown                    | 16               | 50             | Unknown                 | -                         |
| California Water Service                   |                        |                            |                  |                |                         |                           |
| Bakersfield Division                       | 16,268                 | 37,990                     | 22,537           | 69,159         | 182,490                 | 338                       |
| Ashe Water Division                        | 19,723                 | 179                        | 7,583            | 23,270         | 60,720                  | 342                       |
| Casa Loma WC                               | -                      | 215                        | 401              | 1,231          | 2,000                   | 550                       |
| East Niles CSD                             | 6,150                  | -                          | 3,306            | 10,145         | 21,500                  | 421                       |
| Greenfield CWD                             | 693                    | 368                        | 412              | 1,264          | 6,000                   | 188                       |
| North of the River MWD                     | 464                    | 1,485                      | 810              | 2,486          | 5,500                   | 404                       |
| Oildale MWC                                | 379                    | 5,822                      | 2,006            | 6,157          | 20,000                  | 275                       |
| Rancho Verdugo WC                          | -                      | 288                        | 47               | 143            | 880                     | 146                       |
| Stockdale MWC                              | -                      | 80                         | 83               | 254            | 236                     | 961                       |
| Stockdale Annex MWC                        | -                      | 138                        | 52               | 159            | 163                     | 872                       |
| Vaughn WC                                  | 3,618                  | 959                        | 2,156            | 6,616          | 12,861                  | 459                       |
| Victory MWC                                | -                      | 155                        | 55               | 170            | 620                     | 245                       |
| <b>Metro Area Subtotal</b>                 | <b>47,295</b>          | <b>47,679</b>              | <b>39,465</b>    | <b>121,105</b> | <b>323,670</b>          | <b>339</b>                |
| <b>Buttonwillow</b>                        |                        |                            |                  |                |                         |                           |
| Buttonwillow CWD <sup>(5)</sup>            | -                      | 415                        | 158              | 486            | 1,278                   | 340                       |
| <b>Delano</b>                              |                        |                            |                  |                |                         |                           |
| City of Delano                             | 2,685                  | 3,638                      | 2,300            | 7,058          | 31,325                  | 201                       |
| <b>Lamont</b>                              |                        |                            |                  |                |                         |                           |
| Lamont PUD and ID#1                        | 261                    | 3,100                      | 1,853            | 5,685          | 14,677                  | 346                       |
| <b>Lost Hills</b>                          |                        |                            |                  |                |                         |                           |
| Lost Hills Utility District <sup>(5)</sup> | 223                    | -                          | 105              | 322            | 800                     | 360 <sup>(2)</sup>        |
| <b>McFarland</b>                           |                        |                            |                  |                |                         |                           |
| McFarland MWC                              | 1,720                  | 6                          | 401              | 1,231          | 7,000                   | 157                       |
| <b>Rio Bravo</b>                           |                        |                            |                  |                |                         |                           |
| Olcese WD                                  | 358                    | -                          | 249              | 766            | 840                     | 814 <sup>(3)</sup>        |
| <b>Shafter</b>                             |                        |                            |                  |                |                         |                           |
| City of Shafter                            | 26                     | 3,318                      | 917              | 2,814          | 11,000                  | 228                       |
| <b>Taft-Maricopa-McKittrick</b>            |                        |                            |                  |                |                         |                           |
| West Kern WD                               | 7,061                  | -                          | 3,959            | 12,149         | 17,000                  | 638 <sup>(2)</sup>        |
| <b>Wasco</b>                               |                        |                            |                  |                |                         |                           |
| City of Wasco                              | 672                    | 3,091                      | 1,394            | 4,279          | 18,067                  | 211                       |
| Wasco State Prison                         | 2                      | -                          | 203              | 621            | 4,500                   | 123                       |
| <b>Total</b>                               | <b>62,568</b>          | <b>61,247</b>              | <b>51,643</b>    | <b>158,475</b> | <b>440,857</b>          | <b>311 <sup>(4)</sup></b> |

- (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) 1995 data not available; estimated using 1994 data.

is about 250-300 gpcd. Residential water use is about 200 gpcd. Commercial, industrial and institutional water use accounts for the difference. It should be noted that domestic water uses by west side towns (Taft, Maricopa, Lost Hills) are quite low when compared to the domestic water use over the groundwater basin. The average domestic water usage during 1995 was about 190 gallons per capita per day for these west side towns.

Net M&I consumptive use in 1995 was about 47,400 acre-feet over the groundwater basin. Gross return flows from M&I uses over the groundwater basin were about 114,900 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 65,100 acre-feet returned to groundwater supplies. Most of the M&I water used outside the groundwater basin is for oil field operations (only about 30 percent is used domestically), and is all consumptively used.

## 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. No water was exported from Kern County during 1995.

## Water Surface Evaporation

Water surface evaporation normally accounts for a small amount of water lost from the valley portion of Kern County. Open canals, ditches and recharge ponds all lose water via evaporation. In 1995 about 41,600 acre-feet of evaporation losses occurred, with about 41,000 acre-feet occurring over the groundwater basin. This was slightly less than in 1994. Any water lost in this manner is lost from this regional hydrologic system.

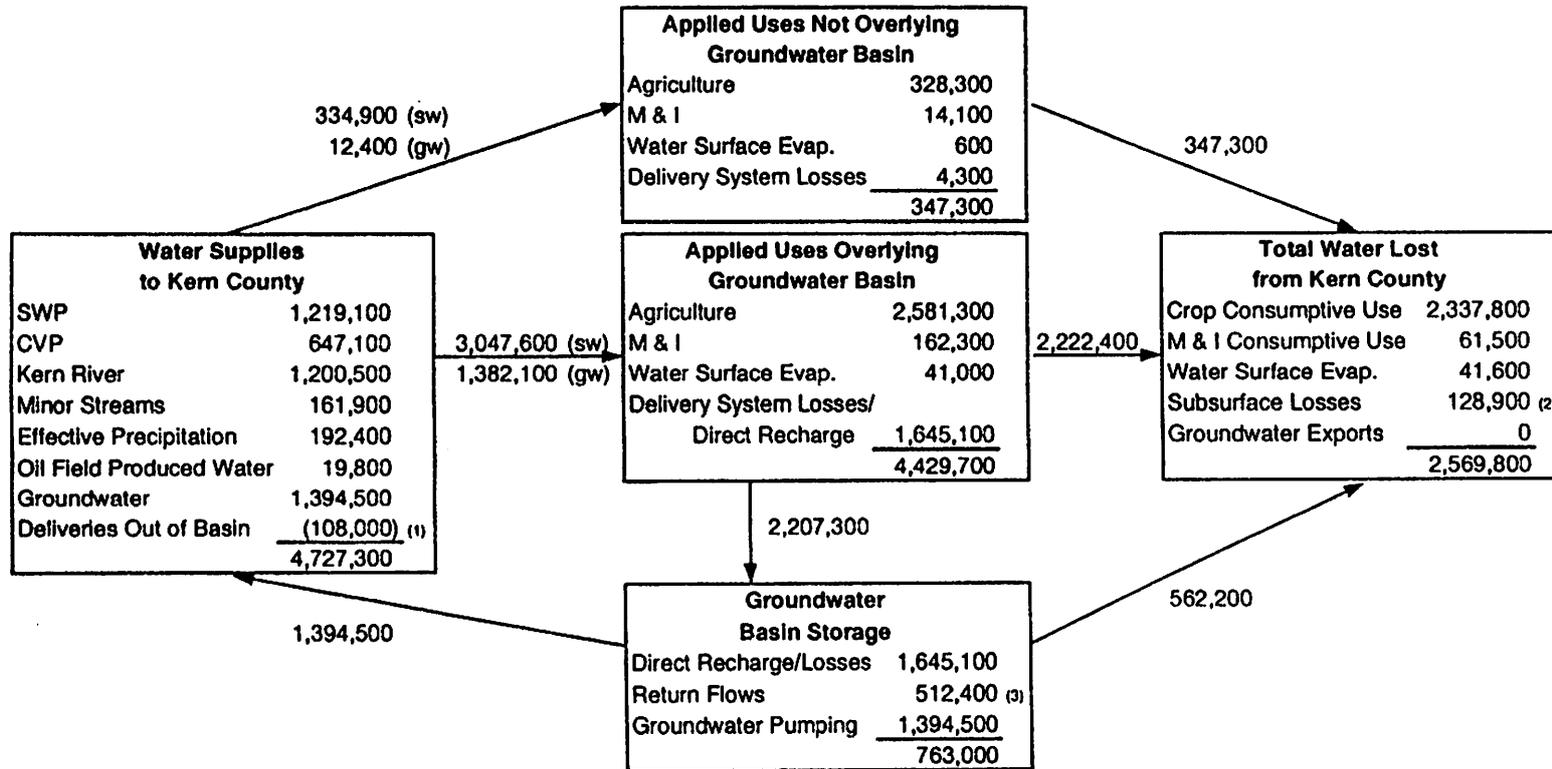
# CHANGE IN GROUNDWATER STORAGE

Figure 16 shows a total gross water demand for the San Joaquin Valley portion of Kern County of 4,727,300 acre-feet in 1995. About 4,429,700 acre-feet occurred over the groundwater basin. A staggering 1,645,100 acre-feet of water was used for direct recharge or unlined delivery system losses. Total net water use was about 2,569,800 acre-feet, with about 2,222,400 acre-feet used over the groundwater basin. Gross available surface water supplies were about 3,332,800 acre-feet. Therefore, there was a net increase in groundwater storage of about 763,000 acre-feet. This was consistent with the fact that 1995 was a very wet 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 groundwater 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 1970-95 about 12,955,000 acre-feet of water was withdrawn from groundwater storage. Over the same period the balance of additions over extractions has replenished about 6,313,000 acre-feet. The average change in storage since 1970 is about 250,000 acre-feet per year. Figure 18 shows the cumulative groundwater balance since 1970 when SWP water was first introduced over

Figure 16. 1995 Water Resources Inventory, San Joaquin Valley Portion of Kern County (acre-feet)



**3,332,800 (Surface Supplies) minus 2,569,800 (Consumptive Use) equals 763,000 (Addition to Storage)**

(1) Delivered to Tulare Lake Basin WSD (41,500 AF), Dudley Ridge WD (245 AF), Westlands WD (60,678 AF) and Tehachapi-Cummings WD (5,527 AF).

(2) Includes 112,900 AF to saline sinks, and 16,000 AF losses to moisture deficient soils.

(3) A total of 49,700 AF of municipal waste water was treated and reused. The reuse is not included here.

(sw) Surface Water

(gw) Groundwater

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

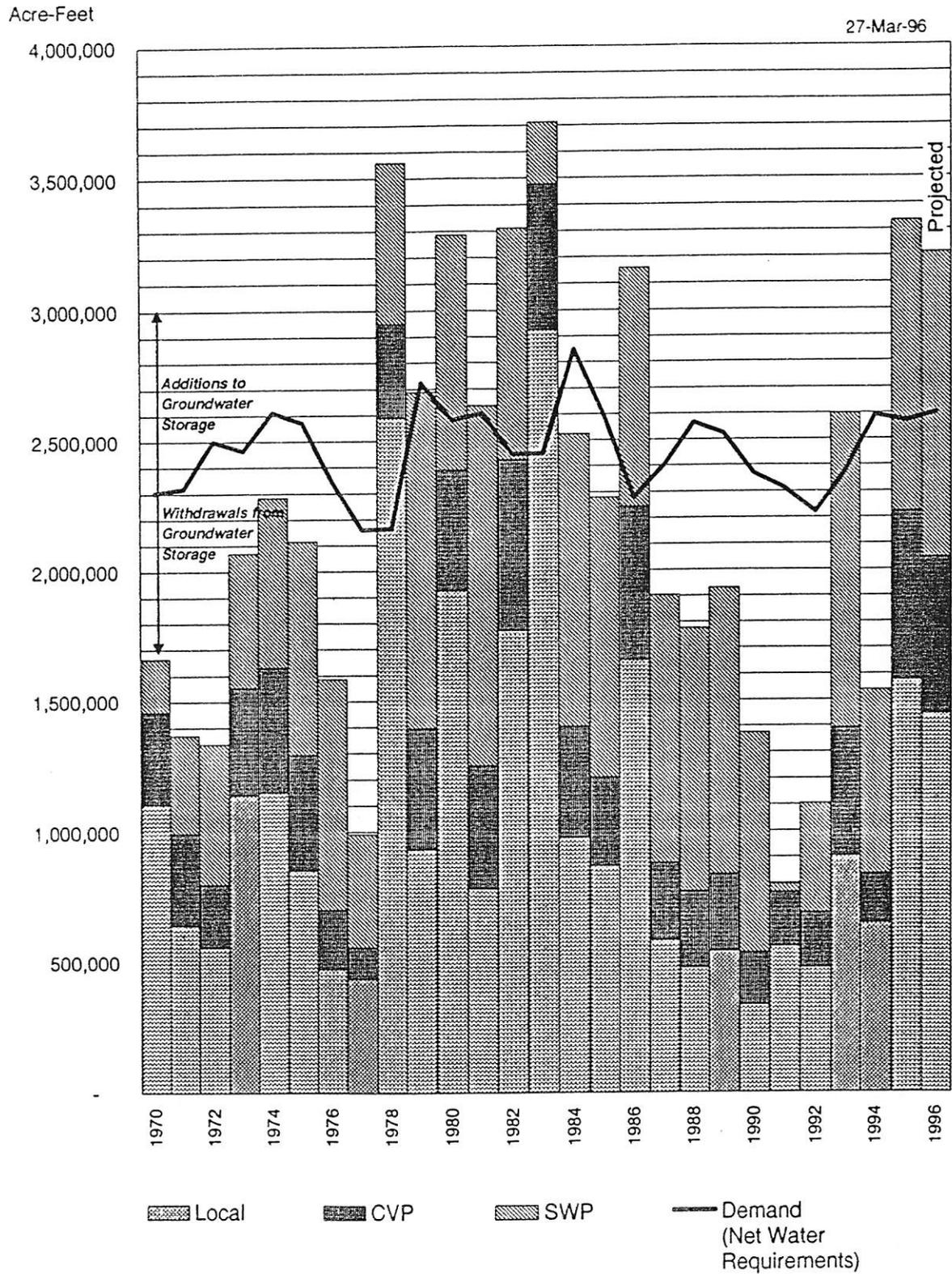
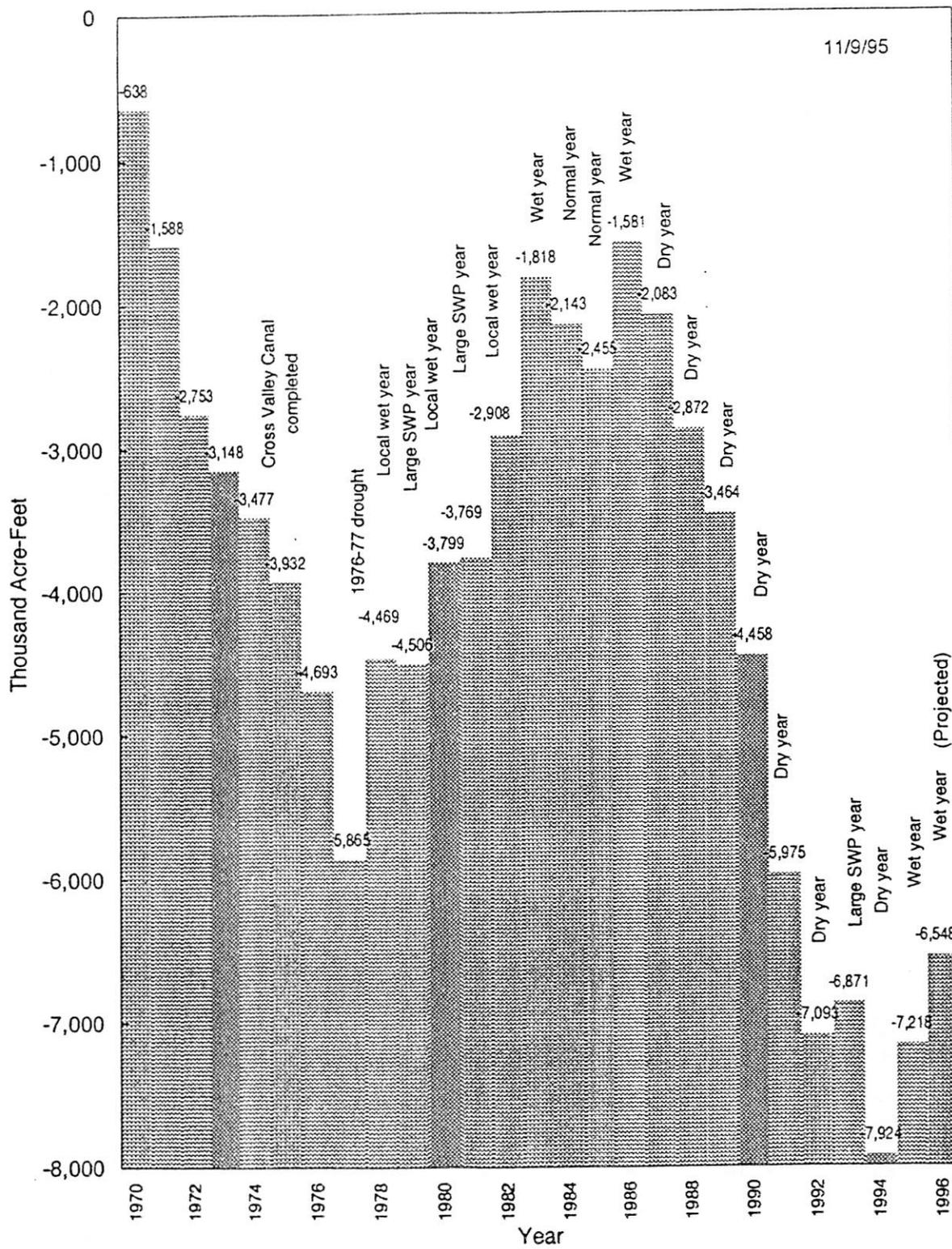


Figure 18. Cumulative Change in Groundwater Storage, San Joaquin Valley Portion of Kern County



the Kern County groundwater basin. In volume of groundwater storage, the basin still stands below 1977 levels, although a definite upward trend is evident.

Kern County's groundwater management plans depend upon the sustained delivery of surface 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 groundwater 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, groundwater comprised only 25 percent of the total water supply. In 1987 the reverse was true, and groundwater pumping increased to make up for the dry-year conditions. Conditions during the most recent drought showed this dependence; as surface water sources were reduced, groundwater pumping increased to make up the shortfall.

## BASIN-WIDE WATER USE EFFICIENCY

Water applied to a crop that is excess to its evapotranspiration requirement percolates past the root zone and returns to groundwater supplies, where it is available for reuse. Sometimes shallow clay lenses in the soil intercept this deep percolation. This condition is called shallow groundwater. In some areas the deep percolation may return to unusable saline groundwater. 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.

Over the entire San Joaquin Valley portion of Kern County, gross water uses were about 4,777,000 acre-feet during 1995 (2,909,600 for agriculture, 176,400 for M&I, 41,600 of evaporation losses, 1,645,100 for groundwater recharge, and 4,300 of unrecoverable delivery system losses). The total consumption of water was about 2,440,900 acre-feet (2,337,800 by agriculture, 61,500 by M&I, 41,600 of evaporation losses). Effective precipitation was about 192,400 acre-feet. The agricultural irrigation efficiency was about 78 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 groundwater returns, which amounted to 691,000 acre-feet. However, about 112,900 acre-feet of deep percolation was intercepted by shallow groundwater. Another 16,000 acre-feet was absorbed by moisture-deficient soils. Therefore, net groundwater returns were 512,400 acre-feet in 1995. Expressed another way, of the 4,777,000 acre-feet of gross water demand during 1995, 4,598,400 acre-feet was beneficially used or available for reuse (via net deep percolation). This means that 96 percent of the water uses during 1995 were put to beneficial use or were 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.

**Table 21. Surface\* and Groundwater Usage or Availability, 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>Groundwater</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        | 589,500           | 19.1              | 517,900                  | 16.8              | 351,400                       | 11.4              | 204,600                    | 6.6               | 1,422,000          | 46.1              | 3,085,400             |
| 1971        | 427,500           | 13.9              | 217,100                  | 7.1               | 348,900                       | 11.4              | 375,500                    | 12.2              | 1,700,000          | 55.4              | 3,069,000             |
| 1972        | 268,400           | 8.4               | 292,600                  | 9.2               | 238,500                       | 7.5               | 535,600                    | 16.8              | 1,857,000          | 58.2              | 3,192,100             |
| 1973        | 979,700           | 26.3              | 161,200                  | 4.3               | 412,200                       | 11.0              | 515,500                    | 13.8              | 1,662,000          | 44.6              | 3,730,600             |
| 1974        | 818,600           | 22.6              | 332,000                  | 9.2               | 480,600                       | 13.3              | 651,800                    | 18.0              | 1,333,000          | 36.9              | 3,616,000             |
| 1975        | 564,600           | 15.2              | 287,300                  | 7.8               | 442,100                       | 11.9              | 821,700                    | 22.2              | 1,587,000          | 42.9              | 3,702,700             |
| 1976        | 249,500           | 7.5               | 225,700                  | 6.8               | 226,500                       | 6.8               | 883,400                    | 26.6              | 1,738,000          | 52.3              | 3,323,100             |
| 1977        | 197,000           | 7.3               | 239,400                  | 8.9               | 121,500                       | 4.5               | 429,400                    | 16.0              | 1,703,000          | 63.3              | 2,690,300             |
| 1978        | 1,653,500         | 36.8              | 1,050,200                | 23.3              | 357,800                       | 8.0               | 611,500                    | 13.6              | 825,000            | 18.3              | 4,498,000             |
| 1979        | 672,700           | 17.0              | 258,700                  | 6.6               | 462,500                       | 11.7              | 1,291,800                  | 32.7              | 1,260,000          | 31.9              | 3,945,700             |
| 1980        | 1,640,000         | 37.8              | 356,500                  | 8.2               | 462,800                       | 10.7              | 900,300                    | 20.8              | 977,000            | 22.5              | 4,336,600             |
| 1981        | 449,300           | 11.8              | 329,100                  | 8.7               | 470,000                       | 12.4              | 1,384,700                  | 36.5              | 1,161,000          | 30.6              | 3,794,100             |
| 1982        | 1,271,100         | 31.4              | 434,600                  | 10.7              | 656,600                       | 16.2              | 884,500                    | 21.8              | 802,200            | 19.8              | 4,049,000             |
| 1983        | 2,489,100         | 52.2              | 723,000                  | 15.2              | 550,900                       | 11.6              | 238,200                    | 5.0               | 762,700            | 16.0              | 4,763,900             |
| 1984        | 821,800           | 21.7              | 165,300                  | 4.4               | 425,400                       | 11.2              | 1,123,000                  | 29.6              | 1,252,200          | 33.1              | 3,787,700             |
| 1985        | 672,400           | 18.8              | 192,600                  | 5.4               | 337,500                       | 9.5               | 1,074,100                  | 30.1              | 1,293,800          | 36.2              | 3,570,400             |
| 1986        | 1,444,900         | 35.2              | 207,000                  | 5.0               | 589,300                       | 14.4              | 913,600                    | 22.3              | 947,600            | 23.1              | 4,102,400             |
| 1987        | 375,900           | 12.1              | 206,800                  | 6.7               | 292,000                       | 9.4               | 1,025,900                  | 33.0              | 1,208,700          | 38.9              | 3,109,300             |
| 1988        | 294,700           | 8.9               | 179,800                  | 5.4               | 292,800                       | 8.8               | 1,006,200                  | 30.4              | 1,540,200          | 46.5              | 3,313,700             |
| 1989        | 397,000           | 11.3              | 141,500                  | 4.0               | 293,900                       | 8.4               | 1,097,200                  | 31.2              | 1,588,500          | 45.2              | 3,518,100             |
| 1990        | 203,600           | 6.4               | 112,800                  | 3.6               | 200,100                       | 6.3               | 857,300                    | 27.0              | 1,796,500          | 56.7              | 3,170,300             |
| 1991        | 406,300           | 14.2              | 220,400                  | 7.7               | 204,400                       | 7.1               | 32,700                     | 1.1               | 2,002,400          | 69.9              | 2,866,200             |
| 1992        | 296,800           | 10.6              | 203,200                  | 7.3               | 208,000                       | 7.4               | 418,000                    | 14.9              | 1,673,600          | 59.8              | 2,799,600             |
| 1993        | 853,800           | 22.5              | 251,200                  | 6.6               | 489,800                       | 12.9              | 1,205,500                  | 31.8              | 987,700            | 26.1              | 3,788,000             |
| 1994        | 336,500           | 10.1              | 222,700                  | 6.7               | 186,300                       | 5.6               | 695,400                    | 20.8              | 1,897,700          | 56.8              | 3,338,600             |
| 1995        | 1,385,200         | 29.1              | 374,100                  | 7.9               | 647,100                       | 13.6              | 1,111,200                  | 23.3              | 1,242,800          | 26.1              | 4,760,400             |
| <b>Avg.</b> | <b>760,000</b>    | <b>21.0</b>       | <b>304,000</b>           | <b>8.4</b>        | <b>375,000</b>                | <b>10.4</b>       | <b>780,300</b>             | <b>21.6</b>       | <b>1,393,100</b>   | <b>38.6</b>       | <b>3,612,400</b>      |

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

## 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 floodwater, 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.

Through 1995, when Intertie water enters the California Aqueduct it has become the property of the State Department of Water Resources, and has been used to meet SWP system needs. During periods of extremely heavy runoff (such as in 1983), temporary pumps were 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 saving for the SWP users.

The Intertie experienced an unusual occurrence during 1995. Because of the severe flooding during the March 9-11, 1995 storms and subsequent breach of the California Aqueduct by Salt and Cantua Creeks (in Fresno County) the Intertie was actually operated backwards. Of course, the Intertie was designed to spill floodwaters into the California Aqueduct. But during March 9-11 the Intertie gates were opened and floodwater was allowed to flow from the aqueduct into the Kern River flood channel, entirely backward from the Intertie's design. It is estimated that a total of 13,100 acre-feet ran backwards into the Kern River flood channel via this reverse operation.

Such quick action on the part of state and local water leaders helped avert a potential disaster on the California Aqueduct, which at the time was running 1-2 feet over the top of its concrete liner. Water officials feared that the water might pond against the Buena Vista Pumping Plant and overtop the Aqueduct, which could result in erosion of its supporting dirt embankments. Had that happened, the Aqueduct could have washed out and collapsed.

Through the end of 1986, a total cumulative flow of 1,143,081 acre-feet of water has passed through the Intertie 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 from and retained in the County. It is expected that water banking programs operated by KCWA and the Kern Water Bank Authority will reduce this loss in the future.

## GROUNDWATER CONDITIONS

### Groundwater Recharge

Numerous entities in Kern County are actively engaged in groundwater replenishment operations. The Semitropic ID, Rosedale-Rio Bravo WSD, North Kern WSD, Arvin-Edison WSD, City of

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

|              | Intertie Inflow  |                |                                 | Amount Exported |             |                | Retained in County |             |                               |
|--------------|------------------|----------------|---------------------------------|-----------------|-------------|----------------|--------------------|-------------|-------------------------------|
|              | 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                        |
| 1995         | (13,117)         | 0              | (13,117) <sup>(1)</sup>         | 0               | 0           | 0              | (13,117)           | 0           | (13,117) <sup>(1)</sup>       |
| <b>Total</b> | <b>1,010,220</b> | <b>132,861</b> | <b>1,143,081</b> <sup>(2)</sup> |                 |             | <b>608,665</b> |                    |             | <b>521,299</b> <sup>(2)</sup> |

\* A breakdown between sources was not available.

<sup>(1)</sup> A major flood event north of Kern County caused SWP water to be reverse flowed into the Kern River flood channel. This is the opposite operation for which the Intertie was designed and constructed.

<sup>(2)</sup> The year 1995 is not included in totals.

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

Bakersfield, Kern Water Bank Authority 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 Water Storage District or in the Kern River and Poso Creek channels, as well as recharge facilities on the Kern River Fan. 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, and in district- or KCWA-operated recharge sites. During wet periods, every effort is made to deliver water through unlined canals to maximize groundwater recharge.

Many water districts in Kern County utilize conjunctive use and banking programs to help balance their supplies, as shown on Figure 19. A correctly managed conjunctive use or banking program is an effective groundwater 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 recharge and withdrawals in any year, to help understand and anticipate local and regional groundwater impacts. A tremendous amount of groundwater 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 1,645,100 acre-feet of water was recharged in 1995, both deliberately and incidentally. The approximate breakdown between sources was:

|               |                  |                  |
|---------------|------------------|------------------|
| Kern River    | 1,053,800        |                  |
| SWP           | 126,900          |                  |
| CVP           | 135,500          |                  |
| Wastewater    | 3,700            |                  |
| Minor Streams | 153,800          |                  |
| Combined      | 171,400          |                  |
| <b>Total</b>  | <b>1,645,100</b> | <b>Acre-feet</b> |

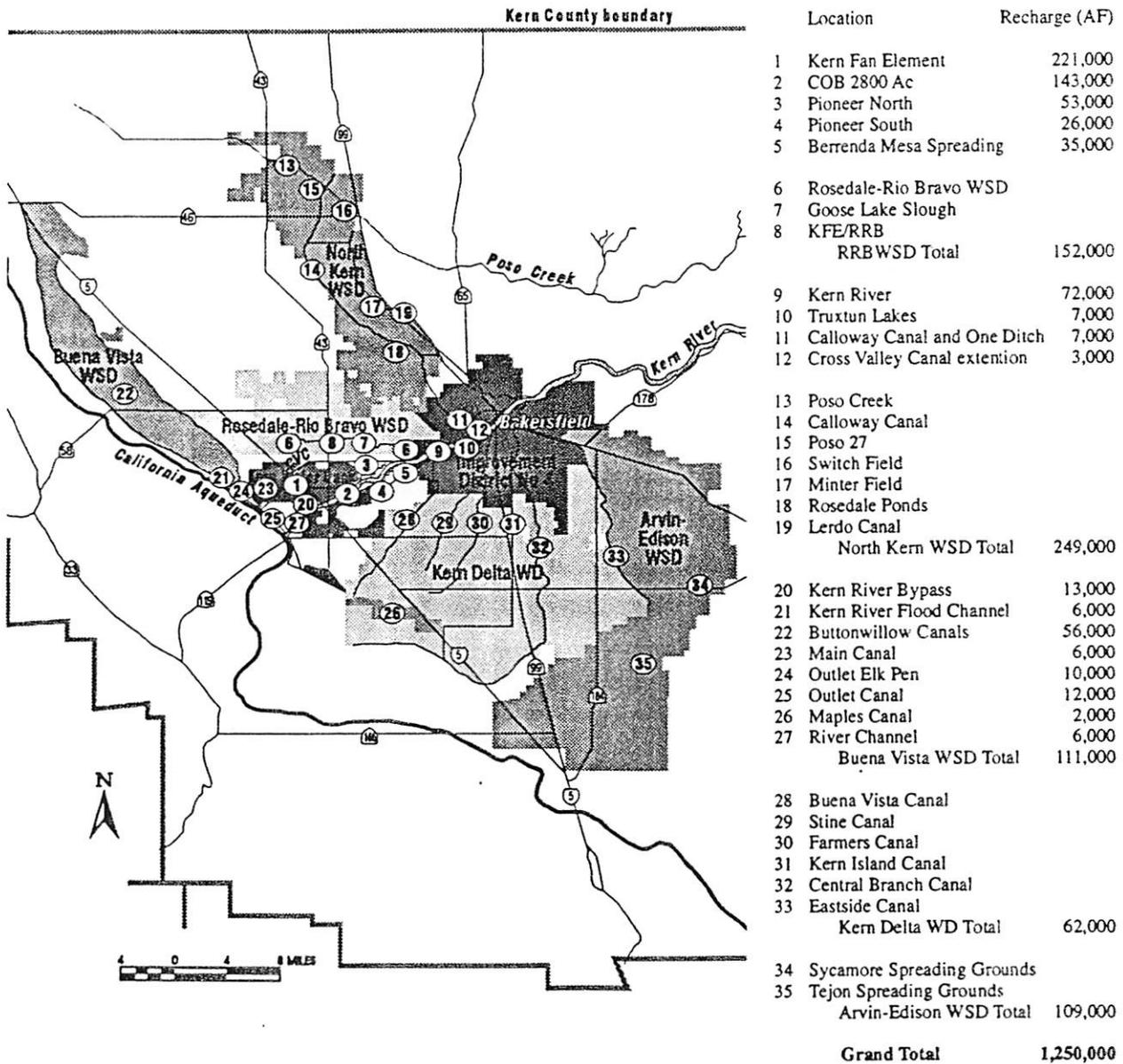
These numbers should only be considered as best estimates since supplies are often intermixed in the same canal systems. Therefore, any differentiation becomes impossible. The amount of recharge shown on Table 23 is more than the amount of recharge listed here. This is because Table 23 includes in lieu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

Such recharge efforts show the importance attached to reducing groundwater overdraft in Kern County, and conserving water. Since 1970 a total of about 11,100,000 acre-feet of water has been recharged (both deliberately and incidentally) as part of groundwater replenishment programs and banking operations. The effectiveness of such recharge activities is apparent in Figure 17. KCWA estimates that the 11,100,000 acre-feet of recharged water results in a gross basin-wide groundwater pumping lift reduction of about 110 feet, or about one foot for every 100,000 acre-feet. Figure 20 shows historic groundwater recharge as a bar graph. This graph clearly shows that 1995 was by far the largest recharge year in recent history.

## Groundwater Banking

Groundwater 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

Figure 19. Groundwater Recharge Sites  
 1995 Summary  
 Southern San Joaquin Valley Portion of Kern County



**Table 23. Summary of Groundwater Recharge Activities (In acre-feet)**

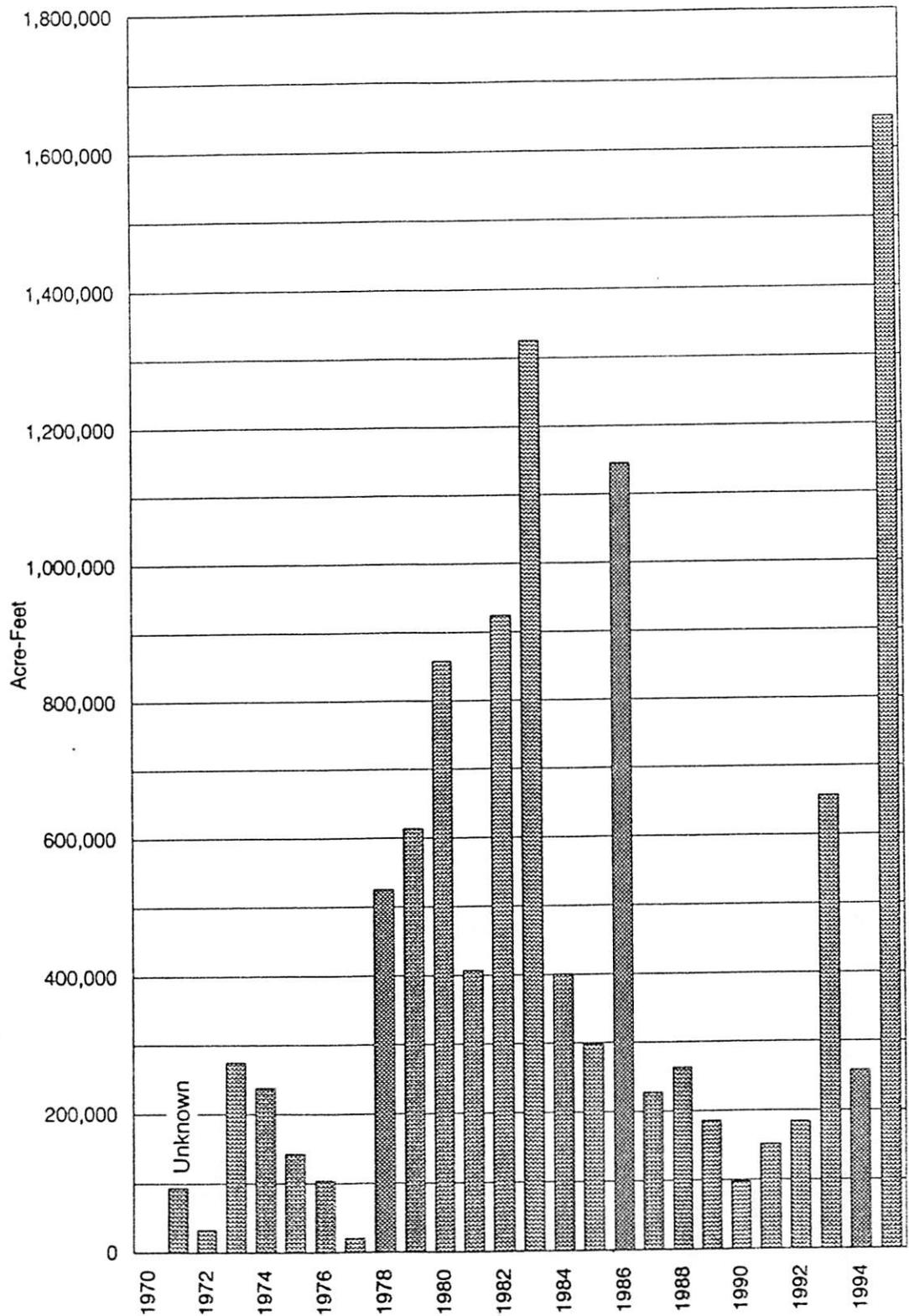
| Entity/Location                      | Source       | 1971-90                 | 1991                  | 1992                  | 1993                  | 1994                  | 1995                    | Total                    |
|--------------------------------------|--------------|-------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------|--------------------------|
| <b>BANKING</b>                       |              |                         |                       |                       |                       |                       |                         |                          |
| City of Bakersfield (2)              |              |                         |                       |                       |                       |                       |                         |                          |
| 2,800 Acre Spreading Area            | Combined (1) | 651,927                 | --                    | --                    | 7,881                 | --                    | 39,117                  | 698,925                  |
| Kern County Water Agency             |              |                         |                       |                       |                       |                       |                         |                          |
| Kern Water Bank                      | Combined (1) | --                      | --                    | --                    | --                    | --                    | 688                     | 688                      |
| Pioneer Property                     | Combined (1) | --                      | --                    | --                    | --                    | --                    | 104,108                 | 104,108                  |
| Berrenda Mesa Spreading Area         | Combined (1) | 33,960                  | --                    | --                    | 7,563                 | 2,333                 | 33,897                  | 77,753 (1)               |
| Kern River Channel                   | Combined (1) | 33,552                  | --                    | --                    | 26,494                | --                    | 2,914                   | 62,960                   |
| 2,800 Acre Spreading Area            | Combined (1) | 82,733                  | --                    | --                    | 125,734               | 20,551                | 73,337                  | 302,355                  |
| Subtotal KCWA                        |              | <u>150,245</u>          | <u>--</u>             | <u>--</u>             | <u>159,791</u>        | <u>22,884</u>         | <u>214,944</u>          | <u>547,864</u>           |
| DWR-Kern Water Bank                  |              |                         |                       |                       |                       |                       |                         |                          |
| 2800 Acre Spreading Area             | SWP          | 7,379                   | --                    | --                    | --                    | --                    | --                      | 7,379                    |
| Local Elements In-lieu Rechg.        | SWP          | 136,300                 | --                    | --                    | --                    | --                    | --                      | 136,300                  |
| Local Elements Direct Rechg.         | SWP          | 4,200                   | --                    | --                    | --                    | --                    | --                      | 4,200                    |
| Subtotal DWR                         |              | <u>147,879</u>          | <u>--</u>             | <u>--</u>             | <u>--</u>             | <u>--</u>             | <u>--</u>               | <u>147,879</u>           |
| Kern Water Bank Authority            |              |                         |                       |                       |                       |                       |                         |                          |
| Kern Water Bank                      | Combined (1) | --                      | --                    | --                    | --                    | --                    | 231,740                 | 231,740                  |
| 2800 Acres                           | Combined (1) | --                      | --                    | --                    | --                    | --                    | --                      | --                       |
| Pioneer Property                     | Combined (1) | --                      | --                    | --                    | --                    | --                    | 231,740                 | 231,740                  |
| Subtotal KWBA                        |              | <u>--</u>               | <u>--</u>             | <u>--</u>             | <u>--</u>             | <u>--</u>             | <u>231,740</u>          | <u>231,740</u>           |
| <b>Total Banking</b>                 |              | <u><b>950,051</b></u>   | <u><b>--</b></u>      | <u><b>--</b></u>      | <u><b>167,672</b></u> | <u><b>22,884</b></u>  | <u><b>485,801</b></u>   | <u><b>1,626,408</b></u>  |
| <b>CONJUNCTIVE USE</b>               |              |                         |                       |                       |                       |                       |                         |                          |
| Arvin-Edison WSD                     | F-K          | 752,323                 | 173                   | 9,253                 | 122,917               | 12,839                | 99,318                  | 996,823                  |
| Buena Vista WSD Direct Rechg.        | Kern         | 1,178,366               | 29,790                | 33,814                | 52,738                | 37,829                | 102,177                 | 1,434,714                |
|                                      | SWP          | 81,395                  | 180                   | 494                   | 4,870                 | 9,332                 | 7,359                   | 103,630                  |
|                                      | F-K          | 23,983                  | --                    | --                    | 2,670                 | --                    | 4,713                   | 31,366                   |
| Semitropic WSD Direct Rechg.         | SWP          | 52,672                  | 6,800                 | 9,326                 | 9,738                 | 8,960                 | 20,881                  | 108,377                  |
| In-Lieu Rechg.                       | SWP          | 636,274                 | 697                   | 1,531                 | 31,728                | 34,638                | 73,954                  | 778,822                  |
|                                      | Combined (1) | 7,289                   | --                    | --                    | --                    | --                    | --                      | 7,289 (1)                |
| LD. No. 4 Direct Rechg.              | Kern         | 414,696                 | 6,279                 | 4,437                 | 30,319                | 15,250                | 76,878                  | 547,859                  |
|                                      | SWP          | 257,607                 | 1,651                 | 2,574                 | 44,557                | 14,030                | 50,200                  | 370,619                  |
|                                      | F-K          | 18,835                  | --                    | --                    | 8,084                 | 193                   | 23,000                  | 50,112                   |
| Kern Delta WD Direct Rechg.          | Combined (1) | 1,058,154               | 42,614                | 37,740                | 57,428                | 47,675                | 61,252                  | 1,304,863                |
| North Kern WSD Direct Rechg.         | Kern         | 1,381,176               | 4,038                 | 26,017                | 61,482                | 4,829                 | 202,581                 | 1,680,123                |
| In-Lieu Rechg.                       | Kern         | 459,505                 | 1,326                 | 26,739                | 45,218                | 108,167               | 124,873                 | 765,828                  |
| Rosedale-Rio Bravo WSD Direct Rechg. | Kern         | 508,904                 | 9,076                 | 1,041                 | 26,890                | --                    | 102,307                 | 648,218                  |
|                                      | SWP          | 514,643                 | --                    | 8,282                 | 55,636                | 6,119                 | 48,375                  | 633,055                  |
|                                      | F-K          | 161,807                 | 62                    | --                    | 6,859                 | --                    | 8,470                   | 177,198                  |
|                                      | Combined (1) | 279,800                 | --                    | --                    | --                    | --                    | --                      | 279,800 (1)              |
| In-Lieu Rechg.                       | SWP          | --                      | --                    | --                    | --                    | 2,657                 | --                      | 2,657                    |
| Wheeler Ridge-Maricopa WSD           |              |                         |                       |                       |                       |                       |                         |                          |
| In-Lieu Recharge                     | SWP          | 193,714                 | --                    | --                    | 6,882                 | --                    | 12,650                  | 213,246                  |
| <b>Total Conjunctive Use</b>         |              | <u><b>7,981,143</b></u> | <u><b>102,686</b></u> | <u><b>161,248</b></u> | <u><b>568,016</b></u> | <u><b>302,518</b></u> | <u><b>1,018,988</b></u> | <u><b>10,134,599</b></u> |
| <b>OVERDRAFT CORRECTION</b>          |              |                         |                       |                       |                       |                       |                         |                          |
| Groundwater Replenishment Programs   |              |                         |                       |                       |                       |                       |                         |                          |
| Direct Rechg.                        | Kern         | 188,185                 | --                    | --                    | --                    | --                    | --                      | 188,185                  |
|                                      | SWP          | 257,920                 | --                    | --                    | 521                   | --                    | --                      | 258,441                  |
|                                      | F-K          | 7,723                   | --                    | --                    | --                    | --                    | --                      | 7,723                    |
| In Lieu Rechg.                       | Kern         | --                      | --                    | --                    | 573                   | --                    | 3,725                   | 4,298                    |
|                                      | SWP          | 96,871                  | --                    | --                    | 1,194                 | --                    | --                      | 98,065                   |
| <b>Total Overdraft Correction</b>    |              | <u><b>550,699</b></u>   | <u><b>--</b></u>      | <u><b>--</b></u>      | <u><b>2,288</b></u>   | <u><b>--</b></u>      | <u><b>3,725</b></u>     | <u><b>556,712</b></u>    |
| <b>GRAND TOTALS</b>                  |              |                         |                       |                       |                       |                       |                         |                          |
|                                      | Kern         | 4,130,832               | 50,509                | 92,048                | 217,220               | 166,075               | 612,541                 | 5,269,225                |
|                                      | SWP          | 2,238,975               | 9,328                 | 22,207                | 155,126               | 75,736                | 213,419                 | 2,714,791                |
|                                      | F-K          | 964,671                 | 235                   | 9,253                 | 140,530               | 13,032                | 135,501                 | 1,263,222                |
|                                      | Combined (1) | 2,147,415               | 42,614                | 37,740                | 225,100               | 70,559                | 547,053                 | 3,070,481 (1)            |
|                                      | <b>Total</b> | <u><b>9,481,893</b></u> | <u><b>102,686</b></u> | <u><b>161,248</b></u> | <u><b>737,976</b></u> | <u><b>325,402</b></u> | <u><b>1,508,514</b></u> | <u><b>12,317,719</b></u> |

(1) Breakdown between sources not available.

(2) Includes banking by Olcese WD, Hacienda WD, Buena Vista WSD, City of Bakersfield; for breakdown between districts see Tables 24.

Note: For a breakdown of 1971 to 1990, see prior Water Supply Reports.

Figure 20. Groundwater Recharge, San Joaquin Valley Portion of Kern County



restraints, DWR cannot presently meet its long-term contractual obligations. Since groundwater 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 underground when it is available and recover it during times when it is not available. Therefore, available surface water supplies are used conjunctively with groundwater.

The Kern Water Bank was a planned banking/recovery program that would have ultimately provided as much as 100,000 acre-feet of annual dry-year yield for the State Water Project. However, through the Monterey Amendment, the Kern Water Bank was transferred to local ownership. During 1995 about 3,000 acres of recharge ponds were constructed, enabling the recharge of 221,930 acre-feet, as shown on Table 24h. On the local level, the City of Bakersfield has maintained its 2,800-acre recharge area as a banking and recovery site for many years, where KCWA and others have deposited water. During 1995 a total of 112,454 acre-feet were recharged in the 2,800 Acres, as shown on Tables 24b and 24f.

During 1992 KCWA purchased 2,400 acres of land to develop additional water recharge and banking facilities. Named the Pioneer Project, 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 Project will increase Kern County's groundwater recharge capacity by about 170,000 acre-feet annually. During 1995 800 acres of the Pioneer Project were developed to recharge ponds, enabling the recharge of 76,880 acre-feet, as shown on Table 24i.

Tables 24a-24i outline banking account balances for those entities who are involved in various banking programs by banking area. These tables are detailed summaries of the banking portion of Table 23, and include recharge, extractions and transfer/sales of banking accounts. The recharge and recoverable balance values shown have not been reduced to reflect evaporation or other losses.

## Shallow Groundwater

When the downward movement of water is intercepted by shallow clay beds or strata of low permeability, shallow groundwater accumulations result. These accumulations generally are undesirable for 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 groundwater problems.

The areas suffering from shallow groundwater in Kern County follow the historic lower-elevation trace of the Kern River channel. Increases in shallow groundwater 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 groundwater seems to be a natural phenomenon. Table 25 lists historic areas with shallow groundwater 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 groundwater area. During 1992-93 the Buena Vista Water Storage District and Lost Hills Water District both expanded their shallow groundwater 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 groundwater 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.

Table 24a. Groundwater Banking Summary

|                                      | 1978    | 1979    | 1980     | 1981      | 1982    | 1983    | 1984    | 1985    | 1986    | 1987    |
|--------------------------------------|---------|---------|----------|-----------|---------|---------|---------|---------|---------|---------|
| <b>Belridge WSD</b>                  |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>Buena Vista WSD</b>               |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    | 6,056   | 9,913   |          |           | 24,465  |         |         |         | 10,000  |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         | (6,000) |
| Storage Balance                      | 6,056   | 15,969  | 15,969   | 15,969    | 40,434  | 40,434  | 40,434  | 40,434  | 50,434  | 44,434  |
| <b>Berrenda Mesa WD</b>              |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          | 9,500     |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          | 9,500     | 9,500   | 9,500   | 9,500   | 9,500   | 9,500   | 9,500   |
| <b>Cawelo WD</b>                     |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>City of Bakersfield</b>           |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    | 104,587 | 4,505   | 68,804   | 2,603     | 37,913  | 113,380 | 16,058  | 402     | 64,168  | 109     |
| Recovery/Sale                        |         |         | (13,772) | (100,837) |         |         | (472)   | (1,615) |         | (656)   |
| Storage Balance                      | 104,587 | 109,092 | 164,124  | 65,890    | 103,803 | 217,183 | 232,769 | 231,556 | 295,724 | 295,177 |
| <b>Dudley Ridge WD</b>               |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>Henry Miller WD</b>               |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>Improvement District No. 4</b>    |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         | 12,766  |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         | 12,766  | 12,766  |
| <b>Kern County Water Agency</b>      |         |         |          |           |         |         |         |         |         |         |
| 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 | 122,379 |
| <b>Kern Delta WD</b>                 |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>Lost Hills WD</b>                 |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>Metropolitan WD of So. Calif.</b> |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |
| <b>Olcose WD/Hacienda WD</b>         |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    | 24,328  |         | 52,604   | 4,465     | 14,266  |         |         |         | 56,197  | 5,344   |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      | 24,328  | 24,328  | 76,932   | 81,397    | 95,663  | 95,663  | 95,663  | 95,663  | 151,860 | 157,204 |
| <b>Rosedale-Rio Bravo WSD</b>        |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                    |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                        |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                      |         |         |          |           |         |         |         |         |         |         |

Table 24a (continued). Groundwater Banking Summary

|                                   | 1978    | 1979    | 1980     | 1981      | 1982    | 1983    | 1984    | 1985    | 1986    | 1987    |
|-----------------------------------|---------|---------|----------|-----------|---------|---------|---------|---------|---------|---------|
| <b>Semitropic WSD</b>             |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                 |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                     |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                   |         |         |          |           |         |         |         |         |         |         |
| <b>State of California</b>        |         |         |          |           |         |         |         |         |         | 7,379   |
| Recharge/Purchase                 |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                     |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                   |         |         |          |           |         |         |         |         |         | 7,379   |
| <b>Tejon-Castac WD</b>            |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                 |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                     |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                   |         |         |          |           |         |         |         |         |         |         |
| <b>Westside Mutual Water Co.</b>  |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                 |         |         |          |           |         |         |         |         |         |         |
| Recovery/Sale                     |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                   |         |         |          |           |         |         |         |         |         |         |
| <b>Wheeler Ridge-Maricopa WSD</b> |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                 |         |         |          | 5,600     |         |         |         |         |         |         |
| Recovery/Sale                     |         |         |          |           |         |         |         |         |         |         |
| Storage Balance                   |         |         |          | 5,600     | 5,600   | 5,600   | 5,600   | 5,600   | 5,600   | 5,600   |
| <b>Total of All Accounts</b>      |         |         |          |           |         |         |         |         |         |         |
| Recharge/Purchase                 | 134,971 | 14,418  | 121,408  | 85,532    | 76,644  | 127,535 | 16,474  | 15,457  | 172,520 | 12,832  |
| Recovery/Sale                     |         |         | (13,772) | (100,837) |         |         | (472)   | (1,615) |         | (6,656) |
| Storage Balance                   | 134,971 | 149,389 | 257,025  | 241,720   | 318,364 | 445,899 | 461,901 | 475,743 | 648,263 | 654,439 |

Note: Storage balances have not been adjusted to reflect evaporation or other losses.

Table 24a (continued). Groundwater Banking Summary

|                                      | 1988    | 1989     | 1990      | 1991     | 1992     | 1993    | 1994    | 1995    | Total     |
|--------------------------------------|---------|----------|-----------|----------|----------|---------|---------|---------|-----------|
| <b>Belridge WSD</b>                  |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          | 14,204  | 325     | 15,685  | 30,214    |
| Recovery/Sale                        |         |          |           |          |          |         | (2,029) |         | (2,029)   |
| Storage Balance                      |         |          |           |          |          | 14,204  | 12,500  | 28,185  | 28,185    |
| <b>Buena Vista WSD</b>               |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          | 7,849   |         | 26,806  | 85,089    |
| Recovery/Sale                        | (5,000) | (3,138)  | (2,242)   | (4,410)  | (4,004)  |         |         |         | (24,794)  |
| Storage Balance                      | 39,434  | 36,296   | 34,054    | 29,644   | 25,640   | 33,489  | 33,489  | 60,295  | 60,295    |
| <b>Berrenda Mesa WD</b>              |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           | 4,002    |          | 7,936   | 6,568   | 59,051  | 87,057    |
| Recovery/Sale                        |         |          | (9,500)   | (4,002)  |          |         | (400)   |         | (13,902)  |
| Storage Balance                      | 9,500   | 9,500    |           |          |          | 7,936   | 14,104  | 73,155  | 73,155    |
| <b>Cawelo WD</b>                     |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          | 14,068  |         | 3,245   | 17,313    |
| Recovery/Sale                        |         |          |           |          |          |         | (44)    |         | (44)      |
| Storage Balance                      |         |          |           |          |          | 14,068  | 14,024  | 17,269  | 17,269    |
| <b>City of Bakersfield</b>           |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          | 32      |         | 13,089  | 425,650   |
| Recovery/Sale                        | (5,432) | (2,859)  | (23,318)  | (57,159) | (30,266) |         | (8,311) | (1,297) | (245,994) |
| Storage Balance                      | 289,745 | 286,886  | 263,568   | 206,409  | 176,143  | 176,175 | 167,864 | 179,656 | 179,656   |
| <b>Dudley Ridge WD</b>               |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          |         |         | 1,587   | 1,587     |
| Recovery/Sale                        |         |          |           |          |          |         |         |         |           |
| Storage Balance                      |         |          |           |          |          |         |         | 1,587   | 1,587     |
| <b>Henry Miller WD</b>               |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          |         |         | 5,611   | 5,611     |
| Recovery/Sale                        |         |          |           |          |          |         |         |         |           |
| Storage Balance                      |         |          |           |          |          |         |         | 5,611   | 5,611     |
| <b>Improvement District No. 4</b>    |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         | 3,500    |           |          |          | 23,007  | 10,641  | 91,806  | 141,720   |
| Recovery/Sale                        |         |          |           |          | (3,500)  |         | (100)   |         | (3,600)   |
| Storage Balance                      | 12,766  | 16,266   | 16,266    | 16,266   | 12,766   | 35,773  | 46,314  | 138,120 | 138,120   |
| <b>Kern County Water Agency</b>      |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           | 42,096   | 6,450    | 5,542   |         | 29,000  | 205,467   |
| Recovery/Sale                        |         | (16,105) |           | (66,775) | (22,684) |         |         |         | (105,564) |
| Storage Balance                      | 122,379 | 106,274  | 106,274   | 81,595   | 65,361   | 70,903  | 70,903  | 99,903  | 99,903    |
| <b>Kern Delta WD</b>                 |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          |         |         | 1,611   | 1,611     |
| Recovery/Sale                        |         |          |           |          |          |         |         |         |           |
| Storage Balance                      |         |          |           |          |          |         |         | 1,611   | 1,611     |
| <b>Lost Hills WD</b>                 |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           | 2,035    |          | 31,153  | 5,280   | 26,307  | 64,775    |
| Recovery/Sale                        |         |          |           |          |          |         |         |         |           |
| Storage Balance                      |         |          |           | 2,035    | 2,035    | 33,188  | 38,468  | 64,775  | 64,775    |
| <b>Metropolitan WD of So. Calif.</b> |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          | 50,000  |         | 45,000  | 95,000    |
| Recovery/Sale                        |         |          |           |          |          |         |         |         |           |
| Storage Balance                      |         |          |           |          |          | 50,000  | 50,000  | 95,000  | 95,000    |
| <b>OlceseWD/Hacienda WD</b>          |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    | 3,214   |          |           | 22,096   | 6,450    |         |         | 6,028   | 194,992   |
| Recovery/Sale                        |         | (873)    | (104,305) | (23,496) | (6,450)  |         | (1,160) |         | (136,284) |
| Storage Balance                      | 160,418 | 159,545  | 55,240    | 53,840   | 53,840   | 53,840  | 52,680  | 58,708  | 58,708    |
| <b>Rosedale-Rio Bravo WSD</b>        |         |          |           |          |          |         |         |         |           |
| Recharge/Purchase                    |         |          |           |          |          |         |         | 5,849   | 5,849     |
| Recovery/Sale                        |         |          |           |          |          |         |         |         |           |
| Storage Balance                      |         |          |           |          |          |         |         | 5,849   | 5,849     |

Table 24a (continued). Groundwater Banking Summary

|                                   | 1988     | 1989     | 1990      | 1991      | 1992      | 1993    | 1994     | 1995      | Total     |
|-----------------------------------|----------|----------|-----------|-----------|-----------|---------|----------|-----------|-----------|
| <b>Semitropic WSD</b>             |          |          |           |           |           |         |          |           |           |
| Recharge/Purchase                 |          |          |           |           |           | 19,972  |          | 1,100     | 21,072    |
| Recovery/Sale                     |          |          |           |           |           |         | (181)    |           | (181)     |
| Storage Balance                   |          |          |           |           |           | 19,972  | 19,791   | 20,891    | 20,891    |
| <b>State of California</b>        |          |          |           |           |           |         |          |           |           |
| Recharge/Purchase                 |          |          | 248,005   |           |           |         |          |           | 255,384   |
| Recovery/Sale                     |          |          |           |           | (72,049)  |         | (12,458) | (752)     | (85,259)  |
| Storage Balance                   | 7,379    | 7,379    | 255,384   | 255,384   | 183,335   | 183,335 | 170,877  | 170,125   | 170,125   |
| <b>Tejon-Castac WD</b>            |          |          |           |           |           |         |          |           |           |
| Recharge/Purchase                 |          |          |           |           |           |         | 70       | 2,329     | 2,399     |
| Recovery/Sale                     |          |          |           |           |           |         |          |           |           |
| Storage Balance                   |          |          |           |           |           |         | 70       | 2,399     | 2,399     |
| <b>Westside Mutual Water Co.</b>  |          |          |           |           |           |         |          |           |           |
| Recharge/Purchase                 |          |          |           |           |           |         |          | 134,517   | 134,517   |
| Recovery/Sale                     |          |          |           |           |           |         |          |           |           |
| Storage Balance                   |          |          |           |           |           |         |          | 134,517   | 134,517   |
| <b>Wheeler Ridge-Maricopa WSD</b> |          |          |           |           |           |         |          |           |           |
| Recharge/Purchase                 |          | 15,019   |           |           |           | 58,290  |          | 61,492    | 140,401   |
| Recovery/Sale                     |          |          |           |           |           |         | (7,551)  |           | (7,551)   |
| Storage Balance                   | 5,600    | 20,619   | 20,619    | 20,619    | 20,619    | 78,909  | 71,358   | 132,850   | 132,850   |
| <b>Total of All Accounts</b>      |          |          |           |           |           |         |          |           |           |
| Recharge/Purchase                 | 3,214    | 18,519   | 248,005   | 70,229    | 12,900    | 232,053 | 22,884   | 530,113   | 1,915,708 |
| Recovery/Sale                     | (10,432) | (22,975) | (139,365) | (155,842) | (138,953) |         | (32,234) | (2,049)   | (625,202) |
| Storage Balance                   | 647,221  | 642,765  | 751,405   | 665,792   | 539,739   | 771,792 | 762,442  | 1,290,506 | 1,290,506 |

Table 24b . City of Bakersfield 2,800 Acre Recharge Facility  
Groundwater 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/<br>Purchase | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase      | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>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                     | 16,105 (1)        | 38,762                 | 15,019                     | 0                 | 20,619                 | 0                     | 0                 | 9,500                  |
| 1990          | 0                     | 0                 | 38,762                 | 0                          | 0                 | 20,619                 | 0                     | 9,500 (3)         | 0                      |
| 1991          | 42,096                | 33,316            | 47,542                 | 0                          | 0                 | 20,619                 | 0                     | 0                 | 0                      |
| 1992          | 6,450                 | 9,953             | 44,039                 | 0                          | 0                 | 20,619                 | 0                     | 0                 | 0                      |
| 1993          | 5,542                 | 0                 | 49,581                 | 34,774                     | 0                 | 55,393                 | 1,506                 | 0                 | 1,506                  |
| 1994          | 0                     | 0                 | 44,039                 | 0                          | 6,261             | 49,132                 | 4,593                 | 0                 | 6,099                  |
| 1995          | 0                     | 0                 | 49,581                 | 5,151                      | 0                 | 54,283                 | 23,850                | 0                 | 29,949                 |
|               | 108,955               | 59,374            | 49,581 (4)             | 60,544                     | 6,261             | 54,283                 | 39,449                | 9,500             | 29,949                 |

| Calendar Year | Improvement District No. 4 |                   |                        | State of California   |                   |                        | Cawelo WD             |                   |                        |
|---------------|----------------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
|               | Recharge/<br>Purchase      | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>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          | 3,500 (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                 | 107,505               | 0                 | 114,884                | 0                     | 0                 | 0                      |
| 1991          | 0                          | 0                 | 16,266                 | 0                     | 0                 | 114,884                | 0                     | 0                 | 0                      |
| 1992          | 0                          | 3,500             | 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                 |
| 1995          | 23,607                     | 0                 | 69,921                 | 0                     | 752               | 86,796                 | 3,245                 | 0                 | 17,269                 |
|               | 73,521                     | 3,600             | 69,921                 | 114,884               | 28,088            | 86,796                 | 17,313                | 44                | 17,269                 |

- (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 Groundwater 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.  
(4) Total of 16,991 AF owed by KCWA to City of San Francisco.

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

Recoverable balances have not been adjusted to reflect evaporation or other losses.

Table 24b (continued). City of Bakersfield 2,800 Acre Recharge Facility  
 Groundwater 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/<br>Purchase | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>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          | 18,581                | 0                 | 20,616                 | 8,284                 | 0                 | 8,284                  | 0                     | 0                 | 0                      |
| 1994          | 4,922                 | 0                 | 25,538                 | 325                   | 1,197             | 7,412                  | 70                    | 0                 | 70                     |
| 1995          | 10,700                | 0                 | 36,238                 | 6,784                 | 0                 | 14,196                 | 0                     | 0                 | 70                     |
|               | 36,238                | 0                 | 36,238                 | 15,393                | 1,197             | 14,196                 | 70                    | 0                 | 70                     |

| Calendar Year | Semitropic WSD        |                   |                        | Total of All Accounts |                   |                        |
|---------------|-----------------------|-------------------|------------------------|-----------------------|-------------------|------------------------|
|               | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>Balance | Recharge/<br>Purchase | Recovery/<br>Sale | Recoverable<br>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                 | 125,734               | 0                 | 305,199                |
| 1994          | 0                     | 181               | 19,791                 | 20,551                | 20,241            | 305,509                |
| 1995          | 0                     | 0                 | 19,791                 | 73,337                | 752               | 378,094                |
|               | 19,972                | 181               | 19,791                 | 486,339               | 108,245           | 378,094                |

**Table 24c. Berrenda Mesa Spreading Grounds  
Groundwater 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/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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                      | 4,002                        | 4,002                    | 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                  |
| 1995          | 6,263                        | 0                        | 24,925                 | 1,186                        | 0                        | 7,913                  | 23,675                       | 0                        | 31,162                 |
|               | <b>40,223</b>                | <b>15,298</b>            | <b>24,925</b>          | <b>9,203</b>                 | <b>1,290</b>             | <b>7,913</b>           | <b>35,364</b>                | <b>4,202</b>             | <b>31,162</b>          |

| Calendar Year | Lost Hills WD                |                          |                        | Belridge WSD                 |                          |                        | Total of All Accounts        |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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                      | 4,002                        | 19,300                   | 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                    | 40,617                 |
| 1995          | 1,190                        | 0                        | 5,996                  | 1,583                        | 0                        | 4,518                  | 33,897                       | 0                        | 74,514                 |
|               | <b>5,996</b>                 | <b>0</b>                 | <b>5,996</b>           | <b>5,350</b>                 | <b>832</b>               | <b>4,518</b>           | <b>96,136</b>                | <b>21,622</b>            | <b>74,514</b>          |

Note: Purchases and sales are shown as italicized and larger.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

**Table 24d. Kern River Channel  
Groundwater 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/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance |
| 1981          | 33,552                       | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1982          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1983          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1984          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1985          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1986          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1987          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1988          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1989          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1990          | 0                            | 0                        | 33,552                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1991          | 0                            | 18,161                   | 15,391                 | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 12,731                   | 2,660                  | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 2,660                  | 15,499                       | 0                        | 15,499                 | 718                          | 0                        | 718                    |
| 1994          | 0                            | 0                        | 2,660                  | 0                            | 0                        | 15,499                 | 0                            | 200                      | 518                    |
| 1995          | 456                          | 0                        | 3,116                  | 0                            | 0                        | 15,499                 | 1,475                        | 0                        | 1,993                  |
|               | 34,008                       | 30,892                   | 3,116                  | 15,499                       | 0                        | 15,499                 | 2,193                        | 200                      | 1,993                  |

| Calendar Year | Lost Hills WD                |                          |                        | Belridge WSD                 |                          |                        | Total of All Accounts        |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance |
| 1981          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 33,552                       | 0                        | 33,552                 |
| 1982          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1983          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1984          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1985          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1986          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1987          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1988          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1989          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1990          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 33,552                 |
| 1991          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 18,161                   | 15,391                 |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 12,731                   | 2,660                  |
| 1993          | 8,124                        | 0                        | 8,124                  | 2,153                        | 0                        | 2,153                  | 26,494                       | 0                        | 29,154                 |
| 1994          | 0                            | 0                        | 8,124                  | 0                            | 0                        | 2,153                  | 0                            | 200                      | 28,954                 |
| 1995          | 630                          | 0                        | 8,754                  | 353                          | 0                        | 2,506                  | 2,914                        | 0                        | 31,868                 |
|               | 8,754                        | 0                        | 8,754                  | 2,506                        | 0                        | 2,506                  | 62,960                       | 31,092                   | 31,868                 |

Note: Purchases and sales are shown as italicized and larger.  
1993 figures include losses in the James and Pioneer Canal systems.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

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

| Calendar Year      | Contracting Entity or Location |               |                        | Total          |
|--------------------|--------------------------------|---------------|------------------------|----------------|
|                    | Buena Vista WSD                | Kern Delta WD | Rosedale-Rio Bravo WSD |                |
| 1987               | 0                              | 0             | 0                      | 0              |
| 1988               | 0                              | 0             | 0                      | 0              |
| 1989               | 0                              | 0             | 0                      | 0              |
| 1990               | 20,000                         | 7,500         | 7,500                  | 35,000         |
| 1991               | 0                              | 0             | 0                      | 0              |
| 1992               | (9,300)                        | (2,814)       | (3,558)                | (15,672)       |
| 1993               | 0                              | 0             | 0                      | 0              |
| 1994               | 0                              | 0             | 0                      | 0              |
| 1995               | 0                              | 0             | 0                      | 0              |
| <b>Subtotal</b>    | <b>10,700</b>                  | <b>4,686</b>  | <b>3,942</b>           | <b>19,328</b>  |
|                    |                                |               |                        | <b>86,796</b>  |
|                    |                                |               |                        | <b>64,001</b>  |
| <b>Grand Total</b> |                                |               |                        | <b>170,125</b> |

Source: KCWA records.

Note: Recoverable balances have not been adjusted to reflect evaporation or other losses.

**Table 24f. Groundwater Banking Summary  
Contracting Entities Other than KCWA or DWR  
City of Bakersfield 2,800 Acre Recharge Facility\*  
Recharge/Purchase or Recovery/Sale (in acre-feet)**

| Calendar<br>Year | City of Bakersfield |                | Olcese/Hacienda WD |                | Buena Vista WSD |               | Total Banking  |                | Storage<br>Balance |
|------------------|---------------------|----------------|--------------------|----------------|-----------------|---------------|----------------|----------------|--------------------|
|                  | Recharge            | Recovery       | Recharge           | Recovery       | Recharge        | Recovery      | Recharge       | Recovery       |                    |
| 1978             | 104,587             | 0              | 24,328             | 0              | 6,056           | 0             | 134,971        | 0              | 134,971            |
| 1979             | 4,505               | 0              | 0                  | 0              | 9,913           | 0             | 14,418         | 0              | 149,389            |
| 1980             | 68,804              | <i>13,772</i>  | 52,604             | 0              | 0               | 0             | 121,408        | 13,772         | 257,025            |
| 1981             | 2,603               | <i>100,837</i> | 4,465              | 0              | 0               | 0             | 7,068          | 100,837        | 163,256            |
| 1982             | 37,913              | 0              | 14,266             | 0              | 24,465          | 0             | 76,644         | 0              | 239,900            |
| 1983             | 113,380             | 0              | 0                  | 0              | 0               | 0             | 113,380        | 0              | 353,280            |
| 1984             | 16,058              | 472            | 0                  | 0              | 0               | 0             | 16,058         | 472            | 368,866            |
| 1985             | 402                 | 1,615          | 0                  | 0              | 0               | 0             | 402            | 1,615          | 367,653            |
| 1986             | 64,168              | 0              | 56,197             | 0              | 10,000          | 0             | 130,365        | 0              | 498,018            |
| 1987             | 109                 | 656            | <i>5,344</i>       | 0              | 0               | <i>6,000</i>  | 5,453          | 6,656          | 496,815            |
| 1988             | 0                   | <i>5,432</i>   | <i>3,214</i>       | 0              | 0               | <i>5,000</i>  | 3,214          | 10,432         | 489,597            |
| 1989             | 0                   | 2,859          | 0                  | 873            | 0               | 3,138         | 0              | 6,870          | 482,727            |
| 1990             | 0                   | 23,318         | 0                  | <i>104,305</i> | 0               | 2,242         | 0              | 129,865        | 352,862            |
| 1991             | 0                   | <i>57,159</i>  | <i>22,096</i>      | <i>23,496</i>  | 0               | 4,410         | 22,096         | 85,065         | 289,893            |
| 1992             | 0                   | <i>30,266</i>  | <i>6,450</i>       | <i>6,450</i>   | 0               | 4,004         | 6,450          | 40,720         | 255,623            |
| 1993             | 32                  | 0              | 0                  | 0              | 7,849           | 0             | 7,881          | 0              | 263,504            |
| 1994             | 0                   | 8,311          | 0                  | 1,160          | 0               | 0             | 0              | 9,471          | 254,033            |
| 1995             | 13,089              | 1,297          | 6,028              | 0              | 20,000          | 0             | 39,117         | 1,297          | 291,853            |
|                  | <b>425,650</b>      | <b>245,994</b> | <b>194,992</b>     | <b>136,284</b> | <b>78,283</b>   | <b>24,794</b> | <b>698,925</b> | <b>407,072</b> | <b>291,853</b>     |

\* 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.

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

Recoverable balances have not been adjusted to reflect evaporation or other losses.

**Table 24g. Semitropic Water Storage District  
Groundwater Banking Summary  
Recharge/Purchase or Recovery/Sale (in acre-feet)**

| Calendar Year | Department of Water Resources |                          |                        | Metropolitan WD of So. California |                          |                        | Total of All Accounts        |                          |                        |
|---------------|-------------------------------|--------------------------|------------------------|-----------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i>  | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i>      | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance |
| 1978          | 0                             | 0                        | 0                      | 0                                 | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1979          | 0                             | 0                        | 0                      | 0                                 | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1980          | 0                             | 0                        | 0                      | 0                                 | 0                        | 0                      | 0                            | 0                        | 0                      |
| 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          | 105,500                       | 0                        | 105,500                | 0                                 | 0                        | 0                      | 105,500                      | 0                        | 105,500                |
| 1991          | 0                             | 0                        | 105,500                | 0                                 | 0                        | 0                      | 0                            | 0                        | 105,500                |
| 1992          | 0                             | 41,499                   | 64,001                 | 0                                 | 0                        | 0                      | 0                            | 41,499                   | 64,001                 |
| 1993          | 0                             | 0                        | 105,500                | 50,000                            | 0                        | 50,000                 | 50,000                       | 0                        | 114,001                |
| 1994          | 0                             | 0                        | 105,500                | 0                                 | 0                        | 0                      | 0                            | 0                        | 114,001                |
| 1995          | 0                             | 0                        | 64,001                 | 45,000                            | 0                        | 45,000                 | 45,000                       | 0                        | 159,001                |
|               | 105,500                       | 41,499                   | 64,001                 | 95,000                            | 0                        | 95,000                 | 200,500                      | 41,499                   | 159,001                |

**Note:** Purchases and sales are shown as italicized and larger.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

**Table 24h. Kern Water Bank Authority  
Kern Water Bank  
Groundwater Banking Summary.  
Recharge/Purchase or Recovery/Sale (in acre-feet)**

| Calendar Year | KCWA General Account         |                          |                        | Wheeler Ridge-Maricopa WSD   |                          |                        | Dudley Ridge WD              |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 688                          | 0                        | 688                    | 50,894                       | 0                        | 50,894                 | 1,587                        | 0                        | 1,587                  |
|               | 688                          | 0                        | 688                    | 50,894                       | 0                        | 50,894                 | 1,587                        | 0                        | 1,587                  |

| Calendar Year | Improvement District No. 4   |                          |                        | Semitropic WSD               |                          |                        | Tejon-Castac WD              |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 40,625                       | 0                        | 40,625                 | 1,100                        | 0                        | 1,100                  | 2,329                        | 0                        | 2,329                  |
|               | 40,625                       | 0                        | 40,625                 | 1,100                        | 0                        | 1,100                  | 2,329                        | 0                        | 2,329                  |

Note: Purchases and sales are shown as italicized and larger.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

Table 24h (continued). Kern Water Bank Authority  
 Kern Water Bank  
 Groundwater Banking Summary.  
 Recharge/Purchase or Recovery/Sale (in acre-feet)

| Calendar Year | Westside Mutual WC           |                          |                        | Total of All Accounts        |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance |
| 1981          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1982          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1983          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1984          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1985          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1986          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1987          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1988          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1989          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1990          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1991          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 134,517                      | 0                        | 134,517                | 231,740                      | 0                        | 231,740                |
|               | 134,517                      | 0                        | 134,517                | 231,740                      | 0                        | 231,740                |

Note: Purchases and sales are shown as italicized and larger.  
 Recoverable balances have not been adjusted to reflect evaporation or other losses.

**Table 24i. Kern County Water Agency  
Pioneer Property  
Groundwater Banking Summary  
Recharge/Purchase or Recovery/Sale (in acre-feet)**

| Calendar Year | KCWA General Account         |                          |                        | Wheeler Ridge-Maricopa WSD   |                          |                        | Berrenda Mesa WD             |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 21,593                       | 0                        | 21,593                 | 4,261                        | 0                        | 4,261                  | 10,051                       | 0                        | 10,051                 |
|               | 21,593                       | 0                        | 21,593                 | 4,261                        | 0                        | 4,261                  | 10,051                       | 0                        | 10,051                 |

| Calendar Year | Improvement District No. 4   |                          |                        | Buena Vista WSD              |                          |                        | Henry Miller WD              |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 27,574                       | 0                        | 27,574                 | 6,806                        | 0                        | 6,806                  | 5,611                        | 0                        | 5,611                  |
|               | 27,574                       | 0                        | 27,574                 | 6,806                        | 0                        | 6,806                  | 5,611                        | 0                        | 5,611                  |

Note: Purchases and sales are shown as italicized and larger.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

Table 24i (continued). Kern County Water Agency  
Pioneer Property  
Groundwater Banking Summary  
Recharge/Purchase or Recovery/Sale (in acre-feet)

| Calendar Year | Kern Delta WD                |                          |                        | Rosedale-Rio Bravo WSD       |                          |                        | Tejon-Castac WD              |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 1,611                        | 0                        | 1,611                  | 5,849                        | 0                        | 5,849                  | 0                            | 0                        | 0                      |
|               | 1,611                        | 0                        | 1,611                  | 5,849                        | 0                        | 5,849                  | 0                            | 0                        | 0                      |

| Calendar Year | Semitropic WSD               |                          |                        | Lost Hills WD                |                          |                        | Belridge WSD                 |                          |                        |
|---------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|------------------------------|--------------------------|------------------------|
|               | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>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          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1992          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1993          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1994          | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      | 0                            | 0                        | 0                      |
| 1995          | 0                            | 0                        | 0                      | 13,787                       | 0                        | 13,787                 | 6,965                        | 0                        | 6,965                  |
|               | 0                            | 0                        | 0                      | 13,787                       | 0                        | 13,787                 | 6,965                        | 0                        | 6,965                  |

Note: Purchases and sales are shown as italicized and larger.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

Table 24i (continued). Kern County Water Agency  
Pioneer Property  
Groundwater Banking Summary  
Recharge/Purchase or Recovery/Sale (in acre-feet)

| Calendar<br>Year | Total of All Accounts        |                          |                        |
|------------------|------------------------------|--------------------------|------------------------|
|                  | Recharge/<br><i>Purchase</i> | Recovery/<br><i>Sale</i> | Recoverable<br>Balance |
| 1981             | 0                            | 0                        | 0                      |
| 1982             | 0                            | 0                        | 0                      |
| 1983             | 0                            | 0                        | 0                      |
| 1984             | 0                            | 0                        | 0                      |
| 1985             | 0                            | 0                        | 0                      |
| 1986             | 0                            | 0                        | 0                      |
| 1987             | 0                            | 0                        | 0                      |
| 1988             | 0                            | 0                        | 0                      |
| 1989             | 0                            | 0                        | 0                      |
| 1990             | 0                            | 0                        | 0                      |
| 1991             | 0                            | 0                        | 0                      |
| 1992             | 0                            | 0                        | 0                      |
| 1993             | 0                            | 0                        | 0                      |
| 1994             | 0                            | 0                        | 0                      |
| 1995             | 104,108                      | 0                        | 104,108                |
|                  | 104,108                      | 0                        | 104,108                |

Note: Purchases and sales are shown as italicized and larger.  
Recoverable balances have not been adjusted to reflect evaporation or other losses.

Table 25. Areal Extent of Shallow Groundwater, San Joaquin Valley Portion of Kern County (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 <sup>(1)</sup>  | 172,320                | --             | --                  | --       | --        | --                    | --                  | --             |
| 1977 | 19,320              | 68,980   | --        | 95,960 <sup>(1)</sup>  | 184,260                | 180            | 16,930              | 52,530   | --        | 67,300 <sup>(3)</sup> | 136,760             | 143            |
| 1978 | 27,680              | 65,760   | --        | 87,920 <sup>(1)</sup>  | 181,360                | 174            | 9,600               | 59,520   | --        | 86,400 <sup>(3)</sup> | 155,520             | --             |
| 1979 | 30,270              | 67,310   | --        | 95,870 <sup>(1)</sup>  | 193,450                | --             | 15,320              | 83,200   | --        | 80,640 <sup>(3)</sup> | 179,160             | 126            |
| 1980 | 74,357              | 82,787   | --        | 125,883 <sup>(1)</sup> | 283,027                | --             | 45,882              | 92,998   | 126,665   | 62,578                | 328,123             | 154            |
| 1981 | 62,002              | 85,556   | --        | 128,323 <sup>(1)</sup> | 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    | -- <sup>(2)</sup>      | 241,641 <sup>(3)</sup> | 350            | --                  | --       | --        | --                    | --                  | --             |
| 1991 | 40,363              | 101,888  | 45,141    | -- <sup>(2)</sup>      | 187,392 <sup>(3)</sup> | 351            | --                  | --       | --        | --                    | --                  | --             |
| 1992 | 9,954               | 102,114  | 46,287    | -- <sup>(2)</sup>      | 158,355 <sup>(3)</sup> | 344            | --                  | --       | --        | --                    | --                  | --             |
| 1993 | 25,184              | 97,357   | 46,893    | -- <sup>(2)</sup>      | 169,434 <sup>(3)</sup> | 518            | --                  | --       | --        | --                    | --                  | --             |
| 1994 | 19,176              | 106,506  | 69,362    | -- <sup>(2)</sup>      | 195,044 <sup>(3)</sup> | 422            | --                  | --       | --        | --                    | --                  | --             |
| 1995 | 96,431              | 82,231   | 57,427    | 55,416                 | 291,505                | 377            | --                  | --       | --        | --                    | --                  | --             |

(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 Groundwater 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.

Depth to shallow groundwater as measured in shallow monitoring wells is contoured on Plate 1. In the summer of 1995 water within five feet of the ground surface was found under an area of about 96,400 acres. This was a 500 percent increase from the summer of 1994 area. The area of shallow groundwater between 5-10 feet of the ground surface was about 82,200 acres, about 30 percent less than the previous year. The area with shallow groundwater between 10-15 feet of the surface was 57,400 acres in 1995, a 20 percent decrease over 1994. The total area with shallow groundwater between ground surface and 20 feet below increased about 21 percent from 1994. The probable cause for the dramatic increase in area for the 0-5 feet interval was the record rainfall in March 1995, combined with the abundance of surface water available. An examination of Table 25 shows that a large increase in area for the 0-5 feet interval commonly occurs in wet years.

## Groundwater Quality

The groundwater 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 groundwater is the recipient of these salts via recharge waters or return flows from irrigation and urban users.

Surface water supplies over the usable groundwater basin in 1995 (some 3,053,900 acre-feet) carried about 517,100 tons of new salts into the groundwater basin. This quantity of salt was about twice the amount that was introduced in 1994, reflecting the higher availability 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 1995:

Surface Water Salt Loads, 1995

| <u>Source</u>         | <u>Volume</u><br>(af) | <u>Avg. TDS</u><br>(ppm) | <u>Salt Load</u><br>(tons) |
|-----------------------|-----------------------|--------------------------|----------------------------|
| SWP Over G.W. Basin   | 863,600               | 212                      | 248,600                    |
| Kern River            | 1,199,400             | 68                       | 110,200                    |
| Minor Streams         | 161,900               | 524                      | 115,400                    |
| Other Local Supplies* | 181,900               | 106                      | 26,200                     |
| CVP                   | 647,100               | 19                       | 16,700                     |
| Total                 | 3,053,900             | 125                      | 517,100                    |

\* Includes effective rainfall, oil field produced water.

Groundwater 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 groundwater. This smaller volume of water carries the salts once held by the total volume applied. The result is a concentration of salts. The construction of local drainage projects would help reduce this buildup of salts by removing some near-surface accumulations in the shallow groundwater 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 groundwater 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 groundwater 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 groundwater 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 more 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. The lower system is partially protected from surface contaminants by the Corcoran Clay. Contours on this map show the groundwater quality of the lower aquifer to be superior to that of the unconfined zone.

Agricultural water well drilling decreased during 1995 compared to activity in 1994. The Kern County Environmental Health Services Department during 1995 issued a total of 30 agricultural water well permits. Comparatively, a total of 61 permits were issued during 1994. The decrease in drilling activity was largely due to the fact that 1995 was a wet year with plenty of surface water available. An additional 105 domestic wells were permitted and drilled during 1995, along with 37 wells for non-ag and non-domestic purposes (i.e., monitoring wells). Altogether, 172 new water wells were drilled during 1995. Annular seals were required on 15 of the new wells to prevent degradation of lower groundwater zones. Annular seals are plugs of cement between the well casing and the drilled hole near a regional stratum of low permeability.

## Groundwater Levels

Plate 4, "Depth to Groundwater, Spring 1996" 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 groundwater trends. Control wells include unconfined and select 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 Groundwater" map shows the distances in feet from the ground surface to the water surface.

A "Groundwater Surface Elevation" map (Plate 5) was prepared based on the same measured wells as the "Depth to Groundwater" map. This map implies the horizontal movement of groundwater from higher to lower elevations. The major direction of groundwater 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 groundwater recharge source. Mounding of water occurs along the Kern River channel, and groundwater moves away from this area. In this area, the rate of horizontal groundwater flow in the upper portions of the aquifer is estimated to be 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 districts' recharge efforts.

Generally, groundwater level lows are associated with areas of higher groundwater 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 groundwater level changes from Spring 1995 to Spring 1996. Differences were plotted and contoured to show areas of relative improvement or decline. Shading 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 groundwater level measurements and simple measuring errors preclude more precision.

In a dramatic change from 1994-95, very few areas within the basin showed water level declines. This is largely due to ample supplies of surface water, resulting in a corresponding lower demand for groundwater. Also, the large-scale groundwater recharge programs, begun in 1993, have contributed to the improved groundwater levels.

Areas that showed the greatest changes in water levels were near the Kern Water Bank, City of Bakersfield 2800 Acres Spreading Grounds and KCWA Pioneer Recharge Facility. Water levels near these recharge areas rose as much as 110 feet above the 1995 depth to water of 150 feet. Areas near the Arvin-Edison Water Storage District's recharge ponds (south of the City of Arvin) had water level increases between 20 and 60 feet. Even areas of the valley which normally show declines in water levels experienced either static conditions (no change) or water level rises between 10 and 20 feet.

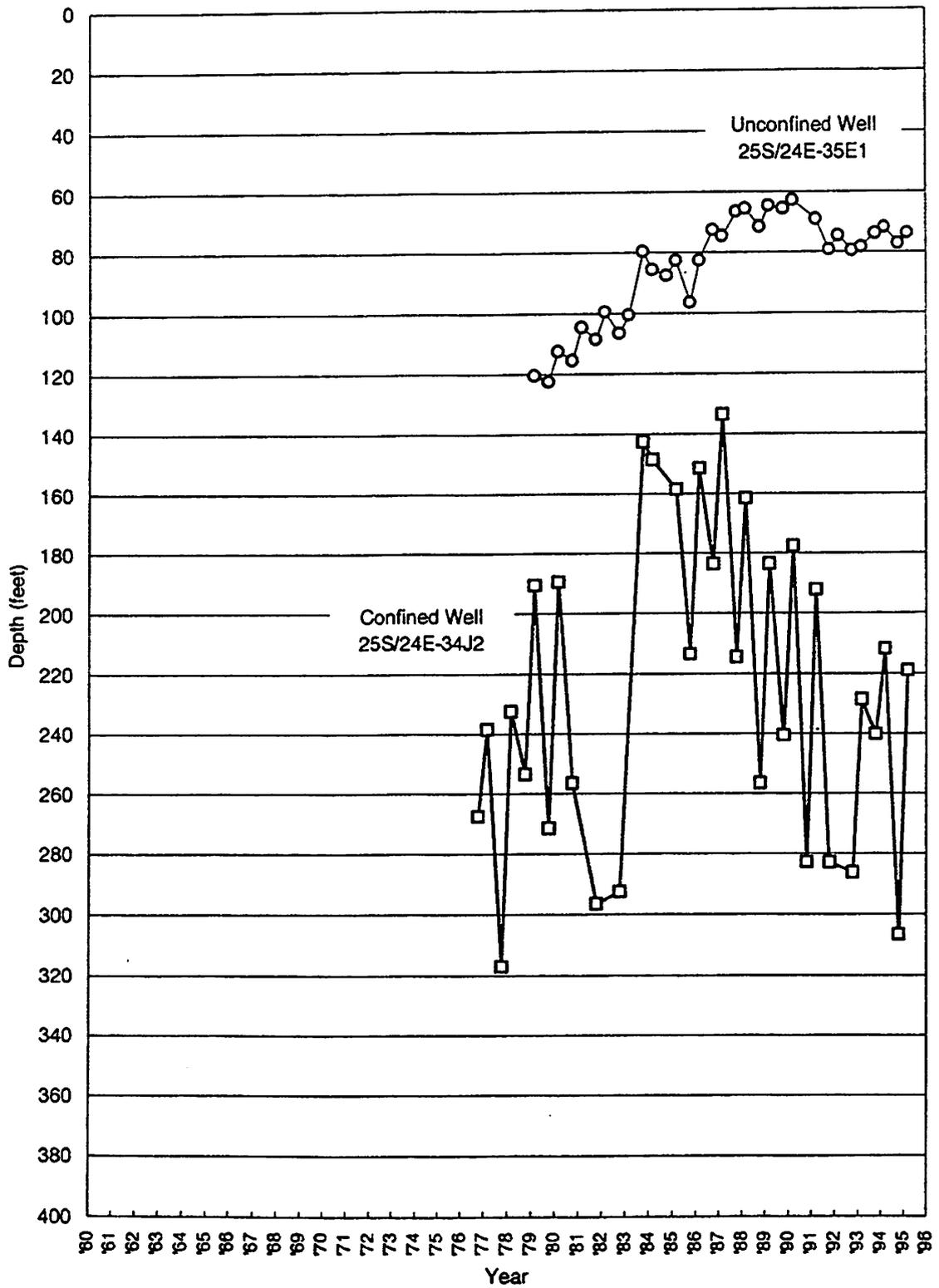
Water level changes in eight key water wells are displayed on hydrographs as Figures 21a, 21b, 21c and 21d. Each hydrograph represents water levels for a pair of wells, one unconfined and the other confined. One well pair is located in the Pond-Poso area. Another pair is between Shafter and Rosedale-Rio 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 groundwater. The recent decline in water levels reflects the expanded use of groundwater during the drought. The confined well shows a steady rise of water levels from the 1977 drought 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 between the Kern River channel and Rosedale-Rio Bravo WSD's recharge facilities. 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 groundwater recharge facilities, the hydrographs show rapid water level rises during the 1978-86 and 1993-95 wet periods and dramatic declines during the 1987-92 drought.

The more moderate groundwater level changes in the Shafter well (T28S/R25S-32F1) reflect the greater distance from the main area of groundwater 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 groundwater levels and fluctuations that are consistent with the shallow wells. Confined and unconfined aquifers usually exhibit characteristic differences in seasonal groundwater level changes.

Figure21a. Water Well Hydrograph  
Pond-Poso Area



**Figure 21b. Water Well Hydrograph**  
**Shafter/Rosedale-Rio Bravo Area**

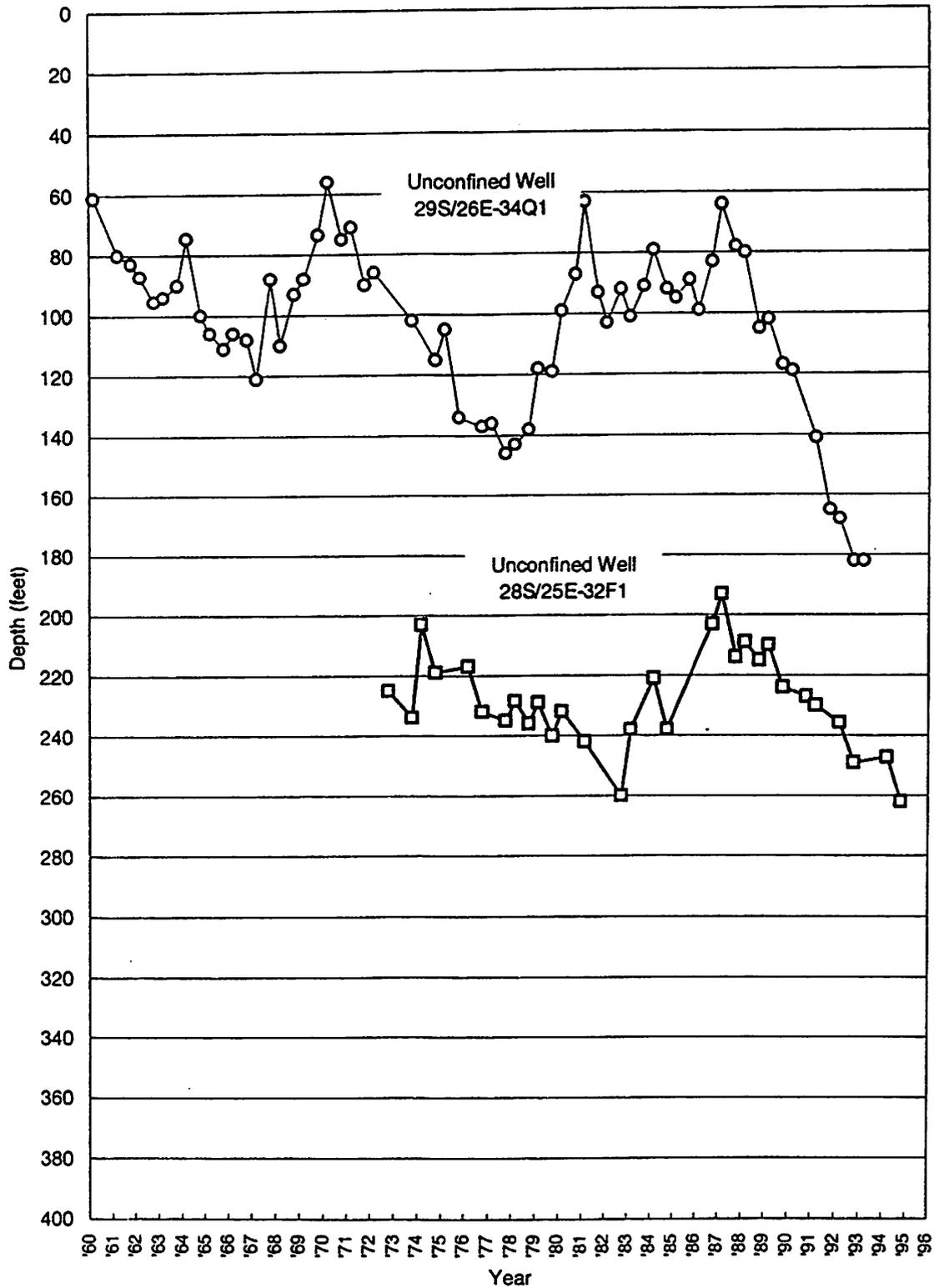


Figure 21c. Water Well Hydrograph  
Southwest Bakersfield Area

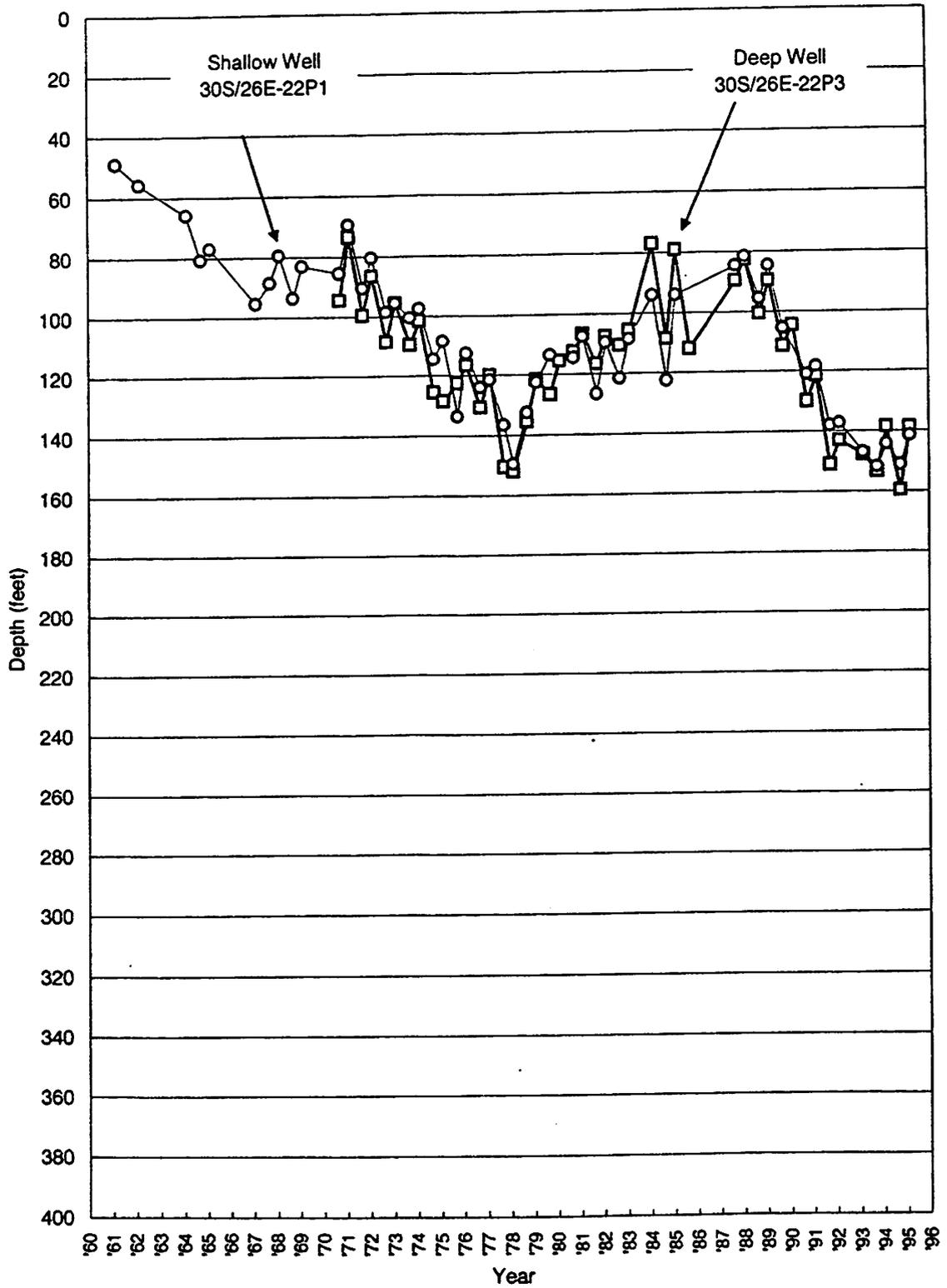
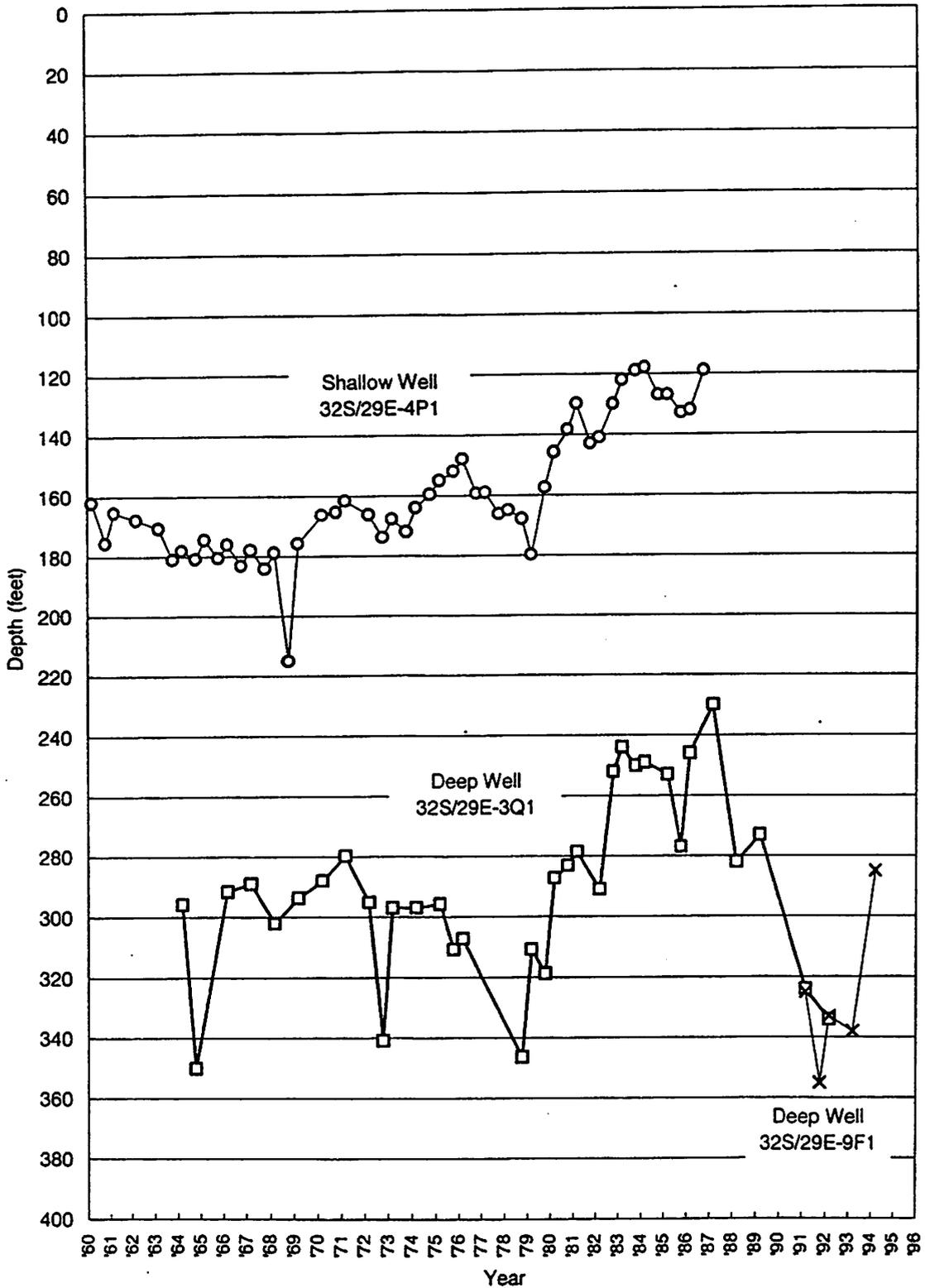


Figure 21d. Water Well Hydrograph  
Arvin-Edison Area



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 groundwater levels in both wells over a long period suggest that a classic confined aquifer may not exist in this area.

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 variability of groundwater levels more consistent with a confined, rather than unconfined, aquifer. The large difference in groundwater 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 groundwater levels to rise, as seen in the shallow well hydrograph. During the 1976-77 drought groundwater levels declined. The deep well showed rising groundwater levels from 1978-86. The recent six-year drought has resulted in groundwater 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 extended valley floor encompasses about 450 square miles. The southern Sierra Nevada Mountains bound the valley on the west, the Coso Range on the north, the Argus Mountains on the east, the Rademacher Hills on the southeast and the El Paso Mountains on the south. Elevations on the valley floor range from 2,300 to 3,000 feet above sea level. Surrounding mountains may reach 9,000 feet. The largest community in the valley is the city of Ridgecrest, with a population of about 29,000. The valley is an arid desert, with rainfall of only 3-4 inches per year. Little, if any, rainfall reaches the groundwater table; it is rapidly evaporated by high winds and high temperatures or transpired by desert plants. Presently, the only source of potable water is groundwater, much of which is of good to excellent quality. Groundwater recharge comes from the adjacent mountain ranges.

The "Cooperative Groundwater Management Plan for the Indian Wells Valley" was signed in September 1995. Participants include the U.S. Bureau of Land Management, Eastern Kern County Resource Conservation District, Indian Wells Valley Water District, Inyokern Airport District, Inyokern Community Services District, City of Ridgecrest and the Kern County Water Agency. The two principle incentives to developing a coordinated plan were documented long-term water level declines throughout the valley and the potential for degradation of good quality groundwater. Participants will collectively set forth guidelines and management principles for the production, distribution and use of groundwater within the purview of the participants. To promote development and implementation of improved groundwater management practices, the Indian Wells Valley Water Management Steering Committee was established. The goal of the Committee is to coordinate operations in a manner that meets ongoing demands, while ensuring the availability of an adequate supply of good quality groundwater for future generations.

The Indian Wells Valley Water District (IWVWD), Brown Road Farming Company, China Lake Naval Air Weapons Station (NAWS) and North American Chemical Company (NACC) are the major groundwater pumpers within the valley. Inyokern Community Services District (ICSD) meets most of the water demands for the City of Inyokern. The City of Ridgecrest pumps a small amount of groundwater to meet landscaping needs. Independent well owners (9,000-10,000

residents within the valley) account for additional pumping in the range of 3,000 to 6,000 acre-feet per year.

Studies indicate that total pumping in the valley is from 25,000 to 29,000 acre-feet annually, as follows:

|                         | <u>Acre-feet</u>    |
|-------------------------|---------------------|
| Brown Road Farming      | 7,500               |
| IWVWD                   | 8,000               |
| NAWS                    | 4,400               |
| NACC                    | 2,500               |
| ICSD                    | 300                 |
| Independent well owners | 3,000 - 6,000       |
| City of Ridgecrest      | 100                 |
| <br>Total               | <br>25,800 - 28,800 |

Several technical investigations have attempted to determine the hydrologic balance for the valley. Results have varied considerably, due to differing assumptions of natural annual recharge to and discharge from the valley. Long-term average annual natural recharge has been estimated from a conservative low of 3,000 acre-feet to more than 43,000 acre-feet. Determining the hydrologic balance for Indian Wells Valley is much more difficult than for the San Joaquin Valley portion of Kern County. The San Joaquin Valley is heavily influenced by large amounts of imported water and Kern River flows, while Indian Wells Valley's water balance is entirely related to natural groundwater recharge.

Water level measurements for wells throughout the valley were the basis for Plate 7, "Depth to Groundwater, Indian Wells Valley" and Plate 8, "Groundwater Elevation, Indian Wells Valley." Solid segments of contours infer a higher degree of confidence in the interpretation. Dashed contours infer a less constrained interpretation due to sparse data or increased variance of the data. Plate 8 shows three definite sinks for groundwater flow in the valley. The first is naturally occurring and represents the discharge of groundwater (via evaporation) within the China Lake playa. The playa is located about 5 miles northeast of Ridgecrest. The second groundwater sink is associated with large-scale agricultural pumping along Brown Road, about 8 miles north of Inyokern. The third sink is a regional pumping depression extending from southeast Ridgecrest to north of Inyokern (called the Ridgecrest-Inyokern pumping corridor). This depression is the most important from a basin-wide groundwater management perspective. The depression has expanded by about 30,000 acres since 1946. This extensive pumping depression is a response to an increase in the valley's population from about 15,000 in 1946 to about 38,000 today.

Hydrographs for key wells are shown in Figures 21e, 21f and 21g. These hydrographs reflect the fact that water levels have systematically declined for decades over broad portions of the valley. The hydrographs represent water levels in wells located along the perimeter of the valley, at sufficient distance from large capacity pumping wells to not be influenced by them. Figure 21e charts a well in the northwest portion of the basin (about 5 miles northwest of Inyokern) near the foot of the Sierra Nevada mountains (26S/38E-35B1). Figure 21f shows a well in the southeast portion of the basin, about 1.5 miles north of Cerro Coso College (27S/39E-7R11). Figure 21g shows a well in the southwest portion of the basin, about 3 miles south of Inyokern and within the Little Dixie Wash (27S/40E-15D1).

Figure 21e. Water Well Hydrograph  
Indian Wells Valley

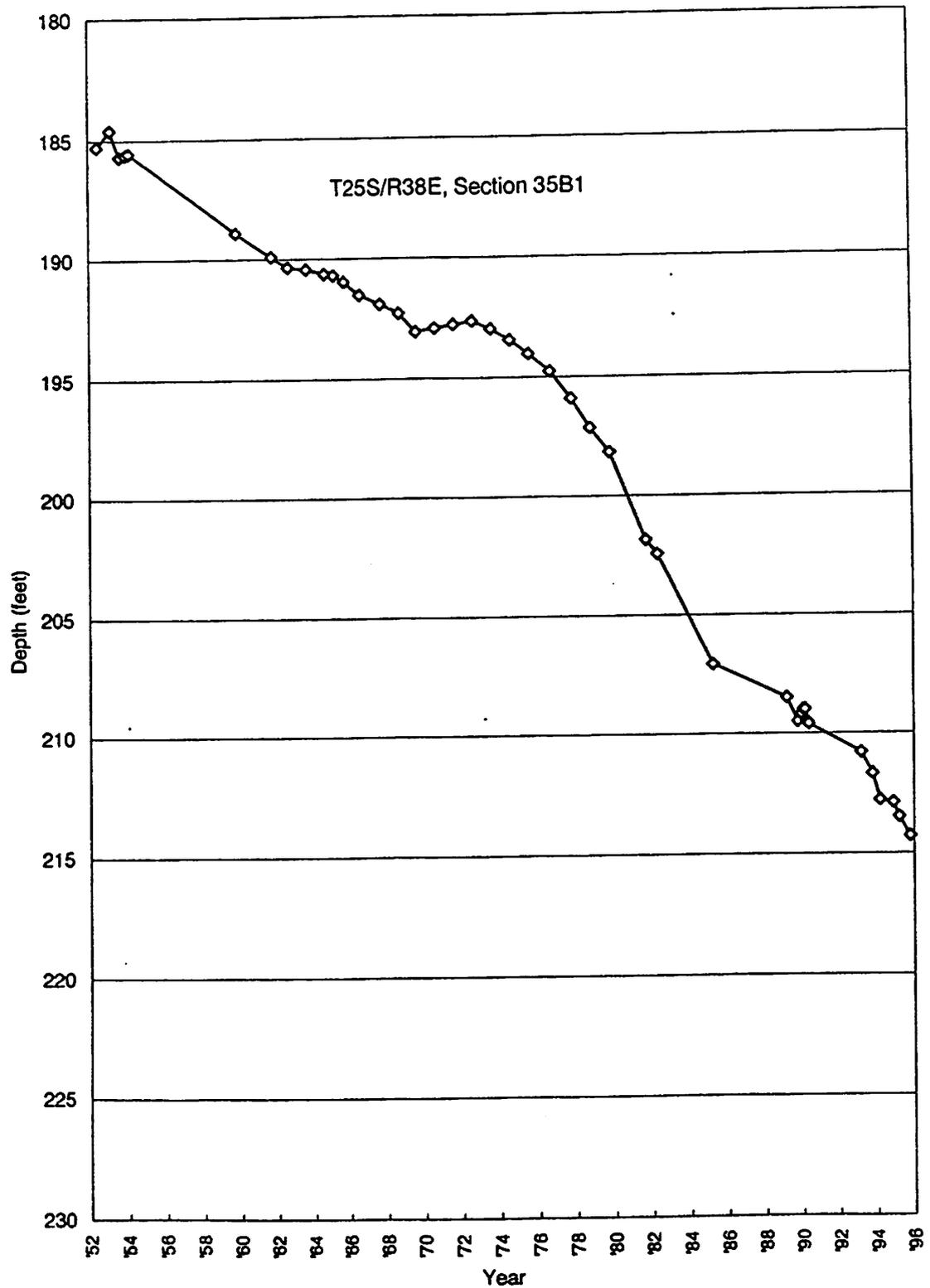


Figure 21f. Water Well Hydrograph  
Indian Wells Valley

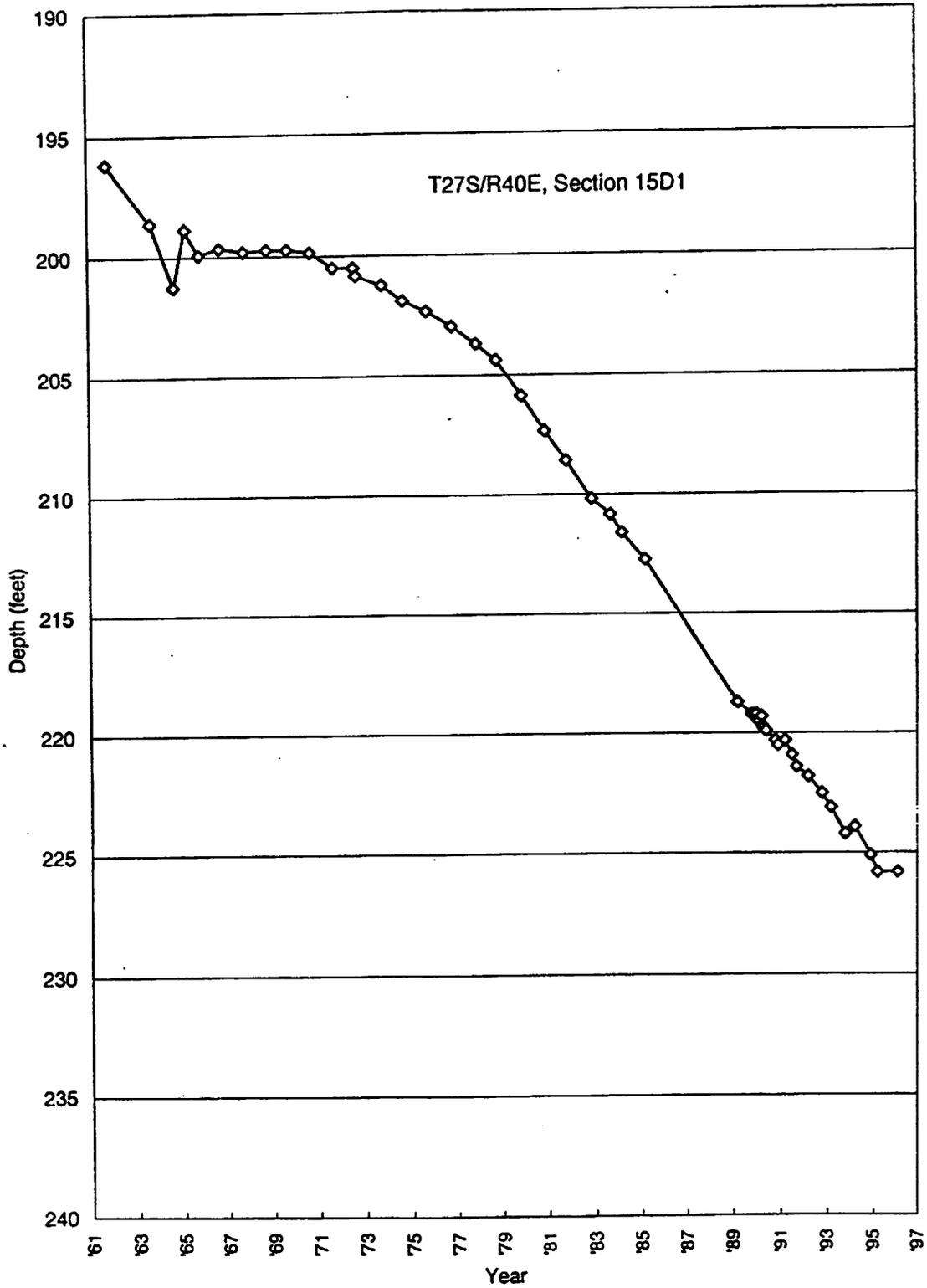
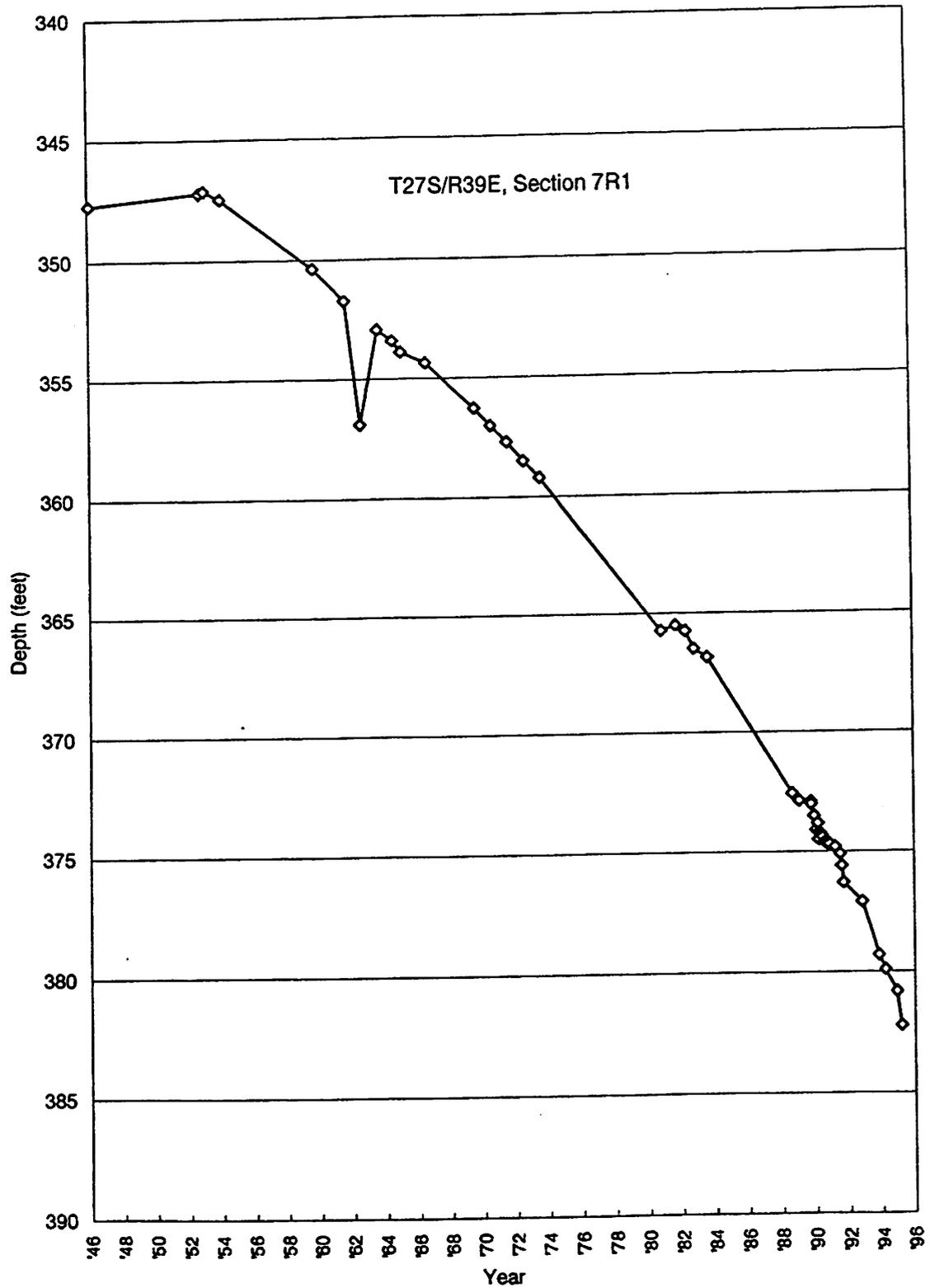


Figure 21g. Water Well Hydrograph  
Indian Wells Valley



In general, water levels have been declining from 0.5 to 1.0 feet per year in areas outside the Ridgecrest-Inyokern pumping corridor. However, in the center of the pumping area water levels have declined by an average of 1.5 feet annually. In this central area, water levels declined only 15 feet between 1920 and 1953. Between 1953 and 1993 water levels declined 60 to 70 feet. In recent years water levels have stabilized, due to the Indian Wells Valley Water District redistributing pumping further to the west. In Figure 21f recent water levels have declined from 1.0 to 1.5 feet per year. This is a matter of great interest, given the very limited groundwater pumping throughout the southwest area.

The accelerated decline of groundwater levels in the southwest area is probably linked to a dramatic change in subsurface geology. Plate 8, "Groundwater Surface Elevations," presents an anomalous steep hydraulic gradient in the southwest portion of the valley. A series of studies suggests that these extreme water level differences might be the manifestation of complex structural geology or stratigraphy. The interpretation of continuity of groundwater flow along this steep gradient is tentative at best. It is presented simply to convey the existence of extreme differences in water levels in the southwest area and not to infer that continuous groundwater flow exists in the area. Additional work during 1996 and 1997 will address whether continuous groundwater flow exists in the southwest portion of the valley.

Plate 8 shows an apparent steep hydraulic gradient in the 2-3 mile wide zone trending southeast from Armitage Field to Ridgecrest Blvd. This trend of the steep gradient parallels the Little Lake Fault Zone. In this area, wells and piezometers perforated at various depths show significant water level differences. The degree of hydraulic communication across the Fault Zone needs evaluation to determine whether pumping in the Ridgecrest-Inyokern pumping corridor influences the lateral or vertical migration of poor quality groundwater.

Plate 9, "Groundwater 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, IWVWD and private well owners. The distribution of relatively good quality water (TDS less than 500 ppm) reflects areas that probably benefit from recharge from adjacent mountains. The map shows the existence of very poor quality groundwater (TDS greater than 2,000 ppm) in large portions of T25S/R39E and T25S/R40E, and in the eastern portion of T26S/R40E, and in the eastern portion of T26E/R40E. To the southeast, south and southwest of Ridgecrest there is poor quality groundwater (TDS greater than 1,000 ppm).

Participants in the Indian Wells Valley Groundwater Management Plan recognize that acquisition of additional hydrologic and geologic data are required to develop sound management practices for the valley. A multi-agency technical committee is developing programs to acquire and analyze needed data and propose prudent management practices, and serve in a consulting role to the Management Steering Committee. A principle long-term goal is to produce a more accurate hydrologic balance for the valley.

KCWA has been instrumental in working with other entities in the implementation of the groundwater management plan. The KCWA, IWVWD and NACC, working with the federal Bureau of Land Management (BLM), helped fund two additional permanent weather stations, upgraded two existing weather stations and installed three temporary stations in adjacent watersheds. The KCWA is working with the BLM to install stream gauges on two ephemeral streams in the nearby Sierra Nevada mountains. To address groundwater level trends and potential influences to groundwater flow, KCWA monitors groundwater levels on a semiannual basis. Over 130 production wells, monitor wells, abandoned wells and piezometers throughout the valley are measured. KCWA

assisted the IWWWD, over a several month period, in their long-term aquifer test in the southwest portion of the valley. KCWA is presently preparing a technical report about the hydrology and geology associated with the southwest portion of the valley.

Numerous governmental agencies, including Kern County Water Agency, have been involved with the federal Restoration Advisory Board, which is overseeing the cleanup of some 70 potential hazardous waste sites located within the boundaries of NAWS. Development and implementation of a long-term groundwater monitoring program will aid in evaluating the effectiveness of site cleanup or contamination risk assessment for each site. This is of particular interest to all groundwater users.

## **FOCUS: KERN-TULARE WATER DISTRICT**

The Kern-Tulare Water District was formed in 1974 to provide a water supply for east side agriculture, which began to develop rapidly during the early 1970s. While groundwater exists in the district, generally it is quite deep and expensive to pump. Much of the agriculture that developed in the 1970s was based on groundwater, but landowners recognized that sustained agriculture would require a long-term surface water supply.

The district straddles the Kern County-Tulare County border. It is located mostly west of Highway 65 (Porterville Highway). The gross area of the district is 20,250 acres, about 15,000 acres of which is in Kern County. In 1995 about 16,000 acres were under cultivation (13,200 acres within Kern County). Elevations range from 350 feet above sea level in the west to 850 feet in the east part of the district, with the land sloping to the west and south. Agriculture in the area requires intensive management practices due to the slope of the land (almost all of the permanent crops in the district are drip irrigated, and all annual crops are sprinkler irrigated). About half the district consists of areas of steep slopes. Terracing has been used on many orchards to control erosion.

In terms of soil fertility, 85 percent of the district is classified as "prime" agricultural land according to the Storie Index. (The Storie Index results from the multiplication of four factors - the percentage rank of the soil in: (a) soil profile - hardness of any clay layer and deepness of the topsoil; (b) surface texture - low rating at any of three extremes (clay, sand, silt), high rating at a good combination of the three (loam soil); (c) slope - nearly level to very steep; (d) a multiplicative combination of several additional factors, such as drainage, alkalinity, fertility, acidity, erosion hazard. Since the factors are combined multiplicatively rather than additively, a high rating is difficult to obtain.) Using the cultivation suitability land classification, about 90 percent of the soils in the district are Class 1 (excellent) or Class 2 (good), with the majority being Class 2. The district is well suited for orchards and vineyards. Lying on the perimeter of the valley, it enjoys more frost-free days than the valley floor, making it excellent for citrus.

The district's water distribution facilities, which it shares with Rag Gulch Water District, consist of 60 miles of pipelines, with several pumping plants totaling 7,000 horsepower. The district's surface water supplies are from the Kern River and the Friant-Kern Canal system. In 1977 Kern-Tulare entered into a long-term contract with the City of Bakersfield for 20,000 acre-feet annually from the City's Kern River water rights. On average, the Kern River contract provides the district with about 18,000 acre-feet of water. The Friant-Kern supplies another 8,000 acre-feet, on average.

Irrigated crops grown in Kern-Tulare in 1995 can be grouped as follows:

|             |              |
|-------------|--------------|
| Field Crops | 4%           |
| Orchards    | 96%          |
| Total       | 14,007 acres |

Obviously, the district is almost entirely permanent crops, and is almost entirely irrigated with low-volume irrigation systems. Likely this reflects the fact that much of the irrigated land in the district has slopes that cannot tolerate more traditional irrigation system types. Because of the preponderance of low-volume irrigation systems, the district's overall irrigation efficiency is quite high, between 80-85 percent. This is one of the highest irrigation efficiencies in Kern County. Table 26 shows irrigated acreage in Kern-Tulare Water District during 1995. The total gross value of the crops grown during 1995 is about \$96 million, with \$46 million generated within Kern County. This translates into about \$300 million for the regional economy via a multiplier effect. Citrus makes up half the irrigated acreage in the district, and accounts for about half of the gross crop value.

**Table 26. 1995 Irrigated Acreage in the Kern-Tulare Water District**

| Crop                           | Total Acres   | Kern Co. Acres |
|--------------------------------|---------------|----------------|
| <b>Annual Crops</b>            |               |                |
| Miscellaneous Field Crops      | 537           | 80             |
| Subtotal                       | 537           | 80             |
| <b>Permanent Crops</b>         |               |                |
| Almonds                        | 530           | 240            |
| Apples                         | 73            | -              |
| Citrus                         | 7,339         | 5,553          |
| Grapes                         | 4,200         | 1,102          |
| Kiwis                          | 201           | -              |
| Misc. Trees, Vines             | 9             | 9              |
| Olives                         | 203           | 203            |
| Pistachios                     | 915           | 910            |
| Subtotal                       | 13,470        | 8,017          |
| <b>Other</b>                   |               |                |
| Dry Farmed Grains, Pasture     | 2,321         | 1,927          |
| Idle or Fallow                 | 3,922         | 3,175          |
|                                | 6,243         | 5,102          |
| <b>Total Irrigated Acreage</b> | <b>14,007</b> | <b>8,097</b>   |
| <b>Total Farmed Acreage</b>    | <b>20,250</b> | <b>13,199</b>  |

## OUTLOOK: 1996

The wet weather conditions in 1995 carried over into 1996. Reservoirs throughout the state had good carryover storage to begin the precipitation season. The season started out slow, with very low amounts of rain and snow between September and December 1995. A series of winter storms from January through March 1996 boosted the state's precipitation totals to above normal.

By the end of January 1996 SWP allocations were set at 100 percent, or 1,112,730 acre-feet. Likewise, Friant-Kern CVP allocations were also set at 100 percent of Class I and Class II contract entitlements. Total CVP deliveries are expected to be about 650,000 acre-feet. The Kern River is expected to yield 125 percent of normal supplies, or about 1,000,000 acre-feet. Minor stream flows are expected to be 150,000 acre-feet. Effective precipitation is expected to be about 200,000 acre-feet. Accordingly, total surface supplies in 1996 are expected to be about 3,100,000 acre-feet. Much of this water is expected to be recharged to groundwater.

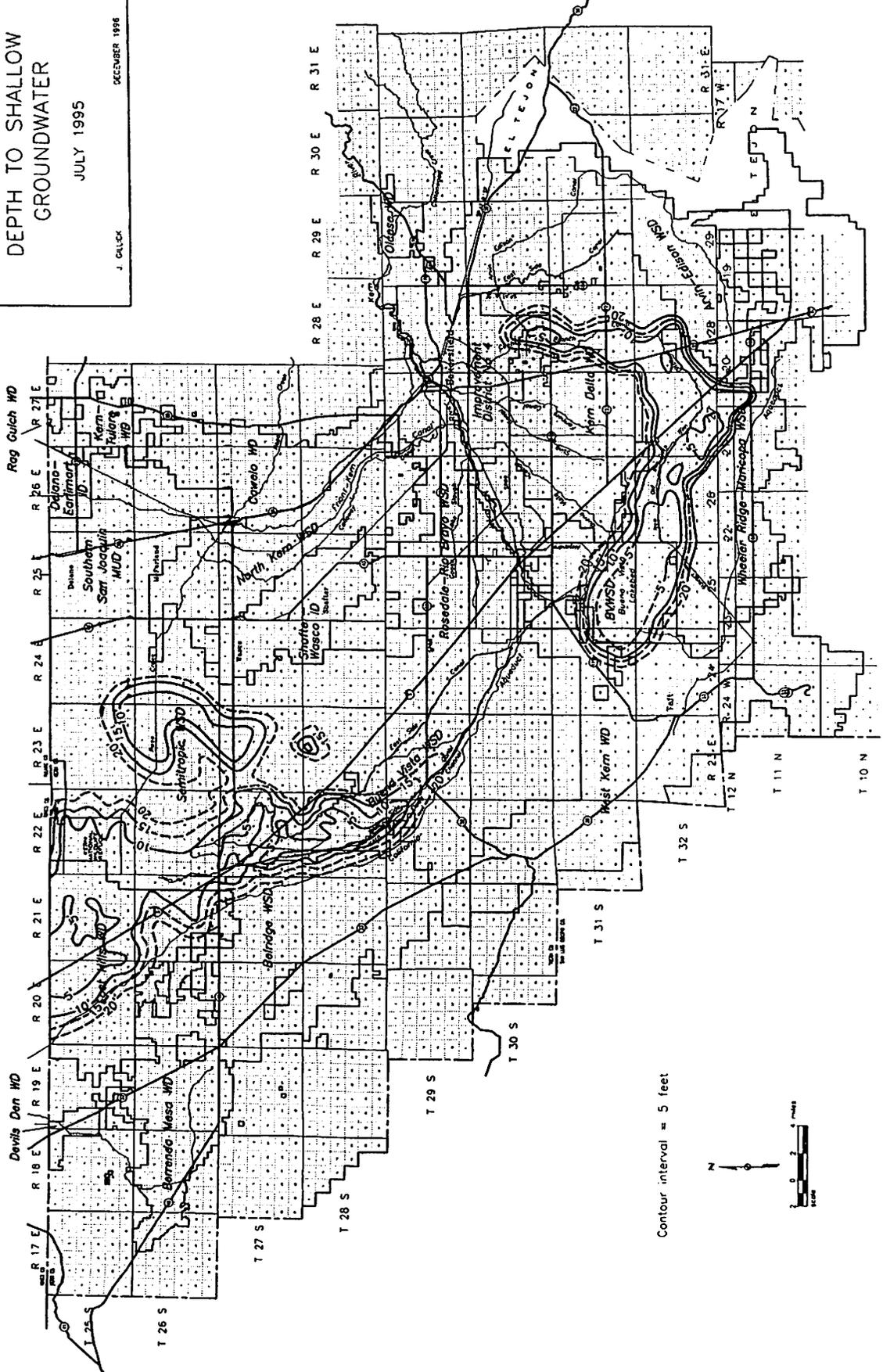
Total water demands during 1996 are projected to be about 3,100,000 acre-feet. Irrigated acreage is expected to be about the same as in 1995 because of ample water supplies received early in the growing season. Hence, irrigated acreage is projected to again be about 850,000 acres. Consumption or losses for all types of uses are estimated to be about 2,500,000 acre-feet. Thus, KCWA projects that a net increase in groundwater storage of about 600,000 acre-feet will occur in 1996. Such an increase will add to the large increase in storage that occurred in 1995.

# DEPTH TO SHALLOW GROUNDWATER

JULY 1995

J. GULICK

DECEMBER 1996

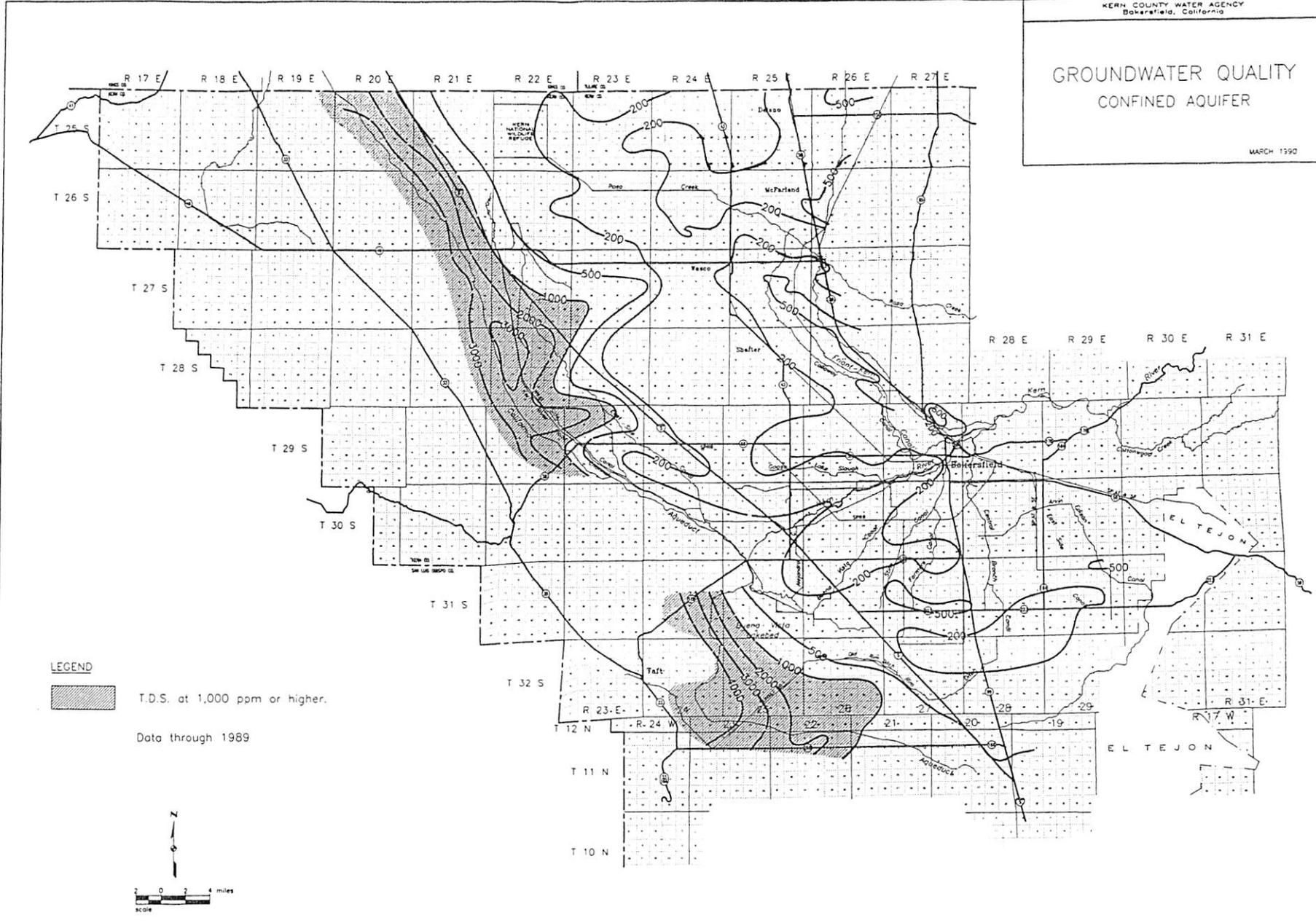




KERN COUNTY WATER AGENCY  
Bakersfield, California

# GROUNDWATER QUALITY CONFINED AQUIFER

MARCH 1990

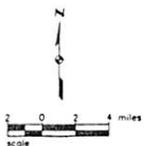


**LEGEND**



T.D.S. at 1,000 ppm or higher.

Data through 1989



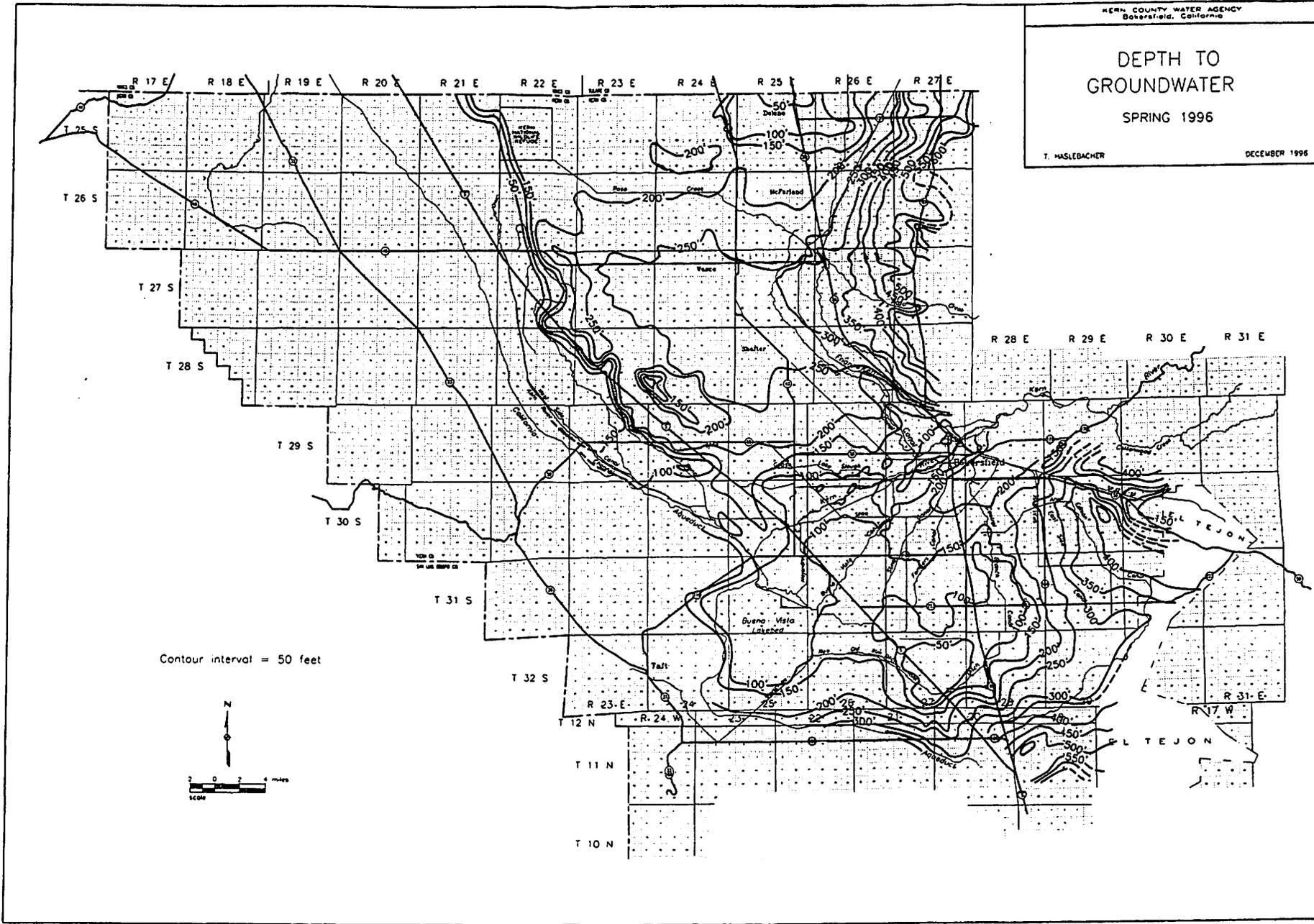
KERN COUNTY WATER AGENCY  
Bakersfield, California

# DEPTH TO GROUNDWATER

SPRING 1996

T. HASLEBACHER

DECEMBER 1996





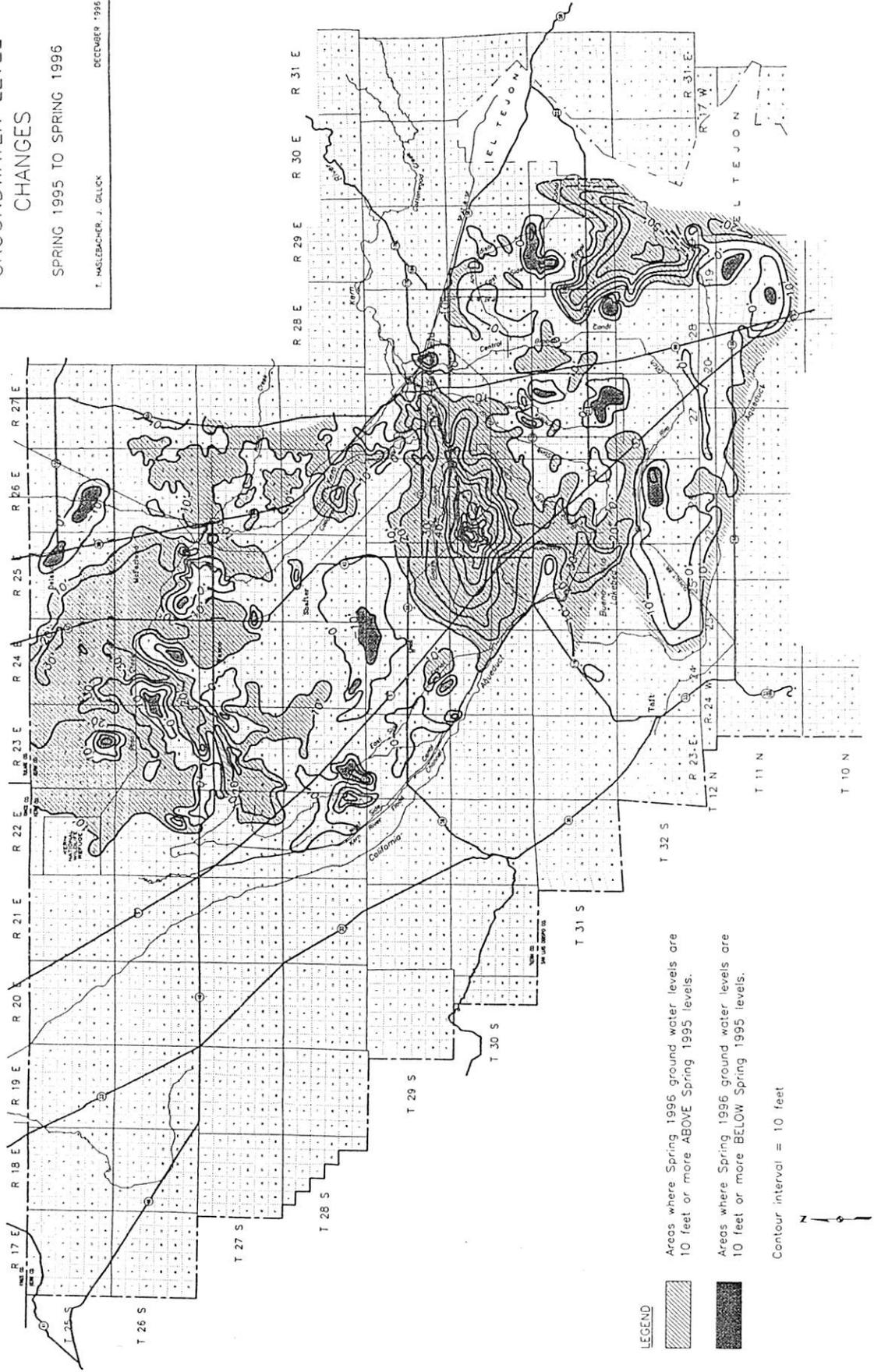
KERN COUNTY WATER AGENCY  
Bakersfield, California

# GROUNDWATER LEVEL CHANGES

SPRING 1995 TO SPRING 1996

T. HASLEBACHER, J. GLICK

DECEMBER 1996

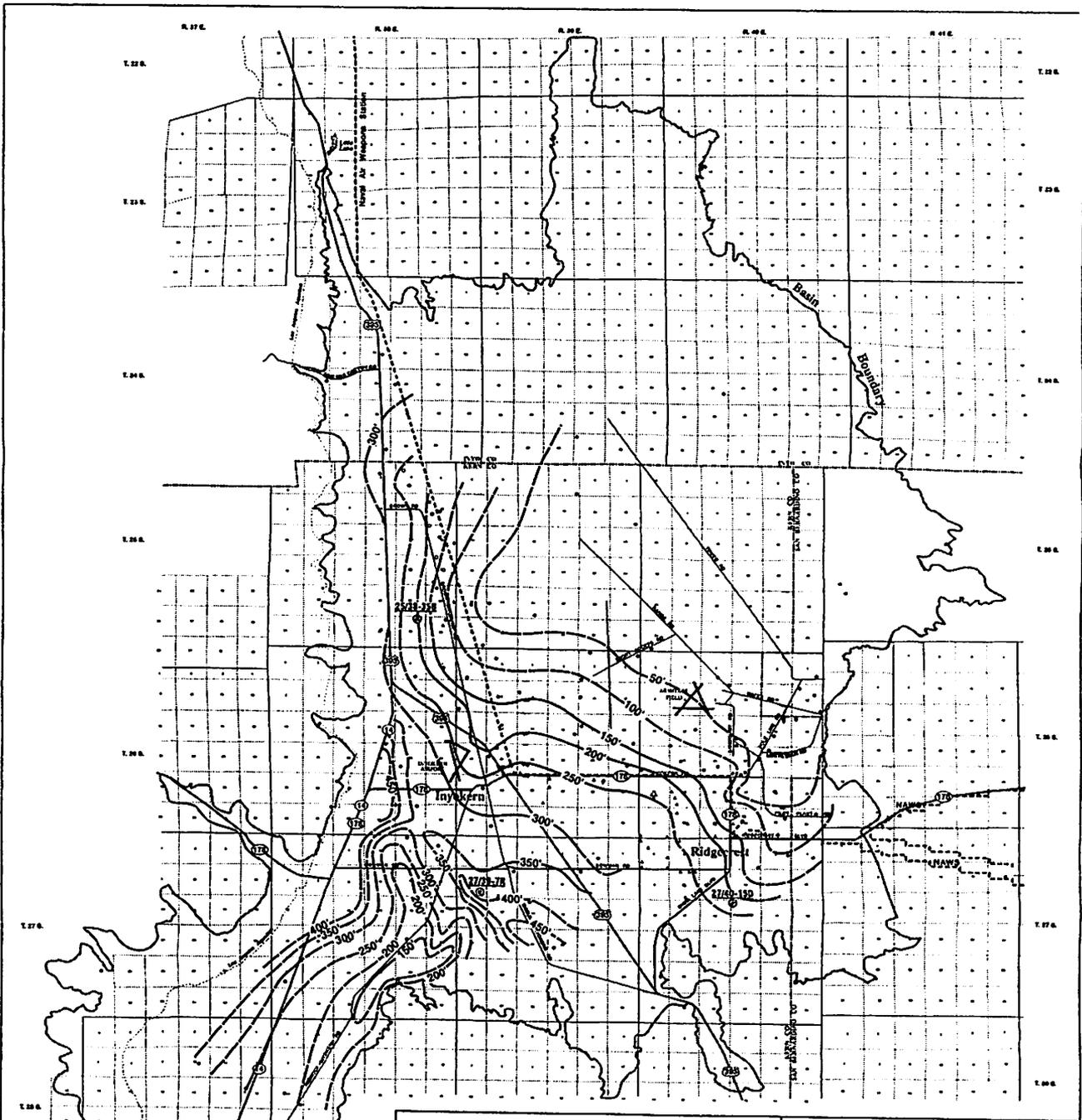


LEGEND

-  Areas where Spring 1996 ground water levels are 10 feet or more ABOVE Spring 1995 levels.
-  Areas where Spring 1996 ground water levels are 10 feet or more BELOW Spring 1995 levels.

Contour interval = 10 feet





**LEGEND**

**WELLS**

- MONITORED BY KCWA
- AGRICULTURE
- △ INDIAN WELLS VALLEY WD
- ▲ PRIVATE

○ 2178-158 HYDROGRAPH WELL

— 200' — DEPTH TO GROUNDWATER (FT) BELOW GROUND SURFACE. CONTOUR INTERVAL = 50'

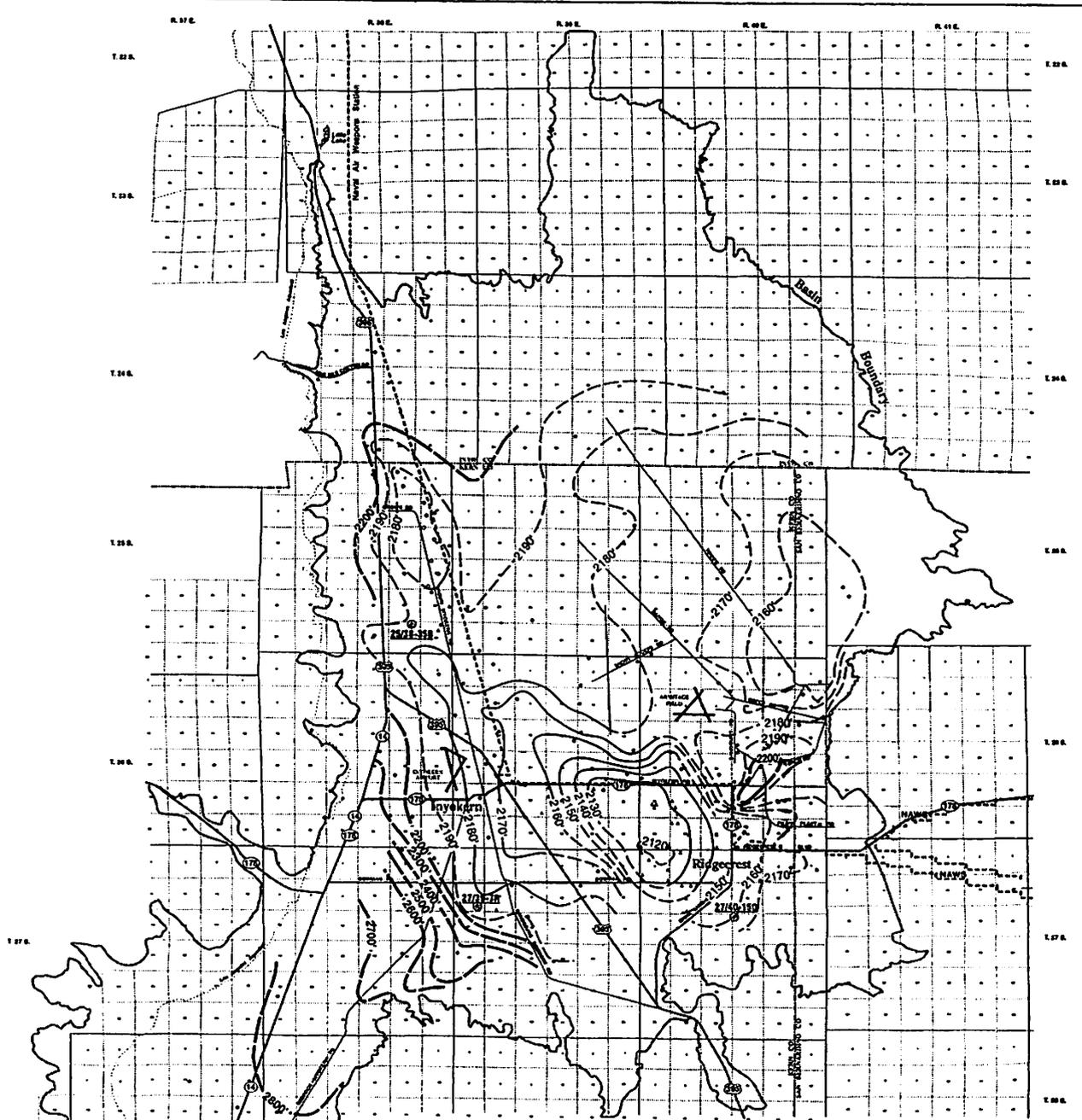
**INDIAN WELLS VALLEY**

**DEPTH TO GROUNDWATER**

**SPRING 1996**

K. TURNER

NOVEMBER 1998



**LEGEND**

**WELLS**

- MONITORED BY KCWA
- AGRICULTURE
- △ INDIAN WELLS VALLEY WD
- ▲ PRIVATE

2149-152 HYDROGRAPH WELL

—2150— GROUNDWATER SURFACE ELEVATION (FT.) W.R.T. MEAN SEA LEVEL. CONTOUR INTERVAL = 10'

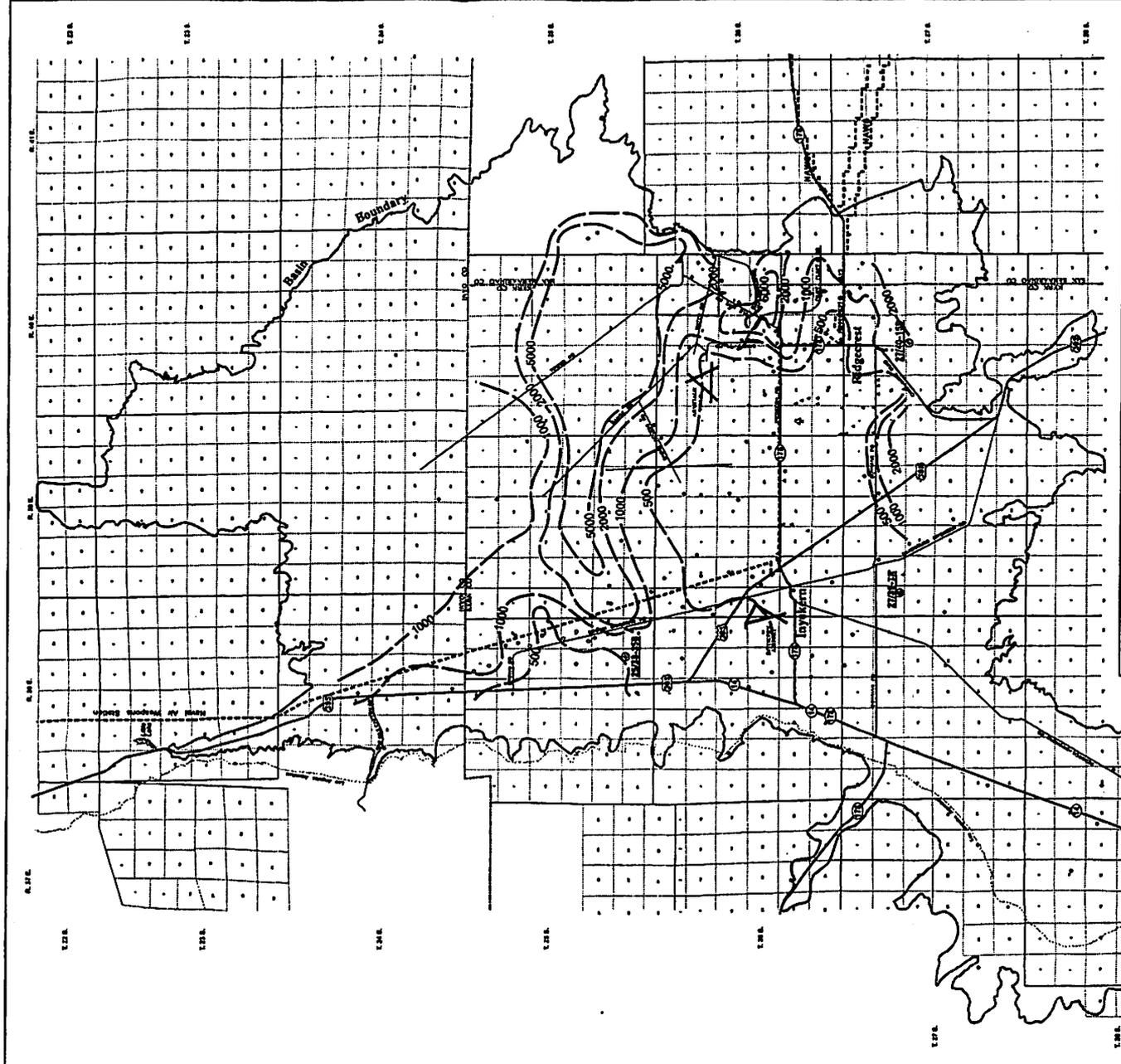
—2800— GROUNDWATER SURFACE ELEVATION (FT.) W.R.T. MEAN SEA LEVEL. CONTOUR INTERVAL = 100'

**INDIAN WELLS VALLEY**  
**GROUNDWATER SURFACE ELEVATION**  
**SPRING 1996**

K. TURNER

NOVEMBER 1996

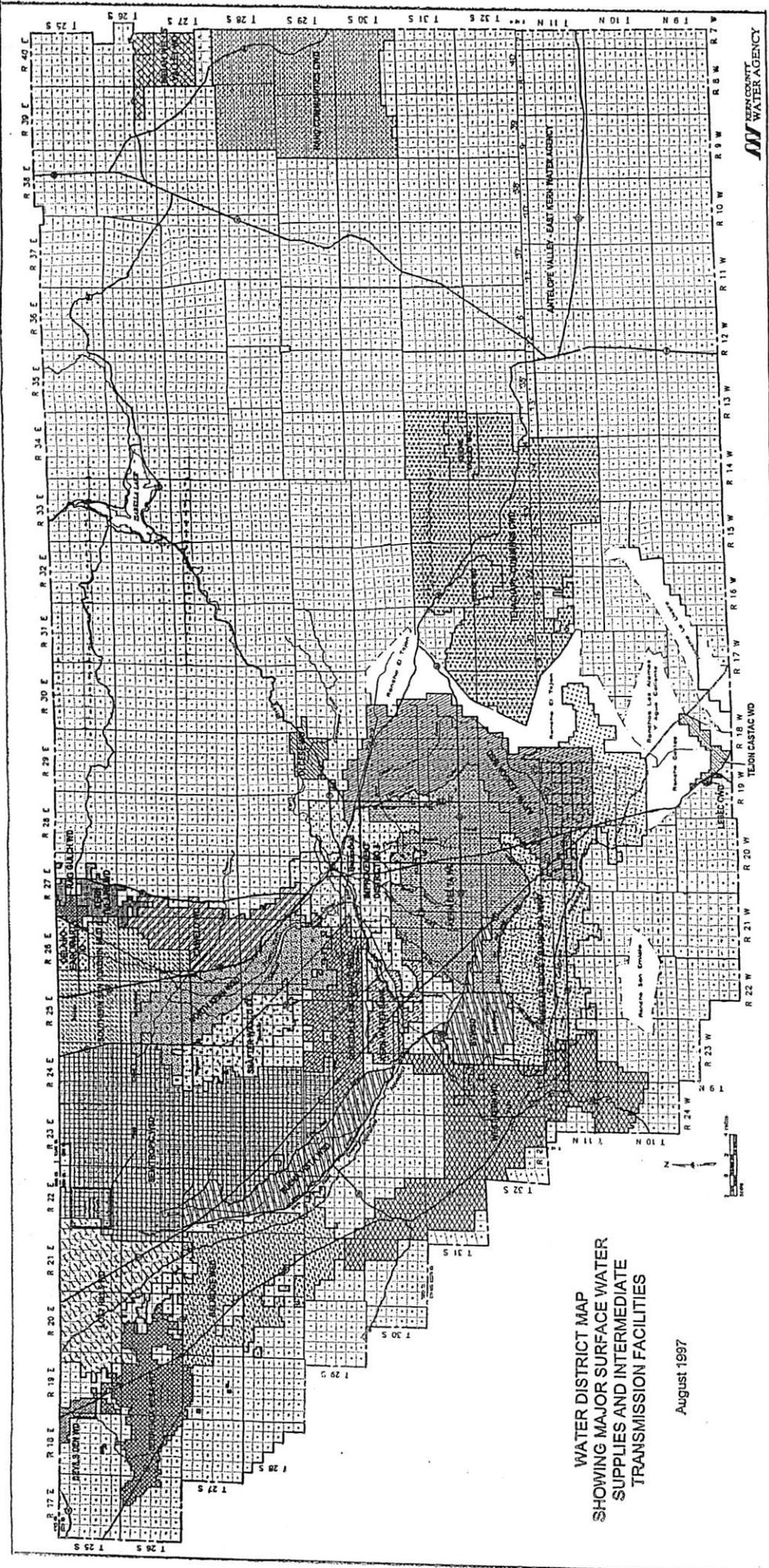




**INDIAN WELLS VALLEY**  
**GROUNDWATER QUALITY**  
**TOTAL DISSOLVED SOLIDS**  
**(PPM)**  
 1980 - 1994 DATA  
 K. TURNER  
 JULY 1995

**LEGEND**  
**WELLS**  
 ● MONITORED BY NCSWA  
 ○ AGRICULTURE  
 △ INDIAN WELLS VALLEY HD  
 □ PRIVATE  
 ● HYDROGRAPH WELL

0 1000  
 FEET  
 WATER AGENCY



WATER DISTRICT MAP  
 SHOWING MAJOR SURFACE WATER  
 SUPPLIES AND INTERMEDIATE  
 TRANSMISSION FACILITIES

August 1997

