Pan Evaporation

Three *USWB Class 'A' evaporation pans were installed and operated at the Arvin-Frick agroclimate station. Besides determining evaporation rates for that location, those pans were used to develop standard methods for operating pans at the outlying stations. Materials for controlling algal growth were tested here, as was development of water supply systems to maintain near-constant water levels in the evaporation pans.*

Evaporation rates were determined each time the station was serviced. This was done routinely each week and on the first day of each month. The station was also serviced each time soil moisture contents were measured in nearby crop evapotranspiration field plots. Thus, this station was often serviced three or four times each week. The station was serviced in early morning, usually between 7 and 9 a.m.

DETERMINING EVAPORATION

THE MECHANICS OF DETERMINING EVAPORATION AFTER MAKING THE APPROPRIATE MEASUREMENTS ARE EXPRESSED IN THIS EQUATION:

$$Ep = \triangle (WS\ tank) \times (F) + \triangle WS\ pan + P$$

Where: Ep = pan evaporation for period

$\triangle$ WS tank = change in water level in tank, inches (previous sight tube reading minus present sight tube reading)

F = tank calibration factor (converts depth of water in tank to equivalent depth of water in pan)

$\triangle$ WS pan = change in water surface level in pan, inches (previous micrometer hook gage reading minus present hook gage reading)

P = precipitation since previous pan serviced, inches.

Evaporation is thus determined to $\pm$.01 inch.

WATER LEVEL CONTROL

Published studies of evaporation from Class 'A' pans indicated a marked effect attributable to depth of water in the pans. A water surface depth of 2.5 inches below the pan rim was selected as optimum for pans used in this investigation. For station servicing intervals of one week, summertime water levels could vary by an unacceptable amount, 2.5 inches or so. Thus, a system was developed to maintain pan water surface level at a near-constant level. Several systems were evaluated at the Arvin-Frick agroclimate station. A water supply tank equipped with a mechanical float valve delivering water to the pan was determined to be the most reliable. The design of that system is shown on Figure 9. After rigorous testing at the Arvin-Frick station, this system was used there and at each of the other agroclimate stations.

At Arvin-Frick, the water supply tank was fabricated locally to DWR specifications. It was 15 inches in diameter and 60 inches tall. The tank was fitted with a flexible sight tube of clear plastic. A scale of inches and fractions was affixed to the sight tube. Water level in the tank could be easily read to 1/16 inch. Various types of metering valves were evaluated, and a mechanical cooler float was selected as the most reliable. Several different float valves were tested before the "flipen" mechanical cooler float was selected. It was determined that the 15-inch diameter tank contained a usable amount of water equivalent to about 4.5 inches depth in a pan. This was deemed an insufficient volume for operational use. Therefore, a larger tank using the same pan water depth control system was designed and used at the outlying agroclimate stations. With this float system, pan water surface level typically fluctuated less than 0.25 inch. Mounting the float box on the supply tank support and connecting that box to the pan with underground plastic tubing kept the pan free of any encumbrances which might modify wind or cast shadows on the pan.

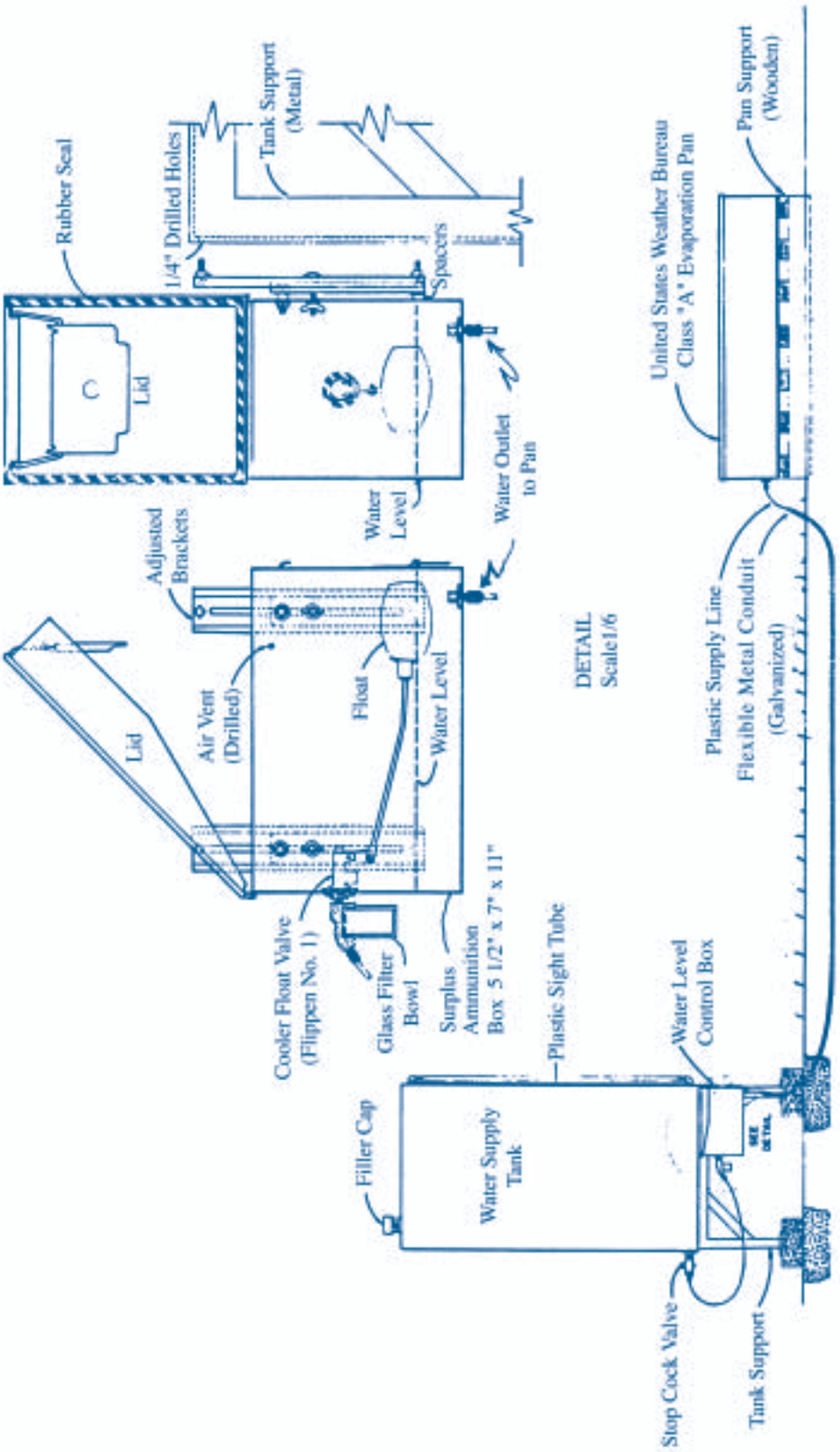
ALGAL CONTROL

Various materials were tested for effectiveness in controlling growth of algae in the evaporation pans. The most effective and longest lasting algal control was obtained with Zephrin chloride (Z-Cl), a germicide used primarily for sterilizing medical instruments.

The pan-cleaning procedure involved removing all but about 0.5 inch depth of water from the pan, adding about 5 milliliters of Z-Cl, and vigorously scrubbing the sides and bottom of the pan with a stiff bristle brush. After scrubbing, the pan was emptied, rinsed, and refilled with fresh tap water. Rapid algal growth in the mid-summer required pan cleaning about every three weeks.

FIGURE 9

Evaporation Pan Water Level Control System Land and Water Use Unit



WATER SUPPLY TANKS

Water supply tanks were fabricated locally to DWR specifications. Factors considered in designing the tanks included:

- Sufficient volume to replenish water evaporated from pan for four to six weeks during mid-summer months.
- Minimal shadowing and wind disruption on pan and other instruments.

Tanks were 50 inches high and 27.5 inches in diameter and held approximately 128 gallons of water. Tanks were constructed of galvanized metal. The metal top was welded to the walls and a 2-inch-diameter pipe nipple with a screw cap was welded to the top. A sight tube of 0.25-inch clear flexible plastic coupled with a graduated scale was installed to determine the depth of water in the tank. Because the pipe fittings to which the sight tube was attached were installed a few inches above the bottom and below the top of the tank, the usable volume of the tank was about 108 gallons. This volume equaled a depth of about 14 inches in the pans, enough to meet total pan evaporation for about five weeks at peak summertime rates.

At the outlying stations, the pans were located about 2 feet north of the center of the enclosures. The supply tanks were located near the southeast corner of the stations, about 15 feet from the pans (page 9, Figure 4). The supply tanks were installed on metal stands which placed the bottom of the tanks about 14 inches above ground surface. Thus, the tops of the tanks were about 5.3 feet above ground (Figure 9). Tanks were designed so that 3 inches of water in each tank was equivalent to 1 inch in the pan. However, the cost of fabricating tanks to close tolerance was considerably greater than for the standard construction, which was specified. Thus, the tanks varied slightly in diameter and each tank was separately calibrated to relate increments of depth of water in the tanks to actual depth of water in the pans. This calibration procedure is described in the following section.

Water surface in Class 'A' evaporation pan is carefully measured using Micrometer Hook gage.

SUPPLY TANK CALIBRATION

Each tank was calibrated by the following method:

Volumes of water equivalent to about 0.15 inch depth in the pan were withdrawn from the tank and added to the pan. The tank sight tube was read and the tank water surface elevation recorded before and after each volume of water was withdrawn. Hook gage readings of water depth in the pan were taken and recorded before and after adding each volume of water. To keep within the approximately 5-inch depth range of the micrometer hook gage, water levels in the pan ranged from about 1 to 4 inches below the pan rim. When the water surface was about 1 inch below the rim, water was removed from the pan to lower the surface to about 4 inches below the rim. Then the process of systematically with-drawing water from the tank and adding it to the pan was continued.

Each tank was calibrated over a range of about 40 inches depth in the tank. The factor relating inches of depth in the supply tanks to equivalent depth in the evaporation pan was calculated and permanently marked on the tanks. Although each tank was constructed from the same drawings, the finished tanks varied slightly from the design specifications. A typical calibration factor was 0.3364. Thus, 1 inch of water withdrawn from the supply tank was equivalent to 0.3364 inch depth in the pan.

The supply tanks were installed on metal stands so that the bottoms of the tanks were about 14 inches above the soil surface. The tank/float box was connected to the pan with a 15-foot length of 0.25-inch plastic (poly-flo) tubing buried about 4 inches below soil surface (Figure 9).

EVAPORATION MEASUREMENT

An evaporation pan was installed at each outlying agroclimate station. USWB Class 'A' pans were used. These pans are 47.5 inches in diameter and 10 inches deep. They are made of 22-gage galvanized sheet metal. A 1 x 0.125-inch galvanized steel hoop provided rigidity to the rim of the open top pans. Specifications and fabrication details for constructing Class 'A' pans are provided in USWB Circular B, "Instructions for Climatological Observers," Tenth Edition, 1955.

The pans were installed on a level 4-foot-square grid constructed of 2 x 4-inch lumber. When placed on the wooden grids, the bottoms of the evaporation pans were about 5 inches above the soil surface. The four grid members in contact with the soil were oriented in the direction of irrigation water flow to minimize any adverse effects on uniform irrigation of the field border strips.

EVAPORATION DATA COLLECTED

Eight agroclimate stations were operated near Bakersfield in the southern San Joaquin Valley during the period 1958 to 1991. The Arvin-Frick master agroclimate station was operated for six years, 1959 to 1965. It was removed when the land surrounding the 2.5-acre grass plot was converted from surface to sprinkler irrigation. The Arvin-Frick station was located on a 440 x 250-foot (2.5-acre) plot of irrigated Goar's fescue. The fescue grass was irrigated at intervals sufficient to keep it green and growing well. The area within the 2.5 acres in which the various instruments were located was maintained at a height of about 3 to 5 inches by mowing with a small gas-powered rotary lawn mower. That area was about 125 x 90 feet (about 0.25 acre). Grass in the rest of the plot was mowed to about 3.5 inches with a tractor mower when the grass grew to a height of about 10 to 12 inches. The mown grass was raked, baled, and removed from the plot by the landowner.

Instruments were moved from Arvin-Frick to Old River 3-S in the fall of 1965. The station instruments were installed in a fenced enclosure measuring 20 x 75 feet. The station was located within a 40-acre irrigated pasture. Instrument layout is shown on Figure 3. The pasture grasses were maintained at a height of about 3 to 5 inches by hand mowing with a rotary power lawn mower. This station was maintained until December 1967, when the pasture in which it was located was prepared for planting to an orchard.

The Old River 3-S station was the last of the large master station design. Following removal of that station in 1968, only stations of the standard design for outlying stations were installed and operated. See Figure 4 for instrument layout for these smaller (25 x 25-foot) stations.

EVAPORATION PATTERNS

Monthly amounts of evaporation measured near Bakersfield from 1958 to 1991 are presented in Table 6. These data were summarized from records of eight agroclimate stations in the vicinity of Bakersfield in the southern Valley. Rotation of irrigated pasture sites to other crops required frequent moving of the agroclimate stations from one site to another. All eight stations were within about 25 miles of Bakersfield.

The same evaporation data summarized into evaporation amounts for weekly periods are shown in Table 7. Evaporation rates show little year-to-year variation for the Bakersfield area. Standard deviations for both monthly and weekly data are on the order of less than 5 percent.

Continued on page 37

TABLE 6

Monthly Class 'A' Pan Evaporation at Agroclimate Stations Near Bakersfield 1958-1991[1] (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mar-Oct Total	Jan-Dec Total
1958	–	–	–	5.02	7.40	8.94	9.96	8.94	5.70	5.13	2.57	1.77	–	–
1959	1.87	2.54	4.60	7.11	8.58	9.31	9.78	8.61	5.92	4.45	2.60	1.65	58.36	67.02
1960	1.96	2.24	4.30	5.82	8.72	9.98	9.39	8.09	6.13	4.08	1.89	1.08	56.51	63.68
1961	0.86	2.63	3.91	6.58	7.61	9.91	9.64	7.82	6.22	4.41	2.44	1.17	56.10	63.20
1962	1.55	1.91	4.31	7.65	8.57	10.54	10.42	8.56	6.04	3.91	2.24	1.75	60.00	67.45
1963	1.75	2.38	5.35	5.25	8.06	9.55	9.69	7.85	5.50	3.35	2.05	0.77	54.60	61.55
1964	1.47	3.32	4.46	6.06	8.18	9.79	9.24	8.06	5.98	4.29	1.90	1.54	56.06	64.29
1965	1.29	2.40	4.55	4.98	9.01	8.98	9.91	8.98	6.34	4.30	1.85	0.89	57.05	63.48
1966	1.94	2.52	4.74	6.18	8.28	9.05	8.91	8.87	6.34	4.19	1.91	0.97	56.56	63.90
1967	1.57	1.97	4.18	3.79	8.29	9.26	10.28	9.40	6.65	5.01	2.43	1.37	56.86	64.20
1969	0.98	0.91	3.93	5.81	7.93	8.24	8.91	8.22	6.36	3.67	3.35	1.32	53.07	59.63
1970	2.13	1.82	3.75	5.61	9.36	9.34	8.48	7.25	6.04	3.90	2.63	1.46	53.73	61.77
1971	1.33	2.06	2.54	5.19	6.04	11.21	10.62	9.01	6.20	4.41	1.73	0.96	55.22	61.30
1972	0.61	2.09	5.16	6.69	9.39	10.23	9.43	8.33	6.68	4.13	1.60	0.45	60.04	64.79
1973	1.64	1.75	3.08	5.66	8.26	9.34	10.03	8.49	7.01	5.06	2.43	1.07	56.93	63.82
1974	1.48	2.04	3.42	5.09	8.50	9.97	9.53	8.38	6.84	4.19	1.86	1.09	55.92	62.39
1975	1.45	2.41	4.79	5.52	8.10	10.42	10.16	9.30	6.73	4.78	2.20	1.34	59.80	67.20
1976	1.62	2.63	4.31	5.50	8.56	9.82	10.31	8.48	5.90	4.12	1.59	1.33	57.00	64.17
1977	0.81	2.62	4.05	7.66	6.96	9.06	8.58	7.59	5.90	4.01	1.80	1.77	53.81	60.81
1978	1.05	1.17	2.60	4.24	7.52	8.62	8.82	8.13	5.13	3.94	1.87	0.86	49.00	53.95
1979	1.48	1.97	3.59	5.96	8.82	8.64	8.66	8.18	6.15	4.28	2.19	1.78	54.28	61.70
1980	0.97	1.85	3.52	5.30	7.52	8.45	8.97	8.08	6.33	4.95	2.83	1.04	53.12	59.81
1981	1.92	2.14	3.34	5.71	8.46	11.00	10.46	9.23	8.22	4.73	2.52	1.25	61.15	68.98
1982	1.33	2.19	2.80	5.27	8.88	8.13	9.78	8.70	6.08	4.29	1.41	1.14	53.93	60.00
1983	1.16	2.01	3.18	5.52	8.54	10.10	9.79	8.51	6.79	4.48	2.06	1.15	56.91	63.29
1984	1.36	2.74	4.66	6.13	9.09	9.85	10.82	9.35	8.07	4.47	2.53	1.39	62.44	70.46
1985	0.96	2.62	4.09	6.72	8.68	9.83	11.04	9.75	6.55	4.96	2.08	0.77	61.62	68.05
1986	1.55	2.18	3.38	5.74	8.39	9.68	9.76	8.92	6.26	4.36	2.30	0.97	56.49	63.49
1987	1.32	2.22	4.43	6.90	8.56	9.40	9.21	9.14	6.51	4.56	1.72	1.77	58.71	65.74
1988	1.30	3.02	5.16	5.40	8.11	8.76	10.28	8.86	6.64	4.34	2.26	1.22	57.55	65.35
1989	1.26	2.42	4.36	6.64	8.12	9.34	9.92	9.00	6.21	4.86	2.33	1.14	58.45	65.60
1990	1.53	2.21	4.33	5.93	7.84	8.89	10.08	8.05	6.51	4.84	2.42	1.22	56.47	63.85
1991	1.42	2.46	3.82	5.90	8.18	9.20	10.04	8.36	7.27	5.10	2.36	1.52	57.87	65.63
Average	1.40	2.23	4.02	5.83	8.26	9.48	9.72	8.56	6.40	4.41	2.18	1.24	56.68	63.73
Std. Dev.	0.35	0.46	0.72	0.84	0.67	0.72	0.65	0.56	0.61	0.43	0.40	0.33	2.77	3.14
Std. Error	0.06	0.08	0.13	0.15	0.12	0.13	0.11	0.10	0.11	0.07	0.07	0.06	0.49	0.55

[1] No data for 1968. Stations: Arvin-Jewett 4/58-5/59; Arvin-Frick 6/59-10/65; Old River 3-S 11/65-12/67; Bakersfield 10-S 5/69-6/70; Wasco 8-SW 1/75-12/80; Bakersfield 10-NW 1/81-12/85; Bakersfield 10-NW and 12-S (average) 1/86-12/89; Bakersfield 12-S and Lamont 2-NW (average) 1/90-12/91.

TABLE 7

Weekly Class ‘A’ Pan Evaporation at Agroclimate Stations Near Bakersfield (inches)

Week No.	Ending Date	Day of Year	1958	1959	1960	1961	1962	1963	1964	1965
1	Jan 4	4	_	0.11	0.15	0.00	0.02	0.32	0.16	0.11
2	11	11	_	0.48	0.49	0.09	0.16	0.56	0.27	0.38
3	18	18	_	0.36	0.31	0.19	0.60	0.37	0.30	0.21
4	25	25	_	0.28	0.50	0.28	0.27	0.37	0.53	0.29
5	Feb 1	32	_	0.52	0.51	0.29	0.36	0.47	0.16	0.30
6	8	39	_	0.60	0.41	0.32	0.32	0.59	0.60	0.22
7	15	46	_	0.47	0.54	0.70	0.39	0.42	0.65	0.58
8	22	53	_	0.84	0.57	0.54	0.63	0.65	1.04	0.79
9	Mar 1	60	_	0.58	0.65	0.86	0.47	1.00	0.99	0.81
10	8	67	_	0.82	0.63	0.73	0.49	1.08	0.69	1.28
11	15	74	_	0.80	0.82	0.85	1.16	1.10	0.81	0.61
12	22	81	_	1.09	1.06	0.91	0.97	1.44	1.17	0.89
13	29	88	_	1.26	1.23	0.84	0.94	1.20	1.08	1.16
14	Apr 5	95	1.10	1.22	1.15	1.15	1.04	0.90	1.28	0.74
15	12	102	1.10	1.36	1.55	1.61	1.48	1.40	1.46	0.71
16	19	109	1.15	1.58	1.26	1.64	1.98	1.14	1.64	1.18
17	26	116	1.10	2.02	1.53	1.48	1.82	1.29	1.42	1.50
18	May 3	123	1.50	1.80	1.23	1.53	1.99	1.78	1.57	2.04
19	10	130	1.60	1.44	1.63	1.60	2.04	1.77	1.45	1.78
20	17	137	1.60	1.75	2.13	1.75	1.91	2.06	1.61	2.16
21	24	144	1.80	2.40	2.13	1.69	1.71	1.90	1.94	1.95
22	31	151	1.85	2.24	1.43	1.89	1.89	1.71	1.92	2.22
23	Jun 7	158	1.70	1.73	2.47	1.80	2.37	2.31	2.35	2.03
24	14	165	2.05	2.35	2.25	2.00	2.47	1.65	1.98	1.86
25	21	172	1.90	2.15	2.53	2.62	2.10	2.73	2.18	2.06
26	28	179	2.20	2.29	2.19	2.21	2.80	2.22	2.69	2.30
27	Jul 5	186	2.35	2.41	2.07	2.62	2.52	2.24	2.06	2.40
28	12	193	2.25	2.18	2.42	2.03	2.32	2.24	2.09	2.59
29	19	200	2.60	2.10	2.05	2.16	2.55	2.22	2.13	2.20
30	26	207	1.00	1.93	2.02	2.21	2.27	2.04	1.92	2.48
31	Aug 2	214	2.75	2.43	2.00	2.29	2.24	2.13	2.10	1.69
32	9	221	2.65	2.10	1.94	1.65	2.08	1.69	1.87	2.15
33	16	228	2.80	2.15	1.90	1.82	1.84	1.87	1.94	1.86
34	23	235	1.95	1.79	1.85	1.84	1.90	1.71	1.74	2.15
35	30	242	2.25	1.90	1.72	1.82	1.86	1.59	1.86	1.87
36	Sep 6	249	1.90	1.63	1.57	1.72	1.83	1.32	1.40	1.78
37	13	256	1.45	1.49	1.45	1.54	1.46	1.42	1.45	1.54
38	20	263	1.05	1.12	1.37	1.45	1.43	0.99	1.42	1.53
39	27	270	1.20	1.32	1.50	1.63	1.41	1.38	1.45	1.36
40	Oct 4	277	1.00	1.53	1.19	1.35	1.28	1.18	1.10	1.14
41	11	284	1.05	1.02	1.13	1.22	1.23	0.82	1.10	0.99
42	18	291	1.25	1.04	0.91	1.08	0.95	0.62	0.98	1.02
43	25	298	0.60	0.94	0.94	0.90	0.75	0.62	0.88	0.88
44	Nov 1	305	0.25	0.93	0.68	0.78	0.69	0.65	0.72	0.75
45	8	312	0.35	0.82	0.58	0.69	0.72	0.66	0.67	0.54
46	15	319	0.45	0.74	0.41	0.77	0.56	0.37	0.40	0.63
47	22	326	0.45	0.50	0.42	0.71	0.41	0.56	0.36	0.37
48	29	333	0.50	0.53	0.44	0.39	0.49	0.18	0.39	0.28
49	Dec 6	340	0.45	0.51	0.52	0.43	0.47	0.19	0.25	0.08
50	13	347	0.45	0.28	0.27	0.30	0.36	0.18	0.29	0.12
51	20	354	0.40	0.28	0.25	0.24	0.49	0.13	0.39	0.21
52	27	361	0.30	0.26	0.08	0.22	0.33	0.11	0.49	0.22
Mar-Oct Total			–	58.31	55.93	56.41	59.77	54.41	55.45	56.85
Jan-Dec Total			–	66.47	63.03	63.43	66.82	61.54	63.39	62.99

TABLE 7 (continued)

Weekly Class 'A' Pan Evaporation at Agroclimate Stations Near Bakersfield (inches)

No. Date	Week Ending	Day of Jan 4	1966	1967	1969	1970	1975	1976	1977	1978
1	4		0.10	0.04	–	0.24	0.27	0.39	0.27	0.11
2	11	11	0.30	0.26	–	0.73	0.30	0.25	0.16	0.22
3	18	18	0.19	0.32	–	0.23	0.18	0.31	0.16	0.34
4	25	25	0.36	0.40	–	0.48	0.34	0.42	0.16	0.26
5	Feb 1	32	0.95	0.44	–	0.50	0.32	0.56	0.22	0.15
6	8	39	0.30	0.28	–	0.32	0.60	0.37	0.44	0.20
7	15	46	0.49	0.26	–	0.18	0.41	0.53	0.68	0.24
8	22	53	0.59	0.63	–	0.58	0.73	0.82	0.71	0.42
9	Mar 1	60	1.03	0.64	–	0.78	0.83	0.81	0.94	0.40
10	8	67	1.52	0.81	–	0.20	0.79	0.58	0.96	0.50
11	15	74	0.58	1.02	–	0.80	0.81	0.93	0.82	0.56
12	22	81	1.02	0.84	–	1.03	1.08	1.04	0.87	0.60
13	29	88	1.17	1.02	–	1.26	1.63	1.12	0.93	0.61
14	Apr 5	95	1.20	1.07	–	1.76	1.17	1.18	1.31	0.64
15	12	102	1.33	0.71	–	1.46	1.34	1.13	1.84	0.99
16	19	109	1.44	0.87	–	1.12	0.95	1.09	2.01	1.08
17	26	116	1.17	0.89	1.64	1.28	1.46	1.46	1.79	0.87
18	May 3	123	1.83	1.01	1.61	1.46	1.77	1.79	1.41	1.56
19	10	130	2.01	1.36	1.51	1.70	1.66	1.84	1.16	1.63
20	17	137	1.57	1.50	1.95	1.99	1.87	1.96	1.36	1.61
21	24	144	1.99	2.14	1.89	2.45	1.84	1.71	1.87	1.75
22	31	151	2.07	2.53	2.67	2.46	2.00	2.23	2.14	1.75
23	Jun 7	158	1.78	1.92	1.83	2.49	2.28	2.06	2.29	2.09
24	14	165	1.93	1.90	1.53	1.94	2.66	1.84	2.09	2.11
25	21	172	2.20	2.19	2.05	1.92	2.32	2.63	2.03	1.97
26	28	179	2.25	2.24	2.18	2.42	2.57	2.34	2.05	1.90
27	Jul 5	186	2.28	2.52	2.18	–	2.07	2.54	2.02	2.00
28	12	193	2.03	2.43	1.85	–	2.32	2.34	1.96	2.31
29	19	200	2.09	2.49	2.00	–	2.21	2.33	1.98	1.99
30	26	207	2.21	2.28	1.95	–	2.48	2.10	1.90	1.88
31	Aug 2	214	1.64	2.21	2.09	–	2.25	2.56	1.79	1.92
32	9	221	1.93	2.20	1.95	–	2.32	2.07	1.67	2.08
33	16	228	2.07	2.11	1.80	–	2.28	1.92	1.40	2.01
34	23	235	2.24	2.10	1.92	–	1.92	1.79	1.79	1.71
35	30	242	1.89	1.96	1.68	–	1.93	1.81	1.93	1.55
36	Sep 6	249	1.71	1.88	1.69	–	1.84	2.05	1.71	1.15
37	13	256	1.63	1.65	1.64	–	1.73	1.25	1.53	1.22
38	20	263	1.46	1.77	1.78	–	1.58	1.20	1.36	1.17
39	27	270	1.49	1.33	0.83	–	1.69	1.52	1.17	1.16
40	Oct 4	277	1.13	1.33	1.21	–	1.61	1.03	1.12	1.16
41	11	284	0.98	1.28	0.99	–	1.24	1.13	1.16	0.91
42	18	291	1.03	1.31	0.98	–	0.73	1.14	0.90	0.81
43	25	298	0.86	1.05	0.42	–	1.06	0.78	0.77	0.93
44	Nov 1	305	0.85	0.84	0.61	–	0.59	0.67	0.61	0.75
45	8	312	0.69	0.91	0.72	–	0.54	0.66	0.52	0.63
46	15	319	0.44	0.63	0.44	–	0.50	0.40	0.41	0.43
47	22	326	0.44	0.40	0.87	–	0.45	0.22	0.45	0.33
48	29	333	0.36	0.34	1.11	–	0.56	0.21	0.31	0.32
49	Dec 6	340	0.19	0.68	0.23	–	0.37	0.36	0.20	0.37
50	13	347	0.26	0.25	0.37	–	0.20	0.28	0.21	0.25
51	20	354	0.19	0.30	0.37	–	0.27	0.27	0.68	0.18
52	27	361	0.23	0.33	0.23	–	0.29	0.27	0.54	0.10
Mar-Oct Total			56.58	56.76	–	–	60.05	57.16	53.70	48.93
Jan-Dec Total			63.69	63.87	–	–	67.21	64.29	60.76	53.88

TABLE 7 (continued)

Weekly Class 'A' Pan Evaporation at Agroclimate Stations Near Bakersfield (inches)

Week No.	Ending Date	Day of Year	1979	1980	1981	1982	1983	1984	1985	1986
1	Jan 4	4	0.17	0.21	0.24	0.27	0.13	0.20	0.25	0.23
2	11	11	0.33	0.22	0.26	0.29	0.07	0.16	0.24	0.26
3	18	18	0.39	0.24	0.50	0.26	0.19	0.28	0.23	0.56
4	25	25	0.24	0.24	0.60	0.28	0.41	0.31	0.16	0.46
5	Feb 1	32	0.43	0.22	0.48	0.37	0.48	0.55	0.25	0.39
6	8	39	0.46	0.27	0.39	0.47	0.39	0.59	0.45	0.60
7	15	46	0.43	0.46	0.41	0.50	0.47	0.61	0.54	0.67
8	22	53	0.49	0.51	0.68	0.58	0.51	0.69	0.71	0.68
9	Mar 1	60	0.63	0.55	0.67	0.62	0.64	0.79	0.97	0.63
10	8	67	0.69	0.50	0.62	0.63	0.65	1.01	0.81	0.72
11	15	74	0.76	0.61	0.73	0.48	0.79	1.01	0.87	0.95
12	22	81	0.66	0.92	0.70	0.57	0.67	0.97	0.90	1.01
13	29	88	1.02	0.89	0.85	0.79	0.78	1.21	1.12	1.01
14	Apr 5	95	1.31	1.14	1.07	0.82	1.22	1.14	1.35	1.20
15	12	102	1.41	1.24	1.37	0.76	1.25	1.03	1.40	1.49
16	19	109	1.34	1.52	1.25	1.26	1.46	1.48	1.61	1.64
17	26	116	1.35	1.22	1.33	1.72	1.24	1.69	1.49	1.59
18	May 3	123	1.58	1.13	1.94	1.84	1.11	1.84	1.94	1.81
19	10	130	1.84	1.46	2.11	1.67	1.65	1.98	1.92	1.97
20	17	137	1.96	1.48	1.92	1.85	1.96	1.77	1.97	2.00
21	24	144	2.09	2.20	1.60	2.20	2.08	2.08	1.99	2.10
22	31	151	2.24	1.77	1.96	2.13	2.19	2.32	2.01	2.39
23	Jun 7	158	2.36	2.05	2.45	1.88	2.23	2.05	2.01	2.23
24	14	165	2.10	1.99	2.58	2.00	2.34	2.17	2.37	2.27
25	21	172	1.89	1.99	2.61	2.02	2.49	2.50	2.41	2.27
26	28	179	1.80	1.90	2.60	1.82	2.49	2.42	2.36	2.13
27	Jul 5	186	1.97	1.77	2.45	1.94	2.32	2.47	2.38	2.30
28	12	193	1.50	2.02	2.26	2.17	2.31	2.57	2.35	2.24
29	19	200	2.33	2.09	2.34	2.17	2.18	2.74	2.32	2.07
30	26	207	2.02	2.18	2.37	2.27	2.19	2.09	2.19	2.17
31	Aug 2	214	1.92	2.02	2.24	2.28	2.23	2.31	2.11	2.24
32	9	221	1.91	2.02	2.10	2.15	1.94	2.17	2.18	1.86
33	16	228	1.98	2.00	2.16	2.06	1.96	2.05	2.04	1.89
34	23	235	1.94	1.66	1.99	2.01	1.77	2.19	2.01	1.85
35	30	242	1.50	1.71	2.10	1.77	1.78	2.09	1.77	1.85
36	Sep 6	249	1.49	1.51	2.25	1.56	1.87	2.01	1.86	1.55
37	13	256	1.50	1.54	2.05	1.62	1.87	1.90	1.53	1.22
38	20	263	1.86	1.49	1.99	1.53	1.79	1.85	1.51	1.17
39	27	270	1.00	1.42	1.65	1.13	1.26	1.86	1.64	1.25
40	Oct 4	277	1.17	1.32	1.21	1.05	1.03	1.47	1.28	1.16
41	11	284	1.08	1.45	1.15	1.27	1.10	1.23	1.46	0.91
42	18	291	0.96	1.17	1.11	1.09	1.02	0.96	1.19	0.69
43	25	298	0.93	0.93	1.04	0.78	0.96	0.89	0.79	0.74
44	Nov 1	305	0.76	0.82	0.90	0.56	0.71	0.89	0.69	0.71
45	8	312	0.62	0.78	0.78	0.42	0.56	0.89	0.72	0.46
46	15	319	0.53	0.64	0.63	0.27	0.52	0.80	0.62	0.37
47	22	326	0.46	0.64	0.56	0.22	0.49	0.40	0.37	0.38
48	29	333	0.45	0.58	0.41	0.34	0.40	0.37	0.25	0.26
49	Dec 6	340	0.42	0.43	0.23	0.30	0.35	0.36	0.29	0.25
50	13	347	0.38	0.25	0.24	0.26	0.31	0.42	0.23	0.20
51	20	354	0.49	0.26	0.39	0.29	0.22	0.33	0.15	0.17
52	27	361	0.42	0.21	0.33	0.24	0.24	0.23	0.06	0.28
Mar-Oct Total			54.22	53.13	61.05	53.85	56.89	62.41	59.83	56.65
Jan-Dec Total			61.56	59.84	68.85	59.83	63.27	70.39	66.32	63.50

TABLE 7 (continued)

Weekly Class 'A' Pan Evaporation at Agroclimate Stations Near Bakersfield (inches)

Week No.	Ending Date	Day of Year	1987	1988	1989	1990	1991	Average	Std. Dev.	Std. Error
1	Jan 4	4	0.26	0.12	0.17	0.16	0.16	0.18	0.09	0.02
2	11	11	0.22	0.21	0.25	0.36	0.19	0.29	0.14	0.03
3	18	18	0.25	0.26	0.26	0.39	0.22	0.30	0.11	0.02
4	25	25	0.38	0.36	0.44	0.27	0.56	0.36	0.11	0.02
5	Feb 1	32	0.36	0.42	0.55	0.43	0.40	0.41	0.15	0.03
6	8	39	0.52	0.48	0.58	0.45	0.52	0.43	0.12	0.02
7	15	46	0.57	0.70	0.43	0.61	0.54	0.50	0.13	0.02
8	22	53	0.55	0.82	0.62	0.52	0.70	0.65	0.13	0.02
9	Mar 1	60	1.02	0.90	0.72	0.60	0.70	0.75	0.17	0.03
10	8	67	1.00	0.91	1.04	0.70	0.56	0.77	0.26	0.05
11	15	74	0.75	1.05	0.90	0.87	0.86	0.83	0.16	0.03
12	22	81	0.70	1.27	0.98	1.17	0.95	0.94	0.20	0.04
13	29	88	1.17	1.37	1.05	1.23	0.82	1.07	0.21	0.04
14	Apr 5	95	1.39	1.39	1.30	1.35	1.07	1.17	0.22	0.04
15	12	102	1.42	1.37	1.58	1.12	1.40	1.30	0.27	0.05
16	19	109	1.77	1.13	1.56	1.33	1.44	1.39	0.28	0.05
17	26	116	1.81	1.06	1.54	1.36	1.26	1.43	0.27	0.05
18	May 3	123	1.86	1.40	1.70	1.84	1.61	1.64	0.27	0.05
19	10	130	2.19	1.59	1.57	2.11	1.70	1.72	0.24	0.04
20	17	137	2.00	1.69	1.84	1.76	1.79	1.82	0.20	0.04
21	24	144	1.82	2.07	1.85	1.73	1.84	1.96	0.20	0.04
22	31	151	1.98	2.12	2.13	1.48	2.35	2.07	0.28	0.05
23	Jun 7	158	1.91	2.00	2.19	1.84	2.14	2.10	0.23	0.04
24	14	165	2.05	2.18	2.12	2.18	2.34	2.11	0.25	0.05
25	21	172	2.23	1.97	2.23	2.12	2.13	2.22	0.24	0.04
26	28	179	2.26	1.99	2.18	2.20	2.16	2.25	0.24	0.04
27	Jul 5	186	2.27	2.33	2.10	2.01	2.02	2.24	0.22	0.04
28	12	193	2.29	2.32	2.18	2.11	2.08	2.21	0.22	0.04
29	19	200	2.08	2.19	2.19	2.53	2.34	2.24	0.19	0.04
30	26	207	1.92	2.31	2.39	2.43	2.32	2.13	0.28	0.05
31	Aug 2	214	2.14	2.30	2.26	2.17	2.38	2.17	0.24	0.05
32	9	221	2.22	2.15	2.15	1.89	1.87	2.03	0.21	0.04
33	16	228	1.99	1.99	2.24	2.00	1.94	2.00	0.22	0.04
34	23	235	1.82	1.92	1.91	1.63	2.00	1.90	0.15	0.03
35	30	242	1.76	2.00	1.88	1.73	1.74	1.83	0.16	0.03
36	Sep 6	249	1.70	1.96	1.84	1.62	1.63	1.72	0.23	0.04
37	13	256	1.53	1.68	1.62	1.84	1.64	1.57	0.19	0.04
38	20	263	1.47	1.45	1.29	1.46	1.64	1.47	0.25	0.05
39	27	270	1.45	1.36	1.17	1.25	1.81	1.38	0.23	0.04
40	Oct 4	277	1.38	1.36	1.23	1.57	1.70	1.26	0.18	0.03
41	11	284	1.24	1.17	1.24	1.30	1.50	1.16	0.16	0.03
42	18	291	1.04	1.00	1.08	1.05	1.24	1.01	0.16	0.03
43	25	298	0.82	0.93	1.08	0.81	1.02	0.86	0.15	0.03
44	Nov 1	305	0.56	0.74	0.88	0.80	0.63	0.72	0.14	0.03
45	8	312	0.41	0.63	0.66	0.80	0.56	0.64	0.14	0.03
46	15	319	0.40	0.62	0.53	0.59	0.62	0.53	0.13	0.02
47	22	326	0.40	0.48	0.52	0.42	0.42	0.45	0.13	0.02
48	29	333	0.38	0.31	0.52	0.44	0.60	0.42	0.17	0.03
49	Dec 6	340	0.41	0.28	0.39	0.28	0.46	0.35	0.12	0.02
50	13	347	0.59	0.34	0.30	0.23	0.18	0.29	0.09	0.02
51	20	354	0.43	0.28	0.24	0.20	0.18	0.30	0.12	0.02
52	27	361	0.23	0.22	0.15	0.21	0.36	0.26	0.11	0.02
Mar-Oct Total			57.99	57.72	58.49	56.59	57.92	56.69	2.85	0.57
Jan-Dec Total			65.37	65.15	65.82	63.55	65.29	63.80	3.24	0.65

[1] No data for 1968. Stations: Arvin-Jewett 4/58-5/59; Arvin-Frick 6/59-10/65; Old River 3-S 11/65-12/67; Bakersfield 10-S 5/69-6/70; Wasco 8-SW 1/75-12/80; Bakersfield 10-NW 1/81-12/85; Bakersfield 10-NW and 12-S (average) 1/86-12/89; Bakersfield 12-S and Lamont 2-NW (average) 1/90-12/91.

FIGURE 10

Class ‘A’ Pan Evaporation Near Bakersfield 1958-1991
(inches per week)

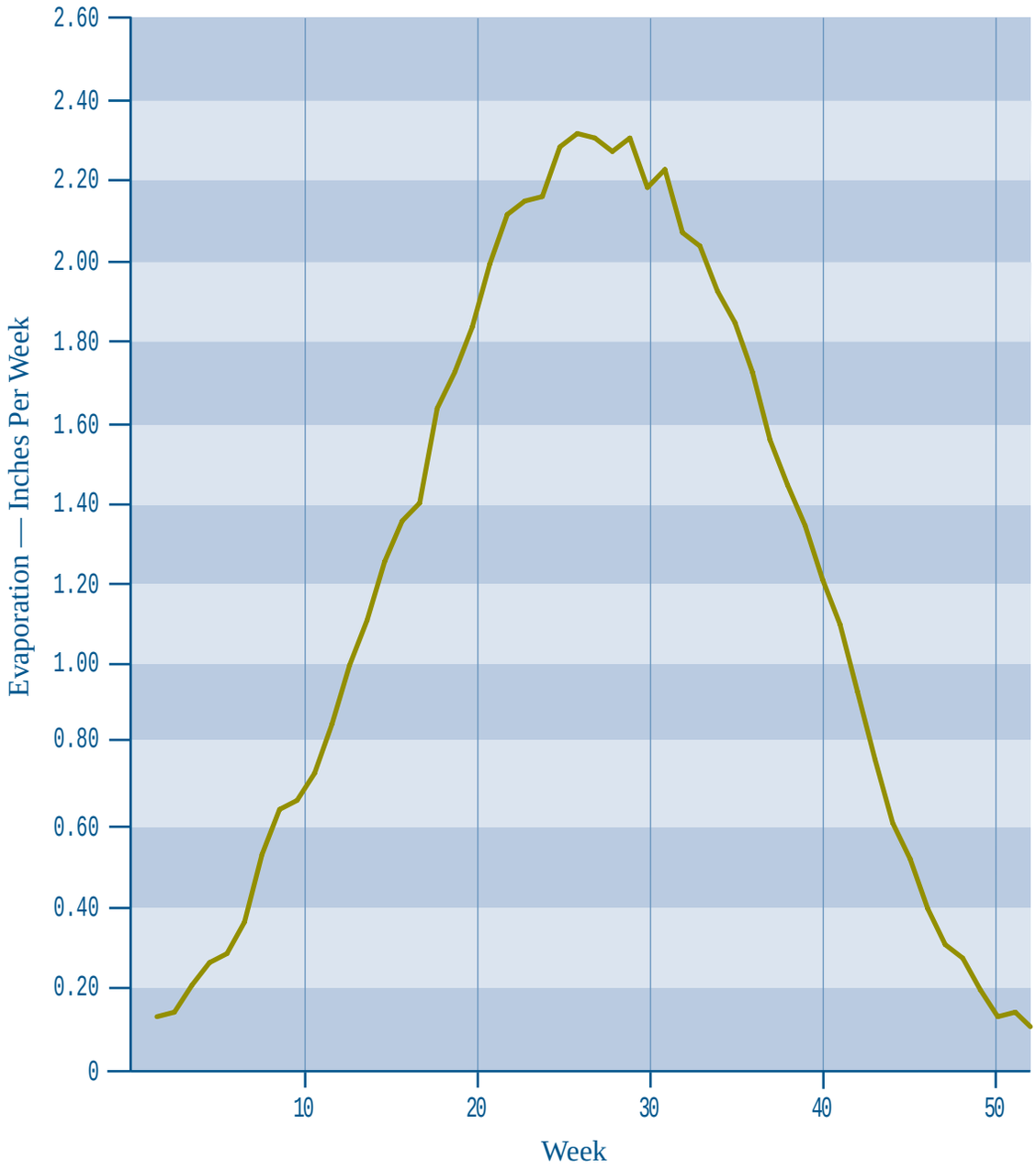


TABLE 8

Monthly Class 'A' Pan Evaporation at Fresno State/DWR Agroclimate Station 1968-1991 (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mar-Oct	Jan-Dec
1968	–	–	–	–	–	–	–	–	6.85	3.64	1.53	1.28	_	_
1969	0.85	0.91	3.95	6.04	8.84	9.47	10.73	9.14	6.69	3.63	1.71	1.01	58.49	62.97
1970	1.43	2.67	5.73	7.18	8.96	10.05	9.57	7.92	6.28	3.76	2.58	1.29	59.45	67.42
1971	1.15	2.05	2.55	5.40	6.40	12.11	11.99	9.85	6.45	4.25	1.70	0.85	59.00	64.75
1972	0.53	2.08	5.19	6.96	9.94	11.05	10.65	9.10	6.95	3.98	1.57	0.40	63.82	68.40
1973	1.42	1.74	3.10	5.89	8.75	10.09	11.32	9.28	7.29	4.88	2.39	0.94	60.60	67.09
1974	1.28	2.03	3.44	5.29	9.00	10.77	10.76	9.16	7.11	4.04	1.83	0.96	59.57	65.67
1975	1.25	2.60	3.63	5.34	8.56	10.82	10.59	8.90	6.64	4.83	2.81	1.35	59.31	67.32
1976	1.61	2.43	4.96	6.31	10.55	11.16	12.54	8.82	6.56	4.31	2.10	1.21	65.21	72.56
1977	0.88	2.65	4.17	6.74	6.74	7.83	11.06	9.98	6.94	4.53	2.16	0.85	57.99	64.53
1978	1.09	1.47	2.59	3.99	8.59	9.51	10.18	9.58	5.93	4.45	1.98	1.00	54.82	60.36
1979	1.23	1.95	3.35	5.95	9.05	10.20	10.44	9.55	7.25	4.26	2.57	1.68	60.05	67.48
1980	0.82	1.88	3.65	5.20	7.73	10.17	10.78	9.69	7.27	4.14	2.88	1.14	58.63	65.35
1981	1.71	2.01	3.27	6.05	9.60	12.84	11.61	9.58	7.50	3.86	1.92	1.05	64.31	71.00
1982	1.20	2.02	3.08	5.36	8.58	9.13	10.85	9.32	6.24	4.12	1.60	1.13	56.68	62.63
1983	1.20	1.95	2.79	4.94	8.28	10.31	10.46	8.64	6.40	3.95	1.83	1.06	55.77	61.81
1984	0.83	2.14	4.10	5.90	10.02	9.72	11.10	10.32	7.40	4.20	2.50	1.20	62.76	69.43
1985	0.83	2.25	3.61	7.04	9.23	10.06	10.14	9.68	6.55	4.46	1.88	0.68	60.77	66.41
1986	1.36	1.92	3.39	5.99	9.37	10.72	10.70	10.45	6.64	4.51	2.15	0.96	61.77	68.16
1987	1.36	2.49	3.54	7.09	9.40	10.26	10.86	9.59	7.06	4.38	2.01	1.23	62.18	69.27
1988	1.49	2.62	4.94	5.06	7.84	9.30	11.49	9.40	6.77	4.74	2.52	1.16	59.54	67.33
1989	1.22	1.63	3.76	6.22	9.44	10.92	10.50	9.53	5.88	5.32	2.04	1.13	61.57	67.59
1990	1.61	2.49	3.79	5.93	7.34	10.10	11.49	8.92	6.97	5.38	2.68	1.49	59.92	68.19
1991	1.50	3.07	3.93	6.83	8.45	9.49	10.36	9.51	7.09	4.86	2.52	1.66	60.52	69.27
Average	1.21	2.13	3.76	5.94	8.72	10.26	10.88	9.39	6.78	4.35	2.14	1.11	60.08	66.67
Std. Dev.	0.30	0.46	0.79	0.79	0.99	1.00	0.64	0.54	0.43	0.46	0.40	0.28	2.51	2.87
Std. Error	0.06	0.10	0.17	0.16	0.21	0.21	0.13	0.11	0.09	0.09	0.08	0.06	0.52	0.60

Continued from page 30

The 1958 to 1991 average of evaporation for one-week periods is plotted on Figure 10. Evaporation increased rather uniformly at 0.10 inch per week during the 15-week period from February 22 to May 31. Similarly, from August 16 to November 22, weekly evaporation rates declined at a uniform rate of 0.11 inch per week.

The monthly evaporation record for the Fresno State/DWR agroclimate station is presented in Table 8. These evaporation data show some variation from year to year at that location. However, standard deviation for both the growing season (March to October) and total annual evaporation is less than 5 percent.

The same evaporation data summarized into weekly amounts are presented in Table 9. Average evaporation at the Fresno State/DWR station for the period 1969 to 1991 ran about 6 percent higher than that measured near Bakersfield for the same years. Figure 11 shows monthly evaporation rates for the two locations. Evaporation for the Fresno State/DWR station was about the same as Bakersfield for the springtime and fall months but was markedly higher during the four summer months (May to August).

Continued on page 44

TABLE 9

Weekly Class 'A' Pan Evaporation at Fresno State/DWR Agroclimate Station 1969-1991 (inches)

Week No.	Ending Date	Day of Year	1969	1970	1971	1972	1973	1974	1975	1976	1977
1	Jan 4	4	0.13	0.22	0.35	0.00	0.26	0.12	0.18	0.35	0.39
2	11	11	0.10		0.20	0.07	0.28	0.11	0.26	0.21	0.32
3	18	18	0.07		0.30	0.05	0.29	0.25	0.21	0.32	0.11
4	25	25	0.12		0.30	0.23	0.36	0.36	0.31	0.45	0.21
5	Feb 1	32	0.49		0.20	0.23	0.37	0.40	0.40	0.49	0.21
6	8	39	0.06		0.21	0.30	0.36	0.48	0.64	0.50	0.46
7	15	46	0.34		0.41	0.47	0.40	0.47	0.66	0.52	0.62
8	22	53	0.33		0.65	0.51	0.46	0.47	0.57	0.55	0.73
9	Mar 1	60	0.26		0.81	0.70	0.52	0.71	0.74	0.86	0.85
10	8	67	0.67		0.55	0.91	0.56	0.65	0.68	0.52	0.93
11	15	74	0.82		0.60	1.04	0.72	0.67	0.64	0.93	0.90
12	22	81	0.91		0.60	1.32	0.82	0.79	0.80	1.43	0.91
13	29	88	1.04		0.60	1.31	0.57	0.92	1.03	1.56	0.99
14	Apr 5	95	0.84		1.00	1.41	1.02	0.96	1.04	1.21	1.19
15	12	102	1.18		1.40	1.39	1.07	1.05	1.11	1.10	1.43
16	19	109	1.43		1.00	1.64	1.46	1.29	1.28	1.08	1.77
17	26	116	1.61		1.40	1.68	1.56	1.38	1.35	1.98	1.73
18	May 3	123	1.66		1.40	2.12	1.70	1.51	1.51	2.04	1.45
19	10	130	1.53	1.51	0.80	2.10	1.75	1.88	1.59	1.81	1.06
20	17	137	2.05	1.67	1.70	2.33	1.86	2.04	1.96	2.73	1.12
21	24	144	2.07	1.75	1.70	2.09	2.20	1.95	2.06	2.32	1.57
22	31	151	2.26	1.69	1.60	2.58	2.19	2.30	2.16	2.72	2.22
23	Jun 7	158	2.30	2.43	2.10	2.65	1.95	2.53	2.47	2.69	2.22
24	14	165	2.05	1.67	3.40	2.33	2.36	2.67	2.64	2.42	1.74
25	21	172	2.32	2.09	3.10	2.67	2.43	2.39	2.51	2.59	1.31
26	28	179	2.46	2.05	2.60	2.33	2.43	2.45	2.46	2.53	1.88
27	Jul 5	186	2.54	2.26	2.70	2.79	2.73	2.47	2.52	3.08	2.36
28	12	193	2.40	2.28	2.70	2.57	2.60	2.42	2.34	2.87	2.37
29	19	200	2.32	2.73	2.70	2.57	2.83	2.38	2.52	2.98	2.45
30	26	207	2.37	2.58	3.00	2.08	2.29	2.48	2.49	2.66	2.67
31	Aug 2	214	2.38	2.20	2.60	2.17	2.37	2.38	2.08	2.64	2.63
32	9	221	2.36	2.21	2.50	2.04	2.17	2.17	2.25	2.38	2.31
33	16	228	2.12	2.04	2.00	2.82	2.03	2.19	2.22	1.92	2.08
34	23	235	1.98	2.38	2.20	2.04	2.33	2.01	1.76	1.50	2.29
35	30	242	1.87	1.73	2.30	1.82	1.95	1.92	1.83	2.07	2.38
36	Sep 6	249	1.72	1.68	1.80	1.63	1.74	2.00	1.69	2.06	1.89
37	13	256	1.68	1.71	1.40	1.87	1.74	1.90	1.55	1.43	1.77
38	20	263	1.54	1.68	1.60	1.52	1.44	1.53	1.64	1.16	1.59
39	27	270	1.45	1.43	1.50	1.73	1.69	1.43	2.17	1.65	1.45
40	Oct 4	277	1.31	1.08	1.20	1.24	1.71	1.31	0.80	1.37	1.43
41	11	284	0.91	0.93	1.00	1.03	0.91	1.06	0.99	1.01	1.30
42	18	291	0.68	0.69	1.00	0.96	1.02	0.89	0.97	0.86	1.08
43	25	298	0.62	0.59	0.90	0.73	1.31	0.87	1.22	1.09	0.97
44	Nov 1	305	0.52	0.65	0.90	0.87	1.09	0.73	0.98	0.84	0.89
45	8	312	0.53		0.50	0.66	0.93	0.52	0.82	0.54	0.72
46	15	319	0.40		0.40	0.35	0.70	0.43	0.81	0.51	0.51
47	22	326	0.36		0.30	0.03	0.34	0.38	0.65	0.50	0.48
48	29	333	0.30		0.50	0.16	0.30	0.41	0.43	0.47	0.41
49	Dec 6	340	0.25		0.20	0.06	0.36	0.31	0.33	0.33	0.24
50	13	347	0.19		0.20	0.07	0.14	0.21	0.24	0.27	0.20
51	20	354	0.21		0.20	0.12	0.22	0.19	0.21	0.24	0.22
52	27	361	0.21		0.20	0.24	0.25	0.21	0.41	0.27	0.18
Mar-Oct Total			57.96		59.55	64.38	60.60	59.57	59.31	65.23	58.33
Jan-Dec Total			62.32		65.46	68.63	67.14	65.60	67.18	72.61	65.19

TABLE 9 (continued)

Weekly Class 'A' Pan Evaporation at Fresno State/DWR Agroclimate Station 1969-1991 (inches)

Week No.	Ending Date	Day of Year	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	Jan 4	4	0.15	0.11	0.22	0.15	0.29	0.09	0.14	0.13	0.14
2	11	11	0.23	0.34	0.19	0.21	0.27	0.10	0.08	0.18	0.26
3	18	18	0.37	0.35	0.18	0.38	0.20	0.23	0.17	0.20	0.21
4	25	25	0.34	0.14	0.18	0.55	0.24	0.40	0.22	0.14	0.37
5	Feb 1	32	0.16	0.35	0.23	0.49	0.36	0.36	0.37	0.18	0.46
6	8	39	0.35	0.38	0.23	0.40	0.40	0.39	0.44	0.41	0.42
7	15	46	0.27	0.48	0.47	0.41	0.43	0.46	0.44	0.44	0.50
8	22	53	0.42	0.48	0.63	0.60	0.55	0.45	0.49	0.67	0.46
9	Mar 1	60	0.36	0.74	0.69	0.60	0.64	0.54	0.72	0.74	0.55
10	8	67	0.50	0.60	0.63	0.54	0.66	0.64	0.78	0.75	0.58
11	15	74	0.60	0.65	0.68	0.79	0.61	0.73	0.82	0.67	0.54
12	22	81	0.60	0.50	0.87	0.69	0.65	0.59	0.88	0.80	0.78
13	29	88	0.74	0.97	0.92	0.83	0.80	0.63	1.11	0.96	1.05
14	Apr 5	95	0.76	1.10	1.14	1.08	0.84	1.04	1.06	1.22	1.02
15	12	102	0.77	1.41	1.19	1.42	0.92	1.12	1.12	1.56	1.10
16	19	109	0.88	1.53	1.48	1.45	1.18	1.11	1.39	1.43	1.40
17	26	116	0.98	1.44	1.13	1.27	1.54	1.14	1.72	2.00	1.65
18	May 3	123	1.37	1.38	1.25	1.89	1.79	1.12	1.63	2.02	1.63
19	10	130	1.46	1.53	1.62	2.24	1.81	1.50	2.01	1.94	1.74
20	17	137	1.85	2.04	1.57	2.08	1.80	1.92	2.20	1.93	2.26
21	24	144	2.26	2.11	2.13	1.86	2.03	2.21	2.45	2.04	2.30
22	31	151	2.27	2.25	1.99	2.19	2.13	2.12	2.30	2.26	2.31
23	Jun 7	158	2.16	2.34	2.21	2.93	2.11	2.15	2.17	1.36	2.43
24	14	165	2.17	2.11	2.32	3.37	2.18	2.36	2.21	2.16	2.43
25	21	172	2.14	2.47	2.46	2.81	2.28	2.46	2.38	2.60	2.60
26	28	179	2.16	2.55	2.63	2.89	2.03	2.53	2.45	2.77	2.50
27	Jul 5	186	2.27	2.56	2.25	2.75	1.96	2.44	2.48	2.62	2.59
28	12	193	2.26	2.41	2.37	2.83	2.38	2.55	2.60	2.63	2.67
29	19	200	2.37	2.42	2.35	2.72	2.53	2.39	2.18	1.93	2.49
30	26	207	2.21	2.01	2.58	2.43	2.53	2.18	2.60	2.83	2.08
31	Aug 2	214	2.39	2.49	2.49	2.41	2.56	2.37	2.73	2.27	2.35
32	9	221	2.24	2.35	2.36	2.17	2.28	2.34	2.37	2.42	2.67
33	16	228	2.21	2.06	2.39	2.11	1.95	2.02	2.37	2.27	2.42
34	23	235	2.13	2.06	1.99	2.18	2.01	1.71	2.31	1.88	2.04
35	30	242	2.05	2.08	1.92	2.11	2.13	1.63	2.25	2.23	2.34
36	Sep 6	249	1.55	1.96	1.89	2.10	2.03	1.68	1.88	1.93	2.01
37	13	256	1.28	1.97	1.91	1.67	1.77	1.78	1.94	1.24	1.87
38	20	263	1.54	1.68	1.54	1.86	1.38	1.64	1.89	1.51	1.55
39	27	270	1.40	1.33	1.39	1.78	1.11	1.16	1.47	1.65	1.20
40	Oct 4	277	1.29	1.32	1.29	1.22	1.02	0.91	1.33	1.35	1.10
41	11	284	1.12	1.21	1.25	0.97	1.07	1.04	1.19	1.11	1.15
42	18	291	1.06	1.04	0.94	1.09	0.89	0.99	0.89	1.11	1.06
43	25	298	0.89	0.86	0.67	0.60	0.72	0.89	0.81	0.92	0.78
44	Nov 1	305	0.79	0.85	0.81	0.77	0.79	0.73	0.78	0.74	1.00
45	8	312	0.69	0.60	0.89	0.61	0.50	0.57	0.90	0.65	0.89
46	15	319	0.40	0.72	0.72	0.50	0.44	0.50	0.82	0.53	0.70
47	22	326	0.47	0.55	0.58	0.44	0.26	0.37	0.41	0.38	0.44
48	29	333	0.35	0.53	0.41	0.33	0.31	0.30	0.32	0.22	0.10
49	Dec 6	340	0.36	0.53	0.47	0.17	0.31	0.60	0.27	0.26	0.29
50	13	347	0.27	0.33	0.33	0.17	0.20	0.33	0.42	0.22	0.16
51	20	354	0.19	0.53	0.26	0.28	0.32	0.19	0.35	0.17	0.24
52	27	361	0.14	0.26	0.15	0.31	0.32	0.15	0.16	0.09	0.22
Mar-Oct Total			54.72	59.64	58.61	64.10	56.46	55.82	62.75	61.09	61.69
Jan-Dec Total			60.24	67.06	65.44	70.69	62.47	61.85	69.47	66.71	68.10

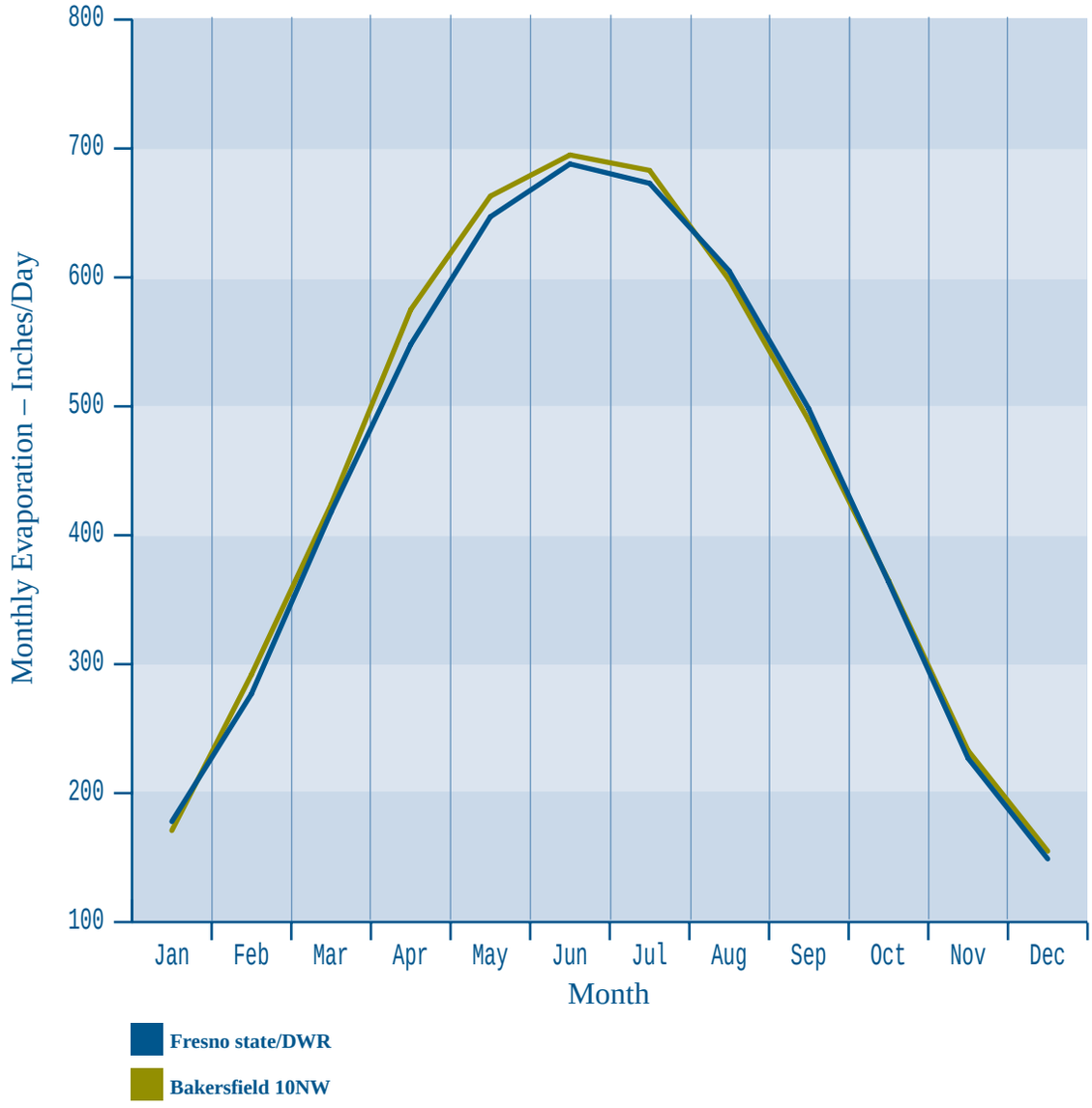
TABLE 9 (continued)

Weekly Class 'A' Pan Evaporation at Fresno State/DWR Agroclimate Station 1969-1991 (inches)

Week No.	Ending Date	Day of Year	1987	1988	1989	1990	1991	Average	Std. Dev.	Std. Error
1	Jan 4	4	0.22	0.28	0.17	0.32	0.16	0.20	0.09	0.02
2	11	11	0.27	0.25	0.22	0.38	0.22	0.22	0.08	0.02
3	18	18	0.19	0.33	0.23	0.36	0.25	0.24	0.09	0.02
4	25	25	0.35	0.36	0.30	0.31	0.59	0.31	0.12	0.03
5	Feb 1	32	0.42	0.45	0.37	0.40	0.38	0.35	0.10	0.02
6	8	39	0.48	0.51	0.32	0.60	0.62	0.39	0.15	0.03
7	15	46	0.68	0.65	0.21	0.75	0.60	0.48	0.13	0.03
8	22	53	0.62	0.75	0.47	0.52	0.95	0.56	0.13	0.03
9	Mar 1	60	0.69	0.72	0.64	0.62	0.90	0.66	0.15	0.03
10	8	67	0.69	0.83	0.54	0.71	0.75	0.67	0.12	0.03
11	15	74	0.76	1.01	0.89	0.73	0.94	0.76	0.14	0.03
12	22	81	0.81	1.17	0.95	1.04	0.81	0.85	0.22	0.05
13	29	88	0.87	1.34	0.91	1.20	0.92	0.97	0.24	0.05
14	Apr 5	95	1.28	1.51	1.25	1.08	1.12	1.10	0.17	0.04
15	12	102	1.37	1.33	1.50	1.28	1.83	1.26	0.23	0.05
16	19	109	1.65	0.95	1.45	1.22	1.51	1.34	0.23	0.05
17	26	116	1.87	0.90	1.47	1.40	1.54	1.49	0.29	0.06
18	May 3	123	1.92	1.34	1.65	1.59	1.73	1.62	0.26	0.06
19	10	130	2.21	1.48	1.60	1.54	1.89	1.68	0.33	0.07
20	17	137	2.31	1.60	2.45	1.84	1.71	1.96	0.33	0.07
21	24	144	1.82	2.02	2.24	1.87	1.68	2.03	0.22	0.05
22	31	151	2.11	2.13	2.24	1.55	2.47	2.18	0.27	0.06
23	Jun 7	158	2.28	2.04	2.18	2.34	2.22	2.27	0.30	0.06
24	14	165	2.05	2.12	2.48	2.48	2.42	2.35	0.40	0.08
25	21	172	2.60	2.06	2.93	2.07	2.30	2.42	0.35	0.07
26	28	179	2.73	2.25	2.57	2.45	2.22	2.43	0.24	0.05
27	Jul 5	186	2.39	2.80	2.22	2.46	2.03	2.49	0.25	0.05
28	12	193	2.57	2.56	2.26	2.38	2.18	2.49	0.18	0.04
29	19	200	2.43	2.38	2.16	3.16	2.97	2.52	0.28	0.06
30	26	207	2.29	2.60	1.84	2.56	1.96	2.41	0.28	0.06
31	Aug 2	214	2.57	2.42	2.82	2.41	2.18	2.43	0.18	0.04
32	9	221	2.39	2.31	2.59	2.46	1.88	2.31	0.17	0.04
33	16	228	2.25	2.17	2.47	2.09	2.15	2.19	0.20	0.04
34	23	235	1.98	2.00	2.10	2.08	2.09	2.05	0.20	0.04
35	30	242	1.92	2.04	1.88	1.43	1.97	1.99	0.22	0.05
36	Sep 6	249	1.75	1.88	1.89	1.36	2.57	1.86	0.23	0.05
37	13	256	1.69	1.66	1.71	2.33	1.79	1.72	0.23	0.05
38	20	263	1.56	1.60	1.11	1.38	1.56	1.54	0.17	0.04
39	27	270	1.64	1.49	1.04	1.46	1.60	1.49	0.24	0.05
40	Oct 4	277	1.66	1.38	1.49	1.28	1.32	1.28	0.20	0.04
41	11	284	1.26	1.24	1.32	1.62	1.27	1.13	0.16	0.03
42	18	291	0.99	0.99	1.20	1.27	1.12	0.99	0.14	0.03
43	25	298	0.86	0.87	1.15	0.94	1.18	0.89	0.19	0.04
44	Nov 1	305	0.71	0.94	0.78	0.90	0.67	0.81	0.12	0.02
45	8	312	0.50	0.89	0.49	0.87	0.69	0.68	0.15	0.03
46	15	319	0.51	0.75	0.48	0.25	0.58	0.55	0.15	0.03
47	22	326	0.49	0.51	0.51	0.82	0.52	0.44	0.15	0.03
48	29	333	0.36	0.37	0.48	0.64	0.61	0.38	0.13	0.03
49	Dec 6	340	0.36	0.26	0.38	0.26	0.44	0.32	0.12	0.03
50	13	347	0.28	0.30	0.29	0.77	0.28	0.27	0.13	0.03
51	20	354	0.24	0.38	0.21	0.24	0.18	0.24	0.09	0.02
52	27	361	0.25	0.22	0.19	0.18	0.35	0.23	0.07	0.01
Mar-Oct Total			62.24	59.41	61.33	59.96	60.55	59.96	2.67	0.58
Jan-Dec Total			69.15	67.39	67.29	68.25	68.87	66.48	2.95	0.64

FIGURE 11

Average Observed Monthly Evaporation[1]
Fresno State/DWR & Bakersfield Area[2] 18 Years of Data



1 Class "A" pans located in irrigated pastures May 1969-April 1970 – Bakersfield 10S

2 January 1975-December 1980 WASCO 85W, January 1981-April 1990 – Bakersfield 10NW, May 1990-December1991 –Average of Bakersfield 12S and Lamont 2NW

FIGURE 12

Relationship Between Monthly Evaporation at Agroclimate Stations Near Bakersfield and Fresno State/DWR 1968-1991 (average monthly evaporation)

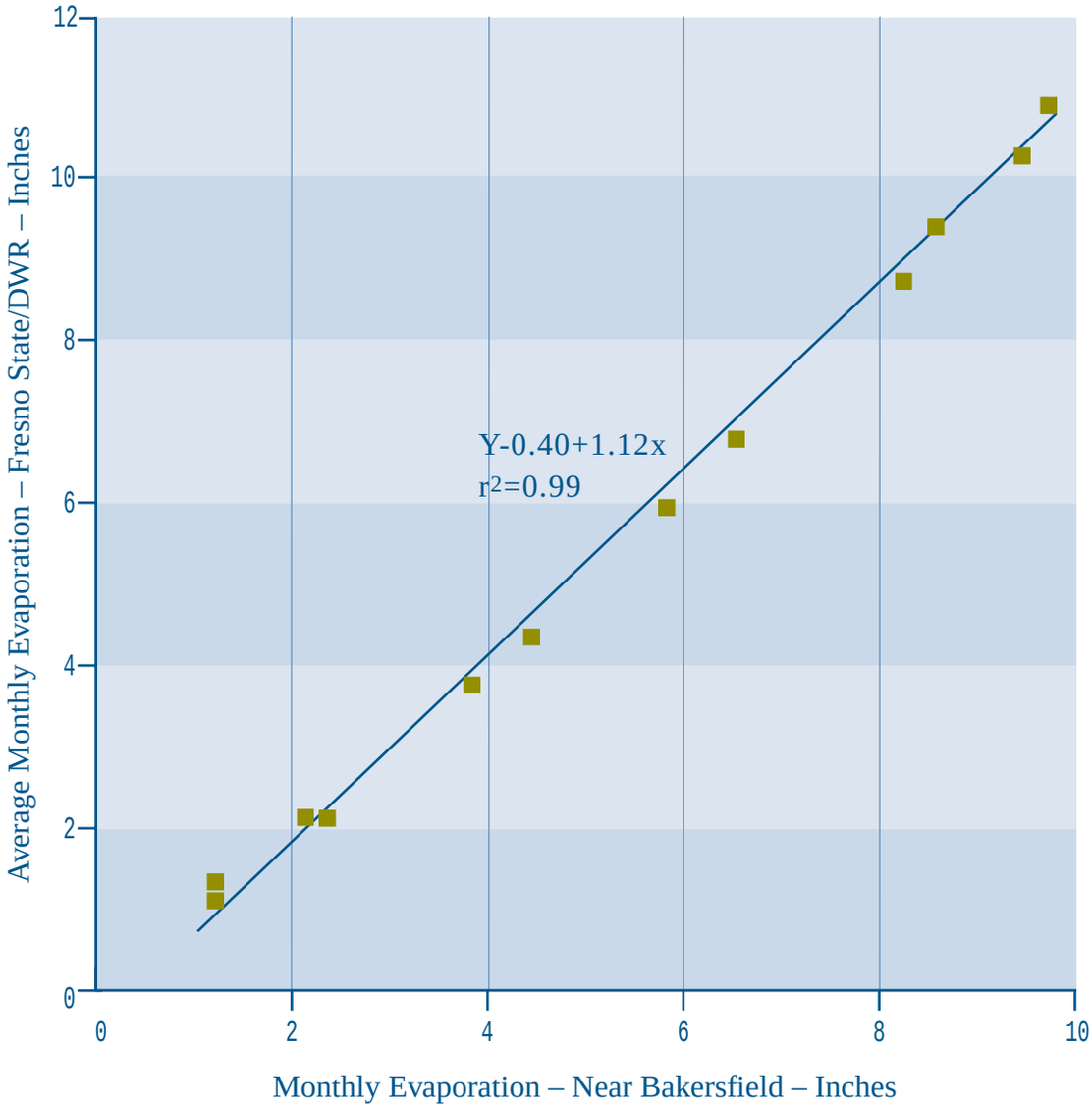


FIGURE 13

Relationship Between Weekly Evaporation at Agroclimate Stations Near Bakersfield and at Fresno State/DWR 1969-1991

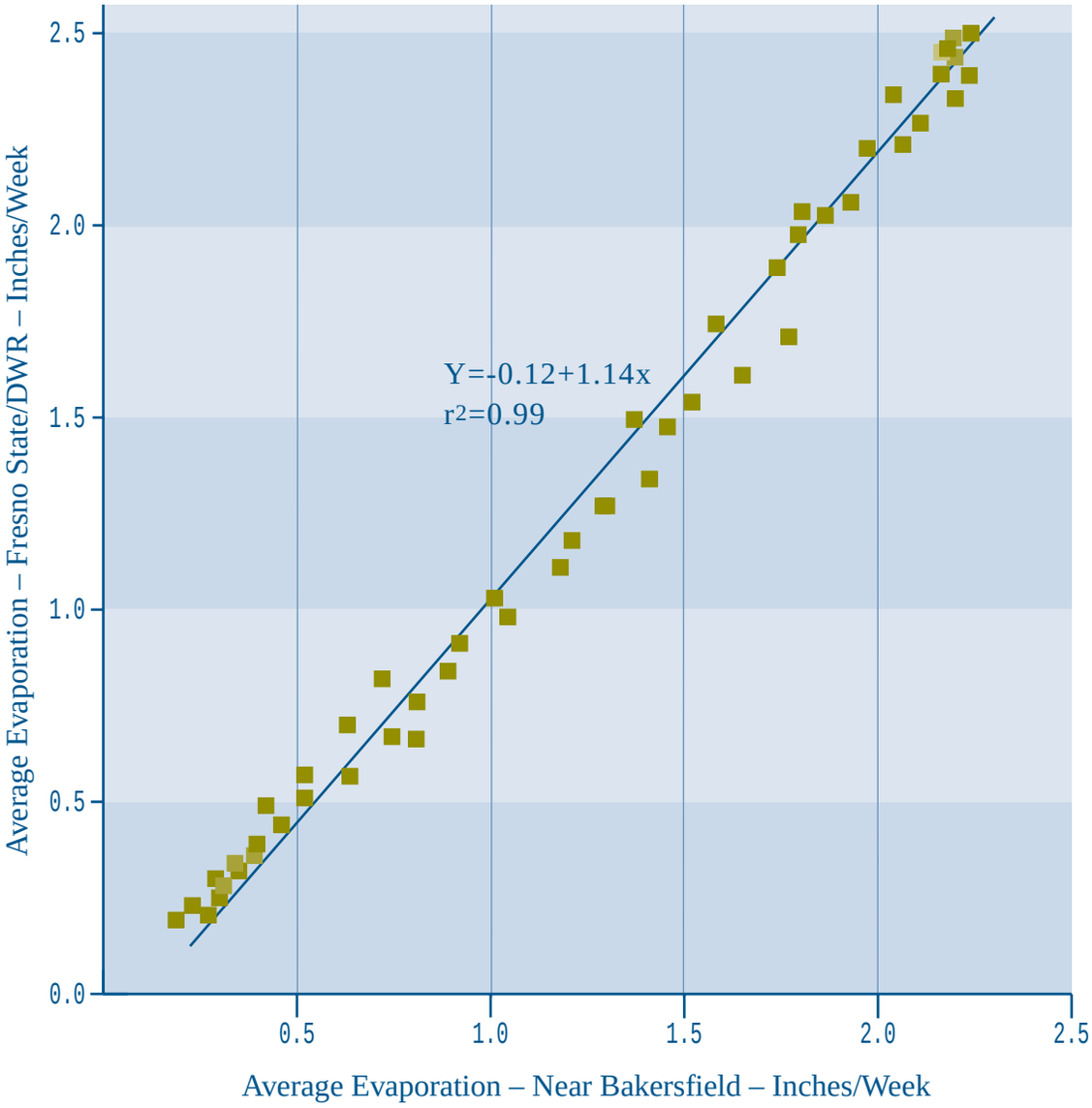
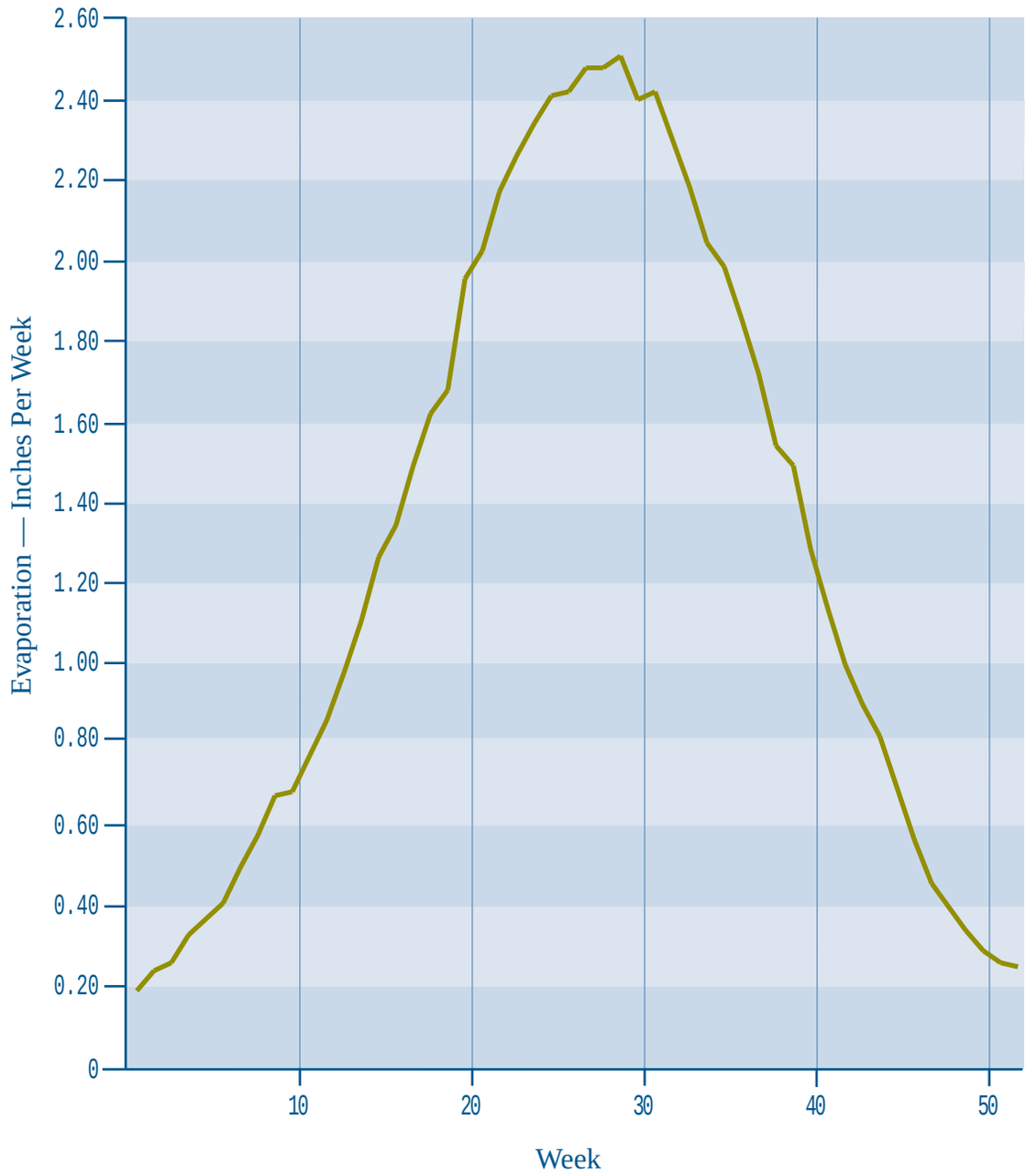


FIGURE 14

Class ‘A’ Pan Evaporation at Fresno State/DWR Agroclimate Station
inches/week — 1969-1991



Continued from page 37

The linear relationship between monthly evaporation measured at Fresno State/DWR and at agroclimate stations near Bakersfield is shown on Figure 12. Figure 13 shows that same linear relationship for weekly periods. The 1969 to 1991 average evaporation for weekly periods at Fresno State/DWR is shown on Figure 14. Weekly evaporation increased uniformly from March 8 to June 14 (weeks 10 to 24) and decreased uniformly between August 2 and November 15 (weeks 31 to 46).

TABLE 10

Normalized Monthly Pan Evaporation Rates for Several Stations in the San Joaquin Valley[1] (inches)

MONTH	BERENDA 2-N	BUTTONWILLOW 1-S	KERMAN 2-ESE	KINGSBURG 5-S	MAZE BRIDGE 2-S	MERCED 5-SE	NEWMAN 1-SE	POND 1-N	STOCKTON 9-S	TRAVER 4-ESE	AVERAGE	STD.DEV	STD.ERROR
Jan	0.91	1.42	1.02	1.31	1.15	1.28	1.10	1.07	1.35	0.91	1.15	0.17	0.05
Feb	1.65	2.13	1.87	2.00	2.23	2.04	2.41	1.89	2.29	1.59	2.01	0.25	0.08
Mar	3.22	3.91	3.76	3.88	3.67	3.64	3.65	3.48	4.29	3.04	3.65	0.34	0.11
Apr	5.27	6.97	5.57	5.38	6.29	6.24	5.58	5.74	5.81	4.76	5.76	0.59	0.19
May	7.92	9.51	8.35	8.38	8.09	8.19	8.01	8.28	8.53	7.41	8.27	0.51	0.16
Jun	9.01	10.49	9.11	9.20	9.44	10.02	8.98	9.15	9.84	8.82	9.41	0.51	0.16
Jul	10.97	9.70	9.51	9.18	9.99	10.94	10.05	9.62	10.29	9.57	9.98	0.57	0.18
Aug	9.67	7.44	8.95	8.18	8.73	9.05	9.36	8.55	8.59	8.14	8.67	0.61	0.19
Sep	6.84	6.13	6.68	6.44	6.85	6.62	7.06	6.54	6.76	6.17	6.61	0.28	0.09
Oct	4.98	4.79	4.87	4.31	5.19	4.67	5.50	4.66	5.69	4.16	4.88	0.46	0.15
Nov	1.90	2.11	2.05	1.83	2.35	2.30	2.10	2.03	2.43	1.77	2.09	0.21	0.07
Dec	1.29	1.32	0.85	1.02	1.13	1.23	0.87	0.89	1.21	0.76	1.06	0.19	0.06
Mar-Oct	57.88	58.94	56.80	54.95	58.25	59.37	58.19	56.02	59.80	52.07	57.23	2.24	0.71
Jan-Dec	63.63	65.92	62.59	61.11	65.11	66.22	64.67	61.90	67.08	57.10	63.53	2.83	0.90

[1] Evaporation from Class 'A' pans located in irrigated pastures. Short-term measured evaporation rates extrapolated to average for 1958-1991 using evaporation measured near Bakersfield as basis.

EVAPORATION AT OUTLYING STATIONS

Pan evaporation was measured at the 10 outlying agroclimate stations listed in Table 10. They were operated for the time periods shown in Table 1. To accurately compare evaporation measured at the various stations, the measured evaporation at each station was extrapolated to the same long-term period, 1958 to 1991. This extrapolation was based on the evaporation record for stations near Bakersfield.

Estimated long-term evaporation for each outlying station is presented in Table 10. Average monthly evaporation for the outlying agroclimate stations and for stations near Bakersfield is shown on Figure 15. The linear relationship between average monthly evaporation at the outlying stations and measured at the stations near Bakersfield is shown on Figure 16.

Continued on page 50

FIGURE 15

Average Evaporation from Class 'A' Pans Located Near Bakersfield and Average for Ten Agroclimate Stations in the San Joaquin Valley – 1958-1991

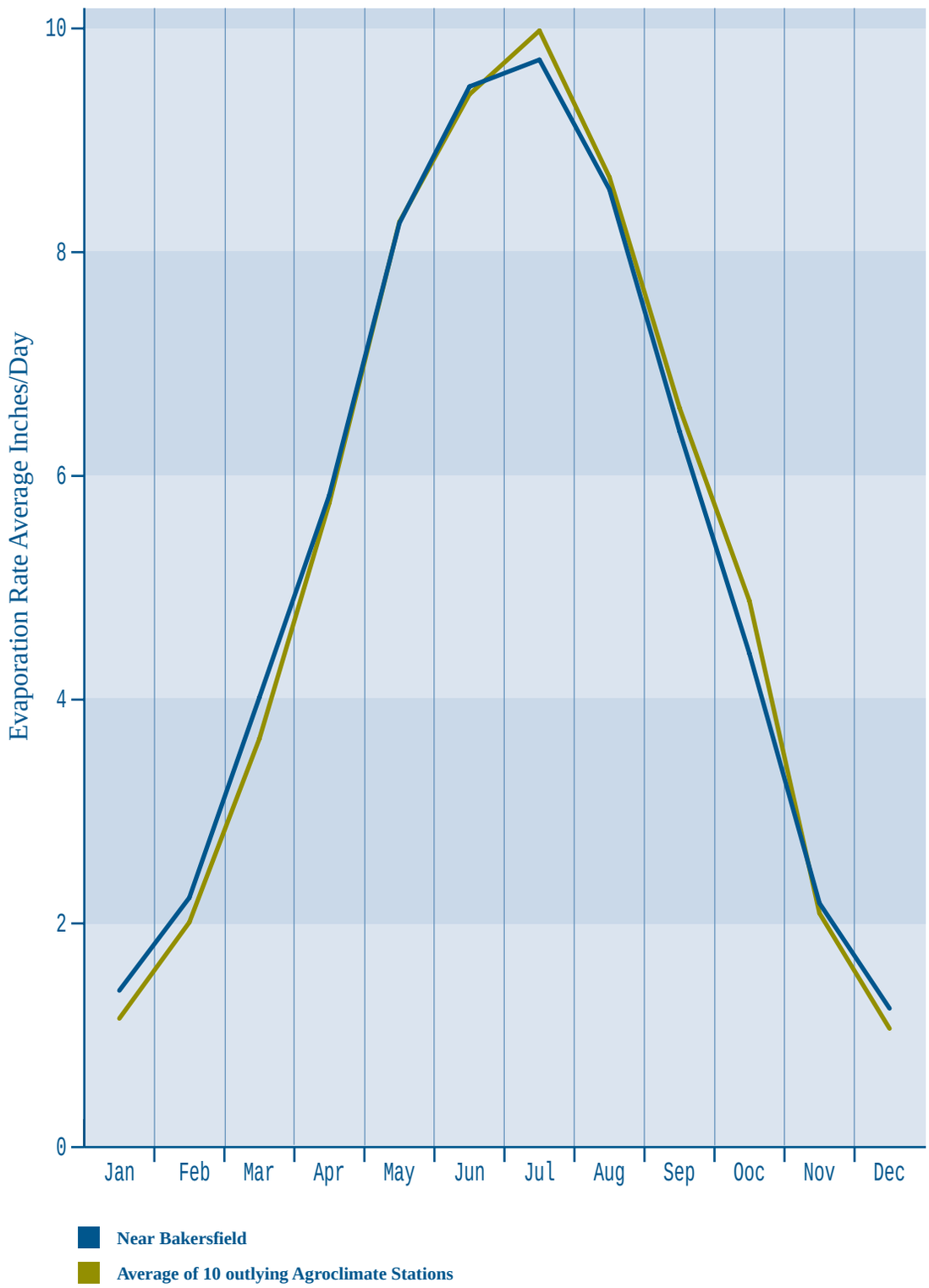


FIGURE 16

Relationship Between Measured Evaporation at Bakersfield and the Average Estimated Long-Term Evaporation for Ten Outlying Agroclimate Stations

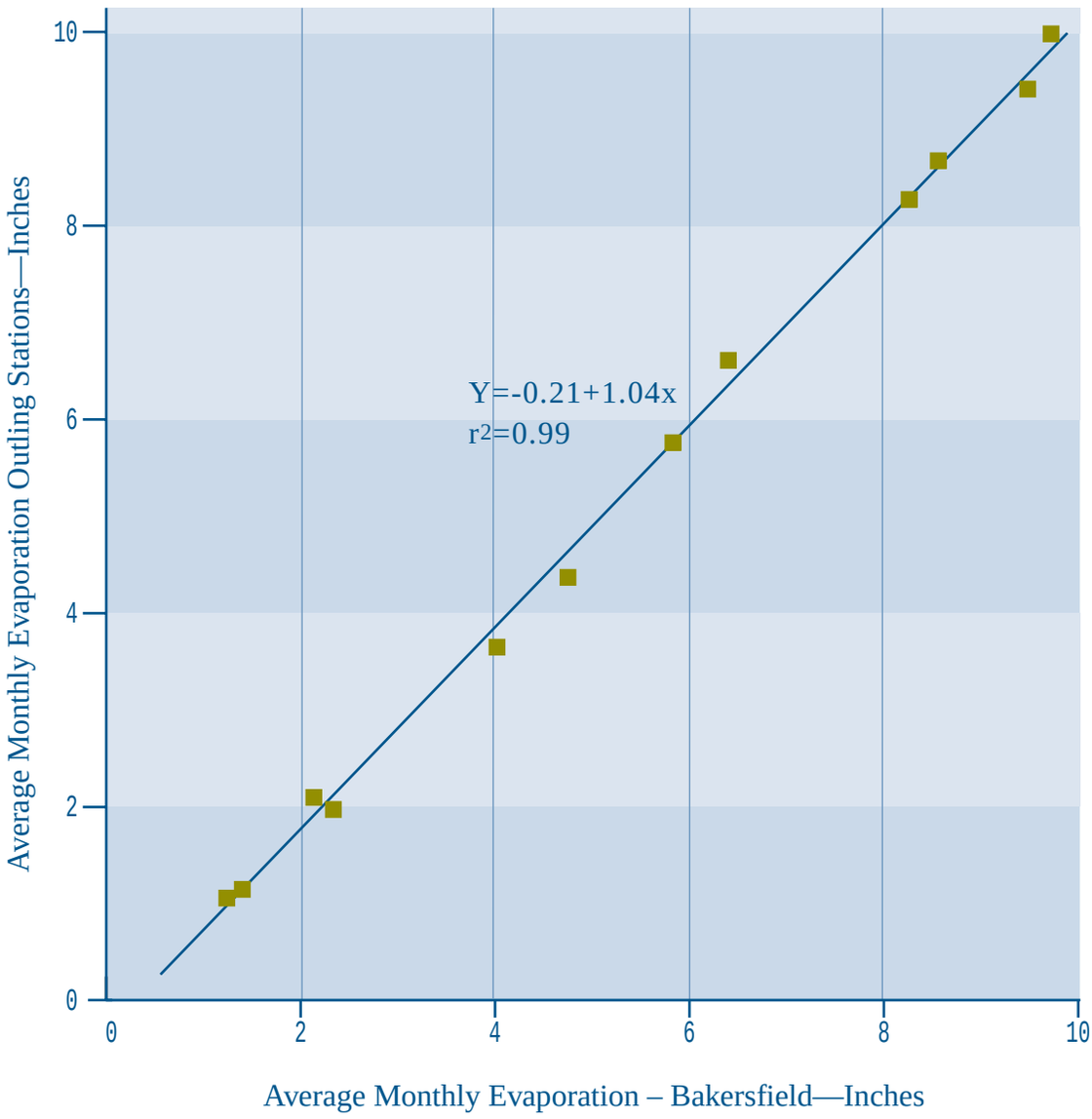


FIGURE 17

Relationship Between Weekly Maximum Air Temp and Weekly Maximum Pan Water Temperature — Wasco 8SW — 1975-1981

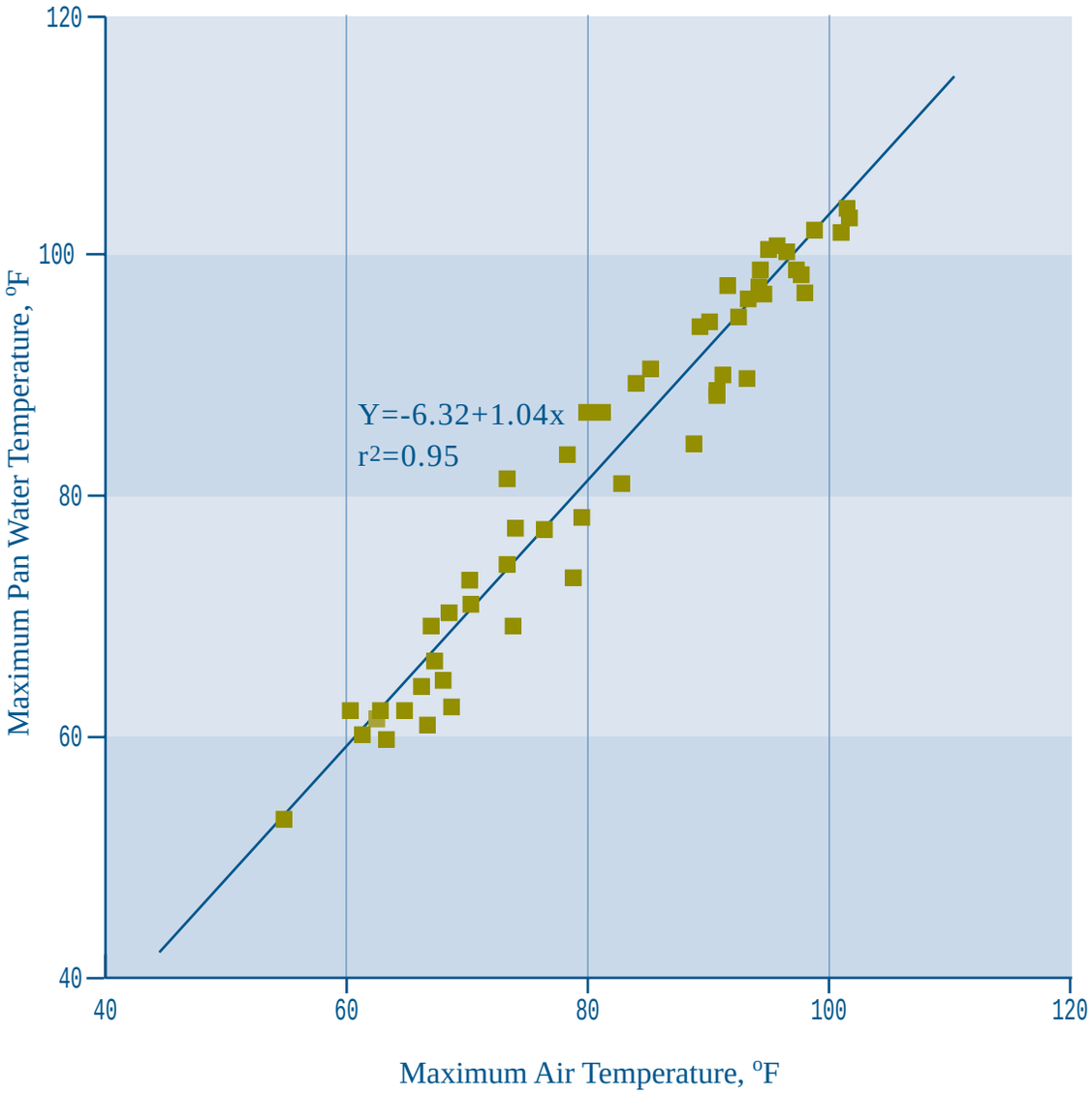
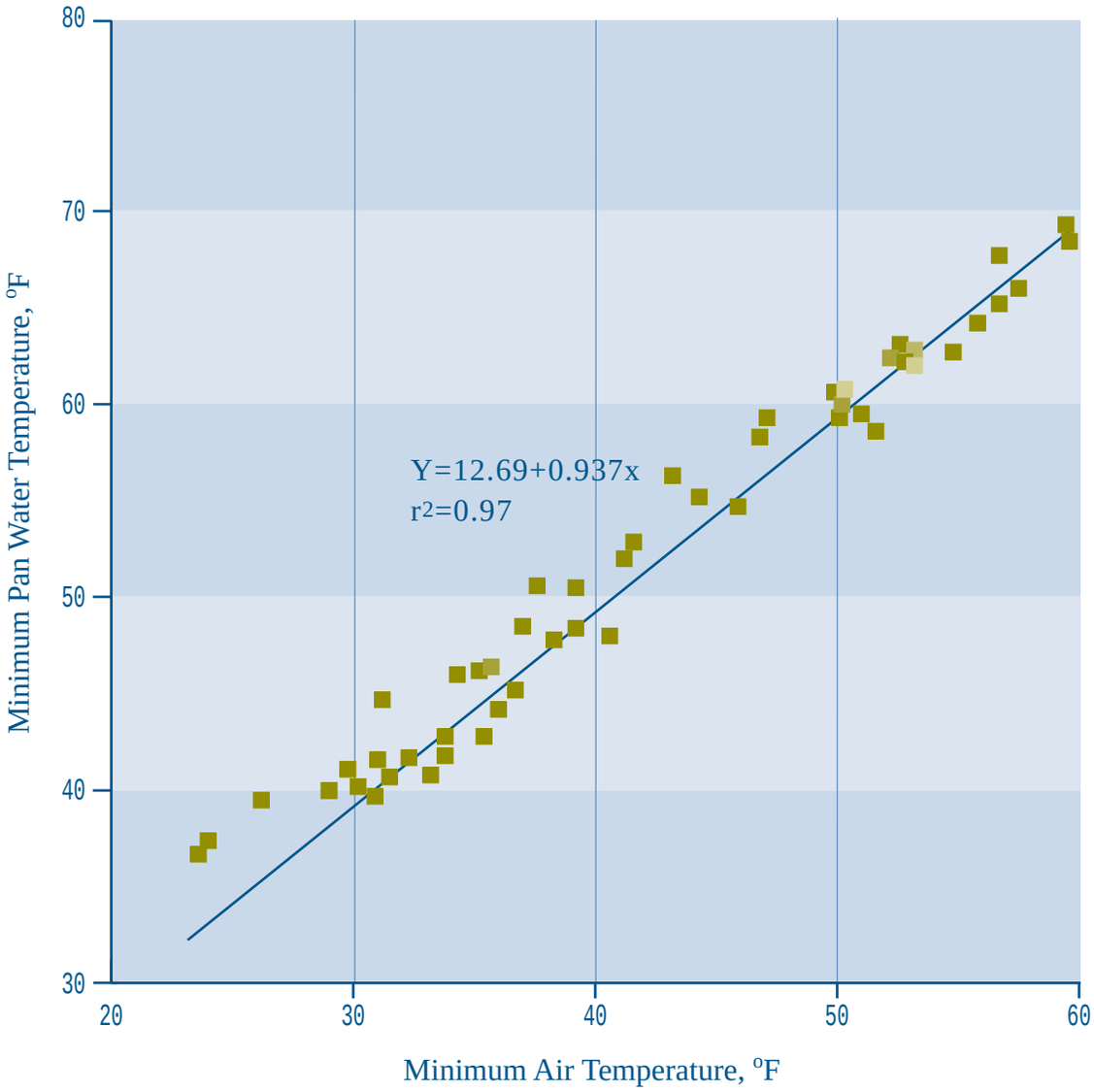


FIGURE 18

Relationship Between Weekly Minimum Air Temperature and Weekly Minimum Pan Water Temperature — Wasco 8SW — 1975-1981



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EVAPORATION PAN WATER TEMPERATURE

Water temperature was measured in each evaporation pan. A 'U' tube (Sixe's) maximum/minimum thermometer was suspended about 3 inches below the pan water surface. The thermometers were read and reset each time the station was serviced.

Maximum/minimum pan water temperatures were compared to similar air temperatures for one station (Wasco 8-SW.) There were weekly data for seven years (1975 to 1981) at this location (325 weeks of data). Maximum water temperatures in the pan were about 2 degrees higher than maximum air temperatures. This close relationship is shown on Figure 17.

Weekly minimum pan water temperatures were highly correlated to minimum air temperatures but consistently ran some 10^{0}F higher. The relationship between minimum pan water temperatures and minimum air temperatures is shown on Figure 18.

ANALYSIS OF DATA

In conclusion, analysis of pan evaporation data indicates little year-to-year variation at the same location and little variation between locations for the same time period.

ESTIMATED HISTORIC EVAPORATION

Many hydrologic analyses include consumptive use estimates for periods beginning in the 1920s. There is a paucity of reliable measured evaporation data on which to base estimates of crop consumptive use in the San Joaquin Valley for the early years. There is, however, a fairly good record of historic air temperatures. Thus, a temperature-based equation (the Blaney-Criddle equation) was used to estimate evaporation for those early years, 1922 to 1958. This empirical equation uses air temperatures "t" and monthly percentage of possible daylight hours "p" to estimate a consumptive use factor "f." Monthly consumptive use is the product of the factor "f" and an empirically derived coefficient "k."

TABLE 11

Average Monthly Air Temperatures for Three U.S. Weather Bureau Dryland Stations in the Southern San Joaquin Valley 1958-1991[1] (degrees fahrenheit)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1958				61.3	71.8	75.5	82.0	85.1	75.9	70.6	54.8	50.3	
1959	50.2	50.4	59.8	67.3	67.0	79.2	85.8	80.4	73.8	67.8	55.9	47.7	65.4
1960	47.2	51.3	59.1	62.2	68.6	82.9	85.2	80.3	76.8	64.3	52.4	44.4	64.6
1961	42.5	53.3	55.1	63.6	65.9	81.4	84.6	83.0	73.4	65.3	52.5	44.7	63.8
1962	41.0	49.2	55.0	65.6	66.1	77.1	82.0	80.1	75.3	64.6	55.7	47.8	63.3
1963	42.6	56.9	55.0	57.4	69.2	74.3	79.2	79.4	76.3	66.1	54.0	40.8	62.6
1964	44.8	49.5	53.7	61.2	66.4	75.5	82.2	81.5	72.7	69.8	51.0	50.2	63.2
1965	46.6	49.9	56.6	61.3	68.9	72.6	80.9	81.3	71.4	67.9	56.8	41.9	63.0
1966	45.1	48.4	57.2	67.2	72.2	76.9	80.1	83.3	74.1	65.9	57.1	46.1	64.5
1967	45.6	48.6	55.8	52.6	69.7	74.8	86.1	86.7	79.3	67.5	59.1	43.8	64.1
1968	45.6	56.7	56.5	63.6	69.2	79.2	84.0	78.1	75.4	64.9	54.0	45.0	64.4
1969	47.0	49.7	55.0	61.6	72.1	75.1	83.5	83.2	78.5	62.4	55.6	48.8	64.4
1970	51.2	54.2	57.2	58.7	71.7	78.6	85.5	82.5	74.7	65.2	56.7	47.0	65.3
1971	45.2	48.0	56.2	59.9	66.1	75.8	84.6	83.3	75.2	62.1	52.3	44.0	62.7
1972	40.7	53.1	62.0	62.5	71.3	78.8	83.5	80.8	73.5	64.4	51.5	42.5	63.7
1973	46.1	55.0	53.0	63.1	75.1	80.4	82.6	81.1	74.3	65.2	54.4	47.3	64.8
1974	49.2	50.3	57.7	61.5	71.0	78.7	83.1	81.6	79.5	67.3	53.7	44.2	64.8
1975	43.9	51.6	55.0	57.2	70.8	78.7	81.4	79.5	79.7	64.3	52.6	45.2	63.3
1976	46.5	53.0	54.9	59.2	72.9	76.7	83.0	76.5	75.6	67.9	56.6	47.3	64.2
1977	44.5	54.1	52.9	65.7	64.7	81.1	82.8	82.5	76.3	68.2	56.3	53.6	65.2
1978	51.6	53.0	60.7	60.5	70.6	78.0	83.2	82.1	73.5	71.8	53.6	43.1	65.1
1979	47.9	50.3	57.5	62.1	73.1	79.4	82.1	79.5	78.6	67.8	55.0	50.0	65.3
1980	50.4	54.7	54.6	62.7	67.6	73.4	83.1	80.3	75.0	69.4	55.6	48.0	64.6
1981	50.4	53.9	56.4	64.6	71.4	82.3	83.8	82.8	78.2	63.1	57.4	49.2	66.1
1982	44.5	54.2	55.6	61.7	72.7	75.7	82.6	81.7	74.4	66.3	51.9	46.3	64.0
1983	44.3	53.4	56.4	58.2	69.6	75.9	78.2	82.0	78.7	68.1	55.6	50.2	64.2
1984	47.8	51.7	58.4	58.9	72.4	75.5	84.6	82.1	79.9	61.9	54.2	46.4	64.5
1985	42.5	51.2	54.2	66.6	68.6	80.4	83.8	78.3	70.7	64.1	51.4	41.9	62.8
1986	51.8	54.2	59.6	62.1	70.1	78.0	79.8	82.2	69.4	64.1	54.3	45.5	64.3
1987	44.1	51.0	55.7	67.5	72.3	78.1	76.2	79.5	74.8	70.1	52.2	45.2	63.9
1988	46.1	52.5	57.8	63.0	68.1	74.9	84.8	80.3	75.2	68.5	53.4	45.0	64.1
1989	43.6	49.6	59.1	67.8	69.5	76.3	82.0	78.6	74.1	65.3	54.2	42.6	63.6
1990	46.1	48.6	58.4	66.9	68.9	76.6	84.1	80.3	75.1	68.3	52.9	41.2	64.0
1991	46.9	56.1	52.8	60.0	66.4	75.4	83.7	78.7	79.8	71.1	55.1	46.2	64.4
Average	46.2	52.0	56.5	62.2	69.8	77.4	82.8	81.1	75.6	66.5	54.4	46.0	64.2
Std. Dev.	3.0	2.5	2.3	3.4	2.5	2.5	2.2	2.1	2.7	2.6	2.0	3.0	0.8
Std. Error	0.5	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.5	0.4	0.3	0.5	0.1

[1] Average of temperature data from Bakersfield, Buttonwillow, and Wasco stations.

TABLE 12

Calculation of Blaney-Criddle F and K for Estimated Evaporation in the San Joaquin Valley 1958-1991

Month	Average t[1]	p[2]	Calculated f[3]	Ep[4]	k[5]	Adjusted k[6]
Jan	46.2	7.04	3.25	1.40	0.43	0.45
Feb	52.0	6.88	3.58	2.23	0.62	0.60
Mar	56.5	8.36	4.72	4.02	0.85	0.85
Apr	62.2	8.82	5.49	5.83	1.06	1.05
May	69.8	9.77	6.82	8.26	1.21	1.20
Jun	77.4	9.76	7.55	9.48	1.26	1.25
Jul	82.8	9.94	8.23	9.72	1.18	1.20
Aug	81.1	9.38	7.61	8.56	1.12	1.10
Sep	75.6	8.36	6.32	6.40	1.01	1.00
Oct	66.5	7.88	5.24	4.41	0.84	0.85
Nov	54.4	6.97	3.79	2.18	0.58	0.60
Dec	46.0	6.84	3.15	1.24	0.39	0.40
Mar-Oct	71.5	9.03	6.50	56.68	1.07	1.06
Jan-Dec	64.2	8.33	5.48	63.73	0.88	0.88

[1] Average air temperature for three USWB locations (Bakersfield airport, Buttonwillow, and Wasco) for 1958-1991 (Table 11).
[2] p = percent possible daylight hours for latitude 35 degrees north, Table 16, Soil Conservation Service Technical Paper 96, August 1950.
[3] f = (t x p) ÷ 100.
[4] Average measured evaporation, 1958-1991 (Table 6).
[5] k = monthly Ep ÷ f.
[6] Calculated k rounded to 0.05.

THE BLANEY-CRIDDLE EQUATION FOR ESTIMATING MONTHLY CROP CONSUMPTIVE USE IS:

$$u = k \times f$$

u = monthly consumptive use (in this case pan evaporation)

k = empirically derived coefficient

f = consumptive use factor – (t X p ÷ 100)

t = mean air temperature – (maximum + minimum) ÷ 2

p = percentage of possible daylight hours (Percentage possible daylight hours varies with latitude and is an index of incoming solar radiation.)

For this study, the Blaney-Criddle equation was used to estimate historic pan evaporation.

TABLE 13

Estimating Pan Evaporation in the San Joaquin Valley 1958-1991 (example for year 1922)

Month	t[1]	p[2]	f[3]	k[4]	Estimated Ep[5]
Jan	42.6	7.04	3.00	0.45	1.35
Feb	51.7	6.88	3.56	0.60	2.13
Mar	52.6	8.36	4.40	0.85	3.74
Apr	57.4	8.82	5.06	1.05	5.32
May	69.6	9.77	6.80	1.20	8.16
Jun	76.7	9.76	7.49	1.25	9.36
Jul	84.6	9.94	8.41	1.20	10.09
Aug	78.2	9.38	7.34	1.10	8.07
Sep	77.8	8.36	6.50	1.00	6.50
Oct	63.6	7.88	5.01	0.85	4.26
Nov	50.7	6.97	3.53	0.60	2.12
Dec	51.2	6.84	3.50	0.40	1.40
Mar-Oct	70.1	9.03	6.38	1.06	55.50
Jan-Dec	63.1	8.33	5.38	0.88	62.50

[1] Average air temperature for three USWB locations for 1922.

[2] p = percent possible daylight hours for Lat 35 degrees N from Table 16.

[3] Calculated consumptive use factor, (t x p) ÷ 100

[4] Monthly coefficient for evaporation from pasture pan.

[5] Estimated evaporation from Class 'A' pan located in irrigated pasture in inches.

Monthly k's were developed from the 1958 to 1991 pan evaporation measured at agroclimate stations near Bakersfield (Table 6). Air temperatures used were the average of those measured by USWB at three dryland stations: Bakersfield, Buttonwillow, and Wasco (Table 11). It is important that temperatures from dryland locations be used in developing the monthly k's to assure they are compatible with the historic temperatures measured at dryland sites. The effect of station environment on measured air temperature is discussed in the section on air temperatures in this report.

TABLE 14

Average Monthly Air Tenperatures for Three U.S. Weather Bureau Stations in the Southern San Joaquin Valley 1922-1958[1] (degrees fahrenheit)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1922	42.6	51.7	52.6	57.4	69.6	76.7	84.6	78.2	77.8	63.6	50.7	51.2	63.1
1923	46.2	50.6	57.2	60.2	68.2	69.7	80.2	79.2	76.0	63.2	56.8	45.3	62.7
1924	47.2	56.7	54.4	61.8	73.6	78.2	82.2	80.2	75.6	61.9	55.1	46.8	64.5
1925	48.3	56.2	58.2	62.2	71.0	78.0	85.0	80.4	71.1	64.0	55.2	48.3	64.8
1926	44.2	56.1	62.5	67.9	71.2	81.8	84.2	80.8	71.6	66.6	61.0	46.6	66.2
1927	49.6	53.0	54.1	61.5	67.8	76.6	83.8	80.0	69.4	66.6	54.6	48.4	63.8
1928	46.4	54.0	60.8	63.1	73.2	76.8	83.0	82.2	76.4	64.4	54.0	44.4	64.9
1929	43.0	47.4	54.6	57.6	70.9	76.1	83.3	82.9	74.4	68.1	54.3	48.5	63.4
1930	46.6	55.0	57.3	64.6	65.3	80.2	84.2	81.2	70.7	64.2	54.4	42.5	63.9
1931	47.6	52.8	57.2	66.1	74.0	75.1	89.5	85.3	73.4	64.7	51.9	46.8	65.4
1932	43.3	48.5	55.7	58.9	69.0	77.4	82.1	80.8	77.4	64.1	57.3	44.0	63.2
1933	42.1	46.4	54.8	60.9	63.3	75.1	87.6	84.1	72.2	71.5	57.6	49.1	63.7
1934	44.3	52.4	63.2	68.0	70.9	73.8	84.2	84.2	77.2	66.7	55.7	47.5	65.7
1935	46.4	50.1	51.3	61.4	69.1	80.6	82.5	84.1	78.6	63.2	50.1	48.1	63.8
1936	49.9	51.2	57.8	63.7	70.9	77.3	85.7	83.8	77.0	64.1	53.7	44.9	65.0
1937	39.3	48.5	53.0	57.0	69.7	76.8	85.5	82.4	74.9	67.4	57.3	50.7	63.5
1938	46.9	52.0	52.9	62.5	70.9	79.7	85.3	82.7	78.3	65.0	54.3	51.0	65.1
1939	48.3	47.9	57.3	66.2	70.6	78.0	83.5	84.7	76.9	66.0	58.0	51.8	65.8
1940	51.6	54.8	58.8	63.7	73.0	81.9	81.9	81.0	71.9	66.9	53.8	53.8	66.1
1941	49.8	53.5	57.5	59.0	70.4	72.5	84.4	78.5	71.1	61.7	56.2	52.0	63.9
1942	49.2	50.6	55.6	60.4	66.2	76.7	84.7	83.0	74.3	67.3	55.6	46.9	64.2
1943	47.4	52.7	57.5	62.0	70.3	72.7	82.5	79.4	79.0	67.4	57.5	50.1	64.9
1944	48.0	49.2	55.6	60.7	70.7	72.5	82.4	80.2	77.8	67.6	54.3	48.6	64.0
1945	44.1	51.2	52.6	61.8	67.6	77.6	87.8	82.0	78.3	67.8	55.2	55.3	65.1
1946	45.1	49.5	55.8	64.0	69.0	75.0	83.5	83.1	76.3	62.0	51.4	45.8	63.4
1947	40.6	52.1	59.7	65.8	74.8	77.4	79.8	77.8	77.9	66.2	50.6	45.4	64.0
1948	50.3	48.7	53.7	61.7	66.1	76.4	81.2	77.6	74.8	65.6	52.2	44.6	62.7
1949	39.0	47.0	55.3	66.1	69.2	78.5	82.4	77.8	77.0	63.1	59.1	45.4	63.3
1950	43.9	52.9	55.6	64.7	70.2	75.6	85.4	81.6	74.4	67.5	58.9	51.8	65.2
1951	46.9	51.4	56.2	63.4	70.4	77.6	82.3	80.5	77.0	63.9	55.1	45.7	64.2
1952	45.3	51.0	51.6	62.0	72.1	71.6	83.7	80.8	76.2	69.1	51.9	47.3	63.6
1953	49.8	49.2	55.5	61.1	64.0	72.0	84.9	77.8	76.8	63.7	55.3	45.6	63.0
1954	46.8	50.5	54.2	65.8	72.0	74.1	83.8	76.7	73.2	64.7	52.8	44.7	63.3
1955	43.0	48.2	55.5	57.7	68.4	75.0	78.8	82.6	76.2	66.5	52.0	50.6	62.9
1956	49.6	46.0	56.0	61.3	69.4	76.8	81.7	77.8	76.0	62.9	53.5	44.4	63.0
1957	42.8	54.2	57.4	63.0	67.5	80.1	82.6	79.0	76.0	63.7	53.1	46.1	63.8
1958	46.6	55.5	53.1										
Average	46.0	51.3	56.0	62.4	69.7	76.4	83.6	81.0	75.4	65.4	54.7	47.8	64.1
Std. Dev.	3.1	2.8	2.7	2.9	2.6	2.9	2.2	2.3	2.5	2.2	2.6	3.0	1.0
Std. Error	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.2

[1] Average of temperature data from Bakersfield station 1922-1958, Buttonwillow station 1948-1958, and Wasco station 1929-1958.

TABLE 15

Estimated Historic Class 'A' Pan Evaporation for Agroclimate Stations in the San Joaquin Valley 1922-1958[1] (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mar-Oct Total	Jan-Dec Total
1922	1.35	2.13	3.74	5.32	8.16	9.36	10.09	8.07	6.50	4.26	2.12	1.40	55.50	62.50
1923	1.46	2.09	4.06	5.58	8.00	8.50	9.57	8.17	6.35	4.23	2.38	1.24	54.46	61.63
1924	1.50	2.34	3.87	5.72	8.63	9.54	9.80	8.28	6.32	4.15	2.35	1.28	56.31	63.78
1925	1.53	2.32	4.14	5.76	8.32	9.52	10.14	8.30	5.94	4.29	2.35	1.32	56.41	63.93
1926	1.40	2.32	4.44	6.29	8.35	9.98	10.04	8.34	5.99	4.46	2.55	1.27	57.89	65.43
1927	1.57	2.19	3.84	5.70	7.95	9.35	10.00	8.25	5.80	4.46	2.28	1.32	55.35	62.71
1928	1.47	2.23	4.32	5.84	8.58	9.37	9.90	8.48	6.39	4.31	2.26	1.21	57.19	64.36
1929	1.36	1.96	3.88	5.33	8.31	9.28	9.94	8.55	6.22	4.56	2.27	1.33	56.07	62.99
1930	1.48	2.27	4.07	5.98	7.66	9.78	10.04	8.38	5.91	4.30	2.28	1.16	56.12	63.31
1931	1.51	2.18	4.06	6.12	8.68	9.16	10.68	8.80	6.14	4.33	2.17	1.28	57.97	65.11
1932	1.37	2.00	4.03	5.45	8.09	9.44	9.79	8.34	6.47	4.29	2.40	1.20	55.90	62.87
1933	1.33	1.92	3.89	5.64	7.42	9.16	10.45	8.68	6.04	4.79	2.41	1.34	56.07	63.07
1934	1.40	2.16	4.49	6.30	8.31	9.00	10.04	8.69	6.45	4.47	2.37	1.30	57.75	64.98
1935	1.47	2.07	3.65	5.69	8.10	9.83	9.84	8.68	6.57	4.23	2.10	1.32	56.59	63.55
1936	1.58	2.11	4.11	5.90	8.31	9.43	10.22	8.65	6.44	4.29	2.25	1.23	57.35	64.52
1937	1.25	2.00	3.77	5.28	8.17	9.37	10.20	8.50	6.26	4.51	2.40	1.39	56.06	63.10
1938	1.49	2.15	3.76	5.79	8.31	9.72	10.17	8.53	6.55	4.35	2.27	1.40	57.18	64.49
1939	1.53	1.98	4.07	6.13	8.28	9.52	9.96	8.74	6.43	4.42	2.43	1.42	57.55	64.91
1940	1.63	2.26	4.18	5.90	8.56	9.99	9.77	8.36	6.01	4.48	2.25	1.47	57.25	64.86
1941	1.58	2.21	4.09	5.46	8.25	8.84	10.07	8.10	5.94	4.13	2.35	1.42	54.88	62.44
1942	1.56	2.09	4.02	5.59	7.76	9.36	10.10	8.56	6.21	4.51	2.33	1.28	56.11	63.37
1943	1.50	2.18	4.09	5.74	8.24	8.87	9.84	8.19	6.60	4.51	2.40	1.37	56.08	63.53
1944	1.52	2.03	3.95	5.62	8.29	8.84	9.83	8.28	6.50	4.53	2.27	1.33	55.84	62.99
1945	1.40	2.11	3.74	5.72	7.93	9.47	10.47	8.46	6.55	4.54	2.35	1.51	56.88	64.25
1946	1.43	2.04	3.97	5.93	8.09	9.15	9.96	8.57	6.38	4.15	2.15	1.25	56.20	63.07
1947	1.29	2.15	4.24	6.09	8.77	9.44	9.52	8.03	6.51	4.43	2.12	1.24	57.03	63.83
1948	1.59	2.01	3.82	5.71	7.75	9.56	9.69	8.01	6.25	4.39	2.18	1.22	55.18	62.18
1949	1.24	1.94	4.00	6.12	8.11	9.58	9.83	8.03	6.44	4.23	2.47	1.24	56.34	63.23
1950	1.39	2.18	3.95	5.99	8.23	9.22	10.19	8.42	6.22	4.52	2.46	1.42	56.74	64.19
1951	1.49	2.12	3.99	5.87	8.25	9.47	9.82	8.31	6.44	4.28	2.30	1.25	56.43	63.59
1952	1.44	2.11	3.67	5.74	8.45	8.74	9.98	8.34	6.37	4.63	2.17	1.29	55.92	62.93
1953	1.58	2.03	4.01	5.66	7.50	8.78	10.13	8.03	6.42	4.27	2.35	1.25	54.80	62.01
1954	1.48	2.08	3.85	6.09	8.44	9.04	10.00	7.91	6.12	4.33	2.21	1.22	55.78	62.77
1955	1.36	1.99	3.94	5.34	8.02	9.15	9.40	8.52	6.37	4.45	2.17	1.38	55.19	62.09
1956	1.57	1.90	3.98	5.68	8.14	9.37	9.75	8.03	6.35	4.21	2.24	1.21	55.51	62.43
1957	1.36	2.24	4.08	5.83	7.91	9.77	9.85	8.15	6.35	4.27	2.22	1.26	56.21	63.29
1958	1.48	2.29	3.77											
Average	1.46	2.12	3.99	5.78	8.18	9.33	9.97	8.35	6.30	4.38	2.30	1.31	56.28	63.45
Std. Dev.	0.10	0.12	0.19	0.27	0.31	0.35	0.26	0.24	0.21	0.15	0.11	0.08	0.88	0.96
Std. Error	0.02	0.02	0.03	0.04	0.05	0.06	0.04	0.04	0.04	0.02	0.02	0.01	0.15	0.16

[1] Estimates calculated from temperature data using Blaney-Criddle equation.