RESEARCH TECHNICAL COMPLETION REPORT

Estimating Consumptive Irrigation Requirements for Crops in Idaho

by

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Submitted to
Idaho Department of Water Resources
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ABSTRACT

Four consumptive use methods presented by the United Nations Food and Agricultural Organization (FAO) (Doorenbos and Pruitt, 1977) and the Jensen-Haise, SCS-modified Blaney-Criddle, standard Penman and Wright-modified Penman (Wright, 1982a) methods were compared using daily weather data from the USDA-ARS Snake River Conservation Research Center at Kimberly, Idaho. The FAO-modified Blaney-Criddle (FAO-BC) method was selected as the best method for estimating consumptive use on a statewide basis, based on accuracy and responsiveness of the equation and the primary data requirement of air temperature, only. An additional benefit of using the single parameter FAO-BC method is that it can be used as a multiple-parameter method where measured values of wind, humidity and solar radiation are available. A ten percent upward adjustment to FAO-BC estimates per 1000 meters elevation suggested by Pruitt (Doorenbos and Pruitt, 1977) was found to be necessary. Alfalfa/FAO-BC reference ratios developed using Kimberly data were found to be transferrable to other Idaho sites.

NOAA weather stations throughout Idaho were objectively rated according to the degree of station aridity and environmental effects on air temperatures. Mean monthly temperatures at each NOAA site were adjusted downward according to the station aridity rating and maximum aridity effects reported by Allen (1983) for Idaho. Monthly statistics were computed for consumptive use estimated for 98 weather sites in Idaho using the calibrated FAO-BC with elevation correction and alfalfa/FAO-BC reference ratios.

Acknowledgements

Adaption and calibration of the FAO-Blaney-Criddle consumptive use method for use in Idaho and calculation of good estimates of consumptive use was made possible by the extensive evapotranspiration research program directed by Dr. James L. Wright, USDA-ARS, at Kimberly. Dr. Wright's research has included precision measurement and interpretation of weather and crop water use over an eighteen year period at Kimberly. Results of his work include development of a combination-energy evapotranspiration method (Wright-1982), presentation of alfalfa-based crop coefficients for Idaho, and refinement of irrigation scheduling methods. The Wright-1982 method and crop coefficients are recognized world wide.

Mr. Joe M. Erpenbeck, formerly with the Agricultural Engineering Department, Washington State Univeristy, provided support and advice to this project. Mr. John L. Stevens, USDA-ARS, provided Kimberly weather data and computer system access.

Mr. Monte McVey, United States Bureau of Reclamation, Boise, provided weather data for Rexburg, Rupert, Aberdeen and Wilder, Idaho. Dr. L. Thomson, Rick's College, Rexburg, provided daily weather data for Rexburg, Idaho. Dr. Myron Molnau, Department of Agricultural Engineering, University of Idaho, furnished computer tapes of all National Weather Service data for Idaho. Mr. William Galkin, National Weather Service, Kimberly, furnished local weather information.

Mr. Randy Kolar and Miss Julie Kruegar assisted in computer operation and data reduction. The Snake River Conservation Research Center, Kimberly, Idaho, provided office space and computer facilities.

CHAPTER I

INTRODUCTION

Good estimates of consumptive use and irrigation requirements by agricultural crops are important in planning, design and operation of irrigation and drainage systems and for evaluation and management of hydrologic systems. Decisions concerning sizing of reservoirs, canals, pipelines, pumping systems and farm application systems require knowledge of timing, volume and variation of irrigation requirements. Knowledge of irrigation requirements is necessary in choosing economic cropping patterns, for operating farm application systems effectively and for estimating labor, capital, and energy requirements and irrigation efficiencies.

State and federal water resources agencies have need of irrigation requirements and consumptive use estimates for use in evaluating stream flow depletion by current and proposed irrigation development and for review and litigation of water rights applications and disputes. The Idaho Department of Water Resources is responsible for review and processing of irrigation development proposals under the Carey Act and the Bureau of Land Management, USDI, is responsible for Desert Land Act irrigation development.

Knowledge of minimum levels of consumptive use are needed by designers of systems for land application of effluent from waste water treatment plants to prevent hydraulic overloading of soil systems.

Definition of Terms

Consumptive Use. (CU). The amount of water transpired by an actively growing or photosynthesizing plant plus water evaporated from soil and foliage in the area occupied by the growing plant. This term is synonomous with evapotranspiration and is usually expressed in units of length per unit of time.

Effective Rainfall. (ER). Rainfall which contributes toward meeting the CU requirement of a crop. Effective rainfall includes that precipitation which does not leave as surface runoff nor contributes to subsurface drainage. Effective Rainfall is expressed in units of length per unit of time.

Consumptive Irrigation Requirement. (CIR). The depth of irrigation water, exclusive of within-season effective rainfall, required to meet the CU requirement of a crop. This term may include contributions from stored soil moisture or groundwater and is expressed in units of length per unit of time.

Irrigation Efficiency. (IE). The percentage of diverted irrigation water that is stored in the soil and available for consumptive use by the crop. This efficiency reflects losses due to canal and reservoir seepage and evaporation, operational spills, pipe leaks, wind drift from sprinkler irrigated fields, excess or nonuniform irrigation application and surface runoff.

Irrigation Requirement. (IR). The amount of water required to be diverted to the irrigation system per unit of time to meet the consumptive irrigation requirement and leaching requirement. The irrigation requirement is calculated by dividing the CIR less carryover soil moisture and groundwater contribution and plus leaching requirement by the irrigation efficiency. Irrigation requirement is expressed in units of length per unit of time or units of volume per unit area per unit of time.

Carryover Soil Moisture. (CM). Moisture stored in soils within rooting depths during winter, at times when the crop is dormant, or before the crop is planted. This moisture is available to help meet the consumptive use needs of the crop and can be expressed in units of length per unit of time or units of volume per unit area per unit of time.

Previous Studies

The importance of consumptive irrigation requirements for Idaho has long been appreciated. The Idaho Code (1948,1969) states that no permit shall authorize the diversion for irrigation purposes of more than 1 second-foot for each 50 acres of land, or more than 5 acre-feet of stored water per acre per annum, unless the administrator finds a greater quantity to be necessary. One second-foot per 50 acres is equivalent to 1.2 acre-feet per acre per month.

Blaney and Criddle (1950) presented a temperature-based method for determining consumptive use in irrigated areas which was used in Idaho to determine irrigation requirements by Jensen and Blaney (1952). Later, the Soil Conservation Service (1967a) published an irrigation guide for southern and southeastern Idaho based on a modified version of the original Blaney-Criddle method. Sutter and Corey (1970) extended application of the SCS-modified Blaney-Criddle equation (Soil Conservation Service, 1967b) to all major agricultural areas within Idaho. Consumptive use and consumptive irrigation requirements by crop were estimated for 42 weather sites in Idaho. The publication by Sutter and Corey was published as University of Idaho College of Agriculture Bulletin 516.

Jensen et al (1971) presented procedures for estimating consumptive requirements and irrigation schedules using methods developed at the USDA Snake River Conservation Research Center at Kimberly, Idaho. Work at Kimberly has included measurement of consumptive use with weighing lysimeters, adaption of a combination-type method to estimate evapotranspiration and development of crop coefficients for southern Idaho crops. Research on consumptive use at Kimberly has been reported by Wright and Jensen (1972;1978), Jensen and Wright (1978), Wright (1979;1981a;1982a), and by Burman et al (1980).

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It has been shown by Pelton et al (1959) that mean air temperature, as used in the SCS-Blaney Criddle method, may not be a suitable predictor of evapotranspiration by itself. They stated that limited success in application of a temperature ET method necessitated regional adjustment to establish a mutual correlation between solar radiation, ET and air temperature for a particular crop surface within a particular locale, and in part to adjust for thermal lag and general advective conditions. Pruitt (1960; Pruitt and Jensen, 1955) found the Blaney-Criddle method to underestimate lysimeter measurements of Ladino clover at Prosser, Washington unless a calibrated variable "K" factor was used.

In a comparison of consumptive use methods reported by Jensen (1974), the SCS-modified Blaney Criddle consistantly underestimated monthly consumptive use for alfalfa at ten international sites. Underestimation was greatest at arid locations. The study concluded that the Blaney-Criddle method appears to require local or regional coefficients to produce reliable results. It should be noted that comparisons of monthly consumptive use were made between the Blaney-Criddle with an alfalfa hay coefficient and an alfalfa reference (uncut alfalfa). When adjustments are made to the alfalfa reference to reflect three cuttings of hay, the difference between the reference (lysimeter) and Blaney-Criddle is reduced by about 50 percent. However, the Blaney-Criddle does still underestimate, even with this correction as is discussed in subsequent sections of this report. Pennington (1980) compared the SCS-modified Blaney-Criddle to lysimeter measurements of alfalfa hay at seven sites in Nevada. Seasonal estimates by the Blaney Criddle averaged 30 percent low.

Erpenbeck (1981; James and Erpenbeck, 1981) compared twenty-three consumptive use methods at Prosser, Washington against lysimeter and gravimetric data. He found the original Blaney-Criddle method to average 16 percent low and the SCS-modified Blaney-Criddle to average 28 percent low for the period 1954 through 1962.

The SCS-modified Blaney-Criddle has been noted to underestimate consumptive use for alfalfa hay, winter and spring grain and corn at Kimberly (Freeman et al, 1981).

Because consumptive use estimates in Bulletin 516 were calculated using the SCS-modified Blaney-Criddle, and because the SCS-modified Blaney-Criddle method has been found to underestimate consumptive use, this study was initiated to evaluate recent advances in consumptive use estimating procedures to determine if better procedures are available and to apply a selected and validated procedure to weather stations in Idaho.

CHAPTER II

ESTIMATING CONSUMPTIVE USE IN ARID ENVIRONMENTS

Potential ET, reference ET and pan evaporation all represent standards on which crop ET can be based. These three ET standards attempt to incorporate most climatic factors influencing crop ET within the standard itself, thereby allowing ET of specific crops to be calculated by multiplying the standard by a coefficient reflecting physiological variations. There is much discussion in the literature defining the standards and dictating their use.

Potential Evapotranspiration

Burman et al (1980) have defined potential evapotranspiration as the rate at which water, if available, would be removed from the soil and plant surface. This term is expressed as the latent heat transfer per unit area or its equivalent depth of water. Van Bavel (1966) noted that evapotranspiration is at potential only when the vapor pressure at the evaporating surface is at the saturation point and adequate mixing of air exists.

Because of the difficulty of attaining and verifying true potential evapotranspiration in field studies, Penman (1948) used clipped grass to represent potential ET. Jensen (1974) represented potential ET with a well-watered alfalfa crop 30 to 50 cm tall to provide adequate mixing of air. Doorenbos and Pruitt (1977) suggested using an extensive surface of 8 to 15 cm tall green grass cover to estimate potential ET. Because of ambiguities involved in interpretation of the concept of potential evapotranspiration and calibration of equations to estimate potential ET, the term "reference evapotranspiration" has been used instead.

Reference Evapotranspiration

The use of the term reference evapotranspiration to define a standard or potential against which ET by crops can be compared has value in that ET by the reference crop can be readily measured and duplicated between locations and climates for local calibration of reference ET methods. There has been debate, however, on what type of crop to use as a reference. Doorenbos and Pruitt (1977) defined reference ET as "the rate of evapotranspiration from an extensive surface of 8 to 15 cm, green grass cover of uniform height, actively growing, completely shading the ground, and not short of water." Jensen et al (1970) proposed that reference ET be defined as "the upper limit or maximum evapotranspiration that occurs under given climatic conditions with a field having a well-watered agricultural crop with an aerodynamically rough surface, such as alfalfa with 30 to 45 cm of top growth."

Erpenbeck (1980) listed reasons for selection of alfalfa as an ET reference, with the primary reason being that alfalfa is more like other agricultural crops than is grass. Since advection is a common occurrence in irrigated areas and its affect on ET depends on crop roughness, it is best to use a reference with a height and roughness similar to most crops. Alfalfa provides sufficient canopy thickness to absorb solar radiation above the ground surface so that the measured reference ET is not influenced by soil conditions. Alfalfa also has low leaf resistance to water vapor diffusion and a large root system, especially compared to grass, which minimizes the effects of high climatic demands and decreasing soil moisture on the reference ET.

Evapotranspiration for agricultural crops is commonly computed with either grass or alfalfa references by multiplying the reference by a simple coefficient which varies with time according to crop type and growth stage. Crop coefficients have been developed for a grass reference by Pruitt (Doorenbos and Pruitt, 1977; Burman et al, 1980) at Davis, California, and for an alfalfa reference by Wright (Wright, 1979; 1981a; 1982a; Burman et al, 1980) at Kimberly, Idaho.

Conversion of coefficients from a grass reference to an alfalfa reference or vice versa is difficult, as no true linearity between the references exists with time, location and climate (Doorenbos and Pruitt, 1977, p 45; Erpenbeck, 1980, p 104).

One benefit of basing crop coefficients on a specific reference is that the coefficients are made independent of the type of method used to estimate that reference. In other words, a reference value can be measured or calculated with a temperature method, a combination method, a radiation method, pan evaporation, or other method, as long as the particular method is calibrated to accurately predict the reference crop selected. This premise was followed by Doorenbos and Pruitt (1977) by presenting four different methods to estimate reference ET with selection of method based according to available weather information. All methods use the same set of crop coefficients.

CHAPTER III

METHODS CONSIDERED FOR REVISION OF BULLETIN 516

During 1982, 158 weather stations throughout Idaho reported daily weather measurements to the National Oceanic and Atmospheric Administration (NOAA, 1982). Of these 158, only nine report pan evaporation and only three report radiation, humidity and wind speed information. However, air temperature and precipitation data were reported by all stations.

Lack of solar radiation, humidity and wind run data at more than three sites in Idaho precludes the use of consumptive use methods requiring this type of information, leaving only temperature based methods as being applicable.

Doorenbos and Pruitt (1977) presented a temperature based method (FAO-Blaney-Criddle) which is self-calibrated according to climate and elevation. Coefficients are presented which adjust the estimated consumptive use depending on the average humidity, windspeed and radiation of the site. The average climatic values of minimum humidity, windspeed and radiation used for adjustment should be as representative of the site as possible. If no values are available, they can be estimated (Doorenbos and Pruitt, 1977). Sensitivity of the FAO-Blaney-Criddle (FAO-BC) to the three climatic parameters is discussed in a subsequent section.

The SCS-modified Blaney Criddle (SCS-BC) and FAO-BC temperature methods were selected during this study for comparison with consumptive use measurements and estimates at four sites in Idaho. The FAO radiation, Penman and corrected Penman methods (Doorenbos and Pruitt, 1977) were also compared to estimated ET at the sites.

Comparative Procedure

The SCS-BC and FAO Blaney-Criddle, Radiation, Penman and corrected Penman methods were evaluated using daily weather data from the USDA-ARS research center at Kimberly, Idaho (Twin Falls WSO). The Kimberly site was selected because of the availability of solar radiation, relative humidity (dew point temperature) daily wind run, hourly wind speed, and air temperature data in an agricultural setting. The Kimberly site also includes two weighing lysimeters (Wright and Jensen, 1978) and data from this site were used to develop a combination ET method (Wright, 1982a; Burman et al, 1980) which can be used to represent the lysimeter measurements (Jensen, 1974). The importance of using data from an irrigated, agricultural setting was demonstrated by Allen (1983) and is discussed in this report.

The adaquacy of method estimation at Kimberly was judged by how well the estimate compared to an alfalfa reference as calculated using the Penman-type combination method and application procedure developed by Wright (1982a), hereafter refered to as Wright-1982. The Wright-1982 method was calibrated to daily lysimeter measurements of evapotranspiration by alfalfa at Kimberly, Idaho by Wright, and has been used in many areas of the world as part of the USDA-ARS irrigation scheduling program (Wright and Jensen, 1978; Jensen and Wright, 1978). This combination equation includes a wind function of the form (a_w+b_w (u)) where a_w and b_w are coefficients which vary with time of season according to polynomial equations presented by Wright (1982a; Burman et al, 1980). The term u is the daily wind travel (km/d) at 2 meters. The Wright - 1982 method is described in detail in Appendix A.

Monthly and daily values of reference ET were calculated by seven different ET methods using a modification of the Fortran computer program presented by Doorenbos and Pruitt (1977). This program, entitled FAO24, includes estimating procedures for the FAO Blaney-Criddle (FAO-BC), FAO Radiation (FAO-RAD), FAO Penman (FAO-PEN) FAO-corrected Penman (FAO-CPEN) and the FAO pan evaporation (FAO-PAN) methods as originally presented by Doorenbos and Pruitt (1977). Procedures for estimating the SCS modified Blaney-Criddle (SCS, 1967b) were included into the routine by Pennington (1980) at the University of Nevada, Reno.

The FAO24 routine was revised during this study to include procedures for estimating reference ET using the Jensen-Haise method (Jensen, 1974), the Penman method as reported and applied by Jensen (1974) and the Wright-1982 method. Revisions to the routine during this study also included modification to allow calculating the FAO Blaney-Criddle using 1) daily values of humidity, wind, solar radiation and temperature; 2) monthly averages of humidity, wind, solar radiation and temperature; and 3) monthly values of humidity, wind, and solar radiation averaged over the period of weather record and monthly values of air temperature. Other modifications to the FAO24 program were incorporation of an elevation correction for the FAO-BC consisting of a 10% increase in the ET estimate per 1000 meters above sea level (Doorenbos and Pruitt, 1977), correction of the equation for calculating air pressure, and calculation of reference ratios for each method.

Reference ratios, calculated as reference ET estimated by Wright-1982 divided by reference ET estimated by the other methods, were used to indicate the relative goodness of fit of each method to Kimberly reference ET. A brief description of each consumptive use method included in the FAO24 program is included in the Appendix A of this report.

Results of Method Comparison

The FAO24 program was operated using a fourteen year period of weather from 1965-1978 collected at Kimberly. Reference ET for a grass reference (ET_o) was calculated with the FAO methods using both daily data and monthly averages. Very small differences were found between monthly values of ET_o calculated with daily data and with monthly data for all fourteen years as shown in Table I for the FAO-Blaney-Criddle method. This result is significant in that the FAO-BC method can be used to estimate monthly consumptive use for weather sites throughout Idaho using monthly values of humidity, wind, solar radiation and temperature, rather than daily values, with very little error. Averaging of daily data has no effect on the monthly estimate due to linearity of the FAO-BC method and linearity of procedures for calculating the coefficients used to adjust the FAO-BC estimate (Doorenbos and Pruitt, 1977). The percent daylight hours term used in the FAO-BC procedure is nonlinear; however, the effect of averaging over a month has little effect. The FAO-BC method is described in Appendix A.

Monthly consumptive use at Kimberly was also computed using the FAO-BC with monthly mean air temperature data, but with monthly values

Table 1. Average monthly values of ETo calculated using the FAO-BC method with daily and monthly weather data at Kimberly, 1966-1978.

	Grass reference ETo, mm/day						
	April	May	June	July	August	September	October
Daily*	3.50	5.46	6.99	7.94	6.81	4.76	2.67
Monthly**	3.52	5.44	6.94	7.93	6.81	4.73	2.63

*Daily values for mean air temperature, solar radiation, daytime wind speed, and relative humidity.

**Monthly averages of mean air temperature, solar radiation, daytime wind speed, and relative humidity.

for humidity, wind and solar radiation averaged over the fourteen year period of record (long term). This computation simulated application of the FAO-BC to sites where only long term averages or estimates of humidity, wind and solar radiation are available. Results are included in Table 2. Table 2 also includes monthly averages for ET_o (grass), ET_r (alfalfa), and alfalfa hay ET, and standard deviations for the period of record as estimated by the various equations.

Table 2 shows that the standard deviations (measure of variance) of estimates by the FAO-BC with short-term (monthly) weather are similar to deviations of ET_r estimated using Wright-1982. However, standard deviations of monthly estimates by the FAO-BC using long-term (14 year average) monthly values for humidity, windspeed and solar radiation (percent sunshine hours) and actual monthly mean air temperature averaged about 60 percent of those for ET_r estimates using Wright-1982. This result is due to the reduction of variables in the FAO-BC from 4 (temperature, humidity, wind, solar radiation) to 1 (temperature). Therefore, variation in the estimates is likely to be reduced, which is the case. However, mean values of consumptive use are unaffected by averaging the secondary weather parameters (humidity, wind, solar radiation) due to linearity of the FAO-BC method. Reduction in variance of estimates by the long term FAO-BC is also shown in Figure I. Each point in this figure represents the monthly consumptive use estimate for one year of record. A more complete comparison of statistics generated from estimates using the FAO-BC, SCS-BC and Wright-1982 methods and lysimeter measurements of consumptive use has been described by Allen and Wright (1983).

Standard deviations of monthly alfalfa ET estimated using the

Table 2. Average monthly values of ET_o and ET_r calculated using FAO methods, Wright-1982, and the SCS-Blaney-Criddle at Kimberly, Idaho, 1965-78.

		April	May	June	July	August	Sept.	Oct.
		Grass Reference ET_o, mm/day						
FAO-BC	Mean*	3.52	5.44	6.94	7.94	6.81	4.73	2.63
short term	Std Dev	.78	.80	.76	.39	.79	.62	.42
FAO-BC	Mean**	3.46	5.44	7.07	8.03	6.79	4.73	2.63
long term	Std Dev	.38	.39	.30	.22	.40	.41	.23
FAO-Radiation	Mean	4.10	5.80	6.77	7.36	6.18	4.48	2.63
	Std Dev	.76	.70	.67	.39	.64	.50	.31
FAO-Penman	Mean	4.55	5.86	6.62	6.89	5.99	4.57	2.98
	Std Dev	.73	.55	.61	.33	.57	.44	.27
FAO-Ct. Penman	Mean	4.48	6.10	7.09	7.51	6.41	4.58	2.77
	Std Dev	.76	.61	.65	.33	.58	.44	.28
		Alfalfa Reference ET_r, mm/day						
Wright-1982	Mean	4.20	6.21	7.54	7.99	6.84	5.12	3.19
	Std Dev	.70	.65	.75	.42	.69	.54	.31
		SCS-Blaney-Criddle alfalfa hay ET, mm/day						
SCS-Blaney-Cr.	Mean	1.62	3.13	4.79	5.82	4.79	2.85	1.42
	Std Dev	.30	.39	.38	.29	.48	.39	.16
Wright-1982	Mean	2.60	5.78	6.64	6.47	5.20	3.48	1.15
	Std Dev	.43	.60	.66	.34	.52	.37	.11

* Using monthly mean air temperature and monthly mean minimum relative humidity, daytime windspeed, and percent sunshine hours.

** Using monthly mean air temperature and long term (14 year) average monthly relative humidity, daytime windspeed, and percent sunshine hours.

FAO-BC calculations include a 10% upward adjustment per 1000 meters elev.

SCS-modified Blaney-Criddle (SCS-BC) are similar to those estimated using the FAO-BC with long-term secondary data (Table 2). This indicates that variation in monthly estimates of consumptive use by methods using temperature as the only variable is likely to be underestimated. This phenomena must be recognized when calculating frequency analyses of consumptive use data in order to obtain meaningful and accurate results. Allen and Wright (1983) suggested multiplying monthly standard deviations of estimates calculated using the FAO-BC method with long-term secondary data by 1.70, 1.64, 2.70, 2.22, 2.13, 1.61 and 1.35 for the months April through October, respectively. These multipliers were calculated by making comparisons with lysimeter measurements of full-cover alfalfa evapotranspiration at Kimberly, Idaho. Standard deviations of seasonal (April-October) estimates using the FAO-BC with long-term data should be multiplied by 2.3. This value was calculated by dividing the standard deviation of seasonal ET_r estimated using the FAO-BC with short-term secondary data (71 mm) by the standard deviation of seasonal ET_r estimated using the FAO-BC with long-term data secondary data (30 mm). The standard deviation of seasonal ET_r estimated using Wright-1982 was 63 mm, which is probably about 15% low, based on monthly comparisons of standard deviations made by Allen and Wright (1983).

As is shown in Table 2 and in Figure 1, the SCS-BC clearly underestimates monthly consumptive use for alfalfa hay at Kimberly as compared to hay ET estimated by Wright-1982. Alfalfa hay ET as estimated by Wright-1982 is for a well-watered, actively growing, disease free, adequately fertilized alfalfa crop with no lodging effects (Wright, 1982b).

The FAO radiation, Penman and corrected Penman methods compare well with Wright-1982 at Kimberly (Figure 1 and Table 2). Grass reference ET_o should be about 85 percent of alfalfa reference ET_r for FAO equations applied at sites with climates similar to Kimberly (Doorenbos and Pruitt, 1977). Comparisons of the FAO, SCS and Wright methods at weather sites near Wilder, Aberdeen and Rexburg are included in Appendix B.

FAO Method Calibration

Reference ratios indicating the average relative comparison of a particular method to the Wright-1982 method were calculated for FAO methods by dividing ET_r estimated using the Wright-1982 method by ET_o estimated using the FAO method. Monthly reference ratios were calculated as:

$$RR_i = ET_{ri} / ET_{oi} \qquad (1)$$

where RR_i is the reference ratio for month i, ET_{ri} is the calculated alfalfa reference for month i using Wright-1982, and ET_{oi} is the calculated grass reference for month i using an FAO method.

Reference ratios were calculated for the FAO Blaney-Criddle, Radiation, Penman and corrected Penman methods. Calculated monthly reference ratios for Kimberly using 14 years of data are listed in Table 3. The ratios are used to convert grass reference as estimated by the specific FAO method to an alfalfa reference at Kimberly. These ratios incorporate a calibration of the FAO-method to Kimberly conditions, besides a conversion from grass to alfalfa. They should not be used to

Table 3. Calculated alfalfa/grass reference ratios for FAO methods at Kimberly, Idaho, and published alfalfa/grass reference ratios.

Reference Ratio	April	May	June	July	August	September	October
FAO-BC*	1.21	1.15	1.09	1.01	1.00	1.09	1.22
FAO-RAD	1.03	1.07	1.11	1.09	1.11	1.14	1.21
FAO-PEN	0.92	1.06	1.14	1.16	1.14	1.19	1.07
FAO-CPEN	0.96	1.04	1.09	1.08	1.08	1.13	1.16
Alfalfa/ grass**	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Alfalfa/ grass***	1.25	1.22	1.21	1.21	1.21	1.23	1.27

*FAO-Blaney-Criddle with an elevation correction of 10% increase per 1000 meters of elevation.

**from Table 23, Doorenbos and Pruitt (1977), for a dry climate with light to moderate wind.

***derived using ET/EPAN relationships for Prosser, Washington, and ETo/EPAN relationships for Davis, California. (Erpenbeck, 1981)

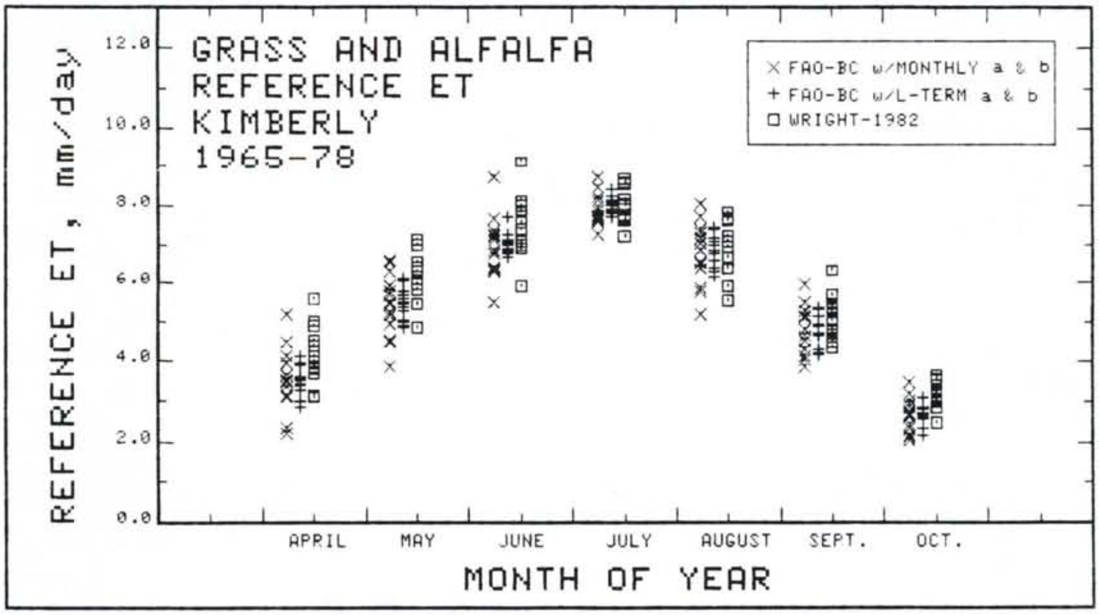

Figure 1. Grass reference ET estimated using FAO-BC with monthly and long-term data and elevation correction and alfalfa reference ET estimated using Wright (1982) for Kimberly, 1965-78.

correct a grass reference calculated by any method other than the particular FAO method stated to an alfalfa reference. Reference ratios calculated for the FAO-BC were tested against data from three other Idaho sites as discussed in a subsequent section.

Included in Table 3 are alfalfa/grass reference ratios presented by Doorenbos and Pruitt (1977) and Erpenbeck (1981). Ratios calculated by Erpenbeck average 7 percent greater than those by Doorenbos and Pruitt for April through October. This may be due to the method used to determine the coefficients and complications due to using pan evaporation as a common denominator between two different sites. Ratios calculated for the FAO Radiation, Penman and corrected Penman approach 1.15 for the months June through October. April and May ratios are low for all three methods indicating a possible overestimation of grass reference ET by these methods for those months.

Reference ratios calculated for the FAO-Blaney-Criddle with an elevation correction vary from month to month, decreasing from April through August and increasing from August through October. The ratios of 1.01 and 1.00 for July and August indicate overestimation of ET_o by the FAO-BC for these months (grass ET should be 15% lower than alfalfa ET). The reason for this overestimation is not clear. Year-to-year variations of reference ratios for the FAO-BC at Kimberly are shown in Figure 2. Variation among years for early and late months is considerable, indicating some instability of the FAO-BC as compared to Wright-1982.

Because the FAO-BC method requires only monthly temperature data and long-term averages for radiation, humidity and wind data, and for Wilder, Aberdeen and Rexburg. The 14-year average monthly reference ratios calculated for Kimberly are also plotted in these figures.

Reference ratios calculated for Wilder, Aberden and Rexburg follow the 14-year mean for Kimberly for each month and each site with the exception of September and October at Wilder, where the FAO-BC estimates higher relative to Wright-1982 than at Kimberly. This may be due to dewpoint and air temperatures recorded at the Wilder site during these months which were greater than at Kimberly. The higher dewpoint would cause the second term of Wright-1982 to estimate lower ET, while the higher temperature would cause the FAO-BC to estimate higher ET (see Appendix A, page 8). The minimum relative humidity term used to adjust the FAO-BC would be unaffected, since the higher air temperture and higher dewpoint temperature would cancel each other in calculating the relative humidity value. However, the higher air temperature would result in a higher estimate by FAO-BC. Kimberly reference ratios fit Wilder, Aberdeen and Rexburg very poorly when the elevation correction was not used. Figures showing comparisons without the elevation correction are included in Appendix B.

Figures 6, 7, 8 and 9 show monthly alfalfa reference ET calculated for Kimberly, Wilder, Aberdeen and Rexburg using the FAO-BC and Wright-1982 methods. Grass reference ET_o estimated by the FAO-BC was multiplied by the Kimberly FAO-BC reference ratios before being plotted in these figures. Monthly values of minimum relative humidity, daytime wind and solar radiation were used in calculating the FAO-BC. Kimberly FAO-BC monthly reference ratios for April through October are 1.21, 1.14, 1.07, 1.01, 1.00, 1.08 and 1.22. Alfalfa reference ET estimated by the FAO-BC with Kimberly reference ratios compares very well with

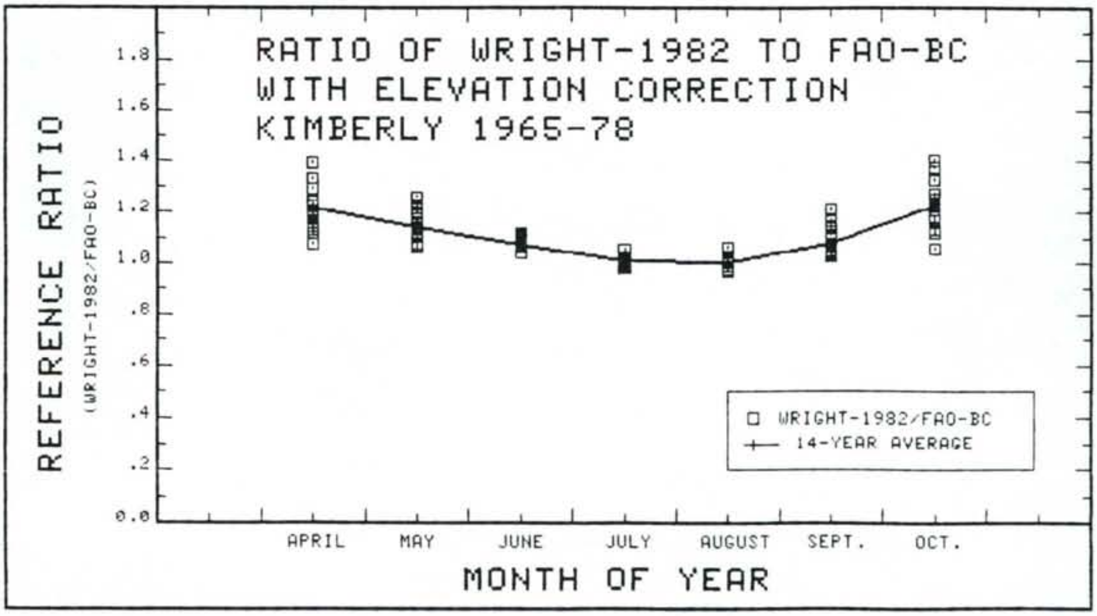

Figure 2. Annual monthly WRIGHT-1982/FAO-BC reference ratios calculated for Kimberly, Idaho, 1965-1978.

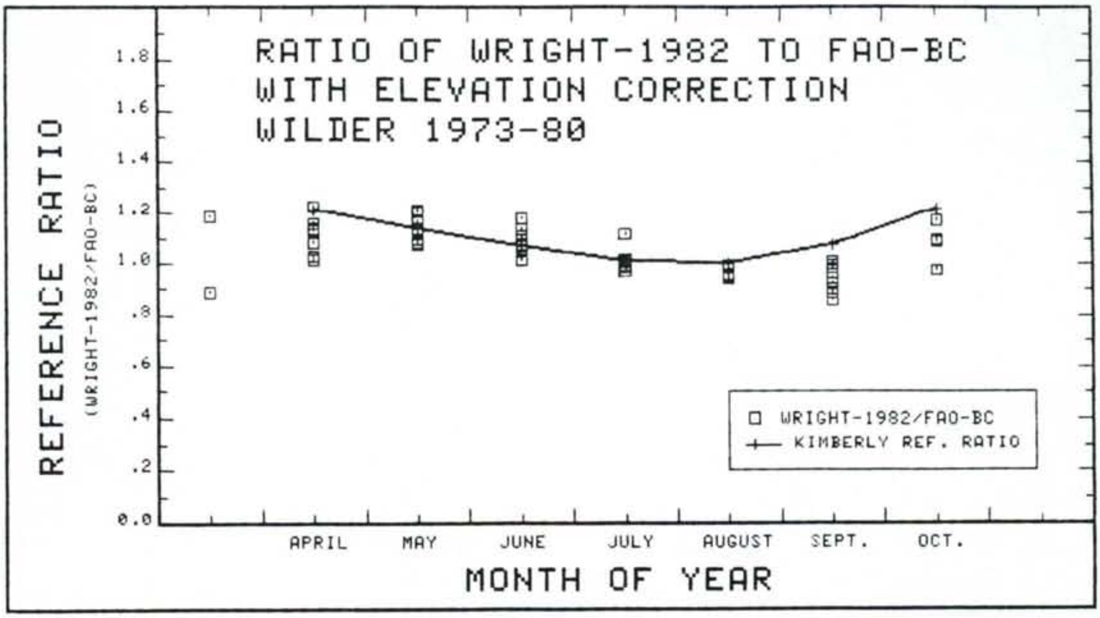

Figure 3. Annual monthly WRIGHT-1982/FAO-BC reference ratios calculated for Wilder, Idaho, 1973-1980 and average reference ratios for Kimberly.

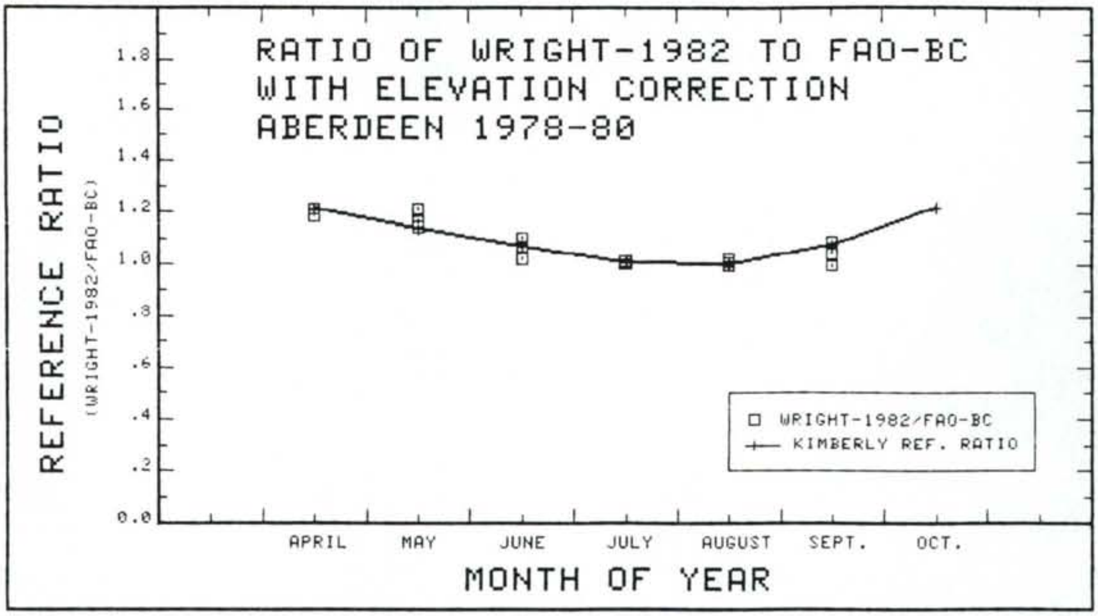

Figure 4. Annual monthly WRIGHT-1982/FAO-BC reference ratios calculated for Aberdeen, Idaho, 1978-1980 and average reference ratios for Kimberly.

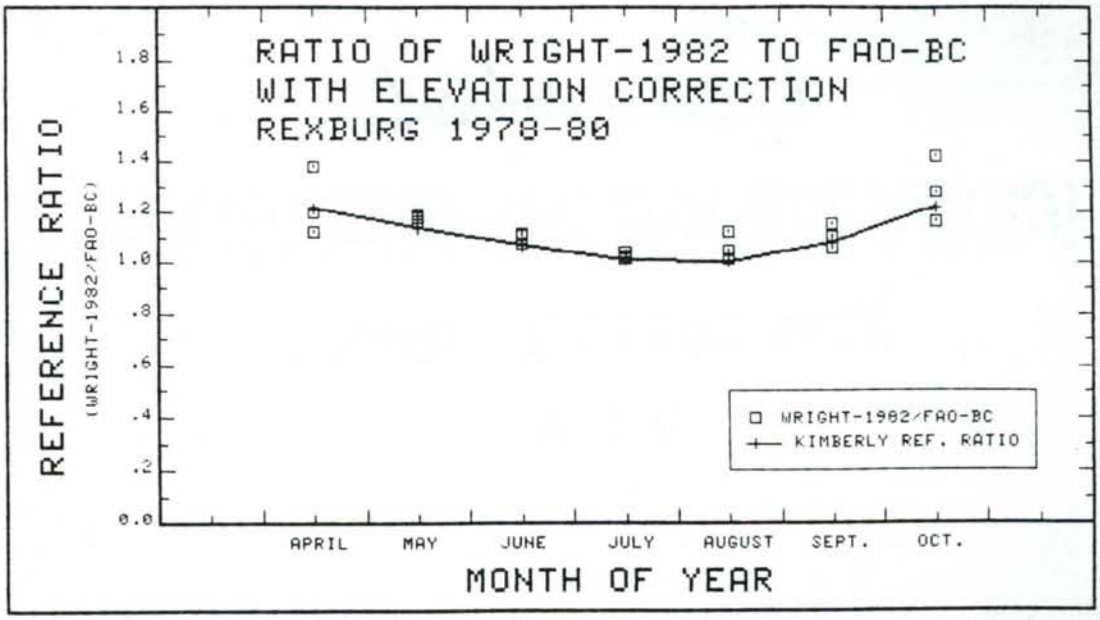

Figure 5. Annual monthly WRIGHT-1982/FAO-BC reference ratios calculated for Rexburg, Idaho, 1978-1980 and average reference ratios for Kimberly.

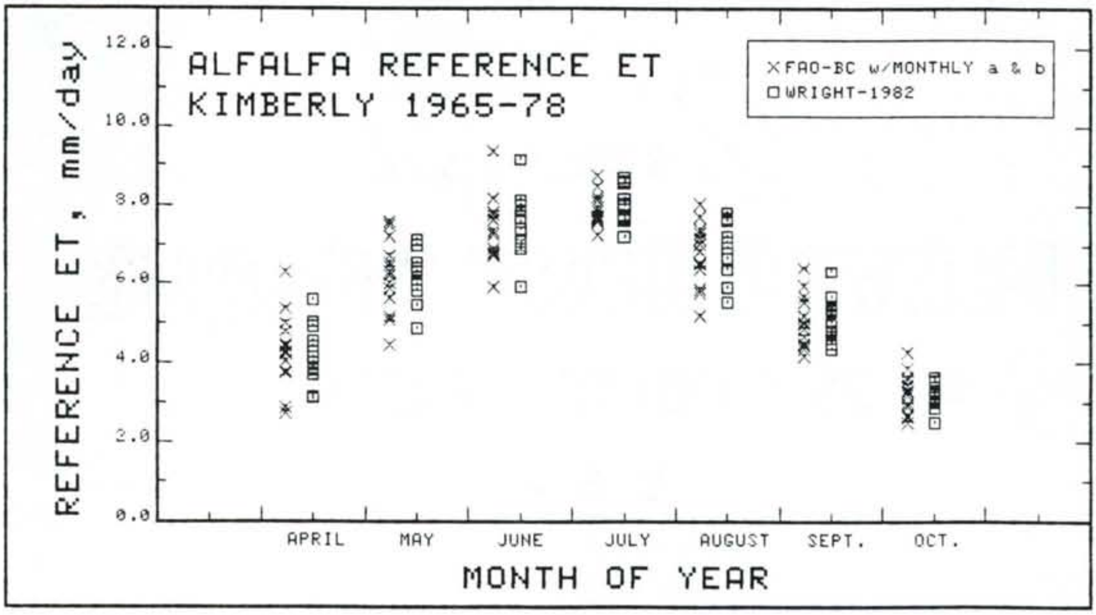

Figure 6. Monthly alfalfa reference evapotranspiration estimated using FAO-BC with Kimberly reference ratios and elevation correction and using WRIGHT-1982 for Kimberly, 1965-1978.

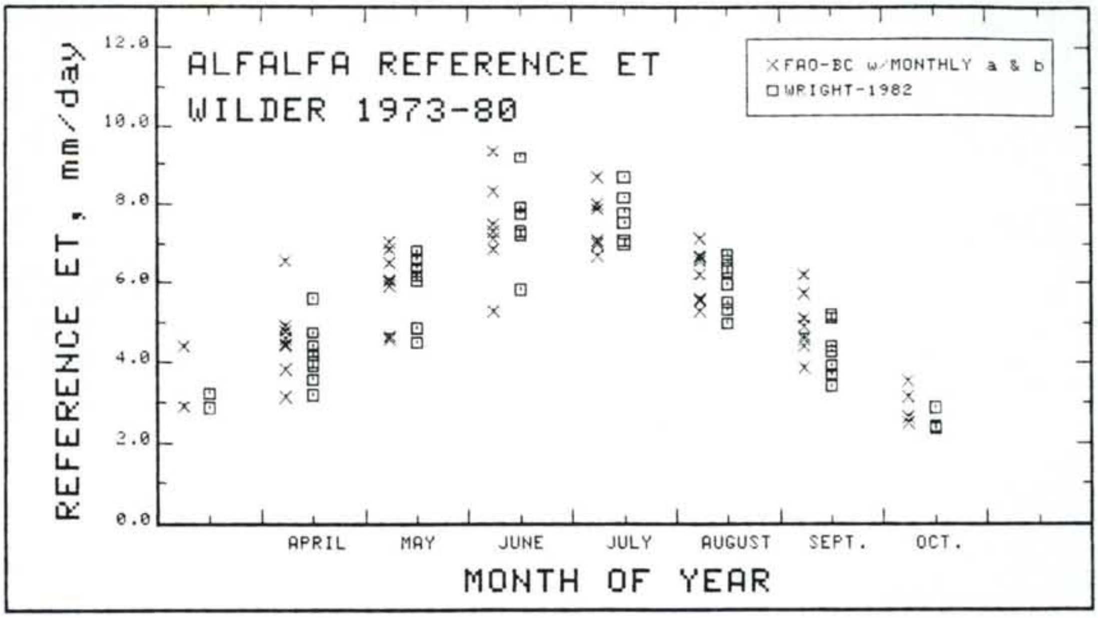

Figure 7. Monthly alfalfa reference evapotranspiration estimated using FAO-BC with Kimberly reference ratios and elevation correction and using WRIGHT-1982 for Wilder, 1973-1980.

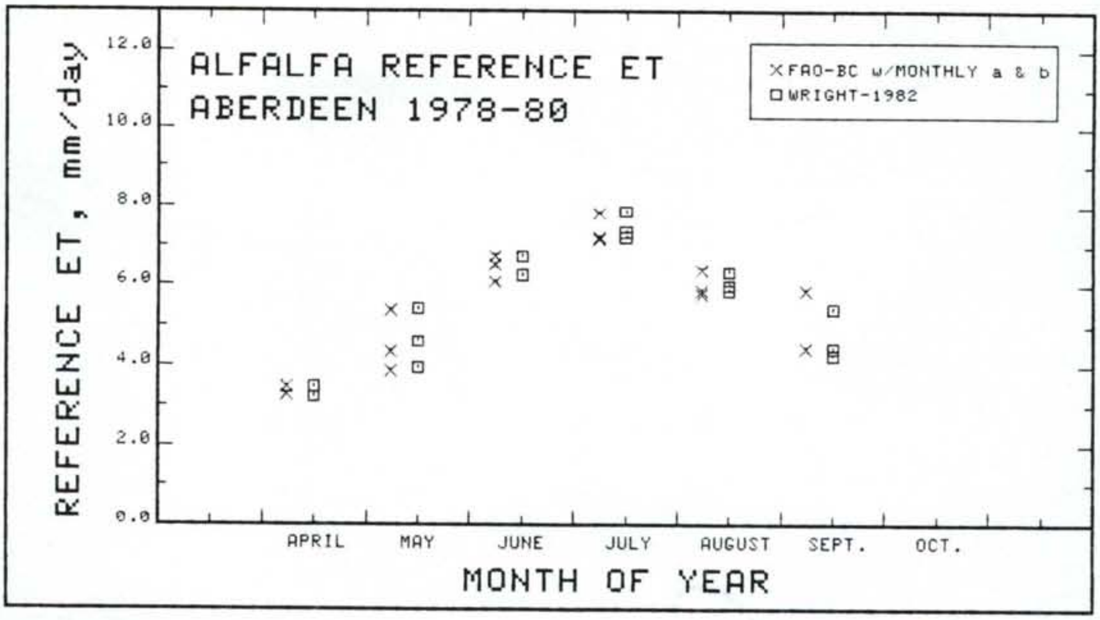

Figure 8. Monthly alfalfa reference evapotranspiration estimated using FAO-BC with Kimberly reference ratios and elevation correction and using WRIGHT-1982 for Aberdeen, 1978-1980.

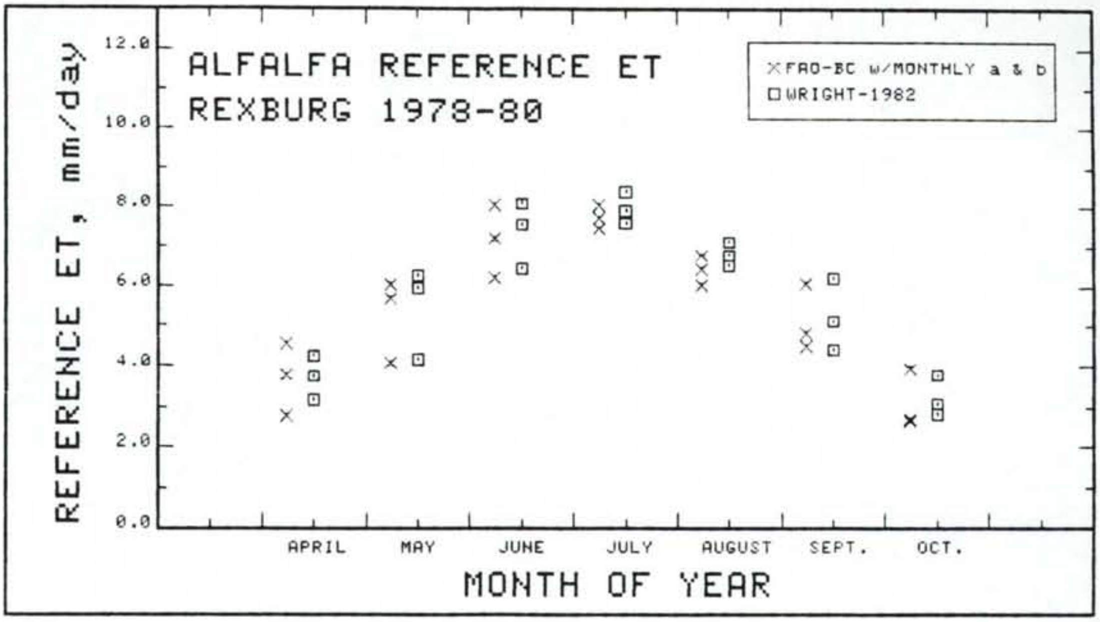

Figure 9. Monthly alfalfa reference evapotranspiration estimated using FAO-BC with Kimberly reference ratios and elevation correction and using WRIGHT-1982 for Rexburg, 1978-1980.

alfalfa reference ET estimated by Wright-1982, with the exception of September and October at Wilder and August at Rexburg.

The FAO-BC with Kimberly FAO-BC/Wright-1982 reference ratios was also tested using daily weather data measured at irrigated sites in the Bell Rapids Mutual and Grindstone Mutual Irrigation projects (Allen, 1983) during 1981. These projects are located in the Bruneau Plateau area south and east of Glenns Ferry. Both weather sites were located over irrigated alfalfa. However, alfalfa at the Grindstone site was raised for seed production, and consequently received less than optimal irrigation required for normal hay production.

Figures 10 and 11 are graphs of ten-day running averages of reference alfalfa ET estimated for the Bell Rapids and Grindstone sites using the FAO-BC with Kimberly reference ratios and an elevation correction, and using Wright-1982. Estimates by the two methods compare very well for the Bell Rapids site (Figure 10) through the entire season. The FAO-BC does estimate low, compared to Wright-1982, for the Grindstone site during July and August. This is most likely due to large-scale advective effects at the Grindstone site during these months due to drying of the alfalfa seed crop and corresponding reduction of actual crop ET. Daily alfalfa reference ET calculated by Wright-1982 and the FAO-BC are shown in Figure 12 for Bell Rapids. The proximity of daily FAO-BC estimates to Wright-1982 estimates is remarkable, considering it is suggested that the FAO-BC only be used to estimate consumptive use for periods of 30 days or longer (Doorenbos and Pruitt, 1977). The closeness of estimates indicates that the FAO-BC is sensitive to changes in temperature, wind humidity and radiation in much the same manner as Wright-1982, even though the FAO-BC is composed of

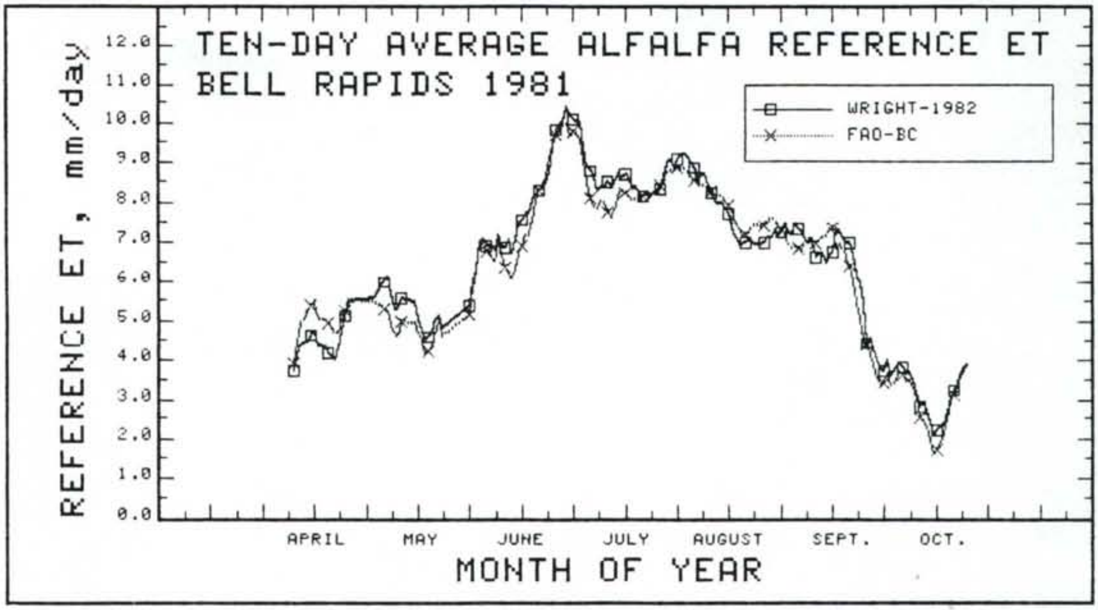

Figure 10. Ten-day average estimates of alfalfa reference evapotranspiration using FAO-BC with Kimberly reference ratios and an elevation correction and using WRIGHT-1982 at Bell Rapids Mutual Irrigation Project during 1981.

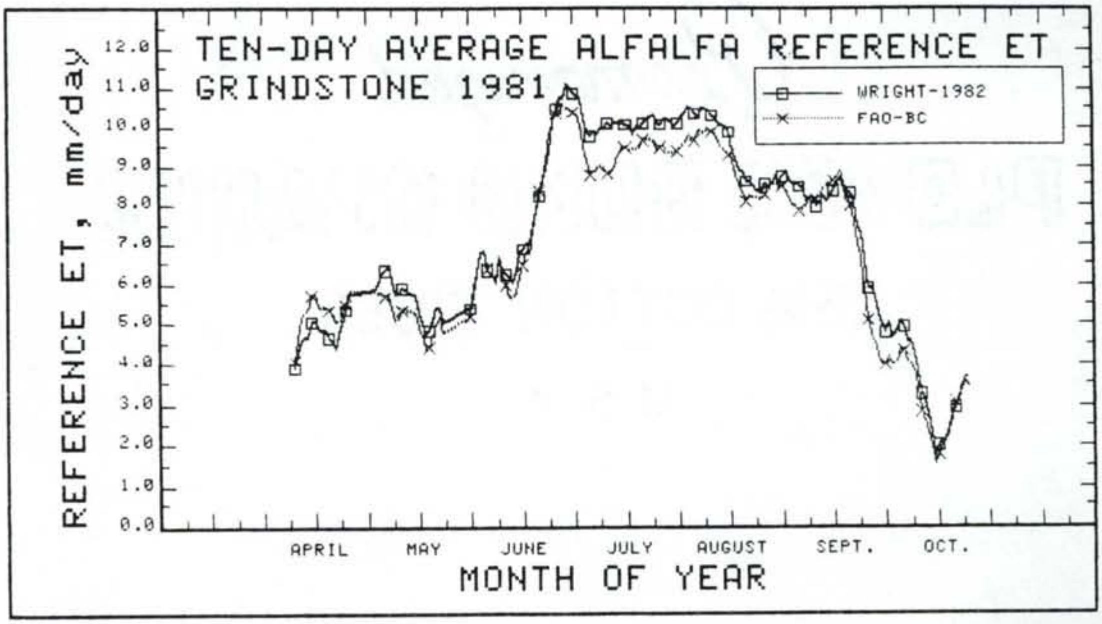

Figure 11. Ten-day average estimates of alfalfa reference evapotranspiration using FAO-BC with Kimberly reference ratios and an elevation correction and using WRIGHT-1982 at Grindstone Butte Mutual Irrigation Project during 1981.

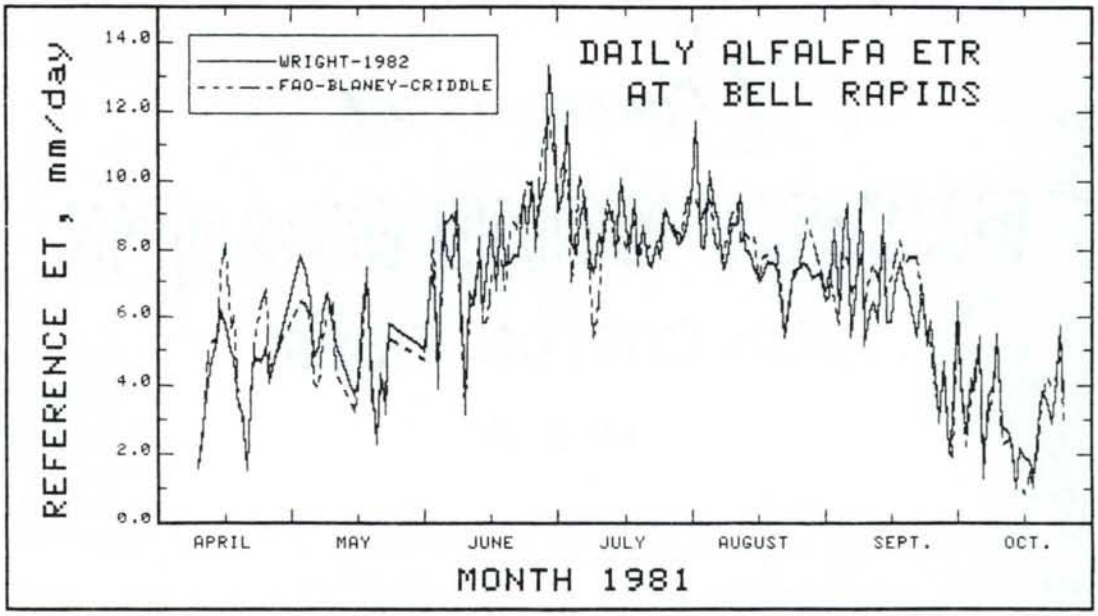

Figure 12. Daily alfalfa reference ET at Bell Rapids Mutual Irrigation Project during 1981 estimated using WRIGHT-1982 and the FAO-Blaney-Criddle with elevation correction and Kimberly reference ratios.

mostly linear relationships and the Wright-1982 method includes many nonlinear relationships (Appendix A). The comparison in Figure 12 may be completely fortuitous. However, it does indicate that the FAO-BC with elevation correction and Kimberly reference ratios could be used to schedule irrigations in the Bell Rapids area, provided daily measurements of temperature and _daily measurements_ of humidity, wind and solar radiation are available. Similar comparisons between daily alfalfa reference estimates using the FAO-BC and Wright-1982 methods for Talmage, Idaho (elevation 1700 meters) indicate a similar goodness of fit and sensitivity between methods (Allen and Brockway, 1982; 1983).

The FAO-BC apparently is not as sensitive to pronounced advection (large vapor pressure deficits and high temperatures of air masses moving in from outside the irrigated areas) as is Wright-1982 (Figure 11). This advection occurred due to the proximity of the alfalfa site to the project boundary (400 meters in an upwind direction) and lack of ET by the drying seed crop upwind of the site to bring the advective air mass into equilibrium with surrounding irrigated fields. This insensitivity of the FAO-BC to severe advection (or extreme evaporative demands) experienced at the Grindstone site would rarely be experienced at weather sites situated over well-watered alfalfa or grass with at least 100 meters of irrigated fetch in an upwind direction.

In summary, the FAO-BC method with Kimberly FAO-BC/Wright-1982 reference ratios and an elevation correction of +10 percent per 1000 meters performs very well using weather data from 6 sites in southern Idaho as compared to Wright-1982. It provides good estimates of reference ET on a 10-day or 30-day basis and should provide improved estimates of monthly consumptive use for temperature stations throughout

Idaho, provided good estimates of average minimum relative humidity, day time wind speed and solar radiation are available.

CHAPTER IV

APPLICATION OF THE FAO-BLANEY-CRIDDLE METHOD TO IDAHO

Application of the FAO-Blaney-Criddle (FAO-BC) method for estimating consumptive use requires monthly averages of mean daily air temperature and general estimates or measurements of humidity, sunshine and wind. Use of humidity, sunshine (radiation) and wind estimates, termed secondary weather parameters, provides an improved prediction of the effect of climate on evapotranspiration (Doorenbos and Pruitt, 1977). The basic form of the FAO-BC is the following:

$$ET_o = (a + b\,[P(0.46\,T + 8.13)])\,(1. + Elev/10{,}000.) \quad (2)$$

where:

ET_o = grass reference evapotranspiration, mm/day

T = mean daily temperature in $^{\circ}$C over the month considered

P = mean daily percentage of total annual daytime hours obtained from Table 1 of appendix B for a given month and latitude

a = intercept to adjust estimates based on minimum relative humidity (RHMIN) and ratio of actual sunshine hours to possible (NRATIO)

a = 0.0043 (RHMIN) - NRATIO -1.41

b = multiplier to adjust estimates based on minimum relative humidity (RHMIN), ratio of actual sunshine hours to possible (NRATIO) and mean daytime (7am-7pm) wind speed in m/sec (UDAY)

Elev = elevation of station in meters.

The b coefficient in equation 2 can be interpolated from tables presented by Doorenbos and Pruitt (1977). The effects of the secondary parameters, minimum relative humidity, ratio of actual sunshine hours and daytime wind speed, on adjustment of reference ET estimated by the FAO-BC is shown in Figure A-1 of Appendix A. The ET reference by the

FAO-BC is sensitive to estimated or measured values of the three secondary parameters. Also, the use of long term monthly averages for secondary parameters rather than measurements for specific years does decrease the year-to-year variation (standard deviation) of the estimates. This decrease was discussed in Chapter 3 and presented in Table 2 and Figure 1.

Availability of Secondary Weather Parameters

Measurement of the secondary weather parameters, minimum daily humidity, daytime wind speed, and ratio of actual sunshine hours (solar radiation), are available for only limited sites in Idaho and for varying periods of time. Because estimates of consumptive use are desired for many areas where only air temperature and precipitation are measured, available long-term measurements of secondary weather parameters must be extended to surrounding temperature stations to enable use of the FAO-BC.

The major sources of secondary weather data used during this study to calculate the a and b coefficients used with the FAO-BC include the Climatological Handbook for Columbia Basin States - Volume 3 (Pacific Northwest River Basins Commission, 1968), and solar radiation studies by Satterlund and Means (1978). Weather data from these sources were compared with hourly wind data for Kimberly, Idaho (Wright, 1981a) and hourly SOLMET data for Boise and Pocatello (NOAA, 1978).

The Pacific Northwest River Basins Commission (PNWRBC) reports include hourly data for relative humidity and wind for ten stations in Idaho. These stations and period of record for each station are listed in Table 4. Data presented by the PNWRBC includes hourly frequency analyses of relative humidity, windspeed and direction, air temperature, sky cover, dewpoint temperature, cloud ceiling heights and precipitation. Actual measurements of global solar radiation (total sky) were not reported.

Satterlund and Means (1978;1979) used a solar radiation model to estimate global solar radiation throughout the Pacific Northwest region. Monthly radiation estimates reported for the ten stations listed in Table 4 were taken from the 1979 report. Values compare well with USDA solar radiation data at Kimberly and solar data from SOLMET.

The SOLMET data consists of hourly weather measurements recorded for Boise, Pocatello and Lewiston, Idaho during the period 1952 - 1976. This data was made available by NOAA on magnetic tape.

Calculation and Comparison of Secondary Data

Mean monthly minimum relative humidity for each secondary station was excerpted from frequency analyses presented in the PNRBC reports by multiplying bracketed humidity levels by the probability of occurrence reported for each bracket. The minimum hourly sum of the products calculated was selected as the minimum relative humidity for the month and station. The minimum usually occurred between 1500 and 1600 hours.

Daytime and nighttime windspeeds were calculated in the same manner as relative humidity. Bracketted wind speeds were multiplied by the probability of occurrence reported for each bracket. Products obtained were summed for each hour and recorded. Daytime windspeeds (UDAY) were calculated by averaging hourly windspeeds between 0700 and 1900 hours.

Table 4. Location and period of record for secondary weather parameters used in FAO-BC.

	Station	Period of record
1	Coeur D´ Alene	1948-1953
2	Lewiston FAA AP	1949-1958
3	Boise WSO AP	1949-1958
4	Mountain Home AF	1951-1961
5	Gooding Airport	1949-1954
6	Burley FAA AP	1948-1954
7	Malad	1948-1953
8	Pocatello WSO AP	1949-1958
9	Idaho Falls FAA AP	1948-1954
10	Dubois Experiment Station	1948-1954

Nighttime wind speeds (UNITE) were calculated by averaging hourly wind speeds between 1900 and 0700 hours. A day/night wind ratio (URATIO) was calculated for each month and site as: URATIO = UDAY/UNITE.

Mean monthly minimum relative humidity and daytime wind speeds and day/night wind ratios for Pocatello and Boise were also calculated using hourly data from the SOLMET tapes for the period 1952-1976. Values for SOLMET humidity and wind agreed well with the data from the PNWRBC reports, thereby verifying reliability of the PNWRBC data. Data from the two sources were from different periods of time. Similarity of data from the two sources indicates that the PNWRBC data should be representative of average climatic weather conditions at the ten weather sites reported.

Figures 13 and 14 include mean monthly minimum relative humidity at Boise and Pocatello from the PNWRBC and SOLMET sources. Also plotted in each figure are 14-year mean monthly values of minimum relative humidity at Kimberly. Humidity at Kimberly is similar to the airport sites at Boise and Pocatello early and late in the growing season when precipitation is greatest. During June, July, August and September, however, relative humidity at the airport sites is 7 to 10 percent lower than at the irrigated, agricultural site at Kimberly. For this reason long term minimum relative humidity at all secondary weather stations was limited to above 30% in the consumptive use estimating program, based on data at Kimberly. Reasons necessitating this adjustment are discussed in more detail by Allen (1982) and Allen et al (1983).

Mean monthly wind speeds for 24-hour and daytime (7am - 7pm) periods are presented in Tables 5 and 6 for Boise and Pocatello from

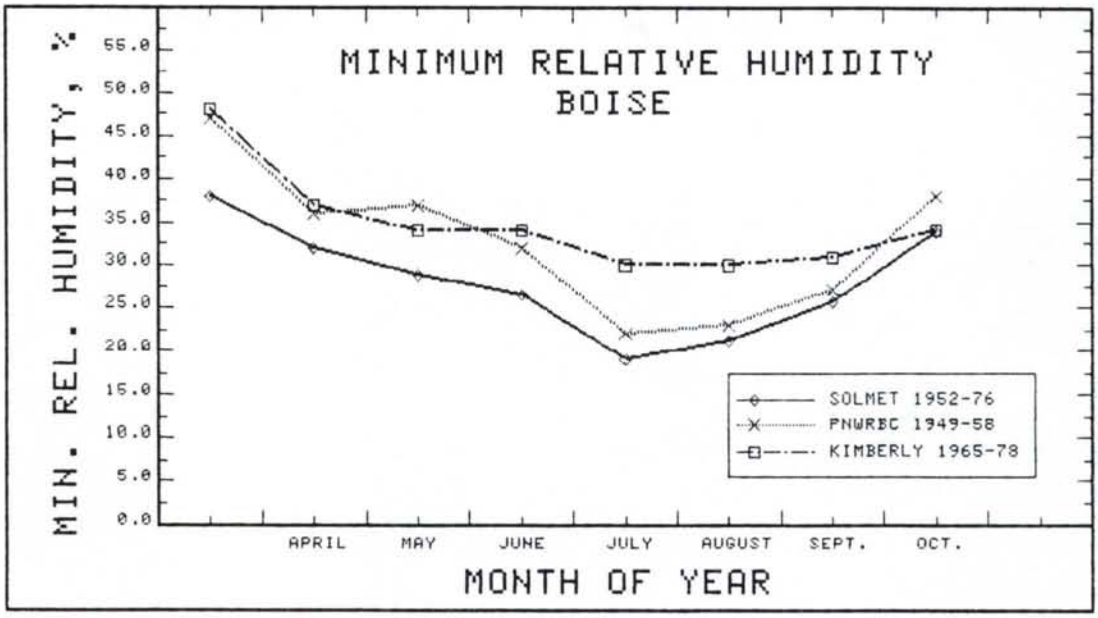

Figure 13. Mean monthly minimum relative humidity at Boise as calculated from SOLMET and PNWRBC sources and mean monthly minimum relative humidity at Kimberly.

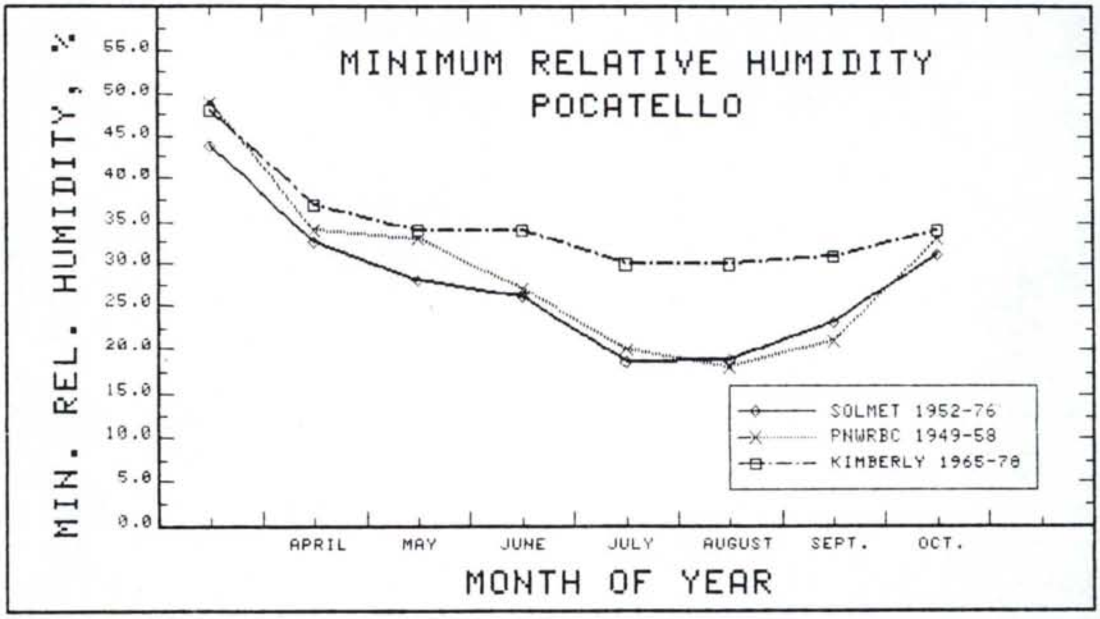

Figure 14. Mean monthly minimum relative humidity at Pocatello as calculated from SOLMET and PNWRBC sources and mean monthly minimum relative humidity at Kimberly.

SOLMET and PNWRBC sources and for the Kimberly USDA-ARS site. Wind means from the SOLMET source are also presented for the period from 1965 - 1976 for comparison with the 1965 - 1978 period at Kimberly. Wind speeds from the SOLMET source compare well with the PNWRBC data as shown in Figures 15 and 16.

The airport 24-hour wind speeds (Boise and Pocatello) exceed those at Kimberly during June, July, August and September. Lower 24-hour winds at Kimberly may result from agricultural crop cover and lower mass transport of air caused by less warming of the ground surface during daylight hours and less cooling of the surface at night due to the effect of irrigation.

Daytime wind speed at Kimberly is similar to wind speed at Boise (Figure 17) for all months, due to higher day/night wind ratios at Kimberly during the summer months (Table 7). Day/night wind ratios at Kimberly do not exceed ratios at Pocatello as much as they do Boise. Consequently daytime wind speeds calculated at Pocatello exceed those at Kimberly during June, July and August as shown in Figure 18.

Secondary parameters calculated for the ten Idaho stations reported by the PNWRBC (1968) and Satterlund and Means (1978) are listed in Table 8 along with parameters calculated for the USDA station at Kimberly. Day/night wind ratios at all sites in Table 8 are less than the 2.0 default value suggested by Doorenbos and Pruitt (1977). The NRATIO values in Table 8, defined as the ratio of actual sunshine hours to possible sunshine hours, were calculated from the Satturland and Means data using relationships presented by Doorenbos and Pruitt (1977). Clear sky solar radiation estimated using the Doorenbos and Pruitt

Table 5. Mean monthly 24-hour wind speed at Boise, Pocatello and Kimberly from SOLMET, PNWRBC and USDA sources.

24-Hour mean monthly wind (m/sec)

	BOISE SOLMET 1952-76	BOISE SOLMET 1965-76	BOISE PNWRBC 1949-58	POCATELLO SOLMET 1952-76	POCATELLO SOLMET 1965-76	POCATELLO PNWRBC 1949-58	KIMBERLY USDA 1965-78
APR	3.76	3.91	3.35	4.44	4.22	3.74	3.79
MAY	3.47	3.58	3.08	3.95	3.77	3.44	3.28
JUNE	3.36	3.37	3.10	3.88	3.64	3.56	2.89
JULY	3.05	3.13	2.80	3.45	3.12	3.16	2.21
AUG	2.99	3.17	2.62	3.40	3.07	2.93	2.14
SEPT	2.95	3.05	2.67	3.44	3.21	2.95	2.50
OCT	3.06	3.04	3.08	3.45	3.23	3.20	2.66

Table 6. Mean monthly daytime wind speed for Boise, Pocatello and Kimberly from SOLMET, PNWRBC and USDA sources.

Daytime mean monthly wind (7-7) (m/sec)

	BOISE SOLMET 1952-76	BOISE SOLMET 1965-76	BOISE PNWRBC 1949-58	POCATELLO SOLMET 1952-76	POCATELLO SOLMET 1965-76	POCATELLO PNWRBC 1949-58	KIMBERLY USDA 1965-78
APR	4.18	4.42	3.60	5.14	4.81	4.40	4.70
MAY	3.96	4.07	3.40	4.61	4.41	4.00	4.00
JUNE	3.82	3.87	3.50	4.60	4.30	4.30	3.60
JULY	3.50	3.56	3.10	4.14	3.73	3.80	2.80
AUG	3.33	3.43	2.90	4.04	3.67	3.40	2.80
SEPT	3.18	3.28	2.80	3.99	3.80	3.30	3.10
OCT	3.15	3.20	3.10	3.89	3.67	3.50	3.30

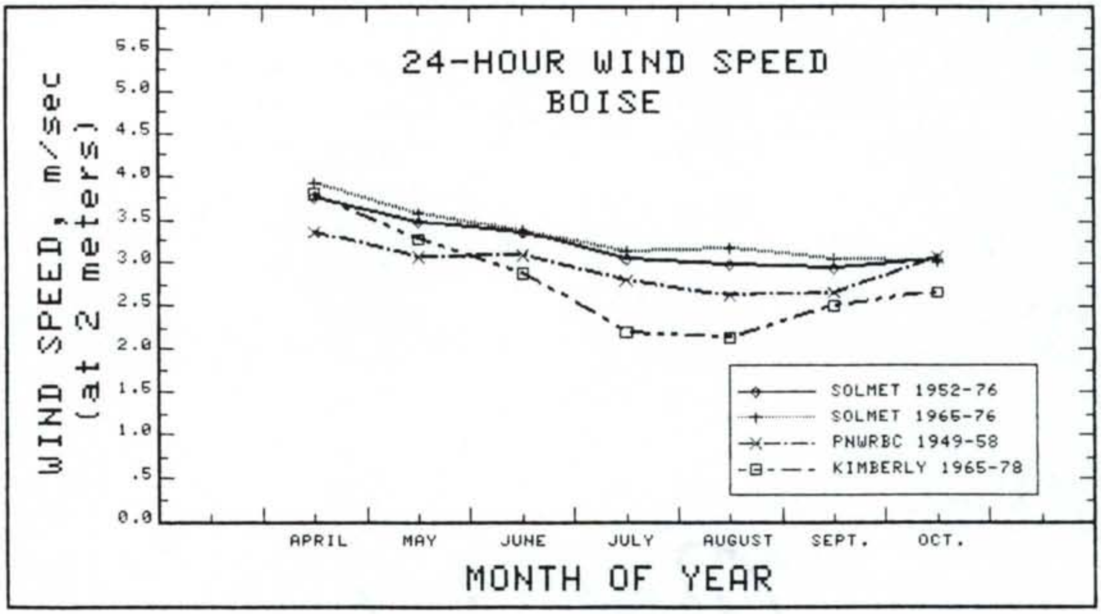

Figure 15. Twenty-four hour wind speeds calculated from SOLMET, PNWRBC and USDA sources for Boise and Kimberly, Idaho.

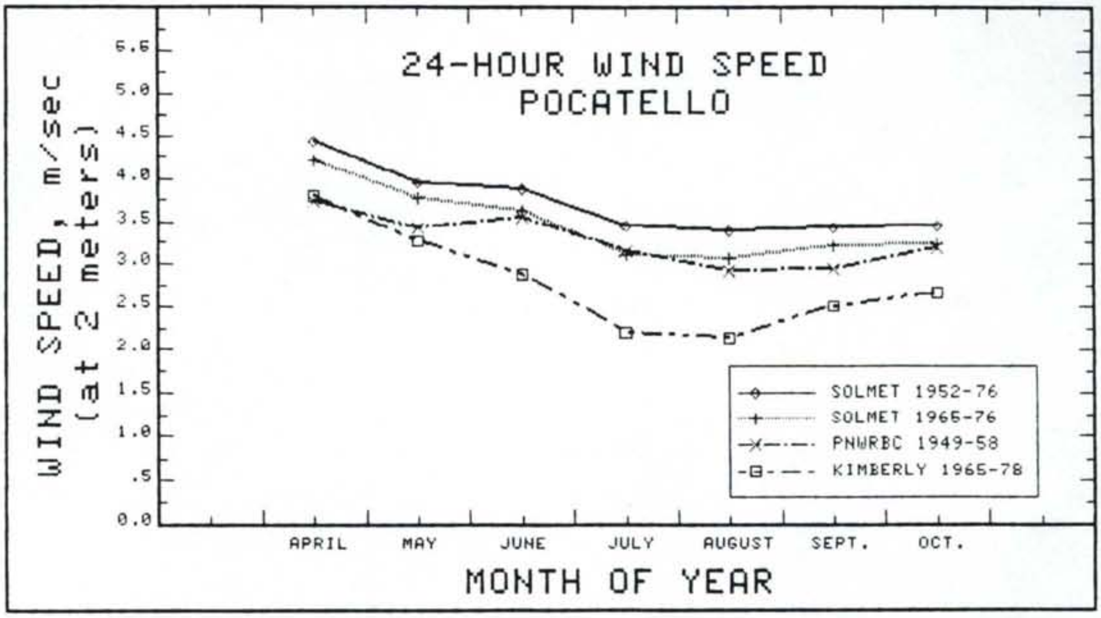

Figure 16. Twenty-four wind speeds calculated from SOLMET, PNWRBC and USDA sources for Pocatello and Kimberly, Idaho.

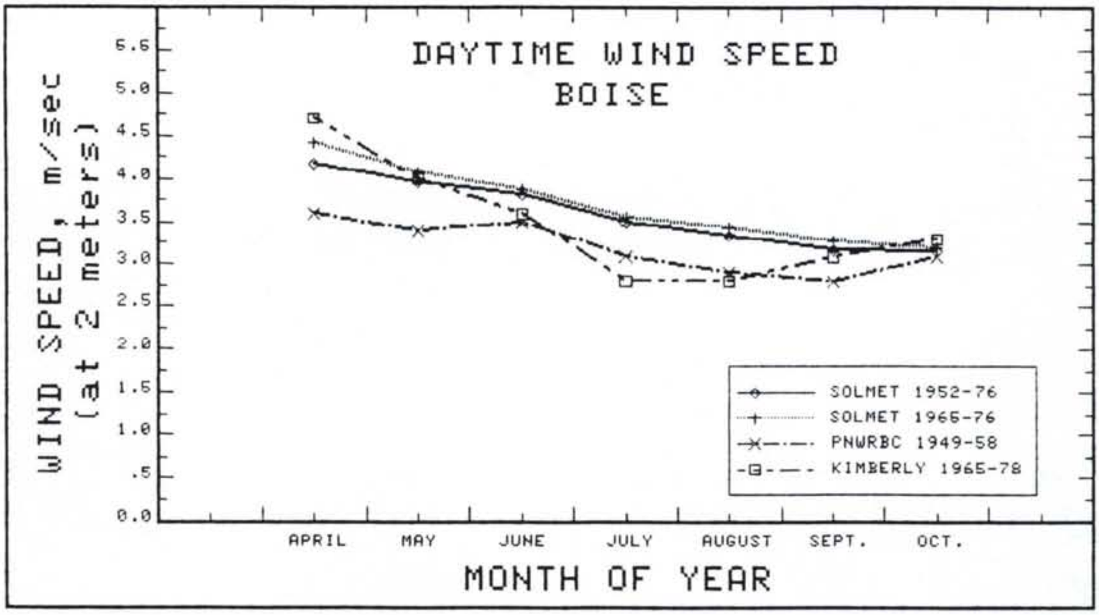

Figure 17. Daytime (7-7) wind speeds calculated from SOLMET, PNWRBC and USDA sources for Boise and Kimberly, Idaho.

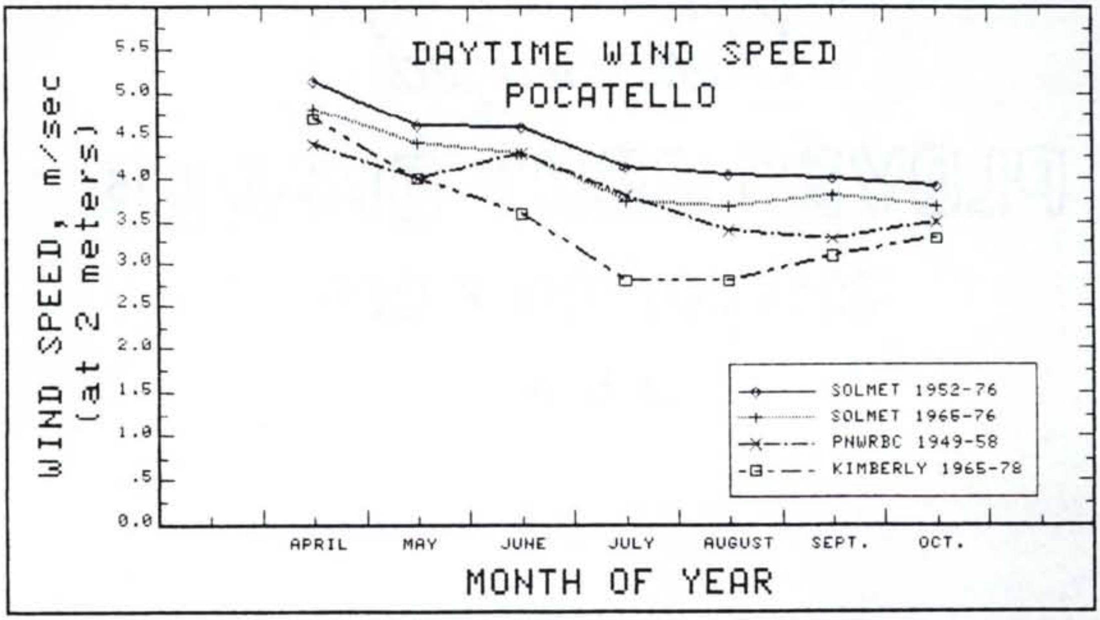

Figure 18. Daytime (7-7) wind speeds calculated from SOLMET, PNWRBC and USDA sources for Pocatello and Kimberly, Idaho.

Table 7. Mean monthly day/night wind ratios for Boise, Pocatello and Kimberly from SOLMET, PNWRBC and USDA sources.

Day/Night mean monthly wind ratios

	BOISE SOLMET 1952-76	BOISE SOLMET 1965-76	BOISE PNWRBC 1949-58	POCATELLO SOLMET 1952-76	POCATELLO SOLMET 1965-76	POCATELLO PNWRBC 1949-58	KIMBERLY USDA 1965-78
APR	1.25	1.30	1.16	1.37	1.33	1.43	1.63
MAY	1.33	1.32	1.23	1.40	1.41	1.39	1.56
JUN	1.32	1.35	1.30	1.46	1.44	1.52	1.65
JUL	1.35	1.32	1.24	1.50	1.49	1.51	1.73
AUG	1.26	1.18	1.24	1.46	1.49	1.38	1.89
SEP	1.17	1.16	1.10	1.38	1.45	1.27	1.63
OCT	1.06	1.11	1.01	1.29	1.32	1.21	1.63

Table 8. Secondary weather parameters calculated from PNWRBC report and from USDA data at Kimberly.

Parameter	March	April	May	June	July	August	Sept.	Oct.
			COEUR D'ALENE					
nratio	.45	.65	.59	.62	.85	.72	.64	.48
min.RH (%)	64.	45.	46.	47.	33.	33.	37.	58.
daywind (m/s)	3.3	3.4	3.5	3.2	3.1	2.9	3.0	2.8
D/N ratio	1.24	1.38	1.46	1.44	1.53	1.44	1.34	1.26
solar (mm/d)	4.64	7.51	8.69	9.64	11.12	8.74	6.43	3.84
			LEWISTON FAA AP					
nratio	.47	.63	.67	.67	.88	.81	.67	.49
min.RH (%)	48.	38.	39.	37.	22.	23.	26.	48.
daywind (m/s)	2.4	2.3	1.8	1.9	1.8	1.7	1.5	1.5
D/N ratio	1.35	1.34	1.30	1.40	1.28	1.37	1.10	1.14
solar (mm/d)	4.85	7.53	9.38	10.13	11.44	9.47	6.72	4.03
			BOISE WSO AP					
nratio	.60	.70	.73	.75	.87	.83	.81	.66
min.RH (%)	47.	36.	37.	32.	22.	23.	27.	38.
daywind (m/s)	3.7	3.6	3.4	3.5	3.1	2.9	2.8	3.1
D/N ratio	1.07	1.16	1.23	1.30	1.24	1.24	1.10	1.01
solar (mm/d)	5.81	8.25	9.94	10.81	11.39	9.79	7.82	5.12
			MOUNTAIN HOME AF					
nratio	.61	.73	.69	.78	.89	.85	.80	.70
min.RH (%)	42.	33.	33.	28.	16.	16.	21.	32.
daywind (m/s)	3.7	3.8	3.8	3.7	3.0	2.9	2.7	3.0
D/N ratio	1.40	1.40	1.39	1.35	1.19	1.30	1.35	1.44
solar (mm/d)	5.93	8.45	9.66	11.05	11.56	10.01	7.79	5.34
			GOODING AIRPORT					
nratio	.64	.80	.75	.81	.86	.84	.82	.72
min.RH (%)	47.	30.	31.	28.	19.	21.	24.	33.
daywind (m/s)	3.9	4.2	4.0	3.9	3.0	3.0	3.1	3.2
D/N ratio	1.24	1.38	1.35	1.47	1.28	1.21	1.26	1.19
solar (mm/d)	6.09	8.96	10.08	11.31	11.31	9.89	7.94	5.46
			BURLEY FAA AP					
nratio	.59	.76	.72	.78	.88	.84	.81	.73
min.RH (%)	48.	36.	34.	31.	25.	26.	26.	35.
daywind (m/s)	4.4	4.2	3.8	3.6	2.9	2.7	2.8	2.8
D/N ratio	1.39	1.47	1.35	1.49	1.34	1.37	1.36	1.37
solar (mm/d)	5.90	8.72	9.86	11.08	11.51	9.91	7.92	5.54

Table 8. continued.

Parameter	March	April	May	June	July	August	Sept.	Oct.
MALAD								
nratio	.60	.78	.71	.80	.88	.84	.81	.72
min.RH (%)	55.	38.	41.	35.	29.	28.	29.	39.
daywind (m/s)	2.2	2.7	2.7	2.4	2.2	2.5	2.1	1.7
D/N ratio	1.29	1.43	1.49	1.33	1.24	1.34	1.27	1.16
solar (mm/d)	5.98	8.89	9.81	11.25	11.51	9.96	7.94	5.58
POCATELLO WSO AP								
nratio	.61	.75	.71	.79	.87	.82	.78	.66
min.RH (%)	49.	34.	33.	27.	20.	18.	21.	33.
daywind (m/s)	4.2	4.4	4.0	4.3	3.8	3.4	3.3	3.5
D/N ratio	1.28	1.43	1.39	1.53	1.51	1.38	1.27	1.21
solar (mm/d)	5.93	8.62	9.77	11.14	11.42	9.77	7.72	5.19
IDAHO FALLS FAA AP								
nratio	.57	.75	.70	.77	.87	.81	.78	.66
min.RH (%)	49.	33.	31.	33.	25.	26.	26.	35.
daywind (m/s)	4.2	4.6	4.2	4.1	3.5	3.2	3.1	3.2
D/N ratio	1.18	1.31	1.26	1.32	1.30	1.27	1.14	1.11
solar (mm/d)	5.64	8.53	9.69	10.95	11.41	9.67	7.65	5.13
DUBOIS EXP. STATION								
nratio	.58	.76	.67	.73	.84	.78	.75	.66
min.RH (%)	53.	31.	28.	29.	18.	18.	19.	32.
daywind (m/s)	2.9	3.6	3.4	3.5	3.5	3.1	2.7	2.3
D/N ratio	1.08	1.27	1.18	1.26	1.24	1.21	1.12	1.01
solar (mm/d)	5.66	8.60	9.40	10.64	11.14	9.38	7.41	5.02
KIMBERLY USDA-ARS 1965-78								
nratio	.59	.67	.73	.75	.83	.78	.76	.69
min.RH (%)	48.	37.	34.	34.	30.	30.	31.	34.
daywind (m/s)	4.4	4.7	4.0	3.6	2.8	2.8	3.1	3.3
D/N ratio	1.39	1.63	1.56	1.65	1.72	1.88	1.63	1.63
solar (mm/d)	5.90	8.64	10.61	10.93	11.22	9.60	7.75	5.47
max RH (%)	0.	86.	86.	86.	86.	85.	86.	89.
ave RH (%)	0.	62.	60.	60.	58.	57.	58.	61.

relationship (NRATIO =1) compare very well with clear sky solar radiation measured at Kimberly by Wright (1978), averaging about 4% lower than Kimberly values. The sum of the two coefficients used in the solar equation averages 0.78 for Kimberly clear-sky solar data.

Calculated a and b coefficients for use with the FAO-BC procedure are listed in Table 9 for the 10 PNWRBC stations and for Kimberly. The 'a' coefficient represents the intercept and 'b' is the slope of the line representing ET_o vs. the FAO-BC 'f' value where: $f = [P(0.46T + 8.13)]$ in equation 2.

The effect of higher relative humidity, lower wind speed and less solar radiation in northern Idaho relative to southern Idaho is accounted for by the lower values of 'b' for Coeur d'alene and Lewiston. Values of 'a' are greater for northern Idaho during most months. Coefficients calculated using Kimberly data follow those for the other south Idaho stations. Mountain Home, Gooding and Pocatello 'b' coefficients exceed those for other stations during some months, possibly due to the aridity of the weather site environment at these stations. Average monthly wind, minimum humidity and solar data for the secondary sites is shown in figures in Appendix B.

Temperature Data and Site Aridity

Air temperature data is available for over 100 weather sites in Idaho on a daily and monthly basis (NOAA, 1982) including maxima, minima and mean values. Lengths of record for NOAA stations vary from 12 to over 90 years.

The majority of temperature stations consist of maximum/minimum

Table 9. Coefficients a and b calculated for secondary weather stations used to adjust FAO-BC estimates.

		March	April	May	June	July	August	Sept.	Oct.
Coeur-d'alene	a	-1.59	-1.87	-1.80	-1.83	-2.12	-1.99	-1.89	-1.64
	b	.99	1.31	1.26	1.26	1.56	1.45	1.36	1.06
Lewiston	a	-1.67	-1.88	-1.91	-1.92	-2.16	-2.09	-1.95	-1.69
	b	1.12	1.30	1.30	1.32	1.53	1.47	1.35	1.09
Boise	a	-1.81	-1.95	-1.98	-2.02	-2.15	-2.11	-2.09	-1.91
	b	1.26	1.44	1.45	1.52	1.61	1.57	1.55	1.37
Mountain-Home	a	-1.84	-2.00	-1.96	-2.06	-2.17	-2.13	-2.08	-1.97
	b	1.32	1.51	1.48	1.58	1.62	1.59	1.54	1.45
Gooding	a	-1.85	-2.08	-2.03	-2.09	-2.14	-2.12	-2.10	-1.99
	b	1.30	1.63	1.57	1.62	1.60	1.58	1.58	1.47
Burley	a	-1.79	-2.01	-1.98	-2.06	-2.16	-2.12	-2.09	-1.99
	b	1.27	1.53	1.49	1.57	1.61	1.56	1.55	1.43
Malad	a	-1.77	-2.03	-1.94	-2.06	-2.16	-2.12	-2.09	-1.96
	b	1.14	1.43	1.35	1.46	1.56	1.55	1.50	1.32
Pocatello	a	-1.81	-2.01	-1.98	-2.07	-2.15	-2.10	-2.06	-1.93
	b	1.27	1.55	1.51	1.63	1.66	1.60	1.56	1.44
Idaho-Falls	a	-1.77	-2.02	-1.98	-2.04	-2.15	-2.09	-2.06	-1.92
	b	1.24	1.57	1.53	1.56	1.64	1.58	1.55	1.40
Dubois	a	-1.76	-2.04	-1.95	-2.01	-2.12	-2.06	-2.03	-1.93
	b	1.16	1.55	1.47	1.53	1.62	1.55	1.49	1.38
Kimberly USDA	a	-1.79	-1.92	-1.99	-2.01	-2.11	-2.06	-2.04	-1.95
	b	1.27	1.46	1.51	1.51	1.56	1.53	1.52	1.44

mercury thermometers housed in white, wooden NOAA "cotton region-type" shelters (CRS) about 4 feet above ground surface. Types of ground surface cover around the CRS may be dry, bare soil, unirrigated grass, weeds, or native vegetation, irrigated turf or pasture, or gardens. Shelters are often located near gravel or asphalt roads, streets and driveways, and near buildings and trees, all of which impact air temperatures in and near the shelter.

Siting and aridity affects on air temperature and vapor pressure have been studied and discussed by many researchers. Holmes (1970) recorded decreases of 3.0 and 2.0°C, respectively, in temperature of air traveling from virgin prairie to a large lake and to an irrigated region in Alberta during August, 1968. Air temperature at 20 meters elevation increased 2.0°C as air moved back to virgin prairie. Surface radiation temperatures measured over irrigated land averaged 10.0°C lower than over uncultivated prairie at 1430 hours during this same period.

Hanks et al (1971) studied temperature, vapor pressure and wind speed gradients along borders between dryland and irrigated fields of grain sorghum during August at Akron, Colorado. They determined that border advection, manifested by horizontal temperature and vapor pressure gradients, occurred over most of the irrigated plot, but was most evident from 0 to 40 meters from the upwind edge. Hanks et al measured air temperature differences of 2.5°C at 40 cm and 1.0°C at 2 meters above ground surface between the dryland and irrigated plots. Vapor pressure at 2 meters averaged 1.3 millibars (14%) higher over the irrigated plots as compared to dryland. Actual measured evapotranspiration rates averaged 5.1 mm/day from the irrigated sorghum and 3.2 mm/day from the dryland sorghum.

Burman et al (1975) measured decreased air temperature, increased vapor pressure and decreased wind speed along a transect extending from dry sagebrush land into the center of a large irrigated area in southern Idaho during August, 1972. Air temperatures averaged 1.0 to 3.0°C lower over irrigated sites than over desert. Vapor pressure deficits were 15 to 22 millibars less over irrigated areas and windspeed was reduced about 40 percent within the irrigated areas, mostly due to stability effects on momentum transfer over irrigated land. Calculated reference ET (potential) averaged 8 mm/day in the center of the irrigated area (Kimberly) and 10 mm/day at the desert site.

Hashemi and Habibian (1979) compared temperature, humidity and wind measurements at dryland and irrigated sites in southwestern Iran. Air temperatures during April, May, June, July and August averaged 2.0, 1.5, 2.5, 1.8, and 2.0°C higher over dryland than over irrigated areas. Relative humidity measurements were 5 percent lower over dryland and measured wind speed was 50 percent higher. Calculated reference ET using dryland weather averaged 1.3 mm/day greater than ET computed using weather measurements over irrigation. They concluded that ET computed using meteorological data from a station in a desert area tends to overestimate ET which will occur when a large irrigated agriculture is established within the area.

Allen (1983) measured differences in daily maximum and minimum air temperatures between two irrigated and two arid desert locations in southern Idaho during 1981. Average monthly departure of air temperatures over the arid sites from the irrigated sites are listed in Table 10 along with smoothed monthly aridity effects in degrees Celsius. These aridity values were used to adjust NOAA temperature data during this study, based on site descriptions, ground cover and local and regional irrigation distribution.

Calculated reference ET reported by Allen (1983) using weather data from the irrigated sites averaged 8.7 mm/day during July, whereas reference ET calculated using temperature and estimated dewpoint data from the desert site averaged 10.5 mm/day during the same period. Use of air and dewpoint temperatures from arid sites caused an overestimation of seasonal ET_r of 210 millimeters (17%) using Wright-1982 and 260 millimeters (21%) using FAO-BC.

Sensitivity of the FAO-BC to changes in mean monthly air temperature is summarized in Table 11. An overestimation of air temperature by 4^oC when actual air temperature over an irrigated field is 20^oC will cause the FAO-BC to overestimate ET_r by 11 percent (Table 11). A corresponding underestimation of dewpoint caused by using data from an arid site and the resulting decrease in relative humidity (caused by both lower dewpoint and higher maximum air temperature) will further increase overestimation of reference ET by the FAO-BC or Wright-1982 methods.

Rating of Temperature Stations

Site and equipment descriptions are filed for all current NOAA temperature stations in Idaho. These descriptions, termed B-44 forms, were made available by the National Weather Service Forecast Office in Boise, Idaho (Olson, 1981). The B-44 forms contain information concerning station location and layout, observer and equipment type. However, information concerning vegetative cover at and around the

Table 10. Average monthly departure of air temperatures over arid areas from air temperatures over irrigated areas in southern Idaho during 1981 and aridity effect used in adjusting data. From Allen (1982).

Month	Temperature Departure, C Maximum	 Minimum	 Average	Aridity
April	2.7*	2.4	2.5	1.0**
May	1.3	0.6	0.9	1.5
June	2.4	1.8	2.1	2.0
July	4.8	2.9	3.8	3.5
August	5.2	4.3	4.7	4.5
September	3.3	2.7	3.0	3.0
October	0.3	1.6	0.9	0.0

* difference between average of desert sites 2 and 4 and average of irrigated sites 1 and 3.

** aridity effect used to adjust mean monthly temperatures from NOAA stations

Table 11. Sensitivity of FAO-BC ET estimates to changes in air temperature.

Mean air temperature (celsius)	Increase in air temperature, C +1	 +2	 +3	 +4	 +5	 +6	 +7	 +8	 +10
	Sensitivity, % change in FAO-BC estimate								
10	3.6	7.3	11.0	14.6	18.3	21.9	25.6	29.2	36.5
15	3.1	6.2	9.3	12.3	15.4	18.5	21.6	24.7	30.9
20	2.7	5.3	8.0	10.7	13.4	16.0	18.7	21.4	26.7
25	2.4	4.7	7.1	9.4	11.8	14.2	16.5	18.9	23.6
30	2.1	4.2	6.3	8.4	10.6	12.7	14.8	16.9	21.1
35	1.9	3.8	5.7	7.6	9.5	11.5	13.4	15.3	19.1

stations is generally lacking.

A questionaire was developed and submitted to observers at 100 NOAA sites in Idaho. Information was requested concerning ground surface type around the weather sites, prevailing wind directions, land use types and irrigated areas and trends within a 1 mile radius and within a 30 mile radius around each site. About 70 of the 100 questionaires were returned. Unreturned questionaires were followed by phone conversations to obtain requested information.

Using information from the questionaires, B-44 forms and phone conversations, NOAA weather sites were objectively rated as to affects of aridity of the site and surrounding area on recorded air temperature. Results of the rating analyses are listed in Table 12. Cummulative ratings are based on ratings for the station, area and region, with most emphasis placed on the station and area environment and precipitation patterns. The mathematical relationship used to calculate cummulative station aridity is: Cummulative aridity = 0.4(Station aridity) + 0.5(Area aridity) + 0.1(Regional aridity). Cummulative aridity ratings are used in the consumptive use estimating program to adjust mean monthly temperatures to temperatures expected in a large, irrigated environment over a well-watered, actively growing grass or alfalfa. Temperature differences listed in column 4 of Table 10 are the maximum adjustments made (aridity = 100).

Results of Temperature Adjustment

Average reference ET estimates for April - October and for July, only are listed in Table 13 for three NOAA stations at Twin Falls. The

Table 12. Aridity ratings for Idaho NOAA weather stations for adjustment of mean monthly air temperatures.

Aridity ratings

0=Irrigated 100=Completely arid

	Station %	Area %	Region %	Cumm %	Ground Cover
Aberdeen Exp. Station	70*	30**	40***	45#	bare ground
American Falls 1 SW	90	40	15	60	bare ground
Anderson Dam	50	70	80	65	bare ground
Arbon 2 NW	50	40	40	45	garden
Arco 3 SW	30	70	70	55	grass
Ashton	10	50	20	30	grass
Bayview Model Basin	50	0	0	20	bare ground
Blackfoot 2 SSW	40	40	30	40	grass
Bliss	20	40	80	35	grass
Boise WSO AP	100	70	20	75	bare ground
Bonners Ferry 1 SW	10	40	20	25	grass
Bruneau	60	30	30	40	bare ground
Burley FAA AP	60	30	10	40	grass
Cabinet Gorge	40	30	20	35	bare ground
Caldwell	40	30	30	35	bare ground
Cambridge	20	40	20	30	grass
Cascade 1 NW	30	40	40	35	grass
Castleford 2 N	40	0	50	20	bare ground
Challis	80	50	25	60	bare ground
Chilly Barton Flat	60	50	50	55	bare ground
Coeur D'Alene 1 E	60	40	30	45	dry grass
Cottonwood	20	10	50	20	grass
Council	50	50	20	45	dry grass
Deer Flat Dam	10	0	0	5	grass
Driggs	30	20	10	25	grass
Dubois Exp. Station	80	90	100	90	bare ground
Emmett 2 E	20	20	30	20	grass
Fairfield Ranger Station	10	20	20	15	grass
Fort Hall Indian Agency	30	30	10	30	grass
Garden Valley RS	70	60	50	65	dry grass
Glenns Ferry	70	90	90	80	dry grass
Grace	30	30	0	25	bare ground
Grand View 2 W	50	10	90	35	bare ground
Grangeville	60	40	30	45	grass
Hailey Airport	70	70	50	70	bare ground
Hamer 4 Nw	20	90	50	60	dry grass
Hazelton	75	60	30	65	bare ground
Hill City	30	30	20	30	bare ground
Hollister	80	60	70	70	dry grass
Howe	20	100	80	65	grass

Table 12. Continued.

Aridity ratings

0=Irrigated 100=Completely arid

	Station %	Area %	Region %	Cumm %	Ground Cover
Idaho City	20	30	30	25	irr grass
Idaho Falls 2 ESE	75	50	20	55	bare ground
Idaho Falls 16 SE	30	40	40	35	grass
Idaho Falls FAA AP	90	70	30	75	dry grass
Idaho Falls 46 W	100	100	100	100	bare ground
Island Park Dam	60	10	10	30	bare ground
Jerome	90	60	10	65	bare ground
Kellogg	80	20	20	45	bare ground
Kilgore	30	10	10	20	bare ground
Kooskia	30	30	30	30	grass
Kuna 2 NNE	0	0	0	0	grass
Lewiston WSO AP	70	50	20	55	dry grass
Lifton Pumping Station	20	20	50	25	bare ground
Mackay Ranger Station	30	50	40	40	bare ground
Malad	20	50	60	40	grass
Malad City	40	50	60	45	dry grass
Malta 2 E	30	0	30	15	bare ground
May	50	50	10	45	bare ground
McCall	60	40	30	45	bare ground
Minidoka Dam	50	70	50	60	grass
Montpelier Ranger Station	70	30	20	45	bare ground
Moscow-Univ. of Idaho	20	15	10	15	wheatgrass
Mountain Home	80	65	90	75	bare ground
New Meadows Ranger Station	20	20	20	20	grass
Nezperce	10	20	20	15	bare ground
Oakley	20	40	80	35	grass
Ola 4 S	20	50	20	35	grass
Orofino	30	30	20	30	grass
Palisades Dam	90	40	40	60	bare ground
Parma Exp. Station	30	0	0	10	bare ground
Paul 1 ENE	40	25	10	30	bare ground
Payette	10	20	0	15	grass
Picabo	30	10	10	20	grass
Pocatello WSO AP	100	90	60	90	roof top
Porthill	70	30	30	45	grass
Potlatch 3 NNE	10	10	10	10	grass
Preston Sugar Factory	50	40	20	40	bare ground
Reynolds	90	90	80	90	range
Richfield	30	40	50	35	grass

Table 12. Continued.

	Aridity ratings 0=Irrigated 100=Completely arid				
	Station %	Area %	Region %	Cumm %	Ground Cover
Riggins	80	60	60	70	bare ground
Rupert	60	50	20	50	bare ground
St Anthony 1 WNW	40	70	60	55	bare ground
Saint Maries	50	30	30	40	dry grass
Salmon	80	80	80	80	dry grass
Salmon 1 N	80	80	80	80	grass
Sandpoint Exp. Station	10	50	20	30	grass
Shoshone 1 WNW	100	50	80	75	bare ground
Stanley	60	60	60	60	dry grass
Strevell	20	60	80	45	grass
Swan Falls Power House	100	75	80	85	bare ground
Swan Valley	40	20	40	30	bare ground
Tensed	20	15	10	15	grass
Tetonia Exp. Station	10	10	10	10	grass
Three Creek	80	80	80	80	bare ground
Twin Falls 2 NNE	90	40	10	55	bare ground
Twin Falls 3 SE	50	30	0	35	grass
Twin Falls WSO	0	0	0	0	grass
Weiser 2 SE	40	10	0	20	dry grass

* Rating of immediate temperature sensor environment (50 meter radius).

** Rating of area within 1 mile (1600 meter) radius in upwind direction.

*** Rating of area within 30 mile (48 km) radius in upwind direction.

Cummulative rating used to adjust air temperature data.
The cummulative rating is based primarily on station and area ratings and is only slightly influenced by regional effects (regional advection).
The cummulative rating is calculated as:
Cumm = 0.4(Station) + 0.5(Area) + 0.1(Regional) aridity ratings.

effect of adjustment of mean temperatures for estimated station aridity effects on ET_r as estimated by the FAO-BC is apparant. Differences between seasonal estimates for Twin Falls 2NNE and Twin Falls WSO were reduced from 96 mm (3.8 inches) to 20 mm (0.8 inches). The Twin Falls 2NNE station was sited in northeast Twin Falls, over bare ground near buildings, asphalt streets and parking lots. The WSO station is sited in an agricultural setting (Kimberly USDA-ARS) over irrigated grass.

The effect of adjusting station temperature records downward based on station aridity is also illustrated by comparing Tables C-3 and C-5, Figures C-2 through C-10 and Figures C-19 through C-27 in Appendix C. The figures especially illustrate the smoothing of reference ET estimates among station groupings, indicating that adjustments to specific stations are reasonable. The net effects of the adjustments are consumptive use estimates representative of irrigated crops in developed areas greater than 500 acres in size, which is the likely case for the vast majority of irrigated development in Idaho. In irrigated developments less than 500 acres in size, border advection of hot, dry air masses from adjacent, dry lands would begin to create a discernable increase in average consumptive use over the developed area. In these instances, consumptive use estimates should be increased.

Effective Precipitation

Monthly estimates of effective precipitation were calculated during this study using a method developed and reported by the SCS (1967b). Estimates were based on monthly precipitation, crop consumptive use and available soil moisture (rooting depth) and were calculated for each crop. The SCS method is applicable to arid areas with high intake soils

Table 13. Result of adjustment of mean monthly temperatures for Twin Falls weather stations.

	Stations		
	Twin Falls 2NNE	Twin Falls 3SE	Twin Falls WSO
Aridity rating, %	55	35	0
Average seasonal ETR, mm			
without temp. adjustment	1446	1418	1350
with temp. adjustment	1376	1374	1350
Average July ETR, mm/day			
without temp. adjustment	8.9	8.8	8.3
with temp. adjustment	8.3	8.4	8.3

with little runoff. It was developed using 50 years of precipitation and consumptive use data at 22 stations throughout the United States. Soil intake rates and rainfall intensity were disregarded in method development (SCS, 1967b).

Selection of Crop Coefficients

Estimating ET for a specific crop can be a very complex process, depending on the degree of refinement used. To obtain accurate estimates, all major contributing crop and environmental conditions must be considered. These include climate, soil moisture, crop type, stage of growth, stomatal resistance and control, and relative leaf area and surface cover.

The development of the reference ET (ET_r) concept has enabled integration of crop variables into linear ET_r multipliers termed crop coefficients. The use of time-variable crop coefficients with a reference ET estimate is widely used in irrigation scheduling, irrigation planning and in estimation of crop water requirements.

Crop ET is estimated with crop coefficients and a reference ET using the following procedure:

$$ET_{cj} = K_{cj}\, ET_{rj} \qquad (3)$$

where: ET_{cj} = Consumptive use by crop "c" during time period j

K_{cj} = Mean crop coefficient for crop "c" during period j

ET_{rj} = Reference ET during period j.

Crop coefficient K_{cj} is dimensionless; therefore ET_{cj} and ET_{rj} have equivalent units.

Information concerning types and application of crop coefficients has been published in many references (Burman, et al, 1980). The magnitude and shape of crop coefficient curves for growing seasons vary widely, depending on the reference or ET method used with the coefficients.

The SCS (1967b) published a series of "crop growth stage coefficient curves" used to estimate monthly crop consumptive use based on the SCS-modified Blaney-Criddle method presented in the same report. Crop growth stage coefficients for many crops were plotted versus percent of growing season to allow adjustment of the shape of the curve depending on length of the growing season. Crop growth stage coefficients should be used only with the SCS-modified Blaney-Criddle, as these coefficients are not based on a particular reference.

Pruitt (Doorenbos and Pruitt, 1977; Burman et al, 1980) developed time-variable crop coefficients for use with a grass reference (ET_o) using data from Davis, California and FAO sources. These coefficients have higher values than alfalfa-based coefficients due to differences in the grass and alfalfa references.

Wright (1981a; 1982a; Burman et al, 1980) presented time-variable crop coefficients based on an alfalfa reference (ET_r) using lysimeter measurements at Kimberly, Idaho. These coefficients can be used to estimate consumptive use on a daily basis for irrigation scheduling. Two sets of crop coefficients have been published by Wright for two different uses. "Mean" crop coefficients (Wright, 1981a) can be used to estimate evapotranspiration by actively growing crops where evaporation from the crop and soil surface due to irrigation and precipitation are accounted for within the coefficient values. The surface evaporation effects are for average occurances of precipitation and irrigation of a silt loam soil in southern Idaho. "Basal" crop coefficients (Wright 1974; 1982a; Burman et al, 1980) estimate evapotranspiraton by crops with dry soil surface conditions in an effort to make the coefficients independent of soil type and irrigation and precipitation frequencies. Numeric adjustment of the basal coefficient for effects of surface wetness and soil drying properties must be done separately using an exponentially shaped drying curve. Length of the curve is based on soil type and magnitude is based on the calculated value of the crop coefficient during the specific time period. The sum of surface evaporation and crop ET is limited to less than or equal to the reference ET (Wright, 1981a).

Comparisons of mean and basal crop coefficients (K_{cm} and K_{cb}) are shown for a bean crop at Kimberly, in Figure 19, and for a generalized crop with a normalized time axis in Figure 20. The K_c curve in Figure 19 represents actual lysimeter measurements divided by calculated ET_r. This curve indicates the large fluctuations in daily K_c values resulting from wet surface evaporation, measurement variation, or other factors. The K_{cm} curve is a result of a smoothing of the measured Kc values, incorporating the effects of surface evaporation. The basal (K_{cb} curve) represents the ratio of crop ET to reference ET when a dry soil surface condition exists.

Figure 20 includes the adjustments made to the basal curve to compensate for known occurrences of irrigation and precipitation. The

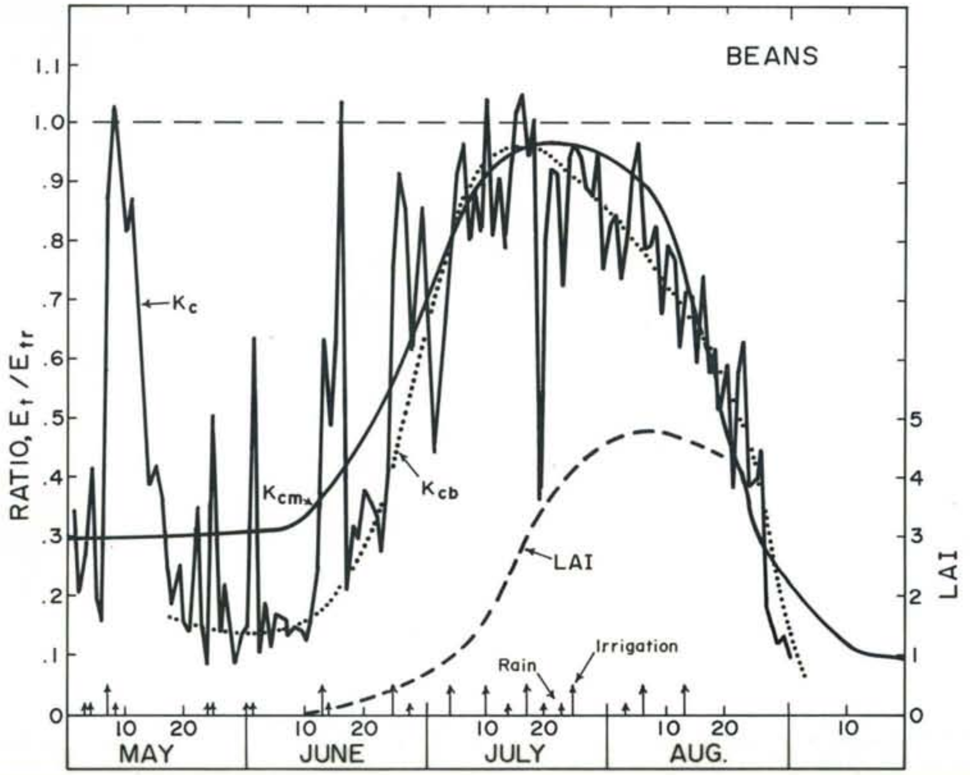

Figure 19. Daily crop coefficient (k_c), calculated by dividing crop ET measured with lysimeter by computed reference ET; fitted basal coefficient (k_{cb}) curve; mean crop coefficient (k_{cm}) curve; and measured leaf-area-index (LAI) for snap beans raised to maturity at Kimberly, Idaho (from Wright, 1982a).

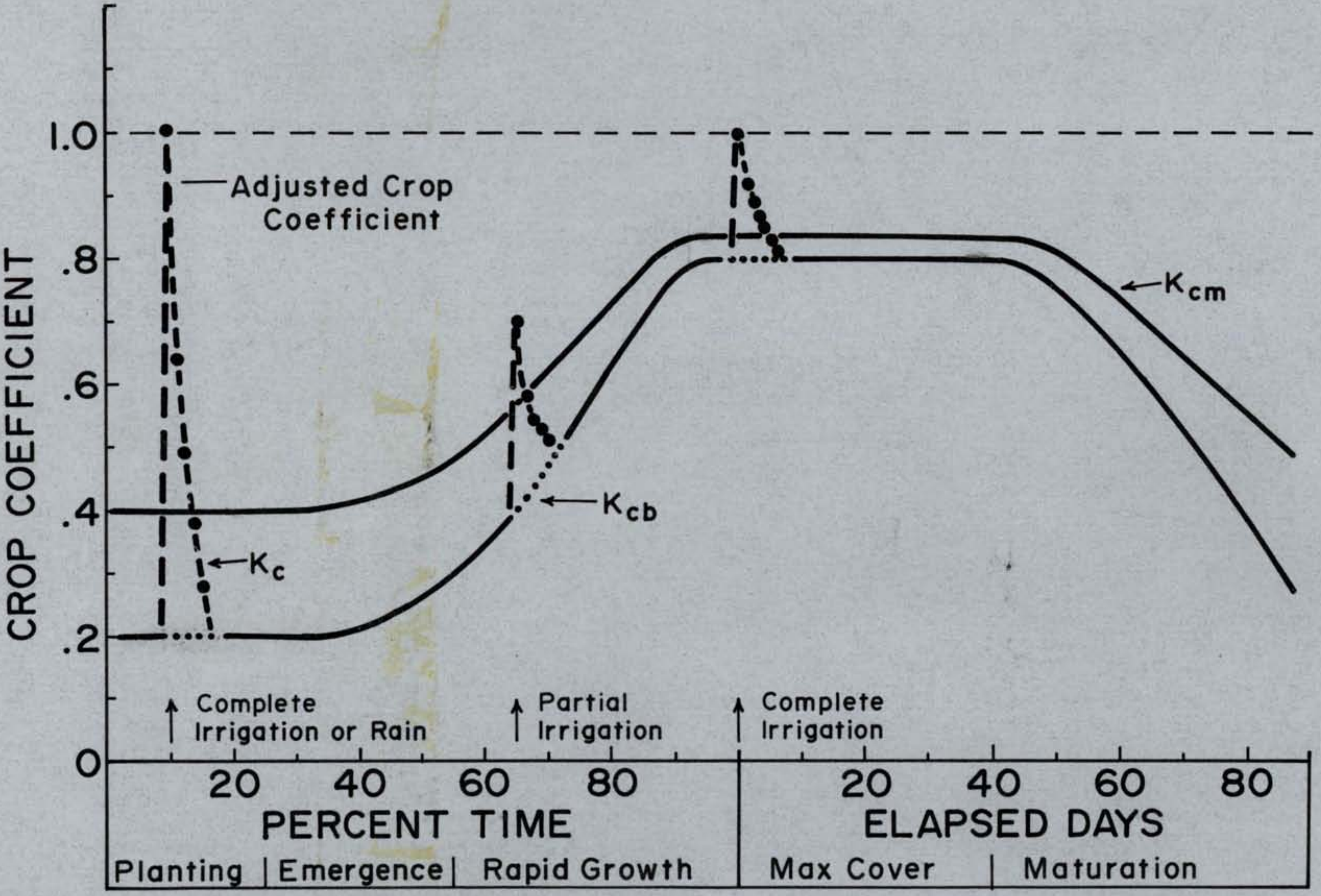

Figure 20. Generalized basal ET crop coefficient, Kcb, curve showing adjustment of the crop coefficient, Kc, for wet surface soil due to irrigation and the resulting mean crop coefficient curve (after Wright, 1981a).

normalized time base plotted in Figure 20 is used for both basal and mean coefficients. Both types of coefficients are to be used to estimate ET from a crop which is not limited by lack of soil moisture with the root zone.

Grass reference-based crop coefficients reported by Doorenbos and Pruitt (1977) were graphically compared to alfalfa-based mean crop coefficients reported by Wright (1981a). Grass-based coefficients were divided by 1.15, a general alfalfa/grass coefficient suggested for a Kimberly-type climate (Doorenbos and Pruitt, 1977). The two curves compared well for most crops after adjustment of lengths of crop development stages for the grass-based coefficients. A major disagreement occurred for potatoes, however, with the FAO (grass reference) curve peaking about 20% above the alfalfa-reference curve. This difference may be due to differences in potato cultivars used to develop the curves (Irish vs. Russet-Burbank) or due to climatic differences between the areas used in curve development.

Mean crop coefficients reported by Wright (1981a) are listed in Table 14. Coefficients are presented in a normalized form with the abscissa (time axis) divided into percent time from planting to effective cover and days after effective cover, as shown in Figure 20. Average dates of growth stages for crops at Kimberly are listed in Table 15.

Because crop coefficients by Wright were developed for southern Idaho conditions using Kimberly lysimeter data and because the FAO-BC with the reference ratio calibration predicts alfalfa reference ET very well for southern Idaho sites (Figures 6-11), mean crop coefficients

Table 14. Daily mean ET crop coefficients (Kc), for normal irrigation and precipitation conditions, for use with alfalfa reference ET for crops grown in an arid region with a temperate intermountain climate. Coefficients were experimentally determined from weighing lysimeter ET data, Kimberly, Idaho, 1968-78. (From Wright, 1981.)

	Mean ET crop coefficients, Kc									
	Time from planting to effective cover (%)									
Crop	10	20	30	40	50	60	70	80	90	100
Barley	0.30	0.30	0.32	0.40	0.65	0.85	0.95	0.99	1.00	1.00
Peas	0.30	0.30	0.30	0.36	0.43	0.51	0.58	0.73	0.85	0.93
Sugar Beets	0.30	0.30	0.30	0.30	0.30	0.32	0.40	0.60	0.80	1.00
Potatoes	0.30	0.30	0.30	0.31	0.44	0.57	0.69	0.77	0.82	0.85
Corn	0.30	0.30	0.30	0.30	0.32	0.42	0.55	0.70	0.85	0.95
Beans	0.30	0.30	0.30	0.35	0.45	0.55	0.68	0.80	0.90	0.95
Winter Wheat	0.30	0.30	0.50	0.75	0.90	0.09	1.00	1.00	1.00	1.00
	Days after effective cover(%)									
	10	20	30	40	50	60	70	80	90	100
Barley	1.00	1.00	0.90	0.50	0.25	0.15	-	-	-	-
Peas	0.90	0.65	0.53	0.35	0.20	0.15	-	-	-	-
Sugar Beets	1.00	1.00	1.00	0.98	0.94	0.89	0.85	0.80	0.74	0.60
Potatoes	0.85	0.83	0.81	0.79	0.75	0.70	0.65	0.50	0.35	0.25
Field Corn	0.96	0.95	0.94	0.90	0.85	0.79	0.74	0.35	0.25	-
Sweet Corn	0.93	0.93	0.90	0.85	0.75	0.58	0.40	0.20	-	-
Beans	0.95	0.90	0.67	0.33	0.15	0.10	-	-	-	-
Winter Wheat	1.00	1.00	1.00	0.95	0.55	0.25	0.15	0.15	-	-
	Time from new growth to harvest (%)									
	10	20	30	40	50	60	70	80	90	100
Alfalfa (1st)	0.70	0.82	0.91	0.96	1.00	1.00	0.98	0.96	0.95	0.95
(2nd & 3rd)	0.40	0.50	0.80	0.96	0.98	1.00	1.00	0.98	0.95	0.95
(4th)	0.40	0.44	0.60	0.65	0.55	0.50	0.45	0.35	0.30	0.25

Table 15. Dates of crop growth stages identifiable in the field for use with crop curves, Kimberly, Idaho, 1968-78. (From Wright, 1981.)

	Month/Day						Days	
Crop	Plant	Emerge	Full Cover	Heading/ Bloom	Ripe	Harvest	Planting to cover	Cover to harvest
Barley	4/4	4/15	6/20	6/20	7/15	8/10	80	55
Peas	4/10	4/25	6/05	6/15	7/05	7/25	55	50
Sugar Beets	4/15	5/10	7/10	-	-	10/15	85	95
Potatoes	4/25	5/25	7/10	7/01	9/20	10/10	75	90
Field Corn	5/5	5/25	7/15	7/30	9/10	9/20	72	70
Sweet Corn	5/5	5/25	7/15	7/20	8/15	8/15	72	30
Beans	5/22	6/05	7/15	7/05	8/15	8/30	55	45
Winter Wheat	(2/15)*	(3/01)	6/05	6/05	7/15	8/10	(110)	60
Alfalfa(1st)	4/01**					6/15		76
(2nd)	6/15					8/01		46
(3rd)	8/01					9/15		46
(4th)	9/15					10/30		46

* Effective dates in parenthesis. Crop planted on 10/10 and emerged 10/25.

** Effective planting date for established alfalfa is date growth begins in spring or harvest of preceding crop. Final harvest is date crop becomes dormant.

reported by Wright (1981a) were used during this study to estimate monthly crop consumptive use for Idaho stations. A computer routine incorporating coefficient data listed in Table 14 is described in a following section of this chapter.

Development of Additional Crop Coefficients

Alfalfa-based crop coefficients for some Idaho crops, such as onions, orchards, hops, small vegetables, and alfalfa seed have not yet been developed for Idaho. Coefficient curves for these crops were adapted to an alfalfa reference during this study by conversion of coefficients for a grass reference or comparison with consumptive use data from other sources. A mean curve for estimating consumptive use by alfalfa hay, including cutting effects, was developed using coefficient data reported by Wright (1981a). Normalized coefficients developed during this study are presented in Table 16.

Coefficients for onions were adapted using mid-season and maturity coefficients and lengths of stage development presented by Doorenbos and Pruitt (1977). Coefficients for small vegetables were excerpted from the same source. The coefficient curve and normalized time scale developed for small vegetables is an average for cabbage, cauliflower, broccoli, radishes, tomatoes, peppers and squash.

Two normalized, alfalfa-based coefficient curves were developed for orchards. The two curves, one for fruit trees without ground cover and one for fruit trees with ground cover, were developed from coefficient data presented for apple and cherry trees by Doorenbos and Pruitt (1977). These curves represent mature trees with infrequent wetting by

Table 16. Daily mean ET crop coefficients (Kc), for normal irrigation and precipitation conditions, for use with alfalfa reference ET for crop growth in Idaho. Coefficients were determined from published research.

	Mean ET crop coefficients, Kc									
	Time from planting to effective cover (%)									
Crop	10	20	30	40	50	60	70	80	90	100
Fruit trees, no cover	0.40	0.46	0.51	0.58	0.66	0.73	0.77	0.81	0.85	0.85
Fruit trees, cover	0.45	0.62	0.75	0.85	0.93	1.00	1.03	1.05	1.07	1.07
Small vegetables	0.30	0.35	0.40	0.50	0.55	0.60	0.65	0.70	0.75	0.80
Onions	0.30	0.35	0.40	0.50	0.55	0.60	0.65	0.70	0.75	0.80
Hops	0.30	0.30	0.30	0.35	0.40	0.60	0.75	0.87	0.92	0.95
Alfalfa seed	0.55	0.65	0.72	0.78	0.84	0.87	0.88	0.89	0.89	0.90
	Days after effective cover(%)									
	10	20	30	40	50	60	70	80	90	100
Fruit trees, no cover	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.80	0.70
Fruit trees, cover	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.00	0.85
Small vegetables	0.80	0.80	0.80	0.80	0.75	0.70	0.65	0.55	0.45	0.40
Onions	0.80	0.80	0.80	0.80	0.80	0.80	0.75	0.70	0.65	0.60
Hops	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.93	0.90
Alfalfa seed	0.90	0.90	0.90	0.88	0.86	0.84	0.75	0.62	0.50	0.45
	Time from green-up to frost* (%)									
	0.0	3.5	7.0	10.5	14.0	83.0	87.3	91.5	95.8	100.
Mean alfalfa hay	0.55	0.71	0.83	0.91	0.95	0.70	0.63	0.50	0.36	0.25

*Last occurence of 24 degrees Fahrenheit in spring until first occcurence of 24 degrees Fahrenheit in fall.

irrigation or rain. For young orchards with tree cover of 20 to 50%, consumptive use estimates reported using these curves should be reduced by 30 to 20% respectively for orchards without ground cover and 10 to 7% respectively for orchards with ground cover.

Consumptive use by hops has been reported by Middleton (1963) based on soil moisture measurements made during 1959-1961 at Prosser, Washington. Consumptive use from mid-June to mid-August averaged 470 mm (18.5 inches). Pan evaporation averaged 640 mm (25 inches) during the same period. Based on these reported results and on observations by Romanko (1982) at Parma, Idaho, a normalized curve was developed for hops, peaking at 0.95 as shown in Table 16.

Consumptive use of water by alfalfa grown for seed production is highly dependent upon stand management, soil type, and amounts and timing of irrigations. Many researchers and growers have concluded that seed yields are often maximized when irrigations are reduced and crop ET is suppressed. Kolar and Kohl (1976), during irrigation trials on alfalfa seed grown on a deep silt loam at Kimberly, found that consistantly good seed yields occurred with two irrigations per season, one in late May and one when available moisture in the upper 2.3 meters (7.5 feet) of soil was largely depleted.

On deep soils in Nevada, Mahannah (1973) found that an irrigation of 380 mm (15 inches) applied in November with an additional 130 mm (5 inches) applied in late May produced more seed than when an irrigation of 115 mm (4.5 inches) in July was added to the previous irrigations. Actual crop use varied from 440 mm to 625 mm (17.5 to 24.6 inches) per year for seed whereas alfalfa for hay used from 1140 to 1220 mm (45 to

48 inches).

Depression of ET through reduction of irrigation tends to discourage green top growth and encourages seed production. However, some transpiration is necessary to carry on plant maintenance processes and for bloom and seed growth. Large applications of water after initial flower bloom can encourage additional regrowth, reducing seed production (Melton, 1972).

Based on published research findings and irrigation and cultivation practices by growers in south-central and south-western Idaho, a normalized crop coefficient curve was developed for alfalfa seed crops, assuming depression of ET due to reduction of irrigation applications. Coefficients from this curve are listed in Table 16 and Figure 21. In instances where alfalfa seed is watered in a manner similar to alfalfa hay, consumptive use will increase toward that of hay. However, lodging of the mature, seed-bearing plants will limit ET to below that for the alfalfa reference (Wright, 1982b).

Because cutting dates of alfalfa hay vary widely from year to year, and according to management attitudes of growers, a mean alfalfa hay curve was developed during this study which incorporates smoothed effects of cuttings on ET. The mean coefficients provide consumptive use estimates for hay which follow a smooth curve through the growing season, whereas actual ET from alfalfa hay decreases greatly immediately after cutting (Wright, 1981a).

Long-term average daily ET estimates for alfalfa hay at Kimberly using mean coefficients and actual coefficients which follow cuttings are plotted in figure 21. Also included in the figure are curves representing ET for seed alfalfa and the alfalfa reference. The areas under the two curves representing ET from alfalfa hay are similar, totaling 941 and 929 mm for a typical growing season. Monthly and seasonal ET totals for the four curves plotted in figure 21 are listed in Table 17.

All crop coefficients presented for alfalfa hay estimate consumptive use for a healthy, disease-free, actively growing, insect-free, well-watered crop with no windrow or compaction effects. Wright (1982b) and Hill (1980) have shown that consumptive use by alfalfa is often linearly proportional to dry matter yield. Therefore, consumptive use estimates for alfalfa hay using the procedures and coefficients in this report may require downward adjustment for areas with suboptimal yields. Wright (1982b) reported yields from lysimeter and adjacent research fields averaged 17.3 tonne/ha (7.8 tons/acre) at 12% moisture over a 7 year period. The Twin Falls county average for alfalfa hay is about 13.3 tonne/ha (6 tons/acre). New alfalfa varieties introduced into Idaho within the last ten years with Flemish background also tend to use less water due to lodging of the fine-stemmed plants (Wright, 1982b).

Crop Stage Development Dates

A questionaire was sent out to each county extension office in Idaho requesting average dates of planting, emergence, effective cover and harvest for all crops grown in each county. Response to the questionaire was generally poor, with only 65% returned. Of those returned, few included reasonable estimates for crop stage development. The returned questionaires were helpful, however, in quantifying crops

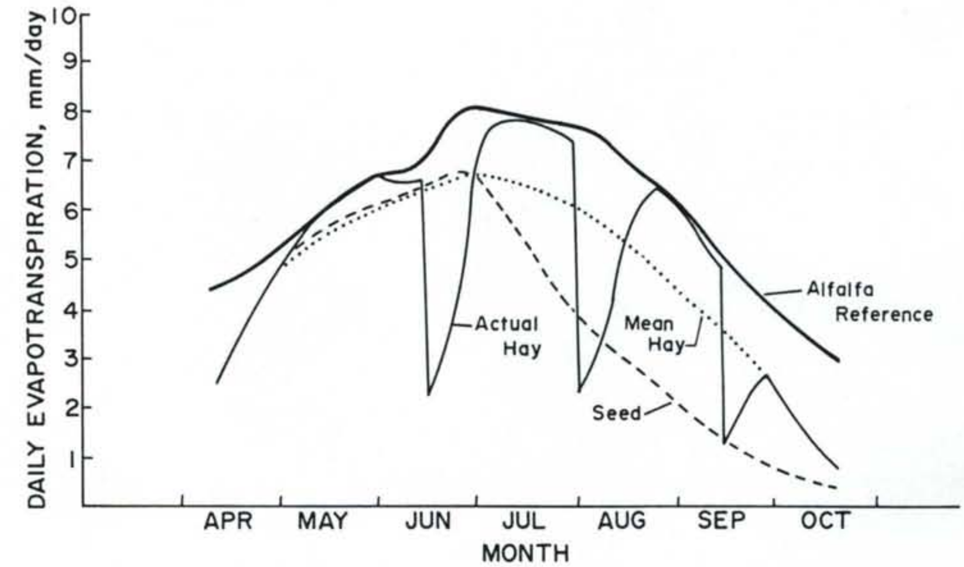

Figure 21. Smoothed fourteen-year average daily ET estimates for alfalfa reference, seed alfalfa and alfalfa hay for Kimberly, Idaho, 1965-1978 (after Wright, 1981a)

Table 17. Average Monthly ET for alfalfa hay, alfalfa seed and reference alfalfa for Kimberly, Id. April 10-October 20, 1965-1978.

	Monthly Evapotranspiration, millimeters (inches)			
	Alfalfa Hay 3 cuttings	Alfalfa Hay Mean cut	Alfalfa Seed	Et_r
April	73 (2.9)	74 (2.9)	81 (3.2)	97 (3.8)
May	185 (7.3)	176 (6.9)	188 (7.4)	190 (7.5)
June	154 (6.1)	191 (7.5)	199 (7.9)	218 (8.6)
July	235 (9.3)	197 (7.8)	186 (7.4)	242 (9.5)
August	152 (6.0)	161 (6.3)	134 (5.3)	212 (8.4)
September	110 (4.3)	102 (4.0)	73 (2.9)	150 (5.9)
October	29 (1.1)	27 (1.1)	25 (1.0)	69 (2.7)
Seasonal	941 (37)	929 (37)	889 (35)	1180 (47)

grown within specific areas of counties.

Fifty-three agricultural regions within Idaho were identified for which dates of crop stage development were estimated. Delineation of regions was based on topography, geography, elevation, weather patterns and weather station proximity.

Dates for planting, greenup, cover and harvest can vary widely from year to year and farm to farm, depending on temperature, precipitation, soil types and cultural practices. Often, however, cover and harvest dates vary considerably less than dates of planting due to greater amounts of degree-days and longer day lengths during midseason, which in effect convert large differences in the number of low energy days in early season to small differences in the number of high energy days later on.

The Bureau of Reclamation has developed and tested procedures for relating crop stage development to a cummulative potential ET calculated using the Jensen-Haise radiation equation. This approach attempts to account for intraseasonal variation in crop development due to variation in weather patterns, most notably radiation and temperature, as reflected in the Jensen-Haise equation. Planting dates for crops must be known, however, and the procedure is still in the testing stages (Buchheim and Brower, 1981).

James, et al (1982) estimated dates of planting and greenup for specific years based on a running 30-day average of mean air temperature. Mean temperatures at which planting or greenup occurs were taken from the Irrigation Water Requirements publication by the SCS (1967b) or from previous work in the state of Washington. No attempt was made to adjust lengths of growth stage development after planting depending on weather during each season. Therefore, delay of planting by 20 days, for example, due to cool spring temperatures was assumed to cause crop development, effective cover and harvest dates to lag by an equal amount. This assumption may not hold true depending on crop types grown. In addition, effects of frost and day-to-day temperature trends on planting or initiation of growth are not accounted for in this approach.

Because cool, wet springs may often be followed by hot, dry summers and vice versa, and because crop development varies with farm and field, it was assumed during this study that dates of planting, greenup, effective cover and harvest are randomly and normally distributed about long-term means. Using this assumption in addition to the fact that reference evapotranspiration in southern Idaho has been found to also be normally distributed (Allen, 1980; Wright and Jensen, 1972; Allen and Wright, 1983), statistics of consumptive use estimates using average dates of planting, cover and harvest should not significantly deviate from actuality.

Information sources used in determining average dates of planting, effective cover and harvest included Wright (1981a), USBR crop information (McVey, 1981), questionaires from and conversations with county extension agents, and Idaho Agricultural experiment station bulletins pertaining to crop weather calendars (Faubian, 1975), soil temperatures (McDole et al, 1980), freezing temperatures and growing seasons (Everson et al, 1978), and growing degree days (Everson et al, 1976) for areas within the state of Idaho.

Planting or greenup dates for cereals and row crops were largely based on Wright (1981a) (Table 15) with adjustment of dates for other sites determined by variation in air temperature, soil temperature and growing degree days of areas as compared to Twin Falls. Greenup for alfalfa at all sites was based on the last average occurrence of 24°F in the spring (Everson et al, 1978) and freeze-down was based on the first average occurrence of 24°F in the fall. These dates compare very well with observed dates of greenup and freeze-down at Kimberly and in western Idaho. Grass pasture was assumed to begin growth 7 days before the last average occurrence of 24°F in the spring and cease 7 days after the first average occurrence of 24°F in the fall (Kruse and Haise, 1974).

Leaf development for orchards and planting and growth of vegetable crops was based on freezing temperature data and growing degrees. Planting and growth stage dates for lentils and peas grown in northern Idaho were based on telephone conversations with county extension agents and University of Idaho, College of Agriculture faculty at Moscow.

Dates for heading and harvesting of grain, and cover and die-down of potatoes for southern Idaho were determined from information by Roylance (1965) and Kleinkopf (1982).

The length of time between planting (greenup) and effective cover were held constant among sites for the crops alfalfa seed, beans, corn, sugar beets, cereals, pasture, orchards, vegetables, onions and hops. Lengths of time between effective cover and harvest were held essentially constant among sites for the crops beans, corn silage, sweet corn, peas, spring grain and hops. Time lengths varied, depending on location and elevation for other crops. Tables of estimates of crop growth dates for Idaho areas are included in Appendix Table C-2.

Crop coefficients listed in Tables 14 and 16 were included in a computer routine described in the following section.

Computer Programs

Monthly estimates of consumptive use and resulting statistics were calculated using the computer program CONSU. This program, written in FORTRAN IV, was developed specifically for this study. A listing of CONSU is included in Appendix D.

The consumptive use method employed in CONSU is the FAO-Blaney-Criddle with Kimberly reference ratios and an elevation correction. Crop coefficients used include mean coefficients developed by Wright (1981a) based on an alfalfa reference.

Data requirements for CONSU include monthly average mean daily temperature and monthly precipitation totals for each NOAA weather station for the available period of record. Temperature and precipitation can be read directly from a tape of monthly valus supplied by NOAA for all stations in the state of Idaho or data can be read from a condensed data file maintained on the HP-1000 computer system at Kimberly. Results are equivalent.

Other data required by CONSU include secondary weather parameters listed in Table 8 for 11 Idaho sites, NOAA weather station descriptors and tape information listed in Table I of Appendix C for each station, and crop stage dates for 56 locations throughout the state. Crop stage dates are included in Table 2 of Appendix C.

Program CONSU generates "a and b" coefficients required by the FAO-BC method and estimates reference ET using portions of programming exerpted from FAO24. The "a and b" coefficients are calculated from tables in program memory for the secondary weather stations. These coefficients are applied to all temperature stations within each secondary weather region (Table C-1 and Figure C-1 in Appendix C). Crop coefficient curves and monthly averages are calculated using subroutine CROP and growth stage dates for the area of interest. Monthly consumptive use is estimated by multiplying reference ET by mean monthly coefficients for crops grown within the weather station area. Irrigation requirements require estimation of effective rainfall, which is calculated using the SCS method (1967b). Maximum net irrigation application depths are included in CONSU for each crop type.

Calculation of Consumptive Use

Monthly means, standard deviations and skews were calculated for reference ET, consumptive use, irrigation requirement and precipitation using available lengths of weather records. Statistics were computed for all crops specified for the agricultural region representing the weather site. These statistics, along with intermediate and summary data, were written to disk files and to paper. The percent of months with nonzero values for precipitation were also recorded.

A program entitled IDAMP was used to plot monthly means and standard deviations of computed reference ET for each Idaho station onto a line printer map of the state of Idaho for comparative purposes.

Program IDAMP was also used to plot the month and day of crop growth stages. Results of program IDAMP are included in Appendix C.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Four consumptive use methods presented by the United Nations Food and Agricultural Organization (FAO) (Doorenbos and Pruitt, 1977) and the Jensen-Haise, SCS-modified Blaney-Criddle, standard Penman and Wright-modified Penman (Wright, 1982a) methods were compared using daily weather data from the USDA-ARS Snake River Conservation Research Center at Kimberly, Idaho. The FAO-modified Blaney-Criddle (FAO-BC) method was selected as the best method for estimating consumptive use on a statewide basis, based on accuracy and responsivness of the equation and the primary data requirement of air temperature, only. An additional benefit of using the single-parameter FAO-BC is that it can be used as a multiple-parameter method where measured values of wind, humidity and solar radiation are available.

Reference ET estimated by the FAO-BC was compared with reference ET estimated using the Wright-modified Penman at four agricultural sites across Idaho. The Wright method includes a wind term calibrated to precision lysimeter measurements of alfalfa ET at the Kimberly site (Wright, 1982a) and closely approximates actual ET by an actively growing alfalfa crop (Jensen, 1974).

Comparison of the FAO-BC and Wright methods at the four sites verified the need for adjustment of FAO-BC estimates to account for elevation effects on radiation and air temperature. The ten percent upward adjustment to FAO-BC estimates per 1000 meters elevation suggested by Pruitt (Doorenbos and Pruitt, 1977) caused the FAO-BC to compare well with the Wright method at all sites. Site elevations ranged from 680 meters elevation at Wilder to 1480 meters elevation at Rexburg. Alfalfa/FAO-BC reference ratios developed using Kimberly data were also found to be transferrrable to other Idaho sites.

Secondary weather data requirements of the FAO-BC include daytime wind speed, minimum relative humidity and percent possible sunshine. Secondary weather data published by the Pacific Northwest River Basins Commission (1968) for 10 Idaho locations was reformatted for use with this study. Relative humidity data was adjusted in some instances to reflect an agricultural setting. Solar weather data published by Satterlund and Means (1979) was also used. Daytime wind speeds and calculated day/night ratios are reported.

Because many National Oceanic and Atmospheric Administration (NOAA) supported weather sites are situated in dry, nonagricultural settings, air temperatures recorded at many stations are greater than those experienced above a well-watered, actively growing and transpiring agricultural crop. Use of arid temperatures with a consumptive use method calibrated using agricultural Weather data can lead to overestimation of consumptive use requirements. Consequently, NOAA weather stations throughout Idaho were objectively rated according to the degree of station aridity and environment effects on air temperatures. Monthly mean temperatures from each NOAA site were adjusted downward according to the station aridity rating and maximum aridity effects reported by Allen (1983; Allen et al, 1983).

Statistics were computed for consumptive use estimated using the calibrated FAO-BC with long-term average secondary data, the calibrated

FAO-BC with yearly averages of monthly secondary data (short term) and with the Wright-modified Penman method. Population means were quite similar among methods; however, standard deviations calculated for monthly consumptive use estimates over a fourteen year period varied among methods used. Standard deviations for the FAO-BC with long term secondary data were half the value of standard deviations calculated for the FAO-BC with short-term secondary data and for the Wright-method. This result is due to use of a single-parameter method as opposed to a multiple parameter consumptive use method where variations within individual weather parameters are better reflected in the equation estimate. Results of these comparisons indicate that coefficients of variation for the single-parameter FAO-BC should be adjusted to account for variation of weather parameters held constant during equation use.

Crops cultivated in various agricultural regions of Idaho were identified and dates of crop growth stage development were determined. Crop coefficient curves based on an alfalfa reference were developed for fruit trees, small vegetabless, onions, hops and alfalfa seed.

A computer routine was written to compute monthly consumptive use and irrigation requirements for 98 NOAA weather sites in agricultural areas of Idaho.

Recommendations

Based on results of this research, it is recommended that coefficients of variation (standard deviation/mean) be adjusted before frequency analyses of consumptive use estimated using the FAO-BC with longterm secondary data are performed. Without necessary adjustment, risk levels calculated using FAO-BC estimates will not represent probabilities of real occurrence.

Consumptive use by crops for periods of less than thirty days duration are useful in design and scheduling of irrigation and river operation systems. It is recommended that consumptive use for periods of less than thirty days duration be estimated for all stations based on monthly estimates computed during this study.

A statewide consumptive use bulletin can be published for Idaho which incorporates all of the research and results reported for this study. The bulletin should include frequency tables computed using adjusted FAO-BC statistics.

Lack of high quality and continuous weather data representative of agricultural settings for sites other than Kimberly severely hampered method comparison, calibration and verification. Installation of an agricultural meterological network across Idaho would greatly facilitate future consumptive use studies. Utilization of current microprocessor and electronic technology can provide completely automated weather and consumptive use data collection, reduction and dissemination.

Development or adaption of remote sensing techniques and satelite imagery could facilitate the quantification of crop types and dates of growth stage development throughout the state.

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APPENDICES

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Appendix A

Description of Evapotranspiration Methods

FAO-BLANEY-CRIDDLE METHOD

The FAO-Blaney-Criddle (FAO-BC) Method is suggested for areas where available primary climatic data includes air temperature data only.

The FAO-BC with elevation correction, as suggested by Doorenbos and Pruitt (1977), representing mean grass reference ET over a given month, is expressed as:

$$ET_o=\{a+b[p(0.46T+8.13)]\}(1.+0.1E/1000.) \quad \text{mm/day} \qquad (A-1)$$

where: ET_o = grass reference evapotranspiration in mm/day for the month considered
T = mean daily temperature in deg. C. over the month considered
p = mean daily percentage of total annual daytime hours obtained from Table A-1 for a given month and latitude
a,b = adjustment factors which depend on minimum relative humidity, sunshine hours and daytime wind estimates
E = elevation of station in meters

Figure A-1 can be used to estimate ET_o graphically using calculated values of $p(0.46T+8.13)$. The value of $p(0.46T+8.13)$ is given on the X-axis and the value of ET_o can be read directly from the Y-axis. Relationships are presented in Figure A-1 for (i) three levels of minimum humidity (RHmin); (ii) three levels of the ratio actual to maximum possible sunshine hours (n/N); and (iii) three ranges of daytime

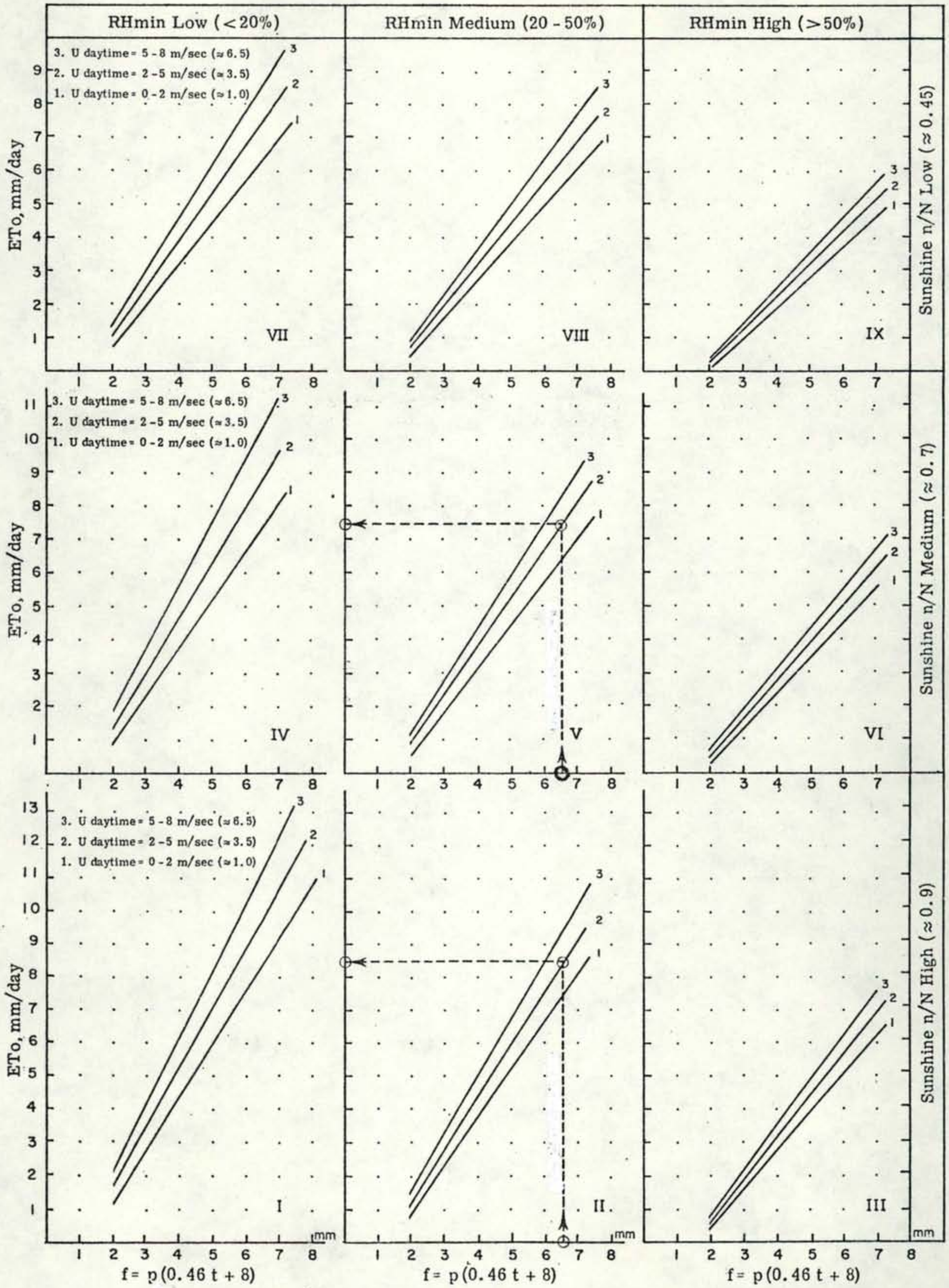

Fig. A-1. **Prediction of ETo from Blaney-Criddle f factor for different conditions of minimum relative humidity, sunshine duration and day time wind.** From Doorenbos and Pruitt (1977).

wind conditions at 2 m height (UDAY).[1] Information on general monthly or seasonal weather conditions and approximate range of RHmin, n/N, and Uday for a given site may be obtained from published weather descriptions or from extrapolation from nearby areas or from local information. The nomenclature used by FAO24 to depict general levels of humidity, sunshine and wind is given in Figure A-2.

Alfalfa reference ET for Idaho stations was calculated in this study by multiplying ET_o estimated by Eq. A-1 by an alfalfa/FAO-BC reference ratio calculated at Kimberly for the appropriate month.

FAO-RADIATION METHOD

The FAO-Radiation Method is essentially an adaption of the Makkink formula (1957). This method is suggested for areas where available climatic data include measured air temperature and sunshine, cloudiness or radiation, but not measured wind and humidity. Knowledge of general levels of humidity and wind is required, and these are to be estimated using published weather descriptions, extrapolation from nearby areas or from a local source.

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[1] Note that air humidity refers here to minimum daytime humidity and that wind refers to daytime wind. If estimates of 24 hour mean wind are available, these need to be converted to daytime wind. Generally Uday/Unight approximately equals 2 and mean 24-hr wind data should be multiplied by 1.33 to obtain mean daytime wind. For areas with either predominantly night or daytime wind, the following factor can be used:

Uday/Unight ratio	1.0	1.5	2.0	2.5	3.0	3.5	4.0
correction for Uday	1.0	1.2	1.33	1.43	1.5	1.56	1.6

Figure A-2. Climatological nomenclature for FAO methods. (From Doorentos and Pruitt, 1977)

Where climatic data are not used as direct input data but general levels of climatic variables are needed, the following nomenclature is used:

TEMPERATURE

hot	Tmean >30 deg. C
cool	Tmean <15 deg. C

Tmean=(Tmax+Tmin)/2. Data is collected from max/min thermometer or thermograph records.

HUMIDITY

RHmin, minimum relative humidity

low	<20%
medium	20-50%
high	>50%

dry	<20%
humid	>70%

RHmin is lowest humidity during daytime and is reached usually at 1400 to 1600 hrs. From hygrograph or wet and dry bulb thermometer. For rough estimation purposes when read at 1600 hrs subtract 5 to 10 for humid climate and up to 30 for desert climate.

RHmean, mean relative humidity

low	<40%
medium-low	40-55%
medium-high	55-70%
high	>70%

low	<40%
medium	40-70%
high	>70%

RHmean is average of max. and min. relative humidity or

RHmean=(RHmin+RHmax)/2.

Whereas for most climates RHmin will, vary strongly, RHmax equals 90 to 100% for humid climates, 80 to 100% for semi-arid and arid climates where Tmin is 20-25 deg.C. lower than Tmax. In arid areas RHmax may be 25-40% when Tmin is 15 deg.C. lower than Tmax.

WIND

light	<110 mi/day
moderate	110-265 mi/day
strong	265-440 mi/day
very strong	>440 mi/day

For rough estimation purposes sum of several windspeed observations divided by number of readings to give wind run in mi/day.

RADIATION

sunshine n/N	
low	< 0.6
medium	0.6-0.8
high	> 0.8

Ratio between daily actual (n) and daily maximum possible (N) sunshine duration.

n/N>0.8: near bright sunshine all day

n/N 0.6-0.8: some 40% of daytime hrs full cloudiness or partially clouded for 70% of daytime hrs.

The form of the FAO-radiation method is:

$$ET_o = c(W \cdot R_s) \qquad \text{mm/day} \qquad \text{(A-2)}$$

where: ET_o = grass reference evapotranspiration in mm/day for the periods considered
R_s = global solar radiaiton in equivalent evaporation mm/day
W = psychrometric weighting factor which depends on temperature and altitude
c = adjustment factor which depends on mean humidity and daytime wind conditions

R_s can be measured directly using a global pyronometer or estimated as:

$$R_s = (0.25+0.50\ n/N)R_a \quad \text{(Doorenbos and Pruitt, 1977)} \qquad \text{(A-3)}$$

where n/N is the ratio between actual measured bright sunshine hours and maximum possible sunshine hours. Both n and N are expressed in mean daily values, in hours. Variable N is fixed with month and latitude, where n must be observed. Values of R_a in mm/day for different months and latitudes can be found in standard tables. R_s is obtained in mean equivalent evaporation in mm/day for the period considered.

Cloudiness observations can be used to calculate R_s as outlined by Doorenbos and Pruitt (1977).

The weighting factor (W) reflects the effect of temperature and altitude on the relationship between R_s and ET_o and is calclated as:

$$W = D/(D+C) \qquad \text{(A-4)}$$

Table A-1. Mean daily percentage (p) of annual daytime hours for different latitudes in the northern hemisphere. (From Doorenbos and Pruitt, 1977).

Latitude	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
60	.15	.20	.26	.32	.38	.41	.40	.34	.28	.22	.17	.13
58	.16	.21	.26	.32	.37	.40	.39	.34	.28	.23	.18	.15
56	.17	.21	.26	.32	.36	.39	.38	.33	.28	.23	.18	.16
54	.18	.22	.26	.31	.36	.38	.37	.33	.28	.23	.19	.17
52	.19	.22	.27	.31	.35	.37	.36	.33	.28	.24	.20	.17
50	.19	.23	.27	.31	.34	.36	.35	.32	.28	.24	.20	.18
48	.20	.23	.27	.31	.34	.36	.35	.32	.28	.24	.21	.19
46	.20	.23	.27	.30	.34	.35	.34	.32	.28	.24	.21	.20
44	.21	.24	.27	.30	.33	.35	.34	.31	.28	.25	.22	.20
42	.21	.24	.27	.30	.33	.34	.33	.31	.28	.25	.22	.21
40	.22	.24	.27	.30	.32	.34	.33	.31	.28	.25	.22	.21
35	.23	.25	.27	.29	.31	.32	.32	.30	.28	.25	.23	.22
30	.24	.25	.27	.29	.31	.32	.31	.30	.28	.26	.24	.23
25	.24	.26	.27	.29	.30	.31	.31	.29	.28	.26	.25	.24
20	.25	.26	.27	.28	.29	.30	.30	.29	.28	.26	.25	.25
15	.26	.26	.27	.28	.29	.29	.29	.28	.28	.27	.26	.25
10	.26	.27	.27	.28	.28	.29	.29	.28	.28	.27	.26	.26
5	.27	.27	.27	.28	.28	.28	.28	.28	.28	.27	.27	.27
0	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27

where: D = the rate of change of the saturation vapor pressure with temperature
C = the psychrometric constant

The temperature at which D is calculated should be the mean air temperature in deg. Celsius for the period considered. Where temperature is given as Tmax and Tmin, the temperature (Tmax+Tmin)/2 should be used.

The adjustment factor (c) is given by the relationship between the radiation term ($W \cdot R_s$) and reference crop evapotranspiration (ET_o) and is shown graphically in Figure A-3. It depends greatly on general levels of mean relative humidity (RHmean) and daytime wind (0700 hours) at 2 m height above the soil surface.

FAO-PENMAN METHOD

For areas where measurements of temperature, humidity, wind and solar radiation are available, an adaption of the Penman method (1948) may be used; compared to the other FAO methods presented it is likely to provide the most satisfactory results (Doorenbos and Pruitt, 1977).

The original Penman (1948) equation predicted evaporation losses from an open water surface (E_o). Experimentally determined crop coefficients ranging from 0.6 in winter months to 0.8 in summer months related E_o to grass evapotranspiration for the climate in England. The Penman equation consisted of two terms: the energy (radiation) term and the aerodynamic (wind and humidity) term. The relative importance of each term varies with climatic conditions. Under calm weather conditions the aerodynamic term is usually less important than the

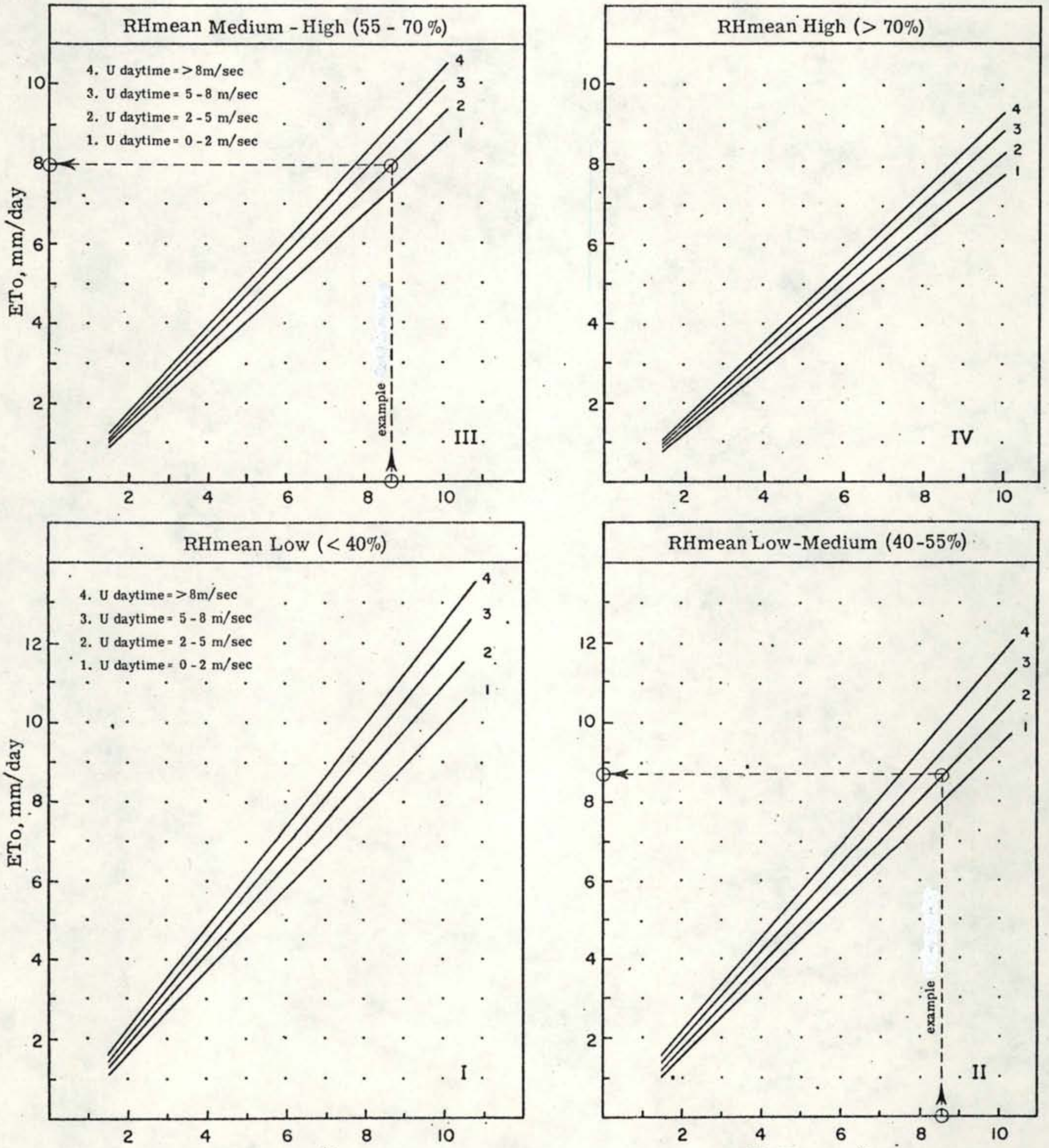

Figure A-3. Prediction of ETo from W. RS for different conditions of mean relative humidity and day time wind. From Doorenbos and Pruitt (1977).

energy term. Under windy conditions and particularly in more arid regions the aerodynamic term becomes more important. The FAO-Penman includes a wind function which is different from the original Penman equation.

The form of the FAO-Penman equation is:

$$ET_o = [\underbrace{W \cdot R_n}_{\text{radiation term}} + \underbrace{(1-W) \cdot f(u) \cdot (e_a - e_d)}_{\text{aerodynamic term}}] \qquad \text{(A-5)}$$

where: ET_o = grass reference evapotranspiration in mm/day
W = weighting factor which depends on temperature and altitude (see radiation method)
R_n = net radiation in equivalent evaporation in mm/day
$f(u)$ = wind-related function
(e_a-e_d) = difference between the saturation vapor pressure at mean air temperature and the mean actual vapor pressure of the air, both in mbar

The suggested wind function applies to conditions found during summer, with moderate winds, RHmax of about 70 percent and day-night wind ratios of 1.5 to 2.0; no adjustment is required for these conditions. However, if 24-hour wind totals are used there will be an under-prediction of ET_o by 15 to 30 percent in areas where daytime wind greatly exceeds nighttime wind, where RHmax approaches 100 percent, and where radiation is high. Conversely, for areas experiencing moderate to strong wind, where nighttime humidity (RHmax) is low, and where radiation is low, the equation will over-predict ET_o; this over-prediction increases with decreasing ratios of Uday/Unight. Under these conditions an adjustment factor (c) (corrected Penman) should be applied.

The mean actual vapor pressure may be measured or calculated from measured air temperature and relative humidity data or wet and dry bulb or dewpoint measurements.

The effect of wind on ET_o is included in the FAO-Penman method in the wind function term of the form:

$$f(u) = 0.27[1+(U/100)] \tag{A-6}$$

where U is 24-hr wind run in km/day at 2 m height. This expression is valid when (e_a-e_d) is expressed in mbar and is calculated according to the methods suggested by Doorenbos and Pruitt (1977).

Net radiation (R_n) is the difference between all incoming and outgoing radiation. It can be measured, but such data are seldom available. R_n can be calculated from solar radiation or sunshine hours (or degree of cloud cover), temperature,humidity data and albedo. For most crops, albedo (reflectance) is 0.25.

To obtain total net radiation (R_n), the algebraic difference between net incoming shortwave radiation (R_{ns}) and net outgoing longwave radiation (R_{nl}) is calculated as:

$$R_n = R_{ns}-R_{nl} \tag{A-7}$$

If measured solar radiation (R_s) is not available, it can be calculated using equation A-3.

Net shortwave radiation (R_{ns}) is calculated as:

$$R_{ns} = (1-A)R_s \qquad \text{(A-8)}$$

where A is the crop albedo.

Net longwave radiation (R_{nl}) can be determined from available temperature (T), vapour pressure (e_d) and ratio n/N data as described by Doorenbos and Pruitt (1977).

FAO-CORRECTED-PENMAN

The FAO-Penman equaion given assumes that most common conditions are where radiation is medium to high, maximum relative humidity is medium to high and moderate daytime wind is about double the nighttime wind. However, these conditions are not always met and correction to the Penman equation is required.

$$ET_o = c[W.R_n+(1-W).f(u).(e_a-e_d)] \qquad \text{(A-9)}$$

radiation term aerodynamic term

This equation is the same as the FAO-Penman with the addition of c, an adjustment factor to compensate for the effect of day and night weather conditions. Table A-2 presents the values of c for different conditions of RHmax, R_s, Uday and Uday/Unight. The information for using Table A-2 may be difficult to obtain from available climatic records but it can usually be derived for the different seasons from published weather descriptions or from local sources. Winter conditions require low c

Table A-2. Adjustment factor (c) in corrected Penman equation.

	RHmax = 30%				RHmax = 60%				RHmax = 90%			
Rs mm/day	3	6	9	12	3	6	9	12	3	6	9	12
Uday m/s					Uday/Unight = 4.0							
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.79	.84	.92	.97	.92	1.00	1.11	1.19	.99	1.10	1.27	1.32
6	.68	.77	.87	.93	.85	.96	1.11	1.19	.94	1.10	1.26	1.33
9	.55	.65	.78	.90	.76	.88	1.02	1.14	.88	1.01	1.16	1.27
					Uday/Unight = 3.0							
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.76	.81	.88	.94	.87	.96	1.06	1.12	.94	1.04	1.18	1.28
6	.61	.68	.81	.88	.77	.88	1.02	1.10	.86	1.01	1.15	1.22
9	.46	.56	.72	.82	.67	.79	.88	1.05	.78	.92	1.06	1.18
					Uday/Unight = 2.0							
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.69	.76	.85	.92	.83	.91	.99	1.05	.89	.98	1.10	1.14
6	.53	.61	.74	.84	.70	.80	.94	1.02	.79	.92	1.05	1.12
9	.37	.48	.65	.76	.59	.70	.84	.95	.71	.81	.96	1.06
					Uday/Unight = 1.0							
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.64	.71	.82	.89	.78	.86	.94	.99	.85	.92	1.01	1.05
6	.43	.53	.68	.79	.62	.70	.84	.93	.72	.82	.95	1.00
9	.27	.41	.59	.70	.50	.60	.75	.87	.62	.72	.87	.96

values smaller than 1.0 to compensate for low radiation, non-summer conditions (similar factors no doubt caused the use of winter crop coefficients of 0.6 as compared to 0.8 for mid-summer in the original 1948 Penman method).

WRIGHT-1982

Procedures for applying the original Penman (Penman, 1943), were modified by Wright and Jensen (1978) and Wright (1982) to improve estimates of net radiation and reference ET throughout the growing season, particularly the early and later portions. The result of improvements made to the Penman is the Wright-1982 equation, which can be used to estimate daily alfalfa reference ET.

The Wright method described in this section is used to estimate daily reference ET for an alfalfa crop which is well watered, actively growing, and at least 30 cm tall. The alfalfa reference is meant to represent the maximum expected level of crop ET for existing climatic conditions. The modified combination equation presented by Wright (1982) is:

$$E_{tr} = [D/(D+C)(R_n-G) + C/(D+C)(15.36)(W_f)(e_s-e_d)](L)^{-1} \qquad \text{(A-10)}$$

in which E_{tr} = the computed reference evaporative flux on a water depth equivalent basis, R_n = the net radiation, G = the soil heat flux, W_f = a wind function and is dependent upon daily wind travel, (e_s-e_d) = the mean daily saturation vapor pressure deficit, D = the slope of the saturation vapor pressure temperature curve, C = the psychrometric constant, 15.36 = a constant resulting from unit conversion, and L = the latent heat of evaporation.

The following outline for applying Wright-1982 was reported by Wright (1982) and should be closely followed for proper application of the method (Burman, et al, 1980).

The latent heat of evaporation is calculated by Wright (1982) as:

$$L = (595-0.51T_a)0.1 \qquad \text{(A-11)}$$

in which T_a = the mean daily air temperature in Celsius and the coefficient 0.1 converts E_{tr} to millimeters per day. The terms D/(D+C) and C/(D+C), whose sum equals one, are temperature and pressure dependent, and weight the two components of the equation. The term D/(D+C) is equivalent to W used in the FAO radiation and Penman methods. However, it is not calculated in the same manner. The D and C terms are calculated by Wright (1982) as:

$$D = 33.8639[0.05904(0.00738T_a+0.8072)^7-3.42\text{x}10^{-5}] \qquad \text{(A-12)}$$

which is valid for $T_a \geq -23$ deg. C., and

$$C = (c_pP)(0.622L)^{-1} \qquad \text{(A-13)}$$

in which c_p = the specific heat of air and P = the atmospheric pressure. The mean values used for Kimberly were $c_p = 0.24\ g^{-1}C^{-1}$ and P = 875 mbar.

The soil heat flux, G, is estimated from changes in daily air temperature by:

$$G = (T_a - T_p)c_s \qquad \text{(A-14)}$$

in which T_p = the mean air temperature for the preceding three days, and c_s = an empirical, specific heat coefficient for the soil. For Kimberly, c_s on a surface soil basis is approximately nine cal $cm^{-2}C^{-1}$.

Measured net solar radiation (R_n), as required for Eq. A-10, is usually not available for a continuous crop of alfalfa. Therefore, R_n is estimated from daily solar radiation, temperature and humidity data as:

$$R_n = (1-A)R_s - R_b \qquad \text{(A-15)}$$

$$R_b = [a(R_s/R_{so})+b]R_{bo} \qquad \text{(A-16)}$$

$$R_{bo} = [a_1 - 0.044(e_d)^{.5}](11.71\text{x}10^{-8})[(T_2^4+T_1^4)/2] \qquad \text{(A-17)}$$

in which R_s = the measured incident solar radiation, A = the crop albedo, R_b = net outgoing longwave radiation, R_{so} = clear day solar radiation, R_{bo} = net clear day outgoing longwave radiation, a_1 = a parameter for estimating the effective emittance of the atmosphere, e_d = the saturation vapor pressure at mean dewpoint temperature, $(11.71\text{x}10^{-8})$ = the Stefan-Boltzman constant, and T_2, T_1 = maximum and minimum daily Kelvin air temperature.

Crop albedo is varied with date (Wright, 1982) to account for sun angle effects. For mostly clear days when (R_s/R_{so}) is greater than 0.7, the albedo is calculated by:

$$A = 0.29+0.06\ \mathrm{SIN}[30(M+0.0333N+2.25)] \qquad \text{(A-18)}$$

in which M = the number of the month (1-12), N = the day of the month, and the sine function is in degrees. M and N are combined to approximate the day of the year in a manner so that the sine function equals -1 on June 21; thus A = 0.23, and 0 on September 21 when A = 0.29. An approximately equivalent term for Eq. A-18 is SIN(D+96) in which D = the day of the year. An A of 0.30 is suggested by Wright (1982) for cloudy days when (R_s/R_{so}) is less than or equal to 0.7.

Coefficients used for Eq. A-16, when (R_s/R_{so}) is greater than 0.7, are a = 1.126, and b = -0.07. When (R_s/R_{so}) is less than or equal to 0.7, coefficients are a = 1.017 and b = -0.06.

The coefficient a_1 of Eq. A-17 is varied to account for seasonal changes in the earth's net emissivity due to changes in day length and upper atmospheric conditions by:

$$a_1 = 0.26+0.1\exp\{-[0.0154(30M+N-207)]^2\} \qquad \text{(A-19)}$$

This is a "normal" distribution equation (Wright, 1982). The exponential term has a maximum value of 1 on June 27; thus $a_1 = 0.36$, and a minimum value of 0 on about March 1 and October 30, when a_1 = 0.26. The approximate day of the year equivalent is: $\exp\{-[0.0154(D-180)]^2\}$. The wind function of Eq. A-10 is obtained by:

$$W_f = a_w+b_wU_2 \qquad \text{(A-20)}$$

in which a_w and b_w = empirical coefficients dependent upon the aerodynamic characteristics of the crop surface and the general nature of the location as it affects sensible heat advection; and U_2 = the 24 hour daily wind at 2 meters. Time dependent functional relationships were developed by Wright (1982) for Kimberly, Idaho, to permit varying W_f to account for the seasonal changes in sensible heat advection. This is caused by changes in the dryness of arid surrounding areas, and changes in the relative proportion of daytime wind travel (Wright,1982). The wind function coefficients are calculated as:

$$a_w = 23.8-0.7865D+9.7182\times10^{-3}D^2-5.4589\times10^{-5}D^3 +1.42529\times10^{-7}D^4-1.41018\times10^{-10}D^5 \qquad \text{(A-21)}$$

$$b_w = -0.0122+5.2956\times10^{-4}D-5.9923\times10^{-6}D^2+3.4002\times10^{-8}D^3 -9.00872\times10^{-11}D^4+8.79179\times10^{-14}D^5 \qquad \text{(A-22)}$$

The vapor pressure deficit, (e_s-e_d), of Eq. A-10 is calculated from e_s as the average of the two saturation vapor pressures corresponding to the daily maximum and minimum air temperature, and e_d as the saturation vapor pressure for the measured 0800 hr dewpoint temperature, T_{dp}. The e_d term is assumed to represent the daily average vapor pressure. This procedure differs from the FAO-Penman methods. The respective saturation vapor pressures can be calculated by the empirical polynomial equation presented by Wright (1982):

$$e = c_0+c_1T+c_2T^2+c_3T^3+c_4T^4+c_5T^5 \qquad \text{(A-23)}$$

in which T = the respective Celsius temperature, $c_0 = 6.105$, $c_1 = 4.44 \times 10^{-1}$, $c_2 = 1.434 \times 10^{-2}$, $c_3 = 2.623 \times 10^{-4}$, $c_4 = 2.953 \times 10^{-6}$, $c_5 = 2.559 \times 10^{-8}$.

Equations A-10 through A-23 and descriptions for use were exerpted from Wright (1982).

SCS-BLANEY-CRIDDLE

The SCS-Blaney-Criddle (SCS-BC), also termed TR21 (Technical Release no 21, 1967) in the FAO24 computer program is unlike the other ET methods presented in that it does not predict ET by a specific reference crop. Rather, ET for any crop must be calculated using special coefficients presented by the SCS (1967b). These coefficients are not the same as coefficients used with an alfalfa reference ET method. The SCS-BC method is of the form:

$$U = K_t K_c (tp)/100 \qquad \text{(A-24)}$$

where U is the monthly consumptive use of a crop in inches; K_t is a climatic coefficient related to mean air temperature. $K_t = 0.173t - 0.314$, where t is mean air temperature in Fahrenheit. K_c is a coefficient reflecting the growth stage of a specific crop. Values for K_c can be selected from curves presented in Technical Release 21 (SCS, 1967b).

The t term in Eq. A-24 is mean air temperature in degrees Fahrenheit. The p term represents the monthly percentage of daylight hours in the month. Values of p are tabularized in Technical Release

21. This p is the same as that used by FAO-Blaney-Criddle.

JENSEN-HAISE

Jensen and Haise (1963) evaluated 3,000 observations of ET as determined by soil sampling procedures over a 35-year period. From about 100 values for well-watered crops with full cover in the western United States, a linear relationship between ET/R_n and mean air temperature was apparent, where R_n is net radiation. The form of the Jensen-Haise equation is:

$$E_{tp} = C_T(T-T_x)R_s \qquad \text{(A-25)}$$

where E_{tp} represents potential evapotranspiration, C_T is a temperature coefficient, and T_x is the intercept of the temperature axis. These coefficients are considered as constants for an area. Constants for Eq. A-25 were initially $C_t = 0.014$ and $T_x = 26.4$ for temperature in deg. Fahrenheit, and 0.025 and -3 for temperature in deg. Celsius. Jensen (1966) later defined C_t as:

$$C_T = 1\ /(C_1+C_2C_H) \qquad \text{(A-26)}$$

and

$$C_H = 50\ \text{mb}/(e_2-e_1) \qquad \text{(A-27)}$$

where e_2 and e_1 are the saturation vapor pressures at the mean maximum and mean minimum temperatures, respectively, for the warmest month of the year in an area, and C_2 = 13 deg. Fahrenheit or 7.6 deg. Celsius. Jensen et al (1970) defined C_1 = 68 deg. F - (3.6 deg. F X elevation in ft/1000 ft), and T_x = 27.5 deg. F - $0.25(e_2-e_1)$ deg. F/mb - (elevation/1000) deg. F. For temperatures in degrees Celsius, C_1 = 38 - (2 deg. C X elevation in m/305) and T_x = -2.5 - $0.14(e_2-e_1)$ deg. C/mb - elevation (m)/550.

Crop coefficients based on alfalfa or grass reference should not be used with potential ET as calculated using Jensen-Haise. Instead, crop coefficients based on the Jensen-Haise method should be used (Jensen et al, 1970).

The Jensen-Haise method was included in the FAO24 computer program during this study.

Table B-1. Average monthly values of ET_o and ET_r calculated using FAO methods, Wright-1982, and SCS-Blaney-Criddle at Kimberly, Idaho, 1965-78.

		April	May	June	July	August	Sept.	Oct.
Grass Reference ET_o, mm/day								
FAO-BC short term	Mean*	3.52	5.44	6.94	7.94	6.81	4.73	2.63
	Std Dev	.78	.80	.76	.39	.79	.62	.42
FAO-BC long term	Mean**	3.46	5.44	7.07	8.03	6.79	4.73	2.63
	Std Dev	.38	.39	.30	.22	.40	.41	.23
FAO-Radiation	Mean	4.10	5.80	6.77	7.36	6.18	4.48	2.63
	Std Dev	.76	.70	.67	.39	.64	.50	.31
FAO-Penman	Mean	4.55	5.86	6.62	6.89	5.99	4.57	2.98
	Std Dev	.73	.55	.61	.33	.57	.44	.27
FAO-Ct. Penman	Mean	4.48	6.10	7.09	7.51	6.41	4.58	2.77
	Std Dev	.76	.61	.65	.33	.58	.44	.28
Alfalfa Reference ET_r, mm/day								
Wright-1982	Mean	4.20	6.21	7.54	7.99	6.84	5.12	3.19
	Std Dev	.70	.65	.75	.42	.69	.54	.31
SCS-Blaney-Criddle alfalfa hay ET, mm/day								
SCS-Blaney-Cr.	Mean	1.62	3.13	4.79	5.82	4.79	2.85	1.42
	Std Dev	.30	.39	.38	.29	.48	.39	.16
Wright-1982	Mean	2.60	5.78	6.64	6.47	5.20	3.48	1.15
	Std Dev	.43	.60	.66	.34	.52	.37	.11

* Using monthly mean air temperature and monthly mean minimum relative humidity, daytime windspeed, and percent sunshine hours.

** Using monthly mean air temperature and long term (14 year) average monthly relative humidity, daytime windspeed, and percent sunshine hours.

FAO-BC calculations include a 10% upward adjustment per 1000 meters elev.

Table B-2. Average monthly values of ET_o and ET_r calculated using FAO methods, Wright-1982, and SCS-Blaney-Criddle at Wilder, Idaho, 1973-1980.

		April	May	June	July	August	Sept.	Oct.
Grass Reference ET_o, mm/day								
FAO-BC short term	Mean*	3.79	5.23	6.88	7.66	6.22	4.57	2.41
	Std Dev	.82	.80	1.09	.66	.65	.69	.40
FAO-BC long term	Mean**	3.96	5.47	7.61	8.72	7.25	5.33	2.61
	Std Dev	.40	.33	.53	.50	.40	.39	.16
FAO-Radiation	Mean	4.17	5.43	6.58	7.17	5.81	4.27	2.43
	Std Dev	.76	.99	1.24	.63	.75	.68	.47
FAO-Penman	Mean	4.43	5.43	6.36	6.59	5.35	3.95	2.43
	Std Dev	.80	.73	.79	.45	.59	.52	.20
FAO-Ct. Penman	Mean	4.37	5.54	6.62	6.85	5.58	4.06	2.40
	Std Dev	.74	.79	.91	.45	.60	.55	.25
Alfalfa Reference ET_r, mm/day								
Wright-1982	Mean	4.20	5.94	7.47	7.72	5.98	4.28	2.59
	Std Dev	.74	.83	.93	.56	.62	.64	.27
SCS-Blaney-Criddle alfalfa hay ET, mm/day								
SCS-Blaney-Cr.	Mean	2.25	3.71	5.69	6.87	5.46	3.58	1.67
	Std Dev	.41	.38	.72	.53	.55	.45	.16

* Using monthly mean air temperature and monthly mean minimum relative humidity, daytime windspeed, and percent sunshine hours.

** Using monthly mean air temperature and long term (14 year) average monthly relative humidity, daytime windspeed, and percent sunshine hours.

FAO-BC calculations include a 10% upward adjustment per 1000 meters elev.

Table B-3. Average monthly values of ET_o and ET_r calculated using FAO methods, Wright-1982, and SCS-Blaney-Criddle at Aberdeen, Idaho, 1978-1980.

		April	May	June	July	August	Sept.
		Grass Reference ET_o, mm/day					
FAO-BC short term	Mean*	2.79	3.99	6.04	7.42	6.01	4.54
	Std Dev	.12	.69	.32	.37	.32	.77
FAO-BC long term	Mean**	3.64	5.18	7.44	8.44	6.90	5.02
	Std Dev	.15	.35	.25	.14	.21	.36
FAO-Radiation	Mean	3.13	3.97	5.87	6.66	5.32	4.04
	Std Dev	.29	.68	.26	.66	.66	.65
FAO-Penman	Mean	3.51	4.27	5.55	6.25	5.22	4.12
	Std Dev	.14	.58	.24	.39	.23	.45
FAO-Ct. Penman	Mean	3.44	4.35	6.00	6.77	5.50	4.16
	Std Dev	.21	.69	.28	.49	.35	.55
		Alfalfa Reference ET_r, mm/day					
Wright-1982	Mean	3.34	4.66	6.43	7.47	6.07	4.71
	Std Dev	.19	.74	.28	.35	.27	.62
		SCS-Blaney-Criddle alfalfa hay ET, mm/day					
SCS-Blaney-Cr.	Mean	1.55	2.80	4.32	5.43	4.36	2.95
	Std Dev	.08	.34	.30	.15	.22	.33

* Using monthly mean air temperature and monthly mean minimum relative humidity, daytime windspeed, and percent sunshine hours.

** Using monthly mean air temperature and long term (14 year) average monthly relative humidity, daytime windspeed, and percent sunshine hours.

FAO-BC calculations include a 10% upward adjustment per 1000 meters elev.

Table B-4. Average monthly values of ET_o and ET_r calculated using FAO methods, Wright-1982, and SCS-Blaney-Criddle at Rexburg, Idaho, 1978-1980.

		April	May	June	July	August	Sept.	Oct.
		Grass Reference ET_o, mm/day						
FAO-BC short term	Mean*	3.07	4.62	6.69	7.77	6.42	4.77	2.54
	Std Dev	.74	.91	.85	.28	.36	.77	.60
FAO-BC long term	Mean**	3.86	5.47	7.15	8.47	6.87	5.07	2.49
	Std Dev	.56	.22	.32	.02	.29	.20	.35
FAO-Radiation	Mean	3.51	4.76	6.50	7.00	5.74	4.22	2.60
	Std Dev	.55	.92	.59	.21	.41	.59	.53
FAO-Penman	Mean	3.91	5.10	6.42	6.77	5.76	4.53	2.99
	Std Dev	.53	1.06	.75	.21	.30	.54	.45
FAO-Ct. Penman	Mean	3.75	5.15	6.74	7.18	5.96	4.42	2.73
	Std Dev	.57	1.13	.74	.22	.29	.61	.45
		Alfalfa Reference ET_r, mm/day						
Wright-1982	Mean	3.73	5.45	7.35	7.99	6.81	5.27	3.23
	Std Dev	.54	1.12	.84	.39	.30	.91	.48
		SCS-Blaney-Criddle alfalfa hay ET, mm/day						
SCS-Blaney-Cr.	Mean	1.64	2.85	4.24	5.47	4.34	2.95	1.38
	Std Dev	.39	.25	.32	.03	.32	.17	.23

* Using monthly mean air temperature and monthly mean minimum relative humidity, daytime windspeed, and percent sunshine hours.

** Using monthly mean air temperature and long term (14 year) average monthly relative humidity, daytime windspeed, and percent sunshine hours.

FAO-BC calculations include a 10% upward adjustment per 1000 meters elev.

Table B-5. Average secondary weather parameters calculated for USBR stations and for the USDA station at Kimberly.

Parameter	April	May	June	July	August	Sept.	Oct.
	KIMBERLY, IDAHO 1965-78				Elevation--1195 meters		
nratio	.67	.73	.75	.83	.78	.76	.69
min.RH (%)	37.	34.	34.	30.	30.	31.	34.
daywind (m/s)	4.7	4.0	3.6	2.8	2.8	3.1	3.3
D/N ratio	1.63	1.56	1.65	1.72	1.88	1.63	1.63
solar (mm/d)	8.64	10.61	10.93	11.22	9.60	7.75	5.47
max.RH (%)	86.	86.	86.	86.	85.	86.	89.
ave.RH (%)	62.	60.	60.	58.	57.	58.	61.
	WILDER, IDAHO (USBR) 1973-80				Elevation--747 meters		
nratio	.66	.70	.74	.76	.72	.73	.66
min.RH (%)	34.	30.	27.	25.	27.	27.	34.
daywind (m/s)	2.6	2.4	2.0	1.5	1.2	1.1	1.3
D/N ratio	1.16	1.23	1.30	1.24	1.24	1.10	1.01[1/]
solar (mm/d)	8.10	9.63	10.62	10.38	8.92	7.36	5.27
	ABERDEEN, IDAHO (USBR) 1978-80				Elevation--1363 meters		
nratio	.52	.48	.71	.79	.71	.70	
min.RH (%)	38.	38.	36.	30.	29.	30.	
daywind (m/s)	3.0	2.6	2.5	2.3	2.0	2.1	
D/N ratio	1.43	1.39	1.53	1.51	1.38	1.27	
solar (mm/d)	7.01	7.79	10.38	10.65	8.91	7.31	
	RUPERT, IDAHO (USBR) 1977				Elevation--1259 meters		
nratio	.66	.70	.72	.82	.78	.76	.69
min.RH (%)	37.	35.	34.	30.	29.	31.	34.
daywind (m/s)	4.6	3.8	3.4	2.7	2.8	2.9	3.2
D/N ratio	1.61	1.55	1.64	1.70	1.86	1.62	1.63
solar (mm/d)	8.02	9.70	10.42	10.90	9.37	7.54	5.34
	REXBURG, IDAHO (USBR) 1978-80				Elevation--1481 meters		
nratio	.59	.58	.75	.80	.76	.73	.64
min.RH (%)	42.	40.	35.	32.	31.	31.	27.
daywind (m/s)	4.0	3.7	3.5	2.9	2.8	2.7	2.4
D/N ratio	1.31	1.26	1.32	1.30	1.27	1.14	1.11
solar (mm/d)	7.34	8.69	10.72	10.72	9.14	7.19	5.14

[1/] Day/night wind ratios (D/N) for Wilder, Aberdeen, Rupert and Rexburg were taken from PNWRBC data for Boise, Pocatello, Kimberly and Idaho Falls. These ratios were used to calculate daytime wind.

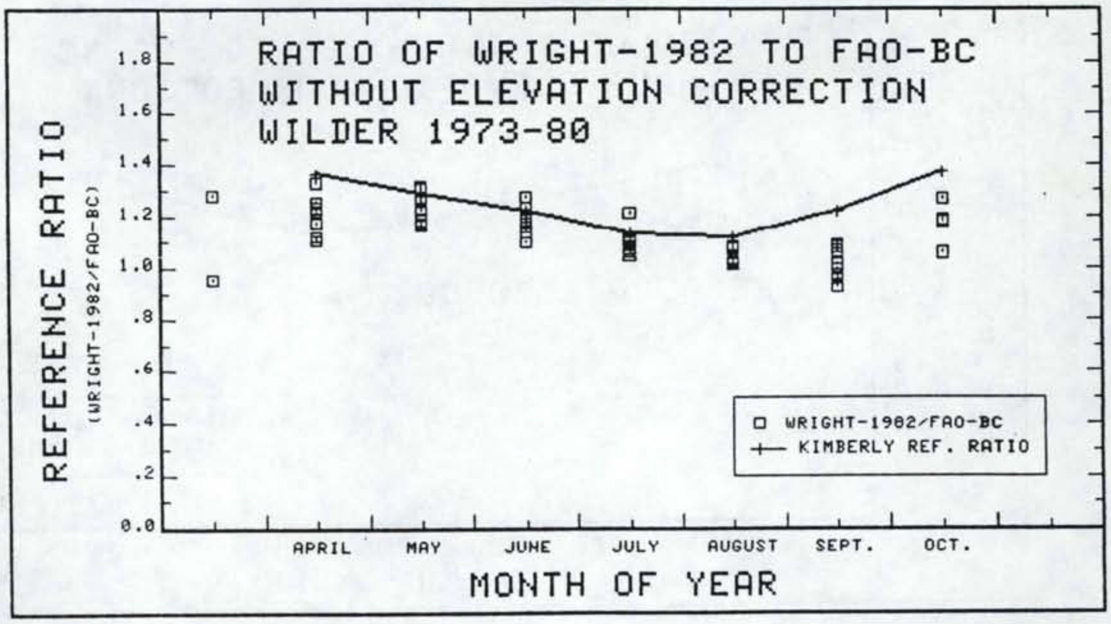

Figure B-1. Ratio of WRIGHT-1982 to FAO-BC without elevation correction for Wilder, 1973-1980 and Kimberly reference ratios for no elevation correction.

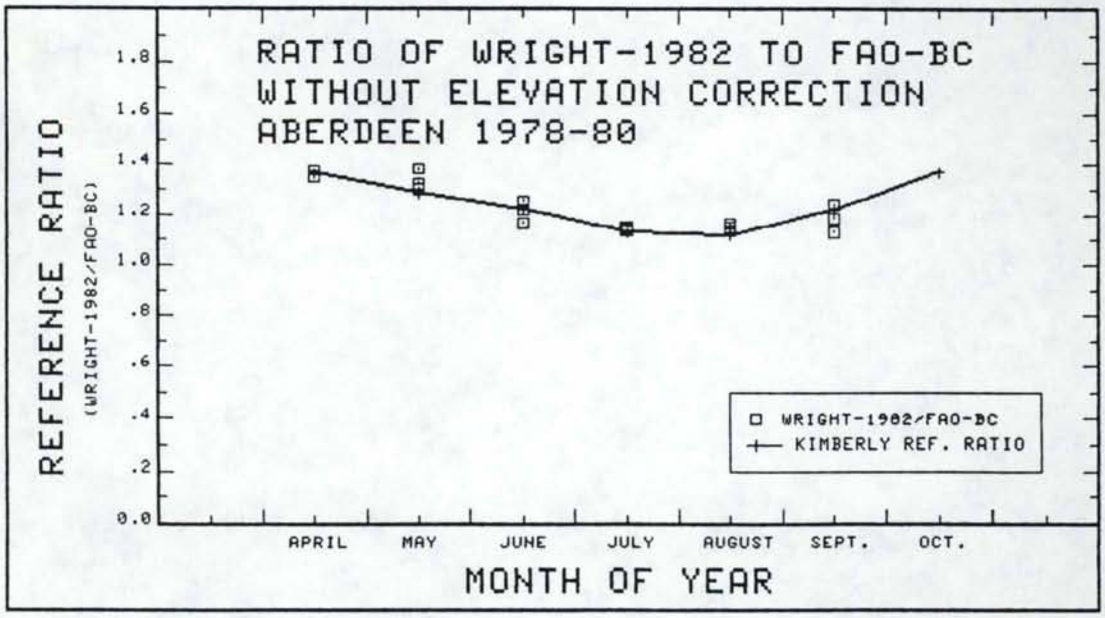

Figure B-2. Ratio of WRIGHT-1982 to FAO-BC without elevation correction for Aberdeen, 1978-1980 and Kimberly reference ratios for no elevation correction.

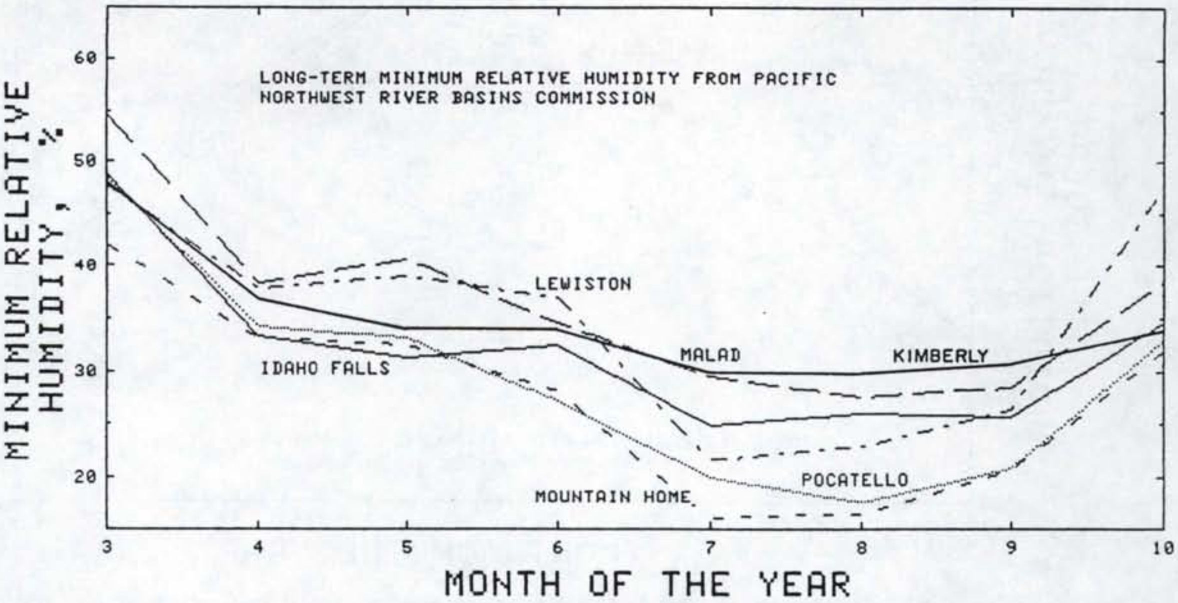

Figure B-4. Long-term average minimum relative humidity for five of eleven Idaho weather stations reported by the Pacific Northwest River Basins Commission (PNRBC) and for Kimberly.

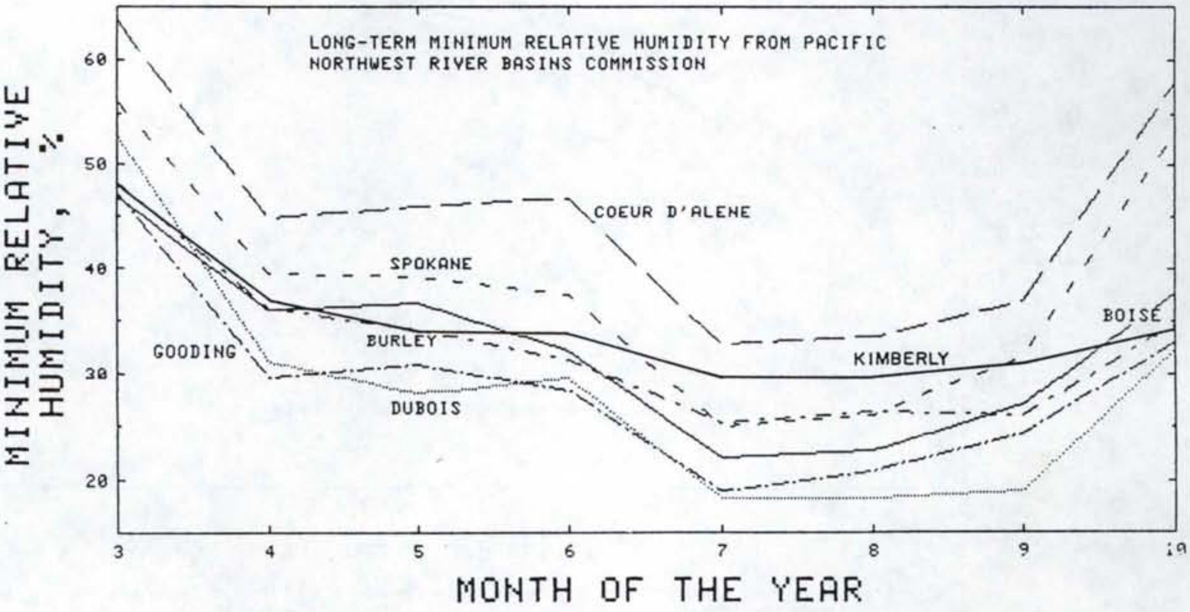

Figure B-5. Long-term average minimum relative humidity for six of eleven Idaho weather stations reported by the Pacific Northwest River Basins Commission (PNRBC) and for Kimberly.

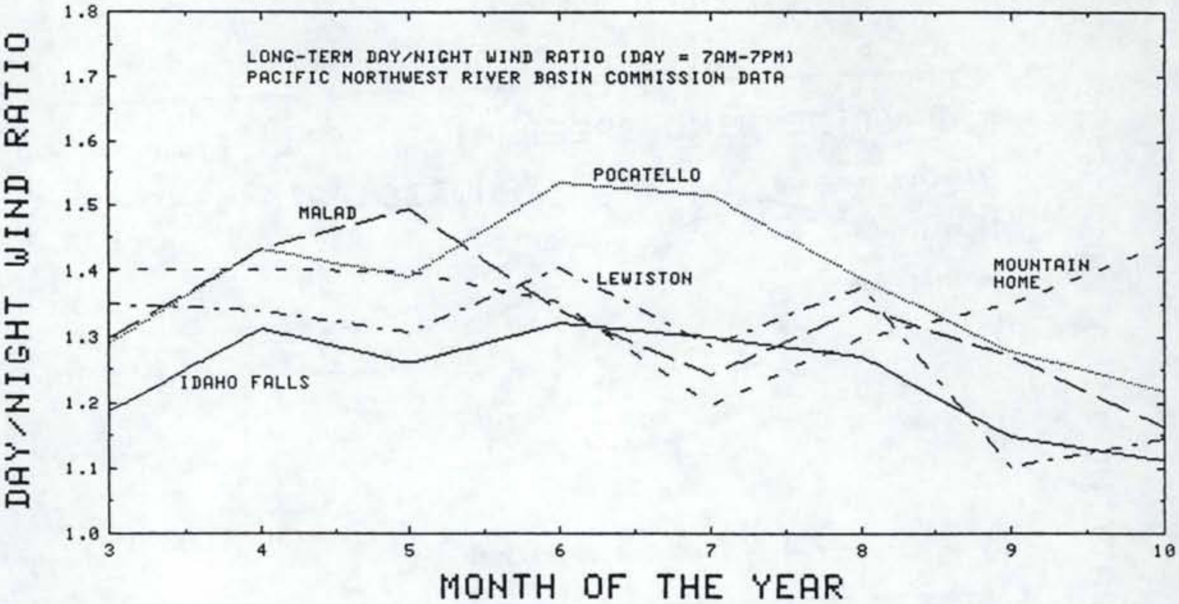

Figure B-8. Long-term day/night wind ratios (7-7) for five of eleven Idahoweather stations reported by the Pacific Northwest River Basins Commission (PNRBC, 1968).

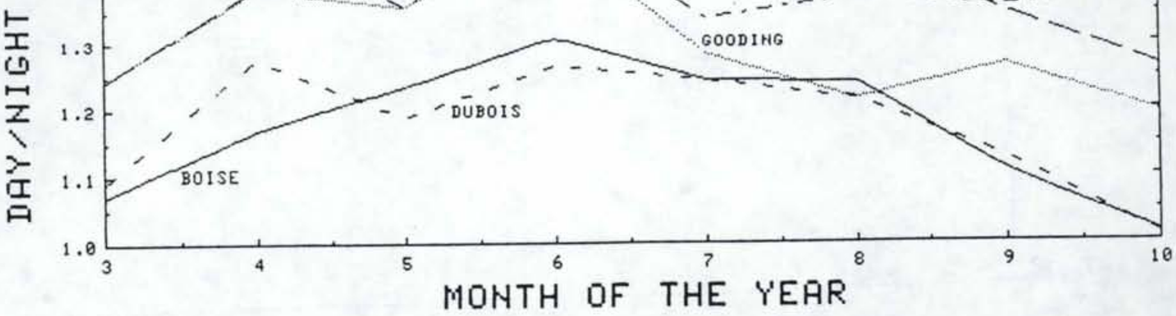

Figure B-9. Long-term day/night wind ratios (7-7) for five of eleven Idaho weather stations reported by the Pacific Northwest River Basins Commission (PNRBC, 1968.

Table C-1. NOAA weather station descriptors and weather tape information.

No	SS	CA	A.R	Lat.	Long.	Elev (ft)	NOAA No.	No. Rec	Start Rec	End Rec	Station Name
1	8*	49#	45%	4258	11250	4405	10	754	1	754	Aberdeen Exp. Station
2	8	49	60	4247	11252	4318	227	661	1312	1972	American Falls 1 SW
3	4	26	65	4321	11528	3882	282	456	1973	2428	Anderson Dam
4	8	19	45	4230	11234	5170	347	210	2429	2638	Arbon 2 NW
5	9	13	55	4336	11320	5328	375	675	2639	3313	Arco 3 SW
6	9	28	30	4404	11127	5260	470	756	4069	4824	Ashton
7	1	09	20	4759	11633	2075	667	392	6301	6692	Bayview Model Basin
8	9	07	40	4310	11221	4487	915	733	7098	7830	Blackfoot 2 SSW
9	5	31	35	4258	11500	3275	1002	736	8226	8961	Bliss
10	3	01	75	4334	11613	2838	1022	361	9380	9740	Boise WSO AP
11	1	11	25	4841	11619	1860	1079	588	9741	10328	Bonners Ferry 1 SW
12	4	24	40	4253	11548	2530	1195	304	10525	10828	Bruneau
13	6	17	40	4232	11346	4157	1303	501	12983	13483	Burley FAA AP
14	1	09	35	4805	11604	2260	1363	278	13484	13761	Cabinet Gorge
15	3	15	35	4340	11641	2370	1380	756	13762	14517	Caldwell
16	3	02	30	4434	11641	2650	1408	736	14518	15253	Cambridge
17	3	54	35	4432	11603	4896	1514	458	15325	15782	Cascade 1 NW
18	5	53	20	4229	11452	3825	1551	199	15818	16016	Castleford 2 N
19	10	21	60	4430	11414	5175	1663	754	16381	17134	Challis
20	10	22	55	4359	11349	6260	1671	536	17135	17670	Chilly Barton Flat
21	1	38	45	4741	11645	2158	1956	696	18506	19201	Coeur D'Alene 1 E
22	2	32	20	4601	11620	3945	2154	493	19677	20169	Cottonwood
23	3	02	45	4444	11626	2950	2187	754	20245	20998	Council
24	3	15	5	4335	11645	2510	2444	732	22323	23054	Deer Flat Dam
25	9	51	25	4344	11107	6116	2676	678	23642	24319	Driggs
26	10	13	90	4415	11212	5450	2707	671	24320	24990	Dubois Exp. Station
27	3	48	20	4352	11628	2370	2942	755	26190	26944	Emmett 2 E
28	5	14	15	4321	11447	5065	3108	384	26945	27328	Fairfield Ranger Station
29	8	07	30	4302	11226	4460	3297	744	27977	28720	Fort Hall Indian Agncy
30	3	02	65	4404	11555	3212	3448	727	28822	29548	Garden Valley RS
31	4	24	80	4256	11519	2510	3631	750	29826	30575	Glenns Ferry
32	8	16	25	4235	11144	5550	3732	876	31147	32022	Grace
33	4	24	35	4300	11608	2400	3760	612	32023	32634	Grand View 2 W
34	2	32	45	4555	11608	3360	3771	685	32635	33319	Grangeville
35	5	14	70	4331	11418	5298	3942	755	35205	35959	Hailey Ranger Station
36	10	35	60	4358	11216	4791	3964	586	35960	36545	Hamer 4 NW
37	6	53	65	4236	11409	4060	4140	739	36546	37284	Hazelton
38	5	14	30	4318	11503	5090	4268	699	37632	38330	Hill City
39	6	52	70	4221	11434	4525	4295	749	38331	39079	Hollister
40	10	35	65	4347	11300	4820	4384	548	39080	39627	Howe
41	3	26	25	4350	11550	3965	4442	744	39628	40371	Idaho City
42	9	10	55	4329	11201	4765	4455	329	40929	41257	Idaho Falls 2 ESE
43	9	10	35	4321	11147	5850	4456	289	41258	41546	Idaho Falls 16 SE
44	9	10	75	4331	11204	4730	4457	741	41547	42287	Idaho Falls FAA AP
45	9	35	100	4332	11257	4938	4460	309	42465	42773	Idaho Falls 46 W
46	10	29	30	4425	11124	6300	4598	515	43375	43889	Island Park Dam
47	6	37	65	4244	11431	3740	4670	749	43890	44638	Jerome
48	1	50	45	4732	11608	2320	4831	744	45382	46125	Kellogg

Table C-1. Continued.

No	SS	CA	A.R	Lat.	Long.	Elev (ft)	NOAA No.	No. Rec	Start Rec	End Rec	Station Name
49	10	29	20	4424	11153	6410	4908	201	46210	46410	Kilgore
50	2	33	30	4609	11559	1260	5011	751	46411	47161	Kooskia
51	3	01	0	4329	11624	2680	5038	644	47162	47805	Kuna 2 NNE
52	2	45	55	4623	11701	1436	5241	550	48446	48995	Lewiston WSO AP
53	7	05	25	4207	11118	5926	5275	723	48996	49718	Lifton Pumping Station
54	10	22	40	4355	11337	5897	5462	753	50306	51058	Mackay Ranger Station
55	7	46	40	4212	11215	4580	5544	839	51345	52183	Malad
56	7	46	45	4210	11219	4470	5559	425	52184	52608	Malad City
57	6	18	15	4218	11317	4540	5563	196	52609	52804	Malta 2 E
58	10	40	45	4436	11355	5110	5685	552	52883	53434	May
59	3	54	45	4454	11607	5025	5708	750	53435	54184	Mc Call
60	6	44	60	4241	11329	4210	5980	392	55526	55917	Minidoka Dam
61	7	05	45	4219	11118	5960	6053	780	55918	56697	Montpelier Ranger Station
62	1	39	15	4644	11658	2660	6152	756	56757	57512	Moscow-Univ. of Idaho
63	4	25	75	4309	11543	3190	6174	752	57513	58264	Mountain Home
64	3	03	20	4458	11617	3870	6388	756	59054	59809	New Meadows Ranger Station
65	2	42	15	4615	11615	3145	6424	339	60225	60563	Nezperce
66	6	18	35	4214	11353	4600	6542	754	60720	61473	Oakley
67	3	02	35	4408	11617	2990	6590	341	62238	62578	Ola 4 S
68	2	20	30	4629	11615	1027	6681	756	62579	63334	Orofino
69	9	28	60	4321	11113	5385	6764	390	63335	63724	Palisades Dam
70	3	15	10	4348	11657	2215	6844	686	63725	64410	Parma Exp. Station
71	6	44	30	4237	11345	4210	6877	547	64411	64957	Paul 1 ENE
72	3	48	15	4405	11656	2150	6891	719	64958	65676	Payette
73	5	14	20	4318	11404	4875	7040	254	65778	66031	Picabo
74	8	04	90	4255	11236	4454	7211	536	67173	67708	Pocatello WSO AP
75	1	12	45	4857	11630	1775	7264	755	67709	68463	Porthill
76	1	39	10	4658	11653	2600	7301	749	68464	69212	Potlatch 3 NNE
77	7	27	40	4204	11151	4726	7353	581	69696	70276	Preston Sugar Factory
78	3	56	90	4312	11645	3930	7648	217	71237	71453	Reynolds
79	5	52	35	4304	11409	4306	7673	692	71454	72145	Richfield
80	2	34	70	4525	11618	1800	7706	607	72146	72752	Riggins
81	6	44	50	4237	11326	4200	7968	571	73498	74068	Rupert
82	9	30	55	4358	11143	4950	8022	480	74108	74587	St Anthony 1 WNW
83	1	06	40	4719	11634	2220	8062	756	74588	75343	Saint Maries
84	10	41	80	4507	11353	3911	8076	612	75344	75955	Salmon
85	10	41	80	4511	11345	3970	8080	145	75956	76100	Salmon 1 N
86	1	08	30	4817	11634	2120	8137	756	76101	76856	Sandpoint Exp. Station
87	5	31	75	4258	11426	3950	8380	743	76857	77599	Shoshone 1 WNW
88	5	23	60	4414	11454	6271	8676	196	79103	79298	Stanley
89	6	19	45	4201	11317	5280	8786	482	79405	79886	Strevell
90	3	15	85	4315	11623	2325	8928	534	81025	81558	Swan Falls Power House
91	9	28	30	4327	11120	5270	8937	231	81559	81789	Swan Valley
92	1	06	15	4710	11655	2550	9029	141	81837	81977	Tensed
93	9	51	10	4351	11116	6170	9065	332	82218	82549	Tetonia Exp. Station
94	4	47	80	4205	11515	5460	9119	470	82550	83019	Three Creek
95	6	53	55	4235	11433	3940	9294	689	83058	83746	Twin Falls 2 NNE
96	6	53	35	4229	11425	3940	9299	631	83747	84377	Twin Falls 3 SE
97	11	53	0	4233	11414	3960	9303	201	84378	84578	Twin Falls WSO
98	3	55	20	4414	11657	2103	9638	756	86042	86797	Weiser 2 SE

* Secondary station number for minimum daytime relative humidity, daytime wind speed and percent sunshine (solar radiaitontion).

Crop area number for crop growth state dates.

% Aridity rating of termperature sensor environment.

Table C-2. Computer date file of crops and growth stage dates* for areas within Idaho.

```
 1 ADA - BOISE AREA                    4336    11610
   1     3,27   0 0 0 0     9,02    10,30
   2     3,27   0 0 0 0     4,19    10,10
   3     5,17   0 0 0 0     7,11     9,01
   4     5,03   0 0 0 0     7,13    10,10
   5     5,03   0 0 0 0     7,13     9,10
   6     5,03   0 0 0 0     7,13     8,14
   7     4,03   0 0 0 0     5,28     7,17
   8     4,19   0 0 0 0     6,28     9,20
   9     4,07   0 0 0 0     7,07    10,30
  10     3,28   0 0 0 0     6,16     8,07
  11     2,08   0 0 0 0     5,29     8,02
  12     3,20   0 0 0 0     4,10    11,10
  13     4,07   0 0 0 0     6,26    10,15
  14     5,20   0 0 0 0     7,15     9,20
  15     4,03   0 0 0 0     7,14     9,01
  17     4,01   0 0 0 0     6,05     9,05
  99     9,09   0 0 0 0     9,09     9,09
 2 ADAMS - COUNCIL AREA                4444    11626
   1     4,14   0 0 0 0    10,15    10,16
   2     4,14   0 0 0 0     5,05    10,20
   5     5,08   0 0 0 0     7,20     9,15
   6     5,05   0 0 0 0     7,14     8,15
   8     4,25   0 0 0 0     7,05     9,20
   9     4,05   0 0 0 0     7,05    10,15
  10     4,04   0 0 0 0     6,20     8,10
  11     2,15   0 0 0 0     6,05     8,08
  12     4,07   0 0 0 0     4,27    10,23
  13     4,15   0 0 0 0     7,10    10,10
  99     9,09   0 0 0 0     9,09     9,09
 3 ADAMS - NEW MEADOWS AREA            4458    11617
   1     5,03   0 0 0 0     0,00    10,01
  10     5,05   0 0 0 0     7,25     9,15
  11     3,20   0 0 0 0     7,09     9,10
  12     4,25   0 0 0 0     5,15    10,08
  99     9,09   0 0 0 0     9,09     9,09
 4 BANNOCK - POCATELLO AREA            4255    11236
   1     4,12   0 0 0 0    10,03    10,16
   2     4,12   0 0 0 0     5,05    10,20
   3     6,02   0 0 0 0     7,26     9,11
   5     5,16   0 0 0 0     7,23     9,20
   6     5,15   0 0 0 0     7,26     8,25
   7     4,18   0 0 0 0     6,11     7,30
   8     5,03   0 0 0 0     7,08     9,15
   9     4,17   0 0 0 0     7,16    10,15
  10     4,11   0 0 0 0     6,30     8,20
  11     2,28   0 0 0 0     6,16     8,15
  12     4,05   0 0 0 0     4,25    10,23
  14     5,21   0 0 0 0     7,15     9,15
  99     9,09   0 0 0 0     9,09     9,09
 5 BEAR LAKE - MONTPELIER AREA         4219    11118
   1     5,09   0 0 0 0     0,00     9,24
   2     5,09   0 0 0 0     6,01    10,05
   5     5,28   0 0 0 0     8,05     9,25
   8     5,20   0 0 0 0     7,18     9,15
  10     5,05   0 0 0 0     7,24     9,12
  11     3,19   0 0 0 0     7,07     9,05
  12     5,02   0 0 0 0     5,22    10,01
  13     5,05   0 0 0 0     7,13    10,10
  14     6,01   0 0 0 0     7,25     9,10
  99     9,09   0 0 0 0     9,09     9,09
 6 BENEWAH - ST. MARIES AREA           4719    11634
   1     3,30   0 0 0 0    10,10    10,26
   5     5,05   0 0 0 0     7,18     9,16
   7     4,10   0 0 0 0     6,10     8,01
   8     4,20   0 0 0 0     7,01     9,15
  10     4,05   0 0 0 0     6,25     8,15
  11     2,25   0 0 0 0     6,15     8,15
  12     3,23   0 0 0 0     4,12    11,02
  14     5,01   0 0 0 0     6,25     9,10
  16     4,10   0 0 0 0     6,05     8,10
  99     9,09   0 0 0 0     9,09     9,09
```

* No.   Plant   E. Cover   Harvest

See legend at end of Table C-2 for definition of crop numbers.

Table C-2. Continued.

```
 7 BINGHAM - BLACKFOOT AREA            4310     11221
    1    4,21   0 0 0 0   10,05   10,10
    2    4,21   0 0 0 0    5,13   10,20
    3    6,03   0 0 0 0    7,28    9,12
    5    5,17   0 0 0 0    7,24    9,22
    6    5,15   0 0 0 0    7,23    8,22
    7    4,19   0 0 0 0    6,12    8,01
    8    5,04   0 0 0 0    7,08    9,15
    9    4,20   0 0 0 0    7,17   10,15
   10    4,13   0 0 0 0    7,02    8,22
   11    3,01   0 0 0 0    6,17    8,16
   12    4,14   0 0 0 0    5,05   10,17
   14    5,21   0 0 0 0    7,18    9,15
   99    9,09   0 0 0 0    9,09    9,09
 8 BONNER - SANDPOINT AREA             4817     11634
    1    4,05   0 0 0 0    0,00   10,21
    5    5,05   0 0 0 0    7,18    9,16
    8    5,02   0 0 0 0    7,12    9,15
   10    4,10   0 0 0 0    6,25    8,17
   11    2,25   0 0 0 0    6,15    8,17
   12    3,29   0 0 0 0    4,19   10,28
   13    4,25   0 0 0 0    7,05   10,30
   14    5,25   0 0 0 0    7,20   10,01
   99    9,09   0 0 0 0    9,09    9,09
 9 BONNER - SOUTHERN PART              48 0     11630
    1    4,11   0 0 0 0    0,00   10,26
    5    5,05   0 0 0 0    7,18    9,16
    8    5,07   0 0 0 0    7,15    9,15
   10    4,15   0 0 0 0    7,01    8,23
   11    2,30   0 0 0 0    6,20    8,22
   12    4,04   0 0 0 0    4,24   11,12
   13    5,01   0 0 0 0    7,10   10,30
   14    5,25   0 0 0 0    7,20   10,01
   99    9,09   0 0 0 0    9,09    9,09
10 BONNEVILLE - IDAHO FALLS            4330     112 2
    1    4,17   0 0 0 0   10,01   10,15
    5    5,20   0 0 0 0    7,26    9,25
    7    4,20   0 0 0 0    6,13    8,02
    8    5,05   0 0 0 0    7,10    9,15
    9    4,25   0 0 0 0    7,20   10,10
   10    4,15   0 0 0 0    7,03    8,23
   11    3,01   0 0 0 0    6,18    8,17
   12    4,10   0 0 0 0    5,01   10,22
   99    9,09   0 0 0 0    9,09    9,09
11 BOUNDARY - BONNERS FERRY AREA       4841     11619
    1    4,05   0 0 0 0    9,25   10,20
    5    5,08   0 0 0 0    7,20    9,18
    6    5,20   0 0 0 0    7,28    8,28
    8    4,25   0 0 0 0    7,05    9,15
   10    4,10   0 0 0 0    6,26    8,17
   11    2,25   0 0 0 0    6,15    8,15
   12    3,29   0 0 0 0    4,20   10,27
   13    4,20   0 0 0 0    7,01   10,01
   99    9,09   0 0 0 0    9,09    9,09
12 BOUNDARY - PORTHILL AREA            4857     11630
    1    4,08   0 0 0 0    9,15   10,21
    5    5,09   0 0 0 0    7,21    9,19
    6    5,20   0 0 0 0    7,28    8,28
    8    4,25   0 0 0 0    7,05    9,15
   10    4,15   0 0 0 0    6,31    8,21
   11    2,25   0 0 0 0    6,15    8,15
   12    4,01   0 0 0 0    4,22   10,28
   13    4,25   0 0 0 0    7,05   10,01
   99    9,09   0 0 0 0    9,09    9,09
13 BUTTE - ARCO AREA                   4336     11320
    1    5,04   0 0 0 0    0,00   10,02
    5    5,25   0 0 0 0    7,31    9,30
    7    5,05   0 0 0 0    6,27    8,15
    8    5,20   0 0 0 0    7,20    9,15
   10    5,05   0 0 0 0    7,20    9,09
   11    3,11   0 0 0 0    7,01    8,30
   12    4,28   0 0 0 0    5,19   10,09
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Table C-2. Continued.

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 13    5,10   0 0 0 0     7,17    10,10
 99    9,09   0 0 0 0     9,09     9,09
 14 CAMAS - FAIRFIELD AREA           4321   11447
  1    5,13   0 0 0 0     0,00     9,27
  5    5,25   0 0 0 0     7,31     9,30
  8    5,20   0 0 0 0     7,20     9,15
 10    5,05   0 0 0 0     7,22     9,11
 11    3,17   0 0 0 0     7,05     9,07
 12    4,26   0 0 0 0     5,16    10,04
 99    9,09   0 0 0 0     9,09     9,09
 15 CANYON - CALDWELL AREA           4340   11641
  1    4,03   0 0 0 0     9,01    10,26
  2    4,03   0 0 0 0     4,26    10,10
  3    5,15   0 0 0 0     7,10     9,01
  4    5,01   0 0 0 0     7,12    10,10
  5    5,01   0 0 0 0     7,12     9,10
  6    5,01   0 0 0 0     7,10     8,11
  7    4,01   0 0 0 0     5,28     7,18
  8    4,17   0 0 0 0     6,27     9,15
  9    4,05   0 0 0 0     7,05    10,30
 10    3,25   0 0 0 0     6,15     8,06
 11    2,05   0 0 0 0     5,27     8,01
 12    3,27   0 0 0 0     4,17    11,02
 13    4,05   0 0 0 0     6,25    10,15
 14    5,15   0 0 0 0     7,10     9,15
 15    4,01   0 0 0 0     7,13     9,01
 17    4,01   0 0 0 0     6,05     9,05
 99    9,09   0 0 0 0     9,09     9,09
 16 CARIBOU - SODA SPRINGS AREA       4240   11135
  1    4,30   0 0 0 0     9,20    10,06
  5    5,23   0 0 0 0     7,31     9,20
  8    5,15   0 0 0 0     7,17     9,15
  9    4,29   0 0 0 0     7,26    10,15
 10    4,29   0 0 0 0     7,17     9,05
 11    3,11   0 0 0 0     6,27     8,26
 12    4,23   0 0 0 0     5,13    10,13
 13    4,28   0 0 0 0     7,09    10,10
 14    5,25   0 0 0 0     7,22     9,15
 99    9,09   0 0 0 0     9,09     9,09
 17 CASSIA - BURLEY AREA             4232   11346
  1    4,16   0 0 0 0    10,01    10,11
  2    4,16   0 0 0 0     5,06    10,25
  3    5,27   0 0 0 0     7,20     9,05
  4    5,10   0 0 0 0     7,20    10,20
  5    5,10   0 0 0 0     7,20     9,15
  6    5,10   0 0 0 0     7,20     8,19
  7    4,10   0 0 0 0     6,05     7,25
  8    4,28   0 0 0 0     7,07     9,15
  9    4,10   0 0 0 0     7,10    10,15
 10    4,06   0 0 0 0     6,22     8,12
 11    2,20   0 0 0 0     6,10     8,15
 12    4,09   0 0 0 0     5,01    10,18
 13    4,17   0 0 0 0     7,01    10,08
 14    5,22   0 0 0 0     7,17     9,15
 99    9,09   0 0 0 0     9,09     9,09
 18 CASSIA - MALTA AREA              4218   11317
  1    4,26   0 0 0 0    10,05    10,09
  3    6,05   0 0 0 0     7,30     9,15
  5    5,15   0 0 0 0     7,24     9,23
  6    5,17   0 0 0 0     7,25     8,24
  7    4,22   0 0 0 0     6,15     8,05
  8    5,02   0 0 0 0     7,11     9,15
  9    4,18   0 0 0 0     7,17    10,20
 10    4,15   0 0 0 0     7,02     8,22
 11    3,01   0 0 0 0     6,19     8,20
 12    4,17   0 0 0 0     5,07    10,30
 99    9,09   0 0 0 0     9,09     9,09
 19 CASSIA - STREVELL AREA           42 1   11317
  1    5,05   0 0 0 0     9,29    10,07
  5    5,20   0 0 0 0     7,27     9,28
  8    5,07   0 0 0 0     7,15     9,15
  9    4,24   0 0 0 0     7,23    10,15
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Table C-2. Continued.

```
  10    4,20    0 0 0 0    7,07     8,27
  11    3,05    0 0 0 0    6,23     8,25
  12    4,28    0 0 0 0    5,19    10,14
  99    9,09    0 0 0 0    9,09     9,09
20 CLEARWATER - OROFINO AREA         4629    11615
   1    3,11    0 0 0 0    0,00    11,18
   5    5,10    0 0 0 0    7,20     9,20
   7    4,05    0 0 0 0    6,01     7,20
  10    4,16    0 0 0 0    7,05     8,27
  11    2,10    0 0 0 0    6,01     8,03
  12    3,04    0 0 0 0    3,25    11,25
  14    5,10    0 0 0 0    7,05     8,21
  16    4,15    0 0 0 0    6,05     8,10
  99    9,09    0 0 0 0    9,09     9,09
21 CUSTER - CHALLIS AREA             4430    11414
   1    4,25    0 0 0 0    0,00    10,11
   5    5,15    0 0 0 0    7,22     9,22
   8    5,02    0 0 0 0    7,10     9,15
  10    4,25    0 0 0 0    7,10     8,30
  11    3,01    0 0 0 0    6,20     8,22
  12    4,18    0 0 0 0    5,10    10,18
  99    9,09    0 0 0 0    9,09     9,09
22 CUSTER - MACKAY AREA              4355    11337
   1    4,30    0 0 0 0    0,00    10,10
   5    5,23    0 0 0 0    7,30     9,30
   8    5,15    0 0 0 0    7,15     9,15
  10    5,03    0 0 0 0    7,18     9,07
  11    3,10    0 0 0 0    6,28     8,28
  12    4,23    0 0 0 0    5,13    10,17
  99    9,09    0 0 0 0    9,09     9,09
23 CUSTER - STANLEY AREA             4414    11454
  12    5,15    0 0 0 0    6,08     9,25
  99    9,09    0 0 0 0    9,09     9,09
24 ELMORE - GLENNS FERRY AREA        4256    11519
   1    4,14    0 0 0 0    9,01    10,14
   2    4,14    0 0 0 0    5,06    10,10
   3    5,15    0 0 0 0    7,10     8,24
   4    5,05    0 0 0 0    7,15    10,15
   5    5,05    0 0 0 0    7,15     9,10
   6    5,05    0 0 0 0    7,15     8,16
   8    4,15    0 0 0 0    6,27     9,15
   9    4,05    0 0 0 0    7,05    10,10
  10    3,25    0 0 0 0    6,10     8,01
  11    2,11    0 0 0 0    5,30     8,05
  12    4,07    0 0 0 0    4,27    10,21
  13    4,05    0 0 0 0    6,25    10,15
  14    5,15    0 0 0 0    7,10     9,15
  99    9,09    0 0 0 0    9,09     9,09
25 ELMORE - GRINDSTONE/MTN HOME AR   43 0    11532
   1    4,17    0 0 0 0    9,05    10,21
   2    4,17    0 0 0 0    5,09    10,15
   3    5,20    0 0 0 0    7,15     8,29
   4    5,05    0 0 0 0    7,15    10,20
   5    5,05    0 0 0 0    7,15     9,15
   6    5,05    0 0 0 0    7,15     8,15
   8    4,15    0 0 0 0    6,27     9,15
   9    4,10    0 0 0 0    7,10    10,15
  10    4,01    0 0 0 0    6,15     8,06
  11    2,13    0 0 0 0    6,01     8,07
  12    4,10    0 0 0 0    4,30    10,28
  13    4,10    0 0 0 0    6,28    10,20
  14    5,17    0 0 0 0    7,12     9,15
  99    9,09    0 0 0 0    9,09     9,09
26 ELMORE - SMITH PRAIRIE            4330    11540
   1    5,10    0 0 0 0    0,00    10,05
   2    5,10    0 0 0 0    6,01    10,05
  10    5,01    0 0 0 0    7,18     9,07
  11    3,13    0 0 0 0    7,01     9,03
  12    4,23    0 0 0 0    5,13    10,10
  99    9,09    0 0 0 0    9,09     9,09
27 FRANKLIN - PRESTON AREA           42 4    11151
   1    4,18    0 0 0 0    9,01    10,20
```

Table C-2. Continued.

```
   3    6,01   0 0 0 0   7,25     9,10
   4    5,15   0 0 0 0   7,21    10,15
   5    5,15   0 0 0 0   7,23     9,20
   6    5,30   0 0 0 0   8,07     9,08
   7    4,18   0 0 0 0   6,09     7,30
   8    5,03   0 0 0 0   7,10     9,15
   9    4,18   0 0 0 0   7,17    10,10
  10    4,10   0 0 0 0   6,27     8,20
  11    2,25   0 0 0 0   6,15     8,20
  12    4,10   0 0 0 0   5,01    10,27
  99    9,09   0 0 0 0   9,09     9,09
28 FREMONT - ASHTON AREA            44 4   11127
   1    4,29   0 0 0 0   0,00    10,02
   5    5,30   0 0 0 0   8,05     9,30
   7    5,10   0 0 0 0   7,02     8,21
   8    5,18   0 0 0 0   7,17     9,15
   9    5,02   0 0 0 0   7,27    10,04
  10    4,29   0 0 0 0   7,18     9,07
  11    3,15   0 0 0 0   6,30     8,29
  12    4,22   0 0 0 0   5,12    10,09
  99    9,09   0 0 0 0   9,09     9,09
29 FREMONT - ISLAND PARK AREA       4425   11124
   1    5,18   0 0 0 0   0,00     9,18
  12    5,11   0 0 0 0   6,05     9,25
  99    9,09   0 0 0 0   9,09     9,09
30 FREMONT - ST. ANTHONY AREA       4358   11143
   1    5,01   0 0 0 0   0,00     9,27
   5    5,27   0 0 0 0   8,02     9,27
   7    5,06   0 0 0 0   6,28     8,17
   8    5,13   0 0 0 0   7,15     9,15
   9    4,29   0 0 0 0   7,24    10,04
  10    4,24   0 0 0 0   7,13     9,02
  11    3,10   0 0 0 0   6,25     8,24
  12    4,24   0 0 0 0   5,14    10,03
  13    4,25   0 0 0 0   7,10    10,01
  14    6,13   0 0 0 0   8,04     9,01
  99    9,09   0 0 0 0   9,09     9,09
31 GOODING - GOODING AREA           4258   11445
   1    4,10   0 0 0 0   9,15    10,18
   3    5,25   0 0 0 0   7,20     9,03
   4    5,05   0 0 0 0   7,15    10,15
   5    5,05   0 0 0 0   7,15     9,15
   6    5,05   0 0 0 0   7,17     8,17
   7    4,10   0 0 0 0   6,05     7,25
   8    4,25   0 0 0 0   7,05     9,15
   9    4,12   0 0 0 0   7,12    10,12
  10    4,01   0 0 0 0   6,18     8,09
  11    2,15   0 0 0 0   6,05     8,10
  12    4,03   0 0 0 0   4,25    10,25
  14    5,20   0 0 0 0   7,15     9,15
  99    9,09   0 0 0 0   9,09     9,09
32 IDAHO - GRANGEVILLE AREA         4555   116 8
   1    4,08   0 0 0 0   0,00    10,25
   5    5,05   0 0 0 0   7,20     9,20
   7    4,10   0 0 0 0   6,10     8,01
   8    4,25   0 0 0 0   7,07     9,15
  10    4,08   0 0 0 0   6,25     8,15
  11    2,20   0 0 0 0   6,10     8,12
  12    4,01   0 0 0 0   4,21    11,02
  16    4,15   0 0 0 0   6,05     8,01
  99    9,09   0 0 0 0   9,09     9,09
33 IDAHO - KOOSKIA AREA             46 9   11559
   1    3,27   0 0 0 0   0,00    11,02
   5    4,30   0 0 0 0   7,15     9,15
   7    4,01   0 0 0 0   6,01     7,20
   8    4,18   0 0 0 0   7,01     9,15
  10    4,02   0 0 0 0   6,20     8,10
  11    2,10   0 0 0 0   6,01     8,03
  12    3,20   0 0 0 0   4,10    11,09
  99    9,09   0 0 0 0   9,09     9,09
34 IDAHO - RIGGINS AREA             4525   11618
   1    3,02   0 0 0 0   9,01    11,23
```

Table C-2. Continued.

```
   4    4,10   0 0 0 0    6,25   10,30
   5    4,10   0 0 0 0    6,25    9,01
   8    4,15   0 0 0 0    6,26    9,15
  10    3,15   0 0 0 0    6,01    7,22
  11    2,01   0 0 0 0    5,20    7,21
  12    2,24   0 0 0 0    3,15   11,30
  99    9,09   0 0 0 0    9,09    9,09
35 JEFFERSON - HAMER AREA           4358   11216
   1    4,25   0 0 0 0    9,25   10,12
   2    4,25   0 0 0 0    5,17   10,01
   5    6,01   0 0 0 0    8,07   10,01
   7    4,25   0 0 0 0    6,17    8,07
   8    5,10   0 0 0 0    7,13    9,15
   9    4,27   0 0 0 0    7,22   10,03
  10    4,20   0 0 0 0    7,07    8,26
  11    3,05   0 0 0 0    6,20    8,19
  12    4,18   0 0 0 0    5,08   10,19
  99    9,09   0 0 0 0    9,09    9,09
36 JEFFERSON - RIGBY AREA           4340   11150
   1    4,20   0 0 0 0    9,20   10,12
   2    4,20   0 0 0 0    5,12   10,01
   4    5,23   0 0 0 0    7,29   10,15
   5    5,23   0 0 0 0    7,29    9,25
   7    4,22   0 0 0 0    6,15    8,03
   8    5,07   0 0 0 0    7,10    9,15
   9    4,23   0 0 0 0    7,18   10,03
  10    4,16   0 0 0 0    7,04    8,24
  11    3,03   0 0 0 0    6,19    8,18
  12    4,13   0 0 0 0    5,03   10,19
  14    6,02   0 0 0 0    7,29    9,01
  99    9,09   0 0 0 0    9,09    9,09
37 JEROME - JEROME AREA             4244   11431
   1    4,08   0 0 0 0    9,24   10,23
   2    4,08   0 0 0 0    4,29   10,20
   3    5,25   0 0 0 0    7,18    9,05
   4    5,05   0 0 0 0    7,15   10,15
   5    5,10   0 0 0 0    7,20    9,20
   6    5,14   0 0 0 0    7,25    8,25
   7    4,04   0 0 0 0    6,01    7,22
   8    4,25   0 0 0 0    7,05    9,15
   9    4,12   0 0 0 0    7,12   10,15
  10    4,04   0 0 0 0    6,23    8,13
  11    2,15   0 0 0 0    6,05    8,10
  12    4,01   0 0 0 0    4,21   10,30
  13    4,25   0 0 0 0    7,10   10,10
  14    5,20   0 0 0 0    7,15    9,15
  99    9,09   0 0 0 0    9,09    9,09
38 KOOTENAI - COEUR D'ALENE AREA    4741   11645
   1    4,11   0 0 0 0    0,00   11,03
   5    5,15   0 0 0 0    7,27    9,25
   7    4,15   0 0 0 0    6,10    8,01
   8    4,25   0 0 0 0    7,05    9,15
  10    4,15   0 0 0 0    7,04    8,25
  11    3,07   0 0 0 0    6,25    8,25
  12    4,04   0 0 0 0    4,24   11,10
  13    4,30   0 0 0 0    7,15   10,10
  14    5,23   0 0 0 0    7,18    9,13
  16    4,20   0 0 0 0    6,15    8,15
  99    9,09   0 0 0 0    9,09    9,09
39 LATAH - MOSCOW AREA              4644   11658
   1    3,19   0 0 0 0    0,00   10,31
   5    5,10   0 0 0 0    7,22    9,22
   7    4,15   0 0 0 0    6,10    8,01
   8    4,25   0 0 0 0    7,05    9,15
  10    4,03   0 0 0 0    6,25    8,15
  11    2,25   0 0 0 0    6,15    8,15
  12    3,12   0 0 0 0    4,02   11,06
  14    5,20   0 0 0 0    7,15    9,15
  16    4,15   0 0 0 0    6,10    8,10
  99    9,09   0 0 0 0    9,09    9,09
40 LEMHI - MAY AREA. ALSO LEADORE   4436   11355
   1    5,05   0 0 0 0    0,00    9,29
```

Table C-2. Continued.

```
 12    4,28   0 0 0 0     5,20     10,05
 99    9,09   0 0 0 0     9,09      9,09
41 LEMHI - SALMON AREA              45 7     11353
  1    4,28   0 0 0 0     0,00     10,06
  5    5,20   0 0 0 0     7,29      9,30
 10    4,22   0 0 0 0     7,08      8,28
 11    2,27   0 0 0 0     6,18      8,22
 12    4,21   0 0 0 0     5,12     10,08
 13    5,01   0 0 0 0     7,16     10,01
 99    9,09   0 0 0 0     9,09      9,09
42 LEWIS - NEZ PERCE AREA           4615     11615
  1    4,11   0 0 0 0     0,00     10,24
  5    5,17   0 0 0 0     7,29      9,30
  7    4,10   0 0 0 0     6,10      8,01
 10    4,03   0 0 0 0     6,20      8,10
 11    2,20   0 0 0 0     6,10      8,10
 12    4,04   0 0 0 0     4,25     10,31
 13    4,10   0 0 0 0     7,01     10,05
 16    4,10   0 0 0 0     6,01      8,05
 99    9,09   0 0 0 0     9,09      9,09
43 MADISON - REXBURG AREA           4350     11150
  1    4,28   0 0 0 0     9,20     10,01
  5    5,25   0 0 0 0     7,31      9,25
  7    4,23   0 0 0 0     6,15      8,04
  8    5,09   0 0 0 0     7,12      9,15
  9    4,25   0 0 0 0     7,20     10,01
 10    4,18   0 0 0 0     7,05      8,25
 11    3,05   0 0 0 0     6,21      8,20
 12    4,21   0 0 0 0     5,11     10,08
 99    9,09   0 0 0 0     9,09      9,09
44 MINIDOKA - RUPERT AREA           4237     11341
  1    4,12   0 0 0 0     9,10     10,23
  2    4,15   0 0 0 0     5,06     10,25
  3    5,25   0 0 0 0     7,20      9,01
  4    5,10   0 0 0 0     7,20     10,15
  5    5,10   0 0 0 0     7,20      9,15
  6    5,15   0 0 0 0     7,25      8,24
  7    4,10   0 0 0 0     6,05      7,25
  8    4,25   0 0 0 0     7,06      9,15
  9    4,10   0 0 0 0     7,10     10,15
 10    4,07   0 0 0 0     6,25      8,15
 11    2,20   0 0 0 0     6,10      8,10
 12    4,05   0 0 0 0     4,25     10,30
 13    4,20   0 0 0 0     7,05     10,10
 14    5,20   0 0 0 0     7,15      9,15
 99    9,09   0 0 0 0     9,09      9,09
45 NEZ PERCE - LEWISTON AREA        4623     117 1
  1    3,07   0 0 0 0     0,00     11,23
  5    4,25   0 0 0 0     7,08      9,10
  7    4,01   0 0 0 0     5,25      7,16
  8    4,15   0 0 0 0     6,26      9,15
 10    3,25   0 0 0 0     6,10      8,02
 11    2,05   0 0 0 0     5,25      7,25
 12    2,28   0 0 0 0     3,20     11,30
 13    4,01   0 0 0 0     6,20     10,30
 14    5,01   0 0 0 0     6,25      8,15
 16    4,09   0 0 0 0     6,01      7,31
 99    9,09   0 0 0 0     9,09      9,09
46 ONEIDA - MALAD AREA              4212     11215
  1    4,15   0 0 0 0     9,15     10,22
  2    4,15   0 0 0 0     5,10     10,10
  5    5,15   0 0 0 0     7,23      9,20
  9    4,16   0 0 0 0     7,15     10,10
 10    4,08   0 0 0 0     6,25      8,19
 11    2,26   0 0 0 0     6,15      8,20
 12    4,08   0 0 0 0     4,28     10,29
 99    9,09   0 0 0 0     9,09      9,09
47 OWYHEE - 5000 FT ELEV AREA       4225     11550
  1    5,03   0 0 0 0     0,00      9,30
  5    5,25   0 0 0 0     7,31      9,30
  8    5,20   0 0 0 0     7,20      9,15
 10    5,05   0 0 0 0     7,22      9,11
```

Table C-2. Continued.

```
 11    3,17   0 0 0 0    7,05    9,07
 12    4,26   0 0 0 0    5,17   10,06
 99    9,09   0 0 0 0    9,09    9,09
48 PAYETTE - PAYETTE AREA          44 5    11656
  1    4,03   0 0 0 0    9,10   10,24
  2    4,03   0 0 0 0    4,25   10,10
  3    5,17   0 0 0 0    7,11    9,01
  4    5,03   0 0 0 0    7,13   10,10
  5    5,03   0 0 0 0    7,13    9,12
  6    5,03   0 0 0 0    7,12    8,14
  7    4,04   0 0 0 0    5,30    7,21
  8    4,14   0 0 0 0    6,24    9,20
  9    4,08   0 0 0 0    7,08   10,30
 10    3,28   0 0 0 0    6,18    8,08
 11    2,09   0 0 0 0    6,01    8,03
 12    3,27   0 0 0 0    4,17   10,31
 13    4,08   0 0 0 0    6,28   10,15
 14    5,12   0 0 0 0    7,07    9,15
 15    4,04   0 0 0 0    7,15    9,01
 17    4,01   0 0 0 0    6,05    9,05
 99    9,09   0 0 0 0    9,09    9,09
49 POWER - AMERICAN FALLS AREA     4247    11252
  1    4,16   0 0 0 0   10,01   10,18
  2    4,16   0 0 0 0    5,09   10,20
  3    6,01   0 0 0 0    7,25    9,10
  5    5,15   0 0 0 0    7,23    9,19
  6    5,15   0 0 0 0    7,25    8,24
  7    4,18   0 0 0 0    6,11    7,29
  8    5,03   0 0 0 0    7,08    9,15
  9    4,15   0 0 0 0    7,15   10,15
 10    4,09   0 0 0 0    6,28    8,18
 11    2,27   0 0 0 0    6,15    8,14
 12    4,09   0 0 0 0    4,30   10,25
 14    5,21   0 0 0 0    7,16    9,15
 99    9,09   0 0 0 0    9,09    9,09
50 SHOSHONE - KELLOGG AREA         4732    116 8
  1    4,01   0 0 0 0    0,00   10,27
  5    5,10   0 0 0 0    7,25    9,30
 10    4,05   0 0 0 0    6,22    8,13
 11    2,20   0 0 0 0    6,12    8,12
 12    3,24   0 0 0 0    4,15   11,03
 99    9,09   0 0 0 0    9,09    9,09
51 TETON - TETONIA-DRIGGS AREA     4347    11111
  1    5,13   0 0 0 0    0,00    9,25
  5    6,01   0 0 0 0    8,07   10,01
  8    5,17   0 0 0 0    7,15    9,15
 10    5,01   0 0 0 0    7,20    9,10
 11    3,15   0 0 0 0    7,01    8,31
 12    5,06   0 0 0 0    5,27   10,01
 99    9,09   0 0 0 0    9,09    9,09
52 TWIN FALLS - HOLLISTER AREA     4221    11434
  1    4,24   0 0 0 0   10,05   10,16
  2    4,21   0 0 0 0    5,13   10,20
  3    6,03   0 0 0 0    7,28    9,12
  5    5,17   0 0 0 0    7,24    9,22
  6    5,15   0 0 0 0    7,23    8,22
  7    4,19   0 0 0 0    6,12    8,01
  8    5,04   0 0 0 0    7,08    9,15
  9    4,20   0 0 0 0    7,17   10,15
 10    4,13   0 0 0 0    7,02    8,22
 11    3,01   0 0 0 0    6,17    8,16
 12    4,17   0 0 0 0    5,08   10,23
 14    5,21   0 0 0 0    7,16    9,15
 99    9,09   0 0 0 0    9,09    9,09
53 TWIN FALLS - TWIN FALLS AREA    4233    11421
  1    4,10   0 0 0 0    9,15   10,21
  2    4,10   0 0 0 0    5,01   10,20
  3    5,22   0 0 0 0    7,15    8,30
  4    5,05   0 0 0 0    7,15   10,15
  5    5,05   0 0 0 0    7,15    9,15
  6    5,05   0 0 0 0    7,15    8,15
  7    4,10   0 0 0 0    6,05    7,25
```

Table C-2. Continued.

```
   8     4,25   0 0 0 0     7,05     9,15
   9     4,10   0 0 0 0     7,10    10,15
  10     4,04   0 0 0 0     6,20     8,10
  11     2,15   0 0 0 0     6,05     8,10
  12     4,03   0 0 0 0     4,24    10,28
  13     4,15   0 0 0 0     7,01    10,10
  14     5,20   0 0 0 0     7,15     9,15
  15     4,20   0 0 0 0     7,25     9,15
  16     0,00   0 0 0 0     0,00     0,00
  99     9,09   0 0 0 0     9,09     9,09
54 VALLEY - CASCADE AREA              4432    116 3
   1     5,04   0 0 0 0     0,00    10,01
   5     6,01   0 0 0 0     8,10     9,25
   8     5,20   0 0 0 0     7,22     9,15
  10     5,01   0 0 0 0     7,20     9,10
  11     3,15   0 0 0 0     7,04     9,05
  12     4,28   0 0 0 0     5,18    10,08
  99     9,09   0 0 0 0     9,09     9,09
55 WASHINGTON - WEISER AREA           4414    11657
   1     4,15   0 0 0 0     8,04    10,18
   2     4,15   0 0 0 0     5,07    10,15
   3     5,18   0 0 0 0     7,12     9,02
   4     5,04   0 0 0 0     7,15    10,10
   5     5,04   0 0 0 0     7,15     9,12
   6     5,04   0 0 0 0     7,13     8,15
   8     4,23   0 0 0 0     7,03     9,20
   9     4,05   0 0 0 0     7,05    10,30
  10     4,02   0 0 0 0     6,21     8,11
  11     2,13   0 0 0 0     6,03     8,05
  12     4,07   0 0 0 0     4,28    10,25
  13     4,01   0 0 0 0     6,19    10,20
  14     5,18   0 0 0 0     7,13     9,17
  15     4,05   0 0 0 0     7,14     9,05
  17     4,01   0 0 0 0     6,05     9,05
  99     9,09   0 0 0 0     9,09     9,09
56 OWYHEE - UPPER REYNOLDS CREEK      4312    11645
   1     4,20   0 0 0 0     9,15     9,25
  12     4,13   0 0 0 0     5,04    10,05
  99     9,09   0 0 0 0     9,09     9,09
99 9 9 9 9 9 9 9 9 9                   0 0      0 0
99 9 9 9 9 9 9 9 9 9                   0 0      0 0
```

Definition of Crops

Crop Number	Crop Name
1	Alfalfa Hay
2	Alfalfa Seed
3	Dry and Edible Beans
4	Field Corn
5	Silage Corn
6	Sweet Corn
7	Peas
8	Potatoes
9	Sugar Beets
10	Spring Grain
11	Winter Grain
12	Grass Pasture
13	Orchards
14	Garden Vegetables
15	Onions
16	Lentils
17	Hops

Table C-3. Alfalfa reference evapotranspiration, mm/day, adjusted for station aridity (from Table 12).

	Mar	Apr	May	June	July	Aug	Sept	Oct	Mar-Oct
Aberdeen Exp. Station	1.56	4.36	6.01	7.96	8.37	6.74	5.00	3.20	1322
American Falls 1 SW	1.74	4.50	6.08	8.02	8.44	6.86	5.21	3.47	1356
Anderson Dam	1.81	4.46	6.13	7.93	8.51	7.03	5.34	3.77	1377
Arbon 2 NW	1.38	3.96	5.76	7.81	8.30	6.75	5.06	3.24	1293
Arco 3 SW	1.07	4.14	6.05	7.48	8.10	6.41	4.74	2.93	1252
Ashton	.80	3.99	6.02	7.34	7.85	6.33	4.72	2.84	1221
Bayview Model Basin	.98	3.19	4.51	5.57	7.11	5.61	3.79	1.63	992
Blackfoot 2 SSW	1.62	4.74	6.44	7.85	8.56	6.88	5.18	3.26	1363
Bliss	2.14	5.28	6.79	8.41	8.54	7.18	5.60	3.73	1459
Boise WSO AP	2.17	4.29	5.91	7.65	8.29	6.72	5.24	3.38	1336
Bonners Ferry 1 SW	1.11	3.63	4.96	5.93	7.53	5.86	4.03	1.71	1064
Bruneau	2.52	4.97	6.56	8.28	8.58	7.13	5.41	3.76	1445
Burley FAA AP	1.90	4.44	6.02	7.67	8.19	6.71	5.14	3.32	1328
Cabinet Gorge	1.08	3.41	4.78	5.82	7.39	5.80	4.00	1.80	1044
Caldwell	2.34	4.74	6.30	7.90	8.55	6.98	5.34	3.26	1389
Cambridge	1.81	4.39	6.01	7.66	8.54	6.96	5.17	3.02	1333
Cascade 1 NW	.99	3.29	5.03	6.68	7.46	6.08	4.50	2.56	1120
Castleford 2 N	2.14	4.96	6.63	8.30	8.31	7.10	5.52	3.54	1423
Challis	1.27	4.35	5.89	7.44	8.11	6.40	4.71	3.00	1260
Chilly Barton Flat	.55	3.45	5.09	6.63	7.20	5.62	3.99	2.41	1069
Coeur D'Alene 1 E	1.18	3.59	4.94	5.90	7.62	6.01	4.23	2.03	1087
Cottonwood	1.33	3.36	4.69	5.82	7.24	5.98	4.16	2.04	1060
Council	1.79	4.33	5.99	7.63	8.45	6.95	5.25	3.17	1333
Deer Flat Dam	2.26	4.72	6.28	7.90	8.66	7.23	5.52	3.26	1403
Driggs	.74	3.66	5.61	7.12	8.01	6.47	4.73	2.74	1196
Dubois Exp. Station	.66	3.83	5.59	7.13	7.95	6.22	4.53	2.89	1187
Emmett 2 E	2.34	4.78	6.32	7.92	8.59	7.11	5.51	3.34	1405
Fairfield Ranger Station	.80	4.10	5.99	7.63	7.86	6.68	5.04	3.07	1259
Fort Hall Indian Agency	1.71	4.58	6.30	8.27	8.72	7.09	5.32	3.44	1391
Garden Valley RS	1.77	4.06	5.64	7.23	7.88	6.41	4.96	3.05	1255
Glenns Ferry	2.47	4.94	6.43	8.11	8.32	6.66	5.10	3.71	1400
Grace	1.11	4.04	5.79	7.79	8.33	6.83	5.09	3.13	1288
Grand View 2 W	2.49	5.08	6.62	8.43	8.73	7.20	5.37	3.60	1454
Grangeville	1.42	3.33	4.63	5.78	7.08	5.79	3.99	2.02	1042
Hailey Ranger Station	1.15	4.29	6.02	7.53	7.69	6.37	4.91	3.31	1263
Hamer 4 NW	.86	4.07	5.74	7.37	7.96	6.24	4.48	2.72	1207
Hazelton	2.04	4.61	6.20	7.85	8.26	6.73	5.21	3.54	1360
Hill City	.74	4.03	5.87	7.36	7.73	6.52	4.85	2.97	1226
Hollister	1.88	4.31	5.80	7.42	8.02	6.50	5.01	3.45	1298
Howe	1.12	4.39	5.95	7.49	7.99	6.26	4.44	2.78	1237
Idaho City	1.46	3.82	5.44	7.03	7.81	6.47	4.90	2.91	1219
Idaho Falls 2 ESE	1.44	4.38	6.22	7.76	8.27	6.63	4.94	3.11	1308
Idaho Falls 16 SE	.95	3.68	5.54	7.10	7.76	6.24	4.56	2.72	1180
Idaho Falls FAA AP	1.32	4.35	6.07	7.43	8.00	6.33	4.73	3.03	1263
Idaho Falls 46 W	1.03	3.80	5.66	7.21	7.67	5.94	4.30	2.70	1172
Island Park Dam	-.00	2.84	4.88	6.54	7.38	5.92	4.13	2.27	1039
Jerome	2.03	4.68	6.28	7.93	8.37	6.82	5.31	3.59	1377
Kellogg	1.20	3.58	4.90	5.82	7.47	5.79	4.09	1.94	1065

Table C-3. Continued.

	Mar	Apr	May	June	July	Aug	Sept	Oct	Mar-Oct
Kilgore	-.05	2.67	4.87	6.51	7.22	5.86	4.00	2.09	1015
Kooskia	1.86	3.94	5.27	6.37	7.52	6.14	4.34	2.19	1152
Kuna 2 NNE	2.21	4.61	6.14	7.74	8.47	7.12	5.44	3.29	1378
Lewiston WSO AP	1.88	3.89	5.24	6.50	7.67	6.24	4.42	2.28	1167
Lifton Pumping Station	.40	3.22	5.01	6.89	7.78	6.53	4.67	2.48	1132
Mackay Ranger Station	.81	4.01	5.65	7.31	8.14	6.51	4.78	2.90	1227
Malad	1.27	3.94	5.26	7.05	7.93	6.74	4.99	2.89	1226
Malad City	1.19	3.77	5.15	6.88	7.75	6.58	4.83	2.79	1192
Malta 2 E	1.87	4.27	5.88	7.76	8.35	6.91	5.15	3.26	1330
May	1.15	4.14	5.68	7.15	7.81	6.26	4.54	2.79	1209
Mc Call	.82	2.95	4.84	6.52	7.28	5.87	4.32	2.49	1074
Minidoka Dam	1.83	4.37	6.04	7.82	8.29	6.80	5.28	3.48	1344
Montpelier Ranger Station	.51	3.23	4.78	6.60	7.51	6.29	4.50	2.48	1098
Moscow-Univ. of Idaho	1.28	3.66	4.88	5.81	7.58	6.06	4.37	2.07	1093
Mountain Home	2.23	4.61	6.09	7.90	8.24	6.70	5.08	3.64	1362
New Meadows Ranger Station	1.07	3.47	5.11	6.74	7.38	6.01	4.40	2.40	1119
Nezperce	1.36	3.27	4.67	5.90	7.14	5.97	4.09	1.94	1051
Oakley	2.01	4.54	6.09	7.77	8.35	6.94	5.38	3.61	1367
Ola 4 S	1.94	4.18	5.84	7.54	8.17	6.70	5.13	3.00	1301
Orofino	1.89	4.07	5.41	6.54	7.75	6.36	4.45	2.24	1185
Palisades Dam	1.01	3.94	5.92	7.43	8.02	6.43	4.90	3.14	1248
Parma Exp. Station	2.23	4.67	6.24	7.86	8.58	7.14	5.39	3.17	1386
Paul 1 ENE	1.83	4.34	6.04	7.68	8.23	6.80	5.17	3.28	1327
Payette	2.29	4.78	6.38	8.01	8.77	7.27	5.48	3.21	1414
Picabo	1.07	4.14	6.02	7.79	8.02	6.79	5.04	3.06	1283
Pocatello WSO AP	1.64	4.24	5.91	7.91	8.23	6.53	4.92	3.36	1308
Porthill	1.00	3.51	4.85	5.75	7.24	5.56	3.79	1.65	1021
Potlatch 3 NNE	1.21	3.53	4.75	5.67	7.32	5.81	4.10	1.92	1051
Preston Sugar Factory	1.17	3.95	5.23	7.00	7.87	6.67	4.94	2.88	1215
Reynolds	1.84	3.64	5.28	6.94	7.48	6.04	4.61	3.00	1189
Richfield	1.52	4.65	6.28	7.87	8.05	6.73	5.17	3.34	1334
Riggins	2.11	4.19	5.44	6.54	7.86	6.47	4.66	2.60	1221
Rupert	1.90	4.62	6.16	7.85	8.38	6.80	5.21	3.43	1357
St Anthony 1 WNW	.98	4.09	5.97	7.28	7.76	6.22	4.64	2.94	1220
Saint Maries	1.24	3.61	4.89	5.82	7.43	5.79	4.13	1.97	1068
Salmon	1.31	4.37	5.78	7.12	7.61	5.92	4.31	2.75	1198
Salmon 1 N	1.48	4.33	5.80	7.52	7.93	6.16	4.40	2.69	1233
Sandpoint Exp. Station	1.05	3.48	4.79	5.70	7.20	5.60	3.88	1.73	1023
Shoshone 1 WNW	1.82	4.91	6.48	8.15	8.27	6.79	5.24	3.57	1384
Stanley	.35	2.89	4.78	6.45	6.32	5.14	3.76	2.40	982
Strevell	1.65	4.11	5.73	7.52	8.23	6.80	5.20	3.29	1301
Swan Falls Power House	2.58	4.97	6.57	8.19	8.89	7.21	5.69	3.79	1466
Swan Valley	1.08	3.82	5.68	7.16	7.84	6.31	4.67	2.74	1203
Tensed	1.18	3.37	4.49	5.58	7.18	5.77	3.99	1.84	1023
Tetonia Exp. Station	.62	3.43	5.55	7.18	7.99	6.52	4.70	2.55	1180
Three Creek	1.53	3.62	5.00	6.65	7.07	5.68	4.16	2.97	1123
Twin Falls 2 NNE	2.13	4.75	6.34	7.92	8.32	6.78	5.22	3.52	1376
Twin Falls 3 SE	2.03	4.66	6.27	7.91	8.41	6.87	5.29	3.45	1374
Twin Falls WSO	1.95	4.18	6.23	7.49	8.10	6.82	5.21	3.34	1326
Weiser 2 SE	2.27	4.73	6.33	7.99	8.67	7.13	5.40	3.20	1399

Table C-4. Standard deviation of Alfalfa Reference Evapotranspiration, mm/day. Adjusted for station aridity.

	Mar	Apr	May	June	July	Aug	Sept	Oct
ABERDEEN EXP. STATION	.47	.54	.51	.48	.32	.31	.40	.36
AMERICAN FALLS 1 SW	.42	.44	.46	.52	.28	.29	.37	.35
ANDERSON DAM	.38	.45	.47	.54	.29	.36	.44	.40
ARBON 2 NW	.44	.49	.40	.47	.22	.37	.44	.38
ARCO 3 SW	.54	.56	.53	.47	.37	.38	.40	.36
ASHTON	.47	.60	.52	.49	.32	.31	.41	.38
BAYVIEW MODEL BASIN	.18	.23	.33	.29	.27	.32	.29	.18
BLACKFOOT 2 SSW	.46	.58	.47	.43	.34	.34	.44	.38
BLISS	.35	.47	.49	.47	.26	.33	.41	.35
BOISE WSO AP	.31	.38	.46	.47	.32	.40	.44	.32
BONNERS FERRY 1 SW	.26	.32	.30	.33	.29	.30	.34	.16
BRUNEAU	.30	.48	.43	.50	.35	.33	.42	.30
BURLEY FAA AP	.34	.45	.46	.46	.24	.31	.40	.34
CABINET GORGE	.22	.28	.35	.32	.29	.37	.38	.16
CALDWELL	.28	.37	.47	.51	.37	.39	.38	.26
CAMBRIDGE	.47	.44	.45	.51	.43	.39	.39	.29
CASCADE 1 NW	.36	.42	.43	.46	.30	.33	.44	.31
CASTLEFORD 2 N	.36	.52	.39	.45	.22	.38	.41	.33
CHALLIS	.39	.48	.52	.52	.33	.37	.37	.34
CHILLY BARTON FLAT	.48	.53	.49	.52	.42	.42	.41	.35
COEUR D'ALENE 1 E	.25	.34	.35	.33	.28	.32	.35	.19
COTTONWOOD	.33	.37	.43	.41	.38	.34	.36	.25
COUNCIL	.46	.43	.46	.49	.30	.38	.42	.28
DEER FLAT DAM	.28	.37	.43	.39	.26	.28	.34	.23
DRIGGS	.47	.57	.52	.53	.32	.30	.44	.38
DUBOIS EXP. STATION	.48	.60	.56	.54	.35	.33	.45	.39
EMMETT 2 E	.30	.41	.47	.46	.32	.34	.37	.27
FAIRFIELD RANGER STATION	.47	.52	.44	.43	.28	.43	.48	.39
FORT HALL INDIAN AGNCY	.40	.49	.52	.48	.28	.32	.34	.34
GARDEN VALLEY RS	.30	.43	.39	.47	.32	.36	.41	.27
GLENNS FERRY	.35	.44	.49	.48	.30	.36	.35	.33
GRACE	.54	.64	.48	.55	.35	.32	.40	.39
GRAND VIEW 2 W	.28	.42	.46	.49	.35	.36	.38	.28
GRANGEVILLE	.30	.38	.42	.37	.32	.36	.41	.26
HAILEY RANGER STATION	.45	.62	.55	.50	.34	.39	.44	.41
HAMER 4 NW	.48	.49	.49	.42	.30	.35	.40	.34
HAZELTON	.37	.49	.55	.51	.39	.36	.41	.38
HILL CITY	.52	.54	.50	.49	.29	.35	.40	.35
HOLLISTER	.38	.54	.57	.59	.32	.37	.44	.40
HOWE	.48	.46	.37	.45	.31	.33	.48	.36
IDAHO CITY	.39	.41	.46	.41	.32	.35	.40	.31
IDAHO FALLS 2 ESE	.44	.50	.48	.44	.26	.36	.42	.32
IDAHO FALLS 16 SE	.43	.48	.35	.41	.31	.43	.51	.40
IDAHO FALLS FAA AP	.54	.54	.53	.49	.26	.30	.41	.35
IDAHO FALLS 46 W	.51	.48	.48	.50	.27	.36	.45	.32
ISLAND PARK DAM	.46	.54	.49	.46	.30	.35	.43	.39
JEROME	.37	.48	.55	.53	.31	.36	.40	.34
KELLOGG	.26	.38	.38	.35	.31	.34	.35	.20

Table C-4. Continued.

	Mar	Apr	May	June	July	Aug	Sept	Oct
KILGORE	.39	.55	.43	.38	.25	.36	.52	.41
KOOSKIA	.25	.33	.36	.34	.26	.30	.32	.20
KUNA 2 NNE	.29	.42	.45	.41	.32	.34	.36	.30
LEWISTON WSO AP	.23	.32	.35	.41	.31	.40	.36	.20
LIFTON PUMPING STATION	.51	.58	.44	.43	.23	.27	.36	.32
MACKAY RANGER STATION	.46	.59	.53	.53	.34	.36	.37	.38
MALAD	.38	.49	.45	.45	.31	.36	.40	.35
MALAD CITY	.42	.39	.41	.42	.21	.34	.34	.30
MALTA 2 E	.41	.50	.40	.52	.29	.49	.44	.29
MAY	.41	.46	.47	.48	.32	.34	.41	.31
MC CALL	.45	.52	.50	.49	.27	.36	.40	.30
MINIDOKA DAM	.41	.45	.47	.47	.28	.36	.41	.35
MONTPELIER RANGER STATION	.50	.62	.48	.52	.27	.31	.36	.37
MOSCOW-UNIV. OF IDAHO	.27	.40	.39	.36	.30	.34	.35	.23
MOUNTAIN HOME	.32	.46	.50	.51	.34	.38	.40	.40
NEW MEADOWS RANGER STATION	.45	.42	.42	.42	.27	.32	.39	.29
NEZPERCE	.28	.36	.40	.37	.29	.38	.42	.23
OAKLEY	.37	.49	.54	.51	.32	.34	.39	.39
OLA 4 S	.35	.38	.41	.42	.27	.38	.43	.27
OROFINO	.24	.32	.36	.35	.25	.29	.31	.20
PALISADES DAM	.42	.52	.46	.47	.31	.34	.40	.37
PARMA EXP. STATION	.29	.42	.46	.48	.33	.34	.34	.26
PAUL 1 ENE	.36	.45	.47	.47	.27	.36	.42	.35
PAYETTE	.29	.36	.41	.40	.27	.31	.34	.25
PICABO	.53	.51	.53	.54	.33	.45	.56	.41
POCATELLO WSO AP	.41	.47	.48	.48	.28	.35	.45	.39
PORTHILL	.27	.28	.30	.31	.27	.30	.31	.17
POTLATCH 3 NNE	.28	.40	.39	.37	.35	.32	.39	.26
PRESTON SUGAR FACTORY	.48	.50	.44	.46	.25	.30	.34	.30
REYNOLDS	.31	.45	.43	.43	.30	.44	.46	.32
RICHFIELD	.54	.48	.50	.51	.31	.37	.40	.34
RIGGINS	.29	.43	.40	.40	.27	.37	.39	.26
RUPERT	.39	.45	.58	.53	.32	.31	.35	.37
ST ANTHONY 1 WNW	.47	.52	.52	.41	.26	.31	.40	.37
SAINT MARIES	.26	.37	.37	.33	.30	.33	.35	.20
SALMON	.40	.37	.48	.43	.27	.27	.35	.28
SALMON 1 N	.33	.50	.36	.42	.27	.35	.38	.30
SANDPOINT EXP. STATION	.26	.33	.33	.30	.25	.28	.30	.17
SHOSHONE 1 WNW	.46	.51	.54	.58	.36	.46	.46	.37
STANLEY	.57	.47	.40	.49	.20	.34	.53	.32
STREVELL	.39	.54	.53	.64	.31	.34	.49	.41
SWAN FALLS POWER HOUSE	.29	.41	.44	.53	.29	.32	.39	.29
SWAN VALLEY	.45	.53	.38	.35	.32	.33	.45	.34
TENSED	.19	.30	.27	.29	.22	.32	.40	.17
TETONIA EXP. STATION	.46	.55	.49	.41	.31	.34	.49	.37
THREE CREEK	.35	.55	.45	.45	.31	.37	.50	.49
TWIN FALLS 2 NNE	.32	.47	.48	.45	.27	.32	.41	.35
TWIN FALLS 3 SE	.36	.48	.51	.52	.28	.30	.39	.37
TWIN FALLS WSO	.35	.43	.42	.36	.24	.36	.47	.34
WEISER 2 SE	.31	.42	.42	.42	.34	.34	.37	.31

Table C-5. Alfalfa reference evapotranspiration, mm/day.
Not adjusted for station aridity.

	Mar	Apr	May	June	July	Aug	Sept	Oct	Mar-Oct
ABERDEEN EXP. STATION	1.56	4.50	6.21	8.24	8.83	7.27	5.33	3.20	1381
AMERICAN FALLS 1 SW	1.74	4.68	6.35	8.40	9.06	7.56	5.65	3.47	1435
ANDERSON DAM	1.81	4.64	6.41	8.33	9.16	7.77	5.81	3.77	1460
ARBON 2 NW	1.38	4.10	5.97	8.10	8.77	7.28	5.40	3.24	1354
ARCO 3 SW	1.07	4.31	6.31	7.83	8.67	7.06	5.16	2.93	1326
ASHTON	.80	4.08	6.16	7.53	8.17	6.68	4.95	2.84	1261
BAYVIEW MODEL BASIN	.98	3.23	4.58	5.67	7.30	5.81	3.92	1.63	1014
BLACKFOOT 2 SSW	1.62	4.86	6.62	8.09	8.97	7.35	5.48	3.26	1415
BLISS	2.14	5.38	6.94	8.62	8.88	7.58	5.86	3.73	1503
BOISE WSO AP	2.17	4.48	6.22	8.08	9.01	7.55	5.77	3.38	1428
BONNERS FERRY 1 SW	1.11	3.69	5.05	6.05	7.76	6.12	4.18	1.71	1092
BRUNEAU	2.52	5.07	6.73	8.51	8.97	7.57	5.68	3.76	1494
BURLEY FAA AP	1.90	4.56	6.19	7.91	8.58	7.17	5.43	3.32	1379
CABINET GORGE	1.08	3.49	4.91	5.99	7.72	6.16	4.21	1.80	1083
CALDWELL	2.34	4.83	6.44	8.09	8.88	7.37	5.58	3.26	1432
CAMBRIDGE	1.81	4.47	6.13	7.84	8.83	7.29	5.38	3.02	1370
CASCADE 1 NW	.99	3.39	5.18	6.89	7.82	6.49	4.77	2.56	1166
CASTLEFORD 2 N	2.14	5.02	6.72	8.42	8.51	7.33	5.67	3.54	1448
CHALLIS	1.27	4.54	6.16	7.81	8.73	7.10	5.14	3.00	1339
CHILLY BARTON FLAT	.55	3.62	5.34	6.97	7.79	6.28	4.40	2.41	1143
COEUR D'ALENE 1 E	1.18	3.69	5.10	6.12	8.05	6.47	4.51	2.03	1137
COTTONWOOD	1.33	3.41	4.77	5.93	7.43	6.19	4.28	2.04	1083
COUNCIL	1.79	4.45	6.17	7.89	8.89	7.45	5.57	3.17	1389
DEER FLAT DAM	2.26	4.73	6.30	7.93	8.71	7.28	5.56	3.26	1409
DRIGGS	.74	3.74	5.73	7.28	8.28	6.77	4.92	2.74	1230
DUBOIS EXP. STATION	.66	4.10	5.99	7.69	8.88	7.27	5.19	2.89	1306
EMMETT 2 E	2.34	4.83	6.41	8.03	8.78	7.33	5.65	3.34	1429
FAIRFIELD RANGER STATION	.80	4.14	6.06	7.73	8.01	6.86	5.16	3.07	1279
FORT HALL INDIAN AGNCY	1.71	4.67	6.43	8.47	9.03	7.44	5.55	3.44	1430
GARDEN VALLEY RS	1.77	4.23	5.91	7.61	8.51	7.14	5.42	3.05	1336
GLENNS FERRY	2.47	5.16	6.76	8.58	9.08	7.54	5.65	3.71	1498
GRACE	1.11	4.11	5.91	7.95	8.60	7.13	5.28	3.13	1322
GRAND VIEW 2 W	2.49	5.18	6.76	8.64	9.07	7.58	5.61	3.60	1497
GRANGEVILLE	1.42	3.44	4.80	6.01	7.51	6.27	4.27	2.02	1094
HAILEY RANGER STATION	1.15	4.52	6.35	7.98	8.40	7.21	5.45	3.31	1358
HAMER 4 NW	.86	4.25	6.01	7.74	8.58	6.93	4.91	2.72	1285
HAZELTON	2.04	4.80	6.48	8.24	8.90	7.47	5.68	3.54	1443
HILL CITY	.74	4.13	6.01	7.56	8.03	6.87	5.08	2.97	1266
HOLLISTER	1.88	4.52	6.11	7.85	8.72	7.30	5.53	3.45	1388
HOWE	1.12	4.58	6.23	7.89	8.65	7.00	4.91	2.78	1321
IDAHO CITY	1.46	3.88	5.55	7.18	8.06	6.76	5.08	2.91	1251
IDAHO FALLS 2 ESE	1.44	4.54	6.47	8.10	8.84	7.28	5.34	3.11	1381
IDAHO FALLS 16 SE	.95	3.79	5.70	7.32	8.13	6.66	4.83	2.72	1227
IDAHO FALLS FAA AP	1.32	4.58	6.41	7.89	8.77	7.20	5.29	3.03	1362
IDAHO FALLS 46 W	1.03	4.10	6.12	7.83	8.71	7.12	5.04	2.70	1305
ISLAND PARK DAM	0.00	2.93	5.02	6.73	7.70	6.28	4.35	2.27	1080
JEROME	2.03	4.86	6.56	8.31	9.01	7.55	5.78	3.59	1460
KELLOGG	1.20	3.69	5.06	6.04	7.89	6.25	4.37	1.94	1115

Table C-5. Continued.

	Mar	Apr	May	June	July	Aug	Sept	Oct	Mar-Oct
KILGORE	-.05	2.73	4.96	6.64	7.44	6.10	4.15	2.09	1043
KOOSKIA	1.86	4.01	5.38	6.51	7.79	6.44	4.52	2.19	1185
KUNA 2 NNE	2.21	4.61	6.14	7.74	8.47	7.12	5.44	3.29	1378
LEWISTON WSO AP	1.88	4.02	5.44	6.77	8.17	6.79	4.74	2.28	1227
LIFTON PUMPING STATION	.40	3.29	5.11	7.04	8.03	6.82	4.86	2.48	1164
MACKAY RANGER STATION	.81	4.14	5.83	7.56	8.56	6.98	5.08	2.90	1281
MALAD	1.27	4.05	5.42	7.28	8.32	7.20	5.27	2.89	1276
MALAD CITY	1.19	3.89	5.33	7.14	8.18	7.09	5.15	2.79	1247
MALTA 2 E	1.87	4.32	5.95	7.85	8.50	7.08	5.27	3.26	1350
MAY	1.15	4.28	5.89	7.42	8.28	6.79	4.86	2.79	1268
MC CALL	.82	3.08	5.03	6.80	7.74	6.40	4.66	2.49	1133
MINIDOKA DAM	1.83	4.54	6.31	8.19	8.88	7.49	5.72	3.48	1421
MONTPELIER RANGER STATION	.51	3.36	4.97	6.87	7.96	6.82	4.83	2.48	1156
MOSCOW-UNIV. OF IDAHO	1.28	3.69	4.94	5.88	7.73	6.22	4.47	2.07	1110
MOUNTAIN HOME	2.23	4.82	6.41	8.35	8.97	7.55	5.61	3.64	1456
NEW MEADOWS RANGER STATION	1.07	3.53	5.20	6.86	7.58	6.24	4.54	2.40	1145
NEZPERCE	1.36	3.31	4.72	5.97	7.28	6.13	4.18	1.94	1068
OAKLEY	2.01	4.64	6.24	7.98	8.69	7.34	5.64	3.61	1413
OLA 4 S	1.94	4.27	5.98	7.74	8.51	7.09	5.38	3.00	1344
OROFINO	1.89	4.13	5.51	6.69	8.02	6.65	4.63	2.24	1217
PALISADES DAM	1.01	4.13	6.20	7.80	8.64	7.15	5.35	3.14	1329
PARMA EXP. STATION	2.23	4.70	6.28	7.92	8.67	7.25	5.46	3.17	1398
PAUL 1 ENE	1.83	4.42	6.17	7.86	8.52	7.14	5.39	3.28	1366
PAYETTE	2.29	4.82	6.44	8.09	8.92	7.44	5.58	3.21	1432
PICABO	1.07	4.21	6.11	7.92	8.22	7.02	5.19	3.06	1309
POCATELLO WSO AP	1.64	4.51	6.30	8.48	9.16	7.58	5.58	3.36	1427
PORTHILL	1.00	3.62	5.01	5.97	7.66	6.02	4.06	1.65	1071
POTLATCH 3 NNE	1.21	3.56	4.78	5.72	7.41	5.91	4.17	1.92	1062
PRESTON SUGAR FACTORY	1.17	4.06	5.39	7.23	8.26	7.13	5.23	2.88	1265
REYNOLDS	1.84	3.89	5.66	7.47	8.37	7.07	5.26	3.00	1303
RICHFIELD	1.52	4.76	6.44	8.09	8.40	7.14	5.43	3.34	1380
RIGGINS	2.11	4.36	5.69	6.89	8.49	7.18	5.08	2.60	1298
RUPERT	1.90	4.76	6.38	8.15	8.87	7.37	5.58	3.43	1421
ST ANTHONY 1 WNW	.98	4.25	6.23	7.62	8.33	6.87	5.05	2.94	1294
SAINT MARIES	1.24	3.71	5.04	6.01	7.81	6.20	4.37	1.97	1113
SALMON	1.31	4.61	6.12	7.59	8.42	6.82	4.87	2.75	1300
SALMON 1 N	1.48	4.56	6.15	8.00	8.73	7.06	4.97	2.69	1335
SANDPOINT EXP. STATION	1.05	3.55	4.90	5.85	7.48	5.91	4.06	1.73	1057
SHOSHONE 1 WNW	1.82	5.14	6.82	8.62	9.01	7.66	5.80	3.57	1482
STANLEY	.35	3.09	5.07	6.86	6.95	5.87	4.23	2.40	1065
STREVELL	1.65	4.24	5.93	7.80	8.68	7.33	5.54	3.29	1361
SWAN FALLS POWER HOUSE	2.58	5.19	6.91	8.66	9.69	8.14	6.28	3.79	1569
SWAN VALLEY	1.08	3.91	5.82	7.35	8.16	6.67	4.90	2.74	1243
TENSED	1.18	3.40	4.54	5.65	7.33	5.93	4.09	1.84	1039
TETONIA EXP. STATION	.62	3.47	5.60	7.25	8.10	6.65	4.77	2.55	1193
THREE CREEK	1.53	3.85	5.36	7.15	7.89	6.64	4.76	2.97	1229
TWIN FALLS 2 NNE	2.13	4.90	6.58	8.25	8.86	7.40	5.61	3.52	1446
TWIN FALLS 3 SE	2.03	4.76	6.42	8.12	8.75	7.26	5.54	3.45	1418
TWIN FALLS WSO	1.95	4.18	6.23	7.49	8.10	6.82	5.21	3.34	1326
WEISER 2 SE	2.27	4.78	6.41	8.10	8.86	7.35	5.54	3.20	1423

Table C-6. Standard deviation of Alfalfa Reference Evapotranspiration, mm/day. Not adjusted for station aridity.

	Mar	Apr	May	June	July	Aug	Sept	Oct
ABERDEEN EXP. STATION	.47	.54	.51	.48	.32	.31	.40	.36
AMERICAN FALLS 1 SW	.42	.44	.46	.52	.28	.29	.37	.35
ANDERSON DAM	.38	.45	.47	.54	.29	.36	.44	.40
ARBON 2 NW	.44	.49	.40	.47	.22	.37	.44	.38
ARCO 3 SW	.54	.56	.53	.47	.37	.38	.40	.36
ASHTON	.47	.60	.52	.49	.32	.31	.41	.38
BAYVIEW MODEL BASIN	.18	.23	.33	.29	.27	.32	.29	.18
BLACKFOOT 2 SSW	.46	.58	.47	.43	.34	.34	.44	.38
BLISS	.35	.47	.49	.47	.26	.33	.41	.35
BOISE WSO AP	.31	.38	.46	.47	.32	.40	.44	.32
BONNERS FERRY 1 SW	.26	.32	.30	.33	.29	.30	.34	.16
BRUNEAU	.30	.48	.43	.50	.35	.33	.42	.30
BURLEY FAA AP	.34	.45	.46	.46	.24	.31	.40	.34
CABINET GORGE	.22	.28	.35	.32	.29	.37	.38	.16
CALDWELL	.28	.37	.47	.51	.37	.39	.38	.26
CAMBRIDGE	.47	.44	.45	.51	.43	.39	.39	.29
CASCADE 1 NW	.36	.42	.43	.46	.30	.33	.44	.31
CASTLEFORD 2 N	.36	.52	.39	.45	.22	.38	.41	.33
CHALLIS	.39	.48	.52	.52	.33	.37	.37	.34
CHILLY BARTON FLAT	.48	.53	.49	.52	.42	.42	.41	.35
COEUR D'ALENE 1 E	.25	.34	.35	.33	.28	.32	.35	.19
COTTONWOOD	.33	.37	.43	.41	.38	.34	.36	.25
COUNCIL	.46	.43	.46	.49	.30	.38	.42	.28
DEER FLAT DAM	.28	.37	.43	.39	.26	.28	.34	.23
DRIGGS	.47	.57	.52	.53	.32	.30	.44	.38
DUBOIS EXP. STATION	.48	.60	.56	.54	.35	.33	.45	.39
EMMETT 2 E	.30	.41	.47	.46	.32	.34	.37	.27
FAIRFIELD RANGER STATION	.47	.52	.44	.43	.28	.43	.48	.39
FORT HALL INDIAN AGNCY	.40	.49	.52	.48	.29	.32	.34	.34
GARDEN VALLEY RS	.30	.43	.39	.47	.32	.36	.41	.27
GLENNS FERRY	.35	.44	.49	.48	.30	.36	.35	.33
GRACE	.54	.64	.48	.55	.35	.32	.40	.39
GRAND VIEW 2 W	.28	.42	.46	.49	.35	.36	.38	.28
GRANGEVILLE	.30	.38	.42	.37	.32	.36	.41	.26
HAILEY RANGER STATION	.45	.62	.55	.50	.34	.39	.44	.41
HAMER 4 NW	.48	.49	.49	.42	.30	.35	.40	.34
HAZELTON	.37	.49	.55	.51	.39	.36	.41	.38
HILL CITY	.52	.54	.50	.49	.29	.35	.40	.35
HOLLISTER	.38	.54	.57	.59	.32	.37	.44	.40
HOWE	.48	.46	.37	.45	.31	.33	.48	.36
IDAHO CITY	.39	.41	.46	.41	.32	.35	.40	.31
IDAHO FALLS 2 ESE	.44	.50	.48	.44	.26	.36	.42	.32
IDAHO FALLS 16 SE	.43	.48	.35	.41	.31	.43	.51	.40
IDAHO FALLS FAA AP	.54	.54	.53	.49	.26	.30	.41	.35
IDAHO FALLS 46 W	.51	.48	.48	.50	.27	.36	.45	.32
ISLAND PARK DAM	.46	.54	.49	.46	.30	.35	.43	.39
JEROME	.37	.48	.55	.53	.31	.36	.40	.34
KELLOGG	.26	.38	.38	.35	.31	.34	.35	.20

Table C-6. Continued.

	Mar	Apr	May	June	July	Aug	Sept	Oct
KILGORE	.39	.55	.43	.38	.25	.36	.52	.41
KOOSKIA	.25	.33	.36	.34	.26	.30	.32	.20
KUNA 2 NNE	.29	.42	.45	.41	.32	.34	.36	.30
LEWISTON WSO AP	.23	.32	.35	.41	.31	.40	.36	.20
LIFTON PUMPING STATION	.51	.58	.44	.43	.23	.27	.36	.32
MACKAY RANGER STATION	.46	.59	.53	.53	.34	.36	.37	.38
MALAD	.38	.49	.45	.45	.31	.36	.40	.35
MALAD CITY	.42	.39	.41	.42	.21	.34	.34	.30
MALTA 2 E	.41	.50	.40	.52	.29	.49	.44	.29
MAY	.41	.46	.47	.48	.32	.34	.41	.31
MC CALL	.45	.52	.50	.49	.27	.36	.40	.30
MINIDOKA DAM	.41	.45	.47	.47	.28	.36	.41	.35
MONTPELIER RANGER STATION	.50	.62	.48	.52	.27	.31	.36	.37
MOSCOW-UNIV. OF IDAHO	.27	.40	.39	.36	.30	.34	.35	.23
MOUNTAIN HOME	.32	.46	.50	.51	.34	.38	.40	.40
NEW MEADOWS RANGER STATION	.45	.42	.42	.42	.27	.32	.39	.29
NEZPERCE	.28	.36	.40	.37	.29	.38	.42	.23
OAKLEY	.37	.49	.54	.51	.32	.34	.39	.39
OLA 4 S	.35	.38	.41	.42	.27	.38	.43	.27
OROFINO	.24	.32	.36	.35	.25	.29	.31	.20
PALISADES DAM	.42	.52	.46	.47	.31	.34	.40	.37
PARMA EXP. STATION	.29	.42	.46	.48	.33	.34	.34	.26
PAUL 1 ENE	.36	.45	.47	.47	.27	.36	.42	.35
PAYETTE	.29	.36	.41	.40	.27	.31	.34	.25
PICABO	.53	.51	.53	.54	.33	.45	.56	.41
POCATELLO WSO AP	.41	.47	.48	.48	.28	.35	.45	.39
PORTHILL	.27	.28	.30	.31	.27	.30	.31	.17
POTLATCH 3 NNE	.28	.40	.39	.37	.35	.32	.39	.26
PRESTON SUGAR FACTORY	.48	.50	.44	.46	.25	.30	.34	.30
REYNOLDS	.31	.45	.43	.43	.30	.44	.46	.32
RICHFIELD	.54	.48	.50	.51	.31	.37	.40	.34
RIGGINS	.29	.43	.40	.40	.27	.37	.39	.26
RUPERT	.39	.45	.58	.53	.32	.31	.35	.37
ST ANTHONY 1 WNW	.47	.52	.52	.41	.26	.31	.40	.37
SAINT MARIES	.26	.37	.37	.33	.30	.33	.35	.20
SALMON	.40	.37	.48	.43	.27	.27	.35	.28
SALMON 1 N	.33	.50	.36	.42	.27	.35	.38	.30
SANDPOINT EXP. STATION	.26	.33	.33	.30	.25	.28	.30	.17
SHOSHONE 1 WNW	.46	.51	.54	.58	.36	.46	.46	.37
STANLEY	.57	.47	.40	.49	.20	.34	.53	.32
STREVELL	.39	.54	.53	.64	.31	.34	.49	.41
SWAN FALLS POWER HOUSE	.29	.41	.44	.53	.29	.32	.39	.29
SWAN VALLEY	.45	.53	.38	.35	.32	.33	.45	.34
TENSED	.19	.30	.27	.29	.22	.32	.40	.17
TETONIA EXP. STATION	.46	.55	.49	.41	.31	.34	.49	.37
THREE CREEK	.35	.55	.45	.45	.31	.37	.50	.49
TWIN FALLS 2 NNE	.32	.47	.48	.45	.27	.32	.41	.35
TWIN FALLS 3 SE	.36	.48	.51	.52	.28	.30	.39	.37
TWIN FALLS WSO	.35	.43	.42	.36	.24	.36	.47	.34
WEISER 2 SE	.31	.42	.42	.42	.34	.34	.37	.31

Table C-7. NOAA WEATHER STATION CONSUMPTIVE USE REFERENCE NUMBERS

1	ABERDEEN EXP. STATION
2	AMERICAN FALLS 1 SW
3	ANDERSON DAM
4	ARBON 2 NW
5	ARCO 3 SW
6	ASHTON
7	BAYVIEW MODEL BASIN
8	BLACKFOOT 2 SSW
9	BLISS
10	BOISE WSO AP
11	BONNERS FERRY 1 SW
12	BRUNEAU
13	BURLEY FAA AP
14	CABINET GORGE
15	CALDWELL
16	CAMBRIDGE
17	CASCADE 1 NW
18	CASTLEFORD 2 N
19	CHALLIS
20	CHILLY BARTON FLAT
21	COEUR D'ALENE 1 E
22	COTTONWOOD
23	COUNCIL
24	DEER FLAT DAM
25	DRIGGS
26	DUBOIS EXP. STATION
27	EMMETT 2 E
28	FAIRFIELD RANGER STATION
29	FORT HALL INDIAN AGNCY
30	GARDEN VALLEY RS
31	GLENNS FERRY
32	GRACE
33	GRAND VIEW 2 W
34	GRANGEVILLE
35	HAILEY RANGER STATION
36	HAMER 4 NW
37	HAZELTON
38	HILL CITY
39	HOLLISTER
40	HOWE
41	IDAHO CITY
42	IDAHO FALLS 2 ESE
43	IDAHO FALLS 16 SE
44	IDAHO FALLS FAA AP
45	IDAHO FALLS 46 W
46	ISLAND PARK DAM
47	JEROME
48	KELLOGG

Table C-7. NOAA WEATHER STATION CONSUMPTIVE USE REFERENCE NUMBERS, CONT'D

49	KILGORE
50	KOOSKIA
51	KUNA 2 NNE
52	LEWISTON WSO AP
53	LIFTON PUMPING STATION
54	MACKAY RANGER STATION
55	MALAD
56	MALAD CITY
57	MALTA 2 E
58	MAY
59	MC CALL
60	MINIDOKA DAM
61	MONTPELIER RANGER STATION
62	MOSCOW-UNIV. OF IDAHO
63	MOUNTAIN HOME
64	NEW MEADOWS RANGER STATION
65	NEZPERCE
66	OAKLEY
67	OLA 4 S
68	OROFINO
69	PALISADES DAM
70	PARMA EXP. STATION
71	PAUL 1 ENE
72	PAYETTE
73	PICABO
74	POCATELLO WSO AP
75	PORTHILL
76	POTLATCH 3 NNE
77	PRESTON SUGAR FACTORY
78	REYNOLDS
79	RICHFIELD
80	RIGGINS
81	RUPERT
82	ST ANTHONY 1 WNW
83	SAINT MARIES
84	SALMON
85	SALMON 1 N
86	SANDPOINT EXP. STATION
87	SHOSHONE 1 WNW
88	STANLEY
89	STREVELL
90	SWAN FALLS POWER HOUSE
91	SWAN VALLEY
92	TENSED
93	TETONIA EXP. STATION
94	THREE CREEK
95	TWIN FALLS 2 NNE
96	TWIN FALLS 3 SE
97	TWIN FALLS WSO
98	WEISER 2 SE
98	WEISER 2 SE

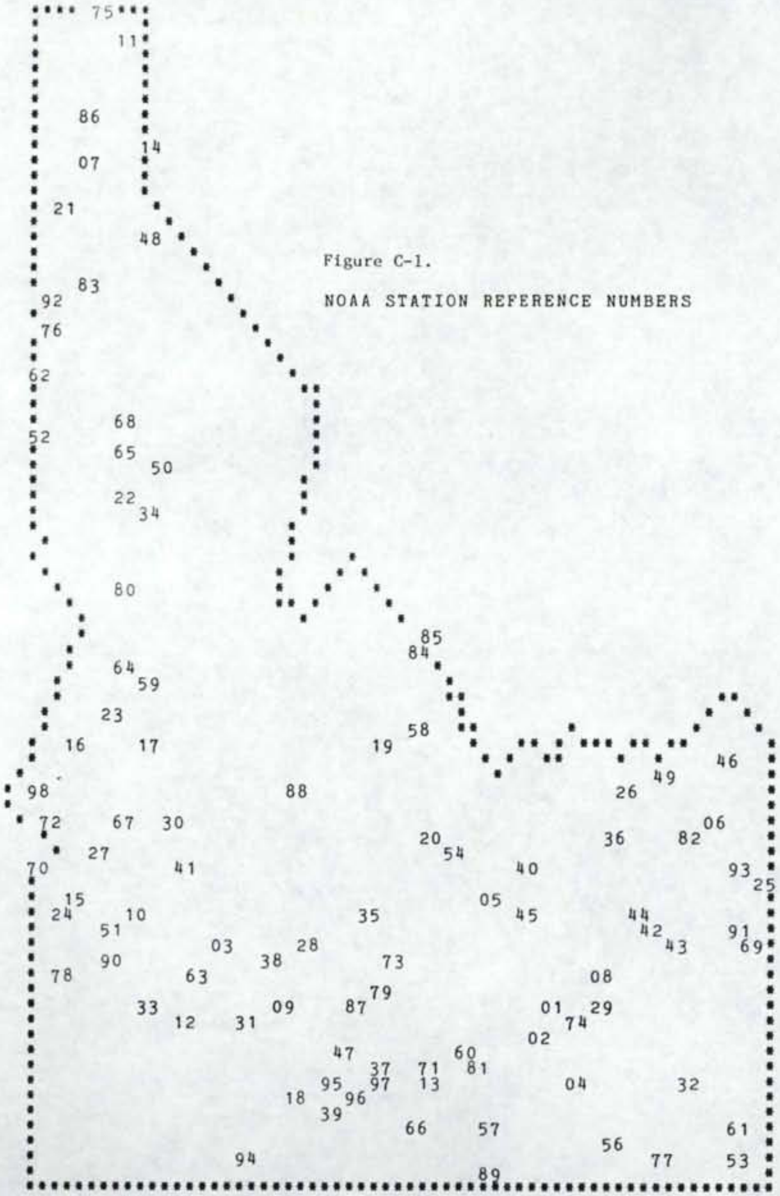

Figure C-1.

NOAA STATION REFERENCE NUMBERS

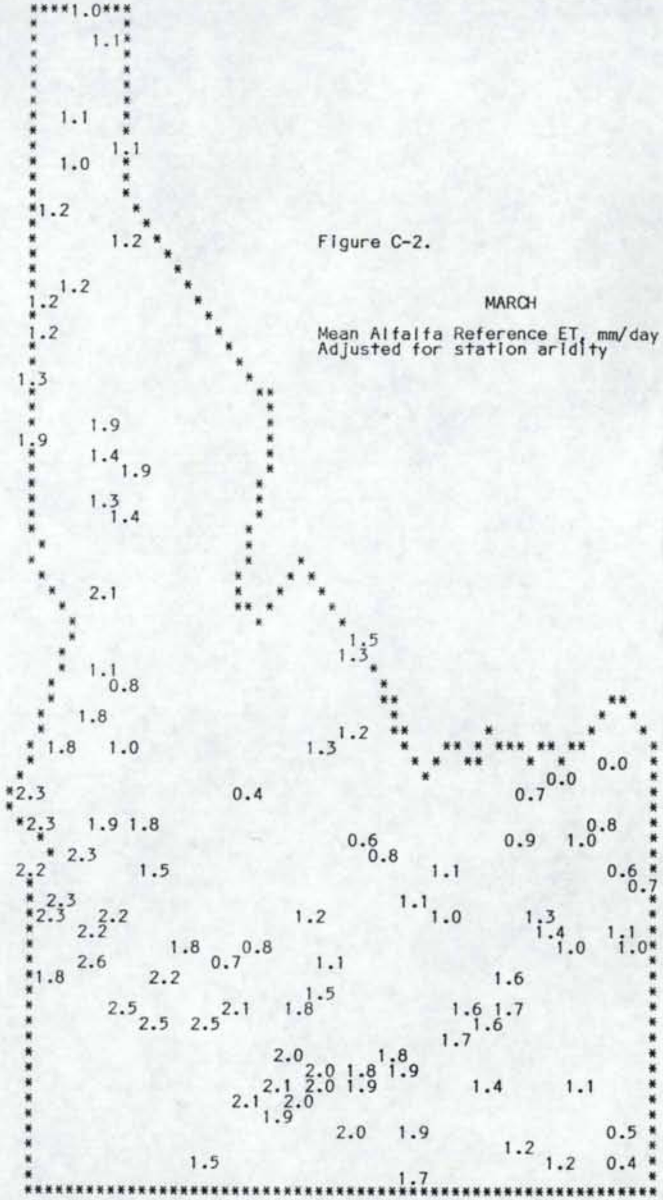

Figure C-2.

MARCH

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

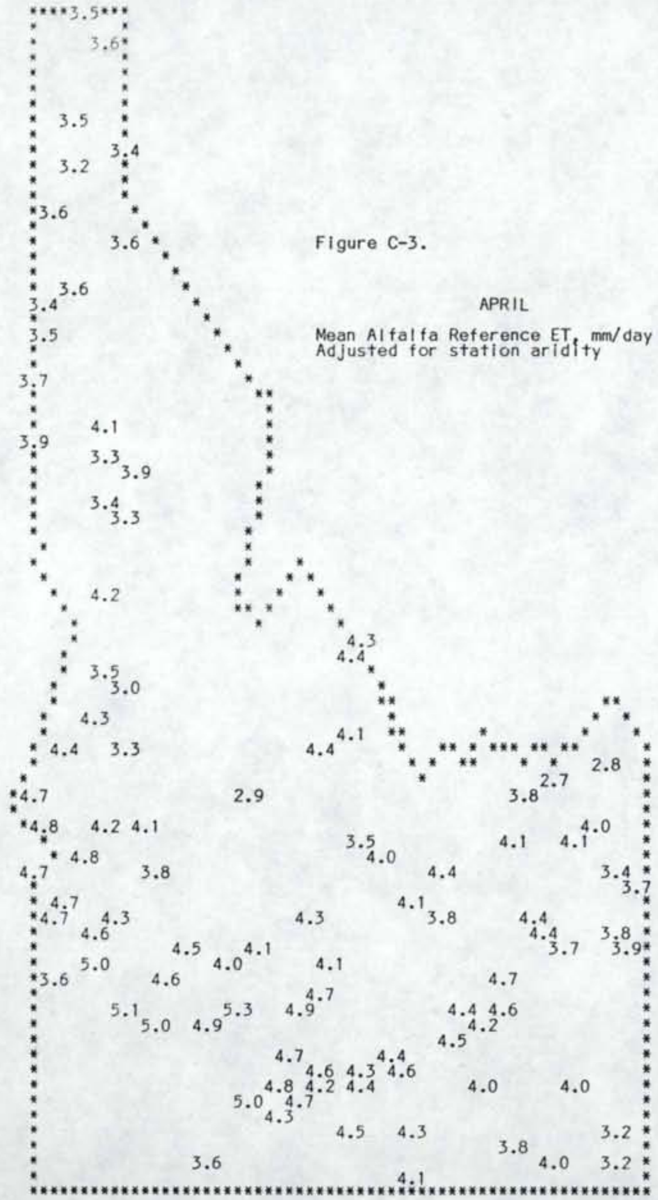

Figure C-3.

APRIL

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

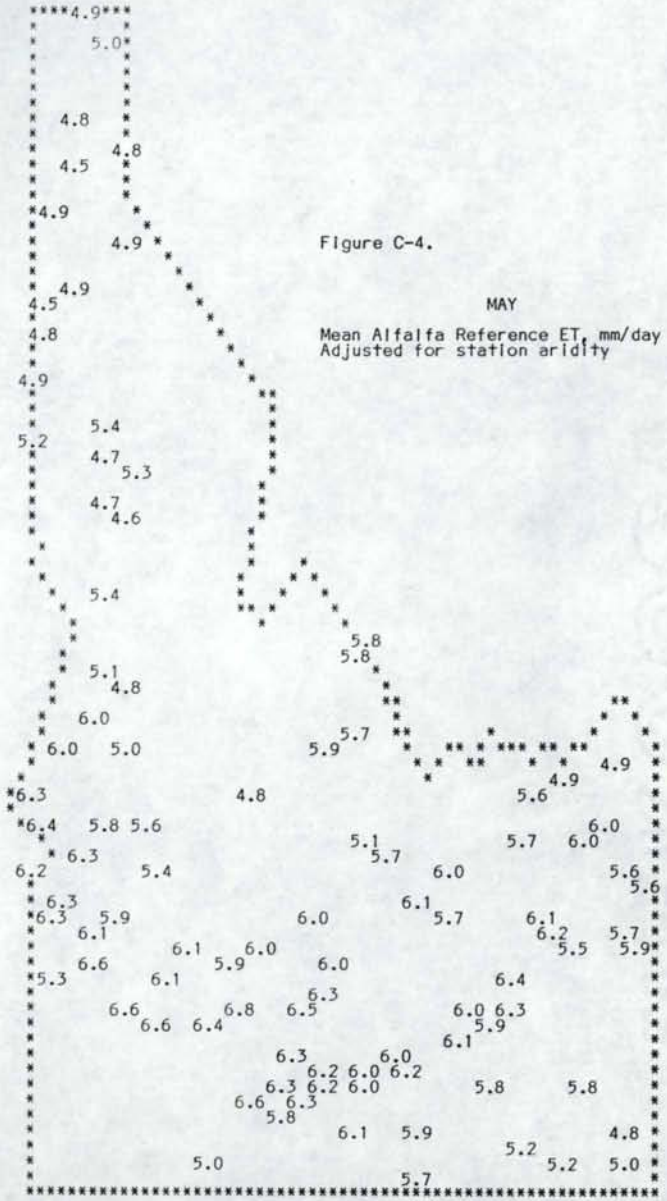

Figure C-4.

MAY

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

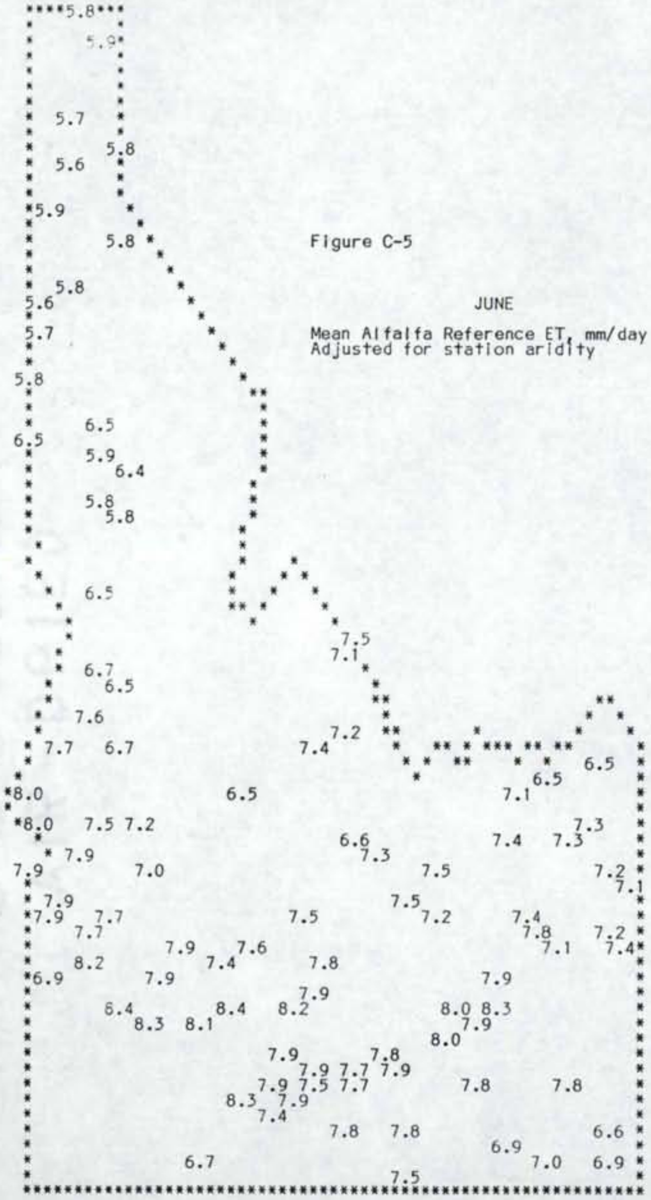

Figure C-5

JUNE

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

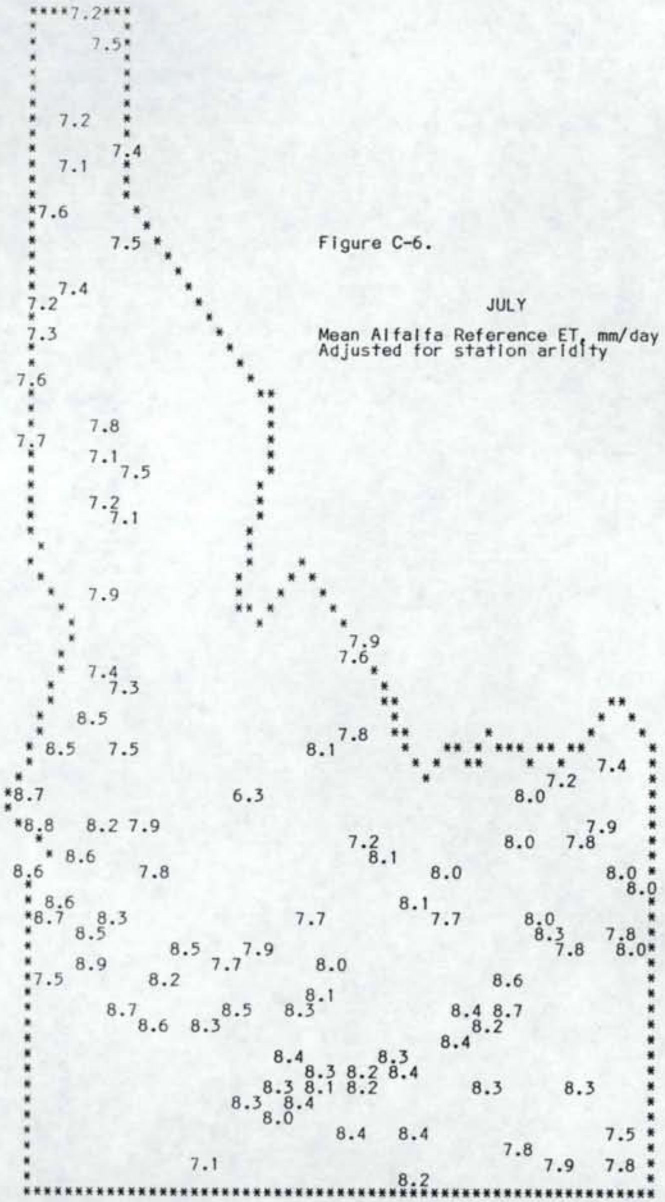

Figure C-6.

JULY

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

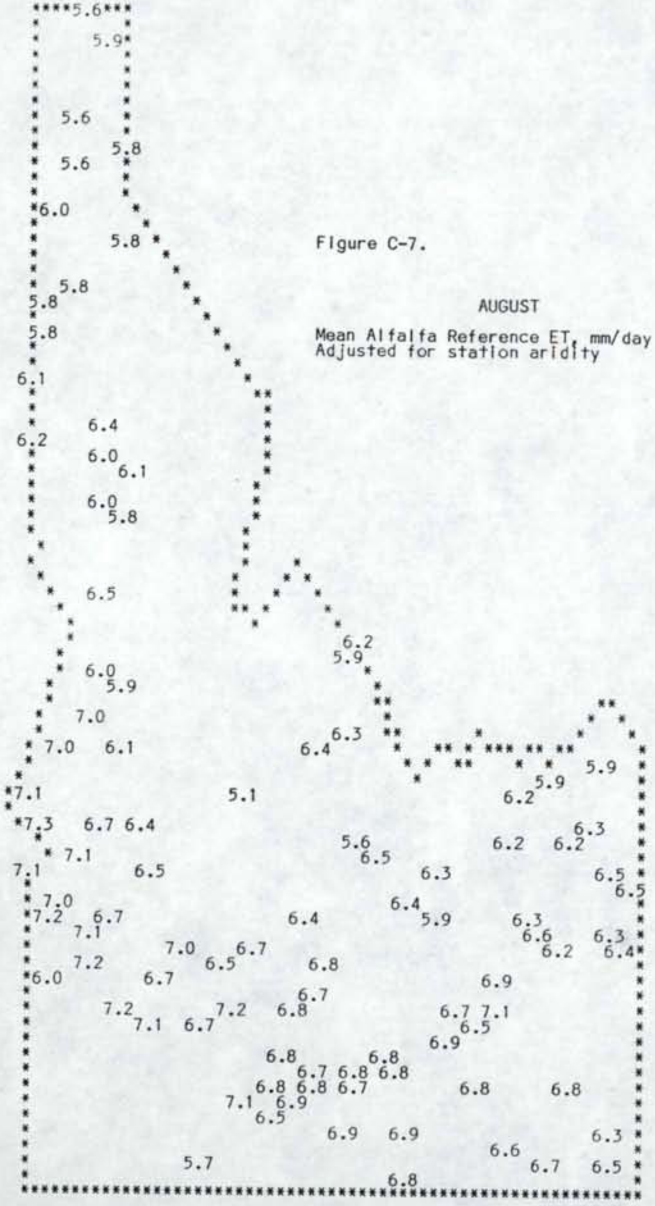

Figure C-7.

AUGUST

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

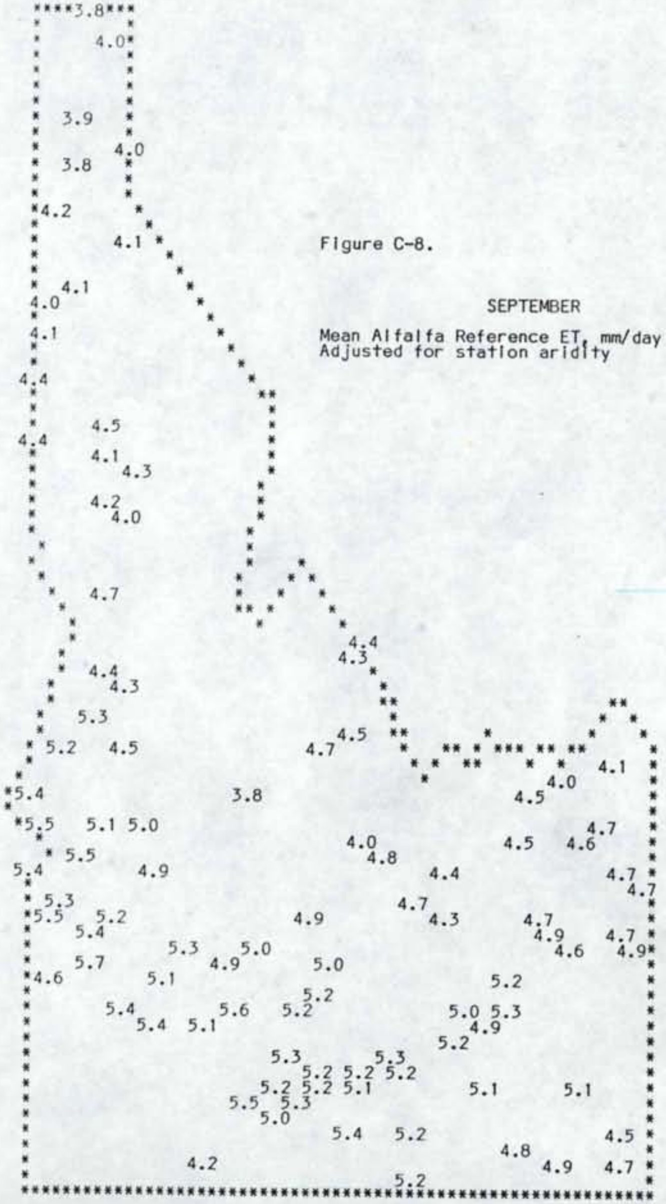

Figure C-8.

SEPTEMBER

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

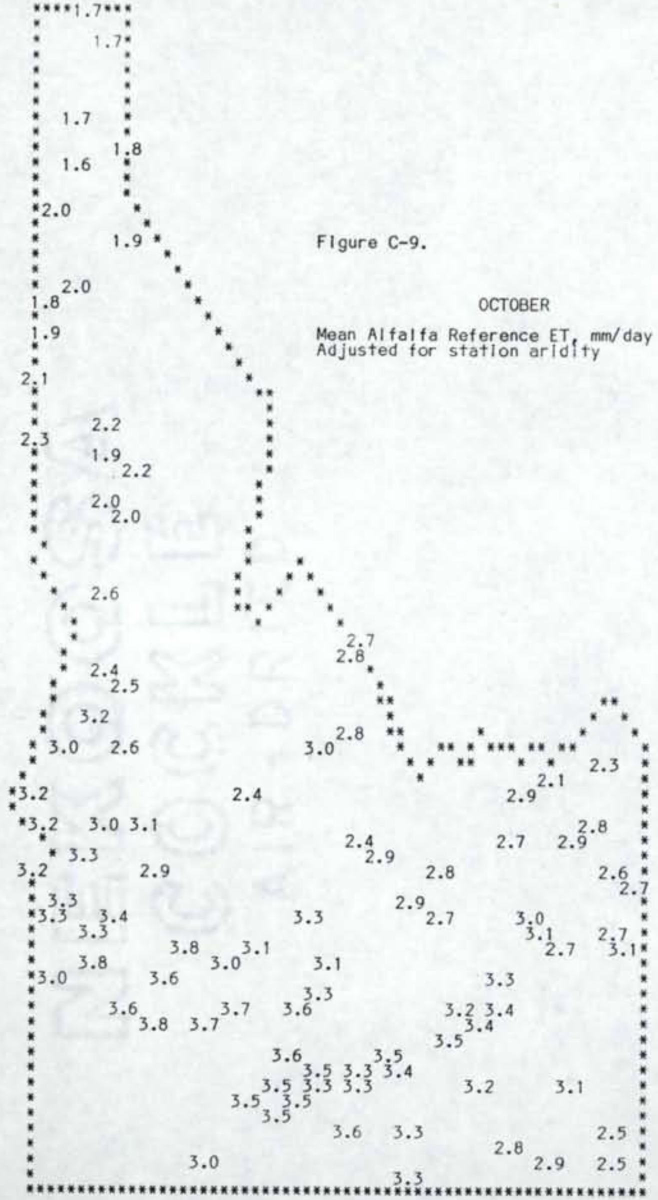

Figure C-9.

OCTOBER

Mean Alfalfa Reference ET, mm/day
Adjusted for station aridity

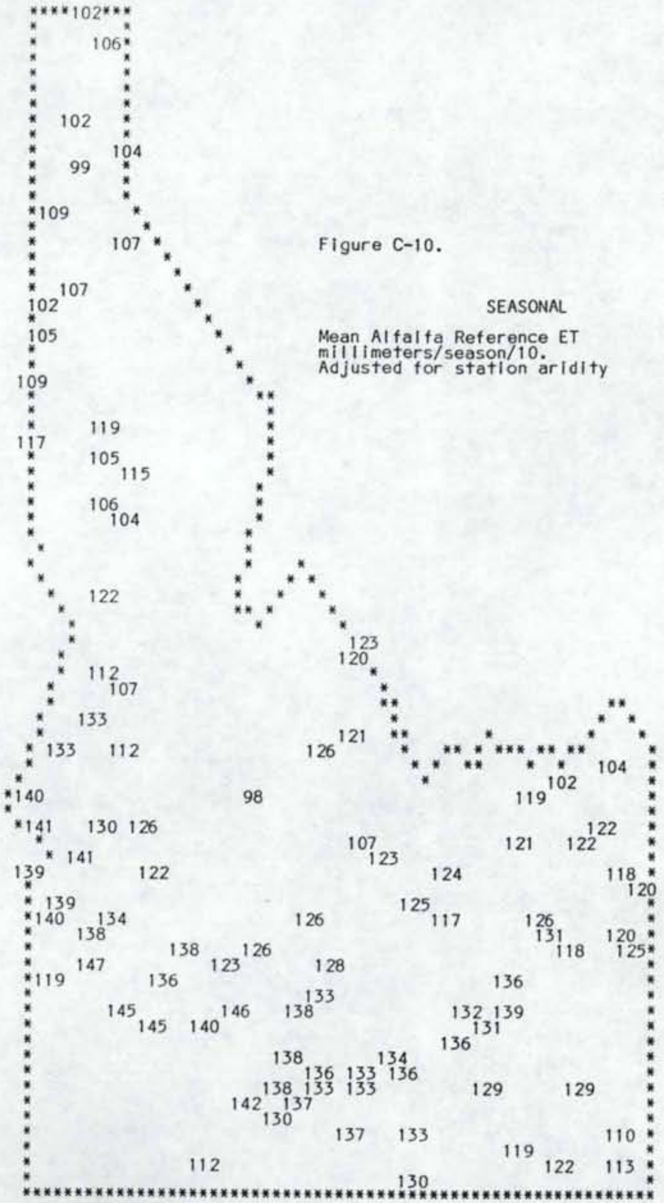

Figure C-10.

SEASONAL

Mean Alfalfa Reference ET
millimeters/season/10.
Adjusted for station aridity

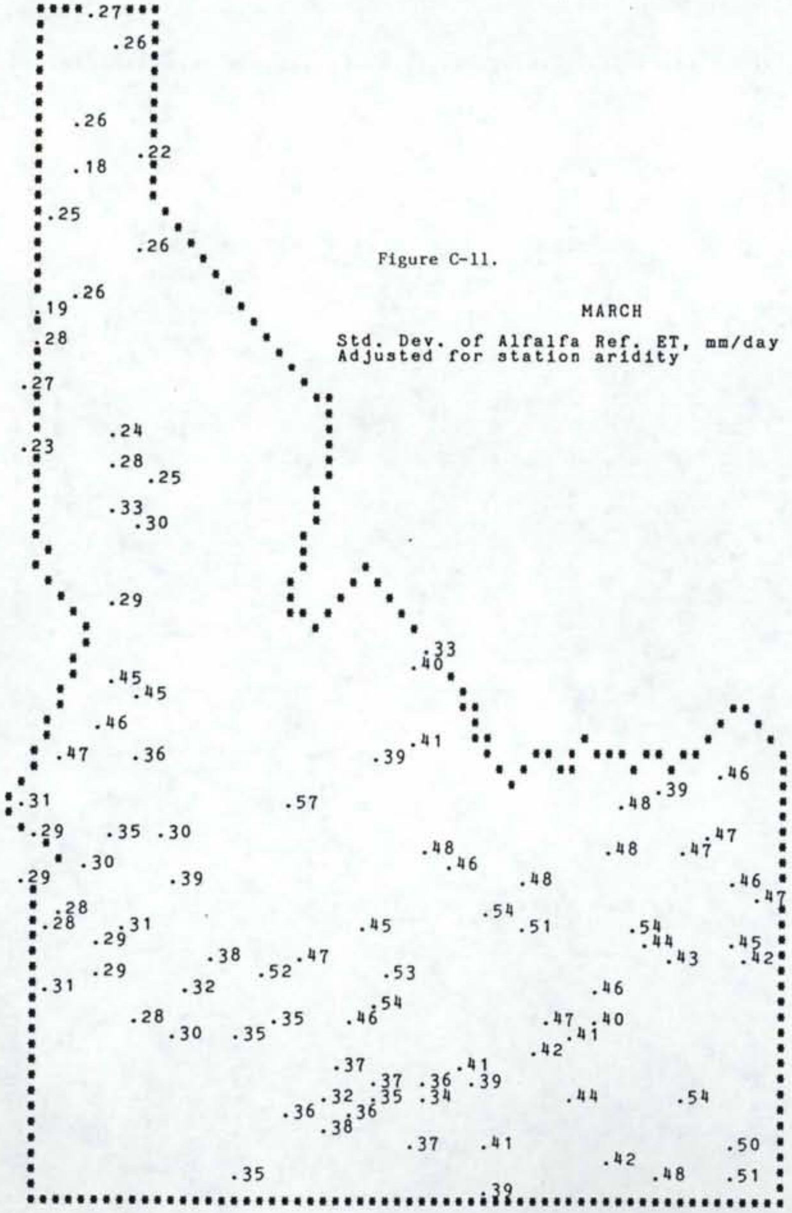

Figure C-11.

MARCH

Std. Dev. of Alfalfa Ref. ET, mm/day
Adjusted for station aridity

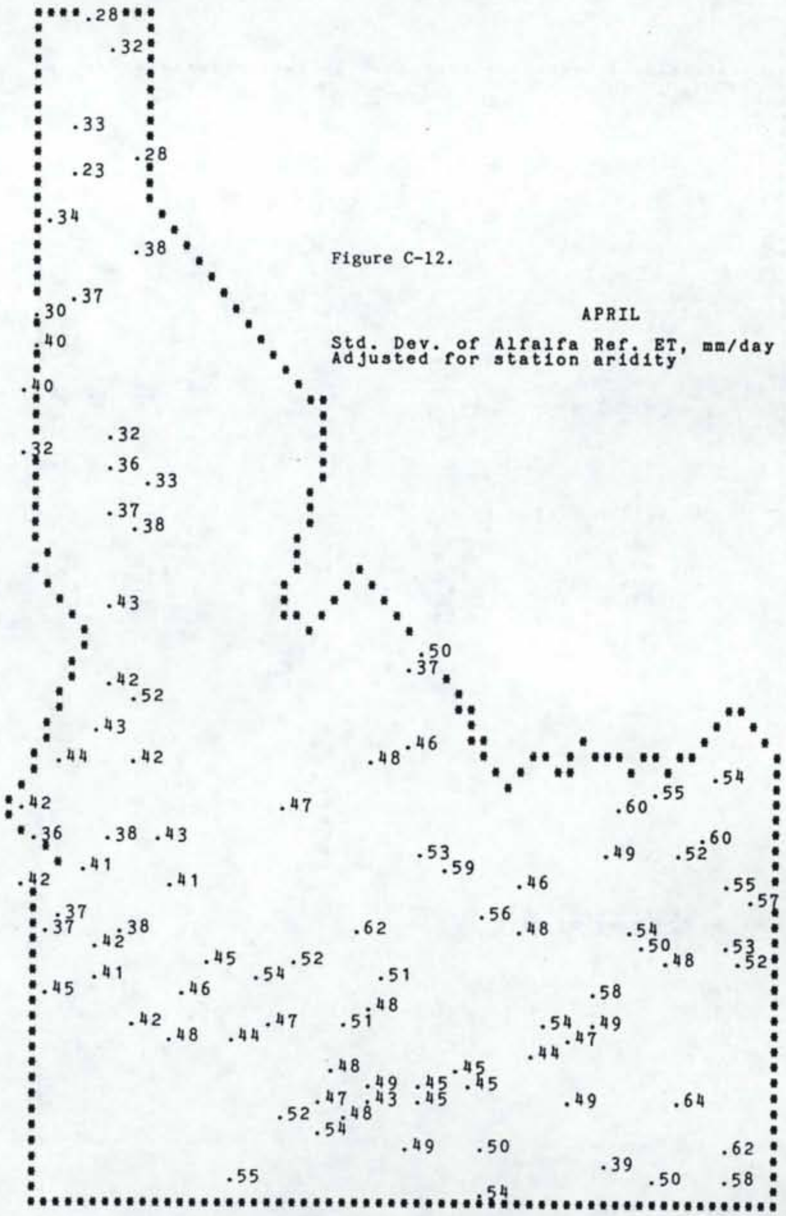

Figure C-12.

APRIL

Std. Dev. of Alfalfa Ref. ET, mm/day
Adjusted for station aridity

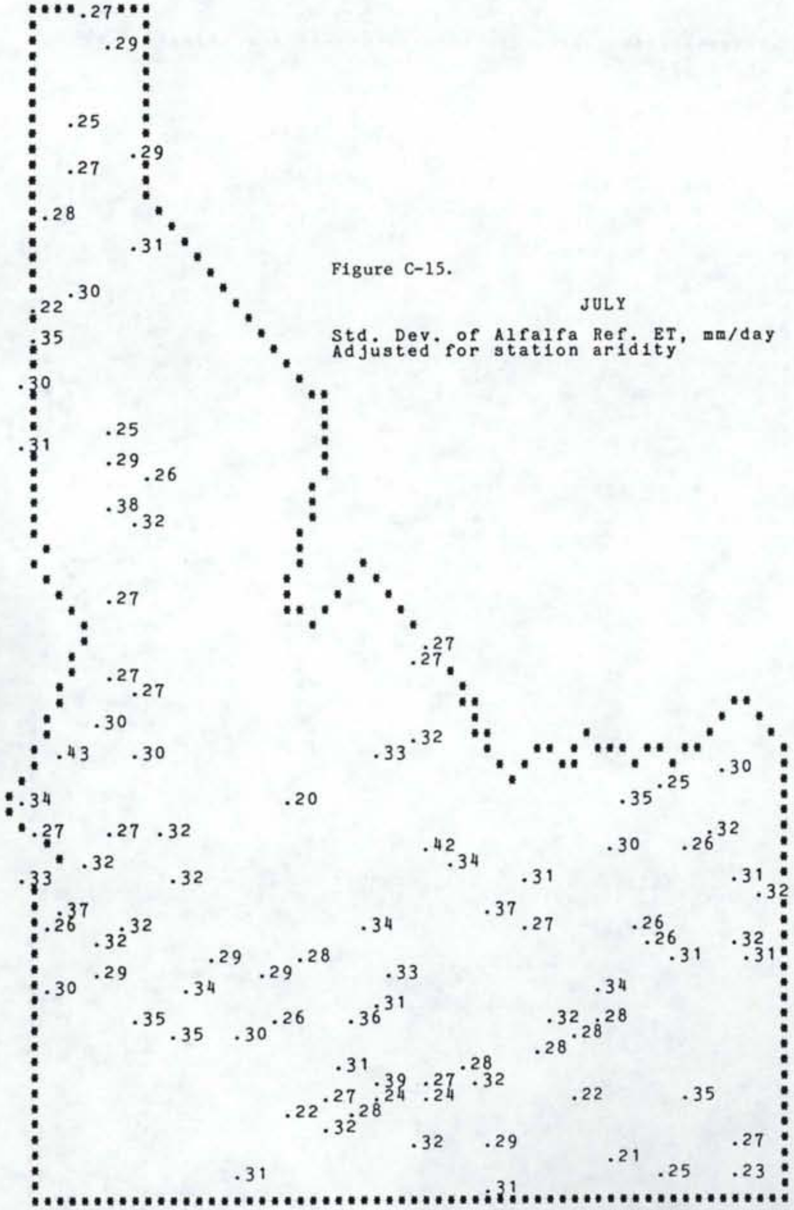

Figure C-15.

JULY

Std. Dev. of Alfalfa Ref. ET, mm/day
Adjusted for station aridity

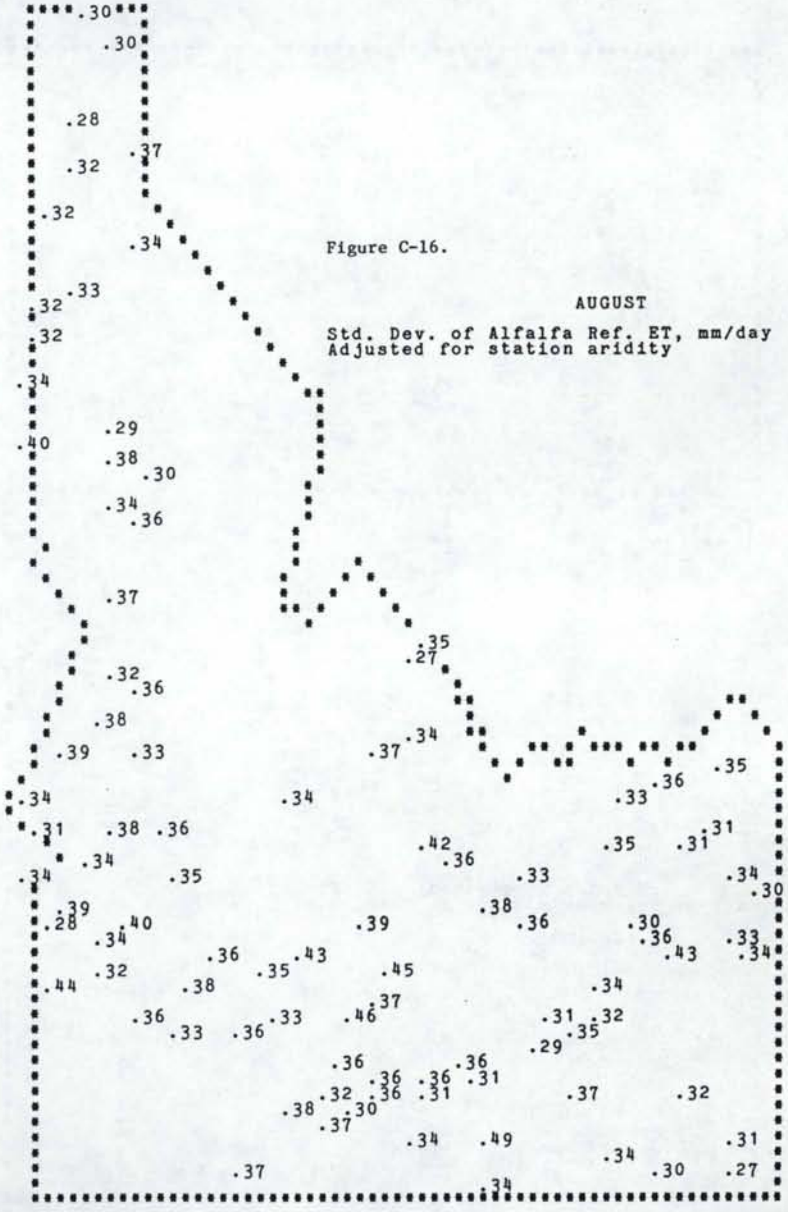

Figure C-16.

AUGUST

Std. Dev. of Alfalfa Ref. ET, mm/day
Adjusted for station aridity

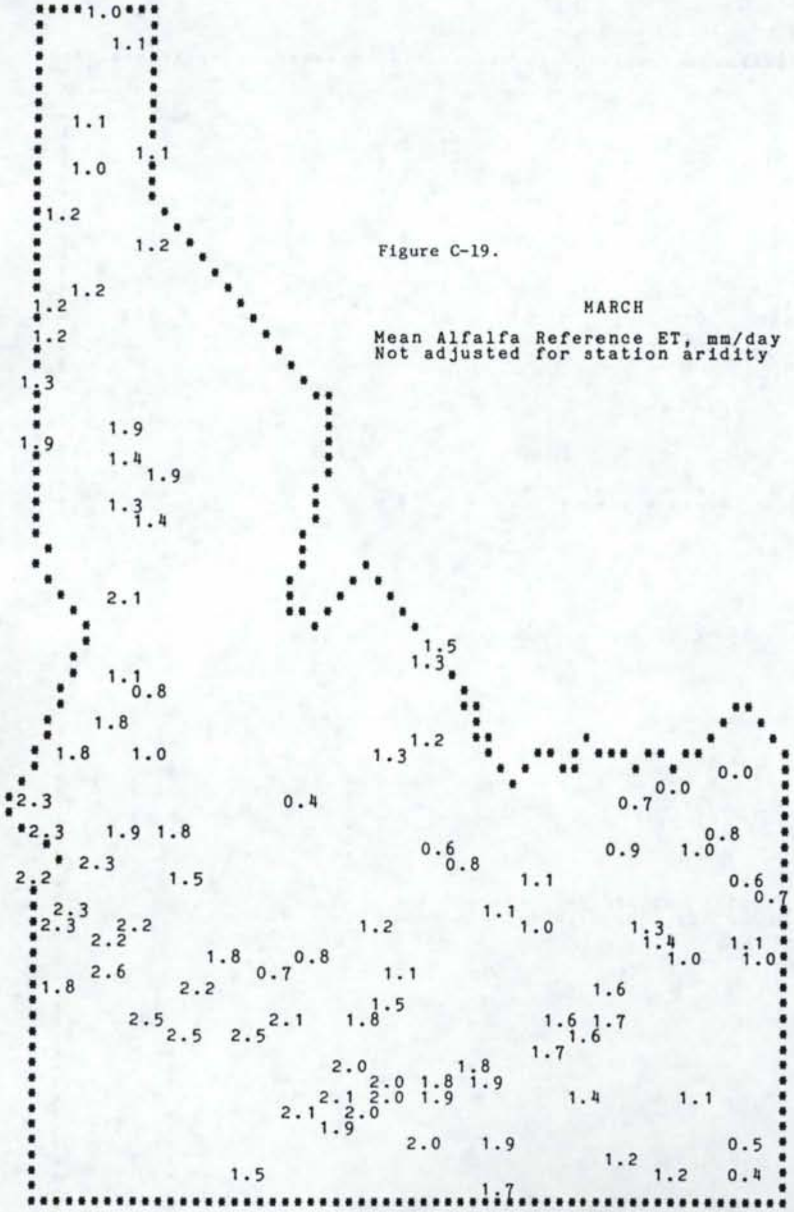

Figure C-19.

MARCH

Mean Alfalfa Reference ET, mm/day
Not adjusted for station aridity

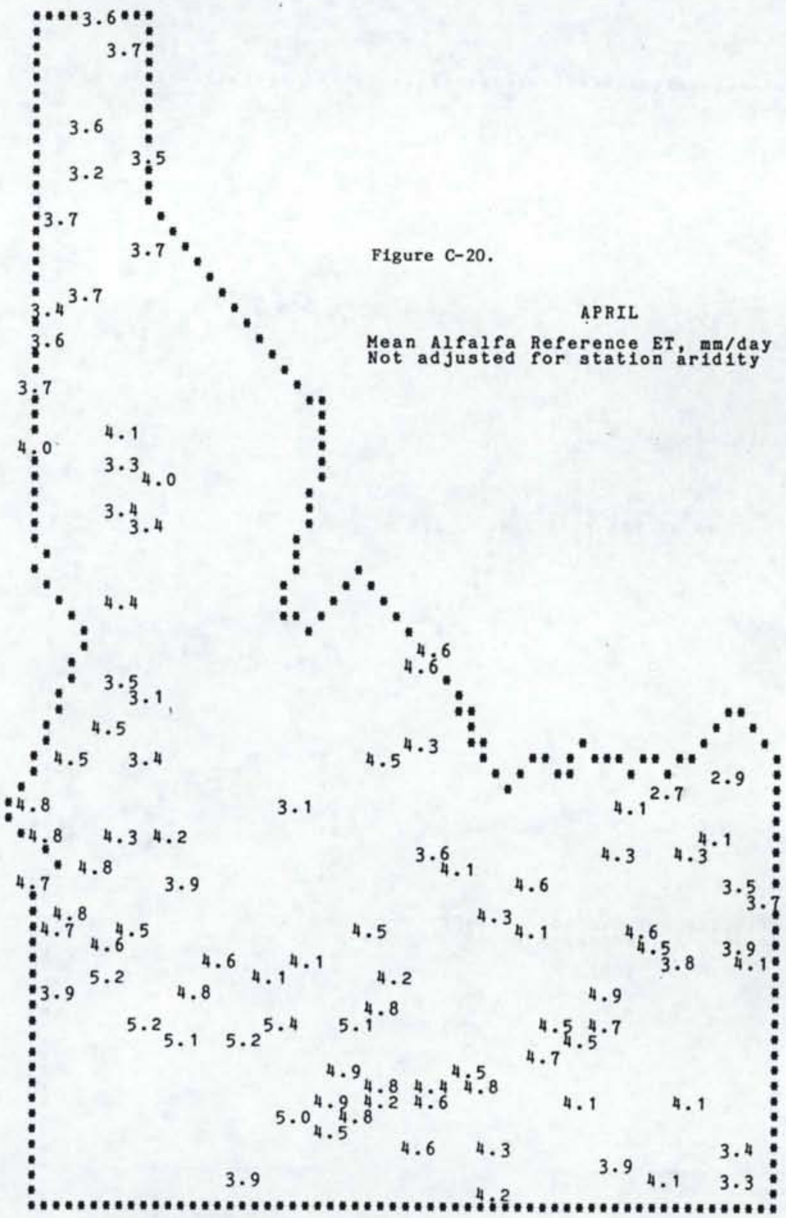

Figure C-20.

APRIL

Mean Alfalfa Reference ET, mm/day
Not adjusted for station aridity

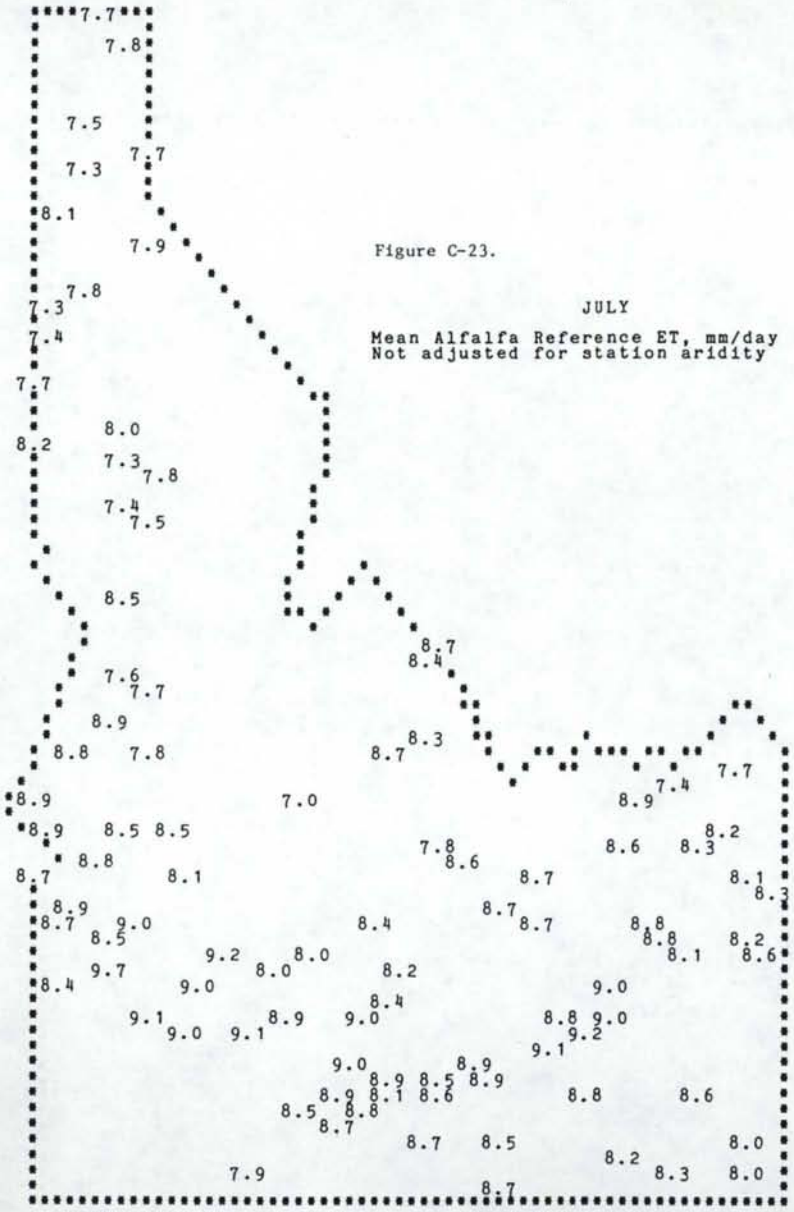

Figure C-23.

JULY

Mean Alfalfa Reference ET, mm/day
Not adjusted for station aridity

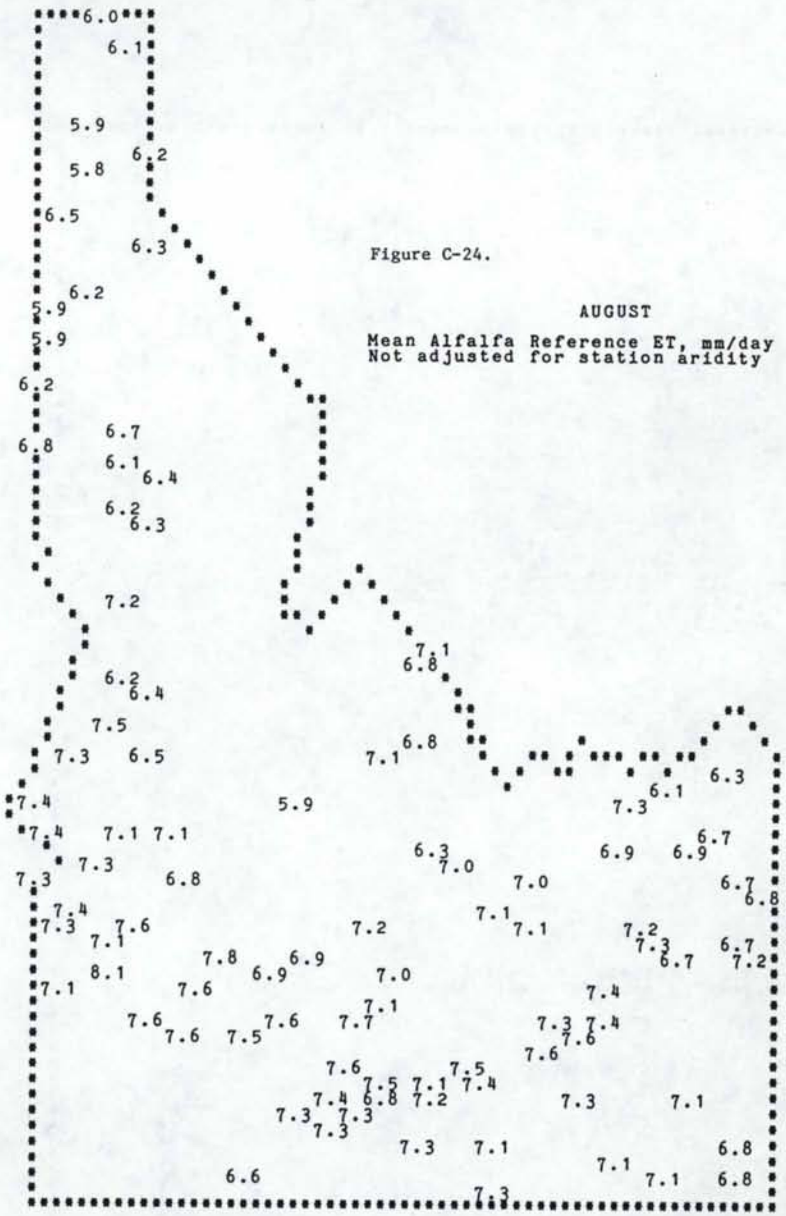

Figure C-24.

AUGUST

Mean Alfalfa Reference ET, mm/day
Not adjusted for station aridity

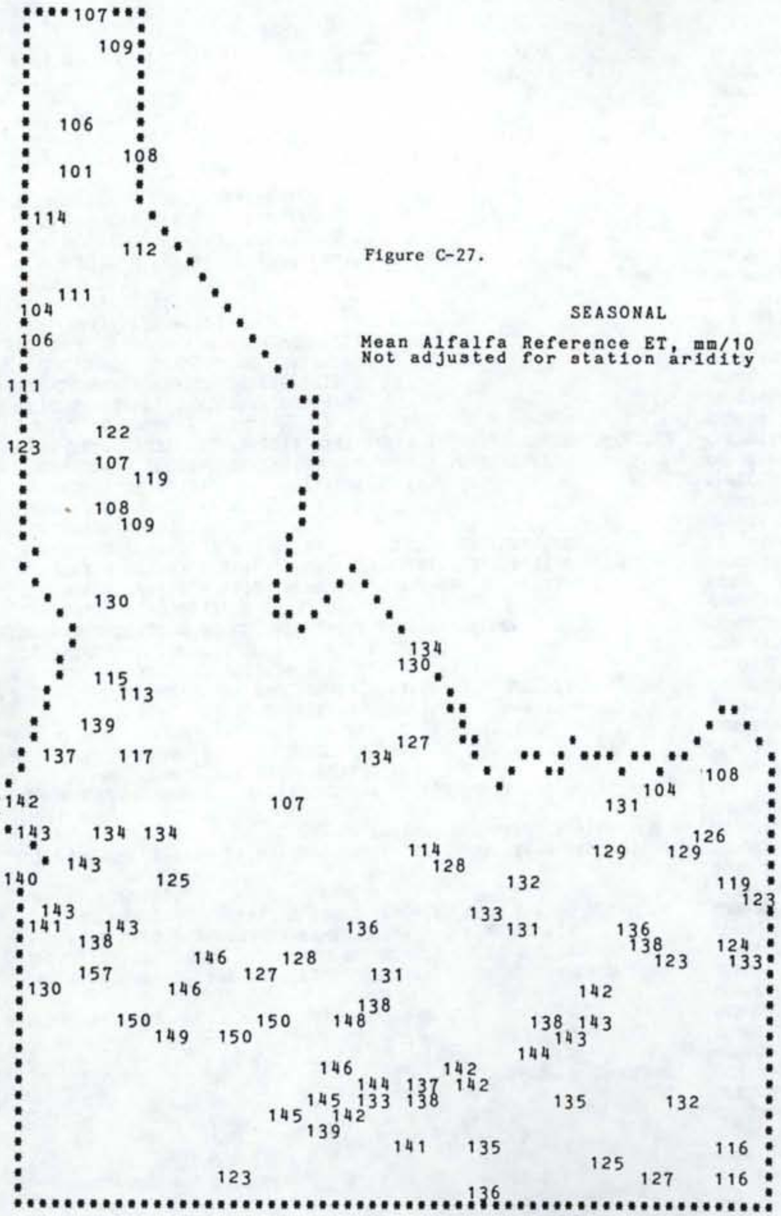

Figure C-27.

SEASONAL

Mean Alfalfa Reference ET, mm/10
Not adjusted for station aridity

```
      READ(ILU4,50)
      READ(ILU4,50)
      READ(ILU4,50)
      READ(ILU4,50)
   50 FORMAT( 6X,12F5.2)
      DO 55 NZR=1,12
      A2ND(N2,NZR)=0.
   55 B2ND(N2,NZR)=0.
      DO 150 NM=3,10
      NRATIO=RATN(NM)
      RHMIN=RHMN(NM)
      UDAY=DAYW(NM)
C     LIMIT RHMIN TO GREATER THAN 30% (IRRIGATION EFFECT) (MANY SECONDA
C     STATIONS WERE LOCATED OVER DRY, AIRPORT LOCATIONS)
      IF(RHMIN.LT.30.) RHMIN=30.
C
      CALL AANDB(RHMIN,NRATIO,UDAY,AP,BP)
C
      A2ND(N2,NM)=AP
      B2ND(N2,NM)=BP
  150 CONTINUE
  200 CONTINUE
      WRITE(57,210) (N2,(A2ND(N2,NM),B2ND(N2,NM),NM=3,10),N2=1,11)
  210 FORMAT(1X,I3,16F6.3)
C
C
C    COMPUTE THE F FACTOR USED IN SCS EFFECTIVE RAINFALL CALCULATION
C    FOR EACH CROP
C    ADEPTH = AVERAGE NET APPLICATION DEPTH FOR EACH CROP WITH
C    AVAL WATER = 2.0 IN/FT,  ROOT DEPTH = (BEG+MAX)/2.
C    ALLOW. DEPLETION VARIES FOR CROP (.4-.6)  (40-60%) (see adepth arr
C
C
     DO 20 IC=1,17
 20  FF(IC)=0.531747+0.295164*ADEPTH(IC)
    &        -0.057697*ADEPTH(IC)**2+0.003804*ADEPTH(IC)**3
C
     WRITE(57,25) (FF(IC),IC=1,17)
 25  FORMAT(' FF = ',17F5.2)
C
C    CALCULATE CROP COEFFICIENTS FOR 17 CROPS.  USE MEAN CROP
C    COEFFICIENTS FOR ALFALFA REFERENCE CROP CALIBRATED AT KIMBERLY
C    IDAHO BY J.L.WRIGHT(1981)  Irrigation Scheduling Conference, Chica
C                               Illinois. Dec. 1981.  ASAE.
     CALL CROPD(ILU5)
C
C
C    L O O P   T H R O U G H   T E M P E R A T U R E   S T A T I O N S
C
C
     LABF=1
     NMOS=0
     DO 1000 NS=1,300
C
C    INITIALIZE ARRAYS
     DO 215 NM=1,12
     PSUM1(NM)=0.
     PSUM2(NM)=0.
     PSUM3(NM)=0.
     ESUM1(NM)=0.
      ESUM2(NM)=0.
      ESUM3(NM)=0.
      NMO(NM)=0.
      DO 215 IC=1,17
      CISUM1(IC,NM)=0.
      CISUM2(IC,NM)=0.
      CISUM3(IC,NM)=0.
      ETSUM1(IC,NM)=0.
      ETSUM2(IC,NM)=0.
      ETSUM3(IC,NM)=0.
      NTIR  (IC,NM)=0.
      ETCP(IC,NM)=0.0
      TIRCP(IC,NM)=0.0
      SUMCN1(IC)=0.
      SUMCN2(IC)=0.
      SUMCN3(IC)=0.
      SUMIR1(IC)=0.
      SUMIR2(IC)=0.
      SUMIR3(IC)=0.
  215 CONTINUE
      SUMET1=0.
      SUMET2=0.
      SUMET3=0.
      SUMPR1=0.
      SUMPR2=0.
      SUMPR3=0.
      NSEAET=0
C
      WRITE(58,217)
  217 FORMAT(///////)
C
C     READ DIRECTORY INFORMATION ON SPECIFIC STATION
C     READ REFERENCE NO., 2NDARY REGION, CROP COEFFICIENT REGION,
C     DESERT EFFECT, LATITUDE, LONGITUDE, ELEVATION (FT), NOAA
C     REFERENCE NUMBER, NUMBER OF RECORDS (MONTHS) ON TAPE,
C     STARTING RECORD ON TAPE AND ENDING RECORD ON TAPE, AND
C     STATION NAME (26 CHARACTERS)
C
      READ (ILU3,220) NREF,NREG,NCRPST,NDESEF,LAT1,LON1,NELEV,NOAA,
     *  NREC,NRECS,NRECE,NAME
  220 FORMAT    (I2,I3,I3,I4,I5,I6,I5,I5,I4,I6,I6,13A2)
  221 FORMAT (1X,I2,I3,I3,I4,I5,I6,I5,I5,I4,I6,I6,13A2)
C     CHECK FOR END OF FILE
      IF(IAND(ISTAT(ISTUS),240B))1999,222,1999
  222 NMOS=0
      WRITE (58,221) NREF,NREG,NCRPST,NDESEF,LAT1,LON1,NELEV,NOAA,
     * NREC,NRECS,NRECE,NAME
      WRITE(1,221)   NREF,NREG,NCRPST,NDESEF,LAT1,LON1,NELEV,NOAA,
     " NREC,NRECS,NRECE,NAME
C          LATITUDE FOR SUNSHINE HOURS (P)
      LAT=LAT1
      MLAT=LAT/100.
      DLAT=LAT-MLAT*100
      LAT=DLAT/60.+MLAT
C     ELEVATION, METERS
      ELEV=NELEV*0.3048
C     ELEVATION CORRECTION FOR FAO-BLANEY CRIDDLE.
C     INCREASE CALCULATED ETR BY TEN PERCENT FOR EVERY 1000 METERS
C     ELEVATION ABOVE SEA LEVEL
C
```

```
      ETR = (A2ND(NREG,MONTH) + B2ND(NREG,MONTH) * F) * ALFCO(MONTH)
C
C     ELEVATION CORRECTION
      ETR = ETR*ELEVC
C
      ETRYR(MONTH) = ETR
C
C
C     COMPUTE CROP ET
      DO 600 IC=1,NCROP
      ET(IC)=ETR*CROPCO(NCRPST,IC,MONTH)
C     COMPUTE IRRIGATION REQUIREMENT
C     TIR CAN BE LESS THAN ZERO IF EFFECTIVE RAIN > ET OF CROP
C
C
      U=ET(IC)*DAYS(MONTH)/25.4
      EFRN=0.
      IF(PRECIP.GT.100.) PRECIP=0.0
      RAIN(MONTH)=PRECIP
      IF(PRECIP.GT.0.001.AND.U.GT.0.001) EFRN=ERAIN(PRECIP,U,FF(IC))
      IF(EFRN.GT.PRECIP)EFRN=PRECIP
      IF(EFRN.LT.0.0)   EFRN=0.0
      EFRN=EFRN*25.4/DAYS(MONTH)
C     WRITE(1,620) IC,ETR,U,ET(IC),PRECIP,EFRN,FF(IC)
C620  FORMAT(I4,6F10.4)
      TIR(IC)=ET(IC)-EFRN
      ETCP(IC,MONTH)=ET(IC)
  600 TIRCP(IC,MONTH)=TIR(IC)
C
C
C     MONITOR NONZERO PRECIP MONTHS FOR STATISTICS
      NMO(MONTH)=NMO(MONTH)+1
      IF(PRECIP) 650,650,630
C
C     S T A T I S T I C S
C
 630  NPRE(MONTH) = NPRE(MONTH) + 1
      PSUM1(MONTH)=PSUM1(MONTH)+PRECIP
      PSUM2(MONTH)=PSUM2(MONTH)+PRECIP*PRECIP
      PSUM3(MONTH)=PSUM3(MONTH)+PRECIP*PRECIP*PRECIP
 650  ESUM1(MONTH)=ESUM1(MONTH)+ETR
      ESUM2(MONTH)=ESUM2(MONTH)+ETR*ETR
      ESUM3(MONTH)=ESUM3(MONTH)+ETR*ETR*ETR
       DO 670 IC=1,17
      IF(CROPCO(NCRPST,IC,MONTH)) 670,670,660
  660 NTIR(IC,MONTH)=NTIR(IC,MONTH)+1
      CISUM1(IC,MONTH)=CISUM1(IC,MONTH)+TIR(IC)
      ETSUM1(IC,MONTH)=ETSUM1(IC,MONTH)+ ET(IC)
      CISUM2(IC,MONTH)=CISUM2(IC,MONTH)+TIR(IC)*TIR(IC)
      ETSUM2(IC,MONTH)=ETSUM2(IC,MONTH)+ ET(IC)*ET(IC)
      CISUM3(IC,MONTH)=CISUM3(IC,MONTH)+TIR(IC)*TIR(IC)*TIR(IC)
      ETSUM3(IC,MONTH)=ETSUM3(IC,MONTH)+ ET(IC)*ET(IC)*ET(IC)
 670  CONTINUE
C
 790  CONTINUE
C
C     SEASONAL STATISTICS
      NN=1
      DO 680 NNN=3,10
      IF(ETRYR(NNN).LE.0.001) NN=0
 680  CONTINUE
      IF(NN.NE.1) GO TO 685
C     COMPLETE SEASON OF ETR
      ETRMM=0.
      PREMM=0.
      DO 681 IC=1,17
      SUMIR(IC)=0.
 681  SUMCN(IC)=0.
      DO 682 NNN=3,10
      ETRMM=ETRMM+ETRYR(NNN)*DAYS(NNN)
      PREMM=PREMM+RAIN(NNN)*25.4
      DO 682 IC=1,17
      SUMCN(IC)=SUMCN(IC)+ETCP(IC,NNN)*DAYS(NNN)
      SUMIR(IC)=SUMIR(IC)+TIRCP(IC,NNN)*DAYS(NNN)
 682  CONTINUE
      SUMET1=SUMET1+ETRMM
      SUMPR1=SUMPR1+PREMM
      SUMET2=SUMET2+ETRMM*ETRMM
      SUMPR2=SUMPR2+PREMM*PREMM
      SUMET3=SUMET3+ETRMM*ETRMM*ETRMM
      SUMPR3=SUMPR3+PREMM*PREMM*PREMM
      DO 684 IC=1,17
      ETRMM=SUMCN(IC)
      ETRRR=SUMIR(IC)
      SUMCN1(IC)=SUMCN1(IC)+ETRMM
      SUMIR1(IC)=SUMIR1(IC)+ETRRR
      SUMCN2(IC)=SUMCN2(IC)+ETRMM* ETRMM
      SUMIR2(IC)=SUMIR2(IC)+ETRRR*ETRRR
      SUMCN3(IC)=SUMCN3(IC)+ETRMM* ETRMM* ETRMM
      SUMIR3(IC)=SUMIR3(IC)+ETRRR*ETRRR*ETRRR
 684  CONTINUE
      NSEAET=NSEAET+1
 685  CONTINUE
C     WRITE(1,683) NSEAET ,SUMET1,SUMET2,SUMET3,SUMPR1,SUMPR2,SUMPR3
 683  FORMAT(' NSEAET ',I9,6E10.4)
D     GO TO 800
 795  WRITE(58,400) NYR,(ETRYR(NNN),NNN=3,10)
      DO 797 NNN=1,12
      ETRYR(NNN)=0.
      DO 797 IC=1,17
      ETCP(IC,NNN)=0.0
      TIRCP(IC,NNN)=0.0
 797  CONTINUE
 800  CONTINUE
 925  CONTINUE
CX    WRITE(55,400) IZIP
 950  CONTINUE
      WRITE(58,444) NMOS
 444  FORMAT(' NO. MONTHS WITH LESS THAN 10 MISSING DAYS =',I6//)
D     REWIND ILU2
CX    IF(STANO.GE.0)GO TO 970
C
C     SUMMARY FOR STATION
      WRITE(57,953)
      WRITE (57,221) NREF,NREG,NCRPST,NDESEF,LAT1,LON1,NELEV,NOAA,
     * NREC,NRECS,NRECE,NAME
      WRITE(57,952) ELEVC
      WRITE(57,954) DESEF
      WRITE(57,955) PMON
      WRITE(57,956) ALFCO
```

```
C                                                                       CON06010
C     WRITE OUT SEASONAL STATISTICS                                     CON06020
      NM=0                                                              CON06030
      WRITE(6,97) NM,NSEAET ,AVEP,AVEE,(AVET(NPRC(ICC)),ICC=1,NCT)      CON06040
      WRITE(6,197) NM,NSEAET ,ZIP,ZIP   ,(AVIR(NPRC(ICC)),ICC=1,NCT)    CON06050
      WRITE(6,297) NM,NSEAET ,STDP,STDE ,(STET(NPRC(ICC)),ICC=1,NCT)    CON06060
      WRITE(6,397) NM,NSEAET ,ZIP,ZIP   ,(STIR(NPRC(ICC)),ICC=1,NCT)    CON06070
      WRITE(6,497) NM,NSEAET ,SKEP,SKEE ,(SKET(NPRC(ICC)),ICC=1,NCT)    CON06080
      WRITE(6,597) NM,NSEAET ,ZIP,ZIP   ,(SKIR(NPRC(ICC)),ICC=1,NCT)    CON06090
C                                                                       CON06100
   99 FORMAT(' AVE ET ',2I4,20F6.2)                                     CON06110
   97 FORMAT(' AVE ET ',2I4,F6.1,19F6.0)                                CON06120
  199 FORMAT(' AVE IR ',2I4,20F6.2)                                     CON06130
  197 FORMAT(' AVE IR ',2I4,F6.1,19F6.0)                                CON06140
  299 FORMAT(' STDD ET',2I4,20F6.2)                                     CON06150
  297 FORMAT(' STDD ET',2I4,F6.1,19F6.0)                                CON06160
  399 FORMAT(' STDD IR',2I4,20F6.2)                                     CON06170
  397 FORMAT(' STDD IR',2I4,F6.1,19F6.0)                                CON06180
  499 FORMAT(' SKEW ET',2I4,20F6.2)                                     CON06190
  497 FORMAT(' SKEW ET',2I4,F6.2,19F6.2)                                CON06200
  599 FORMAT(' SKEW IR',2I4,20F6.2)                                     CON06210
  597 FORMAT(' SKEW IR',2I4,F6.2,19F6.2)                                CON06220
C                                                                       CON06230
C      WRITE OUT PRECIPITATION AND ETR SUMMARY                          CON06240
      PTOT=0.                                                           CON06250
      ETOT=0.                                                           CON06260
      PGROW=0.                                                          CON06270
      EGROW=0.                                                          CON06280
      DO 625 NM=1,12                                                    CON06290
      PTOT=PTOT+PLAVE(NM)                                               CON06300
      ETOT=ETOT+ELAVE(NM)*DAYS(NM)                                      CON06310
      IF(NM.LT.3.OR.NM.GT.10) GO TO 625                                 CON06320
      PGROW=PGROW+PLAVE(NM)                                             CON06330
      EGROW=EGROW+ELAVE(NM)*DAYS(NM)                                    CON06340
  625 CONTINUE                                                          CON06350
C     WRITE(53,652) NAME,PLAVE,PGROW,PTOT                               CON06360
      WRITE(53,651) NAME,ELAVE,EGROW,ETOT                               CON06370
      WRITE(54,651) NAME,ELSTD,ZIP  ,ZIP                                CON06380
      WRITE(55,651) NAME,ELSKE,ZIP  ,ZIP                                CON06390
  652 FORMAT(1X,13A2,12F6.2,2F6.2)                                      CON06400
  651 FORMAT(1X,13A2,12F6.2,2F6.0)                                      CON06410
 1000 CONTINUE                                                          CON06420
 1999 CONTINUE                                                          CON06430
      END                                                               CON06440
C                                                                       CON06450
C                                                                       CON06460
C                                                                       CON06470
D     SUBROUTINE TAPE(LABF,F,G,INO,IBUFF,IBUFR,IT,ILU1,ILU2,            CON06480
D    *                PRINT,IRECL,ILEN,NRECS,NRECE,NBLK,IBLOCK)         CON06490
C     SUBROUTINE TAPE IS WRITTEN EXPRESSLY FOR AN HP1000 RTE-IV         CON06500
C     COMPUTING SYSTEM. IT READS A NOAA MONTHLY WEATHER TAPE. R.G.ALLEN CON06510
D     DIMENSION    IBUFF(13600),IBUFR(16),IT(2)                         CON06520
D     DOUBLE PRECISION NSKPL,NLBLK,NRECS,NRECE,NBLK,NSKIP,NRPB,IBLOCK   CON06530
D     DIMENSION F(3),G(3)                                               CON06540
D     ICDE1=1+100000B                                                   CON06550
D     ICDE2=2                                                           CON06560
D     ICDE3=3+100000B                                                   CON06570
D     IWEOF=8+100B                                                      CON06580
D     IFS1F=8+1300B                                                     CON06590
D     IBS1F=8+1400B                                                     CON06600
```

```
D     IREWD=8+400B                                                      CON06610
D     IFWD=8+300B                                                       CON06620
D     IBKR=8+200B                                                       CON06630
D     NBLOCK =9999                                                      CON06640
D     IT=2HEA                                                           CON06650
C***************READY THE MAG TAPE***************************           CON06660
C                                                                       CON06670
C                                                                       CON06680
D   1 N=LABF                                                            CON06690
D     N=N-1                                                             CON06700
C                                                                       CON06710
C +++  POSITION TAPE AT FILE "N" +++                                    CON06720
C                                                                       CON06730
D     NFI=1                                                             CON06740
D     IF(N.LT.1) GO TO 2                                                CON06750
D     WRITE(1,475) NFI,LABF                                             CON06760
D 475 FORMAT( I5, ' FIND FILE ',I5)                                     CON06770
D 476 FORMAT(2HEA,I5, ' FIND FILE ',I5)                                 CON06780
D     DO 2 I=1,N                                                        CON06790
D     NFI=NFI+1                                                         CON06800
D     WRITE(1,476) NFI,LABF                                             CON06810
D     CALL EXEC(ICDE3,IFS1F)                                            CON06820
D     GO TO 9999                                                        CON06830
D   2 CONTINUE                                                          CON06840
C                                                                       CON06850
D     LBLK=ILEN/(-2)                                                    CON06860
D     NRPB=-ILEN/IRECL                                                  CON06870
D     NBLK=IDINT(NRECS/NRPB)                                            CON06880
D     NSKIP=NRECS-NBLK*NRPB-1                                           CON06890
D     NLBLK=IDINT(NRECE/NRPB)                                           CON06900
D     NSKPL=NRECE-NLBLK*NRPB                                            CON06910
C     WRITE(1,238) LBLK,NRPB,NBLK,NSKIP,NLBLK,NSKPL                     CON06920
C238  FORMAT('LBLK  NRPB  NBLK  NSKIP NLBLK NSKPL'/6I6)                  CON06930
D     J=NBLK                                                            CON06940
D     IF(J.EQ.0) J=1                                                    CON06950
D     NBLKS=J-IBLOCK                                                    CON06960
C                                                                       CON06970
C****************BACKUP ONE BLOCK********************                  CON06980
C                                                                       CON06990
D     IF (NBLKS.GE.0) GO TO 1431                                        CON07000
D     CALL EXEC  (ICDE3,IBKR)                                           CON07010
D     GO TO 9999                                                        CON07020
D1431 IF (NBLKS.LT.0) IBLOCK=IBLOCK-1                                   CON07030
C    SKIP BLOCKS TO START                                               CON07040
D     IF(NBLKS.LT.1) GO TO 50                                           CON07050
D     IF(J.EQ.1) GO TO 50                                               CON07060
C                                                                       CON07070
C**********SKIP BLOCKS TO NEXT STATION**************                    CON07080
D     DO 30 J=1,NBLKS                                                   CON07090
D     CALL EXEC(ICDE1,ILU1,IBUFF,ILEN)                                  CON07100
D     GO TO 9999                                                        CON07110
D1199 IBLOCK=IBLOCK+1                                                   CON07120
D 30  CONTINUE                                                          CON07130
D     J=NBLK+1                                                          CON07140
C**********SKIP RECORDS INTO BLOCK********************                  CON07150
D 50  IF(NSKIP.LT.1) GO TO 60                                           CON07160
D     CALL EXEC(ICDE1,ILU1,IBUFF,ILEN)                                  CON07170
D     GO TO 9999                                                        CON07180
D1258 IBLOCK=IBLOCK+1                                                   CON07190
D     CALL ABREG(IA,IB)                                                 CON07200
```

```
     & .84, .80, .74, .64, .52, .38,1.03, .95, .87, :76, .63, .48,
     &1.22,1.10,1.01, .88, .74, .57,1.38,1.24,1.13, .99, .85, .66,
     &1.54,1.37,1.25,1.09, .94, .75,1.68,1.50,1.36,1.18,1.04, .84,
     & .97, .90, .81, .68, .54, .40,1.19,1.08, .96, .84, .66, .50,
     &1.41,1.26,1.11, .97, .77, .60,1.60,1.42,1.25,1.09, .89, .70,
     &1.79,1.59,1.39,1.21,1.01, .79,1.98,1.74,1.52,1.31,1.11, .89,
     &1.08, .98, .87, .72, .56, .42,1.33,1.18,1.03, .87, .69, .52,
     &1.56,1.38,1.19,1.02, .82, .62,1.78,1.56,1.34,1.15, .94, .73,
     &2.00,1.74,1.50,1.28,1.05, .83,2.19,1.90,1.64,1.39,1.16, .92,
     &1.18,1.06, .92, .74, .58, .43,1.44,1.27,1.10, .91, .72, .54,
     &1.70,1.48,1.27,1.06, .85, .64,1.94,1.67,1.44,1.21, .97, .75,
     &2.18,1.86,1.59,1.34,1.09, .85,2.39,2.03,1.74,1.46,1.20, .95,
     &1.26,1.11, .96, .76, .60, .44,1.52,1.34,1.14, .93, .74, .55,
     &1.79,1.56,1.32,1.10, .87, .66,2.05,1.76,1.49,1.25,1.00, .77,
     &2.30,1.96,1.66,1.39,1.12, .87,2.54,2.14,1.82,1.52,1.24, .98,
     &1.29,1.15, .98, .78, .61, .45,1.58,1.38,1.17, .96, .75, .56,
     &1.86,1.61,1.36,1.13, .89, .68,2.13,1.83,1.54,1.28,1.03, .79,
     &2.39,2.03,1.71,1.43,1.15, .89,2.63,2.22,1.86,1.56,1.27,1.00
     & /
      X=RHMIN
      Y=NRATIO
      Z=UDAY
      I1=INT(X/20.) + 1
      I2=I1 + 1
      IF (I2.GT.6) I2=6
      J1=INT(Y/0.2) + 1
      J2=J1 + 1
      IF (J2.GT.6) J2=6
      K1=INT(Z/2) + 1
      K2=K1 + 1
      IF(K2.GT.6) K2=6
      IF(K1.GT.6) K1 =6
      X1=(I1-1) * 20
      X2=(I2-1) * 20
      Y1=(J1-1) * 0.2
      Y2=(J2-1) * 0.2
      Z1=(K1-1) * 2
      Z2 = (K2-1) * 2
      FACX=0.0
      FACY = 0.0
      FACZ = 0.0
      IF (K1.NE.K2) FACZ=(Z-Z1)/(Z2-Z1)
      C(1,1)=BB(I1,J1,K1) + FACZ * (BB(I1,J1,K2)-BB(I1,J1,K1))
      C(1,2)=BB(I1,J2,K1) + FACZ * (BB(I1,J2,K2)-BB(I1,J2,K1))
      C(2,1)=BB(I2,J1,K1) + FACZ * (BB(I2,J1,K2)-BB(I2,J1,K1))
      C(2,2)=BB(I2,J2,K1) + FACZ * (BB(I2,J2,K2)-BB(I2,J2,K1))
      IF (J1.NE.J2) FACY=(Y-Y1)/(Y2-Y1)
      IF (I1.NE.I2) FACX=(X-X1)/(X2-X1)
      D(1)=C(1,1) + FACY * (C(1,2)-C(1,1))
      D(2)=C(2,1) + FACY * (C(2,2)-C(2,1))
      BP=D(1) + FACX * (D(2)-D(1))
      AP=0.0043*X - Y - 1.41
      RETURN
      END
C
C
C
C
      SUBROUTINE STAT (SUM1,SUM2,SUM3,N,AVG,S,G,IPRNT)
C     THIS PRAGRAM CALCULATES THE MEAN, STANDARD DEVIATION, AND THE SKEW
C
      X=N
      AVG=SUM1/X
      S=((SUM2-SUM1**2/X)/(X-1))**.5
      G=(X**2*SUM3-3*X*SUM1*SUM2+2*SUM1**3)/(X*(X-1)*(X-2)*S**3)
      IF(IPRNT.EQ.1)WRITE(6,98)N,AVG,S,G
  98  FORMAT(2X,I2,10X,F8.4,10X,F8.4,10X,F8.4)
C
C     INITIALIZE
      SUM1=0.
      SUM2=0.
      SUM3=0.
      END
      END$
```

```
C     *  AND PRECIPITATION CONDITIONS, FOR USE WITH ALFALFA      *         CRP01210
C     *  REFERENCE FOR CROPS GROWN IN AN ARID REGION WITH A      *         CRP01220
C     *  TEMPERATE INTERMOUNTAIN CLIMATE.  (WRIGHT,1981)         *         CRP01230
C     *                                                          *         CRP01240
C     * Programmed by Rick Allen  Univ. Idaho, Kimberly          *         CRP01250
C     ************************************************************         CRP01260
C                                                                          CRP01270
C                                                                          CRP01280
C     MALF = 1 IF MEAN ALFALFA COEFFICIENT FOR HAY (CUTTING EFFECTS        CRP01290
C              AVERAGED)   JPL AND JHV USED, ONLY                          CRP01300
C     MALF = 0 IF ACTUAL ALFALFA COEFFICIENT FOR HAY (CUTTING DATES        CRP01310
C              ADHERED TO)  JPL,JHV AND JCUT() USED.                       CRP01320
C                                                                          CRP01330
      DATA G/                                                              CRP01340
C.....ALFALFA HAY (1)                                                       CRP01350
     $0.70,0.82,0.91,0.96,1.00,1.00,0.98,0.96,0.95,0.95,                   CRP01360
     $0.40,0.50,0.80,0.96,0.98,1.00,1.00,0.98,0.95,0.95,                   CRP01370
C.....BEANS    (2)                                                         CRP01380
     $0.30,0.30,0.30,0.35,0.45,0.55,0.68,0.80,0.90,0.95,                   CRP01390
     D0.95,0.90,0.67,0.33,0.15,0.10,0.10,0.10,0.10,0.10,                   CRP01400
C.....CORN      (3)                                                        CRP01410
     $0.30,0.30,0.30,0.30,0.32,0.42,0.55,0.70,0.85,0.95,                   CRP01420
     D0.96,0.95,0.94,0.90,0.85,0.79,0.74,0.35,0.25,0.25,                   CRP01430
C.....GRASS PASTURE  (4)  (0.1 LESS THAN GRASS REF  (LOW STAND))R.G.A,82 CRP01440
     $0.34,0.43,0.52,0.59,0.66,0.73,0.77,0.77,0.77,0.77,                   CRP01450
     D0.77,0.77,0.77,0.77,0.77,0.77,0.77,0.77,0.77,0.77,                   CRP01460
C.....PEAS      (5)                                                        CRP01470
     $0.30,0.30,0.30,0.36,0.43,0.51,0.58,0.73,0.85,0.93,                   CRP01480
     D0.90,0.65,0.53,0.35,0.20,0.15,0.15,0.15,0.15,0.15,                   CRP01490
C.....POTATOES (6)                                                         CRP01500
     $0.30,0.30,0.30,0.31,0.44,0.57,0.69,0.77,0.82,0.85,                   CRP01510
     D0.85,0.83,0.81,0.79,0.75,0.70,0.65,0.50,0.35,0.25,                   CRP01520
C.....SUGAR BEETS (7)                                                      CRP01530
     $0.30,0.30,0.30,0.30,0.30,0.32,0.40,0.60,0.80,1.00,                   CRP01540
     D1.00,1.00,1.00,0.98,0.94,0.89,0.85,0.80,0.74,0.60,                   CRP01550
C.....SPRING GRAIN(8)                                                      CRP01560
     $0.30,0.30,0.32,0.40,0.65,0.85,0.95,0.99,1.00,1.00,                   CRP01570
     D1.00,1.00,0.90,0.50,0.25,0.15,0.15,0.15,0.15,0.15,                   CRP01580
C.....WINTER GRAIN(9)                                                      CRP01590
     $0.30,0.30,0.50,0.75,0.90,0.98,1.00,1.00,1.00,1.00,                   CRP01600
     D1.00,1.00,1.00,0.95,0.55,0.25,0.15,0.15,0.15,0.15,                   CRP01610
C.....SWEET CORN (10)                                                      CRP01620
     $0.30,0.30,0.30,0.30,0.32,0.42,0.55,0.70,0.85,0.95,                   CRP01630
     D0.93,0.93,0.90,0.85,0.75,0.58,0.40,0.20,0.00,0.00,                   CRP01640
C.....ALFALFA SEED (11)     CURVES 11-14 BY R.G.ALLEN 1981                 CRP01650
     $0.55,0.65,0.72,0.78,0.84,0.87,0.88,0.89,0.89,0.90,                   CRP01660
     D0.90,0.90,0.90,0.88,0.86,0.84,0.75,0.62,0.50,0.45,                   CRP01670
C.....FRUIT TREES (12) --APPLE,CHERRY WITH BARE GROUND                     CRP01680
     $0.40,0.46,0.51,0.58,0.66,0.73,0.77,0.81,0.85,0.85,                   CRP01690
     D0.85,0.85,0.85,0.85,0.85,0.85,0.85,0.85,0.80,0.70,                   CRP01700
C.....SMALL VEGETABLES (13)                                                CRP01710
     $0.30,0.35,0.40,0.50,0.55,0.60,0.65,0.70,0.75,0.80,                   CRP01720
     D0.80,0.80,0.80,0.80,0.75,0.70,0.65,0.55,0.45,0.40,                   CRP01730
C.....ONIONS  (14)                                                         CRP01740
     $0.30,0.35,0.40,0.50,0.55,0.60,0.65,0.70,0.75,0.80,                   CRP01750
     D0.80,0.80,0.80,0.80,0.80,0.80,0.75,0.70,0.65,0.60,                   CRP01760
C.....HOPS     (15)                                                        CRP01770
     $0.30,0.30,0.30,0.35,0.40,0.60,0.75,0.87,0.92,0.95,                   CRP01780
     D0.95,0.95,0.95,0.95,0.95,0.95,0.95,0.95,0.93,0.90                    CRP01790
     D/                                                                    CRP01800
```

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C                                                                          CRP01810
C                                                                          CRP01820
C                                                                          CRP01830
C.....ALFALFA HAY DRYDOWN AFTER LAST CUT (AFTER 3RD AT KIMBERLY)           CRP01840
      DATA ACUT4/                                                          CRP01850
     $0.40,0.44,0.60,0.65,0.55,0.50,0.45,0.35,0.30,0.25/                   CRP01860
C                                                                          CRP01870
C      MEAN ALFALFA COEFFICIENTS FOR AVERAGED CUTTING EFFECTS              CRP01880
       DATA ALFM/                                                          CRP01890
C    $0.55,0.70,0.80,0.87,0.90,0.70,0.63,0.50,0.36,0.25/                   CRP01900
     $0.55,0.71,0.83,0.91,0.95,0.70,0.63,0.50,0.36,0.25/                   CRP01910
C                                                                          CRP01920
C                                                                          CRP01930
C...CROP COEFFICIENTS                                                      CRP01940
      J=ICRP                                                               CRP01950
      IZ=I2                                                                CRP01960
C     BRANCH FOR ALFALFA HAY                                               CRP01970
      IF(J.EQ.1) GO TO 323                                                 CRP01980
      REC=JEC-JPL                                                          CRP01990
C                                                                          CRP02000
C...LINEARLY INTERPOLATE BETWEEN COEFFICIENTS                              CRP02010
C                                                                          CRP02020
      IF(IZ.GE.JEC)GO TO 321                                               CRP02030
C...BEFORE EFFECTIVE COVER                                                 CRP02040
  315 P1=(IZ-JPL)/REC*100                                                  CRP02050
      IF(P1.LT.10.)P1=10.01                                                CRP02060
      IP1=INT(P1/10.)                                                      CRP02070
      DIFF=AMOD(P1,10.)/10.                                                CRP02080
  318 CK=G(IP1,J)+(G(IP1+1,J)-G(IP1,J))*DIFF                               CRP02090
      GOTO 327                                                             CRP02100
C                                                                          CRP02110
C...AFTER EFFECTIVE COVER                                                  CRP02120
  321 D1=IZ-JEC                                                            CRP02130
      DIFF=AMOD(D1,10.)/10.                                                CRP02140
      ID1=INT(D1/10.)+10                                                   CRP02150
C82   IF(ID1.LT.11)DIFF=0.                                                 CRP02160
C82   IF(ID1.LT.11)ID1=11                                                  CRP02170
C     EXTRAPOLATE PAST 100 DAYS USING LINEAR CURVE THROUGH LAST TWO POINCRP02180
      IF(ID1.GT.19) DIFF=1.0*(ID1-19)                                      CRP02190
      IF(ID1.GT.19) ID1=19                                                 CRP02200
  320 CK=G(ID1,J)+(G(ID1+1,J)-G(ID1,J))*DIFF                               CRP02210
C82   IF(IZ.GT.JHV) CK=G(20,5)                                             CRP02220
C                                                                          CRP02230
C...ALFALFA HAY                                                            CRP02240
      IF(J.GT.1) GOTO 327                                                  CRP02250
  323 CONTINUE                                                             CRP02260
C...CUTTINGS                                                               CRP02270
      D9=IZ                                                                CRP02280
C     BRANCH FOR MEAN CUTTING EFFECTS                                      CRP02290
      IF(MALF.EQ.1) GO TO 350                                              CRP02300
      DO 310 NQ1=1,NCUT                                                    CRP02310
      NC=NQ1                                                               CRP02320
      IF(D9.LT.JCUT(NQ1)) GO TO 330                                        CRP02330
  310 CONTINUE                                                             CRP02340
      NC=5                                                                 CRP02350
  330 IF(NC.EQ.1) D1=(D9-JPL)/(JCUT(NC)-JPL)*100.                          CRP02360
      IF(NC.GT.1) D1=(D9-JCUT(NC-1))/(JCUT(NC)-JCUT(NC-1))*100.            CRP02370
      IF(NC.GT.4) D1=(D9-JCUT(NCUT))/(JHV      -JCUT(NCUT))*100.           CRP02380
      IF(NC.EQ.1) JAD=0                                                    CRP02390
      IF(NC.GT.1) JAD=10                                                   CRP02400
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FTN4,Y                                                                  FA000000
       PROGRAM FAO24                                                    FA000010
C      USE THIS PROGRAM TO OBTAIN WRIGHT-1982/FAO-BC REF.RATIOS..4/20/82FA000020
C              R.G.ALLEN   UNIVERSITY OF IDAHO   KIMBERLY, IDAHO        FA000030
C---------------------------------------------------------------------- FA000040
C---------------------------------------------------------------------- FA000050
C---------------------------------------------------------------------- FA000060
C                                                                       FA000070
C           THIS COMPUTER PROGRAM WAS DEVELOPED                         FA000080
C                         BY                                            FA000090
C         S.K.GUPTA, W.O.PRUITT, J.LONCZAK, AND K.K.TANJI               FA000100
C         DEPARTMENT OF LAND, AIR, AND WATER RESOURCES                  FA000110
C         WATER SCIENCE AND ENGINEERING SECTION                         FA000120
C         UNIVERSITY OF CALIFORNIA,                                     FA000130
C         DAVIS, CALIFORNIA  U.S.A.                                     FA000140
C                                                                       FA000150
C                     MODIFIED BY                                       FA000160
C                 ROBERT W PENNINGTON                                   FA000170
C             PLANT,SOIL AND WATER SCIENCE                              FA000180
C              UNIVERSITY OF NEVADA-RENO  1977                          FA000190
C              (TR-21, ALPHANUMERICS,ARRAYS)                            FA000200
C                                                                       FA000210
C                     MODIFIED BY                                       FA000220
C                     RICK ALLEN                                        FA000230
C                UNIVERSITY OF IDAHO                                    FA000240
C             R&E CENTER, KIMBERLY, IDAHO 1981                          FA000250
C             (EJLW,JENSEN-HAISE, ALPHANUMERICS)                        FA000260
C              (CORRECTION OF PMB EQUATION)                             FA000270
C             (ELEVATION CORRECTION OF B.C.)                            FA000280
C    (CALCULATION OF LONG TERM AND SHORT TERM ESTIMATES)                FA000290
C         (AND COMPARISION TO WRIGHT82 (REF.RATIOS))                    FA000300
C                                                                       FA000310
C             THIS IS A COMPUTER PROGRAM BASED ON "CROP WATER           FA000320
C        REQUIREMENTS" BY J. DOORENBOS AND W. O. PRUITT, IRRIGATION     FA000330
C        AND DRAINAGE PAPER 24 (SECOND EDITION), WATER RESOURCES        FA000340
C        DEVELOPMENT AND MANAGEMENT SERVICE, LAND AND WATER DEVELOPMENT FA000350
C        DIVISION, F.A.O. OF UNITED NATIONS, ROME.                      FA000360
C                                                                       FA000370
C             IT ESTIMATES REFERENCE CROP EVAPOTRANSPIRATION (ETO)      FA000380
C        BY ANY OR ALL OF THE FOLLOWING METHODS:                        FA000390
C             1) BLANEY-CRIDDLE(FAO)                                    FA000400
C             2) RADIATION(FAO)                                         FA000410
C             3)  MODIFIED PENMAN(FAO) WITH C = 1.0                     FA000420
C             4) MODIFIED PENMAN(FAO)WITH CORRECTION                    FA000430
C             5) PAN EVAPORATION(FAO)                                   FA000440
C                                                                       FA000450
C---------------------------------------------------------------------- FA000460
      REAL MDAY                                                         FA000470
      REAL LAT, NACT, NTBL, NTBL1, NTBL2, NRATIO                        FA000480
      INTEGER RHFLAG, UFLAG                                             FA000490
      INTEGER MONTH, DAY, YEAR, UNITN                                   FA000500
      DOUBLE PRECISION STA,IEOF                                         FA000510
      DOUBLE PRECISION ISTACT(2),ISNDAT(5)                              FA000520
      REAL NNTBL(11,12), WW(5,14), RRAN(11,12), RRAS(11,12),MODAYS(12) FA000530
      DIMENSION SUMET(18),ETO(18),XX(20),STA(5)                         FA000540
      DIMENSION ETJLW(14,7,31)                                          FA000550
      DIMENSION ENSUN(12),ERHMN(12),EUDAY(12),EUDAN(12),ERSOL(12)       FA000560
      DIMENSION ERHMX(12),ERHME(12)                                     FA000570
      DATA SIGMA / 2.0E-9 /                                             FA000580
      DATA ISTACT,ISNDAT/8HACTLDATA,8HESTMATED,6HSUNHRS,6HSUNDEC,       FA000590
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     *                   5HOKTAS,6HTENTHS,6HNODATA/                     FA000600
      DATA S,N,ALPHAA,ALPHAB/1HS,1HN,1HA,1HB /                          FA000610
      DATA ALPHAC,ALPHAF,IEOF/1HC,1HF,6H        /                       FA000620
      DATA MODAYS/31.,28.,31.,30.,31.,30.,31.,31.,30.,31.,30.,31./      FA000630
      DATA XX/20*0./                                                    FA000640
      FUNED(TDEW)= EXP(54.878919-(6790.4985/TDEW)-5.02808*ALOG(TDEW))   FA000650
C     THE ABOVE VALUE OF SIGMA IS EQUIVALENT TO USING L=586 CAL/GM WATERFA000660
C     SINCE SIGMA=11.71*10E-8 CAL /CM.CM                                FA000670
C---------------------------------------------------------------------- FA000680
C     THIS PROGRAM DOES THE FOLLOWING                                   FA000690
C             READS IN ALL INPUT DATA                                   FA000700
C             CONVERTS THE DATA INTO METRIC UNITS                       FA000710
C             CALCULATES THE NEEDED MEANS                               FA000720
C             ADJUSTS THE WIND MEASUREMENTS TO 2 M HEIGHT.              FA000730
C             ESTIMATES THE SOLAR RADIATION IF NOT GIVEN                FA000740
C             CALLS THE SUBROUTINE BY WHICH THE ESTIMATION IS DESIRED.  FA000750
C                                                                       FA000760
C     LIST OF INPUT SYMBOLS                                             FA000770
C             ********************************************************* FA000780
C             ALT = STATION ALTITUDE                                    FA000790
C             CASE = A OR B (SEE DETAILS IN CHAPTER 1.1)                FA000800
C                  - REQUIRED ONLY IF PAN EVAPORATION ESTIMATE OF ETO   FA000810
C                    VALUE IS DESIRED                                   FA000820
C             DAY = TWO DIGIT REPRESENTATION OF DAY (IE. 08)            FA000830
C                 = 00 IF MONTHLY DATA ARE GIVEN                        FA000840
C                 - REQUIRED ON ALL DAILY AND MONTHLY DATA CARDS        FA000850
C             ED = DAY"S ACTUAL VAPOR PRESSURE IF DATA ARE DAILY        FA000860
C                = MEAN OF DAILY VP"S IF DATA ARE MONTHLY               FA000870
C               - OPTIONAL BUT SUGGESTED FOR INCREASING ACCURACY        FA000880
C             EPAN = DAY"S EVAPORATION FROM CLASS A PAN                 FA000890
C                  = MEAN OF DAILY EVAP"S IF DATA ARE MONTHLY           FA000900
C                  - REQUIRED ONLY IF PAN EVAPORATION VALUE ARE DESIRED FA000910
C             FACTED = FACTOR FOR CONVERTING "ED" VALUES TO MILLIBARS   FA000920
C                    = 1.0  IF ED DATA ARE IN TERMS OF MILLIBARS        FA000930
C                    = 1.33 IF IF ED DATA ARE IN MILLIMETERS OF MERCURY FA000940
C                     = 33.78 IF ED DATA ARE IN INCHES OF MERCURY       FA000950
C             FACTEP = FACTOR FOR CONVERTING EPAN DATA INTO MM/DAY      FA000960
C                    = 1 IF DATA ARE ALREADY IN MM/DAY                  FA000970
C                    = 25.4 IF DATA ARE IN IN/DAY                       FA000980
C             FACTRS = FACTOR FOR CONVERTING RS DATA INTO MM/DAY        FA000990
C                    = 1 IF DATA ARE ALREADY IN MM/DAY                  FA001000
C                    = 0.017 IF DATA ARE IN CAL/DAY (LANGLEYS DAY)      FA001010
C                    = 0.406 IF DATA ARE IN MEGA JOULES/M*M             FA001020
C             FETCH = LENGTH OF UPWIND GREEN CROP FROM PAN FOR CASE A   FA001030
C                   = UPWIND DRY SURFACE FOR CASE B                     FA001040
C                   - REQUIRED ONLY IF PAN EVAPORATION VALUE IS DESIRED FA001050
C             FUDAY  = FACTOR FOR CONVERTING DAY TIME WIND DATA         FA001060
C                    =  1. 0 IF UDAY IS IN M/SEC                        FA001070
C                    =  0.447 IF UDAY IS IN MPH                         FA001080
C                    =  0.278 IF UDAY IS IN KM/HR                       FA001090
C                    =  0.515 IF UDAY IS IN KNOTS                       FA001100
C             FU24 = FACTOR FOR CONVERTING WIND DATA TO KM/DAY.         FA001110
C                  = 1.0 IF  U24 IS ALREADY IN KM/DAY                   FA001120
C                  = 24 IF U24 IS IN KM/HR                              FA001130
C                  = 38.6 IF U24 IS IN MPH                              FA001140
C                  = 1.609 IF U24 IS IN MILES/DAY                       FA001150
C                  = 44.47 IF U24 IS IN KNOTS                           FA001160
C             HEMIS = HEMISPHERE (N OR S)                               FA001170
C             LAT = STATION LATITUDE IN DEGREES N OR S (IS ALWAYS POS.) FA001180
C             MONTH = TWO DIGIT REPRESENTATION OF MONTH (IE. 02)        FA001190
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C             THE CONSTANTS AND CONVERSION FACTORS OF THE GIVEN         FA002400
C         STATION ARE READ AND PRINTED.                                 FA002410
C***********************************************************************FA002420
    1 READ (5,500) STA, ALT, LAT, HEMIS, UHT, PMB ,TWMX,TWMN            FA002430
      IF(STA(1).EQ.IEOF) GO TO 300                                      FA002440
    2 READ (5,510) FU24,FUDAY,FACTED,FACTRS,FACTEP,UNITT,UNITN,RHFLAG,  FA002450
     # UFLAG,NFLAG,NPRINT,NALCOR                                        FA002460
      IF(UNITT.NE.ALPHAC.AND.UNITT.NE.ALPHAF) GO TO 300                 FA002470
      READ(5,520)NBLANY,NRADIA,NPENMN,NCORPN,NETPAN,NTR21,NEJLW,NJENH   FA002480
      IF(PMB.LE.0.0)PMB = 1013 - .1152*ALT + 5.44*10.E-7*ALT*ALT        FA002490
C**** ABOVE EQ. IS DRIVED FROM LONG TIME MEAN PMB FOR NUMBER OF STATION FA002500
C     IN AFRICA(CLIMATE OF AFRICA,VOL 10,WORLD SURVEY OF CLIMATOLOGY)   FA002510
C                                                                       FA002520
C     ALTITUDE CORRECTION FOR BLANEY-CRIDDLE.  10% UPWARD ADJUSTMENT    FA002530
C     FOR EACH 1000 METERS ELEVATION. (FAO 24)....ALLEN.1982            FA002540
      ALTCOR=1.+0.1*(ALT/1000.)                                         FA002550
      IF(NALCOR.EQ.0) ALTCOR=1.                                         FA002560
      IEND = 0                                                          FA002570
      NCASE = 0                                                         FA002580
      WRITE(6,621)                                                      FA002590
      WRITE(6,620)                                                      FA002600
      WRITE(6,600) STA, ALT, LAT, HEMIS, UHT, PMB                       FA002610
      WRITE(6,620)                                                      FA002620
      IF(NPRINT.EQ.0) GO TO 3                                           FA002630
      WRITE(6,620)                                                      FA002640
      WRITE(6,610) FU24, FUDAY, FACTED, FACTRS, FACTEP, ALTCOR, UNITT,  FA002650
     1     UNITN, ISTACT(RHFLAG),ISTACT(UFLAG),ISTACT(NFLAG)            FA002660
      WRITE(6,620)                                                      FA002670
C...                                                                    FA002680
C     READ IN LONG TERM PARAMETERS TO BE USED FOR CORRECTION OF ET      FA002690
C     ESTIMATES BY BLANEY-CRIDDLE...READ FOR EACH MONTH          R.G.ALLFA002700
C     NRATIO,RHMIN,AND UDAY (M/SEC),WIND DAY NIGHT,SOLAR,RHMAX,RHMEAN   FA002710
    3 READ(5,550)(ENSUN(I),I=1,12)                                      FA002720
      READ(5,550)(ERHMN(I),I=1,12)                                      FA002730
      READ(5,550)(EUDAY(I),I=1,12)                                      FA002740
      READ(5,550)(EUDAN(I),I=1,12)                                      FA002750
      READ(5,550)(ERSOL(I),I=1,12)                                      FA002760
      READ(5,550)(ERHMX(I),I=1,12)                                      FA002770
      READ(5,550)(ERHME(I),I=1,12)                                      FA002780
C                                                                       FA002790
      WRITE(6,698)                                                      FA002800
      WRITE(6,699) (I,ENSUN(I),ERHMN(I),EUDAY(I),EUDAN(I),ERSOL(I),     FA002810
     *                 ERHMX(I),ERHME(I),I=1,12)                        FA002820
  698 FORMAT(' MONTH  NRATIO   MIN.RH    DAY WIND  DAY NIGHT   RSOLAR ' FA002830
     *       ,'   MAX.RH   MEAN.RH  ')                                  FA002840
  699 FORMAT(I3,7F10.2)                                                 FA002850
C***********************************************************************FA002860
C             THIS 100 LOOP READS IN EACH DAILY OR MONTHLY DATA CARD    FA002870
C        AND IMMEDIATELY PRINTS THE DATA BACK OUT.  IT THEN ADJUSTS,    FA002880
C        CONVERTS, AND CALCULATES VARIOUS VALUES TO OBTAIN THE NEEDED   FA002890
C        PROGRAM VALUES.  FINALLY IT WRITES THESE CONVERTED DATA OUT TO FA002900
C        DISK AND READS THE NEXT CARD.                                  FA002910
C***********************************************************************FA002920
    5 DO 100 I=1,5000                                                   FA002930
      READ(5,530)SID,MONTH,DAY,YEAR,NREAD,TMAX,TMIN,TDEW,RHMAX,         FA002940
     # RHMIN,ED,UDAY,U24,NACT,NRATIO,RS,RN,EPAN,URATIO                  FA002950
      IF(SID.EQ.IEOF) GO TO 105                                         FA002960
    6 IF(MONTH.EQ.0.AND.DAY.EQ.0)GO TO 105                              FA002970
      IF(NREAD.EQ.0)GO TO 10                                            FA002980
C***********************************************************************FA002990
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C          NREAD = 1 WHEN FETCH AND CASE HAS TO BE READ AGAIN           FA003000
C***********************************************************************FA003010
      READ(5,540) FETCH,CASE                                            FA003020
   10 IDAYYY= IDAYYY + 1                                                FA003030
      EA=0.0                                                            FA003040
      IF(NPRINT.LT.2) GO TO 25                                          FA003050
      IF (I.NE.1) GO TO 20                                              FA003060
      WRITE(6,621)                                                      FA003070
      WRITE(6,620)                                                      FA003080
      WRITE(6,625)                                                      FA003090
      WRITE(6,620)                                                      FA003100
      WRITE(6,630) ISNDAT(UNITN)                                        FA003110
   20 IF(NREAD.NE.0)WRITE(6,632)FETCH,CASE                              FA003120
      WRITE(6,634)MONTH,DAY,YEAR,TMAX,TMIN,TDEW,RHMAX,RHMIN,ED,UDAY,U24,FA003130
     #           NACT,NRATIO,RS,RN,EPAN,URATIO                          FA003140
C***********************************************************************FA003150
C             CALCULATING TMEAN AND RHMEAN, AND CONVERTING THE          FA003160
C        TEMPERATURE DATA TO CELCIUS IF NECESSARY.                      FA003170
C***********************************************************************FA003180
   25 IF(RHMAX.GT.100.0.OR.RHMIN.GT.100.0)WRITE(6,624) RHMAX,RHMIN      FA003190
      RHMEAN=(RHMAX+RHMIN)/2.0                                          FA003200
      TMEAN=(TMAX+TMIN)/2.0                                             FA003210
      IF (UNITT.EQ.ALPHAC) GO TO 30                                     FA003220
      TMAX = (TMAX-32.0) * 5.0/9.0                                      FA003230
      TMIN = (TMIN-32.0) * 5.0/9.0                                      FA003240
      TMEAN = (TMEAN-32.0) * 5.0/9.0                                    FA003250
      IF(TDEW.LT.32.1.AND.TDEW.GT.31.9) TDEW=32.1                       FA003260
      IF (TDEW.NE.0.0) TDEW = (TDEW-32.0) * 5.0/9.0                     FA003270
   30 TK = TMEAN + 273.16                                               FA003280
      TKDEW=0.                                                          FA003290
      IF(TDEW.NE.0.0)TKDEW = TDEW +  273.16                             FA003300
C***********************************************************************FA003310
C        ADJUSTING FOR MEASUREMENT HEIGHT IF IT IS OTHER THAN 2 METERS. FA003320
C***********************************************************************FA003330
      A = 0.17                                                          FA003340
      IF(UHT.LE.2.0) A = 0.22                                           FA003350
      UHTCF = ((2.0/UHT)**A)                                            FA003360
      UDAY = UDAY * UHTCF                                               FA003370
      U24 = U24 * UHTCF                                                 FA003380
C***********************************************************************FA003390
C        CORRECTION FACTORS MULTIPLIED.                                 FA003400
C***********************************************************************FA003410
C     KM/DAY AT 2 METERS                                                FA003420
      U24 = U24 * FU24                                                  FA003430
      IF(UDAY.EQ.0.0) GO TO 35                                          FA003440
      UDAY = UDAY * FUDAY                                               FA003450
   35 IF(U24.EQ.0.0.AND.UDAY.EQ.0.0) GO TO 40                           FA003460
      UNIGHT = 0.0                                                      FA003470
      IF(U24.NE.0.0.AND.UDAY.NE.0.0) UNIGHT = U24/43.2 - UDAY           FA003480
      IF(UNIGHT.NE.0.0.AND.UDAY.NE.0.0.AND.URATIO.EQ.0.0)               FA003490
     # URATIO = UDAY/UNIGHT                                             FA003500
C*****IF NO URATIO DATA IS GIVEN OR POSSIBLE FROM DATA URATIO = 2.0     FA003510
C     USE LONG TERM IF GIVEN                                            FA003520
      IF(URATIO.EQ.0.0.AND.EUDAN(MONTH).NE.0.0) URATIO=EUDAN(MONTH)     FA003530
      IF(URATIO.EQ.0.0) URATIO = 2.0                                    FA003540
      IF(U24.NE.0.0.AND.UDAY.EQ.0.0) UDAY=U24*URATIO/(43.2*(1+URATIO))  FA003550
      IF(U24.EQ.0.0.AND.UDAY.NE.0.0) U24=43.2*UDAY*(1+1./URATIO)        FA003560
C***********************************************************************FA003570
C        FROM GIVEN WIND DATA OTHER WIND DATA ARE ESTIMATED.            FA003580
C***********************************************************************FA003590
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      FAC1=(LAT-LL)/5.0                                                 FA004800
      MONTH1 = MONTH                                                    FA004810
      MONTH2 = MONTH                                                    FA004820
      IF (DAY.LT.15.AND.DAY.NE.0) MONTH1=MOD(MONTH+10,12) + 1           FA004830
      IF (DAY.GT.15) MONTH2=MOD(MONTH,12) + 1                           FA004840
      IF (HEMIS.EQ.S) GO TO 70                                          FA004850
      RA1=RRAN(L1,MONTH1) + FAC1 * (RRAN(L2,MONTH1)-RRAN(L1,MONTH1))    FA004860
      RA2=RRAN(L1,MONTH2) + FAC1 * (RRAN(L2,MONTH2)-RRAN(L1,MONTH2))    FA004870
      GO TO 75                                                          FA004880
   70 RA1=RRAS(L1,MONTH1) + FAC1 * (RRAS(L2,MONTH1)-RRAS(L1,MONTH1))    FA004890
      RA2=RRAS(L1,MONTH2) + FAC1 * (RRAS(L2,MONTH2)-RRAS(L1,MONTH2))    FA004900
  75  FAC=DAY - 15                                                      FA004910
      IF (FAC.LT.0.0) FAC=FAC + 30.0                                    FA004920
      FAC2=FAC/30.0                                                     FA004930
      RA=RA1 + FAC2 * (RA2-RA1)                                         FA004940
C*********************************************************************** FA004950
C           HERE NRATIO AND RS ARE CALCULATED IF NOT GIVEN OR           FA004960
C       CALCULATED ABOVE                                                FA004970
C*********************************************************************** FA004980
      IF (NRATIO.EQ.0.0) NRATIO=2.0 * RS/RA - 0.5                       FA004990
      IF (NRATIO.GT.1.0) NRATIO=0.999                                   FA005000
      IF(NRATIO.LT.0.0) NRATIO = 0.0                                    FA005010
      IF (RS.EQ.0.0) RS=(0.25 + 0.5*NRATIO) * RA                        FA005020
      GO TO 85                                                          FA005030
C*********************************************************************** FA005040
C       CALCULATION OF "W" USING PMB, EA, AND T.                        FA005050
C*********************************************************************** FA005060
   85 GG=0.0006595 * PMB                                                FA005070
      D=(EA/TK) * (6790.4985/TK - 5.02808)                              FA005080
      W=D/(D+GG)                                                        FA005090
      IF(RN.NE.0.0) GO TO 95                                            FA005100
      TK=TMEAN + 273.16                                                 FA005110
      FT=SIGMA * (TK**4)                                                FA005120
      FED=0.34 - 0.044*SQRT(ED)                                         FA005130
      FNN=0.1 + 0.9*NRATIO                                              FA005140
      RN=0.75*RS - FT*FED*FNN                                           FA005150
C*********************************************************************** FA005160
C       HERE THE CONVERTED DATA ARE WRITTEN ON  DISK.                   FA005170
C*********************************************************************** FA005180
   95 WRITE(35)MONTH,DAY,YEAR,TMAX,TMIN,TMEAN,RHMAX,RHMIN,RHMEAN,RN,    FA005190
     #        EA,ED,UDAY,U24,NACT,NRATIO,RS,EPAN,CASE,FETCH,URATIO,W,   FA005200
     #        NREAD,TDEW,TKDEW,EAMEAN                                   FA005210
C*********************************************************************** FA005220
C       END OF 100 LOOP.                                                FA005230
C*********************************************************************** FA005240
  100 CONTINUE                                                          FA005250
C*********************************************************************** FA005260
C             THIS SECTION READS THE CONVERTED DATA BACK OFF DISK AND   FA005270
C       PRINTS IT OUT FOR COMPARISON.                                   FA005280
C*********************************************************************** FA005290
  105 NDATA=I-1                                                         FA005300
      DO 107 IJK=1,17                                                   FA005310
  107 XX(IJK)=0.                                                        FA005320
      REWIND 35                                                         FA005330
      NNND=0                                                            FA005340
      DO 120 I=1,NDATA                                                  FA005350
      READ(35)MONTH,DAY,YEAR,TMAX,TMIN,TMEAN,RHMAX,RHMIN,RHMEAN,        FA005360
     1        RN,EA,ED,UDAY,U24,NACT,NRATIO,RS,EPAN,CASE,FETCH,URATIO,W,FA005370
     2        NREAD,TDEW,TKDEW,EAMEAN                                   FA005380
C     IF(EOF(1))125,106                                                 FA005390
      IF(NPRINT.EQ.0) GO TO 111                                         FA005400
      IF (I.NE.1) GO TO 110                                             FA005410
      IF(NDATA.GT.4)WRITE(6,621)                                        FA005420
      WRITE(6,640)STA,YEAR                                              FA005430
      WRITE(6,620)                                                      FA005440
      WRITE(6,631)                                                      FA005450
  110 IF(NREAD.NE.0) WRITE(6,632)FETCH,CASE                             FA005460
  111 IF(I.EQ.1) GO TO 117                                              FA005470
      IF(DAY.EQ.0)GO TO 119                                             FA005480
      IF(MONTH.EQ.MONT) GO TO 118                                       FA005490
  113 DO 114 IJK=1,17                                                   FA005500
  114 XX(IJK)=XX(IJK)/NUM                                               FA005510
      IF(NPRINT.EQ.0) GO TO 116                                         FA005520
      WRITE(6,620)                                                      FA005530
      WRITE(6,636) MONT,IYEIR,(XX(IJK),IJK=1,17)                        FA005540
      WRITE(6,620)                                                      FA005550
  116 WRITE(52)MONT,IYEIR,(XX(IJK),IJK=1,17)                            FA005560
C     WRITE(20,660) SID,MONTH,NNND,YEAR,XX(1),XX(2),XX(4),XX(11),       FA005570
C    * XX(14)                                                           FA005580
  660 FORMAT(A3,3I2,1X,3F5.2,20X,F5.0,10X,F5.2)                         FA005590
      IF(I.EQ.NDATA) GO TO 120                                          FA005600
      IF(NPRINT.EQ.0) GO TO 121                                         FA005610
      IF(NUM.GT.4)WRITE(6,621)                                          FA005620
      WRITE(6,640)STA,YEAR                                              FA005630
      WRITE(6,620)                                                      FA005640
      WRITE(6,631)                                                      FA005650
  121 DO 115 IJK=1,17                                                   FA005660
  115 XX(IJK)=0.                                                        FA005670
  117 MONT=MONTH                                                        FA005680
      IYEIR=YEAR                                                        FA005690
      NUM=0.                                                            FA005700
C     CALCULATE LONGTERM AVERAGES OF WEATHER PARAMETERS    R.G.ALLEN    FA005710
  118 XX(1)=XX(1)+TMAX                                                  FA005720
      XX(2)=XX(2)+TMIN                                                  FA005730
      XX(3)=XX(3)+TMEAN                                                 FA005740
      XX(4)=XX(4)+TDEW                                                  FA005750
      XX(5)=XX(5)+RHMAX                                                 FA005760
      XX(6)=XX(6)+RHMIN                                                 FA005770
      XX(7)=XX(7)+RHMEAN                                                FA005780
      XX(8)=XX(8)+EA                                                    FA005790
      XX(9)=XX(9)+ED                                                    FA005800
      XX(10)=XX(10)+UDAY                                                FA005810
      XX(11)=XX(11)+U24                                                 FA005820
      XX(12)=XX(12)+NALT                                                FA005830
      XX(13)=XX(13)+NRATIO                                              FA005840
      XX(14)=XX(14)+RS                                                  FA005850
      XX(15)=XX(15)+RN                                                  FA005860
      XX(16)=XX(16)+EPAN                                                FA005870
      XX(17)=XX(17)+URATIO                                              FA005880
      NUM=NUM+1                                                         FA005890
  119 IF(NPRINT.EQ.0) GO TO 122                                         FA005900
      WRITE(6,635)MONTH,DAY,YEAR,TMAX,TMIN,TMEAN,TDEW,RHMAX,RHMIN,      FA005910
     &         RHMEAN,EA,ED,UDAY,U24,NACT,NRATIO,RS,RN,EPAN,URATIO      FA005920
  122 IF(DAY.EQ.0) GO TO 120                                            FA005930
      IF(I.EQ.NDATA) GO TO 113                                          FA005940
  120 CONTINUE                                                          FA005950
C*********************************************************************** FA005960
C             BELOW THIS POINT THE PROGRAM AGAIN READS THE CONVERTED    FA005970
C       DATA OFF DISK AND THEN ESTIMATES ET BY THE DESIRED METHODS.     FA005980
C       MONTHLY AVERAGING IS ALSO DONE.                                 FA005990
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     & CALL EJLW  (MONTH,DAY,TMAX,TMIN,TMEAN,TKDEW,EAMEAN,ED,U24,RS,     FA007200
     &               PMB,ETO(7),ETO(9))                                  FA007210
      NYYY=YEAR-64                                                       FA007220
      MMMM=MONTH-3                                                       FA007230
      ETJLW(NYYY,MMMM ,DAY)=ETO(7)                                       FA007240
C     WRITE(33,3333) NYYY,MMMM,DAY,ETO(7),ETJLW(NYYY,MMMM,DAY)           FA007250
C     WRITE(33,3333) YEAR,MONTH,DAY,ETO(7)                               FA007260
 3333 FORMAT(3I5,2F7.2)                                                  FA007270
  160 IF(EPAN.EQ.0.0.OR.NCASE.EQ.0.OR.FETCH.EQ.0.0) GO TO 165            FA007280
      IF(NETPAN.NE.0) CALL ETPAN(EPAN,U24,RHMEAN,FETCH,NCASE,ETO(5))     FA007290
      IF(NETPAN.NE.0) CALL ETPAN(EPAN,U24M,RHME,FETCH,NCASE,ETO(14))     FA007300
  165 DO 166 M=1,18                                                      FA007310
  166 SUMET(M)=SUMET(M)+ETO(M)                                           FA007320
      TMEANT=TMEANT+TMEAN                                                FA007330
      WRITE(6,648) MONTH,DAY,YEAR,(ETO(M),M=1,9)                         FA007340
      MDAY = MDAY   + 1                                                  FA007350
      MO = MONTH                                                         FA007360
  200 CONTINUE                                                           FA007370
  205 REWIND 35                                                          FA007380
      IEND=1                                                             FA007390
      IF(DAY.EQ.0) GOTO148                                               FA007400
      IF(MDAY.GT.1) GO TO 140                                            FA007410
       GO TO 1                                                           FA007420
C-----------------------------------------------------------------        FA007430
C    READ FORMATS                                                        FA007440
C-----------------------------------------------------------------        FA007450
 500  FORMAT (5A6,2F5.0,A1,9X,4F5.0)                                     FA007460
 510  FORMAT (5F5.0,A1,9X,6(1X,I1))                                      FA007470
 520  FORMAT(9(4X,I1))                                                   FA007480
 530  FORMAT(A3,3I2,I1,14F5.0)                                           FA007490
 540  FORMAT(F10.0,A1)                                                   FA007500
 550  FORMAT(12F5.0)                                                     FA007510
C********************************************************************** FA007520
C        PRINT FORMATS                                                   FA007530
C********************************************************************** FA007540
 600  FORMAT (5X,"STATION = ",5A6,//,5X,"ALTITUDE IN METERS =",F9.1,//, FA007550
     #        5X,"LATITIDE IN DEGREES =",F9.1,//,                        FA007560
     #        5X,"HEMISPHERE = ",A1,//,                                  FA007570
     #        5X,"HEIGHT OF WIND MEASUREMENT IN METERS =",F9.2,//,       FA007580
     #        5X,"MEAN PRESSURE FOR THE YEAR IN MILLIBARS =",F9.1)       FA007590
 610  FORMAT (5X,"FACTOR FOR CONVERTING 24HR WIND TO KM/DAY =",F9.3//,   FA007600
     #        5X,"FACTOR FOR CONVERTING DAYTIME WIND TO M/SEC =",F9.3// FA007610
     #        5X,"FACTOR FOR CONVERTING ED DATA TO MILLIBARS =",F9.3,// FA007620
     #        5X,"FACTOR FOR CONVERTING RS DATA TO MM/DAY =",F9.3,//,   FA007630
     #        5X,"FACTOR FOR CONVERTING EPAN DATA TO MM/DAY =",F9.3,//, FA007640
     #        5X,"FACTOR FOR CORRECTING BL-CR FOR ALTITUDE  =",F9.3,//, FA007650
     #        5X,"TEMPERATURE DATA IS GIVEN IN DEGREES :  ",A1,//,       FA007660
     #        5X,"SUNSHINE/CLOUDINESS FLAG =",I5,//,                     FA007670
     #        5X,"RELATIVE HUMIDITY DATA =  ", A8//,                     FA007680
     #        5X,"WIND DATA =  ", A8//,                                  FA007690
     #        5X,"SUNSHINE DATA =  ", A8//)                              FA007700
 620  FORMAT (1H   ,130("-") )                                           FA007710
 621  FORMAT (1H1,  )                                                    FA007720
 624  FORMAT(//" ERROR IN RH ",F10.2," =RHMAX AND RHMIN =",F10.2//)      FA007730
 625  FORMAT (5X,"CLIMATOLOGICAL DATA AS READ IN WITHOUT CONVERSION"/)  FA007740
 630  FORMAT (1H ,"DATE (M/D/Y)    TMAX   TMIN   TDEW   RHMAX   RHMIN", FA007750
     #        "   ED    UDAY    U24   ", A6,"  NRATIO   SOLRAD    RN "FA007760
     #      "  EPAN      URATIO"/)                                       FA007770
 631  FORMAT (1H ,"DATE (MDY)  TMAX  TMIN TMEAN  TDEW  RHMAX  RHMIN",    FA007780
     #        " RHMEAN   EA    ED   UDAY   U24 SUNHRS NRATIO SOLRAD",    FA007790
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     #        "   RN      EPAN   URATIO  "/,                             FA007800
     #         11X,"  (C)   (C)   (C)   (C)     (%)     (%) ",           FA007810
     #        "  (%)     (mb)  (mb)  (m/s) (km/d) (hr)         (mm/d) ", FA007820
     #        "(mm/d)  (mm/d)  "/)                                       FA007830
 632  FORMAT("  VALUES OF FETCH ",F8.2,",CASE ",A1)                      FA007840
 634  FORMAT(1H ,I4,2("/",I2),3X,3F7.1,2(F7.0,1X),3F7.1,F8.2,F9.2,F9.2, FA007850
     #         F8.2,F8.2,F10.2)                                          FA007860
 635  FORMAT(1H ,I3,2("/",I2),1X,4F6.1,3(F6.0,1X),4F6.1,3(F6.2,1X),F6.2 FA007870
     #       ,F8.2,F10.2)                                                FA007880
 636  FORMAT(1H ,'AVE.',I2,'/',I2,1X,4F6.1,3(F6.0,1X),4F6.1,3(F6.2,1X)  FA007890
     #       ,F6.2,F8.2,F10.2)                                           FA007900
 640  FORMAT(1X,"TABLE    CLIMATOLOGICAL DATA FOR ",5A6,3X,"19",I2,/)   FA007910
 645  FORMAT(" RESULT OF ET ESTIMATION BY VARIOUS METHODS FOR MONTH ",   FA007920
     #    I2,",19",I2,10X,5A6,/)                                         FA007930
 646  FORMAT (/,1H ,130("*"),/)                                          FA007940
 648  FORMAT(1H ,2X,I2,"/",I2,"/19",I2,F12.2,8F13.2)                     FA007950
 650  FORMAT(/," MONTH AVE (mm/day)",9(F6.2, 7X), )                      FA007960
 652  FORMAT( ," MONTH AVE (in/day)",9(F6.2, 7X), )                      FA007970
 653  FORMAT(/," MONTHLY TOTAL (in)",9(F6.2, 7X), )                      FA007980
C654  FORMAT(/," DAYSIM= ",F8.3)                                         FA007990
 655  FORMAT (1H ,21X,"FAO",10X,"FAO",10X,"FAO",10X,"FAO",10X,"FAO",    FA008000
     &  9X,"SCS", /," MONTH/DAY/YEAR",6X,"BLANEY", 5X,"RADIATION", 6X,  FA008010
     #        "PENMAN", 5X,"CORR. PEN.", 5X,"ETPAN", 8X,"TR21",          FA008020
     &        9X,"EJLW",3X,"JENSEN-HAISE",3X,"ORIG.PEN."/21X,"E.C.")    FA008030
 656  FORMAT (  " KO = ETO/ETR ",4X,9(F7.2,6X)/)                         FA008040
 657  FORMAT (  " KR = ETR/ETO ",4X,9(F7.2,6X))                          FA008050
 658  FORMAT(  "  day calc  l-t adj",9(F6.2, 7X), )                      FA008060
 659  FORMAT(  "  mon calc  l-t adj",9(F6.2, 7X), )                      FA008070
 662  FORMAT(  "  day calc  mon adj",9(F6.2, 7X), )                      FA008080
 670  FORMAT(2I3, 8F9.4 )                                                FA008090
 672  FORMAT('MON YR ST-FAOBC LT-FAOBC WRIGHT    TR21    FAORAD  ',      FA008100
     &        ' FAOPEN   FAOCPEN ')                                      FA008110
 674  FORMAT('MON YR ST-FAOBC LT-FAOBC   TR21    FAORAD   FAOPEN  ',     FA008120
     &        ' FAOCPEN ')                                               FA008130
C********************************************************************** FA008140
C        PROGRAM END                                                     FA008150
C********************************************************************** FA008160
  300 WRITE(6,621)                                                       FA008170
C     WRITE(7,3938)                                                      FA008180
3938  FORMAT(' MO DAY  1965             THRU 1978')                      FA008190
C     DO 3939 II=1,7                                                     FA008200
C     IV=II+3                                                            FA008210
C     DO 3939 III=1,31                                                   FA008220
C     CALL JDAY(IV,III,JJUUL)                                            FA008230
C     EJAV=0.                                                            FA008240
C     DO 3587 JIMM=1,14                                                  FA008250
C     EJAV=EJAV+ETJLW(JIMM,II,III)/14.                                   FA008260
C3587 CONTINUE                                                           FA008270
C3939 WRITE(7,3940)JJUUL     ,(ETJLW(NYR,II,III),NYR=1,14),EJAV          FA008280
 3940 FORMAT( I5,14F6.2,F10.2)                                           FA008290
      END                                                                FA008300
C                                                                        FA008310
C                                                                        FA008320
C                                                                        FA008330
C                                                                        FA008340
C                                                                        FA008350
C                                                                        FA008360
C                                                                        FA008370
C                                                                        FA008380
      SUBROUTINE BLANY (LAT,HEMIS,MONTH,DAY,TMEAN,RHMIN,NRATIO,          FA008390
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     4          0.87, 0.94, 0.99, 1.03, 1.07, 1.10,                     FA009600
     5          0.76, 0.81, 0.85, 0.89, 0.92, 0.94,                     FA009610
     6          0.64, 0.67, 0.70, 0.73, 0.75, 0.77/                     FA009620
      X=UDAY                                                            FA009630
      Y = RHMEAN                                                        FA009640
      I1=INT(X/2) + 1                                                   FA009650
      I2 = I1 + 1                                                       FA009660
      IF (I2.GT.6) I2=6                                                 FA009670
      IF(I1.GT.6) I1 = 6                                                FA009680
      J1=INT(Y/20) + 1                                                  FA009690
      J2 = J1 + 1                                                       FA009700
      IF (J2.GT.6) J2=6                                                 FA009710
      X1=(I1-1) * 2                                                     FA009720
      X2 =(I2-1) * 2                                                    FA009730
      Y1=(J1-1) * 20                                                    FA009740
      Y2 = (J2-1) * 20                                                  FA009750
      B=INT2D (I1,I2,J1,J2,X,Y,X1,X2,Y1,Y2,BB,6)                        FA009760
      ET2=A + B*W*RS                                                    FA009770
      RETURN                                                            FA009780
      END                                                               FA009790
C                                                                       FA009800
C                                                                       FA009810
C                                                                       FA009820
C                                                                       FA009830
C                                                                       FA009840
      SUBROUTINE ETPAN (EPAN,U24,RHMEAN,FETCH,NCASE,ET4)                FA009850
      DIMENSION C(2,2), D(2)                                            FA009860
      REAL KP,KKP1(3,4,2),KKP2(3,4,2),KKP3(3,4,2),KKP4(3,4,2)           FA009870
      REAL KP111,KP112,KP121,KP122,KP211,KP212,KP221,KP222              FA009880
C********************************************************************** FA009890
C********************************************************************** FA009900
      DATA KKP1/.55,.65,.75,.5,.6,.65,.45,.5,.6,.4,.45,.5,.7,.8,.85,.65,FA009910
     1.75,.8,.6,.65,.7,.5,.6,.65/                                       FA009920
      DATA KKP2/.65,.75,.85,.6,.7,.75,.55,.6,.65,.45,.55,.6,.6,.7,.8,   FA009930
     1.55,.65,.7,.5,.55,.65,.45,.5,.55/                                 FA009940
      DATA KKP3/.7,.8,.85,.65,.75,.8,.6,.65,.7,.5,.6,.65,.55,.65,.75,.5,FA009950
     1.6,.65,.45,.5,.6,.4,.45,.5/                                       FA009960
      DATA KKP4/.75,.85,.85,.7,.8,.8,.65,.7,.75,.55,.6,.65,.5,.6,.7,.45,FA009970
     1.55,.6,.4,.45,.55,.35,.4,.45/                                     FA009980
      X=RHMEAN                                                          FA009990
      Y = U24                                                           FA010000
      Z = ALOGT(FETCH)                                                  FA010010
      L = NCASE                                                         FA010020
   10 IF (X.GT.30) GO TO 15                                             FA010030
      I1=1                                                              FA010040
      I2 = 1                                                            FA010050
      GO TO 30                                                          FA010060
   15 IF (X.GT.57) GO TO 20                                             FA010070
      I1=1                                                              FA010080
      I2 = 2                                                            FA010090
      X1=30.0                                                           FA010100
      X2 = 57.0                                                         FA010110
      GO TO 30                                                          FA010120
   20 IF (X.GE.84.0) GO TO 25                                           FA010130
      I1=2                                                              FA010140
      I2 = 3                                                            FA010150
      X1=57.0                                                           FA010160
      X2 = 84.0                                                         FA010170
      GO TO 30                                                          FA010180
   25 I1=3                                                              FA010190
      I2=3                                                              FA010200
   30 IF (Y.GT.84.0) GO TO 35                                           FA010210
      J1=1                                                              FA010220
      J2 = 1                                                            FA010230
      GO TO 55                                                          FA010240
   35 IF (Y.GT.260.0) GO TO 40                                          FA010250
      J1=1                                                              FA010260
      J2 = 2                                                            FA010270
      Y1=87.0                                                           FA010280
      Y2 = 260.0                                                        FA010290
      GO TO 55                                                          FA010300
   40 IF (Y.GT.465.0) GO TO 45                                          FA010310
      J1=2                                                              FA010320
      J2 = 3                                                            FA010330
      Y1=260.0                                                          FA010340
      Y2 = 465.0                                                        FA010350
      GO TO 55                                                          FA010360
   45 IF (Y.GE.700.0) GO TO 50                                          FA010370
      J1=3                                                              FA010380
      J2 = 4                                                            FA010390
      Y1=465.0                                                          FA010400
      Y2 = 700.0                                                        FA010410
      GO TO 55                                                          FA010420
   50 J1=4                                                              FA010430
      J2 = 4                                                            FA010440
   55 IF (Z.GT.0.0) GO TO 60                                            FA010450
      K1=1                                                              FA010460
      K2 = 1                                                            FA010470
      GO TO 80                                                          FA010480
   60 IF (Z.GT.1.00) GO TO 65                                           FA010490
      K1=1                                                              FA010500
      K2 = 2                                                            FA010510
      Z1=0                                                              FA010520
      Z2=1.0                                                            FA010530
      GO TO 80                                                          FA010540
   65 IF (Z.GT.2.0)   GO TO 70                                          FA010550
      K1=2                                                              FA010560
      K2 = 3                                                            FA010570
      Z1=1.0                                                            FA010580
      Z2 = 2.0                                                          FA010590
      GO TO 80                                                          FA010600
   70 IF (Z.GE.3.0)    GO TO 75                                         FA010610
      K1=3                                                              FA010620
      K2 = 4                                                            FA010630
      Z1=2.0                                                            FA010640
      Z2 = 3.0                                                          FA010650
      GO TO 80                                                          FA010660
   75 K1=4                                                              FA010670
      K2 = 4                                                            FA010680
   80 FACX=0.0                                                          FA010690
      FACY=0.0                                                          FA010700
      FACZ=0.0                                                          FA010710
      IF (K1.NE.K2) FACZ=(Z-Z1)/(Z2-Z1)                                 FA010720
      GO TO (110,120,130,140),K1                                        FA010730
  110 KP111=KKP1(I1,J1,L)                                               FA010740
      KP112=KKP1(I1,J2,L)                                               FA010750
      KP121=KKP1(I2,J1,L)                                               FA010760
      KP122=KKP1(I2,J2,L)                                               FA010770
      GO TO 150                                                         FA010780
  120 KP111=KKP2(I1,J1,L)                                               FA010790
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      IF(I1.GT.4) I1 = 4                                                FA012000
      IF(I1.EQ.0) I1 = 1                                                FA012010
      FAC1=(W-II)/3.0                                                   FA012020
      JJ=INT(X/3) * 3                                                   FA012030
      IF (JJ.GT.9) JJ=9                                                 FA012040
      J1=JJ/3 + 1                                                       FA012050
      J2 = J1 + 1                                                       FA012060
      IF (J2.EQ.5) J2=4                                                 FA012070
      FAC2=(X-JJ)/3.0                                                   FA012080
      KK=INT(Y/30) * 30                                                 FA012090
      IF (KK.EQ.0) KK=30                                                FA012100
      K1=KK/30                                                          FA012110
      K2 = K1 + 1                                                       FA012120
      IF (K2.EQ.4) K2=3                                                 FA012130
      FAC3=(Y-KK)/30.0                                                  FA012140
      LL=INT(Z)                                                         FA012150
      IF (LL.EQ.0) LL=1                                                 FA012160
      L1=LL                                                             FA012170
      L2 = L1 + 1                                                       FA012180
      IF (L2.EQ.5) L2=4                                                 FA012190
      IF(L1.GT.4) L1=4                                                  FA012200
      FAC4=(Z-LL)                                                       FA012210
      GO TO (10,20,30,40),L1                                            FA012220
   10 CC111=CC1(I1,J1,K1)                                               FA012230
      CC112=CC1(I1,J1,K2)                                               FA012240
      CC121=CC1(I1,J2,K1)                                               FA012250
      CC122=CC1(I1,J2,K2)                                               FA012260
      CC211=CC1(I2,J1,K1)                                               FA012270
      CC212=CC1(I2,J1,K2)                                               FA012280
      CC221=CC1(I2,J2,K1)                                               FA012290
      CC222=CC1(I2,J2,K2)                                               FA012300
      CP111=CC2(I1,J1,K1)                                               FA012310
      CP112=CC2(I1,J1,K2)                                               FA012320
      CP121=CC2(I1,J2,K1)                                               FA012330
      CP122=CC2(I1,J2,K2)                                               FA012340
      CP211=CC2(I2,J1,K1)                                               FA012350
      CP212=CC2(I2,J1,K2)                                               FA012360
      CP221=CC2(I2,J2,K1)                                               FA012370
      CP222=CC2(I2,J2,K2)                                               FA012380
      GO TO 50                                                          FA012390
   20 CC111=CC2(I1,J1,K1)                                               FA012400
      CC112=CC2(I1,J1,K2)                                               FA012410
      CC121=CC2(I1,J2,K1)                                               FA012420
      CC122=CC2(I1,J2,K2)                                               FA012430
      CC211=CC2(I2,J1,K1)                                               FA012440
      CC212=CC2(I2,J1,K2)                                               FA012450
      CC221=CC2(I2,J2,K1)                                               FA012460
      CC222=CC2(I2,J2,K2)                                               FA012470
      CP111=CC3(I1,J1,K1)                                               FA012480
      CP112=CC3(I1,J1,K2)                                               FA012490
      CP121=CC3(I1,J2,K1)                                               FA012500
      CP122=CC3(I1,J2,K2)                                               FA012510
      CP211=CC3(I2,J1,K1)                                               FA012520
      CP212=CC3(I2,J1,K2)                                               FA012530
      CP221=CC3(I2,J2,K1)                                               FA012540
      CP222=CC3(I2,J2,K2)                                               FA012550
      GO TO 50                                                          FA012560
   30 CC111=CC3(I1,J1,K1)                                               FA012570
      CC112=CC3(I1,J1,K2)                                               FA012580
      CC121=CC3(I1,J2,K1)                                               FA012590
      CC122=CC3(I1,J2,K2)                                               FA012600
      CC211=CC3(I2,J1,K1)                                               FA012610
      CC212=CC3(I2,J1,K2)                                               FA012620
      CC221=CC3(I2,J2,K1)                                               FA012630
      CC222=CC3(I2,J2,K2)                                               FA012640
      CP111=CC4(I1,J1,K1)                                               FA012650
      CP112=CC4(I1,J1,K2)                                               FA012660
      CP121=CC4(I1,J2,K1)                                               FA012670
      CP122=CC4(I1,J2,K2)                                               FA012680
      CP211=CC4(I2,J1,K1)                                               FA012690
      CP212=CC4(I2,J1,K2)                                               FA012700
      CP221=CC4(I2,J2,K1)                                               FA012710
      CP222=CC4(I2,J2,K2)                                               FA012720
      GO TO 50                                                          FA012730
   40 WRITE(6,888) L1                                                   FA012740
  888 FORMAT(' INCORRECT VALUE FOR L1 ',I3)                             FA012750
   50 T1(1,1,1)=CC111+FAC4*(CP111-CC111)                                FA012760
      T1(1,1,2)=CC112+FAC4*(CP112-CC112)                                FA012770
      T1(1,2,1)=CC121+FAC4*(CP121-CC121)                                FA012780
      T1(1,2,2)=CC122+FAC4*(CP122-CC122)                                FA012790
      T1(2,1,1)=CC211+FAC4*(CP211-CC211)                                FA012800
      T1(2,1,2)=CC212+FAC4*(CP212-CC212)                                FA012810
      T1(2,2,1)=CC221+FAC4*(CP221-CC221)                                FA012820
      T1(2,2,2)=CC222+FAC4*(CP222-CC222)                                FA012830
      T2(1,1)=T1(1,1,1) + FAC3*(T1(1,1,2)-T1(1,1,1))                    FA012840
      T2(1,2)=T1(1,2,1) + FAC3*(T1(1,2,2)-T1(1,2,1))                    FA012850
      T2(2,1)=T1(2,1,1) + FAC3*(T1(2,1,2)-T1(2,1,1))                    FA012860
      T2(2,2)=T1(2,2,1) + FAC3*(T1(2,2,2)-T1(2,2,1))                    FA012870
      T3(1)=T2(1,1) + FAC2*(T2(1,2)-T2(1,1))                            FA012880
      T3(2)=T2(2,1) + FAC2*(T2(2,2)-T2(2,1))                            FA012890
      T4=T3(1) + FAC1*(T3(2)-T3(1))                                     FA012900
      C=T4                                                              FA012910
      ET3C=ET3*C                                                        FA012920
      RETURN                                                            FA012930
      END                                                               FA012940
C                                                                       FA012950
C                                                                       FA012960
C                                                                       FA012970
C                                                                       FA012980
C                                                                       FA012990
      SUBROUTINE TR21 (LAT,HEMIS,MONTH,DAY,TMEAN,ET5)                   FA013000
C         ADDED BY R.PENNINGTON     UNIV. NEVADA  RENO                  FA013010
C         SCS-MODIFIED BLANY-CRIDDLE FOR ALFALFA HAY                    FA013020
      REAL LAT,KC,KKC,K                                                 FA013030
      INTEGER MONTH,DAY                                                 FA013040
      DIMENSION PP(11,12),KC(12)                                        FA013050
      DATA S/1HS/                                                       FA013060
C********************************************************************* FA013070
C         THIS SECTION INTERPOLATES "F".                                FA013080
C********************************************************************* FA013090
      DATA PP                                                           FA013100
     1 / .267,.264,.261,.257,.252,.246,.239,.231,.220,.209,.195,        FA013110
     2   .269,.268,.266,.264,.261,.257,.253,.248,.243,.236,.228,        FA013120
     3   .269,.269,.269,.269,.269,.269,.268,.268,.268,.267,.266,        FA013130
     4   .269,.270,.272,.275,.278,.282,.286,.291,.297,.303,.310,        FA013140
     5   .271,.273,.276,.281,.287,.294,.303,.312,.322,.334,.346,        FA013150
     6   .274,.280,.285,.291,.298,.307,.316,.328,.341,.355,.371,        FA013160
     7   .275,.281,.287,.293,.299,.305,.313,.321,.330,.341,.354,        FA013170
     8   .274,.278,.282,.287,.291,.295,.300,.304,.309,.315,.322,        FA013180
     9   .271,.277,.280,.281,.281,.281,.281,.281,.281,.281,.281,        FA013190
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C                                                                       FA014400
C.....CLEAR SKY INCIDENT SHORTWAVE SOLAR RADIATION FOR KIMBERLY, IDAHO  FA014410
      MDAY=DAY                                                          FA014420
      IF(MDAY.EQ.0) MDAY=15                                             FA014430
      CALL JDAY(MONTH,MDAY,JUL)                                         FA014440
      IF(JUL.LT.1) JUL=1                                                FA014450
      IF(JUL.GT.365) JUL=365                                            FA014460
      RSO=CDS(JUL)                                                      FA014470
      IF(DAY.NE.0) GO TO 12                                             FA014480
C.....MEAN CLEAR DAY SOLAR OVER MONTH                                   FA014490
      JJJ=0                                                             FA014500
      RSO=0.                                                            FA014510
      DO 11 JJ=JUL-14,JUL+15                                            FA014520
      JJJ=JJJ+1                                                         FA014530
   11 RSO=RSO+CDS(JJ)                                                   FA014540
      RSO=RSO/JJJ                                                       FA014550
   12 CONTINUE                                                          FA014560
C.....CONVERT MEASURED INCIDENT SOLAR RADIATION FROM MM/DAY TO LGY'S/DAYFA014570
C     RS=RSW*HEATLT/10.                                                 FA014580
C.....USE SAME CONVERSTION FACTOR AS IS USED IN MAIN ROUTINE             FA014590
      RS=RSW*1./0.017                                                   FA014600
C.....STEFAN-BOLTZMAN CONSTANT  CAL/CM**2/DEGK**4/DAY                   FA014610
      STEFAN=11.71E-08                                                  FA014620
C.....NET OUTGOING LONG WAVE RADIATION ON CLEAR DAY (EQU. 3.7,ASCE,1974)FA014630
      MON=MONTH                                                         FA014640
      DA=MDAY                                                           FA014650
      PI=3.14159                                                        FA014660
C.....A1 AS REPORTED BY WRIGHT,1982                                     FA014670
      A1=0.26 + 0.1*EXP(-1.*((30.*(MON+DA/30.)-207.)/65.)**2)           FA014680
C OLD A1=0.325+0.045*SIN((30.*(MON+DA/30.-1.5)*PI/180.))                FA014690
C OLD A1=0.325+0.045*SIN((30.*(MON+DA/30.-1.5)))                        FA014700
      B1=-0.044                                                         FA014710
      RBO=(A1+B1*SQRT(EDEW))*STEFAN*((TMAX+ABZ)**4+(TMIN+ABZ)**4)/2.    FA014720
C     WRITE(6,35) A1,B1,MON,DA,PI,EDEW,STEFAN,ABZ                       FA014730
  35  FORMAT(' A1=',F6.4,' B1=',F6.4,' MON=',F6.1,' DA=',F6.1,'PI=',    FA014740
     *F8.4,' EDEW=',F6.3,'STEFAN=',E7.2,' ABZ=',F7.2)                   FA014750
C.....ACTUAL NET OUTGOING THERMAL RADIATION (EQU. 3.6  TABLE 3.2,ASCE)  FA014760
      A=1.125                                                           FA014770
      IF(RS/RSO.LT.0.7) A=1.017                                         FA014780
      B=-0.07                                                           FA014790
      RB=(A*RS/RSO+B)*RBO                                               FA014800
C.....ALBEDO OF ALFALFA      WRIGHT,1982                                FA014810
      ALBEDO=0.29+0.06*SIN(30.*(MON+DA/30.+2.25)*PI/180.)               FA014820
C.....NET RADIATION FLUX FROM CROP SURFACE  (EQU. 3.5,ASCE)             FA014830
      RN=(1.-ALBEDO)*RS-RB                                              FA014840
C.....SOIL HEAT FLUX  (0.10 METERS OF SOIL FOR DAILY AND 2 METERS FOR   FA014850
C     MONTHLY ESTIMATES.)  ...AFTER EQU. 3.19                           FA014860
      IF(DAY.EQ.0) GO TO 10                                             FA014870
      IF(LDAY.EQ.0) N=0                                                 FA014880
      IF(LDAY.EQ.DAY-1) GO TO 3                                         FA014890
      IF(DAY.EQ.1.AND.LDAY.GT.27) GO TO 3                               FA014900
      GO TO 15                                                          FA014910
    3 IF(N.EQ.0) GO TO 15                                               FA014920
      TPAST=0.                                                          FA014930
      DO 5 I=1,N                                                        FA014940
    5 TPAST=TPAST+TEMPM(I)/N                                            FA014950
      G=(TMEAN-TPAST)*5.*1.8                                            FA014960
C     WRITE(6,40) G,TMEAN,TPAST,(TEMPM(I),I=1,N)                        FA014970
   40 FORMAT(' G=',F7.3,' TMEAN=',F6.2,' TPAST=',F7.2,' TEMPM1-3=',     FA014980
     *5F6.2 )                                                           FA014990
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      GO TO 20                                                          FA015000
C.....MONTHLY FLUX                                                      FA015010
   10 IF(N.EQ.0) GO TO 15                                               FA015020
      G=(TMEAN-TEMPM(1))/30.*100.*1.8                                   FA015030
C     WRITE(6,50) G,TMEAN,(TEMPM(I),I=1,N)                              FA015040
   50 FORMAT(' G=',F7.3,' TMEAN=',F7.3,' TEMPM(1-3)=',5F7.3)            FA015050
      GO TO 20                                                          FA015060
   15 G=0.                                                              FA015070
   20 TEMPM(3)=TEMPM(2)                                                 FA015080
      TEMPM(2)=TEMPM(1)                                                 FA015090
      TEMPM(1)=TMEAN                                                    FA015100
      N=N+1                                                             FA015110
      IF(N.GT.3)N=3                                                     FA015120
      LDAY=DAY                                                          FA015130
C.....THERMODYNAMIC CONSTANTS                                           FA015140
      CP=0.24                                                           FA015150
      RMOLEC=0.622                                                      FA015160
C.....PSYCROMETRIC CONSTANT  MB/DEG CELSIUS  (BRUNT,1952 EQU. 7.7,ASCE) FA015170
      GAMMA=CP*PMB/(RMOLEC*HEATLT)                                      FA015180
C.....SLOPE OF SAT.VAPOR PRESSURE/TEMPERATURE  MB/DEG CELSIUS (EQU. 7.5BFA015190
      DELTAJ=33.8639*(0.05904*(0.00738*TMEAN+0.8072)**7-0.0000342)      FA015200
C.....SLOPE OF SAT.VAPOR PRESSURE/TEMPERATURE  MB/DEG CELSIUS (GOFF-GRATFA015210
      Z=2.30258509                                                      FA015220
      DELTA=SLOPE((TMEAN+ABZ),Z,T100,EAVE)                              FA015230
C.....WEIGHTING FUNCTION                                                FA015240
      W=DELTAJ/(DELTAJ+GAMMA)                                           FA015250
C.....VAPOR PRESSURE DEFICIT                                            FA015260
      EAMED=(EAVE-EDEW)                                                 FA015270
C.....KIMBERLY WIND FUNCTION   J.L.WRIGHT.1980  AT 2 METERS, U24@KM/DAY FA015280
C     MULTIPLY BY AN ADJUSTMENT FOR DIFFERENCES IN CONVERTING 12FT TO 2MFA015290
C     (.91892/.90237)                                                   FA015300
C     COEFFICIENTS FOR WIND FUNCTION....WRIGHT,1982                     FA015310
      D=JUL                                                             FA015320
      IF(JUL.LT.90)D=90.                                                FA015330
      IF(JUL.GT.315)D=315.                                              FA015340
C                                                                       FA015350
      AW=23.8 -  0.7865    *D    +  9.7182E-03*D**2 - 5.4589E-05*D**3   FA015360
     *         + 1.42529E-07*D**4 - 1.41018E-10*D**5                    FA015370
      BW=-0.0122+5.2956E-04*D    -  5.9923E-06*D**2 + 3.4002E-08*D**3   FA015380
     *         - 9.00872E-11*D**4 + 8.79179E-14*D**5                    FA015390
C                                                                       FA015400
      FU=  AW +( BW   *  U24    ) *0.91892/0.90237                      FA015410
C.....PENMAN   WIND FUNCTION   J.L.WRIGHT.1980  AT 2 METERS, U24@KM/DAY FA015420
      WFP=(1.+(0.01*U24/1.6093)*0.91892/0.91237)                        FA015430
C.....SEASONAL CORRECTION FACTOR FOR PENMAN (PENMAN USING WRIGHT-JENSEN FA015440
C                                            APPLICATION PROCEDURE)     FA015450
      FEPEN=0.7+0.4*EXP(-((((MON+DA/30.)*30.)-210.)/120.)**2)           FA015460
C.....EJLW ET ESTIMATE                                                  FA015470
      ETR=(W*(RN-G)+(1-W)*15.36*FU*EAMED)/HEATLT*10.                    FA015480
C     WRITE(6,60) RS,RSO,RB,RBO,RN,G,W,FU,EAMED,HEATLT,FEJLW            FA015490
   60 FORMAT(/,' RS=',F7.2,' RSO=',F7.2,' RB=',F7.2,' RBO=',F7.2,       FA015500
     *' RN=',F7.2,' G=',F7.2,/,' W=,'F7.2,' FU=',F7.2,' EAMED=',F7.2,   FA015510
     *' HEATLT=',F7.2,' FEJLW=',F9.4)                                   FA015520
C.....ORIGINAL PENMAN ESTIMATE                                          FA015530
      ETPEN=(W*(RN-G)+(1-W)*15.36*WFP*EAMED)/HEATLT*10.                 FA015540
C.....SEASONALLY CORRECTED PENMAN                                       FA015550
      CETR=ETR                                                          FA015560
      CETPEN=ETPEN*FEPEN                                                FA015570
C......TEMPORARILY WRITE OUT DIFFERENT VAPOR PRESSURES,ETC.             FA015580
C     WRITE(6,30) EMEAN,ED,EAVE,EDEW,DELTA,EAVJ,EDEWJ,DELTAJ            FA015590
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Example of Appendix E (on file with the Idaho Department of Water Resources) for Twin Falls WSO

Est. CU and CIR.   Twin Falls WSO   (Allen & Brockway,1983)   mm/day and mm/season

	MO	NYRS	PREC	ETR	ALFH.	ALFS.	BEANS	F.CRN	SILGE	S.CRN	PEAS	POTAT	SBEET	SGRAN	WGRAN	PAST.	ORCHD	VEGES	ONION
AVE ET	3	16	.99	1.95											.89				
AVE IR	3	16	100.00												.41				
STDD ET	3	16	.66	.35											.16				
STDD IR	3	16	100.00												.28				
SKEW ET	3	16	.34	.15											.15				
SKEW IR	3	16	100.00												-.76				
AVE ET	4	16	.93	4.18	2.60	2.95					1.26	1.25	1.25	1.28	3.82	2.61	1.71		1.25
AVE IR	4	16	100.00		2.05	2.38					.82	.88	.76	.85	3.27	2.08	1.21		.88
STDD ET	4	16	.66	.43	.27	.30					.13	.13	.13	.13	.40	.27	.18		.13
STDD IR	4	16	100.00		.54	.58					.39	.34	.42	.38	.64	.53	.45		.34
SKEW ET	4	16	.64	-.04	-.04	-.04					-.04	-.04	-.04	-.04	-.04	-.04	-.04		-.04
SKEW IR	4	16	100.00		.04	.05					-.08	-.04	-.10	-.07	.08	.04	-.03		-.04
AVE ET	5	17	.96	6.23	5.78	5.61	1.87	1.87	1.87	1.87	3.54	2.01	1.88	4.39	6.23	4.80	3.67	1.90	2.48
AVE IR	5	17	100.00		5.10	4.94	1.42	1.36	1.36	1.36	3.02	1.62	1.36	3.85	5.58	4.19	3.10	1.51	2.07
STDD ET	5	17	.71	.42	.39	.37	.12	.12	.12	.12	.24	.13	.13	.29	.42	.32	.24	.13	.17
STDD IR	5	17	100.00		.81	.80	.43	.47	.47	.47	.57	.40	.48	.63	.82	.71	.61	.39	.43
SKEW ET	5	17	1.18	-.05	-.05	-.05	-.05	-.05	-.05	-.05	-.06	-.05	-.05	-.05	-.05	-.05	-.05	-.05	-.06
SKEW IR	5	17	100.00		-.54	-.55	-.73	-.75	-.75	-.75	-.62	-.69	-.75	-.56	-.51	-.57	-.63	-.70	-.65
AVE ET	6	17	1.00	7.49	6.55	6.51	3.28	3.26	3.26	3.26	6.08	5.14	3.71	7.46	7.49	5.77	6.03	3.92	4.45
AVE IR	6	17	100.00		5.78	5.74	2.74	2.67	2.67	2.67	5.42	4.62	3.08	6.76	6.73	5.07	5.32	3.44	3.96
STDD ET	6	17	.73	.36	.32	.32	.16	.16	.16	.16	.30	.25	.18	.36	.36	.28	.29	.19	.22
STDD IR	6	17	100.00		.76	.76	.49	.53	.53	.53	.67	.54	.57	.75	.79	.69	.71	.47	.50
SKEW ET	6	17	.72	.64	.65	.63	.64	.64	.64	.64	.63	.64	.63	.64	.64	.63	.63	.64	.65
SKEW IR	6	17	100.00		-.54	-.54	-.61	-.62	-.62	-.62	-.53	-.51	-.61	-.48	-.50	-.55	-.55	-.57	-.54
AVE ET	7	17	.36	8.10	6.62	5.42	7.31	7.29	7.29	7.20	2.84	6.81	7.85	6.99	6.46	6.24	6.89	6.24	6.07
AVE IR	7	17	88.24		6.40	5.22	7.11	7.07	7.07	6.98	2.69	6.64	7.62	6.79	6.25	6.04	6.67	6.08	5.92
STDD ET	7	17	.36	.24	.20	.16	.22	.22	.22	.21	.08	.20	.23	.21	.19	.19	.20	.19	.18
STDD IR	7	17	88.24		.35	.31	.34	.36	.36	.36	.22	.30	.38	.33	.33	.33	.35	.28	.27
SKEW ET	7	17	1.72	.60	.58	.56	.59	.58	.58	.60	.60	.53	.60	.56	.57	.50	.56	.58	.58
SKEW IR	7	17	88.24		-1.38	-1.52	-1.10	-1.27	-1.27	-1.28	-1.81	-.93	-1.21	-1.13	-1.31	-1.37	-1.30	-.99	-1.03
AVE ET	8	17	.62	6.82	5.17	2.93	3.96	6.29	6.29	5.99		5.29	6.67	1.52	1.25	5.25	5.80	5.42	5.46
AVE IR	8	17	94.12		4.79	2.61	3.66	5.90	5.90	5.61		5.01	6.27	1.26	.98	4.89	5.42	5.14	5.17
STDD ET	8	17	.90	.36	.28	.16	.21	.34	.34	.32		.28	.36	.08	.07	.28	.31	.29	.29
STDD IR	8	17	94.12		.77	.61	.61	.83	.83	.81		.64	.88	.45	.47	.76	.80	.65	.65
SKEW ET	8	17	2.07	.04	.04	.04	.04	.04	.04	.04		.05	.04	.05	.05	.04	.03	.04	.04
SKEW IR	8	17	94.12		-1.71	-1.86	-1.73	-1.62	-1.62	-1.64		-1.55	-1.61	-1.94	-1.96	-1.68	-1.65	-1.53	-1.53
AVE ET	9	17	.68	5.21	3.52	1.48		3.90	3.90			3.05	4.47			4.01	4.37	3.55	4.14
AVE IR	9	17	94.12		3.11	1.13		3.50	3.50			2.76	4.05			3.61	3.96	3.25	3.83
STDD ET	9	17	.58	.47	.32	.13		.35	.35			.28	.41			.36	.40	.32	.38
STDD IR	9	17	94.12		.56	.39		.59	.59			.44	.64			.60	.63	.49	.54
SKEW ET	9	17	1.73	.12	.11	.11		.11	.11			.11	.12			.11	.11	.11	.11
SKEW IR	9	17	94.12		-.36	-.81		-.29	-.29			-.25	-.24			-.28	-.24	-.19	-.13
AVE ET	10	17	.71	3.34	1.20	.44		.93					2.15			2.57	2.20		
AVE IR	10	17	94.12		.85	.11		.60					1.79			2.20	1.85		
STDD ET	10	17	.64	.34	.12	.05		.09					.22			.26	.23		
STDD IR	10	17	94.12		.38	.34		.35					.45			.48	.45		
SKEW ET	10	17	1.78	.12	.12	.12		.13					.12			.12	.13		
SKEW IR	10	17	94.12		-.87	-1.30		-1.00					-.39			-.23	-.35		
AVE ET	SE	16	152.3	1324.	961.	775.	507.	722.	693.	566.	419.	721.	857.	663.	800.	955.	937.	645.	730.
AVE IR	SE	16	0.0	0.	861.	679.	463.	649.	632.	516.	366.	661.	766.	601.	713.	860.	844.	597.	670.
STDD ET	SE	16	48.4	32.	24.	20.	11.	19.	20.	13.	11.	17.	20.	14.	20.	23.	22.	18.	20.
STDD IR	SE	16	0.0	0.	56.	52.	25.	39.	40.	31.	35.	37.	47.	37.	50.	53.	51.	33.	39.
SKEW ET	SE	16	-.10	.19	.25	.29	-.26	.70	.54	-.03	.03	.29	.72	-.25	-.07	.27	.43	.43	.46
SKEW IR	SE	16			.75	.67	.27	.72	.50	-.02	.14	.74	.74	.76	.49	.65	.75	.57	.73