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STATE OF COLORADO

DEPARTMENT OF LAW

AGRICULTURAL ENGINEERING STUDY
SOUTHERN UTE & UTE MOUNTAIN
UTE INDIAN RESERVATIONS

TASK A REPORT
ON-FARM WATER REQUIREMENTS

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NET CROP WATER REQUIREMENTS

1.1 INTRODUCTION

1.1.1 Purpose and Scope

The purpose of this task is to identify a consumptive use methodology suitable for estimates of crop evapotranspiration in southwest Colorado. It includes a review and discussion of the more common predictive equations and sample calculations using measured and derived climatic data at a weather station in the project area. Mean data are used for all calculations except precipitation in which a 60 percent recurrence interval is used in effective precipitation calculations. Discussions of crop coefficients, yield and ET correction factors and other parameters affecting irrigation requirements are included. It does not include the determination of consumptive use for all crops at all locations for all methods.

1.1.2 Location and Climate

The study area is located in southwest Colorado on lands belonging to the Ute Mountain Ute and Southern Ute Indian Reservations. Approximately 1700 square miles of reservation land are in the project area. They are bordered on the west by the Utah state line and on the south by the New Mexico state line. They include portions of Montezuma, LaPlata and Archuleta Counties and lie south of the cities of Cortez, Durango and Pagosa Springs. Lands are in the

Colorado River drainage basin and range in elevation from about 4,800 feet to over 9,000 feet. Existing irrigated areas, however, are on lands within or adjacent to the river valleys lying at elevations between 5,500 and 7,500 feet.

Climatic data for this area are somewhat limited. U.S. Weather Bureau stations generally record only temperature and precipitation. Additional data have been collected, however, at the University of New Mexico Agricultural Experiment Station at Farmington and by other agencies in support of various projects. Table A-1.1 is a temperature and precipitation summary for several stations in the project area. Additional parameters are identified in the section on consumptive use calculations for the project area.

1.1.3 Definition of Terms

Consumptive use and evapotranspiration are used synonymously in this report. Definitions of the more common terms used in determining irrigation water requirements are contained in Appendix A-1.1.

1.2 CURRENT RESEARCH

Several agencies are conducting irrigation research in the four corners area. This section is a brief review of current research efforts in this area and a summary of the major published documents used in the preparation of this report.

COLORADO UTE - AGRICULTURAL ENGINEERING STUDY

NORMAL MONTH TEMPERATURE1/ AND PRECIPITATION2/
TABLE A-1.1

Station	Elevation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Cortez	6,177													
Temp.		27.7	32.7	38.1	47.2	56.3	64.6	71.8	69.8	62.2	51.3	38.1	29.4	49.1
Precip.		1.04	0.82	1.02	1.05	0.94	0.54	1.14	1.60	1.16	1.54	0.84	1.21	12.90
Mesa Verde	7,070													
Temp.		29.9	33.3	37.7	47.2	57.0	66.2	72.4	70.2	64.0	52.8	39.7	31.5	50.2
Precip.		1.74	1.47	1.57	1.36	0.99	0.71	1.77	2.13	1.28	1.82	1.12	1.86	17.82
Fort Lewis	7,600													
Temp.		23.1	25.2	30.8	40.0	49.1	57.6	64.4	62.2	55.4	45.7	33.6	24.5	42.5
Precip.		1.60	1.17	1.25	1.25	0.87	0.78	2.03	2.20	1.42	1.96	1.14	1.78	17.50
Durango	6,600													
Temp.		26.4	31.2	37.3	44.9	53.3	61.2	68.0	66.3	58.5	49.0	37.1	27.7	46.7
Precip.		1.64	1.02	1.41	1.23	0.92	0.75	1.84	2.66	1.49	2.22	1.37	2.14	18.69
Ignacio	6,424													
Temp.		23.8	28.7	35.3	44.3	53.0	61.5	68.4	66.2	58.4	48.6	35.6	26.4	46.3
Precip.		1.30	0.75	0.93	1.12	0.82	0.64	1.56	1.80	1.24	1.60	0.86	1.30	13.90
Aztec Ruins	5,644													
Temp.		29.0	34.4	41.3	50.2	58.6	67.2	73.8	71.9	64.7	53.6	39.2	31.1	51.3
Precip.		0.74	0.76	0.79	0.60	0.67	0.44	0.94	1.32	1.12	1.09	0.49	0.86	9.82

1/ Measured in degrees Farenheit.

2/ Measured in inches.

1.2.1 Navajo Indian Irrigation Project

The Navajo Indian Irrigation Project (NIIP) supplies irrigation water to over 100,000 acres of reservation land south of Farmington, New Mexico. Water is taken from the Navajo reservoir on the San Juan River and diverted through approximately 70 miles of open canals, siphons and tunnels to the project area. Peak diversion capacity to the project area is 1800 cfs. A consumptive use study on the NIIP was completed in September, 1983 by Brian Boman of the USBR.1/ His work consisted of three years of data collection (lysimeter, soil moisture and climatic data) and the calibration of Jensen-Haise and Penman reference ET equations. He also developed crop coefficient curves and water use production functions for the different crops. The modified Jensen-Haise equation developed for the NIIP is:

$$ETr = .015\ (T-21)\ Rs \qquad (1)$$

Where ETr is in inches per day, T is the average daily temperature in degrees F and Rs is solar radiation in langleys (ly). This equation is used for comparison in Section IV of this chapter. The water use production function for alfalfa at 12% moisture content is:

$$Y = 0.0 + .19\ ET\ (t/ac/in) \qquad (2)$$

This equation relates the crop evapotranspiration (ET) to the crop yield (Y) as discussed later in the section on consumptive use methodology.

1.2.2 Farmington Experiment Station

New Mexico State University and New Mexico Water Resources Research Institute (WRRI) have conducted a number of irrigation and water use related research projects at the San Juan Branch Agricultural Station in Farmington. Two major reports have been completed concerning consumptive use in that area.

"Consumptive Use and Yields of Crops in New Mexico" was published in 1979 and gives a water use production function for the state and identifies water requirements for five areas. Their results are supportive of the Blaney-Criddle formula as a method to estimate ET under average conditions. (Note Sammis et al used the original Blaney-Criddle formula with crop growth stage coefficients developed for New Mexico.) There appears to be a more direct and stable correlation between yield and consumptive use of alfalfa than for other crops. The use of locally calibrated crop production functions having high coefficients of determination appears to be a good method of estimating consumptive use provided reasonable estimates of yield can be determined for the area. A single water use production function for alfalfa at 0 percent moisture is recommended state wide. It has the form:

$$Y = -.896 + .147 \text{ ET (t/ac/in)} \qquad (3)$$

Converted to field dry weight at 12 percent moisture the equation has the form:

$$Y = -1.00 + .165 \text{ ET} \cdot \text{(t/ac/in)} \qquad (4)$$

A second WRRI research report was published in 1983 titled "Water Use

Production Functions of Selected Agronomic Crops in Northwestern New Mexico, Phase 3". Research is based upon lysimeter data and climatic measurements taken at the experiment station in Farmington. The experiment station is located approximately 4 miles from the NIIP project site. Evapotranspiration estimates and resulting water use production functions are generally higher than those developed in the NIIP report. An explanation of the higher evapotranspiration rates is that the Agricultural Experiment Station is surrounded by dry, fallow areas. The NIIP data are more representative of an irrigated area as the data reflects evapotranspiration rates that would occur in the center of large irrigated blocks of land. Separate production functions are developed for each year of project operation. The crop production function for alfalfa, adjusted to 12 percent moisture and converted to English units are:

$$1981: \quad Y = -3.16 + .208\ ET\ (t/ac/in) \tag{5}$$

and

$$1982: \quad Y = -8.85 + .360\ ET\ (t/ac/in) \tag{6}$$

1.2.3 Cortez Experiment Station

Colorado State University conducts irrigation research at the San Juan Basin Research Center in Cortez. Dr. Adrian Fisher provided general comments on crop consumptive use, however, research at the center is generally not related to consumptive use.

1.3 BASIC CONSUMPTIVE USE METHODOLOGY

1.3.1 General Approach

Consumptive use estimates can be made by directly measuring the water balance components of a crop through the equation:

$$ET = P + I - D \pm \Delta S \qquad (7)$$

in which ET is crop evapotranspiration, P is effective precipitation, I is irrigation, D is deep percolation, and ΔS is change in soil moisture. Water balance measurements using lysimeters can yield very accurate estimates of evapotranspiration at a given location, but are generally not suited to making project level estimates over a wide area.

Several indirect methods of estimating evapotranspiration have been developed by correlating meterological measurements with known rates of evapotranspiration. Such methods provide a "potential" or "reference crop" evapotranspiration rate which will be defined as ETp or ETo. For most purposes, an alfalfa based reference crop ET can be considered equivalent to ETp.

Crop coefficients (Kc) are used to relate potential or reference crop ET to crop ET (ET crop).

$$ET\ crop = Kc \times ETo \qquad (8)$$

or

$$ET\ crop = Kc \times ETp \qquad (9)$$

Crop coefficients reflect the evapotranspirational demand of the individual crop as affected by planting or growing date, growing season, growth and development characteristics, and cuttings or harvest intervals. Values have been determined for many crops and are given in tabular form, graphical form, or mathematical equations. More recently, basal crop coefficients have been developed which represent conditions when the soil surface is dry so that the evaporation component of ET is a minimum. Basal coefficients must be adjusted for surface soil wetness based upon the frequency of rainfall or irrigation.

Alfalfa crop coefficients developed for an arid region with an intermountain climate such as the project area are used in this report for all methods except the three FAO modified methods and the SCS Blaney-Criddle method 2/. The coefficients are shown in Table A-1.2. A mean alfalfa crop coefficient of 0.95 which reflects the cyclic effect of harvest on crop water use is recommended in an arid climate with light to moderate wind.3/ This coefficient is used in this report for the FAO methods with grass based reference crop.

Caution must be used in applying crop coefficients as they are not interchangeable to all methods. The user must be sure that the crop coefficients he intends to use are compatible with his reference crop methodology. Most crop coefficients in use today are based upon an alfalfa based reference; exceptions are the FAO modified methods (dicussed later in this section) which use a grass based reference and the SCS method which computes crop ET directly using a locally calibrated adjustment factor.

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CROP COEFFICIENTS
TABLE A-1.2

Daily Mean ET Crop Coefficients (K_c), 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, 1968-1978. From Wright (1981).

	Mean ET crop coefficients, K_c									
	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	0.98	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

Consumptive use methodologies have been developed in carefully controlled and monitored research plots. Evapotranspiration estimates produced by these methods reflect the research environment in which they were obtained. Actual ET expected in a commercial farming operation will likely be less due to growth suppression under hay windrows, infrequent and/or non-uniform irrigation, and soil variability 4/, 5/. Correction factors may be applied to compensate for these effects, however, caution must be exercised in their use to assure their applicability to the given project. Correction factors are discussed further under "Application to Project Area".

Water use production functions, or yield-evapotranspiration relationships have been developed for various crops in many areas. They relate the productivity of a given crop to the ET rate. Most annual crops show a very weak correlation between ET and yield. Alfalfa, however, shows a strong linear correlation in most areas, and calibrated production functions of the form:

$$Y = a + b \times ET \tag{10}$$

can fit data with high coefficients of determination. Figure A-1.1 is the recommended production function for alfalfa on the NIIP.

Production functions may provide an alternate method of determining crop ET in certain areas 6/. Known or expected yields in a given area can be used in the production function to determine the seasonal consumptive use. A comparison of various production functions

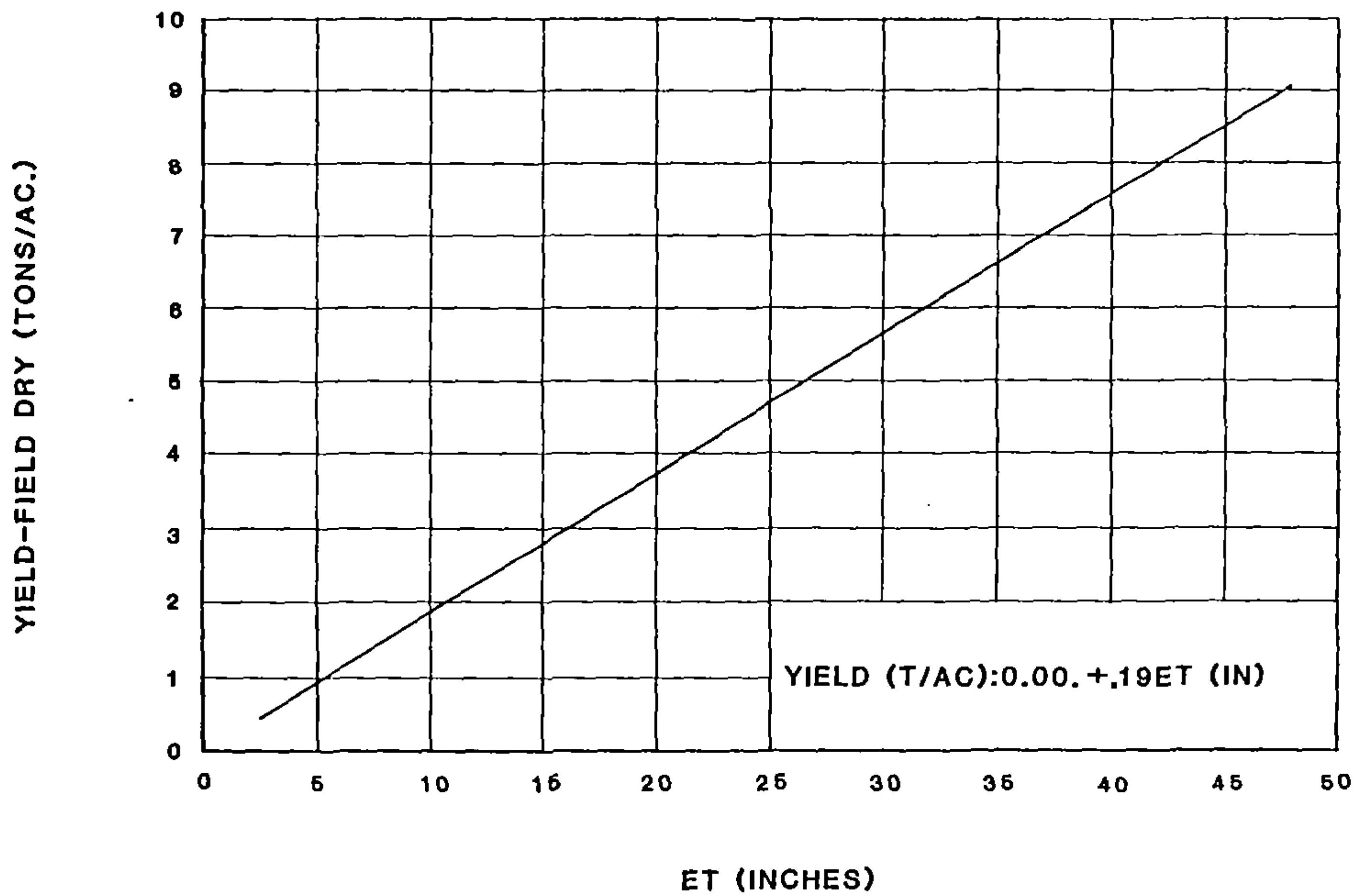

FIGURE A-1.1 -ALFALFA CROP PRODUCTION FUNCTION, FARMINGTON NIIP developed in this area is presented later in this chapter.

Once the crop consumptive use is established, the irrigation requirement can be determined. The irrigation requirement is crop ET as modified by soil carry over moisture, effective precipitation, and leaching requirements.

Carry over moisture is soil moisture stored in the root zone of the crop as supplied by winter precipitation. It is available to meet crop ET in the spring when it starts growing, so is subtracted from the irrigation requirement.

Effective precipitation is rainfall occurring during the growing season that is effective in meeting crop ET. Rainfall effectiveness is influenced by several factors including crop and soil properties, irrigation practices, and precipitation patterns. In general, frequent light rains intercepted by plant foilage with full ground cover are more effective than infrequent heavy rains. Effectiveness ranges from less than 60 percent to 100 percent.

Leaching requirements are additions to the irrigation requirement and are needed to leach soluble salts below the root zone. Salts are concentrated in the root zone by an osmotic process in which the roots act as a semipermeable membrane. If left to accumulate they may become toxic to the crop and result in reduced yields. As identified elsewhere in this report, the leaching requirement for all crops is met by winter precipitation and irrigation water applied in excess of field capacity.

1.3.2 Review of Evapotranspiration Methods

Methods for predicting evapotranspiration can be broadly classified by the climatic variables used in their calculation. These are temperature, radiation, and combination methods. Radiation methods use temperature and solar radiation while combination methods add an advective energy transfer term to the radiation term. Temperature methods considered in this review are the SCS modified Blaney-Criddle method 7/ and FAO modified Blaney-Criddle method 3/. Radiation methods considered in this review are the FAO modified radiation method 3/,and four versions of the Jensen-Haise method. These include the standard Jensen-Haise with and without elevation correction 8/,and two modified Jensen-Haise equations calibrated for conditions in northeast Utah, and the NIIP. The only combination method considered is the FAO modified Penman equation 8/.

1.3.3 Temperature Methods

Temperature methods are the simplest and easiest to use of the various ET prediction methods. The Blaney-Criddle formula is the most popular of the temperature methods. The original form of the equation as developed and later modified by H. F. Blaney and W. D. Criddle in 1950 is not commonly used today. The Soil Conservation Service version and the Food and Agriculture Organization of the United Nations version are the most popular.

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SCS Modified Blaney-Criddle

General form of the consumptive use equation is:

$$ET\ crop = Kc \times Kt \times t \times p \times .01 \qquad (11)$$

in which:

ET crop is monthly crop consumptive use or ET in inches,

Kc is a monthly crop growth stage coefficient,

Kt is a climatic coefficient related to the mean air temperature ($Kt = 0.0173\,t - .314$),

t is mean monthly air temperature in degrees F, and

p is monthly percentage of daylight hours in the year.

Crop ET is computed directly without the use of a reference ET or crop coefficients. Crop factors influencing ET are incorporated in Kc. Crop growth stage coefficients for a number of crops are presented in graphical form in 7/. These coefficients are not universally adaptable, however, they represent a starting point when other data are not available.

FAO Modified Blaney-Criddle

Reference crop ET is calculated by the equation:

$$ETp = c\ [p\,(.46T + 8)] \qquad (12)$$

in which:

ETp is monthly grass reference crop ET in mm/day,

T is mean daily temperature in degrees C over the month considered,

p is mean daily percent of total annual daytime hours for a given month and latitude, and

c is an adjustment factor relating to minimum relative humidity, sunshine hours, and daytime wind.

Estimates of ETp made with the above equation should be increased 10 percent for each 1000 meters altitude above sea level in arid and semi-arid areas. Crop coefficients must be based upon grass reference crops.

1.3.4 Radiation Methods

Several solar radiation-based methods have been developed. The Jensen-Haise and FAO modified radiation methods, however, are the most commonly used. They are popular because they are generally more reliable than the temperature methods without having the complexity or data requirements of the combination methods.

Jensen-Haise

M. E. Jensen and H. R. Haise 9/ evaluated 3000 observations of ET as determined by soil sampling procedures over a 35-year period. From these data they developed the following linear equation for potential ET:

$$ETp = Ct\ (T-Tx)Rs \times 0.000673 \quad 10/ \qquad (13)$$

in which:

ETp is potential evapotranspiration for a well watered crop of alfalfa with 30-50 cm of top growth in in/day,

T is average daily temperature, degrees F,

Tx is the intercept of the temperature axis ($Tx = 2.5 - 0.14\ (e_2-e_1) - elev/550$), with elevation in meters, and

Rs is global solar radiation in langleys/day (multiplied by .000673 to obtain in/day).

2479 Ct was later defined as:11/

$$Ct = 1/(C_1 + C_2\ Ch)$$

where $Ch = 50\ mb/(e2-e1)$,
$C2 = 7.6$ degrees c,
and $C1 = 38 - (2.0 \times elev/305)$

e2 and e1 are the saturation vapor pressures in millibars at the mean maximum and mean minimum temperatures for the warmest month of the year in a given area.

Crop ET is obtained by application of suitable alfalfa based crop factors.

The equation may be used with or without the elevation correction (elev. = 0.0). Caution should be exercised in the use of Ct and Tx with full elevation correction for elevations above 4500 feet 5/. Evidence exists from field studies which indicate Jensen-Haise may over predict ET at these elevations. Jensen-Haise may under predict ET under very windy conditions.

Jensen-Haise equations are frequently modified or calibrated for specific geographic areas. Two of these locally calibrated equations are used for comparison in this report. Equation (14) was developed for use in northeast Utah and provided by Dr. Robert Hill at Utah State University:

$$ETo = 0.009 \times T\ (\text{degrees F}) \times Rs \times 0.000673 \quad (14)$$

and Equation (15) was developed for the NIIP:

$$ETo = 0.15 \times [T(\text{degrees F})-14] \times RS \times 0.000673\ (ly) \quad (15)$$

Equations 14 and 15 provided very similar estimates of reference crop ET in the example calculations found later in this section.

FAO Radiation

The FAO Radiation method is an adaptation of earlier work by G. F. Makkink 3/. Air temperature, sunshine, and cloudiness or radiation data are required along with general levels of humidity and wind. The recommended relationship is:

$$ETp = c\ (W \times Rs) \qquad (16)$$

in which:

ETp is grass based reference crop ET in mm/day,

Rs is solar radiation in equivalent evaporation in mm/day,

W is a weighting factor depending on temperature and altitude, and

c is an adjustment factor depending on mean relative humidity and daytime wind.

Tables and graphical solutions are presented in the original document to determine adjustment factors. More recently, polynomial equations have been developed to speed calculation of coefficients for all FAO methods using hand calculators or programmable computers 12/. Equations are given in Appendix A-1.2 for each method.

1.3.5 Combination Methods

The Penman equation is by far the most commonly used of the combination methods. "Combination" refers to the two components, net radiation and advective energy. It has the most extensive data requirements of all the methods, but is capable of the most accurate

ET estimates when calibrated to a given area and crop. The form used in this study is the FAO modified Penman method as presented in 3/:

$$ETo = c\ [W \times Rn + (1-W) \times F(u) \times (ea-ed)] \quad (17)$$

in which:

ETo is grass reference crop ET in mm/day,

W is a temperature related weighting factor,

Rn is net radiation in equivalent evaporation in mm/day,

F(u) is a wind function in which,
$F(u) = 0.27\ (1 + U/100)$

Where U is 24 hr. wind run in km/day at 2 m height,

(ea-ed) is the difference between the saturation vapor pressure at mean air temperature and the mean actual vapor pressure of the air in mb, and

c is an adjustment factor to compensate for the effect of day and night weather conditions.

Tables and formulas are needed for calculation of most terms in equation (17). Additional information on the calculation of the individual terms in each equation is given in the section on sample project calculations. To obtain the c factor, it is necessary to interpolate between relative humidity, solar radiation, wind speed, and day/night wind ratios. This difficult interpolation can be facilitated by use of the equations in Appendix A-1.2.

1.3.6 General Comparison of Methods

Equations vary greatly in the amount of data required, ease of computation, and accuracy of the predicted results. Table A-1.3 compares the different methods discussed above, and Figure A-1.2

COMPARISON OF EQUATIONS USED FOR ESTIMATING
EVAPOTRANSPIRATION, ADAPTED FROM USBR (1983)
TABLE A-1.3

Name	Crop Condition Referenced	Original Calibration	Data Required	Minimum Usable Time Increment	Minimum Intended Time Increment
SCS Modified Blaney-Criddle	N/A	Field sampling of soil moisture, avg. for a number of sites throughout U.S.	Monthly avg. temperature	1 month 1/	1 month
FAO Blaney-Criddle	Clipped grass	Lysimeter(grass) at Davis, Calif.	Daily to monthly avg. temp.2/	Daily to monthly	1 month
Jensen-Haise	Alfalfa, 30- to 50-cm growth	Lysimeter(alfalfa) & field soil moisture data, western U.S.	Daily avg. temp. & daily solar radiation	Daily	5- to 10-day sums
FAO radiation	Clipped grass	Lysimeter(grass) at Davis, Calif.	Daily avg. temp. & daily solar radiation2/	Daily	10- to 30-day sums
FAO Modified Penman	Varies from alfalfa to short grass; depends on parameter values	Lysimeters(grass) at Davis, Calif.	Daily: max. & min. temp.,avg. dewpt., total wind travel, solar radiation	Daily	10- to 30-day sums

1/ Originally developed for annual estimates.

2/ Additional data such as humidity, percent sunshine, and wind also required although longer time interval is allowed.

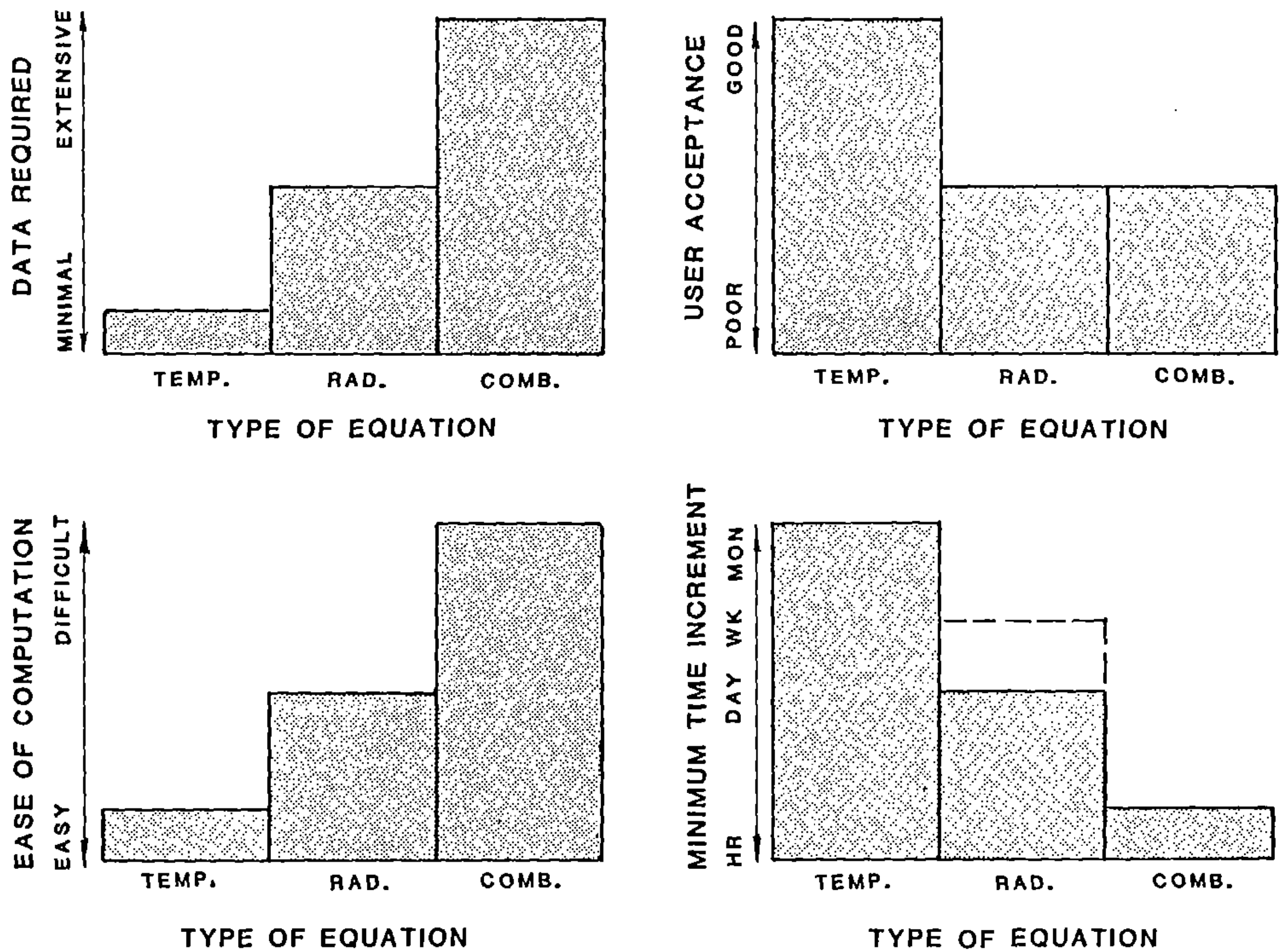

FIGURE A-1.2 - COMPARISON OF METHODS FOR ESTIMATING ET (USBR,1983)

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illustrates the strengths and weaknesses of each type of equation.

Temperature based methods require the least amount of data, are easiest to use, and thus have the greatest general acceptance. Combination equations more accurately reflect the climatic variables driving evapotranspiration processes and thus are more likely to give satisfactory results when applied to an unknown area. They are preferred for estimates over short time periods, daily to weekly. For longer time intervals and seasonal project-level water use estimates, the simpler methods may perform as well as the more complicated methods. Use of temperature-radiation and combination methods should not necessarily be rejected, however, because of insufficient data. In many cases data can be estimated or interpolated for the project area with good results.

Selection of an appropriate method for evapotranspiration estimates is as much a matter of engineering judgement as data availability. Factors to be considered in method selection include the following:

- Intended use of evapotranspiration estimates
- Desired time increment for computation
- Data availability
- Performance of the various methods in areas with similar climates, latitudes and elevations
- General acceptance of the equations
- Availability of research data, lysimeter studies, or calibrated equations in the project area

- Availability of crop coefficients for the method and area
- Knowledge of expected ET levels based upon local information or water use production functions

Alfalfa evapotranspiration estimates were made for several areas in the western United States using seven different equations 4/. For a general comparison, their data are reproduced in Table A-1.4.

1.4 APPLICATION TO PROJECT AREA

1.4.1 General

The 8 methods described are applied to the Fort Lewis area for comparative purposes. Data which were not available from the Fort Lewis weather station were estimated using data from other stations in southwest Colorado or Farmington, New Mexico. Comparisons cannot be made on a reference crop basis unless all methods use the same reference crop (alfalfa or grass). For this reason, appropriate crop factors are applied to use for purposes of alfalfa comparison.

Assumptions have been made for several factors impacting consumptive use. These factors do not generally affect the utility of their application for comparative purposes and selection of appropriate methodology. Some of these assumptions include the following:

o The growing season is assumed to extend from the first of May to the middle of October, and the irrigation season is assumed to

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SEASONAL TOTALS, CALCULATED ALFALFA ET (INCHES), FROM E.L. JOHNS ET AL. (1983)
TABLE A-1.4

City, State, dates	Jensen-Haise: Zero El.	Jensen-Haise: El correction	Penman Combination Kimberly ID: No wind limit	Penman Combination Kimberly ID: Wind limit	Blaney-Criddle SCS-TR21: Sum of monthly	FAO I&D paper 24: BL-CR	FAO I&D paper 24: Radi-tion
Grand Junction, CO, El. 4590 ft, 1978-1980 avg	26.7	36.1	32.6	31.7	28.0	33.9	39.4
Las Cruces, NM El. 3900 ft, 1978-1980 avg.	33.4	42.7	42.1	39.3	40.3	47.4	47.4
Fallon, NV, El. 3965 ft, 1973-1978 avg.	32.1	42.0	35.0	34.5	31.3	45.3	48.3
Farmington, NM, El. 5652 ft, 1980-1981 avg.	28.0	40.9	36.9	34.9	28.7	41.0	42.6
Bushland, TX. El. 3840 ft, 1970-1975 avg.	31.0	39.5	48.6	38.3	35.5	48.6	47.7
Kimberly, ID, El. 3922 ft, 1969-1975 avg.	25.4	33.0	40.3	35.8	27.5	43.9	44.8
Logan, UT, El. 4500 ft, April 1-September 15, 1977	22.3	30.1	26.4	26.1	27.3	35.5	35.1
Huntington, UT, El. 6300 ft, April 23-September 13, 1979	22.4	34.0	30.5	29.2	26.7	38.4	38.0
Flowell, UT, El. 4702 ft, April 1-October 31, 1980	28.2	38.7	40.3	37.4	33.0	48.8	43.0
Oakes, ND, El. 1318 ft, 1973-1977 avg.	17.0	18.4	25.0	23.4	24.8	28.6	27.4

coincide with the growing season. Irrigation seasons and practices were determined for each climatic area to calculate crop water use.

- Three full cuttings of alfalfa can be obtained, one at the end of June, one in mid-August, and one at the end of September. The third cutting in southwest Colorado is generally a "short" cutting, occurring before full regrowth has occurred and results in reduced yield and ET.

- Solar radiation as calibrated by the Bureau of Reclamation for Cortez is similar to that in the project area.

- Assumes a well watered crop.

Other assumptions affecting consumptive use are identified for the individual methods.

1.4.2 Sample Project Calculations

Temperature Methods:

SCS Modified Blaney-Criddle

Table A-1.5 is a summary of calculation procedures for monthly estimates of ET by the SCS modified Blaney-Criddle method using equation (11). Crop ET is calculated directly using crop growth stage coefficient curves as the one shown in Figure A-1.3 7/. Growing season for alfalfa is identified in TR-21 as date of 50

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CALCULATION SUMMARY, SCS MODIFIED BLANEY CRIDDLE1/
ALFALFA AT FORT LEWIS
TABLE A-1.5

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T, degress F	49.1	57.6	64.4	62.2	55.4	45.7	
P (% yearly daylight)	9.85	9.89	10.05	9.44	8.37	7.83	
f 2/	4.84	5.70	6.47	5.87	4.64	3.58	
Kt 3/	.535	.682	.800	.762	.644	.477	
Kc(Growth coefficient)	1.08	1.13	1.11	1.06	.99	.91	
K=Kt x Kc	.578	.771	.888	.808	.638	.434	
ET = Kxf (in/mo)	2.8	4.4	5.7	4.7	3.0	1.0 4/	21.6

Growing Season
← ------------------------------------ →
Δ Δ Δ

1/ ET = Kt x Kc x f

2/ $f = \frac{T \times P}{100}$

3/ Kt = 0.0173 T - 0.314

4/ ET for first two weeks.

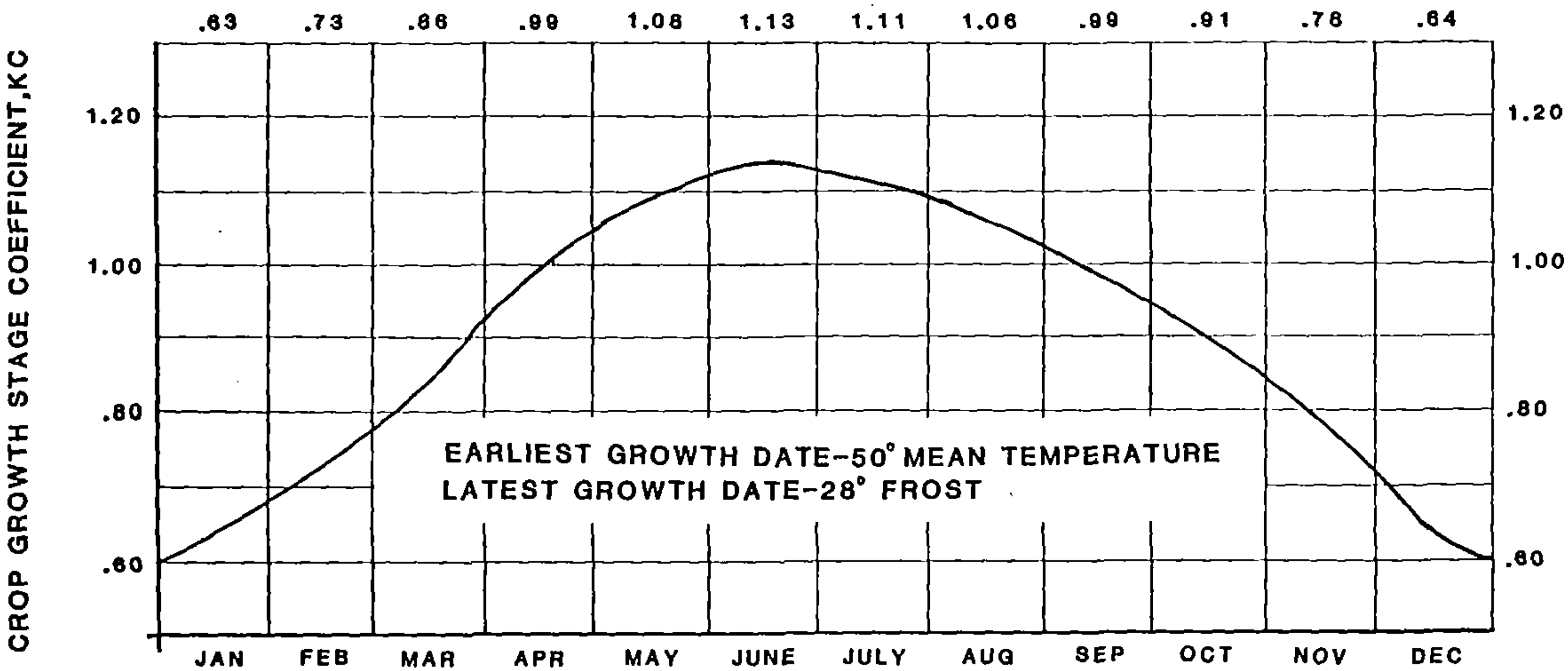

FIGURE A-1.3 CROP GROWTH STAGE COEFFICIENT CURVE FOR ALFALFA , SCS TR-21
(MODIFIED BLANEY CRIDDLE)

degrees mean temperature to 28 degrees frost. These dates coincide fairly well with the assumed May through mid-October growing season.

Kt values are calculated by:

$$Kt = 0.0173\ t - .314 \tag{18}$$

and p values are taken from Table 1 in TR-21. Seasonal consumptive use for alfalfa using this method is 21.6 inches.

FAO Modified Blaney-Criddle

Table A-1.6 is a summary of calculation procedures for monthly estimates of ET by the FAO Modified Blaney-Criddle method using equation (12). Mean daily percentage of annual daytime hours (p) is taken from Table 1 in FAO-24. "c" values can be taken from Figure 1 with a general knowledge of minimum relative humidity, actual and maximum possible sunshine hours, and daytime wind conditions. The procedure involves graphical interpolation in 3 dimensions and can be simplied (and calculated more accurately) through the use of the regression polynomial in Appendix A-1.2.

Mean crop factor for alfalfa for all FAO methods is 0.95 based on a grass reference crop. This gives a total May through October ET of 32.4 inches. These figures are increased 10 percent for each 1000 meters of elevation above sea level.3/ Elevation of the Fort Lewis station is 7600 foot or 2316 meters. An approximate increase of 20% is applied to the data to obtain a total seasonal ET of 37.5 inches.

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CALCULATION SUMMARY, FAO MODIFIED BLANEY CRIDDLE1/
ALFALFA AT FORT LEWIS
TABLE A-1.6

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T, degrees C	9.5	14.2	18.0	16.8	13.0	7.6	
P(% yearly daylight)	.315	.330	.325	.305	.280	.250	
F 2/	3.90	4.80	5.29	4.80	3.91	2.87	
RHmin 3/	.22	.22	.23	.22	.27	.24	
Uday 4/ (m/s)	3.8	3.3	3.0	2.8	2.7	2.7	
n/N 5/	.71	.78	.77	.74	.79	.77	
ETo mm/day	4.20	5.75	6.38	5.49	4.02	2.42	
ETo in/mo	5.18	6.79	7.79	6.70	4.75	2.95	
ETcrop 7/ (in/mo)	5.8	7.7	8.9	7.6	5.4	1.9 6/	37.3

Growing Season

←--------------------------------→

Δ Δ Δ

1/ ETp = C[P(0.46 x T)+ 8]

2/ P (0.46 x T + 8)

3/ Grand Junction, 5 p.m.

4/ Wind, FAO Penman Method (Farmington).

5/ Ratio, actual to maximum possible sunshine hours.

6/ ET for first two weeks in October.

7/ Includes crop coefficient of 0.95 and 20% increase in elevation.

Radiation Methods:

Jensen-Haise With Elevation Correction

Table A-1.7 is a summary of calculation procedures for monthly estimates of ET by the Jensen-Haise method using equation (13) with the full elevation correction. Solar radiation data were taken from the Bureau's Animas-LaPlata report. They were obtained by correlating measured solar radiation at Grand Junction and Cortez.

Cumulative potential ET (synonymous with alfalfa reference ET) is 38.4 inches. Mean crop coefficients are derived from Table A-1.2 assuming cuttings at the end of June, mid-August, and at the end of September. Seasonal mean Kc value is .86 and seasonal consumptive use is 33.0 inches.

Jensen-Haise Without Elevation Correction

The Jensen-Haise method with full elevation correction must be used with caution at elevations above 4500 feet due to its tendency to over-predict ET in certain surroundings.5/ The elevation correction is omitted (set to zero) in this calculation for comparison with the fully corrected version. Calculation procedures are identical. Results are shown at the bottom of Table A-1.7. Seasonal reference crop ET is 23.0 inches and crop ET is 19.7 inches.

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CALCULATION SUMMARY, JENSEN HAISE WITH ALTITUDE CORRECTION 1/
ALFALFA AT FORT LEWIS
TABLE A-1.7

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T max, deg. C	18.6	24.1	27.1	25.4	22.0	16.2	
T min, deg. C	0.4	4.3	8.9	8.1	4.0	-1.0	
T mean, deg. C	9.5	14.2	18.0	16.8	13.0	7.6	
e2 (mb)			35.8				
e1 (mb)			11.4				
e2 - e1			24.4				
CH 2/	2.05	2.05	2.05	2.05	2.05	2.05	
C2 deg. C 4/	7.6	7.6	7.6	7.6	7.5	7.6	
C1 3/	22.8	22.8	22.8	22.8	22.8	22.8	
CT 5/	.0261	.0261	.0261	.0261	.0261	.0261	
Tx, deg. C 6/	-10.13	-10.13	-10.13	-10.13	-10.13	-10.13	
Rs 7/, ly	564	624	599	526	459	342	
ETp ly/day	289	396	440	370	277	158	
ETp in/mo	6.0	8.0	9.2	7.7	5.6	1.9 8/	38.4
Kc (mean)	0.88	0.97	0.81	0.76	0.97	0.57	0.86
ETcrop (in/mo) w/alt.correction	5.3	7.8	7.5	5.9	5.4	1.1	33.0
ETcrop w/o alt. correction	3.0	4.7	4.6	3.6	3.2	0.6	19.7

Growing Season

Table A-1.7, continued

1/ ETp = Ct (T-Tx) Rs x 0.000673

2/ CH = 50/(e2-31)

3/ C1 = 38-(2.0 x elev/305), elev.at Ft. Lewis = 2316 meters.

4/ C2 = 7.6 deg. C.

5/ CT = 1/(C1 + C2 x CH)

6/ TX = (-2.5 - (0.14 x (e2 -el) - elev/550)

7/ Data from USBR Animas-LaPlata Project report.

8/ Potential ET for first two weeks in October.

Jensen-Haise, Northeast Utah

Table A-1.8 is a summary of calculation procedures for monthly ET using Dr. Hill's equation for elevations above 4000 feet in northeast Utah. Certain variables in equation (14) have been determined for that area and combined into a single constant to obtain a local calibration for the method. Calculation is straight forward. Total reference crop ET is 31.4 inches. Crop coefficients are as defined before (.86 annual mean), and seasonal consumptive use is 27.0 inches.

Jensen-Haise, Farmington

Table A-1.9 is a summary of calculation procedures for monthly ET using the modified Jensen-Haise method developed for the NIIP in Farmington using equation (15).

Equation (15) is a modification or calibration of Jensen-Haise for this area. The form of this equation is slightly different from that calibrated for northeast Utah (Eq. 14), but the results are similar. Total alfalfa reference crop ET is 33.2 inches and seasonal consumptive use is 28.4 inches using the mean crop coefficients described previously.

FAO Radiation

Table A-1.10 is a summary of calculation procedures for the FAO Radiation method using equation (16). Rs in langleys is converted to equivalent evaporation of water in mm per day using the latent heat

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CALCULATION SUMMARY, N.E. UTAH MODIFIED JENSEN-HAISE
ALFALFA AT FORT LEWIS
TABLE A-1.8

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T, deg. F	49.1	57.6	64.4	62.2	55.4	45.7	
Rs (ly)	564	624	599	526	459	342	
ETo (in) 1/	5.20	6.53	7.24	6.14	4.62	1.68 2/	31.41
kc (mean)	0.88	0.97	0.81	0.76	0.97	0.57	0.86
ET crop (in/mo)	4.6	6.3	5.9	4.7	4.5	1.0	27.0

Growing Season

← --- →

Δ Δ Δ

1/ ETo = .009 * T * Rs * .000673 in/day

2/ ET for first 2 weeks in October.

Δ Denotes a cutting.

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CALCULATION SUMMARY, NIIP MODIFIED JENSEN-HAISE
ALFALFA AT FORT LEWIS
TABLE A-1.9

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T, deg. F	49.1	57.6	64.4	62.2	55.4	45.7	
Rs (ly)	564	624	599	526	459	342	
days	31	30	31	31	30	31	
ETo (in) 1/	4.96	6.92	8.14	6.78	4.78	1.59 2/	33.17
kc (mean)	0.88	0.97	0.81	0.76	0.97	0.57	0.86
ET crop (in/mo)	4.4	6.7	6.6	5.2	4.6	0.9	28.4
Elevation correction	3.4	5.5	7.1	5.8	3.6	1.1	26.4

Growing Season

← ---------------------------------- →

Δ Δ Δ

1/ ETo = .015 (T-21) RS x .000673 in/day

2/ ET for first 2 weeks in October.

Δ Denotes a cutting.

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CALCULATION SUMMARY, FAO MODIFIED RADIATION METHOD1/
ALFALFA AT FORT LEWIS
TABLE A-1.10

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T, deg. C	9.5	14.2	18.0	16.8	13.0	7.6	
Rs (ly)	564	624	599	526	459	342	
Rs (mm/day)	9.6	10.7	10.2	9.0	7.8	5.8	
W	.61	.67	.72	.71	.66	.58	
U day 2/ (m/s @ 2m)	3.8	3.3	3.0	2.8	2.7	2.6	
RH mean 3/	35	36	37	37	42	37	
B 4/	1.11	1.09	1.08	1.07	1.05	1.07	
ETp mm/day 1/	6.2	7.5	7.6	6.5	5.1	3.3	
ETp in/mo	7.6	8.9	9.3	8.0	6.0	2.3 5/	42.1
ET crop 6/	7.2	8.5	8.8	7.6	5.7	2.2	40.0

Growing Season

←------------------------------→

Δ Δ Δ

1/ ETp = C (W x Rs), See Doorenbos and Pruitt, 1977, Page 8.

2/ Farmington data.

3/ Grand Junction data.

4/ See Appendix B.

5/ ET for first 2 weeks in October.

6/ Using mean Kc of 0.95.

of vaporization of water. Values of the weighting factor, W, for the effect of altitude and temperature on ET were taken from Table 4 in Doorenbos and Pruitt 3/. The adjustment factor, c, for the effect of mean relative humidity and daytime wind speed on ET was calculated by the regression equation given by Frevert, Appendix A-1.2.12/ Mean wind data are taken from Farmington 1/, and mean relative humidity is taken from Grand Junction. May through October reference crop ET is 42.1 inches and seasonal alfalfa water use using a mean crop coefficient of 0.95 is 40.0 inches.

Combination Methods:

FAO Modified Penman

Table A-1.11 is a summary of calculation procedures for the FAO modified Penman method using equation (17). The weighting factor, W, for the effect of temperature and altitude on ET is identical to that used in the FAO Radiation method. Net radiation, Rn, is calculated from average Cortez solar radiation as given by the USBR in the Animas-LaPlata report assuming a crop albedo of .25 and using Tables 13-15 in FAO-24 to calculate net longwave radiation. The wind function, f(u), is calculated using Farmington wind data. Saturation vapor pressure deficit, ea-ed, is calculated using Farmington dew point temperatures to obtain mean actual vapor pressure. Calculation of the adjustment factor, c, requires interpolation in 4 dimensions in Table 16 of FAO-24 by maximum relative humidity, solar radiation, daytime wind, and day/night wind ratios. This difficult interpolation was simplified by use of the

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CALCULATION SUMMARY, FAO MODIFIED PENMAN METHOD
ALFALFA AT FORT LEWIS
TABLE A-1.11

	MAY	JUN	JUL	AUG	SEP	OCT	SEASON
T, deg. C	9.5	14.2	18.0	16.8	13.0	7.6	
Tdp, deg. C	2.8	6.7	11.7	10.6	7.2	0.0	
ea, mb	11.9	16.2	20.6	19.1	15.0	10.5	
ed, mb	7.48	9.83	13.8	12.8	10.2	6.12	
ea-ed, mb	4.42	6.37	6.8	6.3	4.8	4.38	
Wind 1/ km/day	246	217	195	180	177	169	
F (u)	.934	.856	.797	.756	.748	.726	
(1-w)	.39	.33	.28	.29	.34	.42	
w	.61	.67	.72	.71	.66	.58	
Rs (ly)	564	624	599	526	459	342	
Rs (mm/day)	9.64	10.67	10.24	8.99	7.85	5.85	
Rns (mm/d) α =.25	7.23	8.00	7.68	6.74	5.88	4.38	
f (t)	12.6	13.5	14.2	14.0	13.3	12.3	
f (ed)	.220	.202	.177	.183	.199	.231	
n/N 2/	.71	.78	.77	.74	.49	.77	
f (n/N)	.739	.802	.793	.766	.811	.793	
Rnl (mm/d)	2.05	2.19	1.99	1.96	2.15	2.25	
Rn = Rns - Rnl	5.18	5.81	5.69	4.78	3.73	2.13	
Mean U day (m/s)	3.8	3.3	3.0	2.8	2.7	2.6	
RH max 2/	48	49	51	51	56	59	
C 3/	.91	.95	.96	.93	.92	.86	
ETo mm/day	4.34	5.41	5.39	4.44	3.39	2.21	
ETo in/mo	5.30	6.39	6.58	5.42	4.00	1.51 4/	29.2
ET crop (kc=.95)	5.0	6.1	6.3	5.1	3.8	1.4	27.7

Growing Season

← ----------------------------- →

Δ Δ Δ

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Table A-1.11, Continued

1/ Farmington.

2/ Grand Junction.

3/ See Appendix A-1.2.

4/ ET for first 2 weeks in October.

regression equation presented in Appendix A-1.2.2/

Seasonal gross reference crop ET is 29.2 inches. Seasonal alfalfa ET using a mean crop coefficient of 0.95 is 27.7 inches.

1.4.3 Comparison of Methods

Consumptive use estimates are compared for each equation, various crop production functions, and the Colorado Irrigation Guide. The Irrigation Guide is published by the SCS and provides monthly consumptive use estimates for several crops in three climatic zones in the project area using the SCS modified Blaney-Criddle method. Table A-1.12 is a summary of consumptive use estimates by all methods.

In addition to the crop production functions identified previously, two functions developed for Farmington and Grand Junction are included in Table A-1.12.4/ Production functions for each location have identical coefficients and so are included only once:

$$Y = 0.0 + .168\ ET\ (t/ac/in) \qquad (19)$$

Production functions presented in the literature have varying units and moisture contents. All functions in Table A-1.12 have been converted to tons per acre per inch ET at 12 percent moisture content.

Crop production functions are solved for ET assuming an average annual yield of 4.0 t/ac. Average yields at the Cortez Experiment Station with optimum irrigation water management are between 4.5 and

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SUMMARY OF ALL METHODS, HARVESTED ALFALFA AT FORT LEWIS
TABLE A-1.12

Method	APR	MAY	JUN	JUL	AUG	SEP	OCT	Season	Corr. Factor	Expected C.U.
SCS Mod. B-C		2.8	4.4	5.7	4.7	3.0	1.0	21.6	1.14	24.6
FAO Mod. B-C		5.8	7.7	8.9	7.6	5.1	1.9	37.3	.87	32.5
Jensen-Haise (elev)		5.3	7.8	7.5	5.9	5.4	1.1	33.0	.84	27.7
Jensen-Haise (O)		3.0	4.7	4.6	3.6	3.2	0.6	19.7	1.19	23.4
Jensen-Haise (Utah)		4.6	6.3	5.9	4.7	4.5	1.0	27.0	--	27.0
Jensen-Haise (NIIP)		4.4	6.7	6.6	5.2	4.6	0.9	28.4	--	28.4
FAO Mod. Radiation		7.2	8.5	8.8	7.6	5.7	2.2	40.0	.79	31.6
FAO Mod. Penman		5.0	6.1	6.3	5.1	3.8	1.4	27.7	.83	23.0
Colo.Irrig.Guide 1/	1.13	2.80	4.79	5.83	4.89	3.04	1.10	23.6	--	23.6
Equation Mean										26.9
Production Function Equations 2/										
New Mexico (4)								30.3	--	30.3
Farmington (5)								34.4	--	34.4
Farmington (6)								35.7	--	35.7
Farmington (2)								21.1	--	21.1
Farmington-Grand Junction (19)								23.8	--	23.8
Production Function Mean 3/										27.6

1/ Monte Vista, Zone 6.
2/ Seasonal water requirements @ 4.0 t/ac. field dry @ 12% moisture.
3/ Equations 5 and 6 are combined and considered as a single value.

5 tons per acre. Average commerical yields in this area are somewhat less 13/. Elevation of the Cortez station ranges from 6560 feet to 6650 feet. For the 7600 foot elevation at Fort Lewis, it is felt that 4.0 t/ac is a conservative if not optimistic figure for use in the production functions in Table A-1.12.

The concept of applying correction factors to adjust consumptive use estimates generated by lysimeter-based methodologies was previously introduced. Column 10 in Table A-1.12 gives the recommended correction factors for the various equations as an average of those developed for Grand Junction and Farmington 4/. The report does not give a correction factor for the FAO modified Penman method. The value in Table A-1.12 is an average of these given for the FAO Blaney-Criddle and FAO Radiation methods. This is justified by the fact that all FAO methods were originally calibrated to the same grass reference crop. The result obtained by this procedure, however, should be considered tentative. No correction factor should be applied indiscriminately, without careful review of available prediction methods and a knowledge of expected ET levels in the area of application. Correction factors are not available for the Northeast Utah or NIIP equations. 14/

1.4.4 Irrigation Requirements

Irrigation requirements are considered to be the consumptive use requirement as modified by the required leaching fraction, carryover soil moisture, and effective precipitation. As used in this discussion they do not include additional water required for irrigation application efficiencies, pre-plant irrigations for seed germination or other cultural requirements, or runoff. These factors are dependent on the crop, soil type, and irrigation method, and are more properly applied to the overall water balance after the cropping pattern has been determined.

1.4.5 Leaching Requirements

Irrigation water quality parameters that affect crop production were identified in the Agronomic Report. Leaching requirements, defined as the percentage of irrigation water that must pass through the root zone to control salts at a specified level were given for various electrical conductivities of irrigation water (ECw) and crops.15/

Irrigation water salinity is the weighted average EC of applied water plus effective precipitation. Assuming a rainwater EC of 23 umho/cm, an irrigation water EC of 1000 umho/cm, an effective precipitation (including carryover soil moisture) of 11.7 inches, and an irrigation requirement of 16.7 inches, the net ECw is:

$$23 \times 11.7/28.4 + 1000 \times 16.7/28.4 = 598 \text{ umho/cm} \qquad (20)$$

This amounts to a leaching requirement of approximately 2 percent, or approximately 0.6 inches per year. This small amount can be readily supplied by non-effective precipitation and inefficiencies in irrigation application and management, so is not included in Table A-1.14. It is assumed the non-effective precipitation and irrigation inefficiencies will satisfy leaching requirements for other crops that may be grown on reservation lands.

1.4.6 Carryover Soil Moisture

The amount of winter rainfall contributing to the overall irrigation water requirement is difficult to determine accurately. At Fort Lewis, average November through April precipitation is approximately 8.2 inches. The actual amount which enters the soil and is stored in the root zone depends upon the nature of the precipitation and status of the soil moisture reservoir at the end of the irrigation season. Heavy precipitation is likely to exceed the intake capacity of the soil and run off. Light precipitation is more likely to enter the root zone and become effective for crop ET in the spring. Melting snow may contribute to carryover moisture, depending on how fast it thaws. If the soil moisture reservoir is filled at the end of the irrigation season, winter precipitation will percolate through the root zone and be lost as moisture added in excess of field capacity.

For the purposes of this analysis, it is assumed that the soil moisture reservoir is empty at the end of the irrigation season, and that 20 percent of November through April precipitation is lost to runoff or deep percolation. Assuming further an effective rooting depth for alfalfa of 6 feet and an available moisture holding capacity of 1 inch per foot, a maximum of 6 inches of winter precipitation can be carried over to the spring. Carry over moisture will be:

$$COM = .80 \times 8.2 \text{ in} = 6.6 \text{ in} \tag{21}$$

This exceeds the assumed soil moisture reservoir capacity of 6 inches, so must be reduced to that figure. Approximately 2.2 inches will be lost to runoff or deep percolation. This calculation should be performed for each location, crop, and soil type (as it affects moisture holding capacity).

1.4.7 Effective Precipitation

Growing season effective precipitation is affected by the same variables impacting carryover soil moisture with the addition of a crop cover factor. Only a portion of heavy, high intensity rains can enter the root zone. Frequent light rains intercepted by a crop with full ground cover are close to 100 percent effective. When vegetative cover is low and the soil surface is dry, much of the rainfall may be lost by evaporation.

The Soil Conservation Service method for determining average effective rainfall is shown in Table A-1.13 (reproduced from Table 6 in TR-21 7/). Average monthly values from Table A-1.13 are adjusted downward using the average ratio method (Table 7, TR-21) to obtain the expected precipitation effectiveness at a 60 percent chance of occurrence. These values are summed over the irrigation season to obtain net seasonal effective rainfall.

Table A-1.14 shows the average effective rainfall, carryover soil moisture, and net irrigation requirements for alfalfa at Fort Lewis

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AVERAGE MONTHLY EFFECTIVE RAINFALL[1/]
AS RELATED TO MEAN MONTHLY RAINFALL
AND AVERAGE MONTHLY CONSUMPTIVE USE
ADAPTED FROM USDA (1970)
TABLE A-1.13

Monthly Mean Rainfall r_t Inches	Average Monthly Consumptive Use, u, in Inches								
	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
	Average Monthly Effective Rainfall, r_e, in Inches								
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.45
1.0	0.59	0.63	0.66	0.70	0.74	0.78	0.83	0.88	0.93
1.5	0.87	0.93	0.98	1.03	1.09	1.16	1.22	1.29	1.37
2.0	1.14	1.21	1.27	1.35	1.43	1.51	1.59	1.69	1.78
2.5	1.39	1.47	1.56	1.65	1.74	1.84	1.95	2.06	2.18
3.0		1.73	1.83	1.94	2.05	2.17	2.29	2.42	2.56

Note:
Values below line exceed monthly consumptive use and are to be used for interpolation only.

1/ Based on 3-inch net depth of application. For other net depths of application, multiply by the factors shown below.

Net Depth of Application											
	(D)	.75	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0
Factor	(f)	.72	.77	.86	.93	.97	1.00	1.02	1.04	1.06	1.07

Note: Average monthly effective rainfall cannot exceed average monthly rainfall or average monthly consumptive use. When the application of the above factors results in a value of effective rainfall exceeding either, this value must be reduced to a value equal the lesser of the two.

IRRIGATION REQUIREMENTS
ALFALFA AT FORT LEWIS
(all units in inches)
TABLE A-1.14

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	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	DEP	OCT	SEAS.
Crop ET 1/							4.4	6.7	6.6	5.2	4.6	0.9	28.4
Precipitation	1.14	1.78	1.60	1.17	1.25	1.25	.87	.78	2.03	2.20	1.42	1.96	17.50
Avg. Eff. Precip. 2/							.66	.67	1.70	1.66	1.08	.62	6.39
Avg. Ratio 2/							.89	.89	.89	.89	.89	.89	
60% Eff. Precip. 2/							.59	.60	1.51	1.48	.96	.55	5.69
Carryover Moisture 3/	.91	1.42	1.28	.94	1.00	1.00							6.55
Cumulative COM 3/	.91	2.33	3.61	4.55	5.55	6.55							
Water Reqmt. 4/							3.81	6.10	5.09	3.72	3.64	.35	22.71
Soil Moisture 5/	.91	2.33	3.61	4.55	5.55	6.00	6.00	6.00	6.00	3.99	.35	0	
Irrigation Reqmt. 6/							3.81	6.10	5.09	1.71	0	0	16.71

1/ Crop ET as computed using NIIP modified Jensen-Haise method. Growing season May 1-October 15.

2/ Effective precipitation using TR-21, Figure 3 and Table 7. 3" net depth of application, 60% recurrence interval.

3/ Carryover soil moisture from winter precipitation @ 80% of winter precipitation. Neglect balance of October precipitation.

4/ Water requirement = Crop ET assuming 60% effective precipitation.

5/ End of month water remaining in soil moisture reservoir. Maximum water holding capacity of 6 inches.

6/ Irrigation requirments = water requirement ± change in soil moisture.

using the NIIP calibrated Jensen-Haise equation (15). Effective precipitation for other methods will vary slightly since it is dependent on average consumptive use rate. The calculations in Table A-1.14 are intended to show the general approach to determination of irrigation requirements. Requirements for various crops in each climatic zone follow in later sections.

1.4.8 Conclusions and Recommendations

Annual consumptive use estimates produced by the nine equations (including Colorado Irrigation Guide) studied in this chapter range from 23.0 inches to 32.5 inches (Table 12) with a mean value of 26.9 inches. Estimates produced with the five production functions range from 21.1 inches to 35.7 inches (Table 12) with a mean value of 27.6 inches. The two WRRI equations (5 and 6) are combined into a single term in calculating the mean.

It is felt that the mean production function value closely approximates the expected consumptive use of alfalfa in the Fort Lewis area. This figure is approximated by the elevation corrected version of Jensen-Haise (27.7 inches, eq. 13), the Northeast Utah calibrated Jensen-Haise (27.0 inches, eq. 14), and the NIIP calibrated Jensen-Haise (28.4 inches, eq. 15). However, because local calibration is necessary to consider the various climatic factors, production functions will not be used for estimating consumptive use. The NIIP modified Jensen Haise will be used as the predictive equation because the equation has been calibrated in

Cortez which is near the project area and because calculated water requirements in the example calculation are near the average of all the methods considered.

1.5 CROP WATER REQUIREMENTS

1.5.1 Introduction

Crop Water requirements are calculated for each climatic zone as identified in the Agronomic Report. Calculations are based on the modified NIIP Jensen Haise equation. The net irrigation water requirement is calculated considering effective rainfall and carryover soil moisture.

1.5.2 Data and Conclusions

ETP

Irrigation requirements were determined for crops judged suitable and economically viable as identified by the agronomic report and economists for appropriate climatic zones. A computer program was used to simplify the calculations. The ETP calculation is based on the modified NIIP Jensen Haise equation previously discussed:

$$ETP = 0.015 \times (T-21) \times Rx \times 0.000673 \qquad (1)$$

Temperature, precipitation, and solar radiation data used for each climatic zone were presented in the Agronomic Report.

Crop Coefficients

Crop coefficients are generally based on data presented in Table A-1.2. The coefficients vary for each climatic zone as they are affected by the planting, harvesting and maturity schedule of the crop. An example calculation of monthly crop coefficients for barley in climatic zone E is presented in Table A-1.15. The crop coefficients for dry onions and apples were developed from United States Bureau of Reclamation data. The crop coefficient for grass pasture is based on assuming 95 percent of the alfalfa CU as set forth by the FAO; the crop coefficients for Christmas trees are based on verbal communication with Dr. James Wright USDA/ARS at Kimberly, Idaho.

Effective Precipitation

Effective precipitation is calculated from methods presented in SCS Technical Release No. 21.7/ A 60 percent rainfall recurrence interval was used to estimate the amount of effective rainfall.

Carryover Soil Moisture

Carryover soil moisture is rainfall or irrigation water stored in the crop root zone for the following crop. The computer program considers 80 percent of rainfall during dormant crop growth periods as water available for stored moisture. The remaining rainfall evaporates or flows off the soil. Water available for stored soil moisture infiltrates the soil profile and is held in the soil pores. The capacity of the soil to hold water is defined by the soil water holding capacity, crop root zone, and allowable depletion. To estimate carryovr soil moisture, a water holding capacity of 1.8 inches per foot, a 4 foot root zone (2 foot root zone for onions), and

COLORADO UTE - AGRICULTURAL ENGINEERING STUDY

BARLEY CROP COEFFICIENTS, CLIMATIC ZONE E
TABLE A-1.15

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Summary

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Days	0	0	0	4	31	30	31	24	0	0	0	0
kc	0	0	0	0.30	0.39	0.92	1.0	0.60	0	0	0	0

Calculation

Planting	April 26		
		15 days	
Emergence	May 11		= 75 days to full cover=7.5 days per interval
		60 days	
Full cover	July 7		
		45 days	
Harvest	August 24		

Month	Days	Factored Crop Coefficient	Crop Coefficient
April	4	.3 (4) = 1.2	kc = .3
May	31	.3(3.5)+.3(7.5)+.32 (7.5)+.4(7.5)+.65(5)=11.95	kc = .385
June	30	.65(2.5)+.85(7.5)+.95(7.5)+.99(7.5)+1.0(5)=27.55	kc = .918
July	31	1.0(2.5)+1.0(7.5)+1.0(10)+1.0(10)+.9(1)=30.9	kc = .997
August	24	.9(9)+.5(10)+.25(5)=14.35	kc = 0.598

a 50 percent soil moisture depletion are assumed. Soil moisture is then accumulated the first full month after crop dormancy and continues until the crop is planted or begins to grow the next season. If rainfall does not fill the root zone profile, irrigation water is added to fill the profile; all available soil moisture is then used by the crop at the end of the season. Water in excess of root zone soil moisture holding capacity infiltrates below the root zone and is lost.

1.5.3 Summary of Water Requirements

Annual net crop water requirements are summarized in Table A-1.16 for appropriate crops and climatic zones. Detailed calculations that consider climatic, soil, and crop coefficient variables are presented in Appendix A-1.3.

The crop irrigation requirements are expressed as the annual net irrigation requirements for each crop. The irrigation requirement for a particular cropping pattern is determined by proportioning the individual requirements based on the number of years each crop is growing in the rotation. The gross water requirement is then determined by dividing the net irrigation requirement by the estimated irrigation efficiency.

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NET ANNUAL IRRIGATION WATER REQUIREMENT (inches) 1/
TABLE A-1.16

	Climatic Zone 2/									
Crop	A	B	C	D	E	F	G	H	I	J
Alfalfa	33.75	31.30	28.56	25.35	22.74	19.86	17.14	15.05		
Apple	22.55	17.74								
Barley	19.64	18.71	18.06	17.09	16.25	15.18	13.49	11.51		
Christmas Tree	47.48	44.40	41.23	37.75	34.43	31.30	28.14	25.19	22.25	17.39
Corn, Grain	24.14	21.73	19.56	17.15						
Grass Hay/ Pasture	37.03	33.47	29.89	26.13	23.23	20.51	17.61	15.69	12.52	9.84
Onion	29.34	27.30	25.00	23.36	19.86	18.20	15.80	14.33		
Potato	26.78	25.05	23.13	21.61	19.36	16.90	13.94	11.21		
Soybean	23.60	19.54	14.60							

1/ See Appendix A-1.3 for detailed consumptive use calculations.

2/ See agronomy report for discussion of climatic zones and crop suitability.

SECTION A-1

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SECTION A-2

REVIEW ARABLE LAND CLASSIFICATION

SECTION A-2

2519 REVIEW ARABLE LAND CLASSICATION

2.1 IMPACT OF SOIL CHARACTERSTICS ON IRRIGATION METHOD SELECTION

The land classification study performed by Stoneman, Landers, Inc. forms the basis for evaluating the characteristics of arable lands in relation to the types of irrigation systems that can be used to apply water to the range of crops identified in the agronomic report. Generally, the range of observed soil physical characteristics impacts the ability to economically use different methods of irrigation. The pertinent soil physical parameters include topography, slope, soil texture, permeability/intake rate, moisture holding capacity, plant available moisture, and erosion.

The physical soil parameters that largely influence irrigation system suitability include topography, slope, and permeability/intake rate. Susceptibility to erosion is a significant factor in irrigation system design. However, irrigation system design for project lands will use an application rate that is lower than expected permeability/intake rates. Thus, runoff and subsequent erosion are not considered significant potential problems. Moisture holding capacity and plant available moisture impact irrigation system design/costs by influencing the frequency at which irrigation water must be applied. Soils with low available

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moisture holding capacity generally are more expensive to irrigate since more frequent irrigation applications are required to replenish depleted soil moisture. Even though these factors can have an impact on irrigation system selection, for purposes of this analysis they are considered only as a cost component in the design and operation of the selected irrigation system.

The impact of the significant soil physical characteristics (permeability/intake rate and soil topography/slope) to the selection of appropriate irrigation water application methods is summarized in Table A-2.1. Center pivot sprinkler irrigation systems are not suited to soils with a permeability/intake rate of less than .2 inches per hour or to slopes in excess of 15 percent. Sideroll sprinkler irrigation systems are not suited to soils with a permeability/intake rate below .06 inches per hour or to slopes above 15 percent. Handmove sprinkler systems are not suited to soils with a permeability/intake rate of less than .06 inches per hour. Drip/low volume sprinkler systems are also not considered suitable for soils with permeability/intake rates of less than .06 inches per hour. Under some conditions this type of irrigation system has been applied to soils with very slow intake rates; however, on the Southern Ute and Ute Mountain Ute Indian Reservations lands with permeability/intake rates of less than .06 inches per hour are not judged suited to the range crops that can be irrigated with these systems. Flood/furrow irrigation is suitable on all soils with a slope of less than 8 percent. Flood/furrow irrigation has been

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SUMMARY OF IRRIGATION SYSTEM SUITABILITY
TO SELECTED PROJECT SOIL PHYSICAL CHARACTERISTICS
SOUTHERN UTE AND UTE MOUNTAIN UTE INDIAN RESERVATIONS
TABLE A-2.1

Irrigation	Permeability/Intake Rate (in/hr)				Soil Slope (%)			
Method	>.06	.06-.2	.2-6.0	6.0-20.0	0-5	5-8	8-15	15-25
Center Pivot Sprinkler			X 1/	X	X	X	X	
Side Roll Sprinkler		X	X	X	X	X	X	
Hand Move Sprinkler		X	X	X	X	X	X	X
Drip-Low Volume Sprinkler		X	X	X	X	X	X	X
Flood/ Furrow	X	X	X	X	X	X		

1/ X indicates irrigation method suited to identified soil physical characteristic.

judged suitable for soils with a permeability/intake rate less than .06 inches per hour; however, the irrigation of these soils will require extensive irrigation design considerations to address slope, length of run, design flows, and tailwater return facilities. Based on data summarized in Table A-2.1 irrigation system suitability to project soils is summarized in Table A-2.2.

For sprinkler and flood/furrow irrigation techniques, a 50 percent soil moisture depletion is generally used as the basis for scheduling irrigations. For example, if the available water holding capacity of the soil is 6 inches, then the plant available moisture which can be withdrawn between irrigations is approximately 3 inches. If crop consumptive use is .3 inches per day, then the maximum interval between irrigations should be 10 days. For purposes of design/cost estimates, an allowable moisture depletion of 50 percent will be applied for sprinkler and flood/furrow irrigation techniques. Drip/low volume sprinkler irrigation methods do not generally rely on soil moisture storage capability, but instead replace moisture as it is withdrawn by the crop. Drip/low volume sprinkler irrigation system design/cost is typically based on crop irrigation water application requirements without regard to available moisture holding capability. Further discussions of soil physical characteristics and soil moisture depletion as related to irrigation system selection, design, and cost are included in greater detail in the agricultural engineering Task B report.

COLORADO UTE - AGRICULTURAL ENGINEERING STUDY

SUMMARY OF IRRIGATION SYSTEM SUITABILITY TO PROJECT SOILS
SOUTHERN UTE AND UTE MOUNTAIN UTE INDIAN RESERVATIONS
TABLE A-2.2

	Method of Irrigation				
Class and Subclass	Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
1	X 1/	X	X	X	X
2A		X	X	X	X
2AB		X	X	X	X
2ABG		X	X	X	X
2ABH		X	X	X	X
2ABN		X	X	X	X
2AC2/		X	X	X	X
2AE		X	X	X	X
2AEX		X	X	X	X
2AG		X	X	X	X
2AK		X	X	X	X
2B	X	X	X	X	X
2BC2/	X	X	X	X	X
2BGN	X	X	X	X	X
2C2/	X	X	X	X	X
2D	X	X	X	X	X
2DC2/	X	X	X	X	X
2DG	X	X	X	X	X
2E	X	X	X	X	X
2EAX		X	X	X	X
2EX		X	X	X	X

Table A-2.2, Continued Page 2

Class and Subclass	Method of Irrigation: Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
2EXY	X	X	X	X	X
2EXY-2AE		X	X	X	X
2G	X	X	X	X	X
2GA		X	X	X	X
2GD	X	X	X	X	X
2H	X	X	X	X	X
2K	X	X	X	X	X
2N	X	X	X	X	X
2Y	X	X	X	X	X
3A	X	X	X	X	
3AB	X	X	X	X	
3ABC2/	X	X	X	X	
3ABD	X	X	X	X	
3ABG		X	X	X	
3AC2/	X	X	X	X	
3AE		X	X	X	X
3AG		X	X	X	X
3AH		X	X	X	X
3AHB		X	X	X	X
3B	X	X	X	X	
3BA		X	X	X	
3BAG		X	X	X	

Table A-2.2 Continued, Page 3

Class and Subclass	Method of Irrigation Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
3BH	X	X	X	X	X
3BG	X	X	X	X	X
3BN	X	X	X	X	
3BNGA		X	X	X	
3C2/	X	X	X	X	X
3CH2/	X	X	X	X	X
3CNT2/	X	X	X	X	X
3CR2/	X	X	X	X	X
3E	X	X	X	X	X
3EA		X	X	X	X
3EAX		X	X	X	X
3EF	X	X	X	X	X
3EX	X	X	X	X	X
3G	X	X	X	X	X
3GA		X	X	X	X
3GAB		X	X	X	X
3GAC2/		X	X	X	X
3GAD		X	X	X	X
3GB	X	X	X	X	X
3GD	X	X	X	X	X
3GK		X	X	X	X
3K	X	X	X	X	X

Table A-2.2, Continued, Page 4

Class and Subclass	Method of Irrigation: Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
3KG	X	X	X	X	X
3N	X	X	X	X	X
3NA	X	X	X	X	X
3NB	X	X	X	X	X
3NH	X	X	X	X	X
3T	X	X	X	X	X
3TC2/	X	X	X	X	X
3TE	X	X	X	X	X
3TN	X	X	X	X	X
3TNC2/	X	X	X	X	X
3UNT	X	X	X	X	X
4A3/					X
4AB3/					X
4ABCD2/3/					X
4ABDG2/3/					X
4ABEF3/					X
4ABG4/					
4ABP3/					X
4AE3/					X
4AEB3/					X
4AEF3/					X
4AEFX3/					X

Table A-2.2, Continued, Page 5

	Method of Irrigation				
Class and Subclass	Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
4AEP3/					X
4AEXY3/					X
4AF3/					X
4AG3/					X
4AH3/					X
4AKD3/					X
4AP3/					X
4APE3/					X
4B			X	X	
4BAG		X	X	X	
4C2/	X	X	X	X	X
4CN2/	X	X	X	X	X
4D2/	X	X	X	X	X
4DC2/	X	X	X	X	X
4E	X	X	X	X	X
4EAPX		X	X	X	X
4EAX		X	X	X	X
4GAB		X	X	X	X
4FKC2/	X	X	X	X	X
4K	X	X	X	X	X
4KLP	X	X	X	X	X
4KNA		X	X	X	X

Table A-2.2, Continued Page 6

Class and Subclass	Method of Irrigation Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
4LE	X	X	X	X	X
4MGB	X	X	X	X	X
4MN	X	X	X	X	X
4N	X	X	X	X	X
4NHAB		X	X	X	X
4NU	X	X	X	X	X

1/ X indicates irrigation method suitable for particular class/subclass.

2/ Limited available water holding capacity increases the frequency of irrigation which increases irrigation costs.

3/ Very slow soil permeability restricts the ability to efficiently irrigate these soils and increases irrigation costs.

4/ Severe soil physical limitations make this soil uneconomical/ impractical to irrigate.

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2.2 IRRIGATION METHODOLOGY FOR SELECTED CROPS

Based on the physical and operational characteristics of the selected irrigation systems, Table A-2.3 summarizes irrigation system suitability to potential alternative crops. Center pivot sprinkler systems can be used to irrigate all crops with the exception of apples and Christmas trees. Sideroll sprinkler systems are not suited to corn, grain sorghum, apple, and Christmas trees. Handmove sprinkler systems are not suited to corn, grain sorghum, and Christmas trees. Drip/low volume sprinkler systems are suited to apple and Christmas tree crops.

COLORADO UTE - ARICULTURAL ENGINEERING STUDY

SUMMARY OF IRRIGATION SYSTEM SUITABILITY TO POTENTIAL CROPS
SOUTHERN UTE AND UTE MOUNTAIN UTE INDIAN RESERVATIONS
TABLE A-2.3

Crop	Method of Irrigation: Center Pivot Spklr.	Side Roll Spklr.	Hand Move Spklr.	Drip Low Spklr.	Flood/ Furrow
Alfalfa Hay	X 1/	X	X		X
Grass Hay/Pasture	X	X	X		X
Barley	X	X	X		X
Corn, Grain	X				X
Corn, Silage	X				X
Grain Sorghum	X				X
Oats/Oat Hay	X	X	X		X
Wheat	X	X	X		X
Dry Beans	X	X	X		X
Soybeans	X	X	X		X
Onion	X	X	X		X
Potato	X	X	X		X
Apple			X	X	X
Christmas Tree				X	X

1/ X indicates irrigation method suitable for particular crop.

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SECTION A-3

IRRIGATION EFFICIENCY

SECTION A-3

IRRIGATION EFFICIENCY

3.1 GENERAL

Irrigation efficiency is defined as the ratio (usually expressed as a percentage) of water consumed by crops being irrigated to the water applied to cropped areas. The efficiency of irrigation water application techniques has a significant impact on the development/operational cost of both on and off-farm irrigation water systems. Water delivered to the farm headgate can be used consumptively by the crop or be lost to runoff, deep percolation, or other non-consumptive uses. Non-consumptive losses which directly impact irrigation efficiency can vary significantly as a result of climate, management, inherent irrigation system characteristics, and other soil physical factors. As irrigation efficiency decreases, diversion requirements increase with subsequent cost increases for on and off-farm irrigation facilities.

Most irrigation methods have high theoretically obtainable efficiencies when designed, used, and operated under ideal fixed conditions. However, the estimation of practically obtainable irrigation efficiency must consider the intrinsic characteristics of the individual system type for the crops being grown, the physical characteristics of the site being irrigated, the climatic conditions occurring when it is used, and the operational management ability of the operational staff.

Irrigation efficiency can vary markedly with the method of irrigation chosen. Under optimum conditions high efficiencies are obtainable with almost any irrigation method. However, optimum conditions seldom exist in any but the most highly controlled conditions. The following is a discussion of some of the factors which affect irrigation efficiency:

3.1.1 Evaporation

The evaporation of spray from a sprinkler system can change the coefficient to uniformity and is a direct loss when evaluating water application efficiency. Water droplets passing through the air at near terminal velocity rapidly approach wet bulb temperature. Water vapor leaves the water droplet along with heat evaporization. Therefore, warmer water will have more evaporation loss. Sprinkler evaporation losses are expected to range from about 0.5 to 1.5 percent in the project area.

3.1.2 Climate

Climate has a significant effect on irrigation efficiency. Hot, dry, windy conditions tend to accelerate evaporation of applied water, thereby reducing the irrigation efficiency. Cool, low wind conditions maximize the amount of water infiltrated into the soil.

A wet soil initially loses water rapidly to evaporation since soil water can move to the surface through pores as a result of the water potential gradient. Once the soil surface dries, heat energy must be transmitted through the air-dry surface soil to the moist soil below before evaporation can take place. Water vapor must then defuse through the dry surface soil to escape into the atmosphere. Wind serves to reduce the humidity in the microclimate immediately above the soil surface, thereby increasing the water potential gradient. The greater the depth of the dry surface soil, the slower the loss of water from the soil beneath. Bare, medium textured agricultural soils lose water rapidly (within a few days) to evaporation from the surface 10 cm. slowly (over two months) from the next 10 cm., and extremely slowly from below 20 cm. Sprinkler irrigation and natural rainfall in late May through June during canopy development and before full cover increase evaporation losses. After full canopy development, soil wetting does not significantly influence total evapotranspiration. The additional wet surface evaporation during canopy development, whether caused by sprinkling, rainfall, or surface irrigation, is considered a direct water loss. Therefore, frequent light irrigations will tend to result in more evaporation than less frequent heavy irrigations. Soil evaporation losses typically range from 5 to 8 percent of applied water before full canopy development.

Speed and direction are the two wind characteristics that affect sprinkler efficiency. Wind speed generally increases with height above the crop or soil surface. Sprinkler spray ejected high into the air will be subjected to greater wind speeds and greater pattern distortions than spraying near the surface. The ideal angle for a sprinkler jet under calm conditions is about 32 degrees above the horizontal; however, under windy conditions a lower angle must be used to obtain good range. Wind direction is the other characteristic that affects sprinkler efficiency, except in areas where local topographic features exert a dominant influence. Wind direction normally varies because of the movement of atmospheric pressure centers with their characteristic rotational wind patterns. During the growing season these pressure centers tend to follow the same routes, resulting in some dominant wind direction quadrants at many locations. Changing wind direction has a significant influence on system uniformity.

3.1.3 Soil

The soil infiltration rate has an indirect effect on irrigation efficiency. A low soil infiltration rate requires a lower application rate which results in longer application time. The longer the application time, the greater the amount of water exposed to evaporation by wind and solar radiation. This applies to both surface and sprinkler irrigation methods, but has a greater impact on sprinkler irrigation.

3.1.4 Crop Growth Stage

The crop physical growth stage also has an influence on irrigation efficiency. Crops with shallow root zones must be irrigated more frequently and, as as indicated before, frequent irrigations promote higher evaporative losses, thereby reducing irrigation efficiency. As previously discussed, the crop growth stage also influences evaporative losses. The crop physical characteristics also influence the range of irrigation methods from which one can choose. For example, corn cannot be irrigated with the sideroll sprinkler system because of its height and is limited to center pivot or surface irrigation methods. Due to economic considerations, surface irrigation is often the method chosen and inherent limitations usually reduce irrigation efficiencies below those attainable with sprinkler irrigation methods.

3.1.5 Management

Irrigation management can be a significant consideration in evaluating irrigation efficiency. Inadequate system run time increases the number of irrigations required during the season with a corresponding decrease in irrigation efficiency. Excessive system run time can result in significant deep percolation losses. The timing of the irrigation cycle in relation to soil moisture depletion is an important factor. A great deal of management expertise is required to schedule irrigations and apply the needed water without excessive losses. Automated systems such as center pivots and drip/low volume sprinkler systems generally achieve higher efficiencies than other types of irrigation systems because irrigations can be started and stopped automatically. Systems that must be manually moved or changed to start the next irrigation set (handmove/side roll sprinklers and flood/furrow) require more management expertise and often have lower irrigation efficiency.

3.2 IRRIGATION EFFICIENCY

As previously discussed, each irrigation method can be highly efficient if operated under optimum conditions. The range of achievable irrigation efficiency by system is summarized in Table A-3.1. Since optimum conditions rarely occur, practically obtainable irrigation efficiencies are usually estimated by experience/judgement based on existing or anticipated conditions. The estimated irrigation efficiency of systems that may be used to irrigate crops grown on Ute Indian reservation lands is summarized on Table A-3.2.

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PRACTICAL RANGE OF IRRIGATION EFFICIENCY1/
TABLE A-3.1

Irrigation Method	Range of Practical Acieveable Irrigation Efficiency (%)
Flood/Furrow	Up to 90 2/
Sprinkler	65 to 80
Drip/Low Volume Sprinkler	70 to 80

1/ From "Efficient Irrigation", John Merriam, 1977.

2/ Without tailwater return facilities, maximum achievable irrigation efficiency is probably less than 70 to 80%.

IRRIGATION SYSTEM EFFICIENCY
TABLE A-3.2

Irrigation Method	Estimated Irrigation Efficiency (%)
Center Pivot Sprinkler	75
Side Roll Sprinkler	70
Hand Move Sprinkler	70
Drip/Low Volume Sprinkler	80
Flood/Furrow	65

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SECTION A-4

GROSS CROP WATER REQUIREMENTS

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SECTION A-4

GROSS CROP WATER REQUIREMENTS

4.1 GROSS CROP WATER

The analysis of net crop water requirements was summarized in Section A-1. Based on net crop water requirements, irrigation system suitability (summarized Section A-2), and estimated irrigation efficiencies of potential irrigation systems that may be used at the project site (summarized Section A-3), Table A-4.1 summarizes the gross annual crop irrigation water requirement by crop, climatic zone, and method of irrigation. Data summarized in Table A-4.1 set forth irrigation water requirements needed to provide net irrigation water requirements in consideration of irrigation system inefficiencies. In some arid/semi-arid climates additional irrigation water is included to provide salt leaching to prevent soluble salt concentrations from accumulating in the plant root zone, thus adversely impacting crop yield potential. However, analyses performed in Section A-1 indicate that the salt leaching requirement can be satisfied by deep percolation losses which occur as a result of ineffective precipitation and irrigation inefficiencies. Thus, additional water allocations for salt leaching are not included in the calculation of gross annual crop irrigation water requirements.

TABLE A-4.1
SUMMARY OF GROSS ANNUAL CROP IRRIGATION WATER REQUIREMENTS
BY CROP, CLIMATIC ZONE, AND METHOD OF IRRIGATION (inches)[1/]

	Climatic Zone[2/] and Irrigation Efficiency (%)[3/]																			
	A				B				C				D				E			
Crop	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80
Alfalfa	51.92	48.21	45.00		48.15	44.71	41.73		43.94	40.80	38.08		39.00	36.21	33.80		34.98	32.49	30.32	
Apple	34.69	32.21		28.19	27.29	25.34		22.18												
Barley	30.21	28.06	26.19		28.78	26.73	24.95		27.78	25.80	24.08		26.29	24.41	22.79		25.00	23.21	21.67	
Christmas Tree	73.05			59.35	68.31		55.50	63.43				51.54	58.08			47.19	52.97			43.04
Corn Grain	37.14		32.19		34.40		29.81		30.09		26.08		26.38		22.87					
Grass Hay/ Pasture	56.97	52.90	49.37		51.49	47.81	44.63		45.98	42.70	39.85		40.20	37.33	34.84		35.74	33.19	30.97	
Onion	45.14	41.91	39.12		42.00	39.00	36.40		38.46	35.71	33.33		35.93	33.37	31.15		30.55	28.37	26.48	
Potato	41.20	38.26	35.71		38.54	35.79	33.40		35.58	33.04	30.84		33.25	30.87	28.81		29.78	27.66	25.81	
Soybean	36.31	33.71	31.47		30.06	27.91	26.05		22.46	20.85	19.47									

Table A-4.1, Continued

Crop	F 65	F 70	F 75	F 80	G 65	G 70	G 75	G 80	H 65	H 70	H 75	H 80	I 65	I 70	I 75	I 80	J 65	J 70	J 75	J 80
	Climatic Zone 2/ and Irrigation Efficiency (%) 3/																			
Alfalfa	30.55	28.37	26.48		26.37	24.49	22.85		23.15	21.50	20.07									
Apple																				
Barley	23.35	21.69	20.24		20.75	19.27	17.99		17.71	16.44	15.35									
Christmas Tree	48.15			39.13	43.29			35.18	38.75			31.49	34.23			27.81	26.75			21.74
Corn Grain																				
Grass Hay/ Pasture	31.55	29.30	27.35		27.09	25.16	23.48		24.14	22.41	20.92		19.26	17.89	16.69		15.14	14.06	13.12	
Onion	28.00	26.00	24.27		24.31	22.57	21.07		22.05	20.47	19.11									
Potato	26.00	24.14	22.53		21.46	19.91	18.59		17.25	16.01	14.95									
Soybean																				

1/ See Appendix A-1.3 for detailed consumptive use calculations.

2/ See agronomy report for discussion of climatic zones and crop suitability.

3/ See Section A-3 for discussion of irrigation efficiency.

4/ Gross annual crop irrigation water requirement equals net annual requirement divided by the estimated irrigation efficiency.

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4.2 PEAK IRRIGATION WATER REQUIREMENT

Crop consumptive use data are used to determine monthly and annual irrigation water requirements. These data, when considered in conjunction with climatic conditions, provide the basis for determining peak irrigation water requirements. Peak irrigation water requirements are defined as the month or period of highest water use for a given crop or cropping pattern. The determination of peak irrigation water requirements is necessary to develop irrigation water delivery systems, supply schedules, capacity requirements, and irrigation water delivery/application schedules. The peak irrigation water requirement impacts both the on and off-farm irrigation facilities.

Climatic variables and the stage of crop development affect the peak irrigation water requirement. Under conditions of mild, stable climates the peak irrigation water requirement may approach the average daily condition of the peak use month; however, under adverse climatic conditions such as windy periods, periods of low relative humidity and high levels of incoming solar radiation, the consumptive use requirement of the peak period can increase significantly.

Even though the peak use period normally extends for time periods of less than one month, it is still the controlling factor in determining flow capacity requirements for both on and off-farm irrigation facilities. It is necessary to address these potential peak irrigation water requirements since water deficit induced stress can adversely impact crop yield and quality and peak water use normally occurs during active crop growth stages. To determine peak irrigation water requirements the mean daily gross irrigation water requirement of the peak month is multiplied by a peaking factor to address anticipated climatic conditions. Table A-4.2 summarizes average daily consumptive use of the peak month by crop and climatic zone. The peaking factor is determined by methodology reported in FAO Irrigation and Drainage paper, No. 24, Crop Water Requirements. Based on assuming a net 3-inch irrigation application and assuming mid-continental climatic conditions, existing curves in the FAO publication are used to derive the peaking factor of 1.14. The peaking factor is then applied to the average daily consumptive use of the peak month as summarized in Table A-4.2. These data are then further modified to reflect the estimated efficiency of irrigation systems that will be used to apply the water. The summary of peak consumptive use requirements by crop, climatic zone and method of irrigation is shown in Table A-4.3.

4.3 IRRIGATION WATER FLOW REQUIREMENT

The calculation of irrigation water flow requirements is needed to determine the size of on and off-farm irrigation facilities. The calculation of flow requirements is based on the cropping pattern and the peak consumptive use requirements summarized in Table A-4.3.

TABLE A-4.2
SUMMARY OF AVERAGE DAILY CU OF THE PEAK
MONTH BY CROP AND CLIMATIC ZONE (inches)1/
SOUTHERN UTE AND UTE MOUNTAIN UTE INDIAN RESERVATIONS

Crop	Climatic Zone 2/ A	B	C	D	E	F	G	H	I	J
Alfalfa	.28	.31	.32	.30	.26	.26	.24	.22		
Apple	.21	.20								
Barley	.32	.31	.31	.31	.30	.29	.28	.27		
Christmas Tree	.33	.32	.31	.30	.29	.28	.27	.26	.25	.24
Corn, Grain	.33	.31	.29	.26						
Grass Hay/ Pasture	.32	.31	.29	.26	.26	.24	.23	.24	.24	.24
Onion	.29	.29	.29	.29	.29	.28	.27	.25		
Potato	.29	.28	.27	.26	.26	.24	.22	.20		
Soybean	.32	.30	.24							

1/ See Appendix A-1.3 for detailed consumptive use calculations.

2/ See agronomy report for discussion of climatic zones and crop suitability.

TABLE A-4.3
SUMMARY OF PEAK IRRIGATION WATER REQUIREMENTS
BY CROP, CLIMATIC ZONE, AND METHOD OF IRRIGATION
(acre-inches/acre/day)[1]

	Climatic Zone[2] & Irrigation Efficiency[3]																			
	A				B				C				D				E			
	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80
Alfalfa	.49	.46	.43		.54	.50	.47		.56	.52	.49		.53	.49	.46		.46	.42	.40	
Apple	.37	.34		.30	.35	.33		.29												
Barley	.56	.52	.49		.54	.50	.47		.54	.50	.47		.54	.50	.47		.53	.49	.46	
Christmas Tree	.58			.47	.56			.46	.54			.44	.53			.43	.51			.41
Corn, Grain	.58		.50		.54		.47		.51		.44		.46	.42	.40					
Grass Hay/ Pasture	.56	.52	.49		.54	.50	.47		.51	.47	.44		.46	.42	.40		.46	.42	.40	
Onion	.51	.47	.44		.51	.47	.44		.51	.47	.44		.51	.47	.44		.51	.47	.44	
Potato	.51	.47	.44		.49	.46	.43		.47	.44	.41		.46	.42	.40		.46	.42	.40	
Soybean	.56	.52	.49		.53	.49	.46		.42	.39	.36									

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Table A-4.3, Continued

	Climatic Zone [2/] & Irrigation Efficiency [3/]																			
	F				G				H				I				J			
	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80
Alfalfa	.46	.42	.40		.42	.39	.36		.39	.36	.33									
Apple																				
Barley	.51	.47	.44		.49	.46	.43		.47	.44	.41									
Christmas Tree	.49			.40	.47			.38	.46			.37	.44			.36	.42			.34
Corn, Grain																				
Grass Hay/ Pasture	.42	.39	.36		.40	.37	.35		.42	.39	.36		.42	.39	.36		.42	.39	.36	
Onion	.49	.46	.43		.47	.44	.41		.44	.41	.38									
Potato	.42	.39	.36		.39	.36	.33		.35	.33	.30									
Soybean																				

1/ See Appendix A-1.3 for detailed consumptive use calculations.

2/ See agronomy report for discussion of climatic zones and crop suitability.

3/ See Section A-3 for discussion of irrigation efficiency.

4/ Peak requirement equals the average day of the peak month (from Table A-4.2) divided by the irrigation efficiency multiplied by the peaking factor (1.14).

These data are modified to reflect the anticipated irrigation run time. For design purposes it is not practical to assume that irrigation systems can be operated for 24 hours per day because down time is needed for system repair, starting new irrigation sets, and to allow additional run time if required to address periods of higher than anticipated peak water requirements. Generally, 80 to 90 percent of the maximum run time (24 hours) is used to calculate irrigation water flow requirements. For purposes of this study it is assumed, for design purposes, that irrigation systems will be run approximately 90 percent of the allowable time. Thus, irrigation water flow requirements summarized in Table A-4.4 assume a 22 hour run time.

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TABLE A-4.4
SUMMARY OF PEAK IRRIGATION WATER FLOW REQUIREMENTS
BY CROP, CLIMATIC ZONE, AND METHOD OF IRRIGATION (gpm/ac)1/

	Climatic Zone[2] and Irrigation Efficiency (%)[3]																			
	A				B				C				D				E			
Crop	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80
Alfalfa	10.1	9.5	8.8		11.1	10.3	9.7		11.5	10.7	10.1		10.9	10.1	9.5		9.5	8.6	8.2	
Apple	7.6	7.0		6.2	7.2	6.8		6.0												
Barley	11.5	10.7	10.1		11.1	10.3	9.7		11.1	10.3	9.7		11.1	10.3	9.7		10.9	10.1	9.5	
Christmas Tree	11.9			9.7	11.5			9.5	11.1			9.1	10.9			8.8	10.5			8.4
Corn Grain	11.9		10.3		11.1		9.7		10.5		9.1		9.5	8.6	8.2					
Grass Hay/ Pasture	11.5	10.7	10.1		11.1	10.3	9.7		10.5	9.7	9.1		9.5	8.6	8.2		9.5	8.6	8.2	
Onion	10.5	9.7	9.1		10.5	9.7	9.1		10.5	9.7	9.1		10.5	9.7	9.1		10.5	9.7	9.1	
Potato	10.5	9.7	9.1		10.1	9.5	8.8		9.7	9.1	8.4		9.5	8.6	8.2		9.5	8.6	8.2	
Soybean	11.5	10.7	10.1		10.9	10.1	9.5		8.6	8.0	7.4									

Table A-4.4, Continued

Crop	Climatic Zone[2/] and Irrigation Efficiency (%)[3/]																			
	F				G				H				I				J			
	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80	65	70	75	80
Alfalfa	9.5	8.6	8.2		8.6	8.0	7.4		8.0	7.4	6.8									
Apple																				
Barley	10.5	9.7	9.1		10.1	9.5	8.8		9.7	9.1	8.4									
Christmas Tree	10.1			8.2	9.7			7.8	9.5			7.6	9.1			7.4	8.6			7.0
Corn Grain																				
Grass Hay/ Pasture	8.6	8.0	7.4		8.2	7.6	7.2		8.6	8.0	7.4		8.6	8.0	7.4		8.6	8.0	7.4	
Onion	10.1	9.5	8.8		9.7	9.1	8.4		9.1	8.4	7.8									
Potato	8.6	8.0	7.4		8.0	7.4	6.8		7.2	6.8	6.2									
Soybean																				

1/ See Appendix A-1.3 for detailed consumptive use calculations.

2/ See agronomy report for discussion of climatic zones and crop suitability.

3/ See Section A-3 for discussion of irrigation efficiency.

4/ Irrigation flow requirement based on peak requirements (from Table A-4.3) assuming 22 hour system operational time.

SECTION A-5

GROSS TO NET ACREAGE REDUCTION FACTOR

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SECTION A-5

GROSS TO NET ACREAGE REDUCTION FACTOR

5.1 GENERAL

Lands which may be developed for agricultural uses on the Ute Mountain Ute and Southern Ute Indian reservations are identified as a result of the land classification study performed by Stoneman and Landers, Inc. This study identified arable lands. The arable lands were further evaluated under Task B in order to establish expected parcel configuration and size. This analysis was performed using guidelines developed by Boyle Engineering Corporation in consultation with the agricultural economist. Generally, parcels narrower than 300 feet or smaller than 5 gross acres were eliminated for practical and economic reasons. Each area of arable land was analyzed and parcelized. The gross acreage of each parcel was then determined. The parcelization of arable lands resulted in the elimination of small and irregularly shaped arable areas.

The identification of field boundaries and parcels has reduced the total gross arable acreage by eliminating lands that occur outside the identified parcels. The area within these parcels is considered the gross farmable acreage. The gross farmable acreage is further reduced by applying the appropriate "gross to net acreage reduction factor" in order to determine the actual net farmable acreage that occurs as a result of roads and other facilities which are required to facilitate efficient farming practices. Facilities often included which reduce the net farmable acreage are: 1) access roads; 2) farm shop facilities; 3) farm office facilities; 4) equipment storage areas; 5) irrigation water distribution facilities; 6) tailwater return facilities; and 7) homesites. Because of the vast amount of non-arable acreage that surrounds arable reservation lands, it is assumed that all required facilities will be located off the arable parcels. It is further assumed that exterior field roads will also be located on non-arable or non-farmable lands. Therefore, the only factor that will influence the gross to net acreage reduction factor is the requirement for interior access roads as influenced by the irrigation method.

5.2 GROSS TO NET ACREAGE REDUCTION FACTORS

Based on personal experience, observations in the project area, and interviews with agriculturalists and farmers, a maximum field size of 40 acres was selected. It was assumed that this 40 acre parcel would be farmed without the need for interior access roads. Therefore, the gross to net acreage reduction factor would be zero. An incremental analysis was performed assuming square 50 acre parcels (1320 feet x 1320 feet). The square 40 acre parcels were combined to form regularly shaped fields. The interior access roads were then included and the acreage required for roadways calculated assuming a 25 foot road width. The 25 foot road width is selected based on previous experience and is considered adequate for equipment access purposes. For example, a square 160 acre parcel includes four 40 acre parcels and would require one mile of interior roads. The acreage excluded by the road is 3.03. Dividing the area excluded (3.03 acres) by the total area (160 acres) results in a gross to net acreage reduction factor of 98 percent (98.11 rounded to the nearest whole percent). A similar analysis was performed for various sized parcels to estimate the range of gross to net acreage reduction factors.

Four potential irrigation methods have been evaluated for project lands. These methods are: 1) center pivot sprinkler; 2) side roll sprinkler; 3) handmove sprinkler; and 4) gravity. The access road requirements are similar for the proposed methods of irrigation with the exception of the center pivot sprinkler. An additional analysis was performed to estimate the gross to net acreage reduction factor using center pivot irrigation.

Lands excluded from production with center pivot irrigation would include an access road to the pivot point and the circular path under the tower wheels. An analysis was performed assuming a 25 foot wide access road to the pivot point and one foot wide wheels under each tower with the towers spaced 100 feet apart. The analysis was performed for a 40, 80, 120, and 160 acre circle and considered only the irrigated area. In each case, the gross to net acreage reduction factor was calculated at 98 percent.

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The gross to net acreage reduction factors for the proposed irrigation methods are summarized on Tables A-5.1, A-5.2, and A-5.3.

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ACREAGE REDUCTION FACTOR (%)
TABLE A-5.1

Acreage	Sideroll	Handmove	Gravity	Center Pivot*
0- 40	100	100	100	98
41-159	99	99	99	98
160-479	98	98	98	--
≥ 480	97	97	97	--

* Assume maximum pivot length of 1320 feet and minimum length of 660 feet.

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GROSS TO NET ACREAGE REDUCTION FACTOR ANALYSIS FOR HANDMOVE, SIDEROLL, AND GRAVITY1/
TABLE A-5.2

Gross Acres	Length of Access Road(ft)	Area in 25' Access Road(ac)	Percent Nonfarmable Area to Gross Acres
40	0	0	0
80	1,320	.76	0.95
120	2,640	1.52	1.27
160	5,280	3.03	1.89
240	9,240	5.30	2.21
320	13,200	7.58	2.37
480	21,120	12.12	2.53
640	31,680	18.18	2.84

1/ See Figure A-5.1 for schematic of field/road layouts.

GROSS TO NET ACREAGE REDUCTION FACTOR ANALYSIS
FOR CENTER PIVOT1/
TABLE A-5.3

Gross Acres	System Diameter (ft)	Net Acres 2/	No. Towers 3/	Area Under Tower4/ (Ac)	Area in 25'Access Road5/ (Ac)	Total Nonfarmable Area (Ac)	Percent Nonfarmable Area to6/ Net Acres
160	1,320	125.6	13	1.24	.76	2.00	1.59
120	1,143	94.2	11	.91	.66	1.57	1.67
80	934	62.9	9	.61	.54	1.15	1.83
40	660	31.4	6	.29	.38	.67	2.13

1/ Analysis assumes the shortest practical system length is 660 feet and the longest is 1,320 feet.

2/ Based on irrigated acreage. Area not irrigated is assumed to be excluded from analysis.

3/ Towers assumed to be spaced 100 feet apart.

4/ Area excluded under tower is based on an assumed wheel width of 1 foot.

5/ 25 foot wide access road from perimeter to pivot point.

6/ Percent nonfarmable area rounds to 2% for all acreages, thus 98% gross to net acreage reduction factor will be used for all center pivot irrigation systems.

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PARCEL LAYOUT

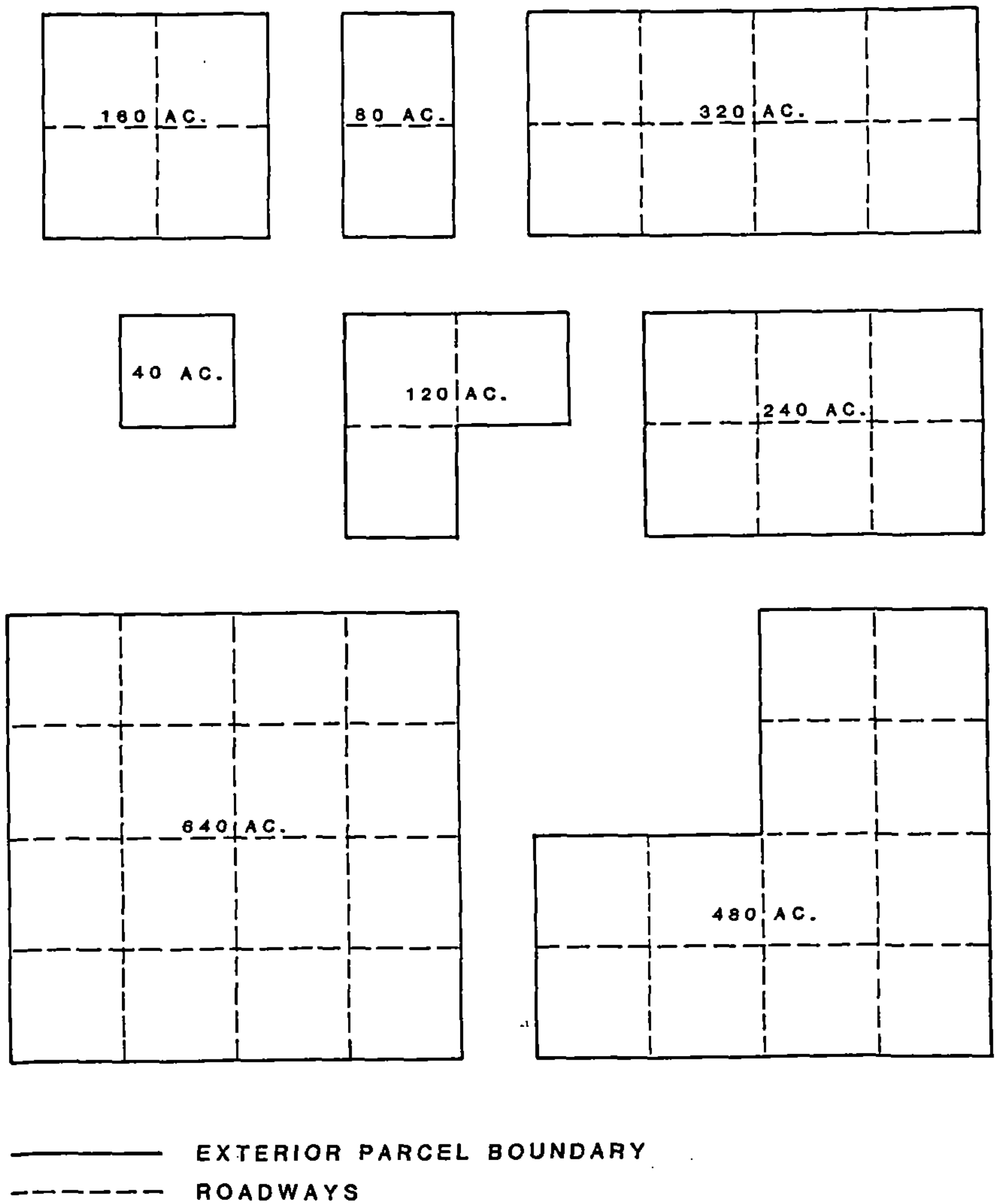

FIGURE A-5.1

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APPENDICES

APPENDIX A-1.1

DEFINITIONS

APPENDIX A-1.1
DEFINITIONS

advection - Horizontal transfer of sensible heat energy by large-scale motions of the atmosphere.

albedo - The ratio of electromagnetic radiation reflected from a soil and crop surface to the amount incident upon it. In practice the value is applied primarily to solar radiation.

anemometer level - The height above ground at which an anemometer is exposed.

bar - A unit of pressure equal to a 10 dynes per cm, 1000 millibars, 29.53 inches of mercury.

calorie - (Abbreviated cal) A unit of heat required to raise the temperature of 1 gram of water from 14.5 degrees Centigrade to 15.5 degrees Centigrade. The International Table calorie equals 1.00032 cal.

carryover soil moisture - Nongrowing season precipitation stored in the soil that may be effective in meeting the crop's ET (evapotranspiration requirement).

clothesline effect - Horizontal heat transfer (advection) from warm and dry upwind area to a relatively cooler crop field resulting in increased ET crop; particularly refers to the field border effects or to patchwork of small interspersed fields.

cloudiness - Degree of cloud cover, usually mean of several observations per day; expressed in oktas (in eighths) of sky covered, or in tenths of sky covered.

consumptive use - The total amount of water taken up by vegetation for transpiration or building of plant tissue, plus the unavoidable evaporation of soil moisture, snow and intercepted precipitation associated with vegetal growth. (Also see evapotranspiration)

crop coefficient - The ratio of evapotranspiration occurring with a specific crop at a specific stage of growth to potential or reference crop evapotranspiration at that time (Not the same as K used in the Blaney-Criddle method).

crop evapotranspiration, ETcrop - Rate of evapotranspiration of a disease-free crop growing in a large field (one or more ha) under optimal soil conditions, including sufficient water and fertilizer and achieving full production potential of that crop under the given growing environment; includes water loss through transpiration by the vegetation, and evaporation from the soil surface and wet leaves; mm/day.

crop production function, or water use production function - The relationship between yield and seasonal consumptive use of a crop.

deep percolation - The drainage of soil water by gravity below the maximum effective depth of the root zone.

effective precipitation - That portion of precipitation which remains on the foliage or in the soil that is available for evapotranspiration, and reduces the withdrawal of soil water by a like amount.

effective rooting depth, D - Soil depth from which the full grown crop extracts most of the water needed for evapotranspiration.

evaporation - The physical process by which a liquid or solid is transformed to the gaseous state which in irrigation usually is restricted to the change of water from liquid to gas.

evapotranspiration - The combined processes by which water is transferred from the earth surface to the atmosphere; evaporation of liquid or solid water plus transpiration from plants. (Also see consumptive use).

extra-terrestial radiation, Ra - Amount of solar radiation received on a horizontal at the top of the atmosphere.

global radiation - The total of direct solar radiation and diffuse sky radiation received by a unit horizontal surface (essentially less than about 3 microns).

ground cover - Percentage of soil surface shaded by the crop if the sun were directly overhead; percentage.

growing season - The time period which is warm enough for plants to transpire and grow. For annual plants, it approximates the time interval between planting and crop maturity; for perennial crops, it is the period between certain temperature conditions that establishes growth and dormant periods. The growing season is sometimes restricted to the period between killing frosts.

langley - A unit of energy per unit area commonly used in radiation measurements which is equal to 1 gram calorie per square centimeter.

latent heat - The heat released or absorbed per unit mass of water in a reversible, isobaric-isothermal change of phase.

leaching requirement - The fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specific value.

long-wave radiation - Electromagnetic radiation with a wave length greater than 0.8 microns. (For convenience long-wave radiation is normally considered all wave lengths greater than solar radiation or essentially 3 microns.

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lysimeter - A device such as a tank or large barrel containing a mass of soil, usually planted to some vegetation, which is isolated hydrologically from its surroundings. The device commonly used in research to determine the ET rate of various crops.

millibar - (Abbreviated mb) A pressure unit of 1000 dynes cm , and equal to one-thousandth of a bar. Atmospheric pressures are commonly reported in millibars.

net longwave radiation, Rnl - Balance between all outgoing and incoming longwave radiation; almost always a negative value.

net radiation - The difference of the downward and upward solar and long-wave radiation flux passing through a horizontal plane just above the ground surface.

net solar radiation, Rns - Difference between shortwave radiation received on the earth's surface and that reflected by the soil, crop or water surface.

oasis effect - Effect of dry fallow surrounding the micro-climate of a relatively small acreage of land where an air mass moving into an irrigated area will give up sensible heat. For small fields this may result in a higher ETcrop as compared to predicted ETcrop using climatic data collected inside the irrigated area; conversely ETcrop predictions based on weather data collected outside the irrigated fields may over-predict actual evapotranspiration losses.

potential evapotranspiration - Evapotranspiration from a well-watered crop like alfalfa (lucern) with 30 to 50 cm (12 to 20 inches) of top growth and about 100 m (330 feet) of fetch under given climatic conditions.

reference crop evapotranspiration - The evapotranspiration from a given well-watered crop selected for comparative purposes under given weather conditions and with adequate fetch and a standardized watering regime appropriate for this crop and the region involved.

relative humidity - The dimensionless ratio of actual vapor pressure of the air to saturation vapor pressure, commonly expressed in percent.

saturation deficit - (Also called vapor pressure deficit). The difference between the actual vapor pressure and the saturation vapor pressure at the existing temperature.

short-wave radiation - A term used loosely to distinguish solar and diffuse sky radiation from long-wave radiation.

solar radiation, Rs - Amount of shortwave radiation received on a horizontal plane at the earth's surface.

transpiration - The process by which water in plants is transferred as water vapor to the atmosphere.

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APPENDIX A-1.2

EQUATIONS FOR FAO MODIFIED METHODS

APPENDIX A-1.2

REGRESSION EQUATIONS FOR COEFFICIENTS FOR FAO MODIFIED METHODS

$$K = a_0 + a_1 x_1 + a_2 x_2 \; . \; . \; . \; a_n x_n$$

FAO Method (1)	Independent variables (2)	Interaction variables used (3)	Coefficients (4)	r^2 (5)
Blaney-Criddle[a] (B term)	x_1 = *Minimum relative humidity (%)* x_2 = Fraction of sunshine x_3 = Daytime windspeed (m/s)	$x_4 = x_1 * x_2$ $x_5 = x_1 * x_3$	a_0 = 0.81917 a_1 = −0.0040922 a_2 = 1.0705 a_3 = 0.065649 a_4 = −0.0059684 a_5 = −0.0005967	0.989
Radiation[b] (B term)	x_1 = Mean relative humidity (%) x_2 = Daytime windspeed (m/s)	$x_3 = x_1 * x_2$ $x_4 = x_1 ** 2$ $x_5 = x_2 ** 2$	a_0 = 1.0656 a_1 = −0.0012795 a_2 = 0.044953 a_3 = −0.00020033 a_4 = −0.000031508 a_5 = −0.0011026	0.999
Penman[c] (C term)	x_1 = Maximum relative humidity (%) x_2 = Solar radiation (mm/d) x_3 = Daytime windspeed (m/s) x_4 = *Day/night wind ratio*	$x_5 = x_3 * x_4$ $x_6 = x_1 * x_2 * x_3$ $x_7 = x_1 * x_2 * x_4$	a_0 = 0.6817006 a_1 = 0.0027864 a_2 = 0.0181768 a_3 = −0.0682501 a_4 = 0.0126514 a_5 = 0.0097297 a_6 = 0.43025 E-4 a_7 = −0.92118 E-7	0.955

[a]FAO Blaney-Criddle equation is $ET_0 = A + BF$ in which ET_0 = *reference evapotranspiration* in mm/d; $A = 0.0043\, x_1 - x_2 - 1.41$; and $F = p\,(0.46T + 8)$ mm/d when p = daily percentage of daylight hours, and T = mean *daily temperature* °C

[b]FAO Radiation equation is $ET_0 = BWR_s - 0.3$ in which ET_0 = reference evapotranspiration in mm/d; W = a weighting factor from Table 4 in Doorenbos' and Pruitt's paper (1); and R_S = equivalent solar radiation in mm/d.

[c]FAO Penman equation is $ET_0 = C[WR_n + (1 - W)f(u)(e_a - e_d)]$ in which ET_0 = *reference evapotranspiration* in mm/d; W = a weighting factor from Table 9 in a paper by Doorenbos and Pruitt (1); Rn = net solar radiation in mm/d. $f(u)$ = a wind *function from Table 7 in a* paper by Doorenbos and Pruitt (1); e_a = saturation vapor pressure in mbar, and e_d = actual vapor pressure in mbar.

From: D.K. Frevert et al, "Estimation of FAO Evapotranspiration Coefficients", JIDD, ASCE v.109, no.2

APPENDIX A - 1.3

DETAILED CONSUMPTIVE USE CALCULATIONS

2569

File name Alf11A Dec 18, 85 Crop Water Requirement

Climatic Zone--------- A
Crop-------------------Alfalfa
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1 8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52 0	61.7	71.2	77.8	75.4	66.8	54 7	41.0	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	.90	.70	1 10	.50	.70	7.40
Av. E.T.P. /day	.000	.000	.000	.155	.234	.320	.347	.292	.213	.116	.000	.000	----
Days	0	0	0	13	31	30	31	31	30	27	0	0	
Av. E.T.P. /month	.000	.000	.000	2.010	7.260	9.593	10.772	9.040	6.394	3.123	.000	.000	48.192
Crop Coeficient	0	0	0	.8	.97	77	.82	.94	.67	.39	0	0	
E.T. Crop	00	.00	.00	1 61	7.04	7 39	8 83	8.50	4 28	1.22	.00	.00	38.87
Effective Precipitation	.00	.00	.00	.25	.26	.18	.54	.68	.42	.56	.00	.00	2.88
E.T. - Eff. Rainfall	.00	.00	.00	1.36	6.79	7.21	8.29	7.81	3.87	.66	.00	.00	35.99
Carry Over Moisture	.48	.40	.40	.00	.00	.00	.00	.00	.00	.00	.40	.56	2.24
Cum. C.O.M. (july/june)	1.44	1.84	2.24	2.24	2.24	2.24	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1 84	2.24	3.60	3.60	3 60	3.60	3.60	.66	.00	.40	.96	----
Irr. Requirement	.00	.00	.00	2.72	6.79	7.21	8.29	7.81	.93	.00	.00	.00	33 75

2570

file name Alf11B Dec 18, 85

Crop Water Requirement

Climatic Zone--------- B
Crop-------------------Alfalfa
Irr. Appl. In. --------- 3.0
W.H.C. (In /ft.)-------- 1 8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69.4	76 0	73.7	65.4	53.6	40.1	30.1	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1.20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	7	31	30	31	31	30	23	0	0	
Av. E.T.P. /month	.000	.000	.000	1.023	6.957	9 249	10.430	8.757	6.199	2.574	.000	.000	45 189
Crop Coeficient	0	0	0	.74	.96	.76	.92	.84	.73	54	0	0	
E.T. Crop	.00	.00	.00	..76	6.68	7 03	9 60	7.36	4.53	1.39	.00	.00	37.33
Effective Precipitation	.00	.00	.00	.30	.34	.18	.66	.80	.50	.62	.00	.00	3.40
E.T. - Eff. Rainfall	.00	.00	.00	.46	6.34	6.85	8.94	6.56	4 03	.77	.00	.00	33.94
Carry Over Moisture	.56	.48	.48	.00	.00	.00	.00	.00	.00	.00	.48	.64	2.64
Cum. C.O.M. (july/june)	1.68	2.16	2.64	2.64	2.64	2.64	.00	.00	.00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	2.16	2 64	3.60	3.60	3.60	3.60	3.60	.77	.00	48	1.12	----
Irr. Requirement	.00	.00	.00	1.42	6.34	6.85	8.94	6.56	1.19	.00	.00	.00	31.30

File name Alf11C Dec 18, 85 Crop Water Requirement

Climatic Zone--------- C
Crop-------------------Alfalfa
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1 8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W H.C.-------- 3 6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71.9	63.9	52.4	39.1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.138	.215	.297	.326	.273	.200	.108	.000	.000	----
Days	0	0	0	1	31	30	31	31	30	19	0	0	
Av. E.T.P. /month	.000	.000	.000	.138	6.654	8.905	10.108	8.458	5.989	2.048	.000	.000	42.300
Crop Coeficient	0	0	0	.7	.92	.76	.98	.78	.82	.58	0	0	
E.T. Crop	.00	.00	.00	.10	6 12	6 77	9.91	6.60	4.91	1 19	.00	.00	35.59
Effective Precipitation	.00	.00	.00	.10	.41	.27	.86	.92	.59	.68	.00	.00	3.83
E.T. - Eff. Rainfall	.00	.00	.00	.00	5.71	6.50	9.04	5.67	4 32	.50	.00	.00	31.76
Carry Over Moisture	.64	.56	.64	.00	.00	.00	.00	.00	.00	.00	.56	.80	3.20
Cum. C.O.M. (july/june)	2.00	2.56	3.20	3.20	3.20	3.20	.00	.00	.00	.00	.56	1.36	----
Avail. Soil Moisture	2.00	2.56	3.20	3.20	3.60	3.60	3.60	3.60	.50	.00	.56	1.36	----
Irr. Requirement	.00	.00	.00	.00	6.11	6.50	9.04	5.67	1.23	.00	.00	.00	28.56

file name Alf11D Dec 18, 85 Crop Water Requirement

Climatic Zone--------- D
Crop-------------------Alfalfa
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.3	32.2	38.8	47.0	56 6	65.8	72.5	70.2	62.4	51.3	38.2	28.7	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.00	.90	.90	.80	.70	.50	1.10	1.50	1.10	1.50	.80	1.10	11.90
Av. E.T.P. /day	.000	.000	.000	.130	.205	.285	.315	.264	.193	.104	.000	.000	----
Days	0	0	0	0	26	30	31	31	30	15	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	5.326	8.561	9.767	8.176	5 780	1.560	.000	.000	39.170
Crop Coeficient	0	0	0	0	.89	.79	.95	77	.94	49	0	0	
E.T. Crop	.00	.00	.00	.00	4.74	6.76	9.28	6.30	5.43	.76	.00	.00	33.27
Effective Precipitation	.00	.00	.00	.00	.46	.35	.93	1.06	.75	.76	.00	.00	4 32
E.T. - Eff. Rainfall	.00	.00	.00	.00	4.28	6.41	8.35	5.23	4.68	.00	.00	.00	28.95
Carry Over Moisture	.80	.72	.72	.64	.00	.00	.00	.00	.00	.00	64	.88	4 40
Cum. C.O.M. (july/june)	2.32	3.04	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.64	1.52	----
Avail. Soil Moisture	2.32	3.04	3.60	3.60	3.60	3.60	3.60	3 60	.00	.00	.64	1 52	----
Irr. Requirement	.00	.00	.00	.00	4.28	6.41	8.35	5.23	1.08	.00	.00	.00	25.35

2573

file name AlfilE Dec 18, 85

Crop Water Requirement

Climatic Zone--------- E
Crop--------------------Alfalfa
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	25.4	30.8	37.2	45.3	54.9	64.0	70.7	68.5	60.9	50.1	37 3	28.0	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.20	1.00	1.10	.90	.90	.60	1.30	1.70	1.20	1.60	.90	1.30	13 70
Av. E.T.P. /day	.000	.000	.000	.121	.195	.274	.304	.255	.186	.100	.000	.000	----
Days	0	0	0	0	20	30	31	31	30	11	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	3.901	8 217	9.425	7.893	5 571	1.099	.000	.000	36.106
Crop Coeficient	0	0	0	0	.86	.9	.86	.75	.98	.95	0	0	
E.T. Crop	.00	.00	.00	.00	3.36	7.40	8.11	5.92	5.46	1.04	.00	.00	31.28
Effective Precipitation	.00	.00	.00	.00	.56	.46	1.04	1.19	.83	.85	.00	.00	4.93
E.T. - Eff. Rainfall	.00	.00	.00	.00	2.80	6.94	7.06	4.73	4.63	.19	00	.00	26.34
Carry Over Moisture	.96	.80	.88	.72	.00	.00	.00	.00	.00	00	.72	1.04	5.12
Cum. C.O M. (july/june)	2.72	3.52	3.60	3 60	3.60	3.60	.00	.00	00	.00	.72	1.76	----
Avail. Soil Moisture	2.72	3.52	3.60	3.60	3.60	3.60	3.60	3.60	.19	.00	.72	1.76	----
Irr. Requirement	.00	.00	.00	.00	2.80	6.94	7 06	4.73	1.22	00	.00	.00	22.74

2574

file name Alf11F Dec 18, 85 Crop Water Requirement

Climatic Zone--------- F
Crop-------------------Alfalfa
Irr. Appl. In. --------- 3.0
W.H.C. (In /ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	24.5	29.3	35.6	43.7	53.2	62.3	69.0	66.7	59 4	49.0	36 4	27.3	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.40	1.20	1.30	1 10	1.00	70	1.50	1.90	1.30	1.70	1.00	1.50	15.60
Av. E.T.P. /day	.000	.000	.000	.119	.185	.263	.294	.245	.179	.096	.000	.000	----
Days	0	0	0	0	13	30	31	31	30	8	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	2.409	7.892	9.103	7.594	5 361	.769	.000	.000	33.128
Crop Coeficient	0	0	0	0	.804	.972	776	.821	.947	.95	0	0	
E.T. Crop	.00	.00	.00	.00	1.94	7.67	7.06	6.23	5 08	.73	.00	.00	28.71
Effective Precipitation	.00	.00	.00	.00	.58	.56	1.14	1.35	.89	.73	.00	.00	5.26
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.36	7.11	5.92	4.88	4.18	.00	.00	.00	23.46
Carry Over Moisture	1.12	.96	1.04	.88	.00	.00	.00	.00	.00	.00	80	1.20	6.00
Cum. C.O.M. (july/june)	3.12	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.80	2.00	----
Avail. Soil Moisture	3.12	3.60	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.80	2.00	----
Irr. Requirement	.00	.00	.00	.00	1.36	7.11	5.92	4.88	.58	00	.00	.00	19.86

file name AlfllG Dec 18, 85 Crop Water Requirement

Climatic Zone--------- G
Crop-------------------Alfalfa
Irr. Appl In. --------- 3 0
W.H.C. (In./ft)-------- 1 8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	23.6	27.9	34.0	42.0	51.5	60 5	67.2	65.0	57.9	47.9	35.5	26.6	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.60	1.30	1.40	1.20	1.10	.80	1.70	2.20	1.50	1 90	1 20	1.70	17.60
Av. E.T.P. /day	.000	.000	.000	.105	.176	.252	.283	.236	.172	.092	.000	.000	----
Days	0	0	0	0	7	30	31	31	30	4	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	1.229	7.548	8.762	7.312	5.152	.369	.000	.000	30.371
Crop Coeficient	0	0	0	0	.74	.96	.768	.92	82	1	0	0	
E.T. Crop	.00	.00	.00	.00	.91	7.25	6 73	6.73	4.22	.37	.00	.00	26.20
Effective Precipitation	00	.00	.00	.00	.61	.63	1.27	1.61	.98	.37	.00	.00	5.47
E.T. - Eff. Rainfall	.00	.00	.00	.00	.30	6.62	5.46	5.12	3.24	.00	.00	.00	20.74
Carry Over Moisture	1.28	1.04	1.12	96	.00	.00	.00	.00	.00	.00	.96	1.36	6.72
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.96	2.32	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3 60	3.24	.00	.00	.96	2.32	----
Irr. Requirement	.00	.00	.00	.00	.30	6.62	5.46	4.76	.00	.00	.00	.00	17.14

2575

file name Alf10H Dec 18, 85 Crop Water Requirement

Climatic Zone--------- H
Crop--------------------Alfalfa
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	22.6	26.4	32.5	40.4	49 9	58.7	65.4	63.3	56 4	46.8	34.5	25.9	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.80	1.50	1.70	1.40	1.30	.90	1.90	2.50	1.60	2.00	1.30	1.90	19.80
Av. E.T.P. /day	.000	.000	.000	.097	.166	240	.272	.227	.165	089	.000	.000	----
Days	0	0	0	0	1	30	31	31	30	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	.166	7.204	8.420	7.029	4.942	.000	.000	.000	27.762
Crop Coeficient	0	0	0	0	.7	.91	.76	.98	.76	0	0	0	
E.T. Crop	.00	.00	.00	-.00	.12	6.56	6.40	6 89	3.76	.00	.00	00	23.72

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Effective Precipitation	.00	.00	.00	.00	.12	.69	1.39	1.83	1.03	00	.00	.00	5.06
E T. - Eff. Rainfall	.00	.00	.00	00	.00	5.87	5 01	5.05	2.73	.00	.00	.00	18.65
Carry Over Moisture	1 44	1.20	1.36	1.12	.00	.00	.00	00	.00	1.60	1.04	1.52	9.28
Cum. C.O.M. (july/june)	3 60	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	1.60	2.64	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	2.73	.00	1.60	2.64	3.60	----
Irr. Requirement	.00	.00	.00	.00	.00	5.87	5.01	4.18	.00	.00	.00	.00	15.05

2576

file name App10A Dec 18, 85

Crop Water Requirement

Climatic Zone--------- A
Crop-------------------Apples
Irr Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	.90	.70	1.10	.50	.70	7.40
Av. E.T P. /day	.000	.000	.000	.155	.234	.320	.347	.292	213	.116	.000	.000	----
Days	0	0	0	5	31	30	31	31	30	22	0	0	
Av. E T.P. /month	.000	.000	.000	.773	7.260	9.593	10 772	9.040	6.394	2.545	.000	.000	46.377
Crop Coeficient	0	0	0	.17	.2	.35	.54	.73	.86	.89	0	0	
E.T. Crop	.00	.00	.00	.13	1.45	3.36	5 82	6.60	5.50	2 26	.00	.00	25.12
Effective Precipitation	.00	.00	.00	.13	.19	.14	.45	.62	.45	.59	.00	.00	2.57
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.26	3.22	5.36	5 98	5.05	1.68	.00	.00	22.55
Carry Over Moisture	.48	.40	.40	.00	.00	.00	.00	.00	.00	.00	.40	.56	2 24
Cum C.O M. (july/june)	1.44	1.84	2.24	.00	.00	.00	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1.84	2.24	.00	3.60	3.60	3.60	3.60	.00	.00	40	.96	----
Irr. Requirement	.00	00	.00	.00	4.86	3.22	5.36	5.98	1.45	1 68	00	.00	22.55

2578

file name App108 Dec 18, 85

Crop Water Requirement

Climatic Zone--------- B
Crop-------------------Apples
Irr. Appl. In. --------- 3.0
W H C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.9	60.0	69.4	76.0	73.7	65.4	53.6	40.1	30 1	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	50	.30	.80	1.10	.80	1.20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	0	31	30	31	31	30	28	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	6.957	9.249	10.430	8.757	6 199	3 133	.000	.000	44.726
Crop Coeficient	0	0	0	0	.19	.32	.5	.71	.84	.89	0	0	
E.T. Crop	.00	.00	.00	.00	1.32	2.96	5.22	6 22	5.21	2 79	.00	.00	23 71
Effective Precipitation	.00	.00	.00	.00	.25	14	.52	.75	.52	.67	.00	.00	2 85
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.07	2.82	4.70	5.47	4.69	2 11	.00	00	20 86
Carry Over Moisture	.56	.48	.48	.48	.00	.00	.00	.00	.00	00	.48	64	3.12
Cum. C.O.M. (july/june)	1.68	2.16	2.64	3.12	.00	.00	.00	.00	00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	2.16	2.64	3.12	3.60	3.60	3.60	3.60	.00	.00	.48	1.12	----
Irr. Requirement	.00	.00	.00	.00	1.55	2.82	4.70	5.47	1.09	2.11	.00	.00	17.74

A-14

File name BarBA Dec 18, 85 Crop Water Requirement
Climatic Zone--------- A
Crop-------------------Barley
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 8

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	.90	.70	1.10	.50	.70	7.40
Av. E.T.P. /day	.000	.000	.000	.155	.234	.320	.347	.292	.213	116	.000	.000	----
Days	0	0	0	28	31	30	31	0	0	0	0	0	
Av. E.T.P. /month	000	.000	.000	4.329	7.260	9.593	10.772	.000	.000	.000	.000	000	31.954
Crop Coeficient	0	0	0	.33	.83	1	.685	0	0	0	0	0	
E.T. Crop	.00	.00	.00	1.43	6.03	9 59	7.38	.00	.00	.00	.00	00	24.43
Effective Precipitation	.00	.00	.00	.25	.24	.20	50	.00	.00	.00	.00	.00	1 19
E.T. - Eff. Rainfall	.00	.00	.00	1.18	5.78	9.39	6.88	.00	.00	00	.00	.00	23.24
Carry Over Moisture	.48	.40	.40	.00	.00	.00	.00	.72	.56	.88	.40	.56	4.40
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3 60	.00	72	1.28	2.16	2 56	3.12	----
Avail. Soil Moisture	3.60	3 60	3.60	3.60	3.60	3.60	.00	.72	1.28	2.16	2.56	3.12	----
Irr. Requirement	.00	.00	.00	1.18	5.78	9.39	3.28	.00	.00	.00	.00	.00	19.64

file name Bar9B Dec 18, 85 Crop Water Requirement

Climatic Zone--------- B
Crop--------------------Barley
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 9

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69.4	76.0	73.7	65.4	53.6	40.1	30.1	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1 20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	22	31	30	31	6	0	0	0	0	
Av. E.T.P. /month	.000	.000	.000	3.215	6.957	9.249	10.430	1.695	.000	.000	.000	.000	31.546
Crop Coeficient	0	0	0	.31	.71	1	.82	.29	0	0	0	0	
E.T. Crop	.00	.00	.00	1.00	4.94	9.25	8 55	.49	.00	.00	.00	.00	24 23
Effective Precipitation	.00	.00	.00	.30	.31	.20	.62	.49	.00	.00	.00	.00	1.92
E.T. - Eff. Rainfall	00	.00	.00	.70	4.63	9.05	7.93	.00	.00	00	.00	.00	22 31
Carry Over Moisture	.56	.48	.48	.00	.00	.00	.00	00	.64	.96	.48	.64	4.24
Cum. C.O.M. (july/june)	3.28	3.60	3.60	3.60	3.60	3.60	.00	.00	.64	1.60	2.08	2.72	----
Avail. Soil Moisture	3.28	3.60	3.60	3.60	3.60	3 60	.00	.00	.64	1.60	2.08	2.72	----
Irr. Requirement	.00	.00	.00	.70	4.63	9.05	4.33	.00	.00	.00	.00	.00	18 71

2581

File name Bar9C Dec 18, 85 Crop Water Requirement

Climatic Zone--------- C
Crop--------------------Barley
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 9

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71.9	63.9	52.4	39.1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	000	.000	.000	.138	.215	.297	.326	273	.200	.108	.000	.000	----
Days	0	0	0	16	31	30	31	12	0	0	0	0	
Av. E.T.P. /month	.000	.000	.000	2.210	6.654	8 905	10.108	3.274	.000	.000	.000	.000	31 151
Crop Coeficient	0	0	0	.3	.58	.99	.94	.42	0	0	0	0	
E.T. Crop	.00	.00	.00	.66	3.86	8.82	9.50	1.38	.00	.00	.00	.00	24.21
Effective Precipitation	.00	.00	.00	.36	.36	30	.84	.69	.00	.00	.00	.00	2 55
E.T. - Eff. Rainfall	.00	.00	.00	.31	3.50	8.52	8.66	.69	.00	.00	.00	.00	21.66
Carry Over Moisture	.64	.56	.64	.00	.00	00	.00	.00	.72	1.04	56	.80	4.96
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.72	1.76	2 32	3.12	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	.69	.00	72	1 76	2 32	3.12	----
Irr. Requirement	00	.00	.00	.31	3.50	8 52	5.74	.00	.00	.00	00	.00	18.06

file name Bar9D Dec 18, 85 Crop Water Requirement

Climatic Zone--------- D
Crop-------------------Barley
Irr. Appl. In. --------- 3.0
W H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 9

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.3	32.2	38.8	47.0	56.6	65.8	72.5	70.2	62.4	51.3	38.2	28.7	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.00	.90	.90	.80	.70	.50	1.10	1.50	1.10	1.50	.80	1.10	11.90
Av. E.T.P. /day	.000	.000	.000	.130	.205	.285	.315	.264	.193	.104	.000	.000	----
Days	0	0	0	10	31	30	31	18	0	0	0	0	----
Av. E.T.P. /month	.000	.000	.000	1.297	6.350	8.561	9.767	4.747	.000	.000	.000	.000	30.722
Crop Coeficient	0	0	0	.3	.48	.97	.98	.5	0	0	0	0	
E.T. Crop	00	.00	.00	.39	3.05	8 30	9.57	2.37	.00	.00	.00	.00	23.69

Effective Precipitation	.00	.00	.00	.39	.42	.39	.95	.85	.00	.00	.00	.00	2.99
E.T. - Eff. Rainfall	.00	.00	.00	.00	2.63	7.92	8.62	1.52	.00	.00	.00	.00	20.69
Carry Over Moisture	.80	.72	.72	.00	.00	.00	.00	.00	.88	1.20	.64	.88	5.84
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.88	2.08	2.72	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	1.52	.00	.88	2 08	2.72	3.60	----
Irr. Requirement	.00	.00	.00	.00	2.63	7.92	6 54	.00	.00	.00	.00	.00	17.09

file name Bar9E Dec 18, 85 Crop Water Requirement

Climatic Zone--------- E
Crop--------------------Barley
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 9

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	25.4	30.8	37 2	45.3	54.9	64 0	70.7	68.5	60.9	50.1	37.3	28.0	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.20	1.00	1.10	.90	.90	.60	1.30	1.70	1 20	1 60	.90	1.30	13.70
Av. E.T.P. /day	.000	.000	.000	.121	.195	.274	.304	.255	.186	.100	.000	.000	----
Days	0	0	0	4	31	30	31	24	0	0	0	0	----
Av. E.T.P. /month	000	.000	.000	.485	6.047	8.217	9.425	6.111	.000	.000	.000	.000	30 285
Crop Coeficient	0	0	0	.3	.39	.92	1	.6	0	0	0	0	
E.T. Crop	.00	.00	.00	.15	2.36	7.56	9.43	3.67	.00	.00	.00	.00	23.16

Effective Precipitation	.00	.00	.00	.15	.53	46	1.12	1.05	.00	.00	.00	.00	3.31
E.T. - Eff. Rainfall	.00	.00	00	.00	1 83	7.10	8.30	2.62	00	00	.00	.00	19.85
Carry Over Moisture	.96	.80	.88	.00	.00	.00	.00	.00	.96	1.28	.72	1.04	6.64
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	96	2.24	2.96	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3 60	3.60	2.62	.00	.96	2.24	2.96	3.60	----
Irr. Requirement	.00	.00	.00	.00	1.83	7.10	7.32	00	.00	.00	.00	.00	16.25

file name Bar9F Dec 18, 85 Crop Water Requirement

Climatic Zone--------- F
Crop-------------------Barley
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 9

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	24.5	29.3	35.6	43.7	53.2	62.3	69.0	66.7	59.4	49.0	36.4	27.3	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1 40	1.20	1.30	1.10	1.00	.70	1.50	1.90	1.30	1.70	1.00	1.50	15.60
Av. E.T.P. /Day	.000	.000	.000	.113	.185	.263	.294	.245	.179	096	.000	000	----
Days	0	0	0	0	28	30	31	30	0	0	0	0	----
Av. E.T.P. /month	.000	.000	.000	.000	5.188	7.892	9 103	7.349	.000	.000	.000	.000	29.532
Crop Coeficient	0	0	0	0	.33	.82	1	.7	0	0	0	0	
E.T Crop	.00	.00	.00	.00	1.71	6.47	9.10	5 14	.00	.00	.00	.00	22.43
Effective Precipitation	.00	.00	.00	.00	.57	.52	1.28	1.27	.00	.00	.00	.00	3.65
E.T. - Eff. Rainfall	00	.00	.00	.00	1.14	5.95	7.82	3.87	.00	.00	.00	.00	18.78
Carry Over Moisture	1 12	.96	1.04	.88	.00	.00	.00	00	1 04	1.36	.80	1.20	8.40
Cum. C.O.M (july/june)	3.60	3 60	3.60	3.60	3.60	3.60	.00	.00	1.04	2.40	3.20	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3 60	3.60	.00	1.04	2.40	3.20	3.60	----
Irr. Requirement	.00	.00	.00	.00	1.14	5.95	7.82	.27	.00	.00	.00	.00	15.18

File name Bar10G Dec 18, 85 Crop Water Requirement

Climatic Zone--------- G
Crop--------------------Barley
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	23.6	27.9	34.0	42.0	51.5	60.5	67.2	65.0	57.9	47 9	35.5	26.6	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.60	1.30	1.40	1.20	1.10	.80	1.70	2.20	1.50	1.90	1.20	1.70	17.60
Av. E.T.P. /day	.000	.000	.000	.105	.176	.252	.283	236	.172	092	.000	.000	----
Days	0	0	0	0	22	30	31	31	6	0	0	0	
Av. E.T P. /month	.000	.000	.000	.000	3.861	7.548	8.762	7.312	1 030	.000	.000	.000	28.513
Crop Coeficient	0	0	0	0	.31	.7	1	82	29	0	0	0	
E.T. Crop	.00	.00	.00	.00	1.20	5.28	8.76	6.00	.30	.00	.00	.00	21 54
Effective Precipitation	00	.00	.00	.00	.62	57	1.42	1 54	.30	.00	.00	.00	4.45
E.T. - Eff. Rainfall	.00	.00	.00	.00	.58	4.72	7.34	4.45	.00	.00	.00	.00	17.09
Carry Over Moisture	1.28	1.04	1.12	.96	.00	.00	.00	.00	.00	1.52	.96	1.36	8.24
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	1.52	2.48	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	1.52	2 48	3.60	----
Irr. Requirement	.00	.00	.00	.00	.58	4.72	7.34	.85	.00	.00	.00	.00	13.49

file name Bar10H Dec 18, 85

Crop Water Requirement

Climatic Zone--------- H
Crop--------------------Barley
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1 8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	22.6	26.4	32.5	40.4	49.9	58.7	65.4	63.3	56.4	46.8	34.5	25.9	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1 80	1.50	1.70	1.40	1.30	.90	1.90	2.50	1.60	2.00	1 30	1.90	19.80
Av. E.T.P. /day	.000	.000	.000	.097	.166	.240	.272	227	.165	.089	.000	.000	----
Days	0	0	0	0	16	30	31	31	12	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	2.661	7.204	8.420	7.029	1.977	.000	.000	.000	27 291
Crop Coeficient	0	0	0	0	.3	.58	.99	.92	.4	0	0	0	
E.T. Crop	00	.00	.00	:00	.80	4.18	8.34	6.47	.79	00	.00	.00	20.57
Effective Precipitation	.00	.00	.00	.00	.72	.60	1 55	1.79	.79	.00	.00	.00	5.46
E.T. - Eff. Rainfall	00	.00	.00	.00	.08	3.57	6.78	4.67	.00	.00	.00	.00	15.11
Carry Over Moisture	1.44	1.20	1.36	1.12	.00	.00	.00	.00	.00	1 60	1.04	1.52	9.28
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	1.60	2 64	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	1.60	2.64	3.60	----
Irr. Requirement	.00	.00	.00	.00	.08	3.57	6.78	1.07	.00	.00	.00	.00	11 51

file name CT A Dec 24, 85 Crop Water Requirement

Climatic Zone--------- A
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30.8	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	.90	.70	1.10	.50	.70	7.40
Av. E.T.P. /day	.016	.044	.091	.155	.234	.320	.347	.292	.213	.116	.050	.015	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.507	1.238	2.829	4.638	7.260	9.593	10.772	9.040	6.394	3.586	1.514	.460	57.831
Crop Coeficient	.63	.63	.63	.77	.95	.95	.95	.95	.95	.91	.63	.63	
E.T. Crop	.32	.78	1.78	3.57	6.90	9.11	10.23	8.59	6.07	3.26	.95	.29	51.87
Effective Precipitation	.28	.24	.25	.28	.25	.20	.58	.69	.46	.62	.24	.29	4.38
E.T. - Eff. Rainfall	.04	.54	1.53	3.29	6.64	8.92	9.65	7.90	5.61	2.64	.71	.00	47.48
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	2.64	.00	.00	.00	----
Irr. Requirement	3.64	.54	1.53	3.29	6.64	8.92	9.65	7.90	4.65	.00	.71	.00	47.48

file name CT B Dec 27, 85 Crop Water Requirement

Climatic Zone--------- 8
Crop--------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69.4	76.0	73.7	65.4	53.6	40.1	30.8	----
Solar Radiation	200	300	400	494	570	691	606	531	461	340	250	150	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1.20	.60	.80	8.60
Av. E.T.P. /day	.015	.043	.085	.146	.224	.308	.336	.282	.207	.112	.048	.015	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.451	1.196	2.629	4.384	6.957	9.249	10.430	8.757	6.199	3.469	1.446	.460	55.626
Crop Coeficient	.63	.63	.63	.7	.95	.95	.95	.95	.95	.87	.63	.63	
E.T. Crop	.28	.75	1.66	3.07	6.61	8.79	9.91	8.32	5.89	3.02	.91	.29	49.49
Effective Precipitation	.28	.30	.31	.34	.34	.20	.67	.84	.54	.68	.30	.29	5.09
E.T. - Eff. Rainfall	.00	.46	1.34	2.73	6.27	8.59	9.24	7.47	5.35	2.33	.61	.00	44.40
Carry Over Moisture	00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	3.60	3.60	3.60	3.60	3.60	3.60	3.60	2.33	00	.00	.00	----
Irr. Requirement	.00	4.06	1.34	2.73	6.27	8.59	9.24	7.47	4.09	.00	.61	.00	44.40

file name CT C Dec 27, 85

Crop Water Requirement

Climatic Zone--------- C
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71.9	63.9	52.4	39.1	29.4	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.013	.038	.078	.138	.215	.297	.326	.273	.200	.108	.046	.013	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.394	1.077	2.428	4.144	6.654	8.905	10.108	8.458	5.989	3.341	1.370	.394	53.264
Crop Coeficient	.63	.63	.63	.64	.95	.95	.95	.95	.95	.86	.63	.63	
E.T. Crop	.25	.68	1.53	2 65	6.32	8.46	9.60	8.04	5.69	2.87	.86	.25	47.20
Effective Precipitation	.25	.36	.43	.40	.42	.29	.85	1.00	.61	.75	.36	.25	5.97
E.T. - Eff. Rainfall	.00	.32	1.10	2.25	5.90	8.17	8.75	7.03	5.08	2.12	.50	.00	41.23
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	3.60	3.60	3.60	3.60	3.60	3.60	3.60	2 12	.00	.00	.00	----
Irr. Requirement	.00	3.92	1.10	2.25	5.90	8.17	8.75	7.03	3.60	.00	.50	.00	41.23

2583

2590

File name CT D DEC 27, 85 Crop Water Requirement

Climatic Zone--------- D
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.3	32.2	38.8	47.0	56.6	65.8	72.5	70.2	62.4	51.3	38.2	28.7	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	1.00	.90	.90	.80	.70	.50	1.10	1.50	1.10	1.50	.80	1.10	11.90
Av. E.T.P. /day	.011	.034	.072	.130	.205	.285	.315	.264	.193	.104	.043	.012	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.332	.950	2.228	3.890	6.350	8.561	9.767	8.176	5.780	3.224	1.302	.361	50.921
Crop Coeficient	.63	.63	.63	.63	.9	.95	.95	.95	.95	.78	.63	.63	
E.T. Crop	.21	.60	1.40	2.45	5.72	8.13	9.28	7.77	5.49	2.51	.82	.23	44.61
Effective Precipitation	.21	.47	.49	.46	.48	.38	.93	1.15	.76	.86	.42	.23	6.86
E.T. - Eff. Rainfall	.00	.13	.91	1.99	5.23	7.75	8.35	6.62	4.74	1.66	.40	.00	37.75
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	3.60	3.60	3.60	3.60	3.60	3.60	3.60	1.66	.00	.00	.00	----
Irr. Requirement	.00	3.73	.91	1.99	5.23	7.75	8.35	6.62	2.79	.00	.40	.00	37.75

2591

file name CT E Dec 27, 85 Crop Water Requirement

Climatic Zone--------- E
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	25.4	30.8	37.2	45.3	54 9	64.0	70.7	68.5	60.9	50.1	37.3	28.0	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	1.20	1.00	1.10	.90	.90	.60	1.30	1.70	1.20	1.60	.90	1.30	13.70
Av. E.T.P. /day	.009	.030	.065	.121	.195	.274	.304	.255	.186	.100	.041	.011	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.275	.831	2.028	3.635	6.047	8.217	9.425	7.893	5.571	3.096	1.234	.329	48.582
Crop Coeficient	.63	.63	.63	.63	.84	.95	.95	.95	.95	.74	.63	.63	
E.T. Crop	.17	.52	1.28	2.29	5.08	7.81	8.95	7.50	5.29	2.29	.78	.21	42.17
Effective Precipitation	.17	.52	.61	.53	.62	.47	1.09	1.30	.83	.92	.48	.21	7.74
E.T. - Eff. Rainfall	.00	.00	.67	1.76	4.46	7.34	7.86	6.20	4.47	1.38	.29	.00	34.43
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	.00	3.60	3 60	3.60	3.60	3.60	3.60	1.38	.00	.00	.00	----
Irr. Requirement	.00	.00	4.27	1.76	4.46	7.34	7.86	6.20	2.24	.00	.29	.00	34.43

2592

file name CT F Dec 27, 85 Crop Water Requirement

Climatic Zone--------- F
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	24.5	29.3	35.6	43.7	53.2	62.3	69.0	66.7	59.4	49.0	36.4	27.3	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	1.40	1.20	1.30	1.10	1.00	.70	1.50	1.90	1.3	1.70	1.00	1.50	15.60
Av. E.T.P. /day	.007	.025	.059	.113	.185	.263	.294	.245	.179	.096	.039	.010	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.219	.704	1.828	3.396	5.744	7.892	9.103	7.594	5.361	2.979	1.166	.296	46.282
Crop Coeficient	.63	.63	.63	.63	.76	.95	.95	.95	.95	.71	.63	.63	
E.T. Crop	.14	.44	1.15	2.14	4.37	7.50	8.65	7.21	5.09	2.12	.73	.19	39.73
Effective Precipitation	.14	.44	.72	.65	.67	.55	1.25	1.43	.89	.97	.54	.19	8.43
E.T. - Eff. Rainfall	.00	.00	.43	1.49	3.70	6.95	7.40	5.78	4.20	1.14	.19	.00	31.30
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	.00	3.60	3.60	3.60	3.60	3.60	3.60	1.14	.00	.00	.00	----
Irr. Requirement	.00	.00	4.03	1.49	3.70	6.95	7.40	5.78	1.74	.00	.19	.00	31.30

File name CT G Dec 27, 85 Crop Water Requirement

Climatic Zone--------- G
Crop--------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	23.6	27.9	34 0	42.0	51.5	60.5	67.2	65.0	57.9	47.9	35 5	26.6	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	200	150	----
Av. Precipitation	1.60	1.30	1.40	1.20	1.10	.80	1.70	2.20	1.50	1.90	1.20	1.70	17.60
Av. E.T.P. /day	.005	.021	.052	.105	.176	.252	.283	.236	.172	.092	.029	.008	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.163	.585	1.627	3.142	5.441	7.548	8.762	7.312	5.152	2.862	.878	.263	43.734
Crop Coeficient	.63	.63	.63	.63	.7	.95	.95	.95	.95	.67	.63	.63	
E.T. Crop	.10	.37	1.03	1.98	3.81	7.17	8.32	6.95	4.89	1.92	.55	.17	37.26
Effective Precipitation	.10	.37	.77	.70	.72	.63	1.39	1.63	1.02	1.08	.55	.17	9.12
E.T. - Eff. Rainfall	.00	.00	.25	1.28	3.09	6.54	6.93	5.32	3.87	.84	.00	.00	28.14
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	.00	3.60	3.60	3.60	3.60	3.60	3.60	.84	.00	.00	.00	----
Irr. Requirement	.00	.00	3.85	1.28	3.09	6.54	6.93	5.32	1.12	.00	.00	.00	28.14

file name CT H Dec 27, 85

Crop Water Requirement

Climatic Zone--------- H
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	22.6	26.4	32.5	40.4	49.9	58.7	65.4	63.3	56.4	46.8	34.5	25.9	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	1.80	1.50	1.70	1.40	1.30	.90	1.90	2.50	1.60	2.00	1.30	1.90	19.80
Av. E.T.P. /day	.003	.016	.046	.097	.166	.240	.272	.227	.165	.089	.034	.007	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.100	.458	1.440	2.902	5.155	7.204	8.420	7.029	4.942	2.745	1.022	.230	41.649
Crop Coeficient	.63	.63	.63	.63	.64	.95	.95	.95	.95	.63	.63	.63	
E.T. Crop	.06	.29	.91	1.83	3.30	6.84	8.00	6.68	4.70	1.73	.64	.14	35.12
Effective Precipitation	.06	.29	.91	.81	.82	.70	1.52	1.81	1.08	1.13	.64	.14	9.93
E.T. - Eff. Rainfall	.00	.00	.00	1.01	2.48	6.14	6.48	4.86	3.61	.60	.00	.00	25.19
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	.00	.00	3.60	3.60	3.60	3 60	3.60	.60	.00	.00	.00	----
Irr. Requirement	.00	.00	.00	4.61	2.48	6.14	6.48	4.86	.62	.00	.00	.00	25.19

File name CT I Dec 27, 85 Crop Water Requirement

Climatic Zone--------- I
Crop-------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.)None

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	21.7	25.0	30.9	38.7	48.1	57.0	63.6	61.6	54.9	45.7	33.6	25.2	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	2.10	1.70	1.90	1.60	1.40	1.00	2.20	2.80	1.80	2.20	1.40	2.10	22.20
Av. E.T.P. /day	.001	.012	.040	.088	.156	.229	.261	.218	.158	.085	.032	.006	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.044	.339	1.239	2.648	4.834	6.880	8.079	6.747	4.733	2.628	.954	.197	39.322
Crop Coeficient	.63	.63	.63	.63	.63	.9	.95	.95	.91	.63	.63	.63	
E.T. Crop	.03	.21	.78	1.67	3.05	6.19	7.67	6.41	4.31	1.66	.60	.12	32.70
Effective Precipitation	.03	.21	.78	.92	.88	.76	1.73	1.99	1.19	1.23	.60	.12	10.45
E.T. - Eff. Rainfall	.00	.00	.00	.75	2.17	5.43	5.95	4.41	3.12	.42	.00	.00	22.25
Carry Over Moisture	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cum. C.O.M. (july/june)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	.00	.00	.00	3.60	3.60	3.60	3.60	3.54	.42	.00	.00	.00	----
Irr. Requirement	.00	.00	.00	4.35	2.17	5.43	5.95	4.35	.00	.00	.00	.00	22.25

2595

2596

file name CT J Dec 27, 85 Crop Water Requirement

Climatic Zone--------- J
Crop--------------------Christmas Trees With Cover
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	20.7	23.5	29.3	37.1	46.5	55.2	61.9	59.8	53.4	44.5	32.7	24.5	----
Solar Radiation	200	300	400	494	570	631	606	531	461	340	250	150	----
Av. Precipitation	2.40	1.90	2.10	1.80	1.60	1.10	2.40	3.10	2.00	2.30	1.60	2.40	24.70
Av. E.T.P. /day	.000	.008	.034	.080	.147	.218	.250	.208	.151	.081	.030	.005	----
Days	31	28	31	30	31	30	31	31	30	31	30	31	
Av. E.T.P. /month	.000	.212	1.039	2.409	4.549	6.536	7.756	6.448	4.523	2.500	.886	.164	37.022
Crop Coeficient	.63	.63	.63	.63	.63	.83	.95	.95	.86	.63	.63	.63	
E.T. Crop	.00	.13	.65	1.52	2.87	5.42	7.37	6.13	3.89	1.58	.56	.10	30.22

Effective Precipitation	.00	.13	.65	1.03	1.00	.81	1.86	2.17	1.30	1.29	.56	.10	10.91
E.T. - Eff. Rainfall	.00	.00	.00	.49	1.87	4.62	5.51	3.95	2.59	.28	.00	.00	19.31
Carry Over Moisture	1.92	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.92
Cum. C.O.M. (july/june)	1.92	1.92	1.92	1.92	1.92	1.92	.00	.00	.00	.00	.00	.00	----
Avail. Soil Moisture	1.92	1.92	1.92	3.60	3.60	3.60	3.60	2.87	.28	.00	.00	.00	----
Irr. Requirement	.00	.00	.00	2.17	1.87	4.62	5.51	3.23	.00	.00	.00	.00	17.39

file name CornllA Dec 18, 85

Crop Water Requirement

2597

Climatic Zone--------- A
Crop------------------Corn
Irr. Appl. In. --------- 3.0
W H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75 4	66.8	54.7	41.0	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	60	.50	.50	.50	.40	.30	.70	.90	.70	1.10	.50	.70	7.40
Av. E.T.P. /day	.000	.000	.000	.155	.234	.320	.347	.292	.213	116	.000	.000	----
Days	0	0	0	0	31	30	31	31	30	15	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	7.260	9.593	10.772	9.040	6 394	1.735	.000	.000	44.794
Crop Coeficient	0	0	0	0	.3	.57	.95	.8	.57	.25	0	0	
E.T. Crop	.00	.00	.00	.00	2.18	5.47	10.23	7.23	3.64	.43	.00	00	29.19
Effective Precipitation	.00	.00	.00	.00	.20	.16	.58	.64	.40	.43	.00	.00	2 41
E T. - Eff Rainfall	.00	.00	.00	.00	1.98	5.31	9.65	6.59	3.24	.00	00	.00	26.78
Carry Over Moisture	.48	.40	.40	.40	.00	.00	.00	.00	.00	.00	.40	.56	2.64
Cum. C.O.M. (july/june)	1.44	1.84	2.24	2.64	.00	.00	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1.84	2.24	2.64	3.60	3.60	3.60	3.24	00	.00	.40	.96	----
Irr. Requirement	.00	.00	.00	.00	2.94	5.31	9.65	6 24	.00	.00	.00	.00	24.14

file name CornllB Dec 18, 85 Crop Water Requirement

Climatic Zone--------- B
Crop--------------------Corn
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69.4	76.0	73.7	65.4	53.6	40.1	30.1	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1.20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	0	26	30	31	31	30	11	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	5.835	9.249	10.430	8.757	6.199	1.231	.000	.000	41.701
Crop Coeficient	0	0	0	0	.3	.48	.93	.9	.66	.27	0	0	
E.T. Crop	.00	.00	.00	.00	1.75	4.44	9.70	7.88	4.09	.33	.00	.00	28.20
Effective Precipitation	.00	.00	.00	.00	.26	.15	.66	.82	.49	.33	.00	.00	2.72
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.49	4.29	9.04	7.06	3.61	.00	.00	.00	25.48
Carry Over Moisture	.56	.48	.48	.48	.00	.00	.00	.00	.00	.00	.48	.64	3.12
Cum. C.O.M. (july/june)	1.68	2.16	2.64	3.12	.00	.00	.00	.00	.00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	2.16	2.64	3.12	3.60	3.60	3.60	3.60	.00	.00	.48	1.12	----
Irr. Requirement	.00	.00	.00	.00	1.97	4.29	9.04	7.06	.01	.00	.00	.00	22.36

file name CornllC Dec 18, 85 Crop Water Requirement

Climatic Zone--------- C
Crop-------------------Corn
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71.9	63 9	52.4	39 1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.138	.215	.297	.326	.273	.200	.108	.000	.000	----
Days	0	0	0	0	20	30	31	31	30	7	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	4.293	8.905	10.108	8.458	5.989	.754	.000	.000	38 508
Crop Coeficient	0	0	0	0	3	.4	.88	.92	.76	.35	0	0	
E.T. Crop	.00	.00	.00	.00	1.29	3.56	8.90	7.78	4.55	.26	.00	.00	26.34
Effective Precipitation	.00	.00	.00	.00	.31	.22	.82	.99	.58	.26	.00	.00	3.18
E.T. - Eff. Rainfall	.00	.00	.00	.00	.97	3 34	8.08	6.79	3.98	.00	.00	.00	23.16
Carry Over Moisture	.64	.56	.64	.56	.00	.00	.00	.00	.00	.00	.56	.80	3.76
Cum. C.O.M. (july/june)	2.00	2.56	3.20	3.60	.00	.00	.00	.00	.00	00	56	1.36	----
Avail. Soil Moisture	2.00	2.56	3.20	3.60	3.60	3.60	3.60	3.60	.00	00	56	1.36	----
Irr. Requirement	.00	.00	.00	.00	.97	3.34	8.08	6.79	.38	.00	.00	.00	19.56

2599

2600

file name Corn11D Dec 18, 85

Crop Water Requirement

Climatic Zone--------- D
Crop--------------------Corn
Irr. Appl. In. --------- 3.0
W.H C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.9	32.2	38.8	47.0	56.6	65.8	72.5	70.2	62.4	51 3	38.2	28 7	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.00	.90	.90	.80	.70	.50	1.10	1.50	1.10	1.50	.80	1.10	11.90
Av. E.T.P. /day	.000	.000	.000	.130	.205	.285	.315	.264	.193	.104	000	.000	----
Days	0	0	0	0	14	30	31	31	30	3	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	2.868	8.561	9.767	8.176	5.780	.312	.000	.000	35.464
Crop Coeficient	0	0	0	0	.3	.35	.81	.94	.81	.74	0	0	
E.T. Crop	.00	.00	.00	.00	.86	3.00	7.91	7.69	4.68	.23	.00	.00	24.37
Effective Precipitation	.00	.00	.00	.00	.37	.29	.86	1.15	.72	.23	.00	.00	3.62
E.T. - Eff. Rainfall	.00	.00	.00	00	.49	2.71	7.05	6.54	3.96	.00	.00	.00	20.75
Carry Over Moisture	.80	.72	.72	.64	.00	.00	.00	.00	.00	.00	.64	.88	4.40
Cum. C.O.M. (july/june)	2.32	3.04	3.60	3.60	.00	.00	.00	.00	.00	.00	.64	1.52	----
Avail. Soil Moisture	2.32	3.04	3.60	3.60	3.60	3.60	3 60	3.60	.00	.00	.64	1.52	----
Irr. Requirement	.00	.00	.00	.00	.49	2.71	7.05	6.54	.36	.00	.00	.00	17.15

file name Grass11A Dec 18, 85 Crop Water Requirement

Climatic Zone--------- A
Crop-------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30 8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	90	.70	1.10	.50	.70	7.40
Av. E.T.P. /day	.000	.000	.000	.155	.234	.320	.347	.292	.213	.116	.000	.000	----
Days	0	0	0	13	31	30	31	31	30	27	0	0	
Av. E.T.P. /month	.000	.000	.000	2.010	7.260	9.593	10.772	9.040	6.394	3 123	.000	.000	48.192
Crop Coeficient	0	0	0	.81	.94	.82	.93	.85	.83	.93	0	0	
E.T. Crop	.00	.00	.00	1.63	6.82	7.87	10.02	7.68	5.31	2.90	.00	.00	42.23
Effective Precipitation	.00	.00	.00	.25	.25	.18	.58	.65	.44	.61	.00	.00	2.97
E.T. - Eff. Rainfall	.00	.00	.00	1.38	6.57	7.69	9.44	7.03	4 87	2.29	.00	.00	39.27
Carry Over Moisture	.48	.40	.40	.00	.00	.00	.00	.00	.00	.00	.40	.56	2.24
Cum. C.O.M. (july/june)	1.44	1.84	2.24	2.24	2.24	2.24	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1.84	2.24	3.60	3.60	3.60	3.60	3.60	2 29	.00	.40	.96	----
Irr. Requirement	.00	.00	.00	2.74	6.57	7.68	9.44	7.03	3.56	00	.00	.00	37.03

file name Grass11B Dec 18, 85 — Crop Water Requirement

Climatic Zone--------- B
Crop--------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69 4	76.0	73.7	65.4	53.6	40.1	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1.20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	7	31	30	31	31	30	23	0	0	
Av. E.T.P. /month	.000	.000	.000	1.023	6.957	9.249	10.430	8.757	6.199	2 574	.000	.000	45.189
Crop Coeficient	0	0	0	.76	.93	.83	.93	.84	.83	.95	0	0	
E.T. Crop	.00	.00	.00	.78	6.47	7.68	9.70	7.36	5.15	2.44	.00	.00	39.57
Effective Precipitation	.00	.00	.00	.30	.33	.18	.66	.80	.52	.66	.00	.00	3 46
E.T. - Eff. Rainfall	.00	.00	.00	.48	6.14	7.49	9 04	6 56	4.63	1.78	.00	.00	36.11
Carry Over Moisture	.56	.48	.48	.00	.00	.00	.00	.00	.00	.00	.48	.64	2 64
Cum. C.O.M. (july/june)	1.68	2.16	2.64	2.64	2.64	2.64	.00	.00	.00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	2.16	2.64	3.60	3.60	3.60	3.60	3.60	1.78	.00	.48	1.12	----
Irr. Requirement	.00	.00	.00	1.44	6.14	7.49	9 04	6.56	2.81	.00	.00	.00	33 47

file name Grass11C Dec 18, 85

Crop Water Requirement

Climatic Zone--------- C
Crop--------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71.9	63.9	52.4	39.1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.138	.215	.297	.326	.273	.200	.108	.000	.000	----
Days	0	0	0	1	31	30	31	31	30	19	0	0	
Av. E.T.P. /month	.000	.000	.000	.138	6.654	8.905	10.108	8.458	5.989	2 048	.000	.000	42.300
Crop Coeficient	0	0	0	.74	.9	.89	.88	.83	.87	.88	0	0	
E.T. Crop	.00	.00	.00	.10	5.99	7.93	8.90	7.02	5.21	1.80	.00	00	36.94
Effective Precipitation	.00	.00	.00	.10	.41	.28	.82	.95	.60	.71	.00	.00	3.86
E.T. - Eff. Rainfall	.00	.00	.00	.00	5.58	7.64	8.08	6.07	4.61	1.10	.00	.00	33.09
Carry Over Moisture	.64	.56	.64	.00	.00	.00	.00	.00	.00	.00	.56	.80	3.20
Cum. C.O.M. (july/june)	2.00	2.56	3.20	3.20	3.20	3.20	.00	.00	.00	.00	.56	1.36	----
Avail. Soil Moisture	2 00	2.56	3.20	3.20	3.60	3.60	3 60	3.60	1.10	.00	.56	1.36	----
Irr. Requirement	.00	.00	.00	.00	5.98	7.64	8 08	6.07	2.11	.00	.00	.00	29.89

file name Grass11D Dec 18, 85 Crop Water Requirement

Climatic Zone--------- D
Crop--------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.3	32.2	38.8	47.0	56.6	65.8	72.5	70.2	62.4	51.3	38.2	28.7	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.00	.90	.90	.80	.70	.50	1.10	1.50	1.10	1.50	.80	1.10	11.90
Av. E.T.P. /day	.000	.000	.000	.130	.205	.285	.315	.264	.193	.104	.000	.000	----
Days	0	0	0	0	26	30	31	31	30	15	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	5.326	8.561	9.767	8.176	5.780	1.560	000	.000	39.170
Crop Coeficient	0	0	0	0	.88	.92	.84	.83	.93	.74	0	0	
E.T. Crop	.00	.00	.00	.00	4.69	7.88	8.20	6.79	5.38	1 15	.00	.00	34.08
Effective Precipitation	.00	.00	.00	.00	.46	.38	.88	1.09	.75	.80	.00	.00	4.35
E.T. - Eff. Rainfall	.00	.00	.00	.00	4.23	7.50	7.33	5.70	4.63	.36	.00	.00	29.73
Carry Over Moisture	.80	.72	.72	.64	.00	.00	.00	.00	.00	.00	.64	.88	4.40
Cum. C.O.M. (july/june)	2.32	3.04	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.64	1.52	----
Avail. Soil Moisture	2.32	3.04	3.60	3.60	3.60	3 60	3.60	3 60	.36	.00	.64	1.52	----
Irr. Requirement	.00	.00	.00	.00	4.23	7.50	7.33	5.70	1.38	.00	.00	.00	26.13

2604

file name Grass11E Dec 18, 85

Crop Water Requirement

Climatic Zone--------- E
Crop--------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	25.4	30.8	37.2	45.3	54.9	64.0	70.7	68.5	60.9	50.1	37.3	28.0	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.20	1.00	1.10	.90	.90	.60	1.30	1.70	1.20	1 60	.90	1.30	13.70
Av. E.T.P. /day	.000	.000	.000	.121	.195	.274	.304	.255	.186	.100	.000	.000	----
Days	0	0	0	0	20	30	31	31	30	11	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	3 901	8.217	9 425	7.893	5 571	1.099	.000	.000	36.106
Crop Coeficient	0	0	0	0	.86	.93	.84	.85	.93	.9	0	0	
E.T. Crop	.00	.00	.00	.00	3.36	7.64	7.92	6 71	5.18	.99	.00	.00	31.79
Effective Precipitation	.00	.00	.00	.00	.56	.47	1.03	1.24	.82	.85	.00	.00	4.97
E.T. - Eff. Rainfall	.00	.00	.00	.00	2.80	7.18	6.89	5.47	4.36	.14	.00	.00	26.83
Carry Over Moisture	.96	.80	.88	.72	.00	.00	.00	.00	.00	.00	72	1.04	5.12
Cum. C.O.M. (july/june)	2 72	3.52	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.72	1.76	----
Avail. Soil Moisture	2.72	3.52	3.60	3.60	3.60	3.60	3.60	3 60	.14	.00	.72	1.76	----
Irr. Requirement	.00	.00	.00	.00	2.80	7.18	6.89	5.47	.90	.00	.00	.00	23.23

2606

file name Grass11F Dec 18, 85 Crop Water Requirement

Climatic Zone--------- F
Crop-------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	24.5	29.3	35.6	43.7	53.2	62.3	69.0	66.7	59.4	49 0	36.4	27.3	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.40	1.20	1.30	1.10	1.00	.70	1.50	1.90	1.30	1.70	1.00	1.50	15.60
Av. E.T.P. /day	.000	.000	.000	.113	.185	.263	.294	.245	.179	.096	.000	.000	----
Days	0	0	0	0	13	30	31	31	30	8	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	2.409	7.892	9.103	7.594	5.361	.769	.000	.000	33.128
Crop Coeficient	0	0	0	0	.81	.94	.83	.93	.88	.92	0	0	
E.T. Crop	.00	.00	.00	.00	1.95	7.42	7.56	7.06	4.72	.71	.00	00	29.41
Effective Precipitation	.00	.00	.00	.00	.58	.55	1.17	1.42	.87	.71	.00	.00	5.30
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.37	6.87	6.38	5.64	3.84	00	.00	.00	24.11
Carry Over Moisture	1.12	.96	1.04	.88	.00	.00	.00	.00	00	.00	.80	1.20	6.00
Cum C.O.M. (july/june)	3.12	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.80	2.00	----
Avail. Soil Moisture	3.12	3.60	3.60	3.60	3.60	3.60	3.60	3 60	.00	.00	.80	2.00	----
Irr. Requirement	00	.00	.00	.00	1.37	6.87	6.38	5 64	.24	.00	.00	.00	20 51

File name   Grass11G Dec 18, 85   Crop Water Requirement

2607

Climatic Zone--------- G
Crop-------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)~ 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	23.6	27.9	34.0	42.0	51.5	60 5	67.2	65.0	57.9	47 9	35.5	26.6	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.60	1.30	1.40	1.20	1.10	.80	1.70	2.20	1.50	1.90	1.20	1.70	17.60
Av. E.T.P. /day	.000	.000	.000	.105	.176	.252	.283	.236	.172	.092	.000	.000	----
Days	0	0	0	0	7	30	31	31	30	4	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	1.229	7.548	8.762	7.312	5.152	.369	.000	.000	30.371
Crop Coeficient	0	0	0	0	.76	.93	.83	.93	.84	.95	0	0	
E.T. Crop	.00	.00	.00	.00	.93	7.02	7.27	6.80	4.33	.35	.00	.00	26.70
Effective Precipitation	.00	.00	.00	.00	.61	.62	1.31	1.61	.99	.35	.00	.00	5.50
E.T. - Eff. Rainfall	00	.00	.00	.00	.32	6.40	5.96	5.19	3.34	.00	.00	.00	21.21
Carry Over Moisture	1.28	1.04	1.12	.96	.00	.00	.00	.00	.00	00	.96	1.36	6.72
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	.00	.00	.00	.00	.00	.00	.96	2.32	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3 34	.00	.00	.96	2.32	----
Irr. Requirement	00	.00	.00	.00	.32	6.40	5.96	4.93	.00	.00	.00	.00	17.61

file name Grass10H Dec 18, 85 Crop Water Requirement
Climatic Zone--------- H
Crop-------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	22.6	26.4	32.5	40.4	49.9	58.7	65.4	63.3	56.4	46 8	34.5	25.9	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.80	1.50	1.70	1.40	1.30	.90	1.90	2.50	1.60	2.00	1.30	1.90	19.80
Av. E.T.P. /day	.000	.000	.000	.097	.166	.240	.272	.227	.165	.089	.000	.000	----
Days	0	0	0	0	1	30	31	31	30	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	.166	7.204	8.420	7.029	4.942	.000	.000	.000	27.762
Crop Coeficient	0	0	0	0	.74	.9	.89	.88	.83	0	0	0	
E.T. Crop	.00	.00	.00	.00	.12	6.48	7.49	6.19	4.10	.00	.00	.00	24.39
Effective Precipitation	.00	.00	.00	.00	.12	.69	1.48	1.76	1.05	.00	.00	.00	5.10
E.T. - Eff. Rainfall	.00	.00	.00	.00	.00	5.80	6 01	4.42	3.06	.00	.00	.00	19.29
Carry Over Moisture	1.44	1.20	1.36	1.12	.00	.00	.00	.00	.00	1.60	1.04	1.52	9.28
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	1.60	2.64	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.06	.00	1.60	2.64	3.60	----
Irr. Requirement	.00	.00	.00	.00	.00	5.80	6.01	3.88	.00	00	.00	.00	15.69

2608

2609

file name Grass10I Dec 18, 85 Crop Water Requirement

Climatic Zone--------- I
Crop--------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	21.7	25.0	30.9	38.7	48.1	57.0	63.6	61.6	54.9	45.7	33.6	25.2	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	2.10	1.70	1.90	1.60	1.40	1.00	2.20	2.80	1.80	2.20	1.40	2.10	22 20
Av. E.T.P. /day	.000	.000	.000	.088	.156	.229	261	.218	.158	.085	.000	.000	----
Days	0	0	0	0	0	25	31	31	26	0	0.	0	
Av. E.T.P. /month	.000	.000	.000	.000	.000	5.733	8.079	6.747	4.102	.000	.000	.000	24.660
Crop Coeficient	0	0	0	0	0	.88	.93	.84	.82	0	0	0	
E.T. Crop	.00	.00	.00	.00	.00	5.04	7.51	5.67	3.36	.00	.00	.00	21.59
Effective Precipitation	00	.00	.00	.00	.00	.71	1.71	1.91	1.13	.00	.00	.00	5 47
E.T. - Eff. Rainfall	.00	.00	.00	.00	.00	4.33	5.80	3.75	2 23	.00	.00	.00	16.12
Carry Over Moisture	1.68	1.36	1.52	1.28	1.12	.00	.00	.00	.00	1.76	1.12	1.68	11.52
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	.00	1 76	2.88	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3.60	3.60	3.60	2.23	00	1 76	2.88	3.60	----
Irr. Requirement	.00	.00	.00	.00	.00	4.33	5.80	2.39	.00	.00	.00	.00	12.52

file name Grass10J Dec 18, 85 Crop Water Requirement

Climatic Zone--------- J
Crop-------------------Grass Hay/Pasture
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3 6
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	20.7	23.5	29.3	37.1	46.5	55.2	61.9	59.8	53.4	44 5	32.7	24.5	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	2.40	1.90	2.10	1.80	1.60	1.10	2.40	3.10	2.00	2.30	1.60	2.40	24.70
Av. E.T.P. /day	.000	.000	.000	080	.147	.218	.250	.208	.151	.081	.000	.000	----
Days	0	0	0	0	0	19	31	31	22	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	.000	4.139	7.756	6.448	3.317	.000	.000	.000	21.660
Crop Coeficient	0	0	0	0	0	.86	.94	.84	.93	0	0	0	
E.T. Crop	.00	.00	.00	.00	.00	3.56	7.29	5.42	3.09	.00	.00	.00	19.35
Effective Precipitation	.00	.00	.00	.00	.00	.73	1.85	2.09	1.24	.00	.00	.00	5.91
E.T. - Eff. Rainfall	00	.00	.00	.00	.00	2.83	5.44	3.33	1 84	.00	.00	.00	13.44
Carry Over Moisture	1.92	1.52	1.68	1.44	1.28	.00	.00	.00	.00	1.84	1.28	1.92	12.88
Cum. C.O.M. (july/june)	3.60	3.60	3.60	3.60	3.60	.00	.00	.00	.00	1.84	3.12	3.60	----
Avail. Soil Moisture	3.60	3.60	3.60	3.60	3 60	3.60	3.60	1.84	.00	1.84	3.12	3.60	----
Irr. Requirement	.00	.00	.00	.00	.00	2.83	5.44	1.57	.00	.00	.00	.00	9.84

file name OnionllA Dec 18, 85 Crop Water Requirement

Climatic Zone--------- A
Crop---------------------Onions
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30.8	----
Solar Radiation	0	0	400	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	.90	.70	1.10	.50	.70	7.40
Av E.T.P. /day	.000	.000	.091	.155	.234	.320	.347	.292	.213	.116	.000	.000	----
Days	0	0	11	30	31	30	31	31	30	15	0	0	
Av. E.T.P. /month	.000	.000	1.004	4.638	7.260	9.593	10.772	9.040	6.394	1.735	.000	.000	50.436
Crop Coeficient	0	0	.21	.67	1.08	.91	.68	.47	.28	.13	0	0	
E.T. Crop	.00	.00	.21	3.11	7.84	8.73	7.32	4.25	1.79	.23	.00	.00	33.48
Effective Precipitation	.00	.00	.21	.24	.24	.17	.44	.48	.33	23	.00	.00	2.34
E.T. - Eff. Rainfall	.00	.00	.00	2.87	7.60	8.56	6.88	3.76	1.46	.00	.00	.00	31.14
Carry Over Moisture	.48	.40	.00	.00	.00	.00	.00	.00	.00	.00	.40	.56	1.84
Cum. C.O.M. (july/june)	1.44	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1.80	1.80	1.80	1.80	1.80	1.80	1.46	.00	.00	.40	.96	----
Irr. Requirement	.00	.00	.00	2.87	7.60	8.56	6.88	3.43	.00	.00	.00	.00	29.34

2611

file name Onion11B Dec 18, 85 Crop Water Requirement

Climatic Zone--------- B
Crop-------------------Onions
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69.4	76.0	73.7	65.4	53.6	40.1	30.1	----
Solar Radiation	0	0	400	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1.20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.085	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	5	30	31	30	31	31	30	11	0	0	
Av. E.T.P. /month	.000	.000	.424	4.384	6.957	9.249	10.430	8.757	6.199	1.231	.000	.000	47.631
Crop Coeficient	0	0	.17	.52	1.06	.94	.7	.47	.26	.13	0	0	
E.T. Crop	.00	.00	.07	2.28	7.37	8.69	7.30	4.12	1.61	.16	.00	.00	31.61
Effective Precipitation	.00	.00	.07	.29	.31	.18	.52	.60	.38	.16	.00	.00	2.51
E.T. - Eff. Rainfall	.00	.00	.00	1.99	7.06	8.52	6.78	3.52	1.23	.00	.00	.00	29.10
Carry Over Moisture	.56	.48	.00	.00	.00	.00	.00	.00	.00	.00	.48	.64	2.16
Cum. C.O.M. (july/june)	1.68	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	1.80	1.80	1.80	1.80	1.80	1.80	1.23	.00	.00	.48	1.12	----
Irr. Requirement	.00	.00	.00	1.99	7.06	8.52	6.78	2.95	.00	.00	.00	.00	27.30

file name OnionIIC Dec 18, 85

Crop Water Requirement

2613

Climatic Zone--------- C
Crop-------------------Onions
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71 9	63.9	52.4	39.1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.138	.215	.297	.326	.273	.200	.108	.000	.000	----
Days	0	0	0	30	31	30	31	31	30	7	0	0	
Av. E.T.P. /month	.000	.000	.000	4.144	6.654	8.905	10.108	8.458	5.989	.754	.000	.000	45.013
Crop Coeficient	0	0	0	.41	.99	.98	.71	.47	.24	.13	0	0	
E.T. Crop	.00	.00	.00	1.70	6.59	8 73	7.18	3 98	1.44	.10	.00	.00	29.70
Effective Precipitation	.00	.00	.00	.34	.38	.27	.66	.72	.43	.10	.00	.00	2.90
E.T. - Eff. Rainfall	.00	.00	.00	1.36	6.21	8.46	6.51	3.26	1.00	.00	.00	.00	26.80
Carry Over Moisture	.64	.56	.64	.00	.00	.00	.00	.00	.00	.00	.56	.80	3.20
Cum. C.O.M. (july/june)	1.80	1.80	1.80	.00	.00	.00	.00	.00	.00	.00	.56	1.36	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.00	.00	.00	.56	1.36	----
Irr. Requirement	.00	.00	.00	1.36	6.21	8.46	6.51	2.46	.00	.00	.00	.00	25.00

2614

file name Onion11D Dec 27, 85 Crop Water Requirement

Climatic Zone--------- D
Crop-------------------Onions
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1 8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.3	32.2	38.8	47.0	56.6	65.8	72.5	70.2	62.4	51.3	38.2	28.7	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.130	.205	.285	.315	.264	.193	.104	.000	.000	----
Days	0	0	0	23	31	30	31	31	30	3	0	0	
Av. E.T.P. /month	.000	.000	.000	2.982	6.350	8.561	9.767	8.176	5.780	.312	.000	.000	41.928
Crop Coeficient	0	0	0	.33	.93	1.02	.73	.47	.23	.13	0	0	
E.T. Crop	.00	.00	.00	.98	5.91	8.73	7.13	3.84	1.33	.04	.00	.00	27.96
Effective Precipitation	.00	.00	.00	.33	.36	.27	.66	.71	.43	.04	.00	.00	2.80
E.T. - Eff. Rainfall	.00	.00	.00	.66	5.54	8.47	6.47	3.13	.90	.00	.00	.00	25.16
Carry Over Moisture	.64	.56	.64	.00	.00	.00	.00	.00	.00	.00	.56	.80	3.20
Cum. C.O.M. (july/june)	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.56	1.36	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.90	.00	.00	.56	1.36	----
Irr. Requirement	.00	.00	.00	.66	5.54	8.47	6.47	2.23	.00	.00	.00	.00	23.36

File name Onion10E Dec 18, 85 Crop Water Requirement

Climatic Zone--------- E

Crop-------------------Onions

Irr. Appl. In. --------- 1.8

W.H.C. (In./ft.)-------- 1.8

Root Zone (ft.)--------- 2

allowable Depletion (%)- 50

Available W.H.C.-------- 1.8

End Growing Season (mo.) 10

2015

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	25.4	30.8	37.2	45.3	54.9	64.0	70.7	68.5	60.9	50.1	37.3	28.0	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.20	1.00	1.10	.90	.90	.60	1.30	1.70	1.20	1.60	.90	1.30	13.70
Av. E.T.P. /day	.000	.000	.000	.121	.195	.274	.304	.255	.186	.100	.000	000	----
Days	0	0	0	17	31	30	31	31	10	0	0	0	
Av. E.T.P. /month	.000	.000	.000	2.060	6.047	8.217	9.425	7.893	1.857	.000	.000	.000	35.500
Crop Coeficient	0	0	0	.26	.82	1.05	.75	.47	.21	0	0	0	
E.T. Crop	.00	.00	.00	.54	4.96	8.63	7.07	3.71	.39	.00	.00	.00	25.29
Effective Precipitation	.00	.00	.00	.43	.55	.44	.88	.94	.39	.00	.00	.00	3.63
E.T. - Eff. Rainfall	.00	.00	.00	.11	4.41	8.19	6.19	2.77	.00	.00	.00	.00	21.66
Carry Over Moisture	.96	.80	.88	.00	.00	.00	.00	.00	.00	1.28	.72	1.04	5.68
Cum. C.O.M. (july/june)	1.80	1.80	1.80	.00	.00	.00	.00	.00	.00	1.28	1.80	1.80	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	1.28	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.11	4.41	8.19	6.19	.97	.00	.00	.00	.00	19.86

2616

file name Onion10F Dec 18, 85 Crop Water Requirement

Climatic Zone--------- F
Crop--------------------Onions
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	24.5	29.3	35.6	43.7	53.2	62.3	69.0	66 7	59.4	49 0	36.4	27.3	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.40	1.20	1.30	1.10	1.00	.70	1.50	1.90	1.30	1.70	1.00	1.50	15.60
Av. E.T.P. /day	.000	.000	.000	.113	.185	.263	.294	.245	.179	.096	.000	.000	----
Days	0	0	0	11	31	30	31	31	16	0	0	0	
Av. E.T.P. /month	.000	.000	.000	1.245	5.744	7.892	9.103	7.594	2 859	.000	.000	.000	34.438
Crop Coeficient	0	0	0	.21	.68	1.07	.79	.48	.21	0	0	0	
E.T. Crop	.00	.00	.00	.26	3.91	8.44	7.19	3.65	.60	00	.00	.00	24.05
Effective Precipitation	.00	.00	.00	.26	.58	.52	1.03	1.05	.60	.00	.00	.00	4.05
E.T. - Eff. Rainfall	.00	.00	.00	.00	3.32	7.92	6.16	2 59	.00	.00	.00	.00	20.00
Carry Over Moisture	1.12	.96	1.04	.00	.00	.00	.00	.00	.00	1.36	.80	1.20	6.48
Cum. C.O.M. (july/june)	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	1.36	1 80	1 80	----
Avail. Soil Moisture	1.80	1.80	1.80	1 80	1.80	1.80	1.80	.00	.00	1.36	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	3.32	7.92	6.16	.79	.00	.00	.00	00	18 20

file name Onion10G Dec 18, 85 Crop Water Requirement

Climatic Zone--------- G

Crop-------------------Onions

Irr. Appl. In. --------- 1.8

W.H C. (In./Ft.)-------- 1.8

Root Zone (ft.)--------- 2

allowable Depletion (%)- 50

Available W.H.C.-------- 1.8

End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	23.6	27.9	34.0	42.0	51.5	60.5	67.2	65.0	57.9	47.9	35.5	26.6	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.60	1.30	1.40	1.20	1.10	.80	1.70	2.20	1.50	1.90	1.20	1.70	17.60
Av. E.T.P. /day	.000	.000	.000	.105	.176	.252	.283	.236	.172	.092	.000	.000	----
Days	0	0	0	5	31	30	31	31	22	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.524	5.441	7.548	8.762	7.312	3.778	.000	.000	.000	33.364
Crop Coeficient	0	0	0	.38	.56	1.06	.81	.47	.2	0	0	0	
E.T. Crop	.00	.00	.00	.20	3.05	8.00	7.10	3.44	.76	.00	.00	.00	22.54
Effective Precipitation	.00	.00	.00	.20	.69	.66	1.30	1.34	.76	.00	.00	.00	4.93
E.T. - Eff. Rainfall	.00	.00	.00	.00	2.36	7.34	5.80	2.10	.00	.00	.00	.00	17.60
Carry Over Moisture	1.28	1.04	1.12	.00	.00	.00	.00	.00	.00	1.52	.96	1.36	7.28
Cum. C.O.M. (july/june)	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	1.52	1.80	1.80	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	1.52	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	2.36	7.34	5.80	.30	.00	.00	00	.00	15.80

2617

File name OnionlOH Dec 18, 85 Crop Water Requirement

Climatic Zone--------- H
Crop--------------------Onions
Irr. Appl. In. --------- 1.8
W H C. (In./ft.)-------- 1 8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	22.6	26.4	32.5	40.4	49.9	58.7	65.4	63.3	56.4	46 8	34.5	25.9	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.80	1.50	1.70	1.40	1.30	.90	1.90	2.50	1.60	2.00	1.30	1.90	19 80
Av. E.T.P. /day	.000	.000	.000	.097	.166	.240	.272	.227	.165	.089	.000	.000	----
Days	0	0	0	0	31	30	31	31	18	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	5.155	7.204	8.420	7.029	2 965	.000	.000	.000	30 774
Crop Coeficient	0	0	0	0	.42	1.03	.86	.47	.19	0	0	0	
E.T. Crop	.00	.00	.00	.00	2.17	7.42	7.24	3.30	.56	.00	.00	.00	20.69
Effective Precipitation	.00	.00	.00	.00	.69	.65	1.31	1.35	.56	.00	.00	.00	4.57
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.47	6.77	5.93	1.96	00	.00	.00	.00	16.13
Carry Over Moisture	1.44	1.20	1.36	1.12	.00	.00	.00	.00	.00	1.60	1.04	1.52	9.28
Cum. C.O.M. (july/june)	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.00	1.60	1.80	1.80	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	1.60	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	1.47	6.77	5.93	.16	.00	.00	.00	.00	14.33

2618

File name PotllA Dec 18, 85 Crop Water Requirement

Climatic Zone--------- A
Crop--------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	.90	.70	1.10	.50	.70	7.40
Av. E.T.P. %/day	.000	000	.000	.155	.234	.320	.347	.292	.213	.116	.000	.000	----
Days	0	0	0	25	31	30	31	31	30	15	0	0	
Av. E.T.P. /month	.000	.000	.000	3.865	7.260	9.593	10.772	9.040	6.394	1.735	.000	.000	48.659
Crop Coeficient	0	0	0	.3	.41	.78	.83	.75	.5	.25	0	0	
E.T. Crop	.00	.00	.00	1.16	2.98	7.48	8.94	6.78	3.20	.43	.00	.00	30.97
Effective Precipitation	.00	.00	.00	.22	.18	.16	.49	.56	.35	.43	.00	.00	2.39
E.T. - Eff. Rainfall	.00	.00	.00	.94	2.79	7.32	8.45	6.22	2.84	.00	.00	.00	28.58
Carry Over Moisture	.48	.40	.40	.00	.00	.00	.00	.00	.00	.00	.40	.56	2.24
Cum. C.O.M. (july/june)	1.44	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	.40	.96	----
Irr. Requirement	.00	.00	.00	.94	2.79	7.32	8.45	6.22	1.04	.00	.00	.00	26.78

2619

file name Pot11B Dec 18, 85

Crop Water Requirement

Climatic Zone--------- B
Crop-------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28 2	35.1	42.0	50.3	60.0	69.4	76.0	73.7	65 4	53.6	40.1	30.1	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1 20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	19	31	30	31	31	30	11	0	0	
Av. E.T.P. /month	.000	.000	.000	2.776	6.957	9.249	10.430	8 757	6.199	1 231	.000	.000	45.600
Crop Coeficient	0	0	0	.3	.43	.79	.83	.74	.47	.25	0	0	
E.T. Crop	.00	.00	.00	.83	2.99	7.31	8.66	6 48	2.91	.31	.00	.00	29 49
Effective Precipitation	.00	.00	.00	.27	.25	.16	.56	.68	.41	31	.00	.00	2.64
E.T. - Eff. Rainfall	.00	.00	.00	.56	2.75	7.14	8.09	5.80	2.51	.00	.00	.00	26.85
Carry Over Moisture	.56	.48	.48	.00	.00	.00	.00	.00	.00	00	.48	.64	2.64
Cum. C.O.M. (july/june)	1.68	1.80	1.80	.00	.00	.00	.00	.00	.00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	1.80	1.80	1.80	1.80	1 80	1.80	1.80	.00	.00	.48	1.12	----
Irr. Requirement	.00	.00	.00	.56	2.75	7.14	8.09	5.80	.71	.00	.00	.00	25.05

file name Pot11C Dec 18, 85

Crop Water Requirement

Climatic Zone--------- C
Crop-------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1 8
End Growing Season (mo.) 11

2621

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33.7	40.4	48.7	58.3	67.6	74.3	71.9	63.9	52 4	39.1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.138	.215	.297	.326	.273	.200	.108	.000	.000	----
Days	0	0	0	13	31	30	31	31	30	7	0	0	
Av. E.T P. /month	.000	.000	.000	1.796	6.654	8.905	10.108	8.458	5.989	.754	.000	.000	42.665
Crop Coeficient	0	0	0	.3	.37	.74	.84	.76	.55	.31	0	0	
E.T. Crop	.00	.00	.00	.54	2.46	6.59	8.49	6 43	3.29	23	.00	.00	28 04
Effective Precipitation	.00	.00	.00	.32	.30	.24	.72	.82	.48	.23	.00	.00	3.11
E.T. - Eff. Rainfall	.00	.00	.00	.22	2.16	6.35	7.78	5.61	2.81	.00	.00	.00	24.93
Carry Over Moisture	.64	.56	.64	.00	.00	.00	.00	.00	.00	00	.56	.80	3.20
Cum. C.O.M. (july/june)	1.80	1.80	1.80	.00	.00	.00	00	.00	.00	.00	.56	1.36	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1 80	1.80	.00	.00	.56	1.36	----
Irr. Requirement	.00	.00	.00	.22	2.16	6.35	7.78	5.61	1.01	.00	.00	.00	23.13

file name Pot11D Dec 18, 85 Crop Water Requirement

Climatic Zone--------- D
Crop--------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	26.3	32.2	38.8	47.0	56.6	65.8	72.5	70 2	62.4	51.3	38.2	28.7	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.00	.90	.90	.80	.70	.50	1.10	1.50	1.10	1.50	.80	1.10	11.90
Av. E.T.P. /day	.000	.000	.000	.130	.205	.285	.315	.264	.193	.104	.000	.000	----
Days	0	0	0	7	31	30	31	31	30	3	0	0	
Av. E.T.P. /month	.000	.000	.000	.908	6.350	8 561	9.767	8 176	5 780	312	.000	.000	39 854
Crop Coeficient	0	0	0	.3	.33	.72	.84	.78	.62	.35	0	0	
E.T. Crop	.00	.00	00	.27	2.10	6.16	8.20	6.38	3.58	.11	.00	.00	26.81

Effective Precipitation	.00	.00	.00	.27	.36	.31	.79	.96	61	.11	.00	.00	3.40
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.74	5.86	7.42	5.42	2.97	.00	.00	.00	23.41
Carry Over Moisture	.80	.72	.72	.00	.00	.00	.00	00	.00	.00	64	.88	3.76
Cum. C.O.M. (july/june)	1 80	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.64	1.52	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1 80	1.80	1.80	.00	.00	.64	1.52	----
Irr. Requirement	00	.00	.00	.00	1.74	5.86	7.42	5.42	1.17	.00	.00	.00	21.61

2623

file name　　　Pot10E　Dec 18, 85　　　Crop Water Requirement

Climatic Zone--------- E
Crop-------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C -------- 1.8
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	25.4	30.8	37.2	45.3	54.9	64.0	70.7	68.5	60.9	50.1	37.3	28.0	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.20	1.00	1.10	.90	.90	.60	1 30	1.70	1.20	1.60	.90	1.30	13.70
Av. E.T.P. /day	.000	.000	.000	.121	.195	.274	.304	.255	.186	.100	.000	.000	----
Days	0	0	0	1	31	30	31	31	29	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.121	6.047	8.217	9.425	7.893	5.385	.000	.000	.000	37.089
Crop Coeficient	0	0	0	.3	.3	.61	.84	.8	.67	0	0	0	
E.T. Crop	.00	.00	.00	.04	1.81	5.01	7.92	6.31	3.61	.00	.00	.00	24 70

Effective Precipitation	.00	.00	.00	.04	.46	.36	.93	1.09	.67	.00	.00	.00	3.55
E.T. - Eff. Rainfall	.00	.00	.00	.00	1.35	4.65	6.99	5.23	2.93	.00	.00	.00	21.16
Carry Over Moisture	.96	.80	.88	.00	.00	.00	.00	.00	00	1.28	.72	1.04	5.68
Cum. C.O.M. (july/june)	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	1.28	1.80	1.80	----
Avail. Soil Moisture	1 80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	1.28	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	1.35	4.65	6.99	5.23	1.13	.00	.00	.00	19.36

file name Pot10F Dec 18, 85 Crop Water Requirement

Climatic Zone--------- F
Crop--------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	24.5	29.3	35.6	43.7	53.2	62.3	69.0	66.7	59.4	49.0	36.4	27.3	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.40	1.20	1.30	1.10	1.00	.70	1.50	1.90	1.30	1 70	1.00	1.50	15.60
Av. E.T.P. /day	000	.000	.000	.113	.185	.263	.294	.245	.179	.096	.000	.000	----
Days	0	0	0	0	25	30	31	31	26	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	4.632	7.892	9.103	7.594	4.646	.000	.000	.000	33.868
Crop Coeficient	0	0	0	0	.3	.53	.82	.82	.72	0	0	0	
E.T. Crop	.00	.00	.00	.00	1.39	4.18	7.46	6.23	3.35	.00	.00	.00	22.61
Effective Precipitation	.00	.00	.00	.00	.51	.41	1.05	1.22	.73	.00	.00	.00	3.91
E.T. - Eff. Rainfall	.00	.00	.00	.00	.88	3.77	6.42	5.01	2 62	.00	.00	.00	18.70
Carry Over Moisture	1.12	.96	1 04	.88	.00	.00	.00	.00	.00	1 36	.80	1.20	7.36
Cum. C O.M. (july/june)	1.80	1.80	1.80	1.80	.00	.00	.00	.00	.00	1 36	1.80	1.80	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	1.36	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	.88	3.77	6.42	5.01	.82	.00	.00	.00	16.90

file name Pot10G Dec 18, 85 Crop Water Requirement

Climatic Zone--------- G
Crop-------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 10

2625

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	23.6	27.9	34.0	42.0	51.5	60.5	67.2	65 0	57.9	47.9	35.5	26.6	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.60	1.30	1.40	1.20	1.10	.80	1.70	2 20	1.50	1.90	1.20	1.70	17 60
Av. E.T.P. /day	.000	.000	.000	.105	.176	.252	.283	.236	.172	.092	.000	.000	----
Days	0	0	0	0	19	30	31	31	22	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	3.335	7.548	8.762	7.312	3 778	.000	.000	.000	30.734
Crop Coeficient	0	0	0	0	.3	.43	.79	83	.76	0	0	0	
E.T. Crop	.00	.00	.00	.00	1.00	3.25	6.92	6.07	2.87	.00	.00	.00	20.11
Effective Precipitation	.00	.00	.00	.00	.55	.45	1.15	1.39	.82	00	.00	.00	4.36
E.T. - Eff. Rainfall	.00	.00	.00	.00	.45	2.79	5.77	4.68	2.05	.00	00	.00	15.74
Carry Over Moisture	1.28	1.04	1.12	.96	.00	.00	.00	.00	.00	1.52	.96	1 36	8.24
Cum. C O.M. (july/june)	1 80	1.80	1.80	1.80	.00	.00	.00	.00	.00	1 52	1.80	1.80	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	.00	1.52	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	.45	2.79	5.77	4.68	.25	.00	.00	.00	13.94

file name Pot10H Dec 18, 85 Crop Water Requirement

Climatic Zone--------- H
Crop--------------------Potatoes
Irr. Appl. In. --------- 1.8
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 2
allowable Depletion (%)- 50
Available W.H.C.-------- 1.8
End Growing Season (mo.) 10

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	22.6	26.4	32.5	40.4	49.9	58.7	65.4	63.3	56.4	46.8	34.5	25.9	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	1.80	1.50	1.70	1.40	1.30	.90	1.90	2.50	1.60	2.00	1.30	1.90	19.80
Av. E.T.P. /day	.000	.000	.000	.097	.166	.240	.272	.227	.165	.089	.000	.000	----
Days	0	0	0	0	13	30	31	31	18	0	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	2.162	7.204	8.420	7.029	2.965	.000	.000	.000	27.781
Crop Coeficient	0	0	0	0	.3	.37	.74	.84	.79	0	0	0	
E.T. Crop	.00	.00	.00	.00	.65	2.67	6.23	5.90	2.34	.00	.00	.00	17.79
Effective Precipitation	.00	.00	.00	.00	.64	.50	1.24	1.56	.85	.00	.00	.00	4.79
E.T. - Eff. Rainfall	.00	.00	.00	.00	.01	2.17	4.99	4.35	1.49	.00	.00	.00	13.01
Carry Over Moisture	1.44	1.20	1.36	1.12	.00	.00	.00	.00	.00	1.60	1.04	1.52	9.28
Cum. C.O.M. (july/june)	1.80	1.80	1.80	1.80	1.80	1.80	.00	.00	.00	1.60	1.80	1.80	----
Avail. Soil Moisture	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.49	.00	1.60	1.80	1.80	----
Irr. Requirement	.00	.00	.00	.00	.01	2.17	4.99	4.04	.00	.00	.00	.00	11.21

file name Soy11A Dec 18, 85 Crop Water Requirement

2027

Climatic Zone--------- A
Crop--------------------Soybeans
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	29.1	35.6	43.6	52.0	61.7	71.2	77.8	75.4	66.8	54.7	41.0	30.8	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.60	.50	.50	.50	.40	.30	.70	90	.70	1.10	.50	.70	7.40
Av. E.T.P. /day	.000	.000	.000	.155	.234	.320	.347	.292	.213	.116	.000	.000	----
Days	0	0	0	0	13	30	31	31	30	15	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	3.045	9.593	10.772	9.040	6 394	1.735	.000	.000	40.579
Crop Coeficient	0	0	0	0	.3	.53	.91	.88	.7	.24	0	0	
E.T. Crop	.00	.00	.00	.00	.91	5.08	9.80	7 96	4.48	.42	.00	.00	28 65
Effective Precipitation	.00	.00	.00	.00	.18	.16	.57	.66	.42	.42	.00	.00	2.41
E.T. - Eff. Rainfall	.00	.00	.00	.00	.73	4.93	9.23	7.29	4.05	.00	.00	.00	26.24
Carry Over Moisture	.48	.40	.40	.40	.00	.00	.00	.00	.00	.00	.40	.56	2.64
Cum. C.O.M. (july/june)	1.44	1.84	2.24	2.64	.00	.00	.00	.00	.00	.00	.40	.96	----
Avail. Soil Moisture	1.44	1.84	2.24	2.64	3.60	3 60	3.60	3 60	.00	.00	.40	.96	----
Irr. Requirement	.00	.00	.00	.00	1.69	4.93	9.23	7.29	.45	.00	.00	.00	23.60

file name Soy11B Dec 18, 85

Crop Water Requirement

Climatic Zone--------- B
Crop--------------------Soybeans
Irr. Appl. In. --------- 3 0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	28.2	35.1	42.0	50.3	60.0	69.4	76.0	73.7	65.4	53.6	40.1	30.1	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.70	.60	.60	.60	.50	.30	.80	1.10	.80	1 20	.60	.80	8.60
Av. E.T.P. /day	.000	.000	.000	.146	.224	.308	.336	.282	.207	.112	.000	.000	----
Days	0	0	0	0	7	30	31	31	30	11	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	1.571	9.249	10.430	8.757	6.199	1.231	.000	.000	37.438
Crop Coeficient	0	0	0	0	.3	.39	.89	.89	.62	.23	0	0	
E.T. Crop	.00	.00	.00	.00	.47	3.61	9.28	7.79	3 84	.28	.00	.00	25.28
Effective Precipitation	.00	.00	.00	.00	.24	.15	.65	.82	.48	.28	.00	.00	2.62
E.T. - Eff. Rainfall	.00	.00	.00	.00	.23	3.46	8.63	6.97	3.36	.00	.00	.00	22.66
Carry Over Moisture	.56	.48	.48	.48	.00	.00	.00	.00	.00	.00	.48	.64	3.12
Cum. C.O.M. (july/june)	1.68	2.16	2.64	3.12	.00	.00	.00	.00	.00	.00	.48	1.12	----
Avail. Soil Moisture	1.68	2.16	2.64	3.12	3.60	3.60	3.60	3.36	.00	.00	.48	1.12	----
Irr. Requirement	.00	.00	.00	.00	.71	3.46	8.63	6.74	.00	.00	.00	.00	19 54

file name SoyllC Dec 18, 85

Crop Water Requirement

Climatic Zone--------- C
Crop-------------------Soybeans
Irr. Appl. In. --------- 3.0
W.H.C. (In./ft.)-------- 1.8
Root Zone (ft.)--------- 4
allowable Depletion (%)- 50
Available W.H.C.-------- 3.6
End Growing Season (mo.) 11

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Av. Temperature	27.3	33 7	40.4	48.7	58.3	67.6	74.3	71.9	63.9	52.4	39.1	29.4	----
Solar Radiation	0	0	0	494	570	631	606	531	461	340	0	0	----
Av. Precipitation	.80	.70	.80	.70	.60	.40	1.00	1.30	.90	1.30	.70	1.00	10.20
Av. E.T.P. /day	.000	.000	.000	.138	.215	.297	.326	.273	.200	.108	.000	.000	----
Days	0	0	0	0	1	30	31	31	30	7	0	0	
Av. E.T.P. /month	.000	.000	.000	.000	.215	8.905	10.108	8.458	5.989	.754	.000	.000	34.430
Crop Coeficient	0	0	0	0	.3	.37	.66	.88	.54	.21	0	0	
E.T. Crop	.00	.00	.00	.00	.06	3.29	6.67	7.44	3.23	.16	.00	.00	20.87
Effective Precipitation	.00	.00	.00	.00	.06	.22	.72	.97	.54	.16	.00	.00	2.66
E.T. - Eff. Rainfall	.00	.00	.00	.00	.00	3.08	5.95	6.47	2.70	.00	.00	00	18.20
Carry Over Moisture	.64	.56	.64	.56	.00	.00	.00	.00	.00	.00	.56	.80	3.76
Cum. C.O.M. (july/june)	2.00	2.56	3.20	3.60	3.60	3 60	.00	.00	.00	.00	.56	1.36	----
Avail. Soil Moisture	2.00	2.56	3.20	3.60	3.60	3.60	3.60	2.70	.00	.00	56	1.36	----
Irr. Requirement	.00	.00	.00	.00	.00	3.08	5.95	5.57	.00	.00	.00	.00	14.60