DOCUMENTATION OF A DEEP PERCOLATION

MODEL FOR ESTIMATING GROUND-WATER RECHARGE

By H. H. Bauer and J. J. Vaccaro

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DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
1201 Pacific Avenue - Suite 600
Tacoma, Washington 98402

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FOR ESTIMATING GROUND-WATER RECHARGE

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ABSTRACT

A deep percolation model, which operates on a daily basis, has been developed to estimate long-term average ground-water recharge from precipitation. It has been designed primarily to simulate recharge in large areas with variable weather, soils, and land uses, but it can also be used at any scale. This report documents the physical and mathematical concepts of the deep percolation model, describes its subroutines and data requirements, and describes the input data sequence and formats. The physical processes simulated are soil-moisture accumulation, evaporation from bare soil, plant transpiration, surface-water runoff, snow accumulation and melt, and accumulation and evaporation of intercepted precipitation.

The minimum data sets for the operation of the model are daily values of precipitation and maximum and minimum air temperature, soil thickness and available water capacity, soil texture, and land-use. Long-term average annual precipitation, actual daily stream-discharge, monthly estimates of base flow, Soil Conservation Service surface-runoff curve numbers, land-surface altitude-slope-aspect, and temperature lapse rates are optional.

The program is written in the FORTRAN 77 language with no enhancements and should run on most computer systems without modifications. Documentation has been prepared so that program modifications may be made for inclusions of additional physical processes or deletion of ones not considered important.

INTRODUCTION

A study of the Columbia River Plateau aquifer system was begun in October 1982 as one of 28 studies of the U.S. Geological Survey's Regional Aquifer System Analyses Program (RASA) to aid in the effective management of the nation's ground-water resource by providing geohydrologic and geochemical information. The area investigated covers approximately 50,600 square miles in central and eastern Washington, north-central and eastern Oregon, and a small part of northwestern Idaho (fig. 1). The ground water in the basalt and overlying sediments is a major source of water for municipal, industrial, domestic, and agricultural uses. Moreover, the basalt is under consideration as a candidate for a national high-level nuclear waste repository.

This report documents the computer program (model) used to estimate recharge to the aquifer system via the unsaturated zone. Estimates of the amount and distribution of recharge are necessary for ground-water modeling, an important aspect of the RASA program. The model is physically based, simulating or reading as data, on a daily basis, the major factors controlling recharge from precipitation. No calibration of parameters is required. It can be applied to systems that vary from a region to a field-plot study and is applicable to irrigated lands. The model was designed for computations over discrete areal blocks that can be either automatically generated or input by a user. Each block is further divided into several soil layers, each of which may be a different type.

This model was designed to fill a need between rigorous unsaturated flow models, for which the necessary soil parameter data are generally unavailable, and generalized methodologies for determining recharge. The model is based on practical and easily implemented physical relations presented in Wight and Neff (1983), Saxton and others (1974), and Leavesley and others (1983).

The model computes recharge from precipitation, evapotranspiration, and stream runoff, and consists of simplified, physical-process based submodels that allow a user to determine which components of the hydrologic system are important. The submodels can be modified and expanded for a user's particular needs. For example, the method used to calculate potential evapotranspiration is that of Jensen and Haise (Jensen, 1973) and was selected on the basis of its suitability to the climate of eastern Washington State, which for the most part is arid to semiarid. For use in a more humid area, a different method could be used, such as that of Thornthwaite (Jensen, 1973). Similarly, the particular runoff formulas and surface-runoff curve number tables used were developed for rangeland (Wight and Neff, 1983); these may need modifications for a densely forested region.

The minimum data sets are daily precipitation, daily maximum and minimum air temperatures, available soil water capacities, soil thickness, soil texture, and land use. Optional inputs are rooting depths, interception capacities, long-term average annual precipitation, land-surface elevation-slope-aspect, temperature lapse rates, and SCS (Soil Conservation Service) surface-runoff curve numbers, herein called CN numbers (U.S. Department of Agriculture, 1972). Daily stream discharge data for a basin, along with monthly estimates of ground-water discharge to the stream, herein called base flow, also can be used (and should be used when available). If streamflow data are not available, the model-computed surface-runoff values are used

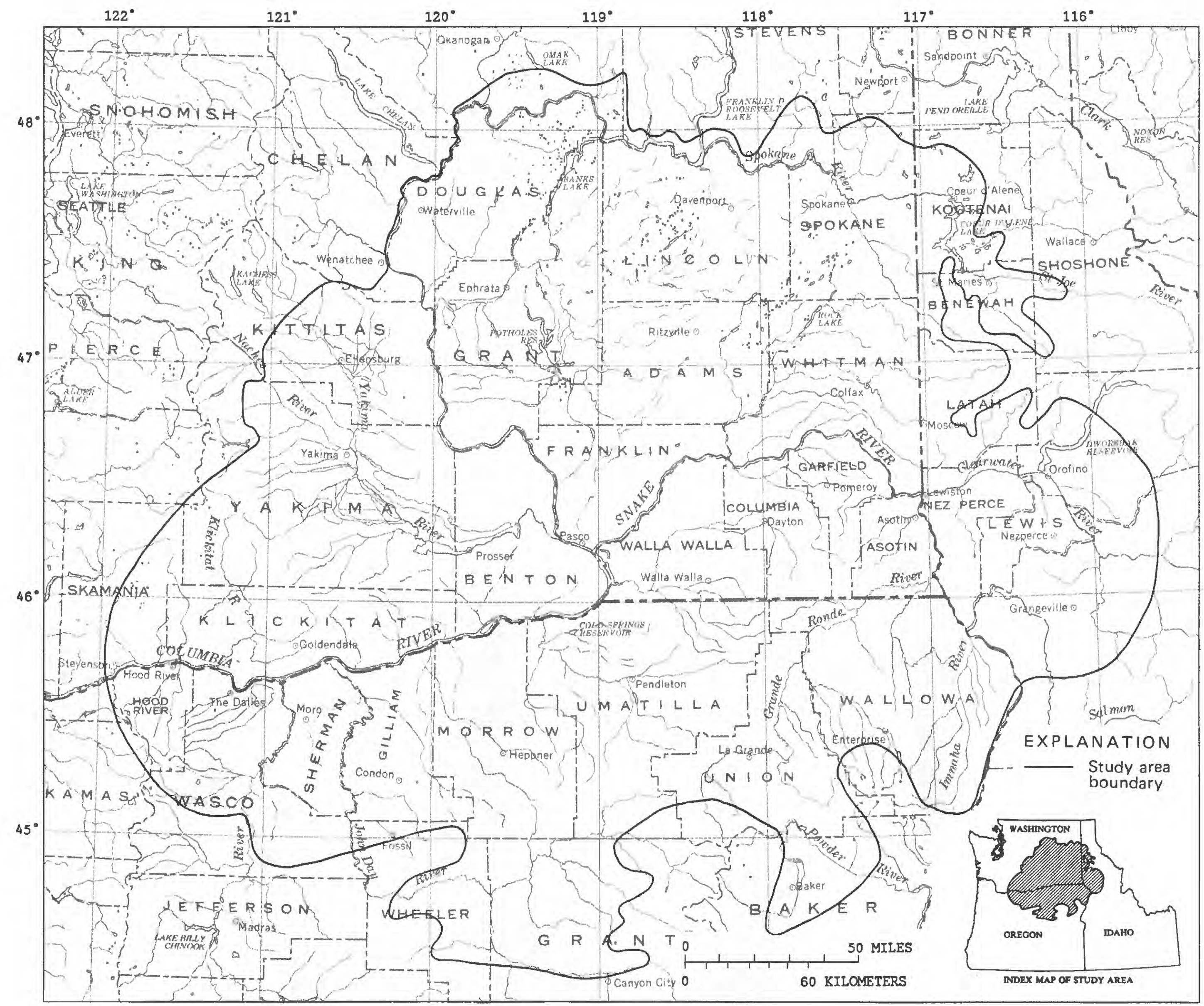

Figure 1.--Study area for which model was developed.

directly, but with less reliable results. The model also may be run under the assumption of no surface runoff.

Temperature and precipitation data generally are available. Other factors are evaluated as functions of temperature, precipitation, soil properties, land use, latitude, altitude, slope, and aspect. Up to 24 soil-type categories may be entered into the model. A soil type is defined by a combination of 6-inch-thick layers, each layer having a particular available water capacity and texture. Fifteen land-use categories are incorporated into the model. For most agricultural land uses there is a built-in crop-growth curve adapted from the U.S. Soil Conservation Service (1967). These curves are used to establish root depth, potential plant transpiration, potential interception, and daily apportionment factors of annual irrigation amounts for the current day of the year. The individual land uses are discussed in detail in the "Subroutines" section.

Consideration of the previously cited models, models cited in Curlin (1970) and Haan (1982), and the characteristics of the project area resulted in the model design incorporating nine major hydrologic and climatic factors:

1) the areal distribution of precipitation, air temperature, and solar radiation;
2) potential evapotranspiration;
3) snow accumulation, evaporation, and melt;
4) interception of precipitation by plant foliage and evaporation of intercepted moisture;
5) surface runoff;
6) soil-moisture accumulation;
7) soil-moisture evaporation;
8) transference of unused energy; and
9) plant transpiration.

The following section describes the physical submodels. These submodels have been designed for ease of understanding, minimum of data inputs, and adaptability to programming changes. The program is documented in later sections of the report through a description of the flow of the program, the subroutines, the common blocks, data attributes, file structure, data input guide, and example simulation. A listing of the program is given in Appendix A.

RECHARGE ESTIMATION MODEL

Theory and General Flow of Model

Several widely accepted and used empirical relations serve as the basis for the model. It should be stressed that the model is no more than an assemblage of these relations, along with a few reasonable assumptions, into a readily executable package. No calibration of unknown or poorly known parameters is necessary except for possible adjustments to estimates of the base-flow component of stream discharge. This is discussed in a later section. The empirical methods are, however, subject to some error, as are much of the required input data, especially soil properties, which are notoriously variable even on a small scale.

The model calculates areal distribution and the overall average of deep percolation for each year simulated as well as the averages for all years simulated. In general, it cannot be assumed that the deep percolation calculated for a particular year is equivalent to the amount of moisture recharging the water table aquifer during that year. For a water table near the land surface overlain by permeable soils or rock in a humid climate the lag time between deep percolation and ground-water recharge may only be a few days or hours, but for arid or semiarid areas where the water table may be several hundred feet below land surface the lag time could be tens or even hundreds of years. For the latter situation "pulses" of deep percolation tend to approach a constant rate at some depth which is equivalent to the average "pulse" rate. Therefore, while a long-term average distribution of deep percolation is probably always a good estimate of the long-term average recharge rate, care must be exercised when applying model output to specific years.

Model output results should be considered along with other methods of estimating recharge. For example, if the ground-water system is in a steady state condition the average discharge should equal the average recharge. If the geology were such that all recharge to an area must discharge to a stream then a base-flow analysis of the streamflow hydrograph could determine total ground-water recharge, although probably not the areal distribution of such recharge.

The conceptual processes simulated by the model are illustrated in figures 2 and 3. The processes are simulated one day at a time for one or more complete calendar years. Each day, each block of an area is simulated separately.

Daily precipitation and maximum-minimum air temperature input data from weather stations are first interpolated to each block. Potential evapotranspiration (PET), the evapotranspiration that would occur for a fully grown, fully covered field of alfalfa, water nonlimiting, is calculated at the temperature observation sites. If land slope and aspect (orientation) are input for selected blocks, PET calculations are made at those blocks and are corrected for the amount of incident solar radiation.

The form of precipitation, rain or snow, is then determined simply by noting whether the average air temperature is above or below 32 °F. If precipitation is snow, the snowpack is increased by the amount of

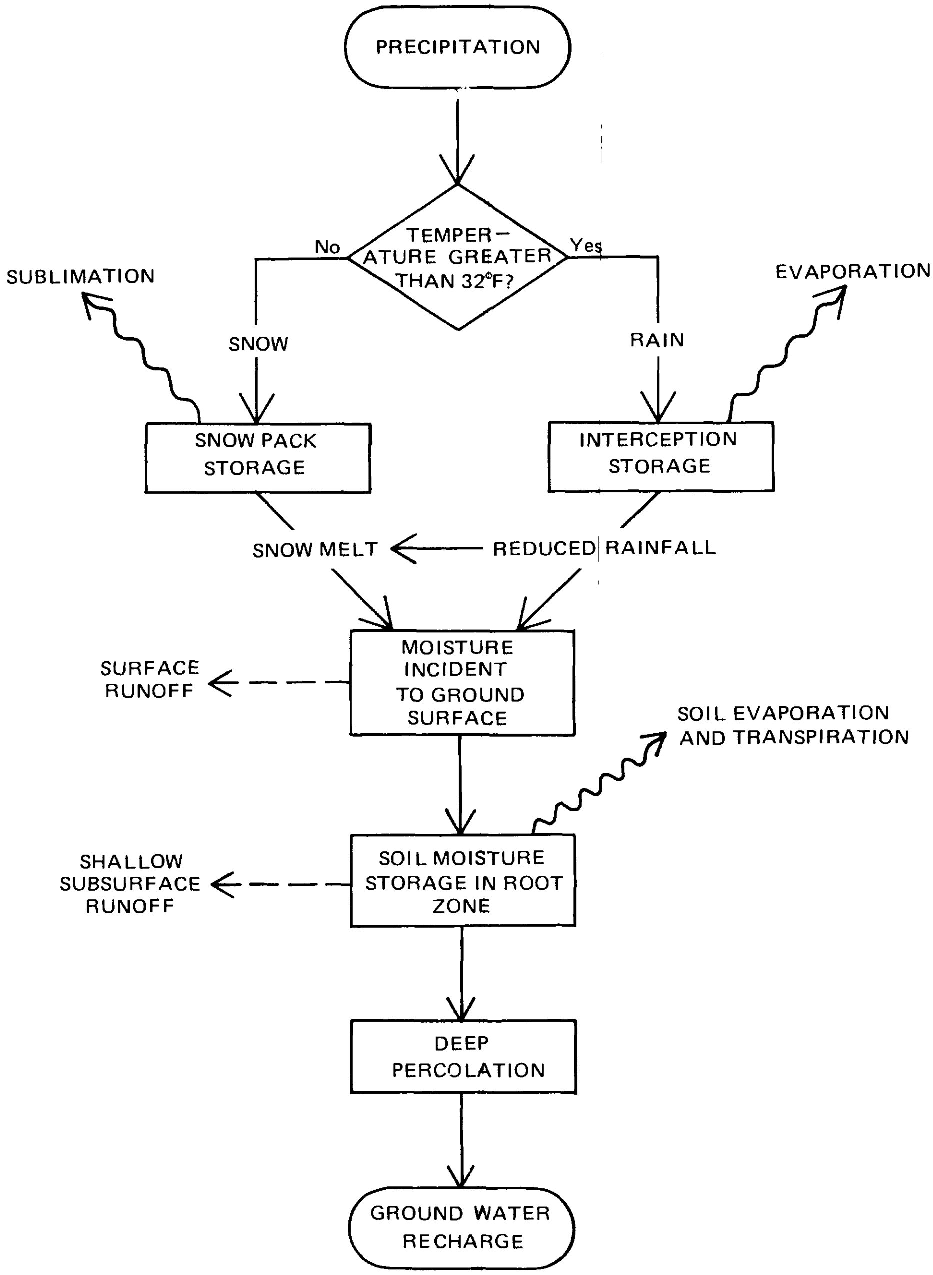

Figure 2.--Conceptual model of the water balance.

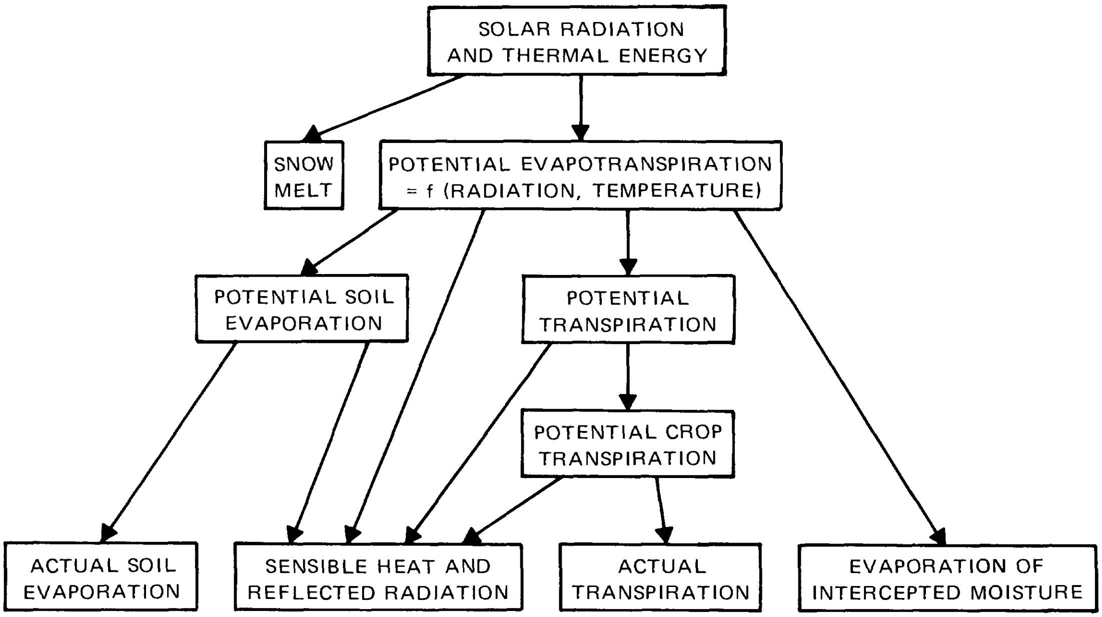

Figure 3.--Conceptual model of the energy balance for evapotranspiration.

precipitation and all further evaporation and transpiration calculations for that day are bypassed.

If precipitation is rain, an amount of moisture, dependent on the amount and type of foliage and leaf litter, is intercepted. This free water evaporates with little or no resistance (compared to soil moisture evapotranspiration) and is allowed to evaporate at the potential rate. Soil moisture evapotranspires at a rate less than PET, and is a function of soil moisture and texture. Moisture that reaches the soil surface (rainfall plus snowmelt minus interception--hereafter referred to as "incident moisture") partly infiltrates and partly runs off as surface water.

The surface runoff for each element is computed on the basis of the modified SCS method of Wight and Neff (1983). This method was developed for rangeland in eastern Montana and is based on the SCS curve number technique for determining surface runoff from small watersheds. When stream-discharge data are used, modified SCS surface-runoff values computed for each block are used to apportion or disaggregate the observed streamflow (minus the base flow) to the blocks of the model. If stream discharge data are not read in, the SCS-computed values are used directly. If the option to bypass runoff computations is in effect, surface runoff for all blocks is set to zero.

After these abstractions, any surplus moisture from precipitation and snowmelt is assumed to infiltrate the soil, where it is added to soil moisture storage in the root zone. When the surplus exceeds the remaining storage capacity, the difference is estimated to be deep percolation.

Potential soil evaporation (SOILPEV) is computed by subtracting the evaporated intercepted moisture from PET and multiplying by the proportion of land not covered by foliage. The difference between PET and SOILPEV becomes potential plant transpiration (PLNTPT). Actual soil evaporation (ACTEV) is estimated from a modification of the relation presented in Saxton and others (1974) and occurs only from the top 12 inches. In the computer program this relation is approximated by two linear functions (see fig. 6). Although Saxton and others (1974) limit bare soil evaporation losses to only the uppermost 6 inches, other investigators have used 12 inches (Wight and Neff, 1983). Cursory inspection of bare soil profiles in east-central Washington indicates that 12 inches is a better estimate. Soil moisture will not evaporate at the potential rate when the soil-moisture content is below field capacity. The unused energy (SOILPEV-ACTEV) is partly reflected back to the foliar cover, where it is added to potential plant transpiration (PLNTPT). According to Saxton and others (1974), the portion reflected back to the cover is 1.67 times the foliar cover fraction when the fraction is less than 0.6. When the fraction is greater than 0.6 all of the reflected energy contributes to PLNTPT. PLNTPT also is dependent on plant type and stage of growth. Finally, PLNTPT, which is based on alfalfa, is multiplied by the appropriate crop-growth coefficient (U.S. Department of Agriculture, 1967) to give the potential transpiration for the particular crop (CROPPT).

The difference between PLNTPT and CROPPT, along with the unused portion of SOILPEV (if any), is accumulated in an energy sink term. The sink term was used for checking the total evaporative energy balance; it is currently not printed in the water-energy budget, but can be printed with minor code modifications.

The amount of transpiration from each soil layer (ACTPLT) is based on root depth, soil type, and actual versus potential relations as shown in figure 4. If all of the CROPPT cannot be used, the remaining portion is added to the energy sink.

ACTPLT is calculated on the basis of the previous day's soil moisture plus moisture added from the current day's rain and snowmelt before any transpiration has occurred (see fig. 8). In reality, the soil moisture is depleted during the day, thereby diminishing the rate of ACTPLT. The error introduced by the simplification is probably quite small because of a "correcting effect" due to the fact that an overestimate of ACTPLT for a given day over-reduces the soil moisture content carried over to the the next day, which then reduces the next day's overestimate of ACTPLT.

A problem arises for days when observed surface runoff (stream discharge minus estimated base flow) exceeds incident moisture. This problem stems from the fact that the model does not attempt to route the movement of water below the root zone or to route the surface runoff (other than reading in a lag time between precipitation and stream discharge). Various phenomena contribute to what appears to be stream discharge in excess of base flow when there is no direct surface runoff. For example, in steep terrain near a stream or tributary, water from precipitation may infiltrate to a shallow impermeable layer, move downslope, and re-emerge after a short time as temporary springs or seepage that feed the stream system. Another documented phenomenon is that of bank storage. When the stage of a stream rises, a portion of the streamflow goes into the banks and is stored there, as the stage declines this water contributes to streamflow. Whatever combination of phenomena, the fact is that this water is not available to ground-water recharge and must be

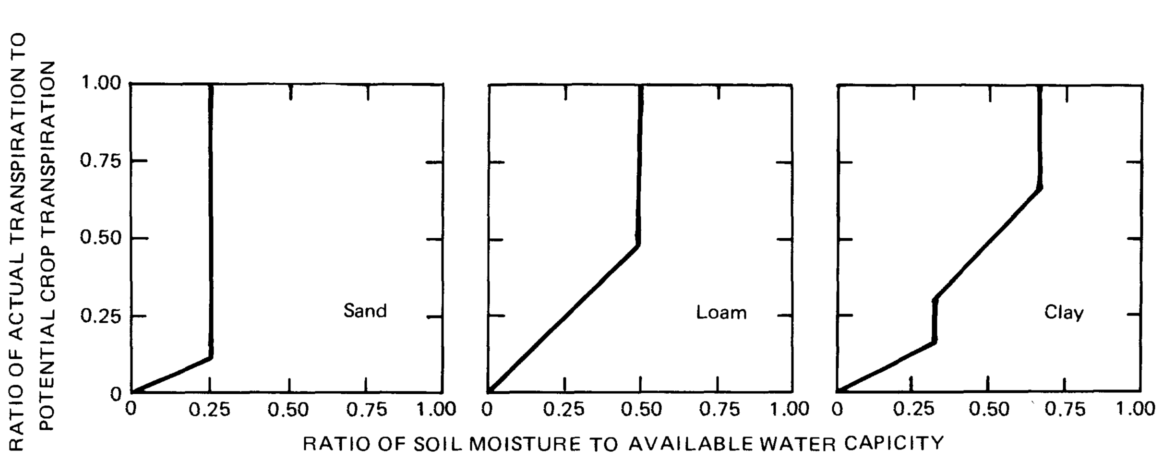

Figure 4.--Relation between actual and potential transpiration based on soil texture and soil moisture (after Leavesley and others, 1983).

accounted for in the water budget. The approach used here is that for any day that observed surface runoff exceeds incident moisture, the excess observed surface runoff amount is removed from soil moisture storage, as long as soil moisture remains at or above 50 percent of field capacity. This, in effect, corrects for water that had previously been added to soil moisture when, in fact, it had gone through other processes before emerging as surface runoff. A slight underestimate of recharge may be introduced as a result of increased rates of simulated soil evaporation and transpiration resulting from temporarily elevated soil-moisture contents.[1] A slight overestimate of recharge could also result when subsequent moisture in excess of remaining soil-moisture holding capacity is added before sufficient time has elapsed to remove the overestimated soil moisture by evapotranspiration.

If there still is excess surface runoff after soil moisture has been reduced to 50 percent of field capacity, a "deficit" is tabulated separately. A deficit would indicate that certain input parameters need to be adjusted, and (or) that there are significant errors in streamflow data and (or) precipitation data and (or) in estimation of base flow.

Regarding the uncertainty of the routing of surface runoff, the model could be operated so as to at least bracket total recharge for an area with respect to runoff. Clearly, if a simulation is made assuming that surface runoff is zero, annual recharge will probably be overestimated. If for such a simulation the average annual total runoff is then subtracted from the computed average annual recharge an underestimate of average recharge should result. This is because a greater total amount of evapotranspiration would be simulated due to generally higher soil moistures and also because a greater total surface runoff would be assumed (surface runoff plus base flow) than for a normal simulation. The usefulness of such bracketing will depend upon the magnitude of the total runoff with respect to the magnitude of the recharge.

The major processes are further described in detail in the following subsections.

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[1] Another approach would have been to reduce precipitation by the observed surface runoff, so that it never enters the soil. To do this, however, it must be known which of many days' surface-runoff values are to be associated with the current day's precipitation, and the model could not then operate on a simple daily basis as it does now.

Potential Evapotranspiration

PET is a measure of the maximum amount of plant transpiration and soil evaporation that can occur for a given weather condition. The method used to compute PET, from Jensen and Haise (Jensen, 1973), makes optimal use of available weather data for a project area. More rigorous methods require other meteorological data components that usually are not available, whereas simpler methods only use mean air temperatures and disregard solar radiation, which can be estimated from the daily maximum and minimum temperatures.

The Jensen-Haise PET (inches of water per day) is computed as a function of daily amount of incident solar radiation, average daily air temperature, and land-surface altitude (Jensen, 1973):

$$PET = \frac{R_I[T+2.5+0.14(E_2-E_1)+A/550]}{(38-2A/305) + 380/(E_2-E_1)} , \qquad (1)$$

where R_I = incident solar radiation, Langleys/hour
T = mean air temperature, ^oC,
A = land surface altitude, meters,
E_1, E_2 = saturation vapor pressures at the long-term mean minimum and maximum temperatures for the warmest month of the year, millibars.

Solar radiation data are generally not available; however, percentage of possible sunshine is available at a few weather stations. Incident solar radiation can be expressed as a function of percentage of possible sunshine, as presented in Jensen (1973):

$$R_I = (0.18 + 0.55S) R_A , \qquad (2)$$

where S = ratio of actual to possible sunshine (percentage of possible sunshine),
R_A = solar radiation intensity assuming no atmosphere, same units as R_I.

S can be estimated from daily temperature extremes. There is excellent linear correlation between percentage of possible sunshine and the difference between maximum and minimum daily temperatures (fig. 5). Regressions on monthly data for the three stations in eastern Washington having sunshine data were compared with one another using the regression curves for each of these stations. The maximum difference of predicted percentage of possible sunshine from station to station is only about 5 percent; therefore, it was possible to obtain a good estimate of solar radiation for any other temperature site in the study area using daily temperature extremes. The temperature-radiation relation coefficients, slope and intercept, are read in as data for the model.

R_A is calculated from relatively complex trigonometric functions of latitude, day of the year and land surface slope, and aspect (Kaufman and Weatherred, 1982). These functions are built into the model in subroutine POTET (see Appendix A), but will not be documented in this section because of their lengthiness.

During the winter season in cold climates PET would be computed as 0.0 inches/day using the method described above. Evaporation processes still occur during the winter season, thus, separate minimum PET rates are read on as data for months October through March. If the computed PET value for any day during those months is less than the minimum PET, it is set to that value. The authors chose a constant value of 0.01 inches/day for all winter season months. This value is nearly equal to the largest value presented by various investigators for sublimation from snowpack (Colbeck and Ray, 1978). It is likely a high value since sublimation occurs with less resistance than evaporation from frozen soil. Also, advective processes contribute more to sublimation than to soil evaporation. This would tend to over-estimate evaporation from bare soils, resulting in less recharge. The authors feel that for water-resource studies and management studies parameters should be chosen such that a conservative estimate at deep percolation results rather than the possibility of an overestimate.

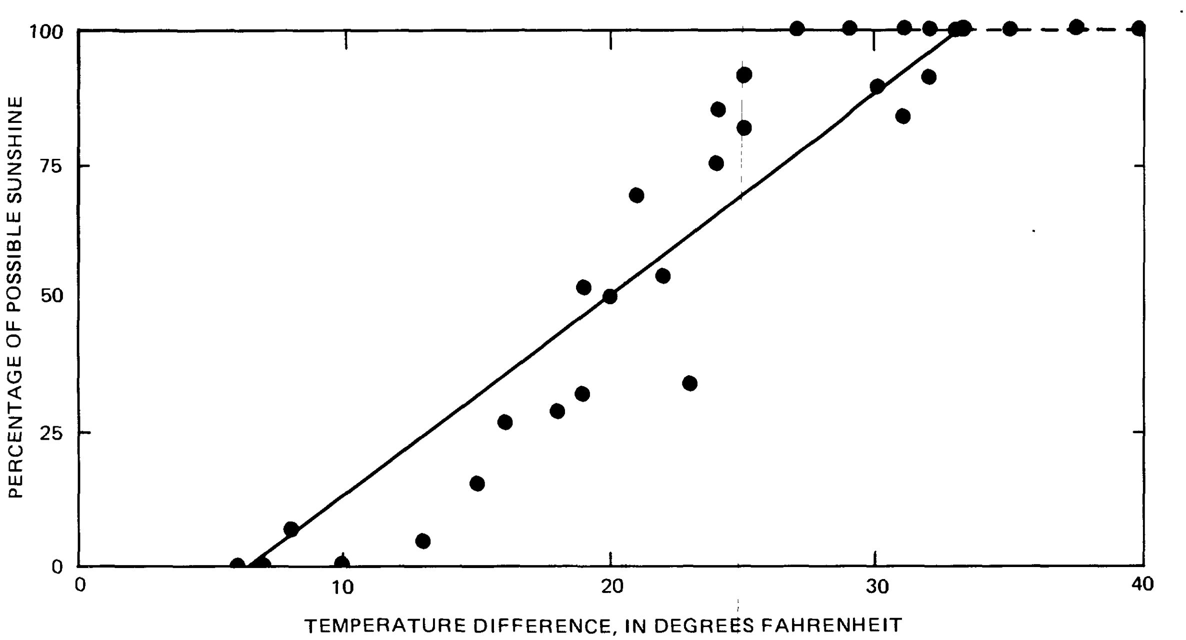

Figure 5.--Difference between daily maximum and minimum air temperatures as a function of percent possible sunshine, Walla Walla, Washington, August 1978.

Snow Accumulation and Ablation

If the average daily temperature is less than or equal to 32 degrees Fahrenheit (^{o}F), precipitation is assumed to be in the form of snow. The precipitation is added to the snowpack and all subsequent transpiration calculations for that day are bypassed. Sublimation (evaporation of the snowpack) is assumed to occur whenever there is a snowpack. A constant daily sublimation rate must be input by the user. If there is snowpack and the temperature is above 32 ^{o}F, the snowpack is melted according to the relation developed by Anderson (1973):

$$\text{snowmelt} = \frac{K_m}{4} * \text{tav6(i)} + 0.0014D, \quad \text{tav6(i)} > T_o \qquad (3)$$

$$= 0, \quad \text{tav6(i)} \leq T_o$$

where K_m is a melt-rate coefficient, inches/day/^{o}C, tav6(i) is the average temperature (^{o}C) for the ith 6-hour period and T_o is some temperature below which no snowmelt occurs. D is the number of days elasped beyond March 15 if the current day is in the first half year; if the current day is in the second half year, D is the number of days preceding October 15. Between October 15 and March 15, D equals zero. The factor 0.0014D roughly accounts for increasing solar radiation and is usually of no consequence for most areas, but it does account for those areas where snowpack is of longer duration, such as at high elevations. The 6-hour totals are obtained from a disaggregation of daily maximum-minimum air temperatures (Anderson, 1973):

tav6(1) = 0.95*tmn+0.05*tmxpre
tav6(2) = 0.40*tmn+0.60tmx
tav6(3) = 0.925*tmx+0.025*tmn+0.05*(tmn+tmxpre-tmx)
tav6(4) = 0.33*tmx+0.67*(tmn+tmxpre-tmx)

where tmn and tmx are all the minimum and maximum temperatures (^{o}C) for the current day, respectively, and tmxpre is the maximum temperature (^{o}C) of the previous day. Sublimation is computed for the two 6-hour periods between 6 a.m. and 6 p.m.

Snowmelt from rain on snow events is accounted for by the following relation of the U.S. Army Corps of Engineers (1956),

$$\text{snowmelt} = (\text{tav6(i)})*(0.029 + 0.0028 \text{ precip}), \quad \text{tav6(i)} \geq 0^{o}C \qquad (4)$$

$$= 0 , \quad \text{tav6(i)} \leq 0^{o}C$$

where the coefficients have been converted from centimeters to inches.

K_m, T_o, and sublimation rate are determined by substituting trial values of K_m and T_o into equations 3 and 4 over a winter season, along with trial values of sublimation, and comparing observed daily snowpack values with the computed values. It is probably sufficient to match when the last of the snow has melted rather than match amounts of snow on the ground, because the water equivalent of snow per unit volume is variable and generally not measured. For east-central Washington State, near latitude 48^{o}, longitude 119^{o} at an altitude of approximately 2,000 feet, values of $T_o = 34\ ^oF$ and $K_m = 0.28$ in./^oC/day gave good predictions. The T_o value of 34^oF is built into the model, but adjustments may be necessary for other locations. K_m was found to vary from 0.06 to 0.28 in./^oC/day* (Male and Granger, 1978) and must be read in. Sublimation rates vary and are a function of many factors. Values ranging from 0.002 to 0.011 in./day have been published (Colbeck and Ray, 1978).

Interception

The amount of precipitation that can be intercepted is determined from the land-use class and from the foliar cover for that land use, which is a function of the time of year. A maximum amount of interception is established for each of the land-use classes, either by default or by user-supplied values. The maximum value is adjusted from the phenological state of the land-use cover. The maximum value for the current day is reduced by any moisture remaining on the foliar cover from the previous day's simulation. If PET is greater than the intercepted amount, all of the intercepted moisture is evaporated and none remains on the foliage for the next day's simulation. If PET is less than the intercepted moisture, no PET energy is available for plant transpiration or soil evaporation for the current day and the difference is carried forward to the next day as remaining intercepted moisture.

Surface Runoff

Observed daily values of stream discharge and average-monthly rates of ground-water base-flow contribution for a basin should be input when daily streamflow records are available. Surface runoff for each block is computed by the U.S. Soil Conservation curve number method modified by Smith and Williams (1980). Total basin discharge minus base flow is apportioned to each block in direct proportion to the computed surface runoff for each block. The modified SCS curve number technique for computing surface runoff was selected over other methods because of its simplicity and because, for apportioning purposes, it is probably as valid as other, more complex methods. Surface runoff is a function of soil moisture and on only one composite parameter--the curve number (CN)--rather than of numerous parameters required by other methods, such as maximum and minimum contributing area and infiltration capacities, which are not readily available or measurable for a large project area.

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* K_m in Male and Granger (1978) is used in conjunction with average daily temperature, whereas K_m in the model is used with the disaggregated quarter-day temperatures; therefore, for each quarter-day the melt coefficient is set to 1/4 the value read in.

The SCS CN number II (CN2) is selected from published values (U.S. Department of Agriculture, 1972) relating soil and terrain characteristics to values of CN2 (table 1). CN2 is used to compute CN1, according to the polynomial relation of Wight and Neff (1983),

$$CN1 = -16.91+1.348(CN2)-0.01379(CN2)^{**}2+0.000177(CN2)^{**}3. \qquad (5)$$

The value CN1 is then used to estimate a maximum retention parameter, smx, by the equation

$$smx = (1000./CN1)-10. \qquad (6)$$

The current retention parameter, s, is then estimated from the weighted average of current soil-moisture content and available water capacity of each soil layer (Smith and Williams, 1980),

$$s = smx^{*}[1.0- \sum_{i=1}^{n} w_i(csm_i/UL_i)] \;, \qquad (7)$$

TABLE 1.--Surface runoff curve numbers, CN2 (from Wight and Neff, 1983)

Range site	Range condition: Fair	Range condition: High-fair and good	Range condition: Excellent
Wetland	95	95	95
Very shallow	95	90	85
Saline subirrigated	90	90	85
Subirrigated	90	90	85
Shale	90	85	90
Dense clay	90	85	80
Alkali clay	90	85	80
Seline upland	90	85	80
Igneous	90	80	75
Shallow clayey	85	80	75
Shallow sandy	90	75	70
Shallow loamy	90	75	70
Thin claypan	80	75	70
Shallow igneous	80	75	70
Steep clayey	80	75	70
Clayey	80	75	65
Gravelly loamy	80	75	65
Steep loamy	80	75	65
Overflow	90	70	60
Loamy overflow	80	70	60
Clayey overflow	80	70	60
Coarse upland	80	70	60
Limey upland	80	70	60
Shallow breaks	80	70	60
Stoney	80	70	60
Steep stoney	80	70	60
Lowland	80	70	60
Saline lowland	80	70	60
Loamy lowland	80	65	55
Loamy	80	65	55
Sandy lowland	75	60	50
Sandy	75	60	50
Gravelly	70	55	45
Sands	70	55	40
Choppy sands	70	55	40

where csm is the current soil moisture for layer i (inches); UL_i is the available water capacity of layer i (inches), n is the number of 6-inch soil layers in the maximum rooting depth for the soil type of a block, and w_i is a unitless weighting factor defined by Wight and Neff (1983) as

$$w_i = 1.016*[\exp{-4.16}\left(\frac{d_{i-1}}{rdmax}\right) - \exp{-4.16}\left(\frac{d_i}{rdmax}\right)] , \qquad (8)$$

where d_i is the depth to the bottom of layer i, and rdmax is the maximum root depth or total soil depth, whichever is less. Weighting factors decrease with depth; the sum of all w_i is unity.

Runoff (RO) is determined from the SCS (U.S. Department of Agriculture, 1972) equation

$$RO = (precp-0.2*s)^2/(precp+0.8*s) , \qquad (9)$$

where precp is this day's total precipitation and includes snowmelt. Since interception is accounted for in this relation, model-computed interception is not subtracted from precipitation in equation 9.

The term 0.2*S in equation 9 is defined as the sum of interception, infiltration, and surface storage at the start of a storm (U.S. Department of Agriculture, 1972). Since S is a function of CN2 and soil-moisture content, and since the CN number also varies with time, the CN2 would also have to be modified daily to account for changes in plant phenology. The selection of CN2 is subjective and would be impractical to do on a daily basis. Sensitivity analysis indicates that changing the CN2 values uniformly upward or downward, as would be done to account for plant phenology changes, produce no significant changes in output results when streamflow data are used.

Soil Moisture

Soil-moisture accounting is completed in two separate stages for each day. Surplus water (precipitation plus snowmelt minus sublimation minus interception minus surface runoff) is first added to the soil, and water is then removed by plant transpiration and soil evaporation.

Surplus water is added to the soil-moisture reservoir layer by layer. Each block is divided into 6-inch layers on the basis of available water capacity (equal to the field capacity minus the wilting point) and texture (sand, silt, etc.) If the surplus is less than the difference between the available water capacity and the current soil-moisture content, the current soil moisture is increased by the surplus. If the surplus is greater than the difference, the water content of the layer is brought to available water capacity and the remaining surplus is passed down to the next layer. This process continues until there is no more surplus water or until all layers are filled. Any surplus after all layers are at field capacity is deep percolation.

This method is simple, yet follows the physical processes. A more detailed analysis would require solving the nonlinear equation for vertical flow in unsaturated soils. The added complexity, data requirements, and computational time required for detailed analysis would be untenable for most project areas.

Soil Evaporation

Soil evaporation is estimated based on the method of Saxton and others (1974). The potential soil evaporation is first estimated from the calculated Jensen-Haise PET value that has been reduced by the evaporation of intercepted moisture. The method of estimation of potential values is

$$SOLPEV=(1.-FC)*ETP \quad (10)$$

where SOLPEV is potential soil evaporation, ETP is the potential evapotranspiration that has been reduced by interception, and FC is fractional foliar cover determined by land use, time of year, and phenological stage of the vegetation. Soil evaporation is then estimated using the relation shown in figure 6.

Applying Jensen-Haise PET to SOLPEV may slightly over-estimate SOLPEV (and therefore underestimate recharge) because bare soil is aerodynamically smoother than plant foliage and also because reflected shortwave radiation is greater for bare soil than for foliage. The importance of computing bare soil evaporation separately is that the soil zone from which moisture is removed is generally shallower than the root zone.

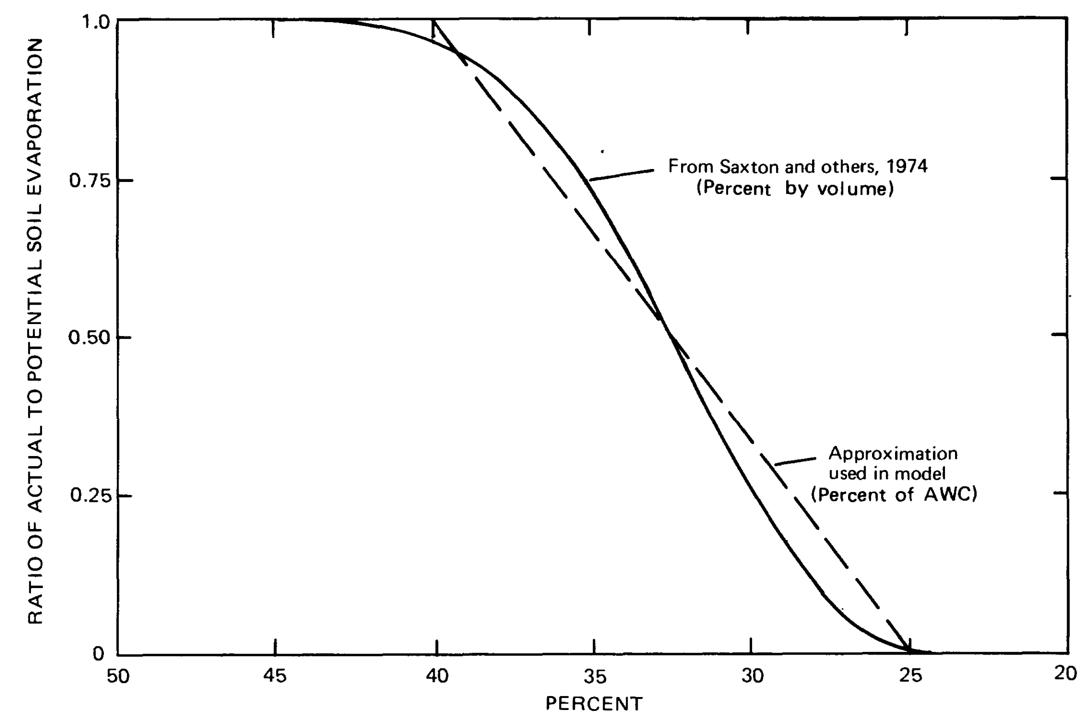


Figure 6.--Relation used to compute actual soil evaporaton from top 12 inches of soil (after Saxton and others, 1974).

Transference

The transfer of unused potential soil evaporation is estimated from the equation

$$PSTRN=(SOLPEV-ACTEV): \quad FC \geq 0.60$$
$$PSTRN=(SOLPEV-ACTEV)*1.666*FC: \quad FC <0.60, \qquad (11)$$

where PSTRN is the amount of unused energy transferred to potential plant transpiration and other variables are as previously defined. The unused energy is added to the energy sink for that day.

Plant Transpiration

Potential plant transpiration (PLNTPT) is evaluated by the following equation of Saxton and others (1974)

$$PLNTPT=(ETP*FC)+PSTRN. \qquad (12)$$

ETP is multiplied by FC to account for the solar radiation directly incident on the foliage.

Potential plant transpiration based on alfalfa is adjusted for the vegetation-growth stage for each land-use category, and for the time of year. The adjusted potential plant transpiration (CROPPT) is computed as:

$$CROPPT=PLNTPT*CP/1.13, \qquad (13)$$

where CP is the Blaney-Criddle crop-growth coefficient (U.S. Department of Agriculture, 1967) for the applicable vegetation and 1.13 is the maximum Blaney-Criddle crop coefficient for alfalfa. The difference between PLNTPT and CROPPT is added to the energy sink. This method accounts for changes in consumptive-use demand due to vegetation growth stage.

Extraction of water by vegetation is calculated for each soil layer within the root zone on the basis of the relations between soil type and actual and potential evapotranspiration given in Leavesley and others (1983) and shown in figure 4. The difference between the actual and potential evapotranspiration values is added to the energy sink term for the day.

PROGRAM DESCRIPTION

The following three sections describe: (1) the general flow of the computer program and some of its attributes, (2) the subroutines which are alphabetically ordered, and (3) the COMMON blocks. It has been assumed that the user is knowledgeable in the FORTRAN programming language and in the use of computers and data bases. The program has been written in FORTRAN 77 with no enhancements. In the discussion that follows, the naming conventions for variables, parameters, subroutines, and COMMON blocks will be the same as in the program.

General

The flow chart in figure 7 shows the order in which data are read by the program. The flow chart in figure 8 shows the flow of the program listed in Appendix A. The program first initializes variables, and then required data are read in by subroutine DATAIN. DATAIN calls DOGRID, PREVAL, AVJMP, TMPVAL, NEWLND, CN2GEN, and APPWAT. DOGRID reads grid information and generates the computational grid. If grid data are read in units of latitude and longitude, then DOGRID calls LAMBRT to convert the grid data into units of feet. PREVAL is called if the option is chosen to correct for the effects of elevation and other orographic influences on precipitation as accounted for on annual isohyetal maps. For example, the interpolated value of daily precipitation between two weather stations to a block that is much higher in elevation than both weather stations would probably have a significant error. PREVAL reads in annual isohyetal values for the blocks coded from the isohyetal map and annual average values at the weather stations so that daily corrections to the distance-interpolated values can be made on the basis of the ratios of the annual values. If PREVAL is not called, average annual values are not read in and interpolation is solely based on a distance-weighted scheme with no factors for variations in annual block values.

Long-term July average maximum and minimum temperatures are read in for each weather station by a call to AVJTMP. This data requirement is unique to the Jensen-Haise PET method and this subroutine should be bypassed if a different PET method were to be used.

TMPVAL is called from DATAIN to read in altitude, slope, and aspect for selected grid blocks, so that temperatures for those blocks may be corrected by the monthly lapse rate. This allows computation of PET using the corrected temperatures instead of interpolating PET from the weather stations. Slope and aspect for these blocks may also be used in the PET calculation. If slope and aspect are not input, then PET is calculated for a horizontal surface. This structure allows a user to collect and code only that data which is meaningfull.

NEWLND is called from DATAIN to read the initial land use numbers for all blocks. This is a separate subroutine because if land use changes from one year to the next, new land uses may be read for subsequent years.

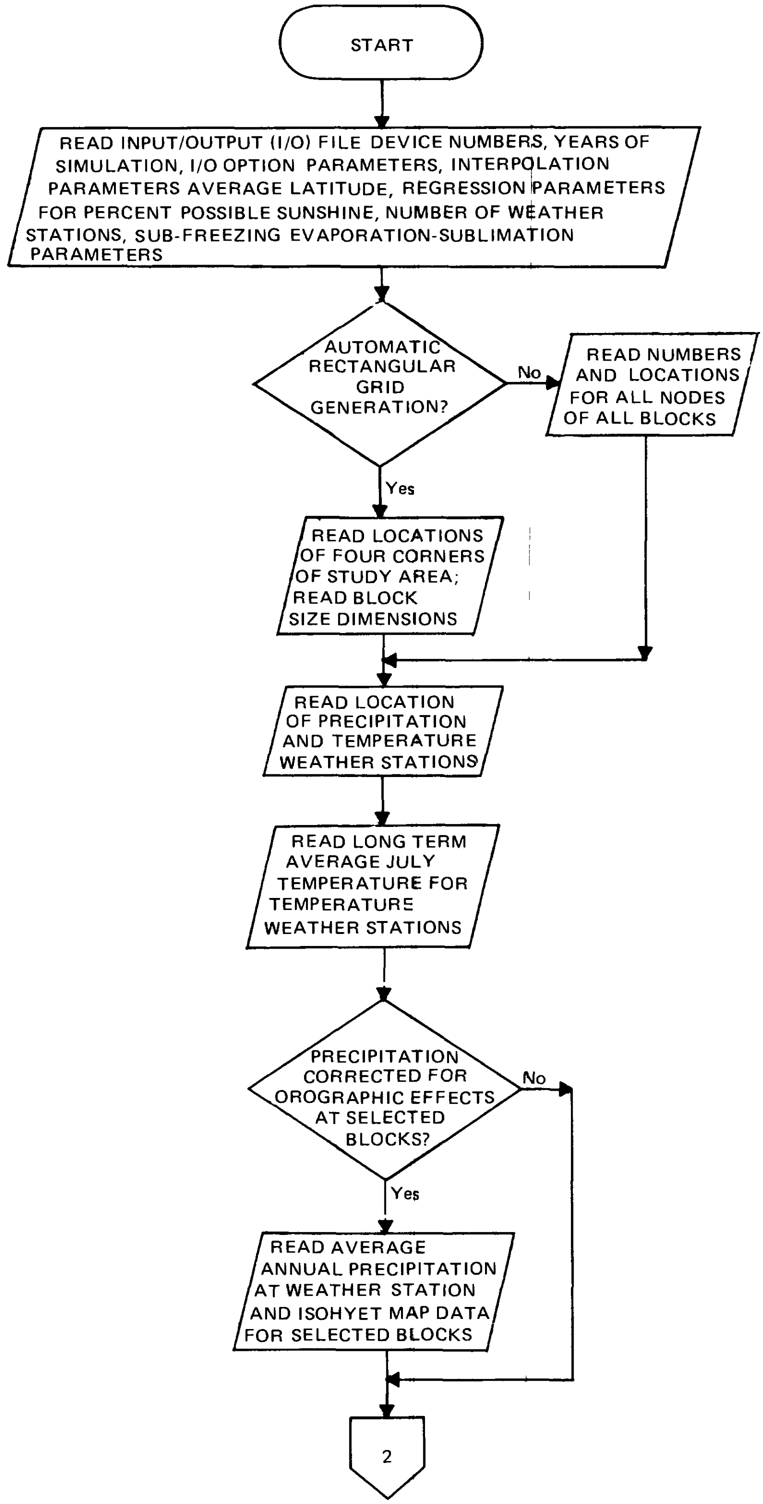


Figure 7.--Input data requirements.

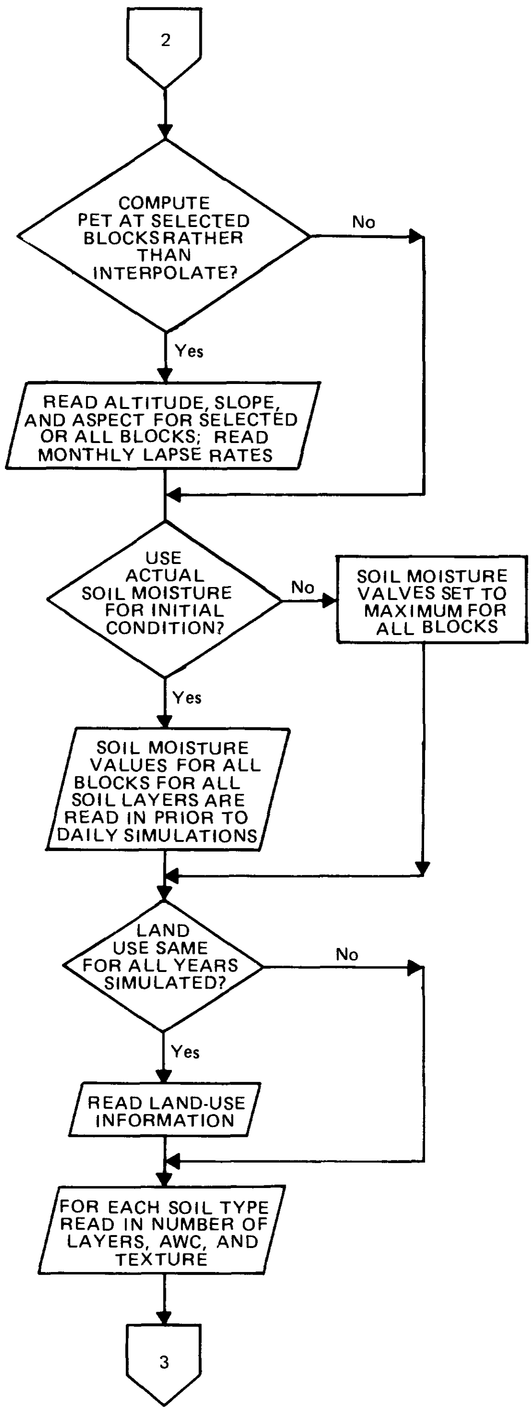

2
COMPUTE PET AT SELECTED BLOCKS RATHER THAN INTERPOLATE?
No
Yes
READ ALTITUDE, SLOPE, AND ASPECT FOR SELECTED OR ALL BLOCKS; READ MONTHLY LAPSE RATES
USE ACTUAL SOIL MOISTURE FOR INITIAL CONDITION?
No
SOIL MOISTURE VALVES SET TO MAXIMUM FOR ALL BLOCKS
Yes
SOIL MOISTURE VALUES FOR ALL BLOCKS FOR ALL SOIL LAYERS ARE READ IN PRIOR TO DAILY SIMULATIONS
LAND USE SAME FOR ALL YEARS SIMULATED?
No
Yes
READ LAND-USE INFORMATION
FOR EACH SOIL TYPE READ IN NUMBER OF LAYERS, AWC, AND TEXTURE
3

Figure 7.--Con.

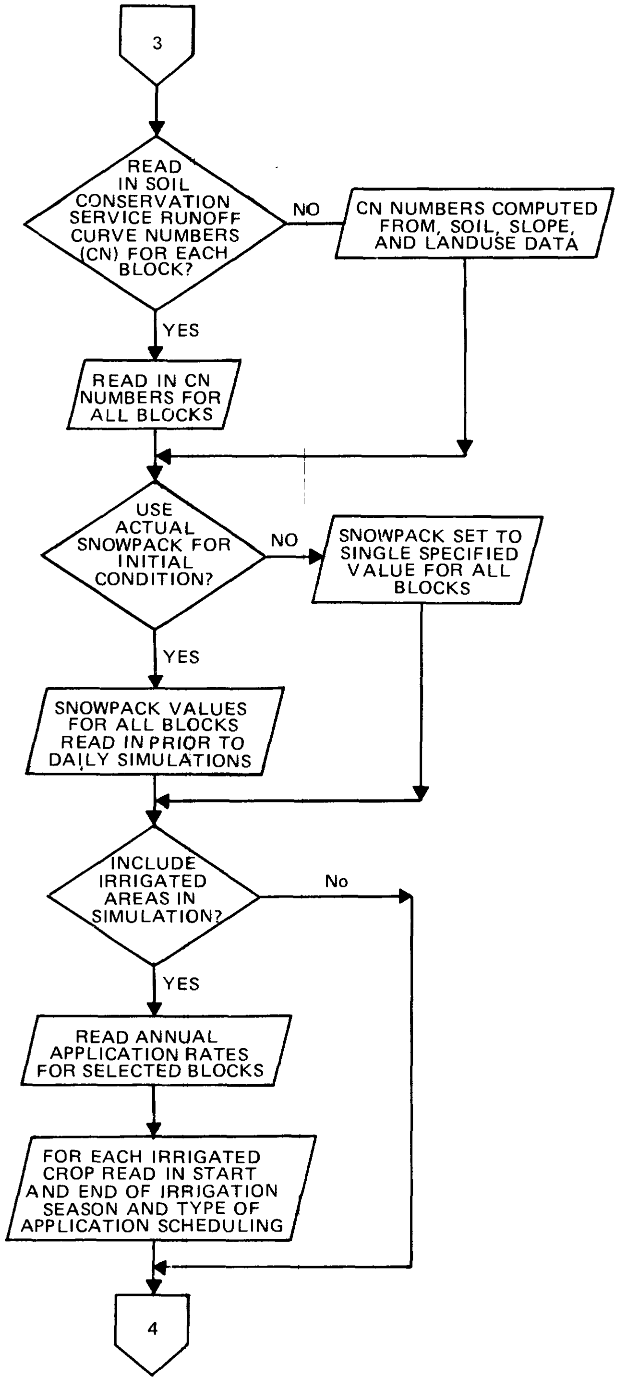

3
READ IN SOIL CONSERVATION SERVICE RUNOFF CURVE NUMBERS (CN) FOR EACH BLOCK?
NO
CN NUMBERS COMPUTED FROM, SOIL, SLOPE, AND LANDUSE DATA
YES
READ IN CN NUMBERS FOR ALL BLOCKS
USE ACTUAL SNOWPACK FOR INITIAL CONDITION?
NO
SNOWPACK SET TO SINGLE SPECIFIED VALUE FOR ALL BLOCKS
YES
SNOWPACK VALUES FOR ALL BLOCKS READ IN PRIOR TO DAILY SIMULATIONS
INCLUDE IRRIGATED AREAS IN SIMULATION?
No
YES
READ ANNUAL APPLICATION RATES FOR SELECTED BLOCKS
FOR EACH IRRIGATED CROP READ IN START AND END OF IRRIGATION SEASON AND TYPE OF APPLICATION SCHEDULING
4

Figure 7.--Con.

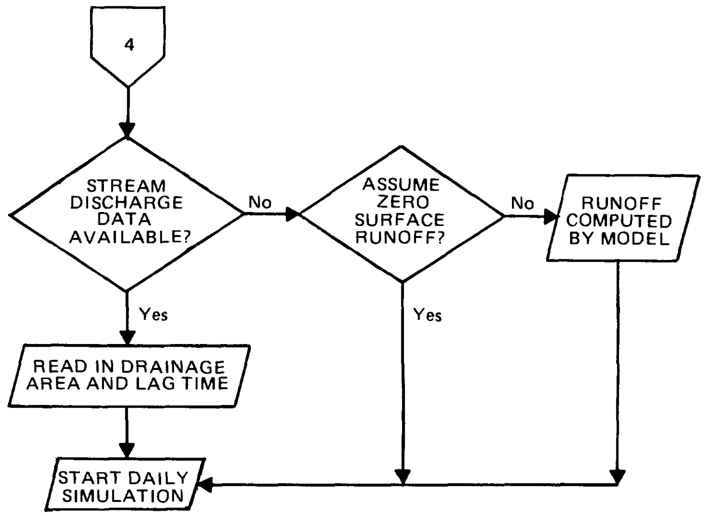

4
STREAM DISCHARGE DATA AVAILABLE?
No
ASSUME ZERO SURFACE RUNOFF?
No
RUNOFF COMPUTED BY MODEL
Yes
READ IN DRAINAGE AREA AND LAG TIME
Yes
START DAILY SIMULATION

Figure 7.--Con.

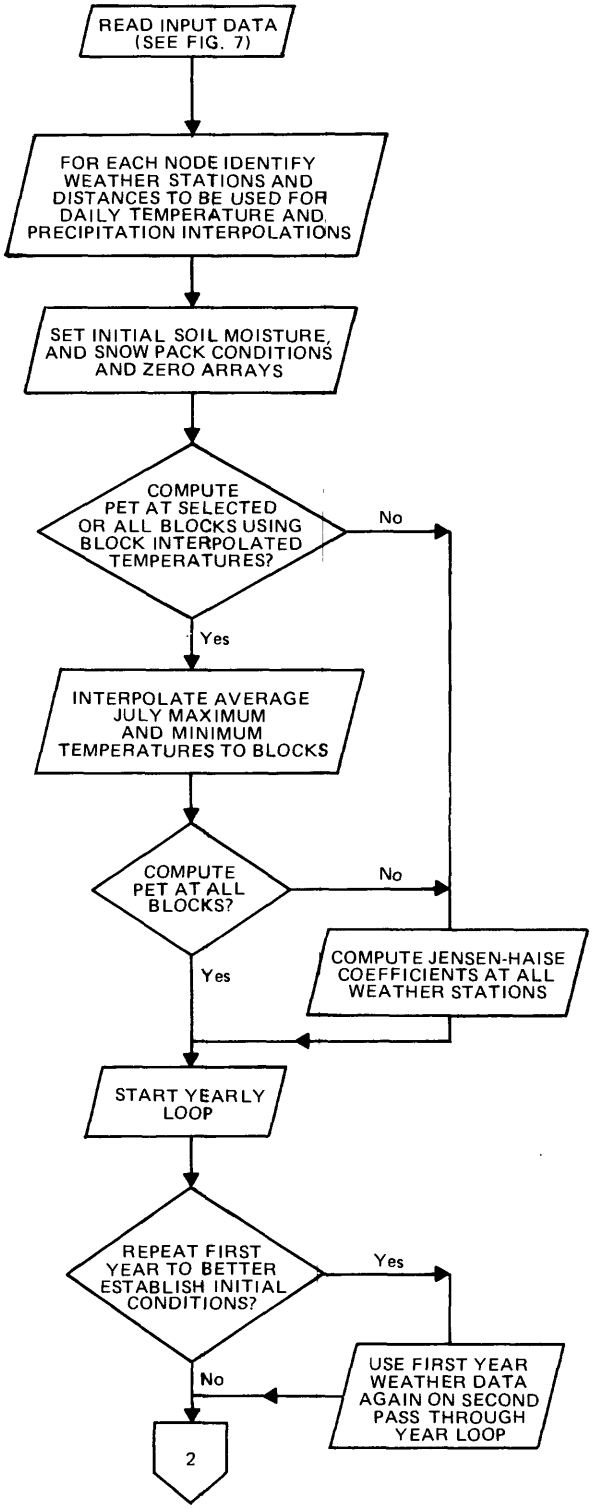


Figure 8.--Flow of program.

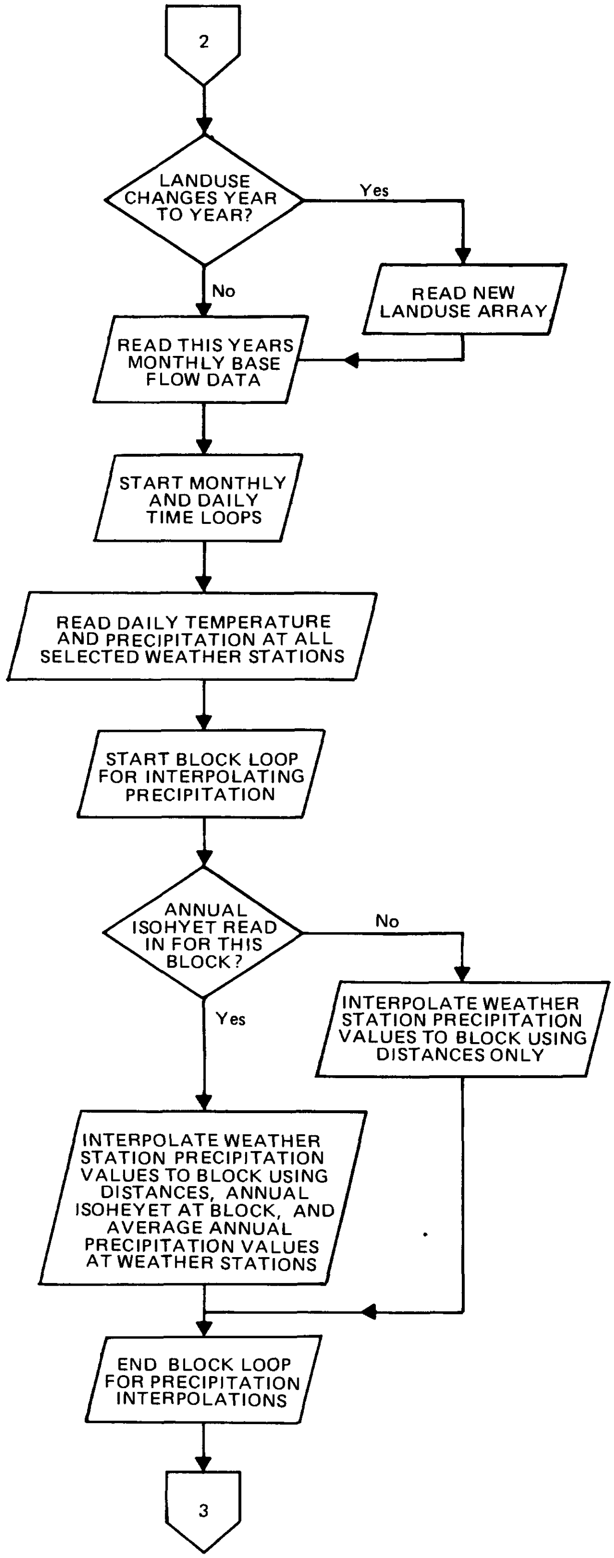

2
LANDUSE CHANGES YEAR TO YEAR?
Yes
READ NEW LANDUSE ARRAY
No
READ THIS YEARS MONTHLY BASE FLOW DATA
START MONTHLY AND DAILY TIME LOOPS
READ DAILY TEMPERATURE AND PRECIPITATION AT ALL SELECTED WEATHER STATIONS
START BLOCK LOOP FOR INTERPOLATING PRECIPITATION
ANNUAL ISOHYET READ IN FOR THIS BLOCK?
No
INTERPOLATE WEATHER STATION PRECIPITATION VALUES TO BLOCK USING DISTANCES ONLY
Yes
INTERPOLATE WEATHER STATION PRECIPITATION VALUES TO BLOCK USING DISTANCES, ANNUAL ISOHEYET AT BLOCK, AND AVERAGE ANNUAL PRECIPITATION VALUES AT WEATHER STATIONS
END BLOCK LOOP FOR PRECIPITATION INTERPOLATIONS
3

Figure 8.--Con.

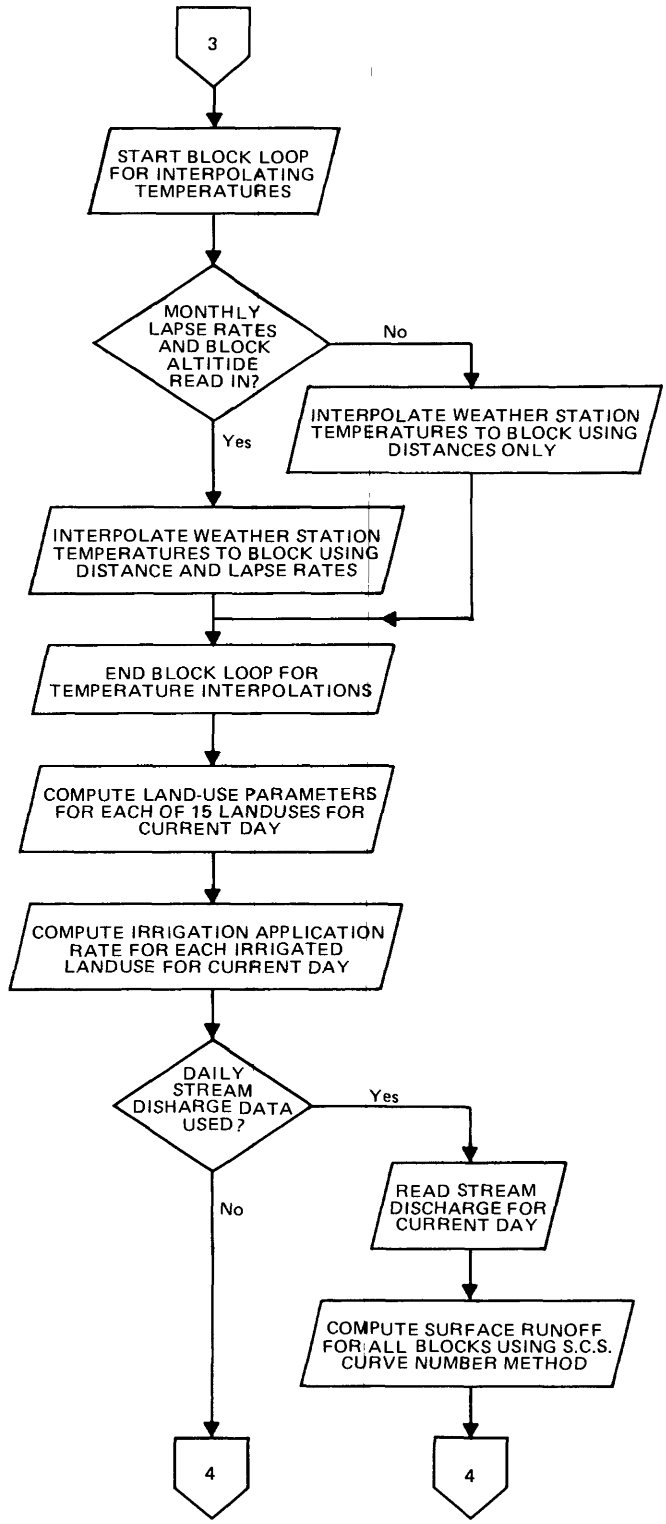

3
START BLOCK LOOP FOR INTERPOLATING TEMPERATURES
MONTHLY LAPSE RATES AND BLOCK ALTITIDE READ IN?
No
Yes
INTERPOLATE WEATHER STATION TEMPERATURES TO BLOCK USING DISTANCES ONLY
INTERPOLATE WEATHER STATION TEMPERATURES TO BLOCK USING DISTANCE AND LAPSE RATES
END BLOCK LOOP FOR TEMPERATURE INTERPOLATIONS
COMPUTE LAND-USE PARAMETERS FOR EACH OF 15 LANDUSES FOR CURRENT DAY
COMPUTE IRRIGATION APPLICATION RATE FOR EACH IRRIGATED LANDUSE FOR CURRENT DAY
DAILY STREAM DISHARGE DATA USED?
Yes
No
READ STREAM DISCHARGE FOR CURRENT DAY
COMPUTE SURFACE RUNOFF FOR ALL BLOCKS USING S.C.S. CURVE NUMBER METHOD
4
4

Figure 8.--Con.

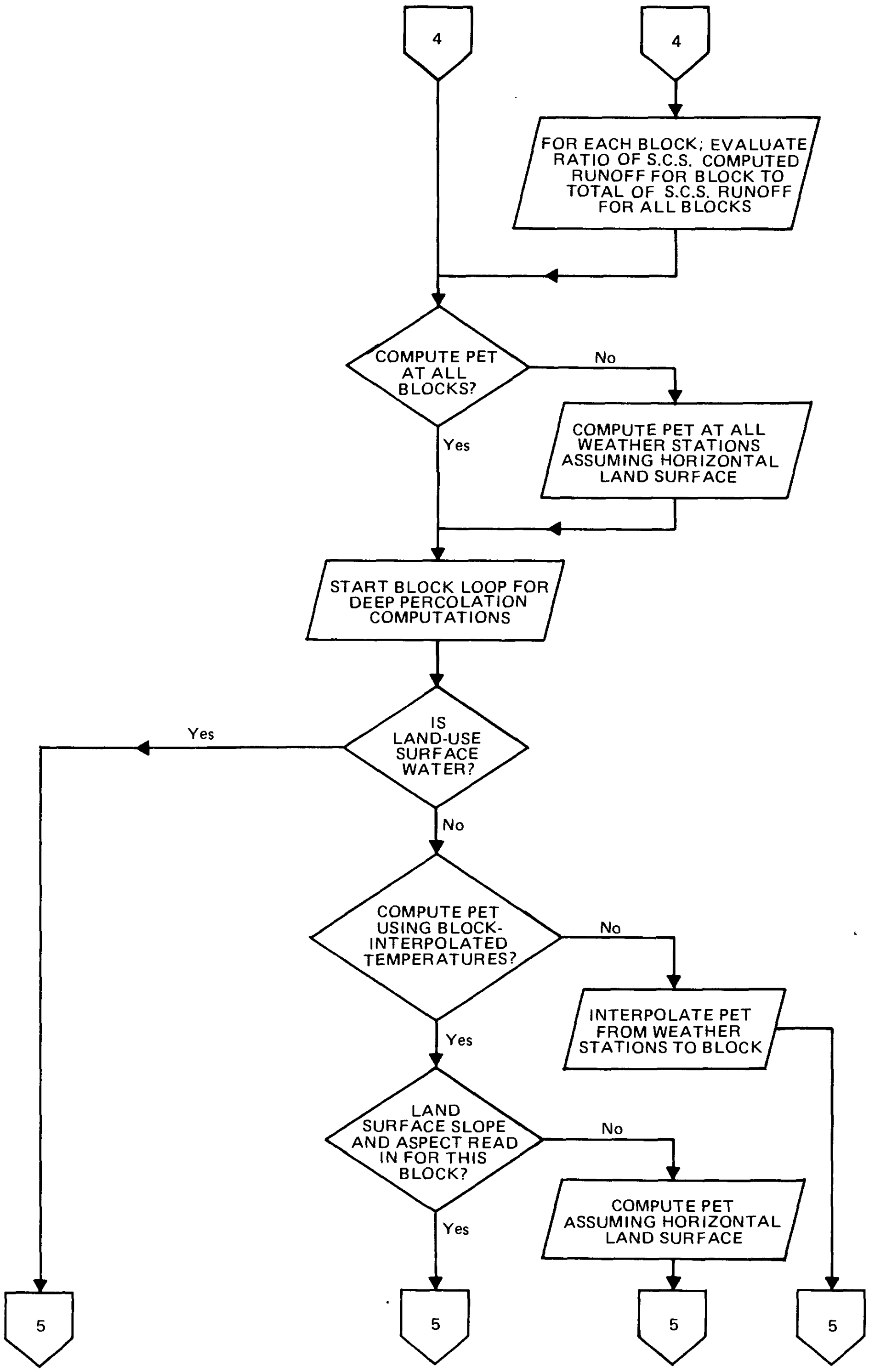

4
4
FOR EACH BLOCK; EVALUATE RATIO OF S.C.S. COMPUTED RUNOFF FOR BLOCK TO TOTAL OF S.C.S. RUNOFF FOR ALL BLOCKS
COMPUTE PET AT ALL BLOCKS?
No
COMPUTE PET AT ALL WEATHER STATIONS ASSUMING HORIZONTAL LAND SURFACE
Yes
START BLOCK LOOP FOR DEEP PERCOLATION COMPUTATIONS
IS LAND-USE SURFACE WATER?
Yes
No
COMPUTE PET USING BLOCK-INTERPOLATED TEMPERATURES?
No
INTERPOLATE PET FROM WEATHER STATIONS TO BLOCK
Yes
LAND SURFACE SLOPE AND ASPECT READ IN FOR THIS BLOCK?
No
COMPUTE PET ASSUMING HORIZONTAL LAND SURFACE
Yes
5
5
5
5

Figure 8.--Con.

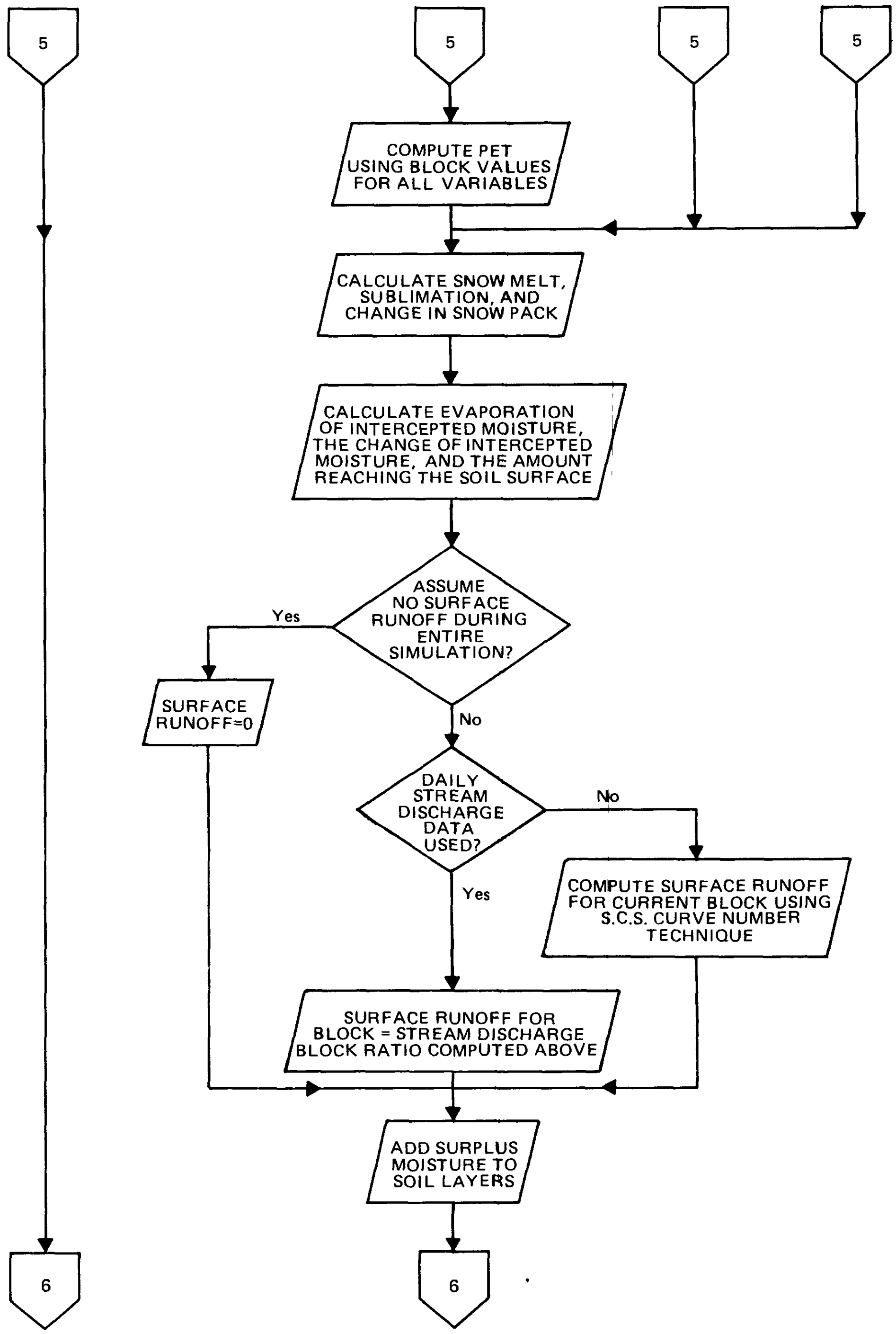

5
5
5
5
COMPUTE PET USING BLOCK VALUES FOR ALL VARIABLES
CALCULATE SNOW MELT, SUBLIMATION, AND CHANGE IN SNOW PACK
CALCULATE EVAPORATION OF INTERCEPTED MOISTURE, THE CHANGE OF INTERCEPTED MOISTURE, AND THE AMOUNT REACHING THE SOIL SURFACE
ASSUME NO SURFACE RUNOFF DURING ENTIRE SIMULATION?
Yes
SURFACE RUNOFF=0
No
DAILY STREAM DISCHARGE DATA USED?
No
COMPUTE SURFACE RUNOFF FOR CURRENT BLOCK USING S.C.S. CURVE NUMBER TECHNIQUE
Yes
SURFACE RUNOFF FOR BLOCK = STREAM DISCHARGE BLOCK RATIO COMPUTED ABOVE
ADD SURPLUS MOISTURE TO SOIL LAYERS
6
6

Figure 8.--Con.

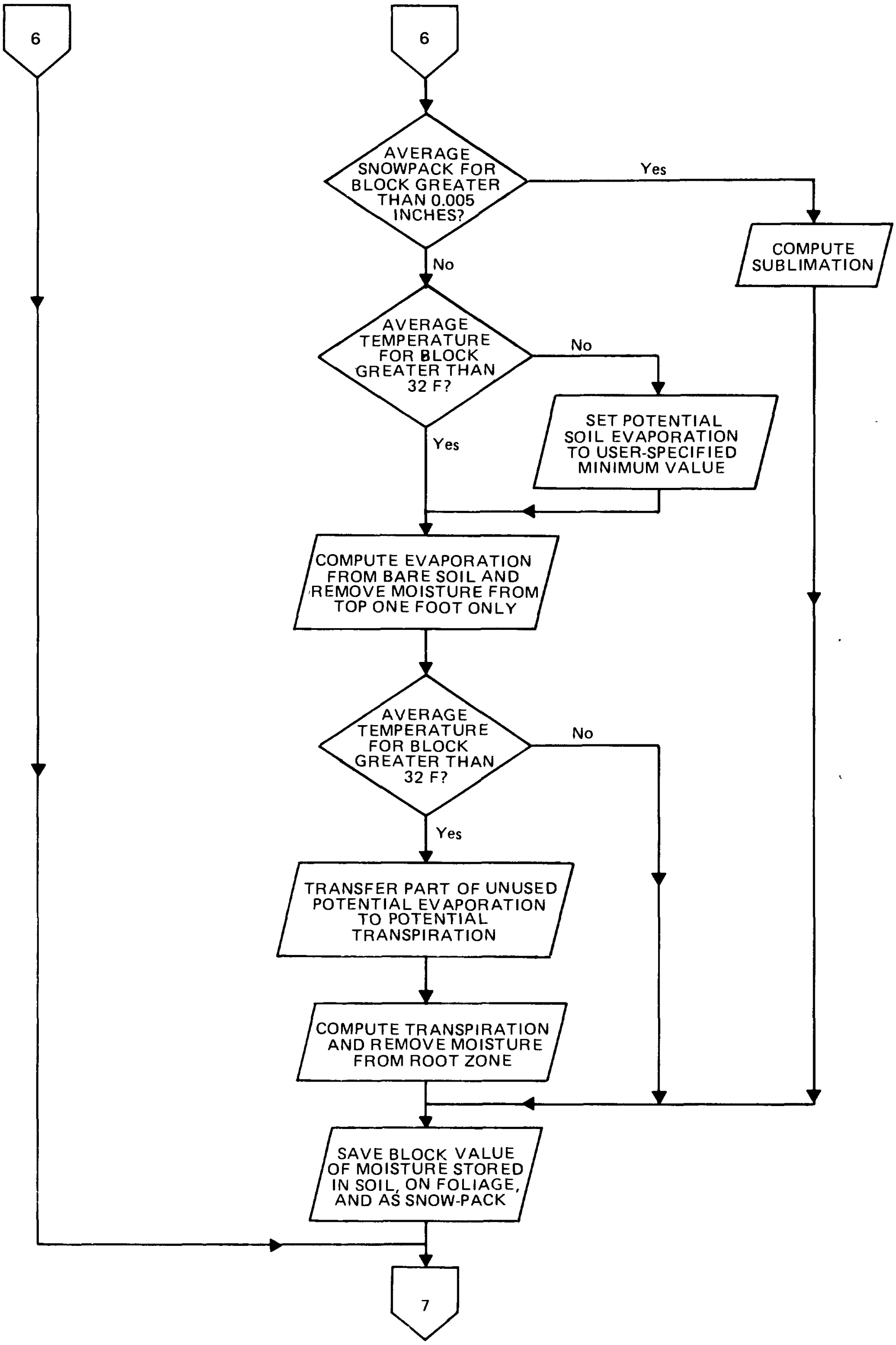

6
6
AVERAGE SNOWPACK FOR BLOCK GREATER THAN 0.005 INCHES?
Yes
No
COMPUTE SUBLIMATION
AVERAGE TEMPERATURE FOR BLOCK GREATER THAN 32 F?
No
Yes
SET POTENTIAL SOIL EVAPORATION TO USER-SPECIFIED MINIMUM VALUE
COMPUTE EVAPORATION FROM BARE SOIL AND REMOVE MOISTURE FROM TOP ONE FOOT ONLY
AVERAGE TEMPERATURE FOR BLOCK GREATER THAN 32 F?
No
Yes
TRANSFER PART OF UNUSED POTENTIAL EVAPORATION TO POTENTIAL TRANSPIRATION
COMPUTE TRANSPIRATION AND REMOVE MOISTURE FROM ROOT ZONE
SAVE BLOCK VALUE OF MOISTURE STORED IN SOIL, ON FOLIAGE, AND AS SNOW-PACK
7

Figure 8.--Con.

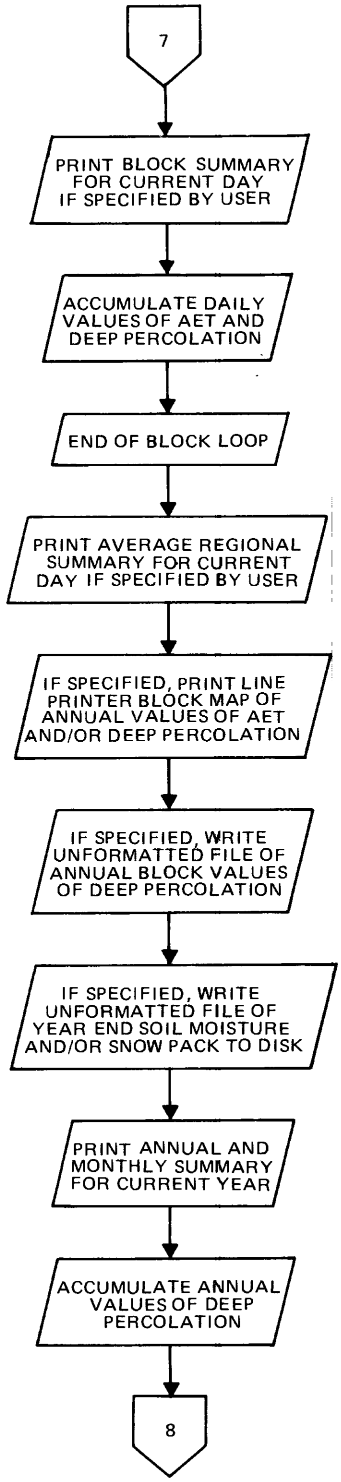

7
PRINT BLOCK SUMMARY FOR CURRENT DAY IF SPECIFIED BY USER
ACCUMULATE DAILY VALUES OF AET AND DEEP PERCOLATION
END OF BLOCK LOOP
PRINT AVERAGE REGIONAL SUMMARY FOR CURRENT DAY IF SPECIFIED BY USER
IF SPECIFIED, PRINT LINE PRINTER BLOCK MAP OF ANNUAL VALUES OF AET AND/OR DEEP PERCOLATION
IF SPECIFIED, WRITE UNFORMATTED FILE OF ANNUAL BLOCK VALUES OF DEEP PERCOLATION
IF SPECIFIED, WRITE UNFORMATTED FILE OF YEAR END SOIL MOISTURE AND/OR SNOW PACK TO DISK
PRINT ANNUAL AND MONTHLY SUMMARY FOR CURRENT YEAR
ACCUMULATE ANNUAL VALUES OF DEEP PERCOLATION
8

Figure 8.--Con.

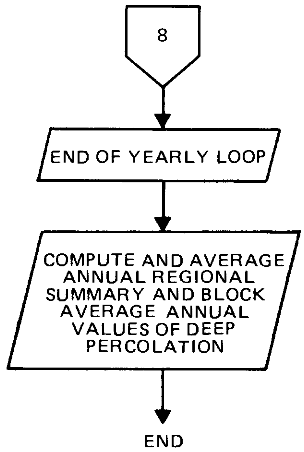

8
END OF YEARLY LOOP
COMPUTE AND AVERAGE ANNUAL REGIONAL SUMMARY AND BLOCK AVERAGE ANNUAL VALUES OF DEEP PERCOLATION
END

Figure 8.--Con.

CN2 numbers required for runoff calculations are read in for each block in DATAIN. Values of CN2 are assigned on the basis of soil properties, topography, and condition of the foliage. Because of the large number of blocks in the original project area, an optional "expedient" subroutine, CN2GEN, which is called from DATAIN, was devised to generate CN2 numbers based upon other required data previouly read in.

APPWAT is called if the effects of applied irrigation water are to be included in the simulation. APPWAT simply reads in the block number and the annual amount of applied water for the block. If irrigated areas and (or) amounts vary from year to year, new sets of irrigated block numbers and annual application rates may be read for subsequent years.

Interpolation factors used for calculating precipitation, temperature, and PET for grid blocks are determined in INTRPO. Two methods are available for distance interpolation. One uses the inverse of the distance squared (D2) as a weighting factor between the weather station and the block. The second uses the inverse of the distance (D1). D2 operates best with interpolating precipitation data and D1 is best for interpolating temperature and PET data (Dean and Snyder, 1977). The method used for temperature is also used for PET, since PET is mainly of function of temperature.

The initial conditions for soil moisture and snowpack are set by a call to ICONDS. If initial conditions or results from a previous simulation are not used, soil moisture is set to the available water capacity of the soil type for each block. The snowpack, in inches of water, is set to a user-defined value. If end-of-year soil moisture and (or) snowpack are stored on a disk file from a previous simulation, the FORTRAN logical unit number for these files must be read.

The July average temperature at weather stations is interpolated to blocks by calls to TOGRID, which interpolates by distance-weight and by monthly lapse rates by a call to LAPSE. JHCOEF is called to compute the Jensen-Haise PET climate coefficients for weather stations. These variable options allow the user to operate the model with or without elevations, slopes and aspects for blocks, and monthly lapse rates, thereby minimizing data input and computational time and storage.

The program cycles through each year of the simulation period and for each day of the year for each grid block. The model is designed to operate for at least 1 calendar year or any number of consecutive years.

The user has the option of letting the first year run twice, so that the initial conditions at the start of the second running of the first year are at least the result of the actual system (although derived from an essentially arbitrary year). If more than 1 year is being simulated, the first year's results are not included in the averaged values of the output.

If land use and (or) irrigation changes for each year, NEWLND and (or) APPWAT is called to read in a new set of land uses and (or) application rates at the beginning of each year.

Daily temperature and precipitation data for the specified number of weather stations are read from three ANSI direct-access files by subroutine CLIMAT. Record length and FORTRAN unit number for each file are user-defined.

CLIMAT calls TOGRID to interpolate the climate data for a day to each block. TOGRID may call ANTVAL and (or) PREVAL, depending upon the selected options for the types of interpolations previously described. PET at the weather stations is computed by POTET if PET is to be interpolated to some or all blocks.

APPLY, an entry point in APPWAT, is called each day to establish the daily application rates for all irrigated blocks and to add them to the block values of precipitation.

For each block for each day, LOOKUP is called to establish parameter values for the current day for the current block.

Subroutine PETBLK either interpolates PET values calculated at the specified number of nearest weather stations to the current block or calls POTET to calculate the PET using the interpolated temperatures (and other variables as discussed previously).

If daily stream discharge data are to be used to determine the surface runoff for each block, ROFACT is called. ROFACT reads in the stream discharge in cubic feet per second and converts to inches per day for the basin. ROFACT calls RUNOFF, which computes surface runoff according to the method of Wight and Neff (1983) for each block. From these values, the apportioning factors, as previously described, are computed. ROFACT also calls LOOKUP and SNWPCK in order to establish the current block values of CN2 number and snowmelt required in RUNOFF.

Subroutines simulating the physical processes for each block for each day are called in the following order: 1) SNWPCK, 2) INTRCP, 3) RUNOFF or RUNTRU or neither depending on option selected, 4) SOILMS, 5) SOILEV, 6) TRNSFR, and 7) PLNTET.

Daily values for soil moisture, snow, and intercepted moisture not evaporated are saved for the next day's simulation by SAVE. Lastly, two optional subroutines may be called in the daily loop, DALYOT and DAYSUM. DALYOT will output a daily summary for selected blocks and will print current soil moisture status for the blocks. DAYSUM prints daily summaries for the complete area (all blocks).

Within the yearly loop, six subroutines can be called at the end of a year's simulation; these are, AMSUM, ANNUAL, RECHOT, SAVSMS, SAVSNO, and AVEOT. For the modeled area, AMSUM will print monthly summaries and year-end totals. The values are originally accumulated and stored in arrays by a call to MASBAL. ANNUAL outputs year-end totals of actual evapotranspiration (AET) and recharge (RECH). Similarly, RECHOT can be called to output the yearly recharge values for each block, by a call to ANNUAL, but values in this case are in cubic feet per second and not inches per year. Further, RECHOT is also called if the user wants to store annual recharge values for all blocks on a disk file (in either of the above to units of measure). SAVSMS is called to save as initial conditions for another simulation. SAVSNO is called to store on disk the year-end snowpack values for all blocks and is an entry to SAVSMS.

Finally, at the end of each year AVEOT is called to accumulate and store the annual values of all budget components so that average values over the entire simulation period can be output. The results of the first year are discarded if actual initial conditions are not read in; determined by the initial soil-moisture-condition parameter ICN.

Subroutines

AMSUM

AMSUM prints out the annual and monthly summary of the budget components at the end of each year simulated.

ANNUAL

ANNUAL prints out annual block values for recharge (RECH) and actual evapotranspiration (AET). ANNUAL is called at the end of each simulated year when MAPET or MAPREC is greater than 0 to print annual block values and is called at the end of the simulated period to print average annual block values.

ANTVAL

ANTVAL is called each day from TOGRID when monthly lapse rates are to be used with the interpolation of maximum and minimum temperatures. ANTVAL calls LAPSE to determine the temperature difference between weather station and block based on altitude difference.

APPSCD

APPSCD is called from DATAIN, which in turn calls the land-use subroutines for those land uses that are irrigated and for which the user specifies to apportion the daily amount of irrigation based on crop-growth activity. The land-use subroutines are called for each day of the user-specified irrigation season in order to sum the daily values of the crop-growth coefficient. During the daily simulations the daily crop coefficient is divided by this "integrated" value in CRPCOF and multiplied by the user specified annual application rate to get the daily application rate.

APPLY

APPLY is an entry point in APPWAT. See APPWAT below for description.

APPWAT

APPWAT is called from DATAIN to read in the block numbers and annual average application rates (inches/year) for blocks with irrigation. If the parameter IAPUNT is greater than 0, application rates are to be read for IAPPLY number of blocks from FORTRAN unit number IAPUNT. Arrays in common block, IRRWAT, should be dimensioned to one if no application rates are specified (IAPUNT and IAPPLY=0). If IAPPLY is greater than 0, then array dimensions in common block, IRRWAT, should be set to IAPPLY. APPWAT has one entry point, APPLY, that is called each day from MAIN. APPLY, in turn, uses the appropriate fraction of the annual application rate to be applied on the current day (see subroutine APPSCD). APPLY then adds the daily irrigation application to the precipitation for the current block. APPWAT may also be called from MAIN at the start of each year after the first year's simulation to read in a new set of blocks and application rates.

AVEOT

After the first year is simulated AVEOT initializes the following simulation period time-average budget arrays: deep percolation (RECHAV), actual evapotranspiration (AETAV), monthly budget components (QBLAVM), and annual budget components (QBLAVY). Monthly and annual component arrays for each year (QBALMO, QBALYR) are initialized in preparation for the following year after they are added to the simulation period time-average arrays. The budget arrays are printed at the end of the simulation after averages are calculated. The recharge and actual evapotranspiration block value arrays are also averaged and printed through two calls to ANNUAL.

AVJTMP

Long-term average July temperatures for each of the NWST weather stations are read by AVJTMP, which is called from DATAIN. Data are read from FORTRAN unit number INJAV. These are used to compute coefficients used in the Jensen-Haise equation, computed in subroutine JHCOEF for each weather station or for specified blocks.

CLIMAT

CLIMAT is called each day to read daily climatic data for each weather station. Three climate data files are read for each day of a simulation--precipitation, maximum temperatures, and minimum temperatures. CLIMAT calls TOGRID to interpolate the climate data to the blocks. Daily precipitation is read from unit INP, minimum temperature from INTN, and maximum temperature from INTX. Each record contains one daily value for each station. Precipitation and the mean daily temperature are put into the budget component arrays by calls to MASBAL. The maximum temperature for yesterday (TMXYST(NEL)), is established before reading the current day maximum temperature. TMXYST is used in the disaggregation of temperatures in SNWPCK subroutine.

CN2GEN

CN2GEN is optionally called from DATAIN. It assigns Soil Conservation Service curve numbers (CN2) to all blocks on the basis of slope, soil depth and available water capacity, and land-use data. CN2GEN is basically a table of values from which CN2 values are selected.

CRPCOF

CRPCOF is called from MAIN and establishes, for each of 15 land uses, the current days value for: 1) root depth (RD), 2) foliar cover (FC), 3) foliar interception capacity (MXNT), 4) Blaney-Criddle crop coefficient (CP), 5) fraction of the annual application rates to be applied (APMULT), 6) maximum root depth (RDMAX), 7) maximum foliar cover (FCMAX), and 8) maximum interception capacity (MAXINT). This is done by calling each of the land-use subroutines. These values are stored in the array COEFS(15,8).

DALYOT

Daily block values of major physical components are printed each day from DALYOT. Daily values are printed for a user-defined number of blocks (NSMBLK). If daily summaries are requested, the block numbers are input in DATAIN and stored in the array NSB(NSMBLK). If no daily block values are requested, then the dimension of NSB should be set equal to 1; otherwise, NSB must be dimensioned to NSMBLK.

DATAIN

This subroutine reads in or calls subroutines that read in most of the input data groups, except for the daily climate and stream discharge data. Certain data sets are read, modified, or generated by separate subroutines called from DATAIN. These subroutines are: 1) APPSCD, 2) APPWAT, 3) AVJTMP, 4) DOGRID, 5) CN2GEN, 6) LAMBRT, 7) NEWLND, 8) PREVAL, 9) TMPVAL.

DAYSUM

The daily budget component values stored in the MASBAL subroutine are printed out by DAYSUM at the end of each day's simulation. DAYSUM is not called if DSUM is less than 1. Output from DAYSUM is also useful for debugging; if the program has terminated abnormally. The last day printed is the day prior to when the termination occurred.

DOGRID

DOGRID, which is optionally called from DATAIN, generates the grid system in one of two ways depending upon the value of IGRID:

1) For IGRID = 1, read:

AX(2)	max. longitude, min. longitude (decimal degrees).
AY(2)	max. latitude, min. latitude (decimal degrees).
GRDSZE	size of equally spaced grids (minutes of latitude and longitude)

DOGRID next computes the number of rows (latitude), columns (longitude), number of grid points (NIJ), and number of blocks (NEL) in a rectangular grid and calculates x,y values in feet from origin of the grid points. In this documentation, subroutine LAMBRT is called to determine x,y values; however, the user should substitute a suitable map projection subroutine for base maps used.

Generally, if the option to automatically generate the grid system is chosen, the user must first use this subroutine in an external FORTRAN program to output the grid system in order to code parameters that vary from block to block.

2) For IGRID = 0, the grid is not necessarily a rectangular array, and the number of grid points (NIJ) and number of blocks (NEL) are read in. The grid numbers are then read for each block into the array NGB(4,NEL). Grid numbers should be read in counterclockwise order. Block ordering is up columns, starting with the left-most column (see fig. 13, in "Example Simulation"

section). X and y values are next read in for each node. DOGRID computes the area of each block, AREA(NEL), and writes out the total area of modeled region, in square miles.

ICONDS

ICONDS establishes initial soil-moisture content and initial snowpack for each block at the start of a year's simulation. Soil-moisture values are either set to the available water capacity or input from a disk file which could have been created during a previous simulation. Either snowpack is set to a user-defined value in DATAIN or read from a disk file, which could have been created from a previous simulation.

INTRCP

Interception from precipitation is computed in INTRCP. The potential evapotranspiration for this block for the current day is first stored by a call to MASBAL. If the average air temperature is greater than 32 ^{o}F and the land use is not sand-barren, interception and evaporation of interception is computed. The maximum amount of interception, user-defined (or default) as MAXINT (=COEFS(LNDUS,8)), for each land use has been already read by DATAIN and modified for the phenological state of the crop in subroutine CRPCOF. The modified value MXNT (=COEFS(LNDUS,3)) is reduced in INTRCP by any intercepted moisture remaining on the foliar cover from the previous day (REMINT) to arrive at today's amount that can be intercepted. Moisture from precipitation is added to the foliage up to but not exceeding MXNT and then evaporated (AETFC) up to an amount not exceeding PET. PET is reduced by AETFC which is put into the mass-balance and is included as a component of actual evapotranspiration. The change in intercepted moisture (CHGINT) is also stored by a call to MASBAL.

INTRPO

INTRPO is entered before the time loop. This subroutine computes the factors used in interpolating daily precipitation and temperature from weather stations to blocks. The user specifies a maximum number of nearest weather stations (NVAL) to be used for interpolation to the block corners (nodes) and a minimum radius within which they must lie. If there are fewer than NVAL stations within the radius, only those within the radius are used. For each node INTRPO identifies the stations to be used and stores their distances for daily interpolation. The interpolation equation for precipitation (Dean and Synder, 1977) is,

$$PN = \sum_{i=1}^{n} PS_i * D_i * FACT / \sum_{i=1}^{n} D_i \quad , \qquad (14)$$

where PN is the daily precipitation at the node, PS_i is the daily precipitation at the ith precipitation weather station, and D_i = 1./distance*distance. FACT is the ratio of the isohyetal value of a block to the average annual precipitation of a weather station. FACT is unity if no isohyetal data are read. n is the number of identified precipitation weather stations (NVAL). The interpolation equation for temperature and PET is,

$$TN = \sum_{i=1}^{n} (TS_i + TMPDIF)*D_i / \sum_{i=1}^{n} D_i \ , \qquad (15)$$

where TN is the daily maximum or minimum temperature at the node, TS_i is the daily maximum or minimum temperature at the ith temperature weather station, D_i = 1./distance and TMPDIF is the temperature difference computed from the lapse rate and altitude difference.

JHCOEF

Coefficients for the Jensen-Haise potential evapotranspiration method are evaluated in this subroutine as functions of altitude and long-term average minimum and maximum air temperatures for the warmest month of the year.

LAMBRT

LAMBRT computes x,y cartesian coordinates from latitude and longitude for the lambert conformal projection (in this case for the south zone of Washington State). Latitude and longitude are in decimal degrees and x,y coordinates are in feet. If, instead, x,y coordinates are read in, LAMBRT is bypassed. Users should substitute a suitable map projection subroutine for LAMBRT for their base maps.

Land-Use Subroutines

The land-use subroutines that may be called by CRPCOF are (1) FOREST, (2) GRASS, (3) SAGE, (4) WWALYR, (5) WWSPRG, (6) WWAUTM, (7) ORCHRD, (8) ALFALF, (9) ROW, (10) SRFWTR, (11) CORN, (12) POTATO, (13) SAND, (14) PEALEN, and (15) SPRGWT. Additional subroutines and changes to the curves contained in the above land-use subroutines would probably be necessary for regions other than eastern Washington.

FCMX, RDMX, and MAXINT, supplied by the user, are passed to the land-use subroutines, where:

FCMX = maximum foliar cover that the crop achieves (decimal percent),
RDMX = maximum root depth that the crop achieves (inches), and
MAXINT = interception capacity at maximum foliar cover (inches).

If any user-supplied value is zero, a default value is used. Daily values, FC, RD, and MXNT, are evaluated by multiplying by a growth-stage factor. For most agricultural land uses the daily factors are assumed proportional to the Blaney-Criddle crop-growth stage coefficient up to the time that the maximum occurs (fig. 9). From then until harvest they remain constant at the maximum values. After harvest they become zero until the next planting.

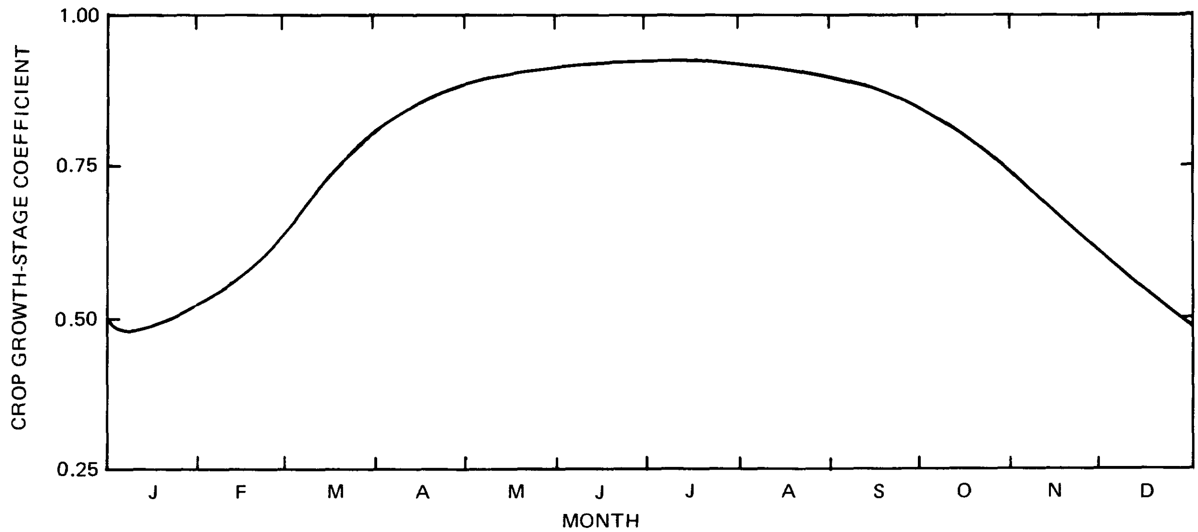


Figure 9.--Crop growth-stage coefficient for pasture grasses (after U.S. Department of Agriculture, 1967).

The following describes variations peculiar to some of these subroutines:

FOREST: Coniferous forest is not an agricultural crop in the usual sense, and therefore has no Blaney-Criddle crop growth curve. However, since crop growth curves are similarly shaped for different perennial crops, a factor was used to convert the pasture (GRASS) curve to a curve representing coniferous forest. The conversion factor used is 0.64 (after Cearloch and others, 1975). Subroutine ORCHRD should be used for deciduous forest.

SAGE: Similarly, a published crop curve could not be found for semiarid rangeland. The consumptive use of sagebrush and cheatgrass was measured during 1971-74 and presented in an unpublished manuscript by Hinds and Thorpe of Pacific Northwest Laboratories (Ecological Sciences and Atmospheric Licenses Departments, respectively). From these data a sagebrush crop-growth curve was constructed. Consumptive-use values from only the wettest months were considered to approach PET. Dry month values for the crop coefficients had to be interpolated between the wet periods.

WWALYR: This subroutine is for winter wheat which is planted in the autumn, harvested the following spring, and has a summer fallow period. This land-use subroutine is structured somewhat differently from the other agricultural land uses because the growth curve spans 2 calendar years.

WWSPRG: This subroutine and subroutine WWAUTM are also used for winter wheat, but for when there is a 1-year fallow period (a common practice when precipitation is less than about 20 in./yr). WWAUTM is for the calendar year when winter wheat is planted in the autumn, but when the fields were fallow in spring. WWSPRG is for the calendar year when winter wheat that had been planted the previous autumn is harvested in the spring, and fields are fallow in autumn and winter. If either of these two land uses are specified the model automatically swaps WWAUTM and WWSPRG at the start of each year.

WWAUTM: Refer to previous subroutine.

ROW: For a large project area it is usually not possible to spatially delineate commercial agricultural crops other than wheat, orchard, and alfalfa. All others are lumped into a single category, referred to here as row crops. For example, in eastern Washington, for which the model was developed, row crops are almost invariably irrigated. A composite Blaney-Criddle crop-growth curve was constructed on the basis of a knowledge of the prevalent crops and their respective Blaney-Criddle growth curves. Different composite curves might be required in other areas.

SRFWTR: If surface water covers an area, there is no need for many of the budgeting routines. SRFWTR directs the flow of the program so that unnecessary subroutines are bypassed.

SAND: This land use is for areas having essentially no vegetation. Consequently, SAND sets RD, FC, and CP to zero. Computations in PLNTET and INTRCP are bypassed for blocks with this land use.

LAPSE

LAPSE is called from ANTVAL when maximum and minimum temperatures are interpolated, using lapse rates, to blocks from the NWST weather stations. LAPSE is entered separately for maximum daily temperatures and for minimum daily temperatures.

LOOKUP

For each block for each day, LOOKUP stores all array elements needed for calculations for the current block into non-subscripted variables and puts them into a named common block, BLKVAL, to provide access by other subroutines. Variables assigned also include the variables defined in the array, COEFS(I,8), described in CRPCOF subroutine.

MASBAL

MASBAL saves any or all of daily, monthly, and annual values in arrays for 16 budget items summed over the modeled region..

MINPET

MINPET is called from PETBLK during the months of October through March. It checks if the calculated value of potential evapotranspiration (ETP), for the current day and current block, is greater than the minimum ETP rate (PETMIN(6)) read in DATAIN. If the calculated value, ETP, is not greater than PETMIN it is set equal to it.

NEWLND

NEWLND is called from DATAIN to read in land use for all blocks. It can also be called from MAIN at the start of each year after the first year's simulation to read in a new land-use array. NEWLND also prints out the number of blocks for each land use.

PETBLK

PETBLK determines the daily potential evapotranspiration for each block. Depending on the user-specified value of IFTEMP, PET value is either interpolated from surrounding weather stations using the same method as that used for temperature, or is computed at the block by calling JHCOEF and POTET. PETBLK calls MINPET to force the block PET value to be at least equal to user input PETMIN values.

PLNTET

This subroutine is called from MAIN to evaluate ACTPLT, the actual amount of moisture transpired by the prevalent vegetation in a block. ACTPLT is a function of potential transpiration, the Blaney-Criddle growth-stage coefficient of the crop (CP), the current root depth (RD), the current moisture distribution within the soil, and soil type. PLNTET first computes the daily potential crop transpiration (CROPPT) by multiplying potential crop transpiration (PLNTPT) by the ratio (CP/1.13), where 1.13 is the maximum Blaney-Criddle growth-coefficient value for alfalfa.

MASBAL is called to store CROPPT. Water is extracted from each layer by one of two user-specified methods. The amount estimated in both methods depends on the current moisture content of each layer, the soil type of each layer, and the current root depth. The ratio of actual to potential transpiration for each layer is determined as a function of the current soil moisture from soil-type-dependent empirical curves (fig. 4)., If the user-specified value of the parameter IROOT is greater than 0, then this ratio is multiplied by the fraction of total root mass occurring within each layer to give the fraction of CROPPT that is ACTPLT. Root density is assumed to decrease exponentially with depth according to the relation of equation 8:

$$WGT = 1.016[\exp -4.16 \left(\frac{d_i-1}{RD}\right) - \exp -4.16 \left(\frac{d_i}{RD}\right)] ,$$

where RD is the current root depth and WGT is the ratio of the root mass in layer i to the total root mass. All other variables are as in equation 8. The constants of 1.016 and 4.16 have been determined with the constraint that the summation of WGT over all layers is unity. Excess CROPPT is added to the energy sink (SNK) for the day and ACTPLT is stored by a call to MASBAL.

If IROOT is less than 1, moisture extraction proceeds one layer at a time beginning with the surface layer. The amount that can be removed from each layer is limited only by the ratio of actual to potential transpiration given by the curves of figure 4. Moisture extraction stops when all of CROPPT is satisfied or after all layers in the root zone have been sampled. As for the previous method any unused CROPPT is added to SINK.

POTET

POTET computes potential evapotranspiration using a method developed by Jensen (1973). POTET is called from either MAIN or PETBLK. When it is called from MAIN, PET is computed at a weather station having temperature data. When it is called from PETBLK, PET is calculated at a block using the interpolated air temperature values previously discussed.

Arguments passed into POTET are day of the year (IDAY), average latitude for the project area (AVLAT), daily maximum and minimum air temperatures (TMAX and TMIN), average temperature for the warmest month of the year (TX), Jensen-Haise coefficients computed in subroutine JHCOEF, land-surface slope (SLP), and aspect of the slope (ASP). SLP and ASP are set to zero if PET is being calculated at weather stations or if SLP and ASP are not read in for the block where the potential evapotranspiration (ETP) calculation is being made. The daily value of, ETP, is returned from POTET.

PREVAL

PREVAL is called only if interpolation of daily precipitation is to include variations in average annual values, as defined by FACT in equation 15. Average annual precipitation values for the weather stations with precipitation data are first read in on unit IN1. Block values of average annual precipitation are read in on unit IN4 for a number of selected blocks (NP). If NP is less than the total number of blocks (NEL), the block numbers (block numbering scheme explained in DOGRID section) are read in along with the annual precipitation values. One common, PRCPVL, is associated with this subroutine. If PREVAL is not called, the dimensions in the common block PRCPVL should be set equal to one (1). If this subroutine is called, the dimensions in the common block PRCPVL must be set equal to NEL. In areas where precipitation varies monotonically between weather stations, PREVAL need not be used and computer storage and computational time can be decreased. PREVAL has one entry point, ANPVAL, which finds the ratio of block to weather station average annual precipitation values.

RECHOT

RECHOT is called when IRECH is greater than 0. If IRECH is greater than 0 then the block values of deep percolation for the year just simulated are written as an unformatted sequential file on FORTRAN unit number IRECH. If IFLUX is also greater than zero the block values are converted to cubic feet per second, printed by a call to ANNUAL, and then written.

ROFACT

ROFACT reads in the stream discharge in cubic feet per second and converts to inches per day for the basin. ROFACT calls RUNOFF, which computes surface runoff according to the method of Wight and Neff (1983) for each block. From these values, a surface runoff apportioning factor for each block, is computed. The apportioning factor for a block is simply the ratio of the computed block runoff to the total of the computed runoff for all blocks.

ROFACT also calls LOOKUP and SNWPCK in order to establish the current block values of snowmelt and CN number required in RUNOFF.

RUNOFF

Surface runoff is computed according to the method of Wight and Neff (1983) on days when there is precipitation, snowmelt, or irrigation-applied water. Surface runoff is computed as a function of incident moisture, the SCS curve number (CN), and the moisture content of each soil layer (SM(I)).

RUNTRU

This subroutine is called for each block from MAIN if the user supplies stream-discharge and ground-water base-flow data. Streamflow minus base flow is multiplied by the apportioning factor for the block (CNFAC(NEL)) determined in ROFACT to give the surface runoff (RO) for the block. RUNTRU calls MASBAL to store RO.

SAVE

SAVE stores end-of-day block values for soil moisture (SMS(NEL,NLAYER)), snowpack (SNOW(NEL)), and intercepted moisture remaining on the foliar cover (REMAIN(NEL)). These values are used for the next day's calculations. The daily change in soil moisture for a block (CHNGSM) is also computed in this subroutine and is stored by a call to MASBAL.

SAVSMS

SAVSMS writes end-of-year block values of soil moisture for each layer. This subroutine is called from MAIN when the parameter ISTS is greater than zero. ISTS is the FORTRAN unit number for writing the soil moisture array. SAVSNO, an entry point in SAVSMS, stores end-of-year snowpack (water-equivalent inches) for each block. SAVSNO is called if IRTSNO is greater than zero and, as above, is the FORTRAN logical unit number for writing the snowpack array. Both soil moisture and snow are written as unformatted sequential files.

SNWPCK

Snow accumulation and abalation are computed in this subroutine based on the methods presented in Anderson (1973). On days when the average daily temperature is less than 32 ^{o}F all precipitation is snow. Snowmelt and sublimation are computed after temperature disaggregation as previously described in the subsection "Theory and General Flow of Model." SNWPCK calls SUBLAT to obtain a 12-hour sublimation rate. SNWPCK calls MASBAL to store the day's values of sublimation (SUB) and change of snowpack (CHGSNO).

SOILEV

Potential and actual soil evaporation from bare soil surfaces are computed in this subroutine provided the block snowpack is less than 0.005 inch. Evaporation is assumed to occur from only the top two 6-inch soil layers. The method used is described by Saxton and others (1974). SOILEV calls MASBAL to store the computed daily block values of potential and actual soil evaporation.

SOILMS

SOILMS distributes surplus water (incident water minus surface runoff) to the soil layers. Starting with the top layer, each 6-inch layer in the soil depth is filled up to available water capacity (WC(NLAYER)) with the surplus water. This is repeated for each layer until there is no more surplus or until all the layers are filled. If all the layers are filled, then the remaining surplus is considered deep percolation, RECR. SOILMS calls MASBAL to store RECR. SOILMS then checks if there is runoff (RO) in excess of incident water. If there is an excess, that quantity is subtracted from soil moisture. Moisture is removed from each layer in proportion to its available moisture content. Soil-moisture reduction to supply runoff is constrained to only 50 percent of available water capacity (WC) in any layer. If there is still an excess after depleting each layer to 50 percent of WC(NLAYER), MASBAL is called to store this excess (DEFCIT).

SUBLAT

SUBLAT is called from SNWPCK for the two daylight 6-hour periods, 6 a.m. to 6 p.m. Each time it is called one-half of the user-defined daily sublimation rate (SBLMTE) is invoked. This could be done in SNWPCK, but the authors felt that this also reserves a subroutine for future, more rigorous treatment of the sublimation process.

TMPVAL

TMPVAL is similar in function to PREVAL. TMPVAL is called when, at specified blocks, the effects of land surface altitude, slope and aspect are to be included in the daily block values of potential evapotranspiration. NT, the total number of such specified blocks, is first read by TMPVAL. If NT is less than NEL then the block number, altitude, slope, and aspect for each block are read. If NT is equal to the total number of blocks in the model, the altitude slope and aspect only are read in increasing order of block number. In addition, the parameter ILAPSE is read to determine if maximum and minimum temperatures interpolated to blocks are to be further adjusted with user-provided monthly lapse rates. Arrays in common block BLKPET must be dimensioned to NT if TMPVAL is called, otherwise they may be set to 1 to save storage.

TOGRID

TOGRID interpolates temperature and precipitation from weather stations to nodes of a block, and then computes a block value by averaging the node values. TOGRID may also be called to interpolate potential evapotranspiration. Each block is processed in this routine and data are interpolated on the basis of the distance dependent interpolating factors determined in INTRPO.

TRNSFR

Transfer of unused potential soil evaporation to the potential plant transpiration demand (PLNTPT) is calculated in this subroutine. The unused energy that is not transferred is accumulated in an energy sink term (SNK).

Common Blocks

The following is a listing of all common blocks and definitions of the variable names contained within them. Table 2 shows all subroutines in which each common block occurs.

TABLE 2.--List of common blocks and associated subroutines

Common block	Subroutine using common block
ANNUAL	AVEOT
BLKPET	ANTVAL, CN2GEN, PETBLK, TMPVAL
BLKVAL	DALYOT, INTRCP, LOOKUP, PLNTET, ROFACT, RUNOFF, RUNTRU, SNWPCK, SOILEV, SOILMS, TRNSFR
CLASLD	APPWAT, CN2GEN, DATAIN, LOOKUP, NEWLND
CLIMIO	CLIMAT, DATAIN
DAYVAL	DALYOT, LOOKUP, PLNTET, RUNOFF, SAVE, SOILEV, SOILMS
FLOWS	DATAIN, ICONDS, LOOKUP, SAVE, SAVSMS
GRID	DOGRID, INTRPO, MASBAL, PETBLK, ROFACT, TOGRID
INOUT	ANNUAL, CN2GEN, DATAIN, ICONDS, RECHOT, SAVSMS
IRRTIM	APPSCD, CRPCOF, DATAIN
IRRWAT	APPWAT
JENHAZ	ANTVAL, CLIMAT, DATAIN, LAPSE, PETBLK, TMPVAL
LRATES	LAPSE, TMPVAL, TOGRID
NWSPRE	CLIMAT, DATAIN
NWSTEM	CLIMAT, DATAIN, PETBLK
PLANT	APPWAT, CRPCOF, DATAIN, LOOKUP
POLATP	CLIMAT, DATAIN
POLATT	CLIMAT, DATAIN, PETBLK
PRCPVL	PREVAL
SIZE	ANNUAL, ANTVAL, AVEOT, CN2GEN, DATAIN, DOGRID, ICONDS, INTRPO, PETBLK, PREVAL, ROFACT, SAVE, SAVSMS, TMPVAL, TOGRID
SOIL1	CN2GEN, DATAIN, ICONDS, LOOKUP, SAVE, SAVSMS
SOIL2	CN2GEN, DATAIN, ICONDS, LOOKUP, SAVE, SAVSMS
SUMMRY	AMSUM, AVEOT, DATAIN, DAYSUM, MASBAL
STRFLW	DATAIN, ICONDS, ROFACT, RUNOFF, RUNTRU, SOILMS
TIME	AMSUM, AVEOT, CLIMAT, DATAIN, DAYSUM, LOOKUP
WEATHR	APPWAT, CLIMAT, DATAIN, ICONDS, LOOKUP
WINTER	DATAIN, PETBLK, SNWPCK

COMMON: SIZE

NEL	NUMBER OF BLOCKS IN MODEL
NIJ	NUMBER OF NODES IN MODEL,
ICOL	NUMBER OF COLUMNS OF BLOCKS IN RECTANGULAR CIRCUMSCRIBING GRID (SEE FIG. 10)
IROW	SAME AS ABOVE FOR ROWS

COMMON: TIME

NDAY(12)	ARRAY CONTAINING NUMBER OF DAYS IN EACH MONTH
IYR1	STARTING YEAR OF SIMULATION
IYR2	ENDING YEAR OF SIMULATION
IDYS	NUMBER OF DAYS IN MODEL SIMULATION
IWARMP	PARAMETER TO DETERMINE IF FIRST YEAR IS TO BE SIMULATED TWICE IN SUCCESSION IN ORDER TO OBTAIN BETTER INITIAL CONDITIONS
NYR	VALUE OF THE CURRENT YEAR

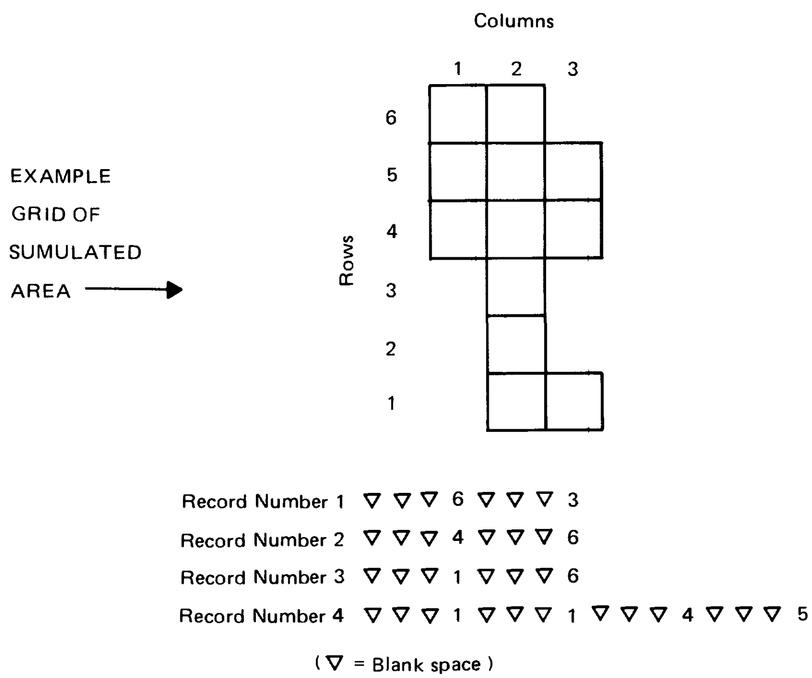


Figure 10.--Example of group 7 input data.

COMMON: GRID

AREA(NEL)	AREA OF EACH BLOCK, IN FEET, USED IN MASS-BALANCE
GX(NIJ)	X-LOCATION OF EACH NODE FOR EACH BLOCK, REAL*8
GY(NIJ)	Y-LOCATION OF EACH NODE FOR EACH BLOCK, REAL*8
TOTARA	TOTAL AREA, IN SQUARE FEET, OF THE SIMULATED AREA
NGB(4,NEL)	NODE NUMBERS OF EACH BLOCK, NUMBERED IN A COUNTERCLOCKWISE DIRECTION (SEE SUBROUTINE DOGRID)

COMMON: WEATHR

PRECP(NEL)	DAILY PRECIPITATION FOR EACH BLOCK
TMAX(NEL)	DAILY MAXIMUM TEMPERATURE FOR EACH BLOCK (DEGREES FAHRENHEIT)
TMIN(NEL)	DAILY MINIMUM TEMPERATURE FOR EACH BLOCK (DEGREES FAHRENHEIT) (ALL BLOCK VALUES OF CLIMATE DATA FORMED FROM AVERAGE OF NODE VALUES THAT HAVE BEEN INTERPOLATED FROM WEATHER STATION)
TMXYST(NEL)	PREVIOUS DAY'S MAXIMUM TEMPERATURE FOR EACH BLOCK (DEGREES FAHRENHEIT)

COMMON: NWSPRE

P(NWSP)	DAILY PRECIPITATION AT PRECIPITATION WEATHER STATION
JP(NWSP)	DAILY PRECIPITATION AT PRECIPITATION WEATHER STATION THAT IS READ FROM DIRECT ACCESS FILE BUT IS INTEGER FORMAT, P(NWSP) = JP(NWSP)/100.
XP(NWSP)	X-LOCATION (FEET) OF PRECIPITATION WEATHER STATION, REAL*8
YP(NWSP)	Y-LOCATION (FEET) OF PRECIPITATION WEATHER STATION, REAL*8
NWSP	NUMBER OF PRECIPITATION WEATHER STATIONS
IFPREC	PARAMETER TO DETERMINE IF PRECIPITATION CLIMATE DATA AT WEATHER STATIONS IS TO BE INTERPOLATED WITH OR WITHOUT A WEIGHTING FACTOR THAT ACCOUNTS FOR VARIATIONS IN LONG-TERM ANNUAL AVERAGE PRECIPITATION VALUES BETWEEN THE WEATHER STATIONS AND THE BLOCK WHERE VALUES ARE TO BE INTERPOLATED

COMMON: NWSTEM

TN(NWST)	DAILY MINIMUM TEMPERATURE AT EACH TEMPERATURE STATION (DEGREES FAHRENHEIT)
TX(NWST)	DAILY MAXIMUM TEMPERATURE AT EACH TEMPERATURE STATION (DEGREES FAHRENHEIT)
XT(NWST)	X-LOCATION VALUE OF TEMPERATURE WEATHER STATION (FEET), REAL*8
YT(NWST)	Y-LOCATION VALUE OF TEMPERATURE WEATHER STATION (FEET), REAL*8
NWST	NUMBER OF TEMPERATURE WEATHER STATIONS

COMMON: CLIMIO

INP	FORTRAN UNIT NUMBER FOR DAILY PRECIPITATION CLIMATE DATA
INTN	FORTRAN UNIT NUMBER FOR DAILY MINIMUM TEMPERATURE DATA
INTX	FORTRAN UNIT NUMBER FOR DAILY MAXIMUM TEMPERATURE DATA
METHDP	PARAMETER USED TO ESTABLISH METHOD TO INTERPOLATE PRECIPITATION FROM CLIMATE STATIONS TO BLOCKS: FOR METHDP = 1, USES 1/DISTANCE*DISTANCE AS WEIGHT
METHDT	PARAMETER USED TO ESTABLISH METHOD TO INTERPOLATE TEMPERATURES FROM CLIMATE STATIONS TO BLOCKS: FOR METHDT = 0 USES 1/DISTANCE FROM WEATHER STATION TO BLOCK AS WEIGHT
IRECP	RECORD LENGTH OF DAILY PRECIPITATION DIRECT ACCESS FILE
IRECT	RECORD LENGTH OF DAILY TEMPERATURES DIRECT ACCESS FILES

COMMON: INOUT

NSB(NSMBLK)	BLOCK NUMBERS WHERE DAILY SUMMARIES OF PHYSICAL COMPONENTS ARE PRINTED
IOT1	OUTPUT FORTRAN UNIT NUMBER FOR WRITING THE INPUT DATA
IOT2	OUTPUT FORTRAN UNIT NUMBER NOT CURRENTLY USED
IN1	INPUT UNIT FOR MAIN DATA SET, VALUE SET EQUAL TO 5 IN DATAIN
IPRNT	OUTPUT UNIT FOR MODEL RESULTS
ISTS	FORTRAN UNIT NUMBER FOR STORING ON A DISK FILE THE END-OF-SIMULATION SOIL MOISTURE FOR ALL BLOCKS
MAPREC	PARAMETER THAT DETERMINES IF ANNUAL RECHARGE AT ALL BLOCKS WILL BE PRINTED AND ALSO STORED: MAPREC>0, PRINT VALUES MAPREC<1, DO NOT PRINT OR STORE
IAPUNT	FORTRAN UNIT NUMBER FROM WHICH THE TOTAL NUMBER OF IRRIGATED BLOCKS, THE BLOCK NUMBERS AND THE ANNUAL AMOUNTS OF IRRIGATION FOR EACH IRRIGATED BLOCK ARE READ
IRDSNO	FORTRAN UNIT NUMBER FROM WHICH INITIAL SNOWPACK DATA ARE READ. IF IRDSNO<1, SNOWPACK IS SET = ASNOW FOR ALL BLOCKS
IRTSNO	OUTPUT FORTRAN UNIT NUMBER FOR STORING SNOPACK AT END OF SIMULATION PERIOD. IF IRTSNO>0, STORE VALUES
MAPET	PARAMETER THAT DETERMINES IF ANNUAL AET DISTRIBUTION IS TO BE PRINTED: MAPET>0, PRINT MAPET<1, DO NOT PRINT
ICN	FORTRAN UNIT NUMBER FROM WHICH INITIAL SOIL-MOISTURE CONDITIONS ARE READ. IF ICN=0 NO SOIL MOISTURE DATA ARE READ
IRECH	PARAMETER TO DETERMINE IF PRINTED ANNUAL RECHARGE IS ALSO TO BE STORED ON DISK FILE: IRECH<1, DO NOT STORE IRECH>0, STORE RECHARGE ON THIS FORTRAN UNIT NUMBER
IFLUX	PARAMETER TO DETERMINE UNITS OF STORED RECHARGE IFLUX<1, IN/YR IFLUX>0, FT**3/SEC
NSMBLK	NUMBER OF BLOCKS WHERE PRINTOUT OF DAILY SUMMARIES REQUESTED

IAPPLY	NUMBER OF BLOCKS WHERE IRRIGATION-APPLICATION RATES ARE TO BE READ IN
MAPEL	THE PRODUCT OF IROW AND ICOL
ARRY(MAPEL)	ARRAY USED TO PRINT LINE PRINTER MAP OF RECHARGE AND ACTUAL EVAPOTRANSPIRATION

COMMON: SUMMRY

QBALDY(16)	DAILY SUMMARIES OF MODELED REGION AVERAGES FOR 16 BUDGET ITEMS, VALUES PRINTED EACH DAY IF DSUM>0, REAL*8
QBALMO(16,12)	MONTHLY SUMMARIES OF MODELED REGION AVERAGES FOR 16 BUDGET ITEMS, REAL*8
QBALYR(16)	ANNUAL SUMMARIES OF MODELED REGION AVERAGES FOR 16 BUDGET ITEMS
QBLAVY(16)	SIMULATION PERIOD AVERAGE ANNUAL SUMMARIES OF MODEL REGION AVERAGES FOR 16 BUDGET ITEMS
QBLAVM(16,12)	SIMULATION PERIOD AVERAGE MONTHLY SUMMARIES OF MODEL REGION AVERAGES FOR 16 BUDGET ITEMS
DSUM	PARAMETER THAT DETERMINES IF DAILY SUMMARIES ARE TO BE PRINTED AFTER EACH DAY SIMULATED

COMMON: SOIL1

WATCAP(NSOLAS, NLAYER)	AVAILABLE WATER CAPACITY (INCHES) FOR EACH SOIL LAYER FOR EACH SOIL ASSOCIATION
SOLTYP(NSOLAS)	SOIL TEXTURE FOR EACH SOIL ASSOCIATION: 1=SAND, 2=LOAM, 3=CLAY; ANY OTHER VALUES BETWEEN 1.0 AND 3.0 ARE PERMITTED, FOR EXAMPLE, 1.5=SANDY LOAM, 2.5=CLAYEY LOAM
NLAYER(NSOLAS)	NUMBER OF 6-INCH SOIL LAYERS FOR EACH SOIL ASSOCIATION
NSOLAS	(MAXIMUM OF 24)

COMMON: SOIL2

CN2(NEL)	SCS CURVE NUMBER FOR EACH BLOCK
NSOIL(NEL)	SOIL ASSOCIATION NUMBER FOR EACH BLOCK

COMMON:PLANT

MAXINT(15)	MAXIMUM INTERCEPTION CAPACITY FOR EACH LAND USE (INCHES)
RDMAX(15)	MAXIMUM ROOT DEPTH FOR EACH LAND USE (INCHES)
FCMAX(15)	MAXIMUM FOLIAR COVER FOR EACH LAND USE (DECIMAL PERCENT)
COEFS(15,8)	ARRAY THAT STORES THE FOLLOWING FOR EACH LAND USE:

<u>I=1, 15</u>   <u>IS DAILY VALUES OF</u>

COEFS(I,1) = RD, CURRENT ROOT DEPTH
COEFS(I,2) = FC, CURRENT FOLIAR COVER FRACTION
COEFS(I,3) = MXNT, CURRENT INTERCEPTION CAPACITY
COEFS(I,4) = CP, CURRENT BLANEY-CRIDDLE CROP COEFFICIENT
COEFS(I,5) = APMULT, CURRENT DAILY FRACTION OF THE ANNUAL IRRIGATION
COEFS(I,6) = RDMX, MAXIMUM ROOT DEPTH

	COEFS(I,7) = FCMX, MAXIMUM FOLIAR COVER FRACTION COEFS(I,8) = XINTER, MAXIMUM INTERCEPTION CAPACITY
IROOT	VARIABLE TO DETERMINE HOW PLANTS EXTRACT WATER: IROOT<1, EXTRACT WATER EQUALLY ALL LAYERS IROOT>0, EXTRACT WATER EXPONENTIALLY FROM LAYERS

COMMON: FLOWS

SNOW(NEL)	SNOWPACK FOR EACH BLOCK FOR CURRENT DAY (INCHES WATER-EQUIVALENT)
SMS(NEL,NLAYER)	SOIL-MOISTURE CONTENT FOR EACH BLOCK FOR EACH LAYER FOR CURRENT DAY (INCHES)
REMAIN(NEL)	AMOUNT OF MOISTURE REMAINING OF FOLIAGE AFTER CURRENT DAY

COMMON: CLASLD

LANDUS(NEL)	LAND-USE CLASSIFICATION NUMBER FOR EACH BLOCK
ILND	FORTRAN UNIT NUMBER FROM WHICH LAND-USE DATA ARE READ
JLND	PARAMETER THAT INDICATES WHETHER OR NOT LAND-USE CHANGES FROM YEAR TO YEAR DURING THE SIMULATION. IF JLND>0, A NEW LAND-USE ARRAY IS READ AT THE BEGINNING OF EACH YEAR. IF JLND<1, ONE LAND-USE ARRAY IS READ AT THE BEGINNING OF THE FIRST YEAR ONLY.
FMTL	FORMAT OF LAND-USE DATA, IF FORMATTED, CHARACTER*8
IFORML	PARAMETER THAT INDICATES WHETHER LAND-USE DATA ARE FORMATTED (IFORML<1) OR UNFORMATTED (IFORML>0)

COMMON: JENHAZ

ALTWS(NWST)	ALTITUDES OF TEMPERATURE WEATHER STATIONS
TNJAVG(NWST)	AVERAGE JULY MINIMUM TEMPERATURES AT WEATHER STATIONS, USED IN CALCULATING JENSEN-HAISE COEFFICIENTS
TXJAVG(NWST)	SAME AS ABOVE, BUT FOR MAXIMUM TEMPERATURES
TXX(NWST)	JENSEN-HAISE COEFFICIENT FOR POTENTIAL EVAPOTRANSPIRATION COMPUTATIONS
ASUN	INTERCEPT OF LINEAR REGRESSION RELATION BETWEEN DAILY AIR TEMPERATURE DIFFERENCE AND PERCENT POSSIBLE SUNSHINE
BSUN	SLOPE OF ABOVE RELATION
CTT(NWST)	JENSEN-HAISE COEFFICIENT FOR POTENTIAL EVAPOTRANSPIRATION COMPUTATIONS
POT(NWST)	POTENTIAL EVAPOTRANSPIRATION AT WEATHER STATION FOR CURRENT DAY
AVELAT	AVERAGE LATITUDE OF STUDY AREA (DECIMAL DEGREES)
IFTEMP	PARAMETER TO DETERMINE: IF LAPSE RATES ARE TO BE USED IN INTERPOLATING TEMPERATURES FROM WEATHER STATIONS TO BLOCKS AND PET CALCULATED (NOT INTERPOLATED) AT BLOCKS; IFTEMP<0, USE LAPSE RATES
IFTMPN	FLAG, WHEN IFTEMP<0, THAT IDENTIFIES THAT MINIMUM TEMPERATURE LAPSE RATES ARE TO BE USED WHEN ENTERING LAPSE SUBROUTINE
IFTMPX	FLAG, WHEN IFTEMP<0, THAT IDENTIFIES THAT MAXIMUM TEMPERATURE LAPSE RATES ARE TO BE USED WHEN ENTERING LAPSE SUBROUTINE

NT	NUMBER OF BLOCKS TO WHICH TEMPERATURES ARE INTERPOLATED, AND FOR WHICH PET WILL BE CALCULATED. NT READ IN ONLY WHEN IFTEMP<0

COMMON: POLATP

DISTP(NIJ,NVALP)	ARRAY OF DISTANCES FROM NVALP WEATHER STATIONS TO EACH NODE OF A BLOCK. THESE DISTANCES USED IN INTERPOLATING PRECIPITATION DATA FROM WEATHER STATIONS TO BLOCKS
NEARP(NIJ,NVALP)	ARRAY CONTAINING THE PRECIPITATION WEATHER-STATION SEQUENCE NUMBER ASSOCIATED WITH THE NVALP NEAREST WEATHER STATIONS
DMAX	MAXIMUM DISTANCE FROM A NODE TO SEARCH FOR A WEATHER STATION (MILES) TO BE USED FOR INTERPOLATION
NVALP	NUMBER OF PRECIPITATION WEATHER STATIONS TO SEARCH FOR IN A RADIUS OF DMAX FOR INTERPOLATING PRECIPITATION TO A BLOCK

COMMON: POLATT

DISTT(NIJ,NVALT)	ARRAY CONTAINING NVALT TEMPERATURE WEATHER-STATION DISTANCES FROM THE NODES TO THE WEATHER STATIONS
NEART(NIJ,NVALT)	ARRAY CONTAINING TEMPERATURE WEATHER-STATION SEQUENCE NUMBER FOR NVALT WEATHER STATIONS THAT WILL BE USED FOR INTERPOLATING TEMPERATURES TO BLOCKS
NVALT	NUMBER OF TEMPERATURE WEATHER STATIONS TO SEARCH FOR IN A RADIUS OF DMAX SURROUNDING EACH NODE

COMMON: DAYVAL

SM(NLAYER)	CURRENT SOIL MOISTURE FOR EACH SOIL LAYER IN THE CURRENT BLOCK
WC(NLAYER)	AVAILABLE WATER CAPACITY FOR EACH LAYER IN THE CURRENT BLOCK

COMMON: BLKVAL

ALL FOR THE FOLLOWING ARE LOCAL VARIABLES FOR THE CURRENT BLOCK AND, IF APPLICABLE, FOR THE CURRENT DAY

PPT	PRECIPITATION
TMN	MINIMUM TEMPERATURE
TMX	MAXIMUM TEMPERATURE
TAV	AVERAGE TEMPERATURE
CP	BLANEY-CRIDDLE CROP GROWTH COEFFICIENT
NL	NUMBER OF 6-INCH LAYERS IN THE SOIL PROFILE AVAILABLE TO ROOT GROWTH
NS	SOIL ASSOCIATION OR IDENTIFICATION NUMBER TO REFERENCE ALL SOIL CHARACTERISTICS FOR A BLOCK
CN	SOIL CONSERVATION SERVICE CURVE NUMBER USED TO DEFINE RUNOFF CHARACTERISTICS OF A WATERSHED
ST	SOIL TEXTURE IDENTIFICATION NUMBER USED TO ESTABLISH WHICH ACTUAL TRANSPIRATION RELATION IS USED

RD	ROOT DEPTH
MXNT	AMOUNT OF MOISTURE THAT CAN BE INTERCEPTED
SNO	AMOUNT OF SNOW ON THE GROUND
RED	THE AMOUNT OF PRECIPITATION INTERCEPTED
SNM	THE AMOUNT OF SNOW MELTED
RDMX	THE MAXIMUM ROOT DEPTH FOR THE YEAR
RO	RUNOFF
RECR	RECHARGE OR DEEP PERCOLATION
REMINT	INTERCEPTED MOISTURE THAT HAS NOT BEEN EVAPORATED BY THE END OF THE DAY
ETP	POTENTIAL EVAPOTRANSPIRATION COMPUTED BY JENSEN-HAISE METHOD
AETFC	AMOUNT OF INTERCEPTED MOISTURE THAT IS EVAPORATED
SOLPEV	POTENTIAL SOIL EVAPORATION - THAT PART OF ETP WHICH ACTS UPON BARE SOIL
ACTEV	ACTUAL AMOUNT EVAPORATED FROM BARE SOIL
PLNTPT	POTENTIAL TRANSPIRATION - THAT PART OF ETP WHICH ACTS UPON PLANTS
ACTPLT	ACTUAL AMOUNT OF PLANT TRANSPIRATION
SNK	THAT PART OF ETP NOT USED IN ACTUAL EVAPORATION OR ACTUAL TRANSPIRATION
FC	FOLIAR COVER - FRACTION OF BLOCK AREA COVERED BY VEGETATION
TMXPRE	PREVIOUS DAY'S MAXIMUM TEMPERATURE
CHGSNO	THE CHANGE IN THE AMOUNT OF SNOW ON GROUND FROM END OF PREVIOUS DAY TO END OF CURRENT DAY
LNDUS	LAND-USE IDENTIFICATION NUMBER (1-15)
SUB	SUBLIMATION FROM THE SNOWPACK

COMMON: ANNVAL

AET(NEL)	ARRAY FOR STORING BLOCK AET VALUES IF MAPET>0, OTHERWISE DIMENSION MAY BE SET TO (1) TO SAVE STORAGE
AETAV(NEL)	ARRAY FOR STORING AVERAGE BLOCK AET VALUES FOR PRINTING AT END OF SIMULATION PERIOD
RECH(NEL)	ARRAY FOR STORING ANNUAL BLOCK RECHARGE VALUES IF MAPREC>0 OR IRECH>0, OTHERWISE DIMENSION MAY BE SET TO (1) TO SAVE STORAGE
RECHAV(NEL)	ARRAY FOR STORING AVERAGE BLOCK RECHARGE VALUES FOR PRINTING AT END OF SIMULATION PERIOD

COMMON: LRATES

RATEMN(12)	AVERAGE MONTHLY MINIMUM TEMPERATURE LAPSE RATES (DEGREES FAHRENHEIT PER 1,000 FEET ELEVATION), VALUES READ IN ONLY IF IFTEMP<0
RATEMX(12)	AVERAGE MONTHLY MAXIMUM TEMPERATURE LAPSE RATES (DEGREES FAHRENHEIT PER 1,000 FEET ELEVATION), VALUES READ IN ONLY IF IFTEMP<0
ILAPSE	IF ILAPSE>1 THEN MAXIMUM AND MINIMUM TEMPERATURE-LAPSE RATES ARE READ IN, READ IN ONLY IF IFTEMP<0

COMMON: BLKPET

ALTBLK(NT)	ALTITUDES FOR NT BLOCKS (FEET) WHERE PET IS CALCULATED (NOT INTERPOLATED)
SLPBLK(NT)	SLOPES FOR NT BLOCKS (DECIMAL DEGREES) MEASURED FROM HORIZONTAL, WHERE PET IS CALCULATED (NOT INTERPOLATED)
ASPECT(NT)	ASPECTS FOR NT BLOCKS (DECIMAL DEGREES) MEASURED CLOCKWISE FROM NORTH WHERE PET IS CALCULATED (NOT INTERPOLATED)
CTBLK(NT)	JENSEN-HAISE COEFFICIENTS FOR NT BLOCKS FOR COMPUTING POTENTIAL EVAPOTRANSPIRATION
TXBLK(NT)	SAME AS ABOVE
TXJAVB(NT)	AVERAGE JULY MAXIMUM TEMPERATURES FOR NT BLOCKS USED IN CALCULATING JENSEN-HAISE COEFFICIENTS
TNJAVB(NT)	SAME AS ABOVE, BUT FOR MINIMUM TEMPERATURES
IBLOCK(NT)	BLOCK NUMBERS WHERE PET IS CALCULATED FROM INTERPOLATED TEMPERATURES AND LAND SURFACE DATA RATHER THAN INTERPOLATED FROM PET VALUES COMPUTED AT WEATHER STATIONS

COMMON: WINTER

SBLMTE	AVERAGE DAILY SUBLIMATION RATE (INCH/DAY), VALUE IS READ IN (GENERALLY RANGES FROM ABOUT 0.002 TO 0.015 INCH/DAY)
PETMIN(6)	AVERAGE DAILY MINIMUM PET VALUE TO BE APPLIED DURING THE MONTHS OCTOBER-MARCH, WHERE PETMIN(1) IS OCTOBER AND PETMIN(6) IS MARCH
KMCOEF	SNOWMELT COEFFICIENT INCHES/^{O}C/DAY, REAL

COMMON: IRRTIM

IRRST1(15)	DAY OF THE YEAR (JULIAN) THAT IRRIGATION STARTS FOR THE FIRST OF TWO IRRIGATION PERIODS DURING THE YEAR FOR EACH OF 15 LAND USES
IRREN2(15)	DAY OF THE YEAR (JULIAN) THAT IRRIGATION CEASES FOR THE FIRST OF TWO IRRIGATION PERIODS DURING THE YEAR FOR EACH OF 15 LAND USES
IRRST2(15)	SAME AS FOR IRRST1(15), BUT FOR THE SECOND IRRIGATION PERIOD
IRREN(15)	SAME AS FOR IRREN1(15), BUT FOR THE SECOND IRRIGATION PERIOD
SUMCP(15)	THE SUM OF THE DAILY VALUES OF THE CROP-GROWTH COEFFICIENT TAKEN OVER ALL DAYS OF THE YEAR THAT WATER IS APPLIED, FOR EACH OF 15 LAND USES

COMMON: PRCPVL

APRENW(NWSP)	AVERAGE ANNUAL PRECIPITATION VALUES FOR WEATHER STATIONS, VALUES ARE READ IN ONLY IF IFPREC>0; OTHERWISE DIMENSION MAY BE SET TO (1) TO SAVE STORAGE
ANPBLK(NEL)	ARRAY OF ANNUAL AVERAGE PRECPITATION VALUES FOR EACH BLOCK, VALUES READ IN ONLY IF IFPREC>0; OTHERWISE DIMENSION MAY BE SET TO (1) TO SAVE STORAGE

COMMON: IRRWAT

APPLD(IAPPLY)	ARRAY OF ANNUAL IRRIGATION APPLICATION FOR BLOCKS. DIMENSION SHOULD BE SET TO (1) IF NO IRRIGATION
IAPBLK(IAPPLY)	ARRAY CONTAINING BLOCK NUMBERS WHERE THE IRRIGATION APPLICATION, APPLD(IAPPLY), ARE TO BE APPLIED. SET DIMENSION TO (1) IF NO IRRIGATION

COMMON: STRFLW

RODATA	INPUT FORTRAN UNIT NUMBER FOR STREAMFLOW DATA. IF RODATA = 0, SURFACE RUNOFF IS COMPUTED AND NOT READ IN. IF RODATA = -1, SURFACE RUNOFF IS ASSUMED TO BE ZERO DURING SIMULATION AND IS NOT READ IN, INTEGER
DISCH	AVERAGE DAILY VALUE OF STREAM DISCHARGE (CUBIC FEET PER SECOND)
BSFLW(12)	AVERAGE MONTHLY VALUE OF GROUND-WATER BASEFLOW TO STREAM (CUBIC FEET PER SECOND) FOR EACH MONTH OF THE CURRENT YEAR
BSNFAC	A FACTOR COMPUTED FROM BASIN AREA (SQUARE MILES) TO CONVERT STREAM DISCHARGE (CUBIC FEET PER SECOND) TO INCHES PER DAY OVER THE BASIN
CNFAC(NEL)	FACTORS TO CONVERT TOTAL SURFACE RUNOFF FOR BASIN TO SURFACE RUNOFF CONTRIBUTION FROM EACH BLOCK
BSDATA	INPUT FORTRAN UNIT NUMBER FOR BASE-FLOW DATA
EHRMRO(NEL)	SCS COMPUTED RUNOFF FOR EACH BLOCK. SET DIMENSION TO (1) IF RODATA<1.

DATA-INPUT GUIDE

The following describes in detail how the input data are to be set up by the user. Data are listed by 18 separate groups, which have similar characteristics. Normally each group is a separate computer file; most groups can be included in group 1 data if desired, which is on logical unit 5(IN1) by setting their FORTRAN input unit number to 5. Those groups would be included in group 1 stream of data records. In general, the authors suggest keeping most or all group data records in separate files. This allows for easier generation, compiling, editing, analyses, and presentation of those group data. The groups are:

GROUP 1:	DATA READ FROM UNIT 5 ESTABLISHING INPUT AND OUTPUT OPTIONS, FORTRAN UNIT NUMBERS, SIZES, AND OTHER VARIABLES OF THE MODEL SIMULATION
GROUP 2:	GRID DEFINITION DATA
GROUP 3:	LONGITUDES, LATITUDES, AND ALTITUDES FOR WEATHER STATIONS WITH PRECIPITATION DATA AND FOR WEATHER STATIONS WITH TEMPERATURE DATA
GROUP 4:	LONG-TERM AVERAGE JULY MINIMUM AND MAXIMUM AIR-TEMPERATURE DATA, USED IN PET CALCULATIONS
GROUP 5:	AVERAGE ANNUAL PRECIPITATION DATA FOR BLOCKS
GROUP 6:	LAND-SURFACE ALTITUDES, SLOPES, AND ASPECTS FOR BLOCKS
GROUP 7:	LINE PRINTER OUTPUT MAP CONFIGURATION
GROUP 8:	LAND-USE NUMBERS FOR BLOCKS
GROUP 9:	SOIL-ASSOCIATION NUMBERS FOR BLOCKS
GROUP 10:	SOIL CONSERVATION SERVICE (SCS) CN2 CURVE NUMBERS FOR BLOCKS
GROUP 11:	ANNUAL IRRIGATION APPLICATION FOR BLOCKS
GROUP 12:	DAILY PRECIPITATION DATA
GROUP 13:	DAILY MAXIMUM AIR-TEMPERATURE DATA
GROUP 14;	DAILY MINIMUM AIR-TEMPERATURE DATA
GROUP 15:	INITIAL SOIL-MOISTURE CONTENTS FOR BLOCKS
GROUP 16:	INITIAL SNOWPACK FOR BLOCKS
GROUP 17:	DAILY STREAM-DISCHARGE DATA
GROUP 18:	AVERAGE MONTHLY BASE-FLOW RATES FOR EACH YEAR SIMULATED

If group data are to be read off the same FORTRAN unit number as group 1 then the data-input guide tells the user where that particular group should be inserted in the group 1 data stream.

The guide is organized by sequentially numbered "records" (card image) for each group. However, if the number of records depends upon an input number such as number of blocks (NEL) in the model or number of weather stations, a variable name or asterisk is used to define the ending record number of the input data item and the beginning record number of the next input data item.

In the next column, after the "record" the format and data type (integer, real, or character--listed as C*) of the data items read for that record is listed. For example, record number 4 of the group 1 data has three integer data items, all with a format of I4; the first item (IYR1) would be right justified in column 4, item 2 (IYR2) would be right justified in column 8, and item 3 (IWARMP) would be right justified in column 12.

In the third column the data item variable name as it appears in the FORTRAN program code is listed and in the last column a short description of the item (definition) is given.

GROUP 1. DATAIN INPUT: FORTRAN UNIT=IN1 (SUBROUTINE:DATAIN)

VALUE OF IN1 IS SET = 5 IN DATAIN.

RECORD	FORMAT	VARIABLE	DEFINITION
1	C*80	TITLE	THE TITLE TO BE PRINTED AT BEGINNING OF MODEL OUTPUT
2	I4	IOT1	FORTRAN OUTPUT UNIT NUMBER FOR PRINTING THE INPUT DATA SET (ECHO OF INPUT)
3	I4	IN2	FORTRAN INPUT UNIT FOR GRID DATA
4	I4	IYR1	FIRST YEAR OF SIMULATION
	I4	IYR2	LAST YEAR OF SIMULATION
	I4	IWARMP	PARAMETER TO DETERMINE IF FIRST YEAR IS TO BE SIMULATED TWICE IN SUCCESSION IN ORDER TO OBTAIN BETTER INITIAL CONDITIONS. IWARMP>0, REPEAT FIRST YEAR
5	I4	IGRID	PARAMETER TO DETERMINE IF GRID IS TO BE AUTOMATICALLY GENERATED OR IF VALUES ARE TO BE INPUT: IGRID<1, GENERATE RECTANGULAR GRID; IGRID>0, INPUT GRID
	I4	LFEET	PARAMETER TO DETERMINE IF LATITUDES AND LONGITUDES ARE CODED IN DECIMAL DEGREES OR IF THEY HAVE ALREADY BEEN CONVERTED TO LAMBERT FEET. LFEET<1 FOR DECIMAL DEGREES, >0 FOR LAMBERT.

GROUP 2 GRID DATA ARE INSERTED HERE ONLY IF IN2=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
6	I4	IN3	FORTRAN INPUT UNIT FOR WEATHER-STATION LOCATIONS (X,Y)
	I4	ILMBRT	DETERMINES WEATHER-STATION LOCATION DATA TYPE: ILMBRT<1, X,Y VALUES IN DECIMAL DEGREES; ILMBRT>0, X,Y VALUES IN LAMBERT COORDINATES
7	I4	NWSP	NUMBER OF PRECIPITATION WEATHER STATIONS IN WEATHER-STATION LOCATION DATA FILE
8	I4	NWST	NUMBER OF TEMPERATURE WEATHER STATIONS IN WEATHER-STATION LOCATION DATA FILE

GROUP 3 WEATHER STATION LOCATION AND ALTITUDE DATA ARE INSERTED HERE IF IN3=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
9			DIRECT ACCESS FORTRAN INPUT UNIT NUMBERS FOR[1]:
	I4	INP	PRECIPITATION DAILY VALUES
	I4	INTN	MINIMUM TEMPERATURE DAILY VALUES
	I4	INTX	MAXIMUM TEMPERATURE DAILY VALUES
	2I4	IRECP,IRECT	RECORD LENGTHS FOR DIRECT ACCESS FILES FOR PRECIPITATION AND TEMPERATURE DATA, RESPECTIVELY IRECP = NUMBER OF PRECIPITATION WEATHER STATIONS *SPACE ALLOCATION FOR DAILY PRECIPITATION VALUE.[2] IRECT = NUMBER OF TEMPERATURE WEATHER STATIONS *SPACE ALLOCATION FOR DAILY TEMPERATURE VALUE.[2]
10	I4	INJAV	FORTRAN INPUT UNIT NUMBER FOR LONG-TERM AVERAGE JULY MAXIMUM AND MINIMUM TEMPERATURES

[1] If more than 1 year is to be simulated, the values of INP, INTN, and INTX are automatically incremented by 1 each year after the first year.

[2] Space allocation recommendations for daily precipitation and temperature values are 4 and 3, respectively. (See instructions for Groups 12, 13, and 14)

GROUP 4 LONG-TERM AVERAGE JULY MAXIMUM AND MINIMUM TEMPERATURE
HERE IF INJAV = IN1

RECORD	FORMAT	VARIABLE	DEFINITION
11	2F6.0	ASUN,BSUN	INTERCEPT AND SLOPE OF REGRESSION EQUATION FOR PREDICTING PERCENT POSSIBLE SUNSHINE BASED ON DIFFERENCE BETWEEN DAILY MAXIMUM AND MINIMUM AIR TEMPERATURE
12	2I4	NVALP,NVALT	NUMBER OF WEATHER STATIONS TO USE IN INTERPOLATION OF PRECIPITATION DATA AND AIR-TEMPERATURE DATA, RESPECTIVELY, TO BLOCKS
13	I4	IFPREC	PARAMETER THAT DETERMINES IF ANNUAL AVERAGE PRECIPITATION VALUES WILL BE READ IN FOR WEATHER STATIONS AND BLOCKS AS A FURTHER WEIGHT IN INTERPOLATING DAILY PRECIPITATION FOR BLOCKS. IFPREC<1, DO NOT READ IN VALUES IFPREC>0, READ IN VALUES

THE FOLLOWING IS READ IN ONLY IF IFPREC=1(>0)
(READ FROM: SUBROUTINE PREVAL)

1-*	10F8.0	APRENW(NWSP)	AVERAGE ANNUAL VALUES OF PRECIPITATION AT WEATHER STATIONS
*+1	I4	NP	NUMBER OF BLOCKS THAT WILL HAVE AVERAGE ANNUAL PRECIPITATION VALUES READ
	I4	IN4	FORTRAN INPUT UNIT NUMBER FOR THE BLOCK VALUES OF AVERAGE ANNUAL PRECIPITATION

*depends upon number of weather stations.

GROUP 5 DATA ARE INSERTED HERE ONLY IF IN4=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
14	F15.5	DMAX	MAXIMUM DISTANCE FROM WHICH WEATHER STATION DATA ARE TO BE USED IN INTERPOLATION (MILES)
15	F15.5	AVELAT	AVERAGE LATITUDE OF MODEL AREA, USED IN PET CALCULATIONS (DECIMAL DEGREES)
16	I4	IFTEMP	PARAMETER TO DETERMINE IF PET FOR BLOCKS IS COMPUTED AT BLOCK USING BLOCK VALUES OF TEMPERATURE, ALTITUDE, SLOPE, AND ASPECT. IF IFTEMP<0, COMPUTE AT BLOCKS; OTHERWISE SET IFTEMP=0

THE FOLLOWING IS READ IN ONLY IF IFTEMP IS LESS THAN 0

RECORD	FORMAT	VARIABLE	DEFINITION
1	I4	NT	NUMBER OF BLOCKS WHERE PET IS TO BE COMPUTED
	I4	INALT	FORTRAN INPUT UNIT NUMBER FOR ALTITUDE, SLOPE, AND ASPECT FOR NT BLOCKS

GROUP 6 DATA ARE INSERTED HERE ONLY IF INALT=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
2	I4	ILAPSE	IF LAPSE RATES ARE NOT USED SET ILAPSE=0; OTHERWISE SET ILAPSE>0.

------THE NEXT TWO RECORDS ARE READ ONLY IF ILAPSE>0-----

RECORD	FORMAT	VARIABLE	DEFINITION
3	12F5.2	RATEMN(12)	MONTHLY MINIMUM TEMPERATURE LAPSE RATES (DEGREES FARHENHEIT PER 1,000 FEET ELEVATION)
4	12F5.2	RATEMX(12)	MONTHLY MAXIMUM TEMPERATURE LAPSE RATES (DEGREES FAHRENHEIT PER 1,000 FEET ELEVATION)

RECORD	FORMAT	VARIABLE	DEFINITION
17	F6.0	SBLMTE	WINTER SEASON AVERAGE DAILY SUBLIMATION RATE IN INCHES/DAY
		KMCOEF	SNOWMELT COEFFICIENT IN INCHES/^{o}C/DAY
18	6F6.0	PETMIN(6)	SIX AVERAGE MINIMUM DAILY PET VALUES FOR OCTOBER THROUGH MARCH
19	I4	ICN	PARAMETER TO DETERMINE IF INITIAL SOIL-MOISTURE CONDITION FOR EACH BLOCK IS TO BE SET TO AVAILABLE WATER CAPACITY OR READ FROM LOGICAL UNIT=ICN ICN<1, SET TO CAPACITY ICN>0, READ OFF DISK FILE
20	I4	ISTS	FORTRAN OUTPUT UNIT NUMBER WHERE END-OF-YEAR SOIL MOISTURE MAY BE SAVED. IF ISTS<1 SOIL MOISTURE WILL NOT BE SAVED. VALUES WRITTEN TO THIS UNIT ARE UNFORMATTED
21	I4	IPRNT	FORTRAN OUTPUT UNIT FOR MODEL RESULTS
22	I4	MAPREC	PARAMETER TO DETERMINE IF ANNUAL RECHARGE FOR EACH BLOCK IS TO BE ACCUMULATED AND PRINTED AS A RECTANGULAR MAP ARRAY ON OUTPUT UNIT IOT1: MAPREC=0, DO NOT PRINT MAPREC=1, PRINT RECHARGE MAP FOR EACH YEAR (AVERAGE MAP FOR SIMULATION PERIOD IS ALWAYS PRINTED)
	I4	MAPET	PARAMETER TO DETERMINE IF ANNUAL EVAPOTRANSPIRATION IS TO BE ACCUMULATED AND PRINTED AS A RECTANGULAR MAP ARRAY ON OUTPUT UNIT IOT1: MAPET=0, DO NOT PRINT MAPET=1, PRINT EVAPOTRANSPIRATION MAP FOR EACH YEAR (AVERAGE MAP FOR SIMULATION PERIOD IS ALWAYS PRINTED)
	I4	MAPEL	PRODUCT OF ROWS x COLUMNS IN RECTANGULAR MAP ARRAY (SEE GROUP 7 DATA). IF AUTOMATIC GRID GENERATION IS USED SET MAPEL=1
	I4	MAPARY	FORTRAN INPUT UNIT FOR RECTANGULAR MAP ARRAY CONFIGURATION

GROUP 7 DATA ARE INSERTED HERE ONLY IF MAPARY=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
23	I4	IRECH	FORTRAN OUTPUT UNIT TO WHICH ANNUAL RECHARGE FOR EACH BLOCK MAY BE WRITTEN, VALUES WRITTEN TO THIS UNIT ARE UNFORMATTED. IF IRECH<1 THEY WILL NOT BE WRITTEN. (NOTE: ANNUAL RECHARGE MAY ALSO BE PRINTED ON IPRNT, SEE ABOVE)
	I4	IFLUX	PARAMETER TO DETERMINE UNITS OF SAVED RECHARGE: IFLUX<1, SAVE AS INCHES/YR IFLUX>0, SAVE AS FT**3/SEC (LEAVE BLANK IF IRECH<1)
24	I4	DSUM	DSUM>0, PRINT DAILY MASS BALANCE FOR MODELED BASIN (ANNUAL AND MONTHLY MASS BALANCES ARE ALWAYS PRINTED)
25	I4	NSMBLK	NUMBER OF BLOCKS WHERE INDIVIDUAL DAILY BLOCK SUMMARIES ARE TO BE PRINTED NOTE: THE USER SHOULD NEVER SPECIFY MORE THAN A FEW BLOCKS, OTHERWISE OUTPUT WILL BE EXCESSIVELY LARGE.
THE FOLLOWING IS READ IN ONLY IF NSMBLK IS GREATER THAN 0			
1-NSMBLK	I4	NSB(NSMBLK)	BLOCK NUMBERS FOR WHICH DAILY MASS BALANCE SUMMARY IS REQUESTED
26	I4	ILND	FORTRAN INPUT UNIT NUMBER FROM WHICH LAND-USE DATA ARE TO BE READ
	I4	IFORML	IFORML<1, DATA ON UNIT ILND ARE FORMATTED IFORML>0, DATA ON UNIT ILND ARE UNFORMATTED
	I4	JLND	PARAMETER TO INDICATE IF LAND USE CHANGES EACH YEAR. JLND>0, CHANGES EACH YEAR AND LAND-USE DATA SETS ARE ON FORTRAN INPUT UNITS ILND THROUGH ILND-1+NUMBER OF YEARS OF SIMULATION. JLND<1, LAND USE ALWAYS THE SAME AS FIRST YEAR
THE FOLLOWING IS READ IN ONLY IF IFORML IS LESS THAN 1			
	C*8	FMTL	FORMAT OF LAND USE ON FORTRAN INPUT UNIT ILND

GROUP 8 LAND-USE DATA ARE INSERTED HERE ONLY IF ILND=IN1, IFORML=0 AND JLND<1

RECORD	FORMAT	VARIABLE	DEFINITION
27	I4	NSOLAS	NUMBER OF SOIL ASSOCIATIONS IN STUDY AREA (UP TO A MAXIMUM OF 24)
28	I4	INSOIL	UNIT NUMBER FROM WHICH SOIL ASSOCIATION NUMBER DATA FOR EACH BLOCK ARE TO BE READ
	I4	IFORMS	IFORMS<1, DATA ON UNIT INSOIL IS FORMATTED IFORMS>0, DATA ON UNIT INSOIL IS UNFORMATTED

THE FOLLOWING IS READ IN ONLY IF IFORMS IS LESS THAN 1

	C*8	FMTS	FORMAT OF SOIL ASSOCIATION NUMBERS ON FORTRAN INPUT UNIT=INSOIL

GROUP 9 SOIL ASSOCIATION NUMBER DATA INSERTED HERE ONLY IF INSOIL=IN1 AND IFORMS=0

29-52*	I4	NLAYER(NSOLAS)	NUMBER OF 6-INCH DEPTH INCREMENTS FOR EACH SOIL ASSOCIATION

*The record numbers given from here on are based on the assumption that NSOLAS=24.

53-76	15F4.1	WATCAP(NSOLAS, NLAYER)	AVAILABLE WATER CAPACITY FOR EACH 6-INCH DEPTH INCREMENT (INCHES), FOR EACH SOIL ASSOCIATION (ONE SOIL ASSOCIATION PER RECORD)
77-100	F15.5	SOLTYP(NSOLAS)	SOIL TEXTURE FOR EACH SOIL ASSOCIATION: 1.0=SAND 1.1-1.9=SAND LOAM MIX 2.0=LOAM 2.1-2.9=CLAY LOAM MIX 3.0=CLAY
101	I4	IROOT	PARAMETER TO DETERMINE WHETHER PLANTS ARE TO EXTRACT SOIL MOISTURE AT THE MAXIMUM RATE FOR EACH LAYER OR AT AN EXPONENTIALLY DECREASING RATE WITH DEPTH IROOT=0, MAXIMUM IROOT=1, EXPONENTIAL

RECORD	FORMAT	VARIABLE	DEFINITION
102-116	F15.5	RDMAX(LANDUS)	MAXIMUM ROOT DEPTH FOR EACH OF 15 LAND USES (INCHES); IF RDMAX(I)=0.0, A DEFAULT VALUE IS USED
	F15.5	FCMAX(LANDUS)	MAXIMUM FOLIAR COVER FOR EACH OF 15 LAND USES (DECIMAL FRACTION); IF FCMAX(I)=0.0, DEFAULT VALUE IS USED
	F15.5	MAXINT(LANDUS)	MAXIMUM INTERCEPTION CAPACITY (INCHES) FOR EACH OF 15 LAND USES, IF MAXINT(I)=0.0, DEFAULT VALUE IN PROGRAM IS USED, REAL
117	I4	ICN2	FORTRAN INPUT UNIT NUMBER FOR SCS CN2 CURVE NUMBERS. (SET ICN2=0 FOR MODEL TO GENERATE CN2 NUMBERS FROM SOIL AND SLOPE DATA; SET ICN2 = -1 WHEN IT IS ASSUMED THAT THERE IS NO RUNOFF.)

GROUP 10 CN2 CURVE NUMBER DATA INSERTED HERE ONLY IF ICN2=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
118	F5.0	ASNOW	INITIAL UNIFORM SNOW COVER (INCHES OF WATER EQUIVALENT) TO BE USED FOR ALL BLOCKS, LEAVE BLANK OR SET TO ANY NUMBER IF VARIABLE INITIAL SNOW IS TO BE READ (SEE BELOW)
	I5	IRDSNO	IF VARIABLE INITIAL SNOW DEPTH IS TO BE READ THEN IRDSNO=FORTRAN INPUT UNIT NUMBER FROM WHICH INITIAL SNOW CONDITIONS ARE TO BE READ; LEAVE BLANK OR SET=0 IF UNIFORM SNOW COVER, ASNOW, IS USED. VALUES ON THIS UNIT ARE UNFORMATTED
	I5	IRTSNO	FORTRAN INPUT UNIT NUMBER IF END-OF-YEAR SNOW IS TO BE STORED FOR NEXT SIMULATION. IF IRTSNO=0 SNOW IS NOT STORED.
119	I4	IAPUNT	FORTRAN INPUT UNIT NUMBER FOR IRRIGATION APPLICATION RATE DATA. SET IAPUNT=0 IF THERE ARE NO IRRIGATED BLOCKS.

GROUP 11 IRRIGATION APPLICATION DATA INSERTED HERE ONLY IF IAPUNT=IN1

RECORD	FORMAT	VARIABLE	DEFINITION
			THE FOLLOWING IS READ IN ONLY IF IAPUNT>0
120	I4	IRLNDS	NUMBER OF IRRIGATED LAND USES
121-130[1]	I4	L	LAND-USE NUMBER FOR IRRIGATED LAND USE
	I4	IRRSCD(15)	PARAMETER FOR LAND USE L TO DETERMINE IF DAILY IRRIGATION WILL BE APPLIED AT A CONSTANT RATE OVER THE IRRIGATION SEASON OR BE PROPORTIONAL TO CROP-GROWTH STAGE IRRSCD=0, CONSTANT IRRSCD=1, PROPORTIONAL
	I4	IRRST1(15)	STARTING JULIAN DAY OF FIRST OF TWO IRRIGATION SEASONS FOR LAND USE L
	I4	IRREN1(15)[2]	ENDING JULIAN DAY OF FIRST IRRIGATION SEASON
	I4	IRRST2(15)[2]	STARTING JULIAN DAY OF SECOND OF TWO IRRIGATION SEASONS
	I4	IRREN2(15)[2]	ENDING JULIAN DAY OF SECOND IRRIGATION SEASON

[1]Ten irrigated land uses assumed.

[2]For only one irrigation season: IRREN2 is used for the last day while IRREN1 and IRRST2 are arbitrarily set such that they are >IRRST1 and <IRREN2 and also that IRRST2 = IRREN1+1.

131	I4	RODATA	FORTRAN INPUT UNIT NUMBER FOR STREAM-DISCHARGE DATA. IF RODATA IS SET = 0, MODEL-COMPUTED RUNOFF VALUES ARE USED DIRECTLY. IF RUNOFF IS ASSUMED TO ALWAYS=0, SET RODATA = -1. (NOTE: RODATA=INTEGER)
	I4	BSDATA	FORTRAN INPUT UNIT NUMBER FOR MONTHLY MEAN BASE-FLOW ESTIMATES. (NOTE: BSDATA=INTEGER)

GROUP 2. GRID DATA: FORTRAN UNIT NUMBER IN2 (SUBROUTINE: DOGRID)

THE FOLLOWING IS READ IN ONLY IF IGRID<1 (NUMBER OF BLOCKS AND BLOCK LOCATIONS DETERMINED AUTOMATICALLY)

RECORD	FORMAT	VARIABLE	DEFINITION
1	F10.0	AX(1)	MAXIMUM LONGITUDE OF STUDY AREA (DECIMAL DEGREES)
	F10.0	AX(2)	MINIMUM LONGITUDE OF STUDY AREA
	F10.0	AY(1)	MAXIMUM LATITUDE OF STUDY AREA
	F10.0	AY(2)	MINIMUM LATITUDE OF STUDY AREA
	F10.0	GRDSZE	SIZE OF BLOCKS (IN MINUTES)

THE FOLLOWING IS READ IN IF IGRID>0

RECORD	FORMAT	VARIABLE	DEFINITION
1	I4	NIJ	NUMBER OF NODES (ONE NODE PER BLOCK BOUNDARY INTERSECTION)
	I4	NEL	NUMBER OF BLOCKS (BLOCKS NEED NOT BE RECTANGULAR BUT MUST BE QUADRILATERAL)
2-(NEL+1)	4I4	NGB(4,NEL)	NODE NUMBERS FOR EACH BLOCK, CODED IN COUNTERCLOCKWISE DIRECTION FOR EACH BLOCK, STARTING IN LOWER LEFT CORNER
(NEL+2)-(NEL+NIJ+1)	6X, F20.0	X1=GX(I)	LONGITUDE OF NODE I (DECIMAL DEGREES IF LFEET<1; LAMBERT FEET IF LFEET>0)
	F20.0	Y1=GY(I)	LATITUDE OF NODE I (DECIMAL DEGREES IF LFEET<1; LAMBERT FEET IF LFEET>0)

GROUP 3. WEATHER STATION LOCATIONS (X,Y,) AND ALTITUDES: FORTRAN UNIT IN3 (SUBROUTINE: DATAIN)

--------ILMBRT<1, X,Y VALUES IN DECIMAL DEGREES
--------ILMBRT>0, X,Y VALUES IN LAMBERT COORDINATES

RECORD	FORMAT	VARIABLE	DEFINITION
1-NWSP	F15.5	XP(NWSP)	LONGITUDE OF PRECIPITATION WEATHER STATION
	F15.5	YP(NWSP)	LATITUDE OF PRECIPITATION WEATHER STATION
(NWSP+1)-(NWSP+NWST)	F15.5	XT(NWST)	LONGITUDE OF TEMPERATURE WEATHER STATION
	F15.5	YT(NWST)	LATITUDE OF TEMPERATURE WEATHER STATION
	F15.5	ALTWS(NWST)	ALTITUDE OF TEMPERATURE WEATHER STATION (LEAVE BLANK IF IFTEMP>-1)

GROUP 4 . LONG-TERM AVERAGE JULY MAXIMUM AND MINIMUM TEMPERATURES AT WEATHER STATIONS: FORTRAN UNIT INJAV (SUBROUTINE: AVJTMP)

RECORD	FORMAT	VARIABLE	DEFINITION
1-NWST	F5.1	TNJAVG(NWST)	LONG-TERM AVERAGE JULY MINIMUM TEMPERATURE (^{o}F) AT WEATHER STATION
	F5.1	TXJAVG(NWST)	LONG-TERM AVERAGE JULY MAXIMUM TEMPERATURE (^{o}F) AT WEATHER STATION

GROUP 5. ANNUAL PRECIPITATION DATA: FORTRAN UNIT NUMBER IN4
DATA SET READ IN ONLY IF IFPRECP>0 (SEE GROUP 1 DATA),
(SUBROUTINE: PREVAL)

THE FOLLOWING IS READ IN IF NP<NEL

1-NP	I4	IBLC	BLOCK NUMBERS FOR THOSE NP BLOCKS WHERE IN ADDITION TO THE DISTANCE INTERPOLATION, DAILY PRECIPITATION IS ADJUSTED FOR VARIATIONS IN ANNUAL PRECIPITATION
	F5.0	ANPBLK(NEL)	ANNUAL AVERAGE PRECIPITATION VALUE FOR IBLC

THE FOLLOWING IS READ IN IF NP=NEL

1-(NEL/10+1)	10F8.0	ANPBLK(NEL)	ANNUAL AVERAGE PRECIPITATION VALUES FOR ALL BLOCKS

GROUP 6. BLOCK NUMBERS, ALTITUDES, SLOPES, AND ASPECTS FOR BLOCKS WHERE TEMPERATURE IS TO BE INTERPOLATED USING LAPSE RATE
DATA SET READ ONLY IF IFTEMP<0 (SEE GROUP 1 DATA)

THE FOLLOWING IS READ IN IF NT<NEL OR IF NT=NEL AND INPUT UNIT INALT=IN1

1-NT	I4	IBLOCK(NT)	BLOCK NUMBER
	F4.0	ALTBLK(NT)	ALTITUDE OF BLOCK (FEET)
	F4.0	SLPBLK(NT)	SLOPE OF BLOCK, CAN BE LEFT BLANK, (DEGREES FROM HORIZONTAL)
	F4.0	ASPECT(NT)	ASPECT OF BLOCK, CAN BE LEFT BLANK, (DEGREES, CLOCKWISE FROM NORTH)

THE FOLLOWING IS READ IN IF NT=NEL AND INPUT UNIT INALT≠IN1

RECORD	FORMAT	VARIABLE	DEFINITION
1-NEL* (DISK)	UNFORMATTED	ALTBLK(I), SLPBLK(I), ASPECT(I),	ALTITUDE, SLOPE, AND ASPECT OF EACH BLOCK

*Each record has 3 unformatted data items

GROUP 7. LINE PRINTER OUTPUT MAP CONFIGURATION (SUBROUTINE: DATAIN)
(SEE FIGURE 10 FOR EXAMPLE OF THIS DATA GROUP)

RECORD	FORMAT	VARIABLE	DEFINITION
1	I4	IROW	NUMBER OF ROWS IN CIRCUMSCRIBING RECTANGLE
	I4	ICOL	NUMBER OF COLUMNS IN CIRCUMSCRIBING RECTANGLE
2	I4	JSTRT(1)	STARTING, JSTRT, AND ENDING, JEND,
	14	JEND(1)	ROWS FOR EACH CONTINUOUS GROUP OF
	I4	JSTRT(2)	BLOCKS IN A COLUMN (MAXIMUM OF 10
	.	.	GROUPS PER COLUMN). IF LESS THAN
	.	.	10 GROUPS ON A COLUMN, LEAVE
	I4	JEND(10)	REMAINING SPACE ON CARD BLANK.

GROUP 8. LAND-USE NUMBER FOR EACH BLOCK: FORTRAN UNIT NUMBER ILND (OR ILND THROUGH ILND + NUMBER OF SIMULATED YEARS -1) (SUBROUTINE: NEWLND)

THE FOLLOWING IS READ IN ONLY IF IFORML=1

DISK	UNFORMATTED	LANDUS(NEL)	LAND-USE NUMBER FOR EACH BLOCK

THE FOLLOWING ARE READ IN ONLY IF IFORML=0 AND FMTL HAVE BEEN READ IN			
1-*	FMTL	LANDUS(NEL)	LAND-USE NUMBER FOR EACH BLOCK

THE FOLLOWING NUMBERS ARE TO BE USED TO REPRESENT THE FOLLOWING LAND USES

1: FOREST
2: GRASS
3: SAGE
4: WINTER WHEAT-HARVEST, PLANTED
5: WINTER WHEAT-HARVEST, FALLOW
6: WINTER WHEAT-FALLOW, PLANTED
7: ORCHARD
8: ALFALFA
9: ROW CROPS
10: SURFACE WATER
11: CORN
12: POTATOES
13: SAND, BARE GROUND
14: PEAS AND OR LENTILS
15: SPRING WHEAT

If JLND>0 there are as many sets of group 8 data as the number of simulated years. They are on FORTRAN unit numbers ILND through ILND + number of simulated years -1.

<u>GROUP 9</u>. SOIL ASSOCATION NUMBER DATA FOR EACH BLOCK: FORTRAN UNIT NUMBER INSOIL (SUBROUTINE: DATAIN)

THE FOLLOWING IS READ IN ONLY IF IFORMS>0			
DISK	UNFORMATTED	NSOIL(NEL)	SOIL ASSOCIATION NUMBER FOR EACH BLOCK

THE FOLLOWING IS READ IN ONLY IF IFORMS<1 AND FMTS HAVE BEEN READ IN			
1-*	FMTS	NSOIL(NEL)	SOIL ASSOCIATION NUMBER FOR EACH BLOCK

*Depends upon format selected.

GROUP 10. CURVE NUMBER DATA: FORTRAN UNIT NUMBER ICN2 (SUBROUTINE: DATAIN) DATA SET READ ONLY IF ICN2>0 (SEE GROUP 1 DATA)

RECORD	FORMAT	VARIABLE	DEFINITION
1-(NEL/20+1)	20F4.0	CN2(NEL)	SOIL CONSERVATION SERVICE CURVE NUMBER FOR EACH BLOCK

GROUP 11. IRRIGATION-APPLICATION RATES: FORTRAN UNIT NUMBER IAPUNT (SUBROUTINE: APPWAT)

1	I5	IAPPLY	NUMBER OF IRRIGATED BLOCKS
2-(IAPPLY+1)	I5	IAPBLK(IAPPLY)	IRRIGATED BLOCK NUMBER
	F10.0	APPLD(IAPPLY)	ANNUAL IRRIGATION APPLICATION RATES (INCHES/YEAR) FOR EACH IRRIGATED BLOCK; DAILY VALUES ARE GENERATED BY MODEL BASED ON IRRSCD(15) PARAMETERS (SEE GROUP 1 DATA)

If JLND>0 group 11 will be read for each year of the simulation from IAPUNT so that several sets of group 11 data will be required on IAPUNT.

GROUP 12. DAILY PRECIPITATION DIRECT ACCESS DATA FILES: FORTRAN UNIT INP THROUGH INP+NUMBER OF YEARS OF SIMULATION-1 (SUBROUTINE: CLIMAT)

DIRECT ACCESS FILES: RECORD LENGTH=IRECP (SPECIFIED IN GROUP 1 DATA)
NUMBER OF RECORDS=NUMBER OF DAYS IN YEAR (365 OR 366)
UNITS=HUNDRETHS OF INCHES (THEREFORE NO DECIMALS IN RECORDS) AND READ AS INTEGER

GROUP 13. DAILY MAXIMUM TEMPERATURE DIRECT ACCESS DATA FILES: FORTRAN UNIT NUMBER INTX THROUGH INTX+NUMBER OF YEARS OF SIMULATION-1 (SUBROUTINE: CLIMAT)

DIRECT ACCESS FILES: RECORD LENGTH=IRECT (SPECIFIED IN GROUP I DATA)
NUMBER OF RECORDS=NUMBER OF DAYS IN YEAR (365 OR 366)
UNITS=WHOLE DEGREES FAHRENHEIT (NO DECIMALS)

GROUP 14. DAILY MINIMUM TEMPERATURE DIRECT ACCESS DATA FILES: FORTRAN UNIT NUMBER INTN THROUGH INTN+NUMBER OF YEARS OF SIMULATION-1 (SUBROUTINE: CLIMAT)

DIRECT ACCESS FILES: RECORD LENGTH=IRECT (SPECIFIED IN GROUP I DATA)
NUMBER OF RECORDS=NUMBER DAYS IN YEAR (365 OR 366)
UNITS=WHOLE DEGREES FAHRENHEIT (NO DECIMALS)

GROUP 15. INITIAL SOIL-MOISTURE DATA: FORTRAN UNIT NUMBER ICN (SUBROUTINE: ICONDS) DATA SET READ ONLY IF ICN>0 (SEE GROUP 1 DATA)

DISK	UNFORMATTED	SMS(NEL,NLAYER)	SOIL MOISTURE STATUS FOR EACH LAYER FOR EACH BLOCK SUCH AS FROM A PREVIOUS SIMULATION

GROUP 16. INITIAL SNOW DATA: FORTRAN UNIT NUMBER IRDSNO (SUBROUTINE: ICONDS) DATA SET READ ONLY IF IRDSNO>0 (SEE GROUP 1 DATA)

DISK	UNFORMATTED	SNOW(NEL)	SNOWPACK FOR EACH BLOCK SUCH AS FROM A PREVIOUS SIMULATION

GROUP 17. STREAM-DISCHARGE DATA: FORTRAN UNIT NUMBER RODATA (SUBROUTINES: DATAIN, ROFACT, RUNTRU) DATA SET READ ONLY IF RODATA>0 (SEE GROUP 1 DATA)

RECORD	FORMAT	VARIABLE	DEFINITION
1	F10.0	BSNARA	DRAINAGE AREA (SQUARE MILES TO POINT OF STREAM-DISCHARGE MEASUREMENTS
	I10	LAGDYS	RESPONSE TIME (WHOLE DAYS) BETWEEN RAINFALL AND (OR) SNOWMELT EVENT AND RESULTING DISCHARGE (OBTAINED FROM HYDROGRAPH ANALYSIS)
2-*	F8.0	DISCH	DAILY STREAM-DISCHARGE RATE (CUBIC FEET PER SECOND)

*= number of days of simulation plus LAGDYS. If IWARMP>0, first year of DISCH values must be repeated.

GROUP 18. BASE FLOW DATA FOR EACH MONTH FOR EACH YEAR SIMULATED: FORTRAN UNIT NUMBER BSDATA (SUBROUTINES: ROFACT, RUNTRU) DATA SET READ ONLY IF RODATA>0 (SEE GROUP 1 DATA)

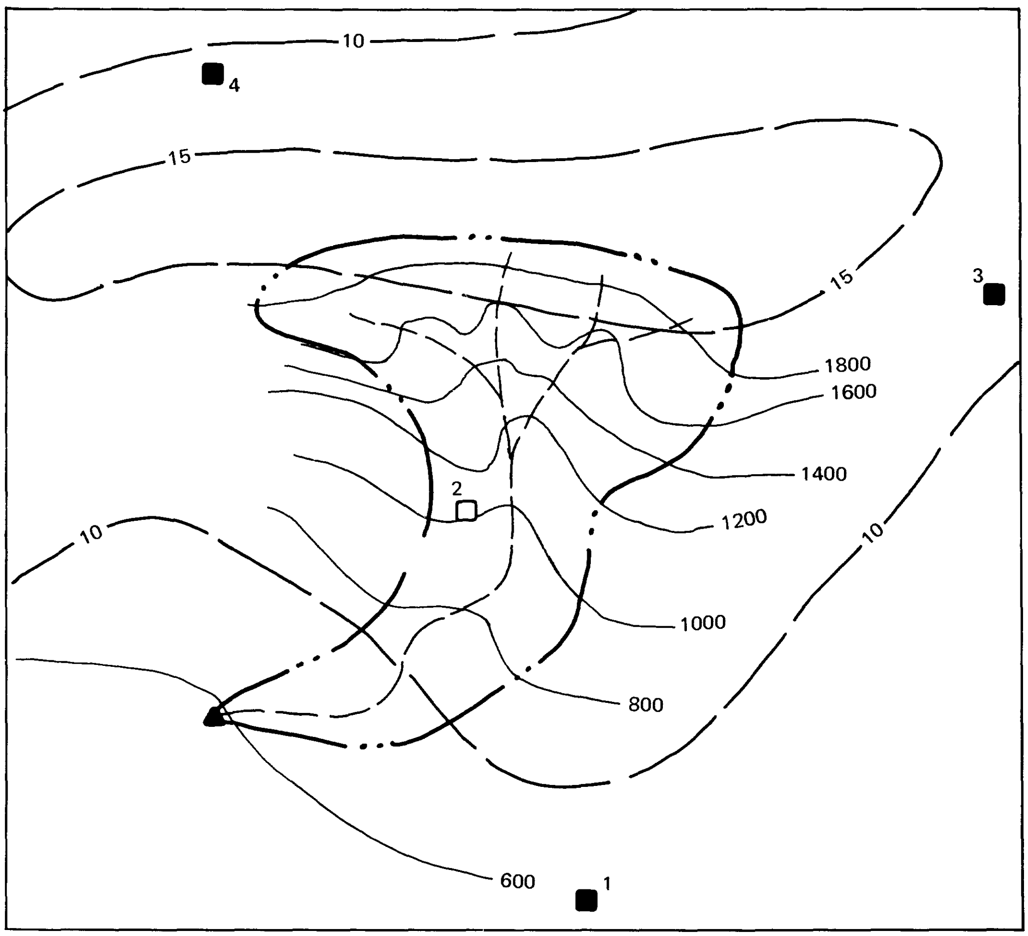
1-*	12F6.0	BSFLW(12)	AVERAGE DAILY BASE FLOWS FOR EACH OF 12 MONTHS (CFS) FOR EACH CALENDAR YEAR. RECORD 1 FOR FIRST YEAR OF SIMULATION, RECORD 2 FOR SECOND YEAR, ETC.

* = Number of years simulated, if first year is repeated (IWARMP>0) then repeat first RECORD.

EXAMPLE SIMULATION

Figure 11 shows a hypothetical surface drainage area of an ephemeral stream that will be used to demonstrate assembling a data set for a recharge simulation to be operated for a period of 3 years. Figure 12 shows simple land-use and soil distributions.

First, it is necessary to discretize the basin into quadrilaterals. An example of how this might be done is shown on figure 13. In general, a far greater number of blocks would be necessary to properly delineate a real area.



EXPLANATION

800 ——— Elevation in feet above sea level; contour interval, 200 feet

— · · — Drainage divide

10 — — Isohyetal contour; interval 5 inches

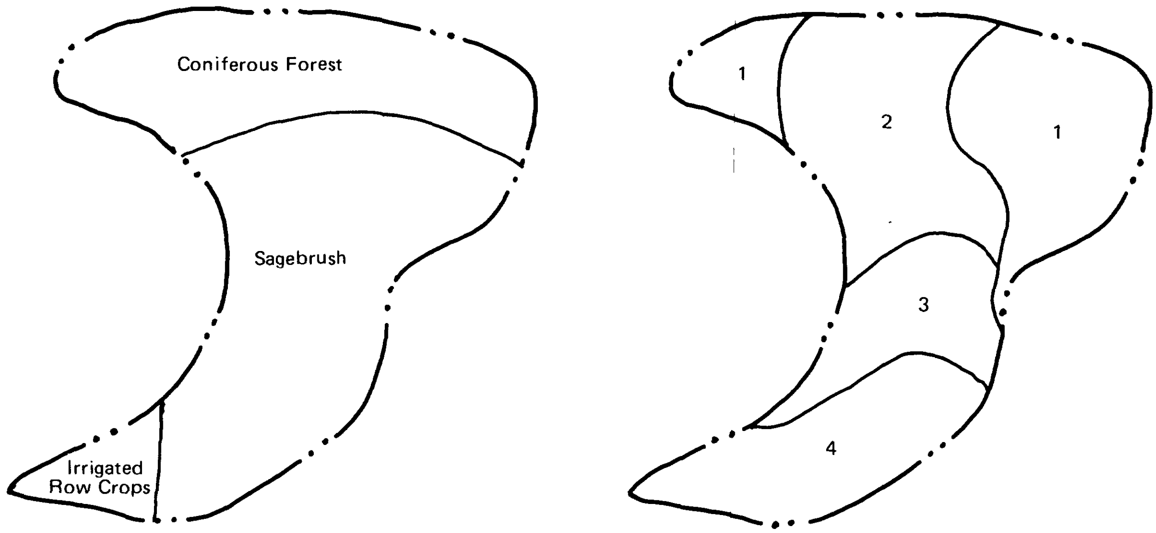
— — Stream

■ 3 Weather station with temperature and precipitation data

□ 2 Weather station with precipitation data only

▲ Stream gage

Figure 11.--Hypothetical surface drainage area for example simulation..



EXPLANATION

1 Sand, stoney, silty	Depth = 0-1.5ft, AWC=1.2in/ft
2 Loam, sandy	Depth = 0-3.0ft, AWC=1.6in/ft
3 Clay loam, sandy	Depth = 0-2.5ft, AWC=2.6in/ft
	Depth = 2.5 5.0ft, AWC=1.9in/ft
4 Loam, sandy	Depth = 0-2.5ft AWC=2.0in/ft
	Depth = 2.5-5.0ft, AWC=1.8in/ft

Figure 12.--Land uses and soil properties for example simulation.

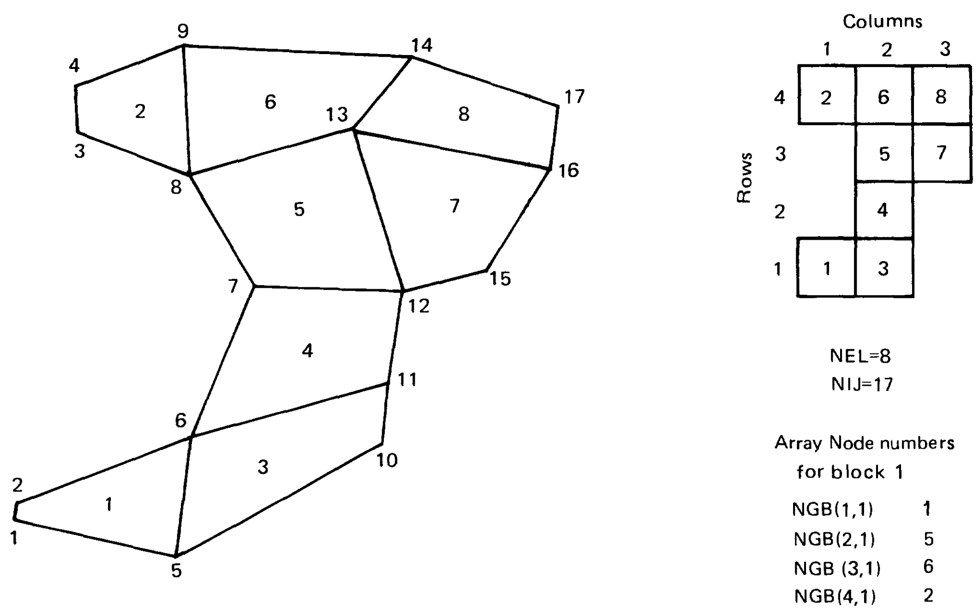


Figure 13.--Discretization for example area, showing node numbers, block numbers, and row-column representation for line printer map.

The following lists the rationale for some of the options used:

1) The first year will not be simulated twice because data for several consecutive years is available.

2) The grid is not automatically generated because the study area cannot be approximated by a rectangular shape.

3) The weather stations shown in figure 11 have average annual precipitation values considerably less than the isohyetal values for much of the upper part of the basin. Therefore, daily values of precipitation interpolated from the weather stations should be adjusted using the block values of annual precipitation indicated by the isohyets.

4) Temperature is not available at the central weather station and other weather stations are roughly equally distant from the basin as a whole. Therefore, all three temperature weather stations will be used for daily interpolations.

5) Potential evapotranspiration should not be interpolated directly from weather stations because much of the basin is at altitudes higher than any of the temperature weather stations. It should be calculated at each block using temperatures corrected for lapse rates. Slopes and aspects are also used in the computations when lapse rates are used. Slope and aspect values in the group 6 data (which below is included in group 1 data) are left blank (=0) for this example.

6) Basin-wide soil moisture values usually are not known. Initial soil-moisture values are arbitrarily set equal to the moisture-holding capacities.

7) Basin-wide budget averages will be output at the end of each year simulated. Daily budgets will not be output. Only the simulation period average-annual-recharge distribution will be printed out as a rectangular line-printer map.

8) Assume for sagebrush and irrigated crops that values of root depth, foliar cover, and interception capacity are known and are input. For forest the default values are used.

9) Assume that a December 31, 1962 snowstorm, deposited 0.5 inch (water equivalent) of snow uniformly over the basin with no prior snow on the ground.

10) Daily stream-discharge data are available. Because the stream is ephemeral, base flow is initially assumed to be zero. Inspection of the hydrograph shows that maximum response at the gage from storms is about 1 day.

It is important to realize that the last record of the daily streamflow data is for January 1, 1966, and not December 31, 1965, because LAGDYS=1. (The first record is nevertheless for January 1, 1963, even though it is not used.) Insufficient records will cause an "end of file" error.

11) Regression analysis of daily temperature extremes versus daily percent of possible sunshine for the closest weather station with such data gives the linear regression parameters of Slope=3.636 and Y=intercept of -20.00.

12) From available literature it is found that the average sublimation rate for snow cover is 0.01 inch per day for this area. Using this rate, available daily snowpack and temperature data, and equation 3; it is determined that $K_m = 0.28$ in./day/^oC. Cold weather (less than 32 ^oF) potential evapotranspiration is assumed to be equivalent to the sublimation rate.

13) An overestimate of transpiration is preferable to a possible underestimate so the parameter IROOT will be set to 0.

14) The irrigation season for row crops is from Julian day 105 to 272 and water is applied at a uniform rate during this time.

The following shows the data input for each group, based on the above assumptions and the synthesized information in figures 11, 12, and 13. The first column of each record or card image is directly beneath the "G" in GROUP. Groups 4 through 10 have been included into group 1 by specifying the input device number for these groups as 5, the device number for group 1.

```
EXAMPLE SIMULATION, 1963-1965
   6
   7
19631965   0
   1   0
   8   0
   4
   3
  40  70 100  12  12
   5
 70.0 90.0
 65.0 80.0
 68.0 85.0
-20.0 3.636
   3   3
   1
     9.0     12.0     12.0     11.0
   8   5
     9.5     14.5     10.5     12.0     13.5     15.0     14.0     16.0
        99.
        45.50
  -1
   8  5
   1 700
   21800
   3 800
   4 950
   51300
   61700
   71600
   81800
   1
```

```
 1.96 2.20 2.76 3.16 3.54 3.79 4.09 3.93 3.39 2.51 2.08 1.93
 1.68 2.44 3.65 3.93 3.90 3.88 3.24 3.02 2.85 2.39 2.16 1.65
0.01   0.28
0.010 0.010 0.010 0.010 0.010 0.010
   0
   0
   9
   0   0  12  13
   0   0   0
   0
   0
   5   0   0
(20I4   )
   9   1   3   3   3   1   3   1
   4
   5   0
(20I4   )
   4   1   4   3   2   2   1   1
   3
   6
  10
  10
  .6  .6  .6
  .8  .8  .8  .8  .8  .8
 1.3 1.3 1.3 1.3 1.3 .95 .95 .95 .95 .95
 1.0 1.0 1.0 1.0 1.0 .90 .90 .90 .90 .90
           1.2
           1.8
           2.3
           1.9
   0
             0            0            0
             0            0            0
           5.0           .7          .12
             0            0            0
             0            0            0
             0            0            0
             0            0            0
             0            0            0
           3.5          1.0          0.5
             0            0            0
             0            0            0
             0            0            0
             0            0            0
             0            0            0
             0            0            0
   5
  85  85  65  65  75  85  80  85
  0.0     0     0
   5
    1
    1      25.0
   1
   9   1 105 200 201 272
  14  19
```

GROUP 2

17	8				
1	5	6	2		
3	8	9	4		
5	10	11	6		
6	11	12	7		
7	12	13	8		
8	13	14	9		
12	15	16	13		
13	16	17	14		
				120.73	45.33
				120.73	45.34
				120.67	45.70
				120.67	45.75
				120.53	45.29
				120.53	45.40
				120.44	45.55
				120.52	45.66
				120.52	45.78
				120.26	45.40
				120.25	45.45
				120.23	45.55
				120.31	45.70
				120.24	45.77
				120.13	45.47
				120.04	45.66
				120.03	45.73

GROUP 3

120.26	45.15	
120.40	45.52	
119.72	45.72	
120.73	45.93	
120.26	45.15	590.0
119.72	45.72	1825.0
120.73	45.93	750.0

GROUPS 4 THROUGH 6 INCLUDED IN GROUP 1

GROUP 7

3	4		
1	1	4	4
1	4		
3	4		

GROUPS 8 THROUGH 11 INCLUDED IN GROUP 1

GROUPS 12, 13, and 14

The following FORTRAN program segment illustrates how the direct access file for this group might be created. P is the daily temperature array (in hundreths of inches) for day IDY for the four weather stations. INP is the FORTRAN output device number to which P is written. PP is an array of one year's precipitation data for the four stations. (The form of PP will, of course, vary depending upon the format of the input precipitation data.) The double-closed lines indicate lines of code that would be a function of the users initial data.

```
--------------------------------------------------
--------------------------------------------------
       DIMENSION P(4), PP(4,366)
       INTEGER P
       INP=40
       NWST=4
C.....READ IN PRECIPITATION DATA FOR ALL WEATHER STATIONS
C     FOR YEAR INYEAR.
--------------------------------------------------
--------------------------------------------------
C.....WRITE OUT PRECIPITATION DATA TO UNFORMATTED DIRECT ACCESS FILE
C     FOR YEAR IYEAR.
C
      OPEN(INP,ACCESS='DIRECT',RECL=12)
      IYRDYS=365
      IF(MOD(IYR,4).EQ.0) IYRDYS=366)
      DO 110 IDY=1,IYRDYS
      DO 100 ISTN=1,NWST
100   P(I)=PP(I,IDY) +0.5
110   WRITE(INP)  P
      STOP
      END
```

GROUP 15

This group is not required since the option is used to set initial soil moisture equal to available water capacities.

GROUP 16

This group is not required since the option is used to set the initial snowpack equal to 0.5 inch for all blocks.

GROUP 17

```
      595          1
    0.00
 6402.04
  160.05
    0.00
    0.00
    0.00
    ---
    ---
    ETC.
```

GROUP 18

0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0

The following shows the output produced by this simulation.

EXAMPLE SIMULATION, 1963-1965

FOLLOWING ARE MONTHLY TOTALS FOR MODELED REGION FOR YEAR 1963

MON	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT	
JAN	0.73	0.33	0.03	0.41	0.00	0.08	0.08	0.05	0.01	0.01	-0.36	0.11	0.53	26.6	0.06	-0.12	0.000
FEB	1.42	0.68	-0.01	1.29	0.05	0.09	0.06	0.03	0.10	0.09	-0.05	0.50	-0.53	40.8	1.14	-0.02	0.000
MAR	0.96	1.34	0.11	0.14	0.00	0.26	0.18	0.00	0.43	0.23	-0.25	0.61	0.00	42.1	0.30	-0.04	0.000
APR	2.42	1.79	-0.12	1.08	0.13	0.23	0.20	0.00	0.39	0.27	-0.07	1.04	0.00	44.1	1.30	-0.11	0.000
MAY	1.56	3.69	-0.01	0.55	0.00	0.81	0.27	0.00	1.49	0.56	-0.57	0.83	0.00	54.4	0.60	-0.08	0.000
JUN	0.81	4.73	0.01	0.00	0.00	1.08	0.00	0.00	2.23	0.24	-0.22	0.78	0.00	60.3	0.00	0.00	0.000
JUL	1.04	5.68	-0.01	0.05	0.00	1.31	0.03	0.00	2.67	0.19	-0.02	0.82	0.00	64.6	0.19	-0.02	0.000
AUG	0.87	5.46	0.02	0.00	0.00	1.29	0.00	0.00	2.63	0.07	0.02	0.75	0.00	68.9	0.00	0.00	0.000
SEP	2.30	3.82	0.00	0.71	0.08	0.83	0.19	0.00	1.58	0.27	0.20	0.89	0.00	64.4	1.05	-0.03	0.000
OCT	0.67	1.72	-0.02	0.00	0.00	0.31	0.03	0.00	0.63	0.13	-0.08	0.61	0.00	52.6	0.00	0.00	0.000
NOV	2.45	0.54	0.06	1.08	0.24	0.08	0.05	0.00	0.05	0.01	0.62	0.39	0.00	41.7	1.64	-0.01	0.000
DEC	1.37	0.33	0.05	0.47	0.33	0.05	0.05	0.08	0.00	0.00	0.21	0.18	0.00	31.6	1.09	0.00	0.000

FOLLOWING ARE YEAR END TOTALS FOR MODELED REGION FOR YEAR 1963

PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT
16.60	30.10	0.11	5.78	0.85	6.42	1.13	0.15	12.20	2.06	-0.56	7.49	0.00	49.37	7.37	-0.42

FOLLOWING ARE MONTHLY TOTALS FOR MODELED REGION FOR YEAR 1964

MON	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT	
JAN	1.32	0.38	0.01	0.45	0.34	0.05	0.05	0.03	0.00	0.00	0.15	0.29	0.00	35.8	1.04	0.00	0.000
FEB	0.09	0.68	-0.13	0.00	0.00	0.20	0.19	0.00	0.28	0.23	-0.41	0.20	0.00	37.9	0.00	0.00	0.000
MAR	0.38	1.14	0.00	0.00	0.00	0.28	0.13	0.01	0.50	0.17	-0.24	0.31	0.00	38.8	0.00	0.00	0.000
APR	0.34	2.09	0.01	0.00	0.00	0.53	0.07	0.00	1.14	0.26	-0.32	0.33	0.00	44.4	0.00	0.00	0.000
MAY	0.26	3.81	-0.01	0.00	0.00	0.99	0.00	0.00	2.06	0.15	-0.15	0.27	0.00	52.1	0.00	0.00	0.000
JUN	1.74	4.63	0.00	0.11	0.00	0.91	0.08	0.00	1.83	0.25	0.03	1.31	0.00	60.3	0.50	-0.04	0.000
JUL	0.63	6.39	0.00	0.00	0.00	1.54	0.00	0.00	3.20	0.05	-0.06	0.62	0.00	68.5	0.00	0.00	0.000
AUG	0.59	4.97	0.02	0.00	0.00	1.22	0.00	0.00	2.48	0.01	0.03	0.53	0.00	64.9	0.00	0.00	0.000
SEP	0.49	3.19	-0.01	0.00	0.05	0.79	0.00	0.00	1.61	0.01	0.03	0.41	0.00	58.5	0.00	0.00	0.000
OCT	0.98	1.53	0.11	0.13	0.00	0.33	0.00	0.00	0.67	0.04	0.34	0.37	0.00	49.5	0.28	-0.01	0.000
NOV	2.20	0.40	0.02	0.73	0.46	0.04	0.04	0.04	0.00	0.00	0.63	0.30	0.00	36.6	1.52	0.00	0.000
DEC	7.99	0.33	-0.01	5.87	1.31	0.03	0.03	0.14	0.00	0.00	0.29	0.18	0.18	30.5	7.43	0.00	0.000

FOLLOWING ARE YEAR END TOTALS FOR MODELED REGION FOR YEAR 1964

PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT
17.02	29.53	0.02	7.29	2.16	6.90	0.58	0.23	13.76	1.16	0.32	5.12	0.18	48.19	10.77	-0.05

FOLLOWING ARE MONTHLY TOTALS FOR MODELED REGION FOR YEAR 1965

MON	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT	
JAN	1.74	0.37	-0.03	1.00	0.60	0.05	0.05	0.10	0.00	0.00	-0.04	0.24	-0.18	34.9	0.85	0.00	0.000
FEB	0.13	0.64	-0.10	0.00	0.00	0.18	0.17	0.00	0.24	0.21	-0.37	0.21	0.00	39.7	0.00	0.00	0.000
MAR	0.50	1.17	0.01	0.15	0.00	0.36	0.19	0.01	0.62	0.22	-0.23	0.15	0.00	39.3	0.20	0.00	0.000
APR	1.48	2.35	-0.01	0.35	0.00	0.42	0.22	0.00	0.79	0.35	-0.31	0.97	0.00	48.4	0.56	-0.10	0.000
MAY	0.73	3.87	0.00	0.03	0.00	0.86	0.02	0.00	1.79	0.33	-0.23	0.60	0.00	52.3	0.19	-0.02	0.000
JUN	2.26	5.20	0.00	0.84	0.15	1.22	0.24	0.00	2.37	0.41	-0.04	0.76	0.00	61.5	1.06	-0.11	0.000
JUL	1.15	6.68	0.00	0.05	0.00	1.54	0.03	0.00	3.17	0.17	-0.03	0.96	0.00	70.1	0.17	-0.03	0.000
AUG	2.07	5.24	0.02	0.23	0.00	1.10	0.17	0.00	2.12	0.29	0.14	1.28	0.00	67.8	0.74	-0.06	0.000
SEP	0.47	3.00	0.00	0.00	0.10	0.75	0.01	0.00	1.52	0.12	-0.12	0.36	0.00	56.7	0.00	0.00	0.000
OCT	0.62	2.00	-0.02	0.10	0.00	0.48	0.05	0.00	0.93	0.15	0.01	0.34	0.00	54.6	0.22	-0.01	0.000
NOV	2.61	0.54	0.12	0.89	0.37	0.08	0.05	0.01	0.06	0.00	0.79	0.39	0.00	42.0	1.72	-0.01	0.000
DEC	0.47	0.35	0.01	0.04	0.07	0.07	0.07	0.03	0.01	0.01	0.05	0.20	0.00	33.4	0.16	0.00	0.000

FOLLOWING ARE YEAR END TOTALS FOR MODELED REGION FOR YEAR 1965

PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT
14.21	31.22	0.00	3.68	1.28	7.11	1.26	0.15	13.60	2.27	-0.37	6.45	-0.18	50.13	5.87	-0.33

FOLLOWING ARE MONTHLY AVERAGES FOR MODELED REGION FOR SIMULATION

	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT
JAN	1.53	0.37	-0.01	0.73	0.47	0.05	0.05	0.07	0.00	0.00	0.05	0.27	-0.09	35.33	0.95	0.00
FEB	0.11	0.66	-0.11	0.00	0.00	0.19	0.18	0.00	0.26	0.22	-0.39	0.20	0.00	38.83	0.00	0.00
MAR	0.44	1.16	0.00	0.08	0.00	0.32	0.16	0.01	0.56	0.19	-0.24	0.23	0.00	39.10	0.10	0.00
APR	0.91	2.22	0.00	0.18	0.00	0.47	0.15	0.00	0.96	0.30	-0.32	0.65	0.00	46.41	0.28	-0.05
MAY	0.50	3.74	0.00	0.02	0.00	0.92	0.01	0.00	1.92	0.24	-0.19	0.43	0.00	52.22	0.09	-0.01
JUN	2.00	4.91	0.00	0.48	0.07	1.07	0.16	0.00	2.10	0.33	0.00	1.03	0.00	60.92	0.78	-0.07
JUL	0.89	6.54	0.00	0.03	0.00	1.54	0.02	0.00	3.18	0.11	-0.04	0.79	0.00	69.33	0.08	-0.01
AUG	1.33	5.11	0.02	0.12	0.00	1.16	0.08	0.00	2.30	0.15	0.09	0.91	0.00	66.34	0.37	-0.03
SEP	0.48	3.09	-0.01	0.00	0.07	0.77	0.00	0.00	1.56	0.07	-0.04	0.39	0.00	57.63	0.00	0.00
OCT	0.80	1.77	0.05	0.12	0.00	0.41	0.02	0.00	0.80	0.09	0.18	0.36	0.00	52.04	0.25	-0.01
NOV	2.41	0.47	0.07	0.81	0.41	0.06	0.04	0.02	0.03	0.00	0.71	0.34	0.00	39.27	1.62	-0.01
DEC	4.23	0.34	0.00	2.96	0.69	0.05	0.05	0.09	0.00	0.00	0.17	0.19	0.09	31.96	3.80	0.00

FOLLOWING ARE ANNUAL AVERAGES FOR MODELED REGION FOR SIMULATION

PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	EHRM-RO	DEFCIT
15.61	30.37	0.01	5.49	1.72	7.00	0.92	0.19	13.68	1.72	-0.03	5.78	0.00	49.16	8.32	-0.19

AVG ANNUAL RECHARGE DISTRIBUTION, HUNDRETHS OF INCHES

	1	2	3	4
1	227	-1	-1	86
2	194	206	252	0
3	-1	-1	238	89

AVG ANNUAL AET DISTRIBUTION, TENTHS OF INCHES

	1	2	3	4
1	279	-1	-1	71
2	60	69	67	79
3	-1	-1	66	82

On the line printer maps, notice the large variability of recharge from block to block (a "-1" on a line printer map indicates outside modeled area). Also, notice that north is to the right. The abbreviations used on the tables are defined as follows. Units are in inches of water for all columns except temperature.

PRECP	PRECIPITATION
POTET	POTENTIAL EVAPOTRANSPIRATION
CHGINT	CHANGE OF MOISTURE ON FOLIAR COVER
RUNOFF	STREAM DISCHARGE CONVERTED TO INCHES IF READ IN, OR SCS METHOD COMPUTED RUNOFF IF NO STREAM DISCHARGE IS READ IN (VALUES WILL ALL BE ZERO IF RUNOFF=0 OPTION IS SELECTED)
RECHRG	DEEP PERCOLATION
SOLPEV	POTENTIAL BARE-SOIL EVAPORATION
ACTSEV	ACTUAL BARE-SOIL EVAPORATION
SNWEVP	DIRECT EVAPORATION OF SNOW (SUBLIMATION)
PPLTR	POTENTIAL PLANT TRANSPIRATION
APLTP	ACTUAL PLANT TRANSPIRATION
CHGSM	CHANGE IN TOTAL SOIL MOISTURE
EVINT	INTERCEPTED MOISTURE EVAPORATED
CHGSNO	CHANGE IN SNOWPACK
AVTMP	AVERAGE TEMPERATURE FOR THE PERIOD
EHRM-RO	RUNOFF VALUES COMPUTED BY THE SCS CURVE NUMBER TECHNIQUE TO APPORTION OBSERVED STREAM-RUNOFF DATA (VALUES WILL BE ZERO IF NO STREAM-DISCHARGE DATA ARE READ IN)
DEFCIT	THE AMOUNT OF STREAM DISCHARGE THAT CANNOT BE ACCODUNTED FOR (VALUES WILL BE ZERO IF NO STREAM DISCHARGE IS READ IN)

Notice that the annual values of DEFCIT for 1963 and 1965 are -0.42 and 0.33, respectively. Because they are large percentages of the annual values of RECHRG, it would be prudent, for non-hypothetical data, to investigate the initial zero values of base flow estimated for those months showing non-zero DEFCIT values, and to re-run the model with new base-flow estimates.

The last column of the monthly totals for a specific year is a mass-balance check. The values should all equal zero (or very nearly zero). It was incorporated into the output during developing and de-bugging of the model. Non-zero values may also indicate data problems and therefore this output item has been retained in the final version.

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APPENDIX A. PROGRAM LISTING

The following is a list of the MAIN program and the subroutines for the model. Dimensions given the variables in the COMMON blocks may be shown as variable names or as numeric values. Those shown as variables need to be replaced with the appropriate numeric value prior to executing the program. The variable names should be self-explanatory and should help to guide the user for setting dimensions. For example, (BLKS) is the numer of blocks which is equal to NEL and (NODES) is equal to NIJ. Similarly, NVLT and NVLP are equal to the variables NVALT and NVALP. Those with numeric values should generally not need to be changed. The numeric values represent the following:

24 = maximum numer of soil associations (NSOLAS)
10 = maximum number of 6-inch soil layers (NL)
15 = maximum number of land-use categories
16 = number of energy water budget components
12 = number of months in year
8 = number of land-use variables saved for each day
6 = the months October-March for the PETMIN values

The first three dimensions probably would not need to be changed for any simulations, except for the case where the soil and plant rooting depth is typically greater than 5 feet. The next four values should stay the same for any project-study area.

MAIN PROGRAM

```
C
C
C
C
      COMMON/GRID/   AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/INOUT/  NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .       IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .       MAPEL,ARRRY(MAPIJ)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/FLOWS/  SNOW(BLKS),SMS(BLKS,10),REMAIN(BLKS)
      COMMON/CLASLD/ LANDUS(BLKS),ILND,JLND,FMTL,IFORML
      COMMON/POLATT/ DISTT(NODES,NVLT),NEART(NODES,NVLT),NVALT
      COMMON/POLATP/ DISTP(NODES,NVLP),NEARP(NODES,NVLP),DMAX,NVALP
      COMMON/ANNVAL/ AET(BLKS),AETAV(BLKS),RECH(BLKS),RECHAV(BLKS)
      COMMON/BLKPET/ ALTBLK(BLKS),SLPBLK(BLKS),ASPECT(BLKS),CTBLK(BLKS),
     .   TXBLK(BLKS),TXJAVB(BLKS),TNJAVB(BLKS),IBLOCK(BLKS)
      COMMON/PRCPVL/ APRENW(NWSP),ANPBLK(BLKS)
      COMMON /IRRWAT/ APPLD(IRIGS),IAPBLK(IRIGS)
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON /TIME/  NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/NWSPRE/ P(NWSP),JP(NWSP),XP(NWSP),YP(NWSP),NWSP,IFPREC
      COMMON/NWSTEM/ TN(NWST),TX(NWST),XT(NWST),YT(NWST),NWST
      COMMON/CLIMIO/ INP,INTN,INTX,METHDP,METHDT,IRECP,IRECT
      COMMON/SUMMRY/ QBALDY(16),QBALMO(16,12),QBALYR(16),
     .               QBLAVY(16),QBLAVM(16,12),DSUM
      COMMON/SOIL1/  WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
      COMMON/PLANT/  MAXINT(15),RDMAX(15),FCMAX(15),COEFS(15,8),IROOT
      COMMON/WINTER/ SBLMTE,PETMIN(6),KMCOEF
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     . RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     . TMXPRE,CHGSNO,LNDUS,SUB
      COMMON/LRATES/ RATEMN(12),RATEMX(12),ILAPSE
      COMMON/IRRTIM/ IRRST1(15),IRREN1(15),IRRST2(15),IRREN2(15),
     .               IRRSCD(15),SUMCP(15)
C
      REAL        MAXINT,MXNT,KMCOEF
      INTEGER     BSDATA,DSUM,RODATA
      CHARACTER*8 FMTL
      DOUBLE PRECISION GX,GY,XT,YT,XP,YP,QBALDY,QBALMO,QBALYR
C
      CALL DATAIN
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      CALL INTRPO(XP,YP,DISTP,NEARP,DMAX,NWSP,NVALP,METHDP)
      CALL INTRPO(XT,YT,DISTT,NEART,DMAX,NWST,NVALT,METHDT)
      CALL ICONDS
C
C ...   MOVE AVERAGE JULY TEMPS TO BLOCKS IF, IFTEMP<0
C ..    THEN PET WILL BE COMPUTED AT NT NUMBER OF BLOCKS
C
      IF(IFTEMP.GE.0) GO TO 90
      NMO=7
      CALL TOGRID(TNJAVG,TNJAVB,NVALT,DISTT,NEART,IFTMPN,NMO,NT)
      CALL TOGRID(TXJAVG,TXJAVB,NVALT,DISTT,NEART,IFTMPX,NMO,NT)
      IF(NT.EQ.NEL)  GO TO 110
90    DO 100  I=1,NWST
100   CALL JHCOEF(TNJAVG(I),TXJAVG(I),ALTWS(I),TXX(I),CTT(I))
110   CONTINUE
      INCMNT=0
      JREP=2
      INCRMT=0
      DO  1000 NYR=IYR1,IYR2
C.....INCREMENT YEARLY INPUT FILE NUMBERS FOR WEATHER AND LANDUSE DATA
      INP=INP+INCMNT
      INTN=INTN+INCMNT
      INTX=INTX+INCMNT
      IF(JLND.GT.0)   CALL NEWLND(INCMNT,NEL,IOT1)
      IF(JLNO.GT.0.AND.IAPUNTT.GT.0.AND.INCMNT.GT.0) THEN
          CALL APPWAT(IAPUNT,IAPPLY)
       ELSE
      END IF.
      INCMNT=1
C.....REPEAT FIRST YEAR TO ESTABLISH INITIAL CONDITIONS
      IF(IWARMP.LT.1.OR.NYR.GT.IYR1) JREP=1
      DO 1000 JREPET=1,JREP
      INCRMT=INCRMT+1
      IDYS=365
      IF(MOD(NYR,4).EQ.0) IDYS=366
      IDAY=0
      NDAY(2)=28
      IF (IDYS.GT.365)  NDAY(2)=29
C
C.....IF STREAM DISCHARGE USED READ AVERAGE MONTHLY BASEFLOW
C.....FOR THE 12 MONTHS OF THE CURRENT YEAR,IF REPEATING FIRST
C.....YEAR THEN REPEAT BSFLW DATA FOR FIRST YEAR
C
      IF(RODATA.GT.0) READ (BSDATA,5000) BSFLW
      DO 500  NMO=1,12
      NDYS=NDAY(NMO)
      DO 500  ITIME=1,NDYS
      IDAY=IDAY+1
```

```
      INCK=1
      CALL CLIMAT(NEL,NMO,IDAY)
      CALL CRPCOF(IDAY)
      IF(IAPPLY.GT.0) CALL APPLY(IAPPLY,NMO,IDAY)
      IF(RODATA.GT.0) CALL ROFACT(NMO,IDAY)
      IF(NT.EQ.NEL) GO TO 180
      DO 150  I=1,NWST
150   CALL POTET(IDAY,AVELAT,TX(I),TN(I),ASUN,BSUN,TXX(I),CTT(I),0.0,0.0
     .           ,POT(I))
180   DO  400 I=1,NEL
      CALL LOOKUP(I,NMO,IDAY,1)
      IF(LNDUS.EQ.10) GO TO 200
      CALL PETBLK(I,NMO,IDAY,TMAX(I),TMIN(I),TAV,ETP)
      CALL SNWPCK(I,NMO,IDAY,1)
      CALL INTRCP(I,NMO,IDAY)
      IF(RODATA.EQ.-1) GO TO 190
      IF(RODATA.LT.1) CALL RUNOFF(I,NMO,IDAY)
      IF(RODATA.GT.0.AND.DISCH.GT.0.0) CALL RUNTRU(I,NMO,IDAY)
190   CALL SOILMS(I,NMO,IDAY)
      CALL SOILEV(I,NMO,IDAY)
      IF(TAV.LE.32.0) GO TO 195
      CALL TRNSFR
      CALL PLNTET(I,NMO,IDAY,IROOT)
195   CALL SAVE(I,NMO,IDAY,NL,SNO,REMINT)
200   IF (NSMBLK.LT.1) GO TO 205
      IF (NSB(INCK).EQ.I) CALL DALYOT(I,IDAY,INCK,IPRNT)
205   IF (MAPET.GT.0)   AET(I)=AET(I)+AETFC+ACTEV+ACTPLT
      IF (MAPREC.GT.0.OR.IRECH.GT.0)  RECH(I)=RECH(I)+RECR
      IF (INCRMT.LT.2.AND.ICN.LT.1) GO TO 400
                        AETAV(I)=AETAV(I)+AETFC+ACTEV+ACTPLT
                        RECHAV(I)=RECHAV(I)+RECR
400   CONTINUE
      IF(DSUM.GT.0) CALL DAYSUM(IPRNT,IDAY)
500   CONTINUE
      IF (MAPET. GT.0)   CALL ANNUAL(AET,0)
      IF (MAPREC.GT.0)   CALL ANNUAL(RECH,1)
      IF (IRECH. GT.0)   CALL RECHOT(RECH,AREA,NEL,IDYS,0)
      IF (ISTS.  GT.0)   CALL SAVSMS
      IF (IRTSNO.GT.0)   CALL SAVSNO
      CALL AMSUM(IPRNT)
      CALL AVEOT(IPRNT,INCRMT)
C
C.....FOLLOWING SECTION ADDED TO CHANGE DRYLAND WHEAT LANDUSES EACH YEAR
C
      IF (JREP.EQ.1) THEN
        DO 900 ICHNGE=1,NEL
         ICP=LANDUS(ICHNGE)
          IF(ICP.EQ.5) LANDUS(ICHNGE)=6
```

```
          IF(ICP.EQ.6) LANDUS(ICHNGE)=5
900     CONTINUE
       END IF
C ..............................................................
1000  CONTINUE
5000  FORMAT(12F6.0)
      STOP
      END
```

```
      SUBROUTINE ALFALF (IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                   IRSRT1,IREND1,IRSRT2,IREND2,
     .                   IRSCD,SUMCP)
C
C.....LANDUSE # 8-ALFALFA
C
      REAL MXI,MXNT
      DIMENSION CRP(16),JDATE(16)
      DATA CRP/.6,.66,.75,1.0,1.04,1.10,1.125,1.13,1.13,1.1,1.05,.95,
     ..85,.7,.625,.60/
      DATA JDATE/1,25,51,110,120,140,156,166,176,206,240,273,303,339,
     .352,366/
C
C.....THIS SUBROUTINE COMPUTES CROP COEFFICIENTS, CP, ROOT DEPTH, RD,
C.....FOLIAR COVER, FC, AND "POTENTIAL" INTERCEPTION, MXNT, FOR IDAY
C
      CRPMX=1.13
      IF (RDMX.LT.0.00001)RDMX=60.
      IF (FCMX.LT.0.00001)FCMX=1.0
C.....ALFALFA INTERCEPTION FROM LINSLEY,KOHLER,PAULUS,1975
      IF (MXI.LT.0.00001)MXI=0.11
      DO 100 JJ=2,16
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
       J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=RDMX
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE AMSUM (IPRNT)
      COMMON/SUMMRY/ QBALDY(16),QBALMO(16,12),QBALYR(16),
     .               QBLAVY(16),QBLAVM(16,12),DSUM
      COMMON /TIME/ NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      INTEGER DSUM
      DOUBLE PRECISION QBALDY,QBALMO,QBALYR
      DOUBLE PRECISION ERROR
      CHARACTER*3 AMON(12)
      DATA AMON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     .          'OCT','NOV','DEC'/
C
C.....AVERAGE TEMPERATURES
      DO 5 NMO=1,12
5     QBALMO(14,NMO)=QBALMO(14,NMO)/NDAY(NMO)
      QBALYR(14)=QBALYR(14)/IDYS
C
      WRITE (IPRNT,6006)
      WRITE(IPRNT,6002) NYR
      DO 3  I=1,12
      ERROR=QBALMO(3,I)+QBALMO(4,I)+QBALMO(5,I)+QBALMO(7,I)+
     .QBALMO(10,I)+QBALMO(11,I)+QBALMO(12,I)+QBALMO(13,I)+
     .QBALMO(16,I)-QBALMO(1,I)+QBALMO(8,I)
      WRITE(IPRNT,6003) AMON(I),(QBALMO(J,I),J=1,16),ERROR
3     CONTINUE
      WRITE(IPRNT,6006)
      WRITE(IPRNT,6004)NYR
      WRITE(IPRNT,6005) (QBALYR(I),I=1,16)
      RETURN
C
C .....FORMATS
C
6002  FORMAT(//11X,'FOLLOWING ARE MONTHLY TOTALS FOR MODELED REGION FOR
     .YEAR',I5,//5X,   'MON  PRECP  POTET  CHGINT RUNOFF RECHRG SOLPEV
     .ACTSEV  SNWEVP PPLTR  APLTR  CHGSM  EVINT  CHGSNW AVTMP EHRM-RO DE
     .FCIT',/)
6003  FORMAT(5X,A,1X,13(2X,F5.2),2X,F5.1,2(2X,F5.2),F8.3)
6004  FORMAT (//2X,'  FOLLOWING ARE YEAR END TOTALS FOR MODELED REGION
     .FOR YEAR',I5,//9X,'  PRECP  POTET  CHGINT  RUNOFF RECHRG SOLPEV AC
     .TSEV SNWEVP PPLTR  APLTR CHGSM  EVINT  CHGSNW AVTMP EHRM-RO DEFCIT
     .',/)
6005  FORMAT (9X,16(1X,F6.2))
6006  FORMAT (1H )
      END
```

```
      SUBROUTINE ANNUAL(ARRY,IAORR)
      COMMON/INOUT/  NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .       IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .       MAPEL,ARRRY(MAPIJ)
      COMMON/SIZE/  NEL,NIJ,ICOL,IROW
      DIMENSION ARRY(NEL),LINE(30)
C
C .....THIS SUBROUTINE PRINTS OUT ANNUAL AET AND RECH MAPS
C .....AET AND RECH ARRAY MUST BE FORMED DURING THE
C .....DAILY MODELING.MAP IS DIVIDED VERTICALLY INTO 30 ROWS(LAT) AND
C .....ALL COLUMNS (LONG).
C .....START PRINTING BY BLOCK NUMBERS, AND AFTER
C .....ALL COLUMNS FOR ROWS 1-30 PRINTED THE NEXT WILL BE 31-60,ETC
C
C.....PUT ARRY INTO "OVERLAY" ARRAY (ARRRY) IN ORDER TO MAP CORRECT
C.....RELATIVE POSITIONS IF NO AUTOMATIC GRID GENERATION.
C
      IF(MAPEL.EQ.1)      GO TO 11
      J=0
      DO 10 I=1,MAPEL
      IF(ARRRY(I).LT.0.0) GO TO 10
      J=J+1
      ARRRY(I)=ARRY(J)
10    CONTINUE
C
11    IF(IAORR.LT.1) KFACT=10
      IF(IAORR.GT.0) KFACT=100
      IF(IAORR.EQ.3) KFACT=10
      IF(IAORR.EQ.0) WRITE (IPRNT,6006)
      IF(IAORR.EQ.1) WRITE (IPRNT,6010)
      IF(IAORR.EQ.2) WRITE (IPRNT,6011)
      IF(IAORR.EQ.3) WRITE (IPRNT,6012)
      NPAGES=(ICOL-1)/30 +1
      DO 20 J=1,NPAGES
      IADD=(J-1)*30 +1
      INCR=J*30
      IF(J.EQ.NPAGES.AND.INCR.GT.ICOL) INCR=ICOL
      WRITE(IPRNT,6007) (IP,IP=IADD,INCR)
      DO 20 I=1,IROW
      K=0
      KOLS=INCR-IADD+1
      DO 15 IP=IADD,INCR
      K=K+1
      IF(MAPEL.EQ.1)LINE(K)=ARRY(IP)*KFACT +0.5
      IF(MAPEL.GT.1)LINE(K)=ARRRY(IP)*KFACT +0.5
15    IF(LINE(K).LT.0) LINE(K)=-1
      WRITE(IPRNT,6008)I,(LINE(K),K=1,KOLS)
      IADD=IADD+ICOL
```

```
20    INCR=INCR+ICOL
      RETURN
C ...
C .....FORMATS
C
6006  FORMAT(//10X,'ANNUAL AET DISTRIBUTION, TENTHS OF INCHES',/)
6007  FORMAT(//,4X,30I4)
6008  FORMAT(/,I3,1X,30I4)
6010  FORMAT(//10X,'ANNUAL RECHARGE DISTRIBUTION, HUNDREDTHS OF INCHES',
     ./)
6011  FORMAT(//10X,'AVG ANNUAL RECHARGE DISTRIBUTION, HUNDREDTHS OF INCHE
     .S',/)
6012  FORMAT(//10X,'AVG ANNUAL AET DISTRIBUTION, TENTHS OF INCHES',/)
      END
```

```
      SUBROUTINE ANTVAL(INEL,NWS,NMO,TMDIF,IFCHK)
      COMMON/BLKPET/ ALTBLK(BLKS),SLPBLK(BLKS),ASPECT(BLKS),CTBLK(BLKS),
     .    TXBLK(BLKS),TXJAVB(BLKS),TNJAVB(BLKS),IBLOCK(BLKS)
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
C
C ....THIS SUBROUTINE IS CALLED TO ADJUST FOR LAPSE RATES FOR EACH OF
C ....NT BLOCKS, CALLED FROM HERE DUE TO THE DIMENSION OF VALUES
C ....IN THE BLKPET COMMON, IN THIS WAY, IF ONE DOES NOT USE LAPSE RATES
C ....BUT MERELY INTERPOLATES FROM NWS WEATHER STATIONS FOR PET AND
C ....TEMPS THEN THIS SUBROUTINE IS NOT CALLED AND STORAGE
C ....IS SAVED FOR THE BLKPET COMMON (DIMENSIONS CAN BE SET=1)
C
      TMDIF=0.0
      IF(NT.EQ.NEL) GO TO 15
      DO 10  I=1,NT
      K=IBLOCK(I)
      IF(K.NE.INEL) GO TO 10
      CALL LAPSE(NWS,TMDIF,IFCHK,NMO,ALTBLK(I))
      GO TO 20
10    CONTINUE
      GO TO 20
15    CALL LAPSE(NWS,TMDIF,IFCHK,NMO,ALTBLK(INEL))
20    RETURN
      END
```

```
      SUBROUTINE APPSCD
      COMMON/IRRTIM/ IRRST1(15),IRREN1(15),IRRST2(15),IRREN2(15),
     .               IRRSCD(15),SUMCP(15)
C
C.....SUBROUTINE TO INTEGRATE THE CROP COEFFICIENT CURVES OVER THE
C.....SPECIFIED IRRIGATION SEASON.
C
      DO 100 IDAY=1,366
      L=2
      IF(IRRSCD(L).LT.1) GO TO 4
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 4
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 4
      CALL GRASS(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
4     L=4
      IF(IRRSCD(L).LT.1) GO TO 5
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 5
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 5
      CALL WWALYR(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
5     L=5
      IF(IRRSCD(L).LT.1) GO TO 6
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 6
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 6
      CALL WWAUTM(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
6     L=6
      IF(IRRSCD(L).LT.1) GO TO 7
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 7
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 7
      CALL WWSPRG(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
7     L=7
      IF(IRRSCD(L).LT.1) GO TO 8
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 8
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 8
      CALL ORCHRD(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
8     L=8
      IF(IRRSCD(L).LT.1) GO TO 9
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 9
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 9
      CALL ALFALF(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
```

```
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
9     L=9
      IF(IRRSCD(L).LT.1) GO TO 11
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 11
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 11
      CALL ROW(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
11    L=11
      IF(IRRSCD(L).LT.1) GO TO 12
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 12
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 12
      CALL CORN(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
12    L=12
      IF(IRRSCD(L).LT.1) GO TO 14
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 14
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 14
      CALL POTATO(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
14    L=14
      IF(IRRSCD(L).LT.1) GO TO 15
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 15
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 15
      CALL PEALEN(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
15    L=15
      IF(IRRSCD(L).LT.1) GO TO 100
      IF(IDAY.LT.IRRST1(L).OR.IDAY.GT.IRREN2(L)) GO TO 100
      IF(IDAY.LT.IRRST2(L).AND.IDAY.GT.IRREN1(L)) GO TO 100
      CALL SPRGWT(IDAY,0,0,0,DUM1,DUM2,DUM3,CP,0.0,IRRST1(L),IRREN1(L),
     .           IRRST2(L),IRREN2(L),0,-1.0)
      SUMCP(L)=SUMCP(L)+CP
100   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE APPWAT(IAPUNT,IAPPLY)
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/CLASLD/ LANDUS(BLKS),ILND,JLND,FMTL,IFORML
      COMMON /IRRWAT/ APPLD(IRIGS),IAPBLK(IRIGS)
      COMMON/PLANT/ MAXINT(15),RDMAX(15),FCMAX(15),COEFS(15,8),IROOT
      REAL MXNT,MAXINT
      INTEGER*2 LANDUS
      CHARACTER*8 FMTL
C
C .....THIS SUBROUTINE IS CALLED FROM DATAIN IF IAPUNT > 0,
C ....AND IS CALLED FROM MAIN IF LANDUSES CHANGE EACH YEAR
C ....    , THAT IS, NEWLND IS CALLED AND HAVE NEW IRRIGATED LANDS.
C ....     A NEW SET OF DATA IS REQUIRED WHEN LANDUSES CHANGE
C.....     EACH YEAR.  THE DATA WOULD ALL BE IN THE SAME FILE
C.....     WITH EACH YEAR OF DATA BEING THE BLOCKS WITH
C.....     APPLICATION RATES FOR THAT YEAR
C....
C .....ANNUAL APPLICATION RATES (APPLD) ARE READ IN FOR IAPPLY
C .....NUMBER OF BLOCKS. THE ANNUAL RATES ARE MULTIPLIED BY
C .....A DAILY FACTOR FROM THE CROP SUBROUTINES AND ADDED TO PRECIP.
C .....FIRST READ IN NUMBER OF BLOCKS FOR IRRIGATION (IAPPLY)
C .....WHEN APPWAT CALLED FROM MAIN DUE TO NEW IRRIGATION, THEN IAPPLY
C .....IS A DUMMY VARIABLE THAT INCREMENTS THE OLD IAPPLY IN THE MAIN
C .....FOR THE NUMBER OF NEW IRRIGATION BLOCKS
C
      READ(IAPUNT,5000) IAPPLY
      DO 1  I=1,IAPPLY
1     READ(IAPUNT,5000) IAPBLK(I),APPLD(I)
      RETURN
      ENTRY APPLY(IAPPLY,NMO,IDAY)
      DO 100  J=1,IAPPLY
      K=IAPBLK(J)
      L=LANDUS(K)
      APP=APPLD(J)*COEFS(L,5)
C...PUT APPLIED WATER FOR THIS BLOCK INTO PRECP MASBAL BUDGET ITEM
      CALL MASBAL(K,APP,1,NMO,IDAY)
C... INCREASE PRECIP FOR THIS BLOCK (K), BY AMOUNT OF APPLIED WATER
100   PRECP(K)=PRECP(K)+APP
      RETURN
C
C .....FORMATS
C
5000  FORMAT (I5,F10.0)
      END
```

```
      SUBROUTINE AVEOT (IPRNT,ICHECK)
      COMMON/ANNVAL/ AET(BLKS),AETAV(BLKS),RECH(BLKS),RECHAV(BLKS)
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON /TIME/  NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      COMMON/SUMMRY/ QBALDY(16),QBALMO(16,12),QBALYR(16),
     .               QBLAVY(16),QBLAVM(16,12),DSUM
      INTEGER DSUM
      DOUBLE PRECISION QBALDY,QBALMO,QBALYR
      CHARACTER*3 AMON(12)
      DATA AMON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     .          'OCT','NOV','DEC'/
C
C.....THIS SUBROUTINE TOTALS ANNUAL RECHARGE FROM YEAR TO YEAR AND
C.....COMPUTES AVERAGES OVER THE SIMULATION PERIOD.
C
C.....ZERO ARRAYS AFTER FIRST YEAR OF RUN, BEFORE SECOND YEAR RUN
C
      IF(ICHECK.GT.1) GO TO 10
      DO 5 N=1,NEL
      AETAV(N)=0.0
 5    RECHAV(N)=0.0
      DO 6 M=1,16
      DO 7 MO=1,12
 7    QBLAVM(M,MO)=0.0
 6    QBLAVY(M)=0.0
C
C.....IF WARMUP YEAR NOT USED DO NOT USE FIRST YEAR.
C
 10   IF(ICHECK.LT.2) GO TO 25
      DO 22 M=1,16
      DO 21 MO=1,12
 21   QBLAVM(M,MO)=QBLAVM(M,MO)+QBALMO(M,MO)
 22   QBLAVY(M)=QBLAVY(M)+QBALYR(M)
C
C.....INITIALIZE OUTPUT SUMMARY ARRAYS FOR NEXT YEAR
C
25    DO 27 M=1,16
      DO 26 MO=1,12
26    QBALMO(M,MO)=0.0
27    QBALYR(M)=0.0
C
C.....GET AVERAGES
C
      IF(NYR.NE.IYR2) RETURN
      IF(ICHECK.LT.2) RETURN
      JYEARS=IYR2-IYR1
      IF(IWARMP.GT.0) JYEARS=JYEARS+1
      DO 30 N=1,NEL
```

```
      AETAV(N)=AETAV(N)/JYEARS
30    RECHAV(N)=RECHAV(N)/JYEARS
      DO 32 M=1,16
      DO 31 MO=1,12
 31   QBLAVM(M,MO)=QBLAVM(M,MO)/JYEARS
 32   QBLAVY(M)=QBLAVY(M)/JYEARS
C
C.....PRINT RESULTS
      WRITE(IPRNT,6002)
      DO 40 MO=1,12
 40   WRITE(IPRNT,6001) AMON(MO),(QBLAVM(M,MO),M=1,16)
      WRITE(IPRNT,6004)
      WRITE(IPRNT,6003)(QBLAVY(I),I=1,16)
C     -------      MAP AVG ANNUAL RECHARGE    ------------
      CALL ANNUAL(RECHAV,2)
C     ---------      MAP AVG ANNUAL AET    -----------
      CALL ANNUAL(AETAV ,3)
C
C.....FORMATS
C
6001  FORMAT(5X,A,1X,16(1X,F6.2))
6002  FORMAT (//2X,'  FOLLOWING ARE MONTHLY AVERAGES FOR MODELED REGION
     .FOR SIMULATION',//9X,'  PRECP  POTET  CHGINT  RUNOFF RECHRG SOLPEV
     . ACTSEV SNWEVP PPLTR  APLTR CHGSM  EVINT  CHGSNW AVTMP EHRM-RO DEF
     .CIT',/)
6003  FORMAT(9X,16(1X,F6.2))
6004  FORMAT (//2X,'  FOLLOWING ARE ANNUAL AVERAGES FOR MODELED REGION
     .FOR SIMULATION',//9X,'  PRECP  POTET  CHGINT  RUNOFF RECHRG SOLPEV
     . ACTSEV SNWEVP PPLTR  APLTR CHGSM  EVINT  CHGSNW AVTMP EHRM-RO DEF
     .CIT',/)
      RETURN
      END
```

```
      SUBROUTINE AVJTMP(NWST,TNJAVG,TXJAVG,INJAV)
      DIMENSION TNJAVG(NWST),TXJAVG(NWST)
C
C ....THIS SUBROUTINE READS LONG TERM AVERAGE JULY DAILY MAX AND MIN
C.....TEMPERATURES
C
      DO 100 I=1,NWST
 100  READ(INJAV,1000)TNJAVG(I),TXJAVG(I)
 1000 FORMAT(2F5.1)
      RETURN
      END
```

```
      SUBROUTINE CLIMAT (NEL,NMO,IDAY)
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/POLATP/ DISTP(NODES,NVLP),NEARP(NODES,NVLP),DMAX,NVALP
      COMMON/POLATT/ DISTT(NODES,NVLT),NEART(NODES,NVLT),NVALT
      COMMON /TIME/  NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      COMMON/NWSPRE/ P(NWSP),JP(NWSP),XP(NWSP),YP(NWSP),NWSP,IFPREC
      COMMON/NWSTEM/ TN(NWST),TX(NWST),XT(NWST),YT(NWST),NWST
      COMMON/CLIMIO/ INP,INTN,INTX,METHDP,METHDT,IRECP,IRECT
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
      DOUBLE PRECISION XP,YP,XT,YT
      OPEN(INP,ACCESS='DIRECT',RECL=IRECP)
      OPEN(INTN,ACCESS='DIRECT',RECL=IRECT)
      OPEN(INTX,ACCESS='DIRECT',RECL=IRECT)
      IR1=IDAY
      IR2=IDAY
      IR3=IDAY
C
C .....READ PRECP FOR IDAY OF NYR
C
      READ (INP,REC=IR1) JP
C.....CONVERT NON-DECIMAL STORED VALUES TO ACTUAL VALUES
      DO 5 I=1,NWSP
 5    P(I)=JP(I)/100.
C
C .....INTERPOLATE TO GRIDS, METHD<1=1/D*2
C .....                      METHD>0=1/D
C ..... METHD HAS BEEN DETERMINED AND BUILT IN FROM SUBRTNE INTRPO
C
      CALL TOGRID (P,PRECP,NVALP,DISTP,NEARP,IFPREC,NMO,NT)
C
C... PUT DAILY PRECIP INTO THE BUDGET
C
      DO 10 I=1,NEL
10    CALL MASBAL(I,PRECP(I),1,NMO,IDAY)
C
C .....READ T-MIN FOR IDAY OF NYR
C
15    READ (INTN,REC=IR2) TN
C
C .....INTERPOLATE TO GRIDS
C
      CALL TOGRID (TN,TMIN,NVALT,DISTT,NEART,IFTMPN,NMO,NT)
C
C.....YESTERDAY'S MAXIMUM TEMPERATURE:
      DO 20 I=1,NEL
20    TMXYST(I)=TMAX(I)
C
```

```
C .....READ TMAX FOR IDAY OF NYR
C
      READ (INTX,REC=IR3) TX
C
C .....INTERPOLATE TO GRIDS
C
      CALL TOGRID (TX,TMAX,NVALT,DISTT,NEART,IFTMPX,NMO,NT)
C
C.....PUT AVG DAILY TEMPS INTO BUDGET
      DO 25 I=1,NEL
      TAVG= 0.5*TMAX(I)+0.5*TMIN(I)
25    CALL MASBAL(I,TAVG,14,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE CN2GEN(IFTEMP)
      COMMON/INOUT/  NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .       IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .       MAPEL,ARRRY(MAPIJ)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/CLASLD/ LANDUS(BLKS),ILND,JLND,FMTL,IFORML
      COMMON/BLKPET/ ALTBLK(BLKS),SLPBLK(BLKS),ASPECT(BLKS),CTBLK(BLKS),
     .    TXBLK(BLKS),TXJAVB(BLKS),TNJAVB(BLKS),IBLOCK(BLKS)
      COMMON/SIZE/ NEL,NIJ,ICOL,IROW
      COMMON/SOIL1/ WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
      DIMENSION SLPMIN(20),SLPMAX(20),WCAPMX(20),WCAPMN(20),NLMIN(20),
     .NLMAX(20),LNDSIT(16,20),CCN(20)
      CHARACTER*8 FMTL
      DATA SLPMIN/0,0,0,0,0,0,0,0,20,0,0,20,10,6,20,0,0,0,0,0/
      DATA SLPMAX/0,20,10,20,20,20,20,20,90,20,20,90,90,20,90,5,20,20,
     .            20,20/
      DATA WCAPMN/0,.1,1,2.5,2,.1,1.5,.5,2,2,1.5,1.5,.5,1.5,1.5,1.5,1.5,
     .            .8,.3,.1/
      DATA WCAPMX/0,4,2.5,4,2.5,1.5,2.5,2.5,2.7,2.7,2,2.5,1.5,2.5,2.5,
     .            2.5,2.5,1.5,.8,.7/
      DATA NLMIN/0,1,6,2,2,2,2,2,4,4,4,4,3,6,6,6,6,6,6,6/
      DATA NLMAX/0,1,20,20,4,4,4,3,20,20,20,20,4,20,20,20,20,20,20,20/
      DATA CCN/95,95,90,90,85,80,80,80,80,80,80,80,80,80,80,80,80,75,
     .        70,70/
      DATA LNDSIT/1,0,0,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            4,7,8,9,11,12,0,0,0,0,0,0,13,14,15,16,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,4,5,6,7,8,9,11,12,0,13,14,15,16,
     .            1,2,3,4,5,6,7,8,9,11,12,0,13,14,15,16,
     .            1,2,3,4,5,6,7,8,9,11,12,0,13,14,15,16,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            1,2,3,4,5,6,7,8,9,11,12,0,13,14,15,16,
     .            1,2,3,4,5,6,7,8,9,11,12,0,13,14,15,16,
     .            1,2,3,4,5,6,7,8,9,11,12,0,13,14,15,16,
     .            1,2,3,0,0,0,0,0,0,0,0,0,13,0,0,0,
     .            2,3,0,0,0,0,0,0,0,0,0,0,13,0,0,0/
C.....SUBROUTINE TO DETERMINE CN2 #S FROM OTHER  INPUT DATA.
C
      WRITE(IOT1,2000)
      DO 200 IBLK=1,NEL
```

```
      IF(LANDUS(IBLK).EQ.10) CN2(IBLK)=100
      IF(LANDUS(IBLK).EQ.10) GO TO 200
      SLOPE=SLPBLK(IBLK)
      IF(IFTEMP.GE.0) SLOPE=0.0
      NS=NSOIL(IBLK)
      NL=NLAYER(NS)
      LNDUS=LANDUS(IBLK)
      AVWCAP=0.0
      CNN=0
      NCN=0
      IQUAL=4
C.....GET AVG AVAILABLE WATER CAPACITY. (CODED AS INCHES H2O PER
C     6 INCH SOIL LAYER, THEREFORE MULTIPLY BY 2 TO GET INCHES/FOOT TO
C     COMPARE WITH WCAPMN AND WCAPMX DATA.)
      DO 10 N=1,NL
 10   AVWCAP=WATCAP(NS,N)+AVWCAP
      AVWCAP=2.0*AVWCAP/NL
 20   IQUAL=IQUAL-1
C.....FOR EACH CN# CHECK "FIT" OF SOIL TYPE, SLOPE, AND LANDUSE. IF MORE
C.....THAN ONE CN# "QUALIFIES" THEN USE AVERAGE OF THOSE CN#'S.
      DO 100 I=1,20
      IQ=0
      IF(SLOPE.GE.SLPMIN(I).AND.SLOPE.LE.SLPMAX(I)) IQ=IQ+1
      IF(AVWCAP.GE.WCAPMN(I).AND.AVWCAP.LE.WCAPMX(I)) IQ=IQ+1
      IF(NL.GE.NLMIN(I).AND.NL.LE.NLMAX(I)) IQ=IQ+1
      DO 50 L=1,16
 50   IF(LNDUS.EQ.LNDSIT(L,I)) IQ=IQ+1
      IF(IQ.GT.IQUAL) CNN=CNN + CCN(I)
      IF(IQ.GT.IQUAL) NCN=NCN+1
 100  CONTINUE
      IF(IQUAL.LT.2) WRITE(IOT1,1000)IBLK,SLOPE,AVWCAP,NL,LNDUS
      IF(IQUAL.LT.2) STOP
C.....IF NO CN# FOR SOIL, SLOPE, LANDUSE COMBINATION THEN FIND CN#
C.....WHERE 2 OF THESE FIT. IF NOT, THEN 1. IF NONE THEN STOP.
      IF(NCN.LT.1) GO TO 20
      CN2(IBLK)=CNN/NCN
 200  CONTINUE
      WRITE(IOT1,3000)CN2
 1000 FORMAT(1X,'******ERROR******* LESS THAN 2 OF THE FOLLOWING ARE ',/,
     .1X,'WITHIN RANGE ON CN2 TABLE.',/,
     .'IBLK=',I4,'   SLOPE=',F4.1,'    AVWCAP=',F4.1,'    NL=',I4,
     .'    LNDUS=',I4)
 2000 FORMAT(1X,'THE FOLLOWING CN2 NUMBER DATA SET HAS BEEN MODEL-',/,
     .1X,'GENERATED FROM SOIL, SLOPE, AND LANDUSE DATA.',/)
 3000 FORMAT(20I4)
      RETURN
      END
```

```
      SUBROUTINE CORN(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE # 11-CORN
C
      REAL MXI,MXNT
      DIMENSION CRP(14),JDATE(14)
      DATA CRP/0,0,.54,.68,.9,1,1.06,1.08,1.08,1.06,1,.86,0,0/
      DATA JDATE/1,126,155,178,198,209,220,229,240,253,273,310,311,366/
      CRPMX=1.08
      IF(RDMX.LT.0.0001)RDMX=48.0
      IF(FCMX.LT.0.0001)FCMX=1.0
C.....INTERCEPTION "INTERPOLATED" FROM LINSLEY,ETC
      IF(MXI.LT.0.0001)MXI=0.03
      DO 100 JJ=2,14
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
        J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=FACT*RDMX
      FC=FACT*FCMX
      MXNT=MXI*FACT
      IF(IDAY.LT.241.OR.IDAY.GT.310) GO TO 120
      RD=RDMX
      FC=FCMX
      MXNT=MXI
120   IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE CRPCOF(IDAY)
      COMMON/PLANT/ MAXINT(15),RDMAX(15),FCMAX(15),COEFS(15,8),IROOT
      COMMON/IRRTIM/ IRRST1(15),IRREN1(15),IRRST2(15),IRREN2(15),
     .               IRRSCD(15),SUMCP(15)
      REAL MAXINT,MXNT
      DO 25 I=1,15
      APMULT=0.0
      RD=0.0
      CP=0.0
      FC=0.0
      MXNT=0.0
      IF(I.EQ.10) GO TO 20
      RDMX=RDMAX(I)
      FCMX=FCMAX(I)
      XINTER=MAXINT(I)
C
C ...    GET BL-CR CROP GROWTH PARAM (CP) ROOT DEPTH (RD),FOLIAR
C ...    COVER (FC), AND INTERCEPTION CAPACITY (MXNT)
C
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15) I
1     CALL FOREST(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP)
      GO TO 20
2     CALL GRASS(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .            IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .            IRRSCD(I),SUMCP(I))
      GO TO 20
3     CALL SAGE(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP)
      GO TO 20
C ........WINTER WHEAT HARVESTED THIS SUMMER AND PLANTED THIS FALL
4     CALL WWALYR(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .            IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .            IRRSCD(I),SUMCP(I))
      GO TO 20
C .....WINTER WHEAT HARVESTED THIS SUMMER AND FALLOW NEXT FALL'S PLANTNG
5     CALL WWSPRG(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .            IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .            IRRSCD(I),SUMCP(I))
      GO TO 20
C ........WINTER WHEAT FALLOW THIS SPRING AND PLANTED THIS FALL
6     CALL WWAUTM(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .            IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .            IRRSCD(I),SUMCP(I))
      GO TO 20
7     CALL ORCHRD(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .            IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .            IRRSCD(I),SUMCP(I))
      GO TO 20
8     CALL ALFALF(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
```

```
     .              IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .              IRRSCD(I),SUMCP(I))
      GO TO 20
9     CALL ROW(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .              IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .              IRRSCD(I),SUMCP(I))
      GO TO 20
C.....SURFACE COVERED BY WATER
10    GO TO 20
11    CALL CORN(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .              IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .              IRRSCD(I),SUMCP(I))
      GO TO 20
12    CALL POTATO(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .              IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .              IRRSCD(I),SUMCP(I))
      GO TO 20
13    CALL SAND(IDAY,RDMX,RD,FC,MXNT,CP,APMULT)
      GO TO 20
14    CALL PEALEN(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .              IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .              IRRSCD(I),SUMCP(I))
      GO TO 20
15    CALL SPRGWT(IDAY,RDMX,FCMX,XINTER,RD,FC,MXNT,CP,APMULT,
     .              IRRST1(I),IRREN1(I),IRRST2(I),IRREN2(I),
     .              IRRSCD(I),SUMCP(I))
20    COEFS(I,1)=RD
      COEFS(I,2)=FC
      COEFS(I,3)=MXNT
      COEFS(I,4)=CP
      COEFS(I,5)=APMULT
      COEFS(I,6)=RDMX
      COEFS(I,7)=FCMX
      COEFS(I,8)=XINTER
25    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE DALYOT (IBLK,IDAY,INCK,IPRNT)
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC
     .,TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
      INCK=INCK+1
      WRITE(IPRNT,6000)
      WRITE (IPRNT,6001) IBLK,IDAY
      WRITE (IPRNT,6002) PPT,RED,RO,RECR,ACTEV,ACTPLT,SUB,SNO,AETFC,SNM
      WRITE (IPRNT,6003) NS,NL
      DO 1 N=1,NL
1     WRITE (IPRNT,6004) N,WC(N),SM(N)
      RETURN
C
C ......FORMATS
C
6000  FORMAT (1H1)
6001  FORMAT (//25X,'DAILY SUMMARY FOR BLOCK ',I6,' FOR DAY  ',I4,/5X,
     .' PRECIP  INTERCP  RUNOFF   RECHRGE  SOILEVP  PLNTTRN   SNWEVP
     .SNOW   EVPINTR  SNOMLT',/)
6002  FORMAT (5X,10(F7.3,2X))
6003  FORMAT (/5X,'THIS BLOCK HAS SOIL AS. ',I3,' AND',I3,' LAYERS',
     ./2X,' LAYER    WATCAP OF THIS LAYER     CURRENT SOIL MOISTURE',/)
6004  FORMAT(5X,I3,13X,F5.3,26X,F5.3)
      END
```

```
      SUBROUTINE DATAIN
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/INOUT/  NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .       IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .       MAPEL,ARRRY(MAPIJ)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/FLOWS/  SNOW(BLKS),SMS(BLKS,10),REMAIN(BLKS)
      COMMON/CLASLD/ LANDUS(BLKS),ILND,JLND,FMTL,IFORML
      COMMON/POLATP/ DISTP(NODES,NVLP),NEARP(NODES,NVLP),DMAX,NVALP
      COMMON/POLATT/ DISTT(NODES,NVLT),NEART(NODES,NVLT),NVALT
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON /TIME/  NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/NWSPRE/ P(NWSP),JP(NWSP),XP(NWSP),YP(NWSP),NWSP,IFPREC
      COMMON/NWSTEM/ TN(NWST),TX(NWST),XT(NWST),YT(NWST),NWST
      COMMON/CLIMIO/ INP,INTN,INTX,METHDP,METHDT,IRECP,IRECT
      COMMON/SUMMRY/ QBALDY(16),QBALMO(16,12),QBALYR(16),
     .               QBLAVY(16),QBLAVM(16,12),DSUM
      COMMON/SOIL1/  WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
      COMMON/PLANT/  MAXINT(15),RDMAX(15),FCMAX(15),COEFS(15,8),IROOT
      COMMON/WINTER/ SBLMTE,PETMIN(6),KMCOEF
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
      COMMON/IRRTIM/ IRRST1(15),IRREN1(15),IRRST2(15),IRREN2(15),
     .               IRRSCD(15),SUMCP(15)
      DIMENSION JSTRT(10),JEND(10),NSCNT(24)
      REAL      MAXINT,KMCOEF
      INTEGER   DSUM,RODATA,BSDATA
      CHARACTER*8  FMTL,FMTS
      CHARACTER*80 TITLE
      DOUBLE PRECISION XP,YP,XT,YT,QBALDY,QBALMO,QBALYR
C
C......INITIALIZE DATAIN INPUT DEVICE NUMBER (IN1)
C
      IN1=5
C
      NDAY(1)=31
      NDAY(2)=28
      NDAY(3)=31
      NDAY(4)=30
      NDAY(5)=31
      NDAY(6)=30
      NDAY(7)=31
      NDAY(8)=31
      NDAY(9)=30
      NDAY(10)=31
      NDAY(11)=30
```

```
      NDAY(12)=31
C
C.....ZERO ARRAYS
C
      DO 2 I=1,16
 2    QBALDY(I)=0.0
      DO 3 I=1,12
      QBALYR(I)=0.0
      DO 3 J=1,16
 3    QBALMO(J,I)=0.0
      IAPPLY=0
      DO 44 I=1,15
      IRRST1(I)=0
      IRREN1(I)=0
      IRRST2(I)=0
      IRREN2(I)=0
      IRRSCD(I)=0
 44   SUMCP(I)=0.0
C
C .....READ TITLE (CHARACTER*80)
C
      READ (IN1,5000) TITLE
C
C .....READ IOT1, OUTPUT UNIT FOR PRINTOUT,INPUT UNIT=IN1 HAS BEEN
C .....INITIALIZED ABOVE
C
      READ (IN1,5001)   IOT1
      WRITE (IOT1,6001) IOT1
      WRITE (IOT1,6000) TITLE

C
C .....READ IN2, INPUT UNIT FOR GRID DATA
C
      READ (IN1,5001)   IN2
      WRITE (IOT1,6002) IN1,IN2
C
C .....READ TIME THAT SIMULATION STARTS, AND ENDS (EG,1955), AND WHETHER TO
C .....REPEAT THE FIRST YEAR,EG, DO A WARMUP YEAR
C
      READ (IN1,5001)   IYR1,IYR2,IWARMP
      NYRS=IYR2-IYR1+1
      WRITE (IOT1,6003) IYR1,IYR2,NYRS,IWARMP
C
C .....READ MODEL SIZE PARAMETERS:
C ......READ IGRID, IF IGRID >0 THEN NODE POINTS WILL BE INPUT
C ......AND WILL NOT BE CALCULATED. IF LFEET>0 THEN NODE POINTS
C.......ARE ALREADY IN LAMBERT FEET AND SUBROUTINE LAMBERT (CALLED
C.......FROM DOGRID) IS BYPASSED.
```

```
C
      READ (IN1,5001)   IGRID,LFEET
      WRITE (IOT1,6004) IGRID
      WRITE(IOT1,6047)  LFEET
      CALL DOGRID (IGRID,LFEET,IN2,IOT1)
C
C .....READ CLIMATE PARAMETERS AND DATA
C .....FIRST READ UNIT NUMBER THAT X,Y VALUES OF THE PRECP AND TEMP
C .....STATIONS ARE ON, PARAMETER ILMBRT, IF ILMBRT=0 THEN X,Y VALUES IN
C ....DECIMAL DEGREES, AND IF ILMBRT=1 THEN X,Y ALREADY IN LAMBRT COORDS
C
      READ (IN1,5001)   IN3,ILMBRT
      WRITE (IOT1,6005) IN3,ILMBRT
C
C .....READ NUMBER OF PRECP STATIONS
C
      READ (IN1,5001)   NWSP
      WRITE (IOT1,6006) NWSP
C
C ....READ NUMBER OF TEMP STATIONS (MAX/MIN WEATHER STATIONS)
C
      READ (IN1,5001)   NWST
      WRITE (IOT1,6007) NWST
C
C ....... READ X,Y VALUES OF PRECP STATIONS (ON UNIT=IN3)
C
      DO 5  I=1,NWSP
      READ(IN3,5005)  XP(I),YP(I)
5     IF(ILMBRT.EQ.0) CALL LAMBRT(XP(I),YP(I))
C
C ....READ X,Y VALUES AND ELEVATION OF TEMP STATIONS (ON UNIT=IN3)
C
      DO 6  I=1,NWST
      READ (IN3,5005) XT(I),YT(I),ALTWS(I)
6     IF(ILMBRT.EQ.0) CALL LAMBRT(XT(I),YT(I))
C
C ....READ UNIT NUMBER THAT PRECP VALUES, MAX-MIN TEMP VALUES
C .....ARE CURRENTLY STORED ON
C
      READ (IN1,5001)   INP,INTN,INTX,IRECP,IRECT
      WRITE (IOT1,6008) INP,INTN,INTX,IRECP,IRECT
C
C.....READ UNIT NUMBER THAT LONG TERM AVERAGE JULY MAXIMUM AND
C.....MINIMUM TEMPERATURES ARE ON.
C
      READ(IN1,5001)   INJAV
      WRITE(IOT1,6048) INJAV
C
```

```
C.....READ IN LONG TERM AVG JULY TEMPS BY CALLING AVJTMP
      CALL AVJTMP(NWST,TNJAVG,TXJAVG,INJAV)
      WRITE(IOT1,6049)
      DO 4 I=1,NWST
4     WRITE(IOT1,6050)I,TNJAVG(I),TXJAVG(I)
C
C....READ IN INTERCEPT AND SLOPE(ASUN,BSUN) FOR REGRESSION OF
C....PERCENT POSSIBLE SUNSHINE WITH MAX-MIN TEMPERATURE, FOR
C....THE COLUMBIA PLATEAU, ASUN= -20., BSUN=3.636
C
      READ(IN1,5012)   ASUN,BSUN
      WRITE(IOT1,6054) ASUN,BSUN
C
C .....SET METHOD TO INTERPOLATE PRECP,TEMPS TO GRIDS:
C ...                                             <1=1/DISTANCE*2
C ...                                             >0=1/DISTANCE
C ...PET USED SAME METHOD AS TEMPERATURE
C
      METHDP=0
      METHDT=1
      WRITE (IOT1,6009) METHDP,METHDT
C
C ....READ MAX NUMBER OF NWS WEATHER STATIONS TO INTERPOLATE PRECIP AND TEMP
C ....DAILY VALUES TO GRID POINTS
C
      READ (IN1,5001)   NVALP,NVALT
      WRITE (IOT1,6010) NVALP,NVALT
C
C .....READ PARAMETER IFPREC TO DETERMINE IF INTERPOLATION SCHEME
C .....WILL ACCOUNT FOR ANNUAL VARIATIONS, I.E., ANNUAL AVERAGE VALUES
C .....WILL BE READ IN FOR ALL NWS WEATHER STATIONS AND ALSO FOR ALL BLOCKS OR
C .....CERTAIN BLOCKS, IF IFPREC>0 THEN YES READ ANNUAL VALUES BY
C .....CALLING PREVAL
C
      READ (IN1,5001)   IFPREC
      WRITE (IOT1,6011) IFPREC
      IF (IFPREC.GT.0)  CALL PREVAL(NWSP,IN1,IOT1)
C
C .....READ MAXIMUM DISTANCE SURROUNDING A GRID THAT WILL BE SEARCHED
C .....FOR NVALP NEAREST NWS WEATHER STATIONS (IN MILES)
C
      READ (IN1,5005)   DMAX
      WRITE (IOT1,6012) DMAX
C
C .....READ AVE LATITUDE (DECIMAL DEGREES) FOR MODEL AREA
C
      READ (IN1,5005)   AVELAT
      WRITE (IOT1,6013) AVELAT
```

```
C
C .....READ IFTEMP PARAMETER TO DETERMINE IF LAPSE RATES WILL BE USED
C .....TO MOVE MIN-MAX TEMPS FROM NWS WEATHER STATIONS TO BLOCKS, THIS WILL
C .....ALSO MEAN THAT PET WILL BE CALULATED AT THOSE BLOCKS INSTEAD
C .....OF BEING MOVED TO THEM, IFTEMP<0 : USE LAPSE RATES
C .....                                  OTHERWISE USE METHDT
C ..... ALSO IF IFTEMP<0 LAPSE RATES ARE USED BUT THIS DOES NOT
C ......HAVE TO BE DONE FOR ALL BLOCKS (SEE SUB TMPVAL)
C
      READ (IN1,5001)  IFTEMP
      IF(IFTEMP.LT.-1) IFTEMP=-1
      IFTMPX=IFTEMP
      IFTMPN=IFTMPX-1
      WRITE(IOT1,6014) IFTEMP,IFTMPN,IFTMPX

C
C .....IF IFTEMP<0 THEN READ NT, THE NUMBER OF BLOCKS WHERE LAPSE
C .....RATES WILL BE USED TO MOVE MAX-MINS AND COMPUTE PET @ BLOCKS
C .....NT=0 MEANS IFTEMP IS NOT <0, NT>0< OR = NEL, MEANS THAT
C .....THERE WILL BE A CALL TO TMPVAL WHERE LAPSE RATES AND ELEVATIONS
C .....OF BLOCKS WILL BE READ,THEREFORE IF IFTEMP<0 CALL TMPVAL AND
C .... READ NT THEN READ OTHER DATA
C
      NT=0
      IF(IFTEMP.LT.0) CALL TMPVAL(IN1,IOT1)
      WRITE (IOT1,6015) NT
C
C.....READ IN WINTER SEASON AVERAGE SUBLIMATION RATE IN INCHES/DAY,
C.....RATES GENERALLY VARY OVER SEASON BUT APPROXIMATE WITH ONE VALUE
C.....PUBLISHED RATES VARY FROM .0028-.0114 IN/DAY, AND READ IN THE
C.....SNOWMELT FACTOR, GENERALLY RANGES FROM ABOUT 0.09-0.002
C
      READ (IN1,5012)  SBLMTE,COEF
      KMCOEF=COEF*.25
      WRITE(IOT1,6051) SBLMTE,COEF,KMCOEF
C
C.....READ IN WINTER SEASON MINIMUM MONTHLY RATES FOR PET, THIS VALUE WILL
C.....BE USED DURING THE APPROPIATE MONTH WHEN JENSEN-HAISE PET IS EQUAL
C.....TO 0.0 OR ELSE AVE-TEMP IS LE 32 DEGREES, WINTER SEASON IS OCT-MARCH
C.....IF PET =0.0 OR AVE-TEMP LE 32 DURING REST OF YEAR MARCH VALUE WILL BE
C.....USED
C
      READ(IN1,5012)    PETMIN(1),PETMIN(2),PETMIN(3),PETMIN(4),PETMIN(5)
     .                 ,PETMIN(6)
      WRITE(IOT1,6052) PETMIN
C
C .....READ I-O PARAMETERS, READ OUTPUT AND STORAGE UNIT NUMBERS
C .....READ SAVING AND PRINTING PARAMETERS
```

```
C
C ....READ ICN, IF ICN<1 SET SOIL MOISTURE @ BEGINING OF SIMULATION
C ....AS FIELD CAPACITY,IF ICN>0 READ SOIL MOISTURE OFF UNIT ICN
C
      READ (IN1,5001)  ICN
      WRITE(IOT1,6016) ICN
C
C .....READ ISTS, IF ISTS>0 SAVE SMS ON UNIT ISTS AT END OF SIMULATION
C .....           IF ISTS<1 DO NOT STORE SMS AT END OF YEAR(SIMULATION)
C
      READ (IN1,5001)    ISTS
      WRITE (IOT1,6017)  ISTS
C
C .....READ PRINTING(WRITING) UNIT FOR LOOKING AT MODEL OUTPUT
C
      READ (IN1,5001)   IPRNT
      WRITE (IOT1,6018) IPRNT
      WRITE(IPRNT,6000) TITLE
C
C .....READ VARIABLES TO DETERMINE IF WANT ANNUAL RECHARGE, AET MAPS
C .....IF VARIABLES >0 THEN ACCUMULATE AND SAVE DAILY VALUES IN ANNUAL
C .....ARRAY. IF MAPREC, MAPET=1 THEN ANN. VALUES ARE MAPPED EACH YEAR.
c.....IF GRID IS NOT AUTOMATICALLY GENERATED MAP CONFIGURATION DATA IS
C.....READ FROM DEVICE # MAPARY. EACH CARD IMAGE HAS POSITION NUMBERS
C.....FOR ONE ROW OF MAP. THIS INFORMATION GOES INTO VECTOR CALLED
C.....ARRRY(IROWS*ICOLS) AS -1 OR 0 FOR EACH ELEMENT OF ARRRY.
C
      READ (IN1,5001)   MAPREC,MAPET,MAPEL,MAPARY
      WRITE (IOT1,6019) MAPREC,MAPET
      IF (MAPEL.LT.2)GO TO 38
      IF(IGRID.LT.1) GO TO 38
      READ(MAPARY,5001) IROW,ICOL
      DO 32 J=1,MAPEL
 32   ARRRY(J)=-1
      DO 37 I=1,IROW
      READ(MAPARY,5001)(JSTRT(J),JEND(J),J=1,10)
      DO 35 J=1,10
      IF(JSTRT(J).LT.1) GO TO 37
      JSTR=JSTRT(J)+(I-1)*ICOL
      JEN=JEND(J)+(I-1)*ICOL
      DO 34 K=JSTR,JEN
 34   ARRRY(K)=0.0
 35   CONTINUE
 37   CONTINUE
 38   CONTINUE
C
C .....READ PARAMETER (IRECH) AND IFLUX TO DETERMINE IF WANT TO STORE
C ......ANNUAL RECHARGE AT END OF SIMULATION
```

```
C ....TO DO THIS MAPREC MUST BE>0; IF IFLUX>0 THEN ANNUAL RECHARGE AT
C ....END IF SIMULATION IS PRINTED IN BOTH IN/YR & CFS, AND ANNUAL
C ....STORED IS VOLUMETRIC FLUX (FT3/SEC), IF IFLUX<1 THEN MAP AND
C ....SAVE RATE ONLY (IN/YR)
C .... IF IRECH>0 THEN IRECH DEFINES LOGICAL FORTRAN
C .....UNIT NUMBER THAT RECHARGE WILL BE STORED ON
C
      READ (IN1,5001)   IRECH,IFLUX
      WRITE (IOT1,6020) IRECH,IFLUX
C
C ......READ PARAMETERS THAT DETERMINE IF WANT SUMMARIES OF WATER
C .....BUDGET FOR MODELED REGION, ISUM>0 MEANS WANT SUMMARIES
C .....
C
C .....IF WANT DAILY SUMMARIES (ALWAYS GET MONTHLY AND YEARLY) THEN
C .....SET DSUM >0
C
      READ (IN1,5001)   DSUM
      WRITE (IOT1,6021) DSUM
C
C ....READ IF WANT DAILY WATER BALANCE SUMMARIES AT PARTICULAR BLOCKS
C ....IF SO THEN NSMBLK>0 AND NSMBLK=NUMBER OF BLOCKS WHERE WANT DAILY
C ....SUMMARIES
C
      READ(IN1,5001)    NSMBLK
      WRITE (IOT1,6023) NSMBLK
C
C .....READ IN BLOCK NUMBER OF EACH BLOCK THAT WANT DAILY SUMMARY
C
      IF (NSMBLK.LT.1)  GO TO 7
      WRITE (IOT1,6024)
      DO 61  I=1,NSMBLK
      READ (IN1,5004) NSB(I)
61    WRITE (IOT1,6025) I,NSB(I)
C
C.....READ FORTRAN DEVICE# THAT FIRST YEAR'S LANDUSE DATA IS ON AND
C.....WHETHER FORMATTED OR UNFORMATTED: IF IFORML>0 THEN UNFORMATTED
C.....IF JLND<1 THEN LANDUSE IS SAME FOR ALL YEARS OF SIMULATION AND
C.....ARE READ NOW. OTHERWISE NEWLAND IS CALLED FROM MAIN AT
C.....THE BEGGINNING OF EACH YEAR.
C
7     READ(IN1,5001)    ILND,IFORML,JLND
      WRITE (IOT1,6044) ILND,IFORML,JLND
C
C.....READ FORMAT OF FORMATTED DATA
      IF(IFORML.LT.1) READ(IN1,5000)   FMTL
      IF(IFORML.LT.1) WRITE(IOT1,6039) FMTL
      IF(JLND.LT.1) CALL NEWLND(0,NEL,IOT1)
```

```
C
C .....READ SOIL AND PLANT PROPERTIES
C
C .....READ NUMBER OF SOIL TYPES (24 FOR COLUMBIA BASIN)
C
      READ(IN1,5001)    NSOLAS
      WRITE (IOT1,6026) NSOLAS
C
C .....READ SOIL # (1-NSOLAS) FOR EACH BLOCK, FIRST  READ THE
C .....THE LOGICAL  UNIT# (INSOIL) ARE ON,AND WHETHER UNFORMATTED
C .....OR FORMATTED, IF IFORMS>0 THEN UNFORMATTED
C
      READ (IN1,5001)    INSOIL,IFORMS
      WRITE (IOT1,6027)  INSOIL,IFORMS
      IF (IFORMS.LT.1)  GO TO 9
8     READ (INSOIL) NSOIL
                        GO TO 11
C .....READ FORMAT OF FORMATTED DATA
9     READ (IN1,5000)    FMTS
      WRITE (IOT1,6028)  FMTS
10    READ (INSOIL,FMTS) NSOIL
C
C .....READ NUMBER OF SOIL LAYERS FOR EACH SOIL TYPE (LAYER=.5 FT)
C
11    DO 12  I=1,NSOLAS
12    READ (IN1,5001)      NLAYER(I)
      WRITE (IOT1,6029)
      DO 13  I=1,NSOLAS
13    WRITE (IOT1,6030)  I,NLAYER(I)
C
C .....READ AVAILABLE WATER CAPACITY FOR EACH SOIL LAYER(INCHES/6 INCHES)
C
      WRITE (IOT1,6031)
      DO 14  I=1,NSOLAS
      NL=NLAYER(I)
      READ (IN1,5003)      (WATCAP(I,J),J=1,NL)
      DO 14 J=1,NL
14    WRITE (IOT1,6032) I,J,WATCAP(I,J)
C
C .....READ SOIL TYPE (SOLTYP) FOR EACH SOIL: SOLTYP=1.0=SAND
C .....                                              1-2=SAND-LOAM
C .....                                              2.0=LOAM
C .....                                              2-3=LOAM-CLAY
C .....                                              3.0=CLAY
      WRITE (IOT1,6033)
      DO 15  I=1,NSOLAS
      READ (IN1,5005)     SOLTYP(I)
15    WRITE (IOT1,6034) I,SOLTYP(I)
```

```
C
C.....WRITE OUT THE SOIL TYPE NUMBERS USED ALONG WITH THE NUMBER OF
C.....BLOCKS THEY HAVE BEEN ASSIGNED TO.  BE SURE TO CHECK THAT THE
C.....NUMBERS USED ALL HAVE A WATER CAPACITY LISTED WITH EACH LAYER
C.....THIS WILL HAVE BEEN ALREADY PRINTED OUT
C
      DO 45 I=1,NSOLAS
45    NSCNT(I)=0
      DO 46 I=1,NEL
      NS=NSOIL(I)
46    NSCNT(NS)=NSCNT(NS)+1
      WRITE(IOT1,6055)
      NCNT=0
      DO 47 I=1,NSOLAS
      NCNT=NCNT+NSCNT(I)
47    WRITE(IOT1,6056) I,NSCNT(I)
      WRITE(IOT1,6057) NCNT,NEL
C
C.....READ PARAMETER THAT DETERMINES TYPE OF MOISTURE EXTRACTION BY PLANTS
C.....THE EXTRACTION CAN BE EXPONENTIAL, WHERE ROOTS ARE ASSUMED
C.....TO BE EXPONENTIAL IN ROOT-MASS AND THATS HOW WATER IS TRANSPIRED
C.....WITH ONLY SMALLER QUANTITIES FROM BOTTOM OF ROOT ZONE (THIS IS
C.....GOOD APPROX. FOR WATER NON-LIMITING). EXTRACTION CAN ALSO BE MAXIMIZED
C.....WHERE THE POTENTIAL TRANSPIRATION IS APPLIED OVER THE COMPLETE ROOT
C.....DEPTH, STARTING WITH THE TOP LAYER.  THIS ALLOWS FOR MORE WATER
C.....USE BY THE PLANTS AND WILL TEND TO GIVE CONSERVATIVE ESTIMATES OF
C.....RECHARGE
C
      READ(IN1,5001)   IROOT
      WRITE(IOT1,6053) IROOT
C
C .....READ MAX ROOT DEPTH, MAX FOLIAR COVER,  MAX INTERCPTION CAPACITY
C .....FOR THE LAND USE CATEGORIES (15 LAND USES)
C......IF 0 IS READ IN DEFAULT VALUES IN SUBROUTINES ARE USED.
C
      WRITE (IOT1,6035)
      DO 16  I=1,15
      READ (IN1,5005)      RDMAX(I),FCMAX(I),MAXINT(I)
16    WRITE (IOT1,6036)  I,RDMAX(I),FCMAX(I),MAXINT(I)
C
C ..... READ CN2 NUMBERS FOR EACH BLOCK, FIRST READ FORTRAN UNIT NUMBER
C ..... CN2 VALUES ARE ON (ICN2). IF CN2 NUMBERS ARE TO BE AUTOMATICALLY
C...... GENERATED FROM SOIL, SLOPE, AND LANDUSE DATA SET ICN2=0. IF RUNOFF
C...... IS ASSUMED TO ALWAYS =0, SET ICN2= -1.
C
      READ(IN1,5001)   ICN2
      WRITE(IOT1,6037) ICN2
      IF(ICN2.GT.0) READ(ICN2,5007) CN2
```

```
      IF(ICN2.EQ.0) CALL CN2GEN(IFTEMP)
C
C .....READ ASNOW,IRDSNO,IRTSNO. IF IRDSNO > 0 SET INITIAL SNOW (INCHES)
C .....AS VALUES READ OFF DISK FROM PREVIOUS SIMULATION. THE UNIT NUMBER
C .....THIS DATA IS ON IS IRDSNO, IF IRDSNO=0 THEN SET INITIAL SNOW FOR
C .....ALL BLOCKS =ASNOW. IRTSNO IS UNIT NUMBER TO WHICH END OF YEAR
C .....SNOWPACK IS TO BE STORED ON: IF IRTSNO=0 DO NOT STORE SNOW
C .....                             IF IRTSNO>0 STORE SNOW ON UNIT IRTSNO
C
C
      READ(IN1,5008)   ASNOW,IRDSNO,IRTSNO
      WRITE(IOT1,6038) ASNOW,IRDSNO,IRTSNO
      IF(IRDSNO.GT.0)  GO TO 20
      DO 19 I=1,NEL
19    SNOW(I)=ASNOW
C
C .....READ INPUT UNIT IAPUNT,IF IAPUNT>0 THEN READ THE ANNUAL APPLICATION
C .....RATES FOR IAPPLY NUMBER OF BLOCKS THAT ARE IRRIGATED (IN/DAY)
C
20    READ (IN1,5001) IAPUNT
      IF(IAPUNT.GT.0) CALL APPWAT (IAPUNT,IAPPLY)
      WRITE (IOT1,6043) IAPPLY
      IF(IAPUNT.LT.1) GO TO 225
C
C.....READ START AND END OF TWO IRRIGATION PERIODS FOR EACH IRRIGATED
C.....LANDUSE. IF ONLY ONE IRRRIGATION PERIOD USE IRRST1 FOR BEGINNING
C.....BUT USE IRREN2 FOR END AND USE ARBITRARY INTERMEDIATE VALUES FOR
C.....IRREN1+1=IRRST2. ALSO READ IN TYPE OF IRRIGATION SCHEDULING:
C.....   IRRSCD=0 FOR CONSTANT DAILY RATE
C.....   IRRSCD=1 FOR RATE PROPORTIONAL TO GROWTH STAGE.
C.....FIRST READ NUMBER OF IRRIGATED LANDUSES.
      READ(IN1,5001) IRLNDS
      DO 22 I=1,IRLNDS
      READ(IN1,5001) L,IRRSCD(L),IRRST1(L),IRREN1(L),IRRST2(L),IRREN2(L)
22    WRITE(IOT1,6058) L,IRRSCD(L),IRRST1(L),IRREN1(L),IRRST2(L),
     .                 IRREN2(L)
      CALL APPSCD
C
C.....IF STREAMFLOW DATA IS TO BE USED SET RODATA=F-UNIT AND READ IN
C.....BASEFLOW FOR EACH MONTH, BSFLW(CFS); AREA OF DRAINAGE BASIN,
C.....BSNARA(SQ MI); AND TRAVEL TIME BETWEEN PRECIP OR SNOWMELT EVENT
C.....TO STREAM GAGE, LAGDYS(DAYS). IF RUNOFF IS TO BE MODEL-GENERATED
C.....SET RODATA=0. IF RUNOFF IS ASSUMED TO =0 SET RODATA =-1.
C
225   READ(IN1,5001)     RODATA,BSDATA
      WRITE(IOT1,6046)   RODATA,BSDATA
      IF(RODATA.LE.0)      GO TO 25
      READ(RODATA,5010) BSNARA,LAGDYS
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      IF(LAGDYS.LT.1) GO TO 24
      DO 23 I=1,LAGDYS
23    READ(RODATA,5014) DISCH
24    BSNFAC=.037190083/BSNARA
25    CONTINUE
C
C .....FORMATS
C
5000  FORMAT (A)
5001  FORMAT (20I4)
5003  FORMAT (15F4.2)
5004  FORMAT (10I5)
5005  FORMAT (5F15.0)
5007  FORMAT (20F4.0)
5008  FORMAT (F5.0,10I5)
5010  FORMAT (F10.0,I10)
5012  FORMAT (12F6.0)
5014  FORMAT (10F8.0)
6000  FORMAT (20X,A,//)
6001  FORMAT (2X,'OUTPUT UNIT FOR INPUT DATA (IOT1) =',I4,//)
6002  FORMAT (2X,'INPUT UNIT FOR MOST DATA   (IN1)  =',I4,/2X,
     .        'INPUT UNIT FOR GRID DATA   (IN2)  =',I4,//)
6003  FORMAT (2X,'BEGINNING YR OF SIMULATION IS (IYR1) =',I5,/2X,
     .        'ENDING YEAR OF SIMULATION IS (IYR2)  =',I5,/2X,
     .        'NUMBER OF YRS OF SIMULATION (NYRS) =',I4,/2X,'DO FIRST YE
     .AR TWICE?- IWARMP=',I4,' : GT 0, THEN REPEAT',//)
6004  FORMAT (2X, 'THE PARAMETER IGRID  =',I4,'  IF >0 THEN NODE PTS OF
     .BLOCKS INPUT AND NOT CALCULATED',//)
6005  FORMAT (2X,'THE INPUT UNIT FOR X,Y-VALUES OF PRECP STATIONS, AND X,Y,
     .ELEV-VALUES OF TEMP STATIONS (IN3) =',I4,//2X,
     .'ILMBRT=',I3,' IF ILMBRT=0 THEN X,Y ARE DECIMAL LONG-LAT',/12X,
     .' IF ILMBRT=1 THEN X,Y VALUES ARE ALREADY LAMBRT COORDS',//)
6006  FORMAT (2X,'THE NUMBER OF PRECP STATIONS (NWSP) =',I4)
6007  FORMAT (2X,'THE NUMBER OF TEMP STATIONS  (NWST) =',I4,//)
6008  FORMAT (2X,'THE INPUT UNIT FOR DA FILE OF DAILY PRECP VALUES IS (I
     .NP) =',I4,/2X,  'THE INPUT UNIT FOR DA FILE OF MINIM TEMP VALUES I
     .S (INTN) =',I4,/2X,     'THE INPUT UNIT FOR DA FILE OF MAXIM TEMP
     .VALUES IS (INTX) =',I4,/2X,'THE RECORD LENGTH FOR PRECP. DA UNFORM
     .ATTED FILES (IRECP)=',I4,/2X,'THE RECORD LENGTH FOR TEMP.  DA UNFO
     .RMATTED FILES (IRECT)=',I4,//)
6009  FORMAT (2X,  'THE METHOD FOR INTERPOLATION OF DAILY PRECP VALUES
     .(METHDP) =',I4,':WHERE <1=1/DIST*2,>0=1/DIST',/2X,'THE METHOD FOR
     .INTERPOLATION OF DAILY TEMP. VALUES  (METHDT) =',I4, ' *NOTE*  ALS
     .O USED FOR PET VALUES',//)
6010  FORMAT (2X,'THE MAX NUMBER OF WEATHER STATIONS TO INTERPOLATE DAILY P
     .RECP TO BLOCKS (NVALP) =',I4,/2X,'THE MAX NUMBER OF WEATHER STATIONS
     .TO INTERPOLATE DAILY TEMPS TO BLOCKS (NVALT) =',I4,//)
6011  FORMAT (2X,  'THE PARAMETER IFPREC=',I4,' IF >0 THEN:  1) READ IN
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     .ANN. AVE PRECP VALUES FOR NWSP NWS-WEATHER STATIONS',/41X,  '2) READ IN # OF
     .BLOCKS THAT WILL HAVE AN ANNUAL VALUES READ IN (NP)',/41X,'3) IF
     .NP<1 (=0) THEN READ IN ANNUAL PRECP VALUES FOR ALL BLOCKS',
     ./48X,          'NP>0 THEN READ IN ONLY A BLOCK # (IBLOCK) AND THE
     .ANNUAL VALUE FOR IBLOCK',/10X,         'THEREFORE IFPREC>0 WEIGHT
     .INTERPOLATION SCHEME BY ANNUAL VALUES BESIDES METHP',//)
6012 FORMAT (2X,  'THE MAXIMUM DISTANCE SURROUNDING A BLOCK (IN MILES)
     .TO LOOK FOR NVALP,NVALT NWS WEATHER STATIONS TO INTERPOLATE TO THAT BLOCK (DM
     .AX) =',I4,//)
6013 FORMAT (2X,   'THE AVERAGE LATITUDE OF THE STUDY AREA (IN DECIMAL
     .DEGREES) USED FOR PET CALCULATIONS (AVELAT) =',F10.4,//)
6014 FORMAT (2X, 'THE PARAMETER IFTEMP=',I4, '  :IF <0 USE LAPSE RATES
     .BESIDES METHDT FOR INTERPOLATION OF TEMPS',/31X,  'ALSO, CAN THEN
     .READ IN LAPSE RATES',/29X,':IF IFTEMP=0  THEN JUST USE METHDT',
     ./2X,'IFTMPN,IFTMPX (COMPUTED VALUES) =',2I4,//)
6015 FORMAT (2X,'THE NT PARAMETER=',I4,' READ IN ONLY IF IFTEMP<0',/2X,
     .        ' NT IS # OF BLOCKS THAT PET WILL BE COMPUTED AT (NOT JUST
     . INTERPOLATED TO), WHEN IFTEMP<0 NT>0 AND LE NEL',//)
6016 FORMAT (2X,'THE ICN PARAMETER =',I4,' : <1 (BLANK CARD) SET INITIA
     .L SOIL MOIS 2 FIELD CAP',/28X,'>0 READ SOIL MOS INITIAL CONDITIONS
     . OFF OF UNIT ICN, WHERE ICN IS NOW >0',//)
6017 FORMAT (2X,'THE PARAMETER THAT DETERMINES IF END OF YEAR SOIL MOIS
     .TR SAVED HAS BEEN READ AND: IF >0 THEN SAVE ON UNIT ISTS=',I4,//)
6018 FORMAT (2X,'THE PRINTING-OUTPUT UNIT FOR MODEL RESULTS (IPRNT)=',
     .I4,//)
6019 FORMAT (2X,'THE PARAMETERS MAPREC AND MAPET ARE =',2I4,' :>0 THEN
     .PRINT AND SAVE IN ARRAYS THE ANNUAL VALUES OF RECHARGE AND AET',//
     .)
6020 FORMAT (2X,'THE PARAMETER IRECH =',I4,/17X,'IFLUX=',I4,/27X,
     .       ' IRECH>0 MEANS STORE RECHARGE ON UNIT IRECH AT END OF RUN
     .IN INCHES/YEAR',/28X,'IFLUX>0 THEN SAVE ON IRECH AS FT*3/SEC',/28X
     .,'MAPREC MUST BE >0 TO STORE RECHARGE',//)
6021 FORMAT (2X,'THE PARAMETER DSUM =',I4,' : >0 MEANS CALCULATE WATER
     .BUDGET FOR MODEL AREA ON DAILY BASIS',//)
6023 FORMAT (2X,'THE PARAMETER NSMBLK =',I4, ' : >0 THEN PRINT ON IPRNT
     .THE WATER BUDGET FOR NSMBLK # OF BLOCKS',//)
6024 FORMAT (2X,'IF NSMBLK >0 THEN THE FOLLOWING ARE THE BLOCK #-S READ
     .IN FOR PRINTING DAILY BUDGET AT',/4X,'NUMBER    BLOCK NUMBER',/)
6025 FORMAT (5X,I4,7X,I6)
6026 FORMAT (2X,'THE NUMBER OF SOIL ASSTNS IS (NSOLAS) =',I4,//)
6027 FORMAT (2X,'THE INPUT UNIT FOR SOIL ASS FOR EACH BLOCK (INSOIL) =
     .',I4,' AND IFORMS =',I4,' :>0 DATA ON INSOIL IS UNFORMATTED',/77X,
     .' <1 DATA ON  INSOIL IS FORMATTED SO MUST READ FORMAT',/)
6028 FORMAT (2X,'IFORMS WAS <1 SO JUST READ FORMAT OF SOIL ASS AND FMT
     .WAS (FMT) =',A,//)
6029 FORMAT (2X,'THE NUMBER OF LAYERS (NLAYER) OF EACH SOIL (NSOLAS)
     .THAT HAVE BEEN READ IN ARE LISTED BELOW',//12X,'NSOLAS=    NUMBER
     .LAYERS = (NLAYER)',/)
```

```
6030  FORMAT (12X,I4,10X,I4)
6031  FORMAT(/2X,'THE WATER CAPACITIES JUST READ IN FOR EACH LAYER FOR
     .EACH SOIL ARE LISTED BELOW',/3X,'NSOLAS    NLAYER    WATCAP(IN)',
     ./)
6032  FORMAT (3X,I4,5X,I4,8X,F6.2)
6033    FORMAT (//2X,    'THE SOIL PARTICLE SIZE TYPE (SOLTYP) FOR EACH
     .NSOLAS ARE LISTED BELOW',/4X,'NSOLAS    SOLTYP',/)
6034  FORMAT (4X,I4,4X,F4.2)
6035  FORMAT (//2X,'THE MAX: ROOT DEPTH, FOLIAR COVER, AND INTERCEPTION
     .FOR THE LAND USE CLASSES ARE LISTED BELOW',/4X,
     .'LANDUSE  RDMAX  FCMAX  MAXINT',/)
6036  FORMAT (5X,I4,2X,3(2X,F5.1))
6037  FORMAT(//2X,'THE INPUT UNIT FOR CN2 NUMBERS(ICN2)=',I4,/,
     .2X,'IF ICN2=0, NO CN# DATA SET IS REQUIRED. CN#S AUTOMATICALLY GEN
     .ERATED FROM SOIL,',/2X,' SLOPE, AND LANDUSE DATA. IF ICN2=-1, RUNOFF
     .=0.',//)
6038  FORMAT(//2X,'THE INITAL SNOW FOR ALL BLCKS IS DETERMINED BY IRDSNO
     . OR ASNOW',
     ./8X,'ASNOW=',F5.2,/12X,  'IF IRDSNO >0 READ INITIAL SNOW OFF UNIT
     .IRDSNO',/12X,'IF IRDSNO=0 SET INITAL SNOW=ASNOW FOR ALL BLOCKS',/2
     .X,'IRDSNO =',I4,' IF=0, ASNOW MUST BE GE 0.0,  IF>0, ASNOW=0.0',/2
     .X,'IRTSNO =',I4,' IF=0 DO NOT SAVE SNOW AT END OF SIMUALTION',/15X
     .,'IF>0 THEN SAVE SNOW PACK AT END OF SIMULATION ON UNIT IRTSNO',//
     .)
6039  FORMAT(2X,'IFORML WAS <1 SO JUST READ FORMAT OF LANDUSE. (FMTL)=',
     .A,//)
6043  FORMAT (//2X, 'THE PARAMETER IAPPLY =',I4,' :>0 THEN CALL APPWAT
     .AND READ IN IRRIGATION APPLICATION RATES (IN/DAY) FOR IAPPLY # OF
     .BLOCKS',//)
6044  FORMAT (/2X,'THE INPUT UNIT FOR LAND USE DATA IS (ILND)=',I4,
     .'AND IFORML=',I4,' :>0 DATA ON ILND IS UNFORMATTED',/77X,
     .'<1 DATA ON ILND IS FORMATTED (FORMAT MUST BE READ IN)',/,
     .2X,'  JLND=',I4,' : < 0,  THEN LANDUS SAME FOR ALL SIMULATION',
     ./13X,'; > 0, CHANGES EACH YEAR, CALL NEWLND FROM MAIN',//)
6045  FORMAT(2X,'IFORML WAS <1,THEREFORE LANDUSE DATA FORMAT WAS READ
     .IN: (FMTL)=',2A8,//)
6046  FORMAT(//2X,'RODATA=',I4,3X,'IF RODATA >0, DAILY STREAM DISCHARGE
     .DATA IS READ FROM FUNIT NO.= RODATA.',/,' IF RODATA=0, MODEL COMPU
     .TES RUNOFF. IF RODATA=-1, RUNOFF IS ALWAYS=0.',/2X,
     .'BASEFLOW DATA UNIT NUMBER=',I4)
6047  FORMAT(2X,'PARAMETER LFEET=',I4,'   IF>0 THEN COORDINATES ARE IN L
     .AMBERT FEET AND SUB. LAMBERT IS BYPASSED.')
6048  FORMAT(/2X,'THE INPUT UNIT FOR LONG TERM AVERAGE JULY MAX AND MIN
     .TEMPERATURES=',I4)
6049  FORMAT(/2X,'THE FOLLOWING ARE JULY LONG TERM AVERAGE MAX AND MIN
     .TEMPS FOR ALL STATIONS')
6050  FORMAT(2X,I5,2F10.1)
6051  FORMAT(/3X,'THE WINTER SEASON SUBLIMATION RATE=',F6.4,' IN/DAY',/2
```

```
     .X,' THE DAILY SNOWMELT COEFF READ IS =',F6.4,' IN/C/DAY',/2X,' THE
     . VALUE USED IN MODEL (KMCOEF) =',F6.4,' IN/C/.25-DAY',//)
6052  FORMAT(/2X,'THE FOLLOWING ARE MINIMUM PET VALUES TO BE APPLIED DUR
     .ING THE WINTER SEASON IF PET WOULD NORMALLY BE SET =0.0',/2X,' OCT
     .   NOV    DEC    JAN    FEB    MAR  ',/2X,6F6.2,/)
6053  FORMAT(/2X,'THE ROOT EXTRACTION FUNCTION IS IROOT AND IS =',I4,/22
     .X,' IROOT=0, MEANS LINEAR',/22X,' IROOT=1, MEANS EXPONENTIAL',/)
6054  FORMAT(/2X,'THE REGRESSION EQUATION PARAMETERS FOR PERCENT POSSIBL
     .E SUNSHINE AND MAX-MIN AIR TEMPERATURE ARE:',/2X,'ASUN (INTERCEPT)
     .=',F6.1,' BSUN (SLOPE)=',F6.4,/)
6055  FORMAT(/20X,'*********NOTE***********',/2X,'THE DATA LISTED BELOW
     .ARE ASSIGNED SOIL ASS. NUMBERS, AND EXCEPT FOR WATER LANDUSE THEY'
     .,/2X,'SHOULD ALL HAVE AN ASSIGNED TOT. AVAIL. WATER CAP, WHICH CAN
     . BE CHECKED BY DATA PRINTED ABOVE',/2X,' SOIL ASS. NUMBER     NUMB
     . BLOCKS ASSIGNED TO THIS CATEOGRY',//)
6056  FORMAT(7X,I4,14X,I5)
6057  FORMAT(/3X,'_____________      _________',/12X,'SUM OF BLOCKS=',I5,
     .'  SHOULD EQUAL NEL=',I4,//)
6058  FORMAT('LANUSE=',I4,'  IRR SCED.=',I4,'  IRR SEASON=',4I4)
      RETURN
      END
```

```
      SUBROUTINE DAYSUM(IPRNT,IDAY)
      COMMON/SUMMRY/ QBALDY(16),QBALMO(16,12),QBALYR(16),
     .               QBLAVY(16),QBLAVM(16,12),DSUM
      COMMON /TIME/ NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      INTEGER DSUM
      DOUBLE PRECISION QBALDY,QBALMO,QBALYR
      DOUBLE PRECISION ERROR
C .....ERROR IS HERE IN CASE USER WANTS TO
C .....WRITE OUT ERROR LIKE IN SUB.AMSUM
      IF(IDAY.LT.2) WRITE(IPRNT,6000) NYR
      WRITE(IPRNT,6001)  IDAY,(QBALDY(J),J=1,16)
      DO 10 I=1,16
10    QBALDY(I)=0.0
      RETURN
C
C .....FORMATS
C
6000  FORMAT(//11X,'FOLLOWING ARE DAILY SUMMARIES FOR COMPLETE MODELED
     .REGION FOR CALENDAR YEAR',I5,//5X,     ' DAY  PRECP  POTET  CHGINT
     .RUNOFF RECHRG SOLPEV ACTSEV EVPSNW  PPLTR  APLTR  CHGSM EVINT  CHG
     .SNW AVTMP  EHRM-RO DEFCIT',/)
6001  FORMAT(5X,I4,13(2X,F5.2),2X,F5.1,2(2X,F5.2),F8.4)
      END
```

```
      SUBROUTINE DOGRID (IGRID,LFEET,IN2,IOT1)
      COMMON/GRID/ AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      COMMON/SIZE/ NEL,NIJ,ICOL,IROW
      DIMENSION AX(2),AY(2)
      DOUBLE PRECISION GX,GY,X,Y,X1,Y1
C
C
      IF (IGRID.GT.0)  GO TO 50
C
C .....GENERATE GRID THAT WILL BE EQUAL SIZE BASED ON MAX-MIN LONG AND
C .....LAT OF STUDY AREA. FIRST READ MAX LONG, MIN LONG, MAX LAT, MIN
C......LAT (DECIMAL DEGREES) AND SIZE OF BLOCKS (IN MINUTES)
C
      WRITE (IOT1,6003)
      READ (IN2,5000) AX,AY,GRDSZE
      FAC=60./GRDSZE
      XA=AX(1)-AX(2)
      ICOL=IFIX(XA*FAC+1.01)
      YA=AY(1)-AY(2)
      IROW=IFIX(YA*FAC+1.01)
      NIJ=ICOL*IROW
      IX=ICOL-1
      JY=IROW-1
      NEL=IX*JY
      WRITE (IOT1,6000) AX(1),AX(2),AY(1),AY(2),GRDSZE,ICOL,IROW,NIJ,NEL
C
C .....GENERATE NODE NUMBERS FOR EACH BLOCK
C

      DO 1  M=1,IX
      IJ =(M-1)*IROW
      KEL=(M-1)*JY
      DO 1 N=1,JY
      NO=IJ+N
      NE=KEL+N
      NGB(1,NE)=NO
      NGB(2,NE)=NO+IROW
      NGB(3,NE)=NO+IROW+1
1     NGB(4,NE)=NO+1
C
C .....GENERATE GRID
C
      GSX=-GRDSZE/60.
      GSY=-GSX
      XS=AX(1)
      YS=AY(2)
      I=0
      DO 2  J=1,ICOL
```

```
      DO 2  K=1,IROW
      I=I+1
      X=XS+GSX*(J-1)
      Y=YS+GSY*(K-1)
      CALL LAMBRT(X,Y)
      GX(I)=X
2     GY(I)=Y
      GO TO 200
C
C .....GRID IS IRREGULAR RECTANGULAR, SO NEED TO READ IN TOTAL NUMBER
C .....OF NODES (NIJ) AND TOTAL # OF BLOCKS (NEL). THEN FOR EACH BLOCK
C .....READ IN A NODE NUMBER  FOR EACH OF THE FOUR CORNERS, NGB(4,NEL),
C .....NODE NUMBERS MUST BE NUMBERED IN COUNTER CLOCKWISE DIRECTION
C
50    READ (IN2,5001) NIJ,NEL
      WRITE (IOT1,6002) NIJ,NEL
      DO 100  N=1,NEL
100   READ (IN2,5001) (NGB(I,N),I=1,4)
C
C .....HAVE READ IN NODE #'S FOR EACH BLOCK, NOW READ IN X-Y VALUES
C ....(LONGITUDE,LATITUDE IN DECIMAL DEGREES) FOR EACH NODE (NIJ
C .....NUMBER OF VALUES)
C
      DO 110  N=1,NIJ
      READ(IN2,5002) X1,Y1
      IF(LFEET.GT.0) GO TO 105
      CALL LAMBRT(X1,Y1)
105   CONTINUE
      GX(N)=X1
110   GY(N)=Y1
C
C .....GENERATE AREA OF EACH BLOCK
C
200   TOTARA=0.0
      DO 250  NE=1,NEL
      N1=NGB(1,NE)
      N2=NGB(2,NE)
      N3=NGB(3,NE)
      N4=NGB(4,NE)
      AREA(NE)=.5*((GX(N1)-GX(N3))*(GY(N2)-GY(N4))
     .            -(GX(N2)-GX(N4))*(GY(N1)-GY(N3)))
250   TOTARA=TOTARA+AREA(NE)
      TOTARA=TOTARA/(5280.*5280)
      WRITE (IOT1,6001) TOTARA
      TOTARA=TOTARA*5280.*5280.
      RETURN
C
C .....FORMATS
```

```
C
5000  FORMAT (8F10.0)
5001  FORMAT (20I4)
5002  FORMAT(6X,2F20.0)
6000  FORMAT (/2X,    ' PARAMETER IGRID <1 SO THAT MAX-MIN LONG AND LAT
     .HAVE BEEN READ IN (DECIMAL DEGREES)',/2X,'THE SIZE OF THE BLOCKS
     .(GRDSZE) HAS BEEN READ IN (MINUTES)',/2X,'THE MAX LONG IS',
     .   F10.4,' THE MIN LONG IS',F10.4,/2X,'THE MAX LAT IS',F10.4,'
     .THE MIN LAT IS',F10.4,/2X,'THE GRDSZE(MINUTES)=',F8.4,/2X,'  **
     .THE FOLLOWING PARAMETERS HAVE BEEN CALCULATED',/3X,'NUMB COLMNS='
     .,I4,' NUMB ROWS=',I4,' NUMB GRIDPTS=',I6,' NUMB BLOCKS=',I6,//)
6001  FORMAT (3X,'THE TOTAL MODELED AREA IS',F15.2,' SQ MI',//)
6002  FORMAT (//3X,       'PARAMETER IGRID>0 SO HAVE READ IN THE NUMBER
     .OF NODE-GRID POINTS AND THE NUMBER OF BLOCKS',/3X,'THE NUMB OF GRI
     .D POINTS HAS BEEN READ AND  (NIJ)=',I6,/3X,
     .'THE NUMB OF BLOCKS READ IN FOR THIS RUN IS (NEL)=',I6,/)
6003  FORMAT (25X,'*** GRID DATA ***')
      END
```

```
      SUBROUTINE FOREST(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP)
C
C.....LANDUSE # 1-CONIFER FOREST
C
      REAL MXI,MXNT
      DIMENSION CRP(16),JDATE(16)
      DATA CRP/.314,.304,.304,.378,.429,.467,.522,.560,.586,.592,
     .          .592,.576,.560,.531,.400,.314/
      DATA JDATE/1,5,10,51,64,74,90,115,151,176,201,237,258,
     .        278,329,366/
C
C.....THIS SUBROUTINE USES BLANEY-CRIDDLE PASTURE CROP CURVE
C.....MULTIPLIED BY 0.64 TO REPRESENT MIXED CONIFER AND SHRUB.
C.....(FROM COLE, ET. AL., 1980, P. 4.12)
C
      CRPMX=.592
      IF(RDMX.LT.0.00001)RDMX=36.0
      IF(FCMX.LT.0.00001)FCMX=0.8
C.....PONDEROSA INTERCEPTION=0.10 (+.30 FOR PONDEROSA FLOOR COVER),
C.....AFTER ZINKE.
      IF(MXI.LT.0.00001)MXI=0.40
      DO 100 JJ=2,16
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
        J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      FACT=CP/CRPMX
      RD=RDMX
      FC=FCMX*FACT
      MXNT=MXI*FACT
      RETURN
      END
```

```
      SUBROUTINE GRASS (IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE # 2-GRASS
C
      REAL MXI,MXNT
      DIMENSION CRP(16),JDATE(16)
      DATA CRP/.49,.475,.475,.59,.67,.73,.815,.875,.915,.925,.925,
     .         .90,.875,.83,.625,.49/
      DATA JDATE/1,5,10,51,64,74,90,115,151,176,201,237,258,278,329,
     .           366/
C
      CRPMX=.925
      IF(RDMX.LT.0.00001)RDMX=24.0
      IF(FCMX.LT.0.00001)FCMX=1.0
C.....MXI=.06 AFTER ZINKE
      IF(MXI.LT.0.00001)MXI=0.06
      DO 100 JJ=2,16
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
         J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=RDMX
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE ICONDS
      COMMON/INOUT/  NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .       IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .       MAPEL,ARRRY(MAPIJ)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/FLOWS/  SNOW(BLKS),SMS(BLKS,10),REMAIN(BLKS)
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/SIZE/  NEL,NIJ,ICOL,IROW
      COMMON/SOIL1/ WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
      INTEGER   RODATA,BSDATA
C
C .....PURPOSE OF SUBROUTINE IS TO SET INITIAL SOIL MOISTURE CONDITIONS
C ..... AND TO SET INITAL SNOW CONDITIONS IF THEY ARE TO BE READ OFF A
C ..... DISK FILE (ONLY IF ASNOW WAS=0.0 IN DATAIN AND IRDSNO>0)
C
C.....WHEN STREAMFLOW DATA IS USED SET FIRST DAY'S APPORTIONING FACTOR
C     ,CNFAC, TO 1.0 FOR ALL ELEMENTS.
C
      IF(RODATA.LT.1) GO TO 5
      DO 4 I=1,NEL
4     CNFAC(I)=1.0
5     CONTINUE
C
C.....SET REMAINING INTERCEPTED MOISTURE TO 0 AND YESTERDAY'S MAX
C.....TEMP TO 32
      DO 6 I=1,NEL
      TMXYST(I)=32
 6    REMAIN(I)=0.0
C
C  ....        THIS PORTION SETS INITAL SOIL MOISTURE CONDS.
C .....        IF ICN=0 SET INITIAL = WAT.CAP.
C .....        IF ICN>0 READ INITIAL SOIL MOIST (SMS) OFF DISK FROM A
C .....           PREVIOUS SIMULATION (ON UNIT NUMBER=ICN)
C
      IF (ICN.GT.0)  GO TO 50
      DO 10  I=1,NEL
      NS=NSOIL(I)
      NL=NLAYER(NS)
      DO 10 N=1,NL
   10 SMS(I,N)=WATCAP(NS,N)
      GO TO 200
50    READ(ICN) SMS
200   IF(IRDSNO.EQ.0) RETURN
      READ(IRDSNO) SNOW
      RETURN
      END
```

```
      SUBROUTINE INTRCP (IBLK,NMO,IDAY)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .  RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT,MXNTR
C
C......COMPUTE INTERCEPTED PART OF PRECIPITATION(RED)
C .....AT GRIDS AND REDUCE POT ET (ETP) BY AMOUNT OF INTERCEPTED
C .....MOISTURE ON FOLIAGE (RED+ REMINT-YESTERDAYS AMNT NOT ET'D)
C .....AMOUNT REDUCED BY WILL DEPEND ON VALUES OF ETP AND RED+REMINT
C
      IPOS=2
      CALL MASBAL (IBLK,ETP,IPOS,NMO,IDAY)
      IF(TAV.LE.32.0) RETURN
      IF(LNDUS.EQ.13) RETURN
      MXNTR=MXNT-REMINT
      IF(MXNTR.LT.0.0) MXNTR=0.0
C
C .....REMINT IS ANY INTERCEPTED MOISTURE THAT HAS NOT YET BEEN
C .....EVAPORATED AS OF YESTERDAY, MXNTR IS MAX REMAINING INTERCEPTION
C .....POSSIBLE.  RED=REDUCED BY INTERCEPTION
C
      IF (PPT.GT.MXNTR)  GO TO 1
      RED=PPT
      PTN=PPT + REMINT
      IF (PTN.LT.0.00000001)  RETURN
C
C .....PTN IS THE AMOUNT OF PET REQUIRED TO EVAPORATE THE
C .....INTERCEPTED MOISTURE. IT IS ALWAYS GE 0.0 AND IS ALGEBRAICALLY
C......SUBTRACTED FROM PET AT EACH BLOCK.
C .....ALSO, PPT IS NOT YET REDUCED BY INTERCEPTION(ACCOUNTED FOR
C .....IN THE LATER SUBROUTINES
C
      GO TO 2
1     RED=MXNTR
      PTN=RED+REMINT
2     IF (ETP.LT.PTN)  GO TO 3
C .....ALL ON FOLIAGE CAN BE EVAPORATED
      REMNEW=0.0
C .....REDUCE ETP BY AMOUNT EVAPORATED
      ETP=ETP-PTN
      AETFC=PTN
      GO TO 5
C .....ALL ON FOLIAGE CANN'T BE ET'D,AET=ETP,ETP=0,FIND REMINT
3     AETFC=ETP
      ETP=0.0
      REMNEW=PTN-AETFC
5     CONTINUE
```

```
C.....CHANGE OF INTERCPTED MOISTURE STORAGE
      CHGINT=REMNEW-REMINT
      REMINT=REMNEW
C....PUT CHANGE OF INTERCEPTED MOISTURE AND EVAPORATION OF
C.....INTERCEPTED MOISTURE INTO MASS BALANCE FOR IDAY.
      IPOS = 3
      CALL MASBAL(IBLK,CHGINT,IPOS,NMO,IDAY)
      IPOS=12
      CALL MASBAL(IBLK,AETFC,IPOS,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE INTRPO (X,Y,DIST,NEAR,DMAX,NWSTAT,NVAL,MTH)
      COMMON/GRID/ AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      COMMON/SIZE/ NEL,NIJ,ICOL,IROW
      DIMENSION DIST(NODES,*),X(*),Y(*),NEAR(NODES,*)
      DOUBLE PRECISION GX,GY,X,Y
C
C .....MAX RADIUS FOR SEARCHING FOR STATIONS (IN FEET)
C
      DM=DMAX*5280.
C
C .....FIND NVAL NEAREST STATIONS FOR EACH NODE FOR INTERPOLATION OF
C .....CLIMATE DATA TO BLOCKS
C
C .....FIRST ZERO ALL ARRAYS
C
      DO 5  I=1,NIJ
      DO 5  J=1,NVAL
      NEAR(I,J)=0.0
5     DIST(I,J)=0.0
C
C ....NOW DO ALL BLOCKS
C
      DO 20  NE=1,NEL
C
C .....DO THE 4 NODES FOR EACH BLOCK
C
      DO 20  IN=1,4
      NG=NGB(IN,NE)
C
C .....FIND NVAL NEAREST STATIONS
C
      DO 20 L=1,NVAL
      SMIN=1.E16
      LM1=L-1
C
C .....LOOP THROUGH WEATHER STATIONS FOR EACH NODE (NG)
C
      DO 20 M=1,NWSTAT
      IF(L.LT.2)  GO TO 15
C .......MAKE SURE DO NOT USE SAME STATION TWICE
      DO 10 I=1,LM1
10    IF (M.EQ.NEAR(NG,I))  GO TO 20
15     CONTINUE
       DIS=DSQRT((GX(NG)-X(M))**2+(GY(NG)-Y(M))**2)
       IF (DIS.GT.DM)  GO TO 20
       IF (DIS.GE.SMIN)  GO TO 20
       SMIN=DIS
       NEAR(NG,L)=M
```

```
      IF (MTH.LT.1)  DIS=DIS*DIS
      DIST(NG,L)=DIS
 20   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE JHCOEF(TNAVG,TXAVG,ALT,TX,CT)
C
C .....CALCULATE COEFFICIENTS, TXX AND CH FOR JENSEN-HAISE EQUATION FOR
C .....WEATHER STATION OR BLOCK. COEFFICIENTS ARE A FUNCTION OF LONG TERM
C .....AVERAGE JULY TEMPERATURES(WARMEST MONTH OF THE YEAR) AND ALTITUDE
C
C .....CONVERT TO CELCIUS
      TNAV=0.5555556*(TNAVG-32.)
      TXAV=0.5555556*(TXAVG-32.)
C .....CALCULATE VAPOR PRESSURES
C
      E1=23.38*EXP(18.1-5303.3/(TNAV+273.0))
      E2=23.38*EXP(18.1-5303.3/(TXAV+273.0))
C
C .....EVALUATE COEFFICIENTS
      TX=27.5-.25*(E2-E1)-ALT/1000.0
      CH=50.0/(E2-E1)
      C1=68.0-3.6*ALT/1000.
      CT=1.0/(C1+13.0*CH)
      RETURN
      END
```

```
      SUBROUTINE LAMBRT (LON,LAT)
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 LON,LAT,LA,LAO
      DIMENSION A(10,2)
      DATA A/2.0D6,4.35D5,18798081.67D0,19205863.43D0,.9999422551D0,
     . .7445203390D0,2878.0D0,22.15711D0,3.80336D0,5.06556D0,
     .2.0D6,4.338D5,19832653.52D0,20289119.60D0,.9999145875D0,
     . .7263957947D0,2786.0D0,21.72121D0,3.80474D0,4.80336D0/
      DATA ARCONE/4.848136811D-6/,E2/6.768657997291D-3/
      DATA LA/20925832.1619D0/,C1/101.2794065D0/,C2/1052.893882D0/
      DATA C3/4.483344D0/,C4/2.352D-2/
C......XO=122.0 DEGREES, X-ORGIN
C......YO =44.3 DEGREES, Y-ORGIN
      XO=1607018.186122
      YO=-373155.852444
      PHO=LAT*3600.D0
      LAO=LON*3600.D0
      IZONE=1
C     IF(LAT.LT.47.25) IZONE=2
      I=IZONE
      PHINOT=((60.0D0*A(7,I))+A(8,I))
      OME2=+1.0D0-(E2*DSIN(PHINOT*ARCONE)**2)
      X=LA*(1.0D0-E2)/OME2**1.5D0
      Y=LA/DSQRT(OME2)
      K=(5.0D0+(3.0D0*DTAN(PHINOT*ARCONE)**2))/(120.0D0*X*Y**3)
      COSPHI=DCOS(PHO*ARCONE)
      S=C1*(PHINOT-PHO+DSIN(PHO*ARCONE)*COSPHI*(C2-COSPHI**2*(C3-(C4*COS
     .PHI**2))))
      V1=A(9,I)*1.0D-16
      V2=A(10,I)*1.0D-24
      R=A(3,I)+S*A(5,I)*(1.0D0+S**2*(V1-S*V2))
      IF (LAO.LT.0.0D0)  LAO=LAO+1.296D6
      PHA=(A(6,I)*(A(2,I)-LAO))
      LON=R*DSIN(PHA*ARCONE)+A(1,I)-XO
      PHA2=(PHA/2.0D0)*ARCONE
      LAT=A(4,I)+R*(2.0D0*DSIN(PHA2)**2-1.0D0)+YO
      RETURN
      END
```

```
      SUBROUTINE LAPSE(NWS,TMPDIF,IFCHK,NMO,ALBLOK)
      COMMON /LRATES/ RATEMN(12),RATEMX(12),ILAPSE
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
C
C .....THIS SUBROUTINE ADJUSTS THE WEATHER STATION TEMPERATURES TO THE
C .....BLOCK ACCORDING TO A REGIONAL MONTHLY LAPSE RATE AND DIFFERENCE
C .....IN ALTITUDE BETWEEN BLOCK AND WEATHER STATION
C
      ALTDIF=(ALTWS(NWS)-ALBLOK)*0.001
      IF(IFCHK.LT.-1)  TMPDIF=ALTDIF*RATEMN(NMO)
      IF(IFCHK.GT.-2)  TMPDIF=ALTDIF*RATEMX(NMO)
      RETURN
      END
```

```
      SUBROUTINE LOOKUP (I,NMO,IDAY,IIN)
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/FLOWS/  SNOW(BLKS),SMS(BLKS,10),REMAIN(BLKS)
      COMMON/CLASLD/ LANDUS(BLKS),ILND,JLND,FMTL,IFORML
      COMMON/SOIL1/  WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
      COMMON/PLANT/  MAXINT(15),RDMAX(15),FCMAX(15),COEFS(15,8),IROOT
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     . RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     . TMXPRE,CHGSNO,LNDUS,SUB
      COMMON/TIME/NDAY(12),IYR1,IYR2,IDYS,IWARMP,NYR
      REAL MAXINT,MXNT
      CHARACTER*8 FMTL
C
C .....THIS SUBROUTINE "LOOKS UP" (EXTRACTS) VALUES NEEDED IN SUBSEQUENT
C .....SUBROUTINES AND PUTS THEM INTO NON-DIMENSIONED VARIABLES
C
C .....FIRST INITIALIZE ALL VALUES TO BE CALCULATED TODAY
C
      ACTEV=0.0
      ACTPLT=0.0
      AETFC=0.0
      CHGSNO=0.0
      ETP=0.0
      PLNTPT=0.0
      RED=0.0
      RO=0.0
      RECR=0.0
      REMINT=0.0
      SUB=0.0
      SNM=0.0
      SOLPEV=0.0
      SNK=0.0
C ...    DAILY PRECIP + APPLIED WATER
      PPT= PRECP(I)
C ....   MINIMUM DAILY TEMP
      TMN=TMIN(I)
C ....   MAXIMUM DAILY TEMP
      TMX=TMAX(I)
C ....   AVERAGE DAILY TEMP
      TAV=0.5*(TMN+TMX)
C.....YESTERDAY'S MAXIMUM TEMPERATURE
      TMXPRE=TMXYST(I)
C ...    CURRENT SNOW ACCUMULATION (INCHES OF WATER)
      SNO=SNOW(I)
C ...    CURRENT AMOUNT OF INTERCEPTED MOISTURE REMAINING ON FOLIAGE
      REMINT=REMAIN(I)
```

```
C ...     LANDUSE (TYPE OF VEGATION) IDENTIFICATION NUMBER
      LNDUS=LANDUS(I)
C ...     SOIL IDENTIFICATION NUMBER FOR THIS BLOCK
      IF(LNDUS.EQ.10) NSOIL(I)=1
      NS=NSOIL(I)
C ...     NUMBER OF 6 IN LAYERS OF SOIL
      NL=NLAYER(NS)
C ...     CN NUMBER OF USDA RUNOFF METHOD
      CN=CN2(I)
C
      DO 100 N=1,NL
C ...     CURRENT SOIL MOISTURE CONTENT (INCHES) IN EACH SOIL LAYER
      SM(N)=SMS(I,N)
C ...     FIELD CAPACITY (INCHES) FOR EACH SOIL LAYER
100   WC(N)=WATCAP(NS,N)
C
C ...     SOIL TYPE (PARTICLE SIZE DISTRIBUTION) IDENTIFICATION NUMBER
      ST=SOLTYP(NS)
C ...     GET BL-CR CROP GROWTH PARAM (CP) ROOT DEPTH (RD),FOLIAR
C ...     COVER (FC), AND INTERCEPTION CAPACITY (MXNT)
C
      IF(LNDUS.EQ.10) THEN
        CALL SRFWTR(I,NMO,IDAY,PPT,TMX,TMN,TAV,ETP,IIN)
        RETURN
      END IF
C ...     SET VARIABLES DETERMINED IN CRPCOF
      RD=  COEFS(LNDUS,1)
      FC=  COEFS(LNDUS,2)
      MXNT=COEFS(LNDUS,3)
      CP=  COEFS(LNDUS,4)
      RDMX=COEFS(LNDUS,6)
      FCMX=COEFS(LNDUS,7)
      MAXINT(LNDUS)=COEFS(LNDUS,8)
C
C......WANT MAX ROOT DEPTH NOT TO EXCEED NUMBER OF LAYERS (NL)
C......WANT NL NOT TO EXCEED MAX ROOT DEPTH
C
C......ALWAYS MAKE SURE THAT NL AND RDMX ARE AT LEAST 6 INCHES (1 LAYER)
C
      IF(NL.LT.1)    NL=1
      IF(RDMX.LT.6.) RDMX=6.
C
      FULLRD=NL*6.0
      IF(RDMX.GT.FULLRD) RDMX=FULLRD
      IF(RD.GT.RDMX)     RD=RDMX
C......NOW CONSTRAIN NL NOT TO EXCEED MAX ROOT DEPTH
      IF(FULLRD.GT.RDMX) NL=RDMX/6.+0.5
C
```

```
C......ALL SUBROUTINES WILL USE NL AS COUNTER (MAX LAYERS IN THE MAX ROOT DEPTH)
C......EXCEPT PLNTET WILL USE THE NUMBER OF LAYERS IN THE CURRENT ROOT DEPTH
C
      RETURN
      END
```

```
      SUBROUTINE MASBAL(IBLK,DUMY,IP,NMO,IDAY)
      COMMON /GRID/ AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      COMMON/SUMMRY/ QBALDY(16),QBALMO(16,12),QBALYR(16),
     .               QBLAVY(16),QBLAVM(16,12),DSUM
      DOUBLE PRECISION QBALDY,QBALMO,QBALYR,GX,GY
      INTEGER DSUM
C
C .....STORE IDAY VALUES FOR COMPLETE REGION,WHERE ITEMS 1-11 ARE:
C .....      1=PRECP
C .....      2=PET
C......      3=CHANGE IN INTERCEPTED STORAGE
C .....      4=RUNOFF
C .....      5=RECHARGE
C .....      6=POTENTIAL SOIL EVAP
C .....      7=ACT SOIL EVAP
C .....      8=SNOW SUBLIMATION-EVAPORATION
C .....      9=POTENTIAL PLANT TRANSPIRATION
C .....      10=ACTUAL PLANT TRANS.
C .....      11=CHANGE IN SOIL MOISTURE
C .....      12=EVAPORATED PORTION OF INTERCEPTION (AETFC)
C .....      13=CHANGE IN SNOWPACK
C......      14=AVERAGE TEMPERATURE
C......      15=EHRHYM MODEL COMPUTED RUNOFF
C......      16=DEFICIT SOIL MOISTURE FROM RUNOFF
C
C ...   STORE DAILY VALUES FOR WHOLE REGION
C
      IF(DSUM.LT.1)  GO TO 10
      QBALDY(IP)    =QBALDY(IP)    +DUMY*AREA(IBLK)/TOTARA
C
C ...   STORE MONTHLY VALUES FOR COMPLETE REGION
C
10    QBALMO(IP,NMO)=QBALMO(IP,NMO)+DUMY*AREA(IBLK)/TOTARA
      QBALYR(IP)    =QBALYR(IP)    +DUMY*AREA(IBLK)/TOTARA
C
      RETURN
      END
```

```
      SUBROUTINE MINPET(ETP,PETMIN,NMO)
      DIMENSION PETMIN(6)
C
C.....MINIMUM PET IF USER DEFINED AS A DAILY RATE FOR THE MONTHS
C.....OCT-MARCH, THE DAILY COMPUTED PET VALUE IS COMPARED TO THIS
C.....VALUE FOR THE APPROPRAITE MONTH AND THE MAXIMUM IS USED
C
      NM=NMO-9
      IF(NM.LT.0) NM=NM+12
      IF(ETP.GT.PETMIN(NM)) RETURN
      ETP=PETMIN(NM)
      RETURN
      END
```

```
      SUBROUTINE NEWLND(INCMNT,NEL,IOT1)
      COMMON/CLASLD/ LANDUS(BLKS),ILND,JLND,FMTL,IFORML
      CHARACTER*8 FMTL
C
C.....READ EITHER FORMATTED OR UNFORMATTED LANDUSE #S FOR EACH BLOCK
C.....FROM INPUT FILE ILND.
C
      ILND=ILND+INCMNT
      IF(IFORML.LT.1) GO TO 40
      READ(ILND) LANDUS
      GO TO 45
 40   READ(ILND,FMTL)LANDUS
 45   CONTINUE
      IALF=0
      IDRY=0
      IRR=0
      IFOR=0
      IWAT=0
      IRAW=0
      IPEALN=0
      ISPWHT=0
      ISAND=0
      IPOTA=0
      IGRAS=0
      ICORN=0
      ISAGE=0
      IWHEAT=0
      IORCHD=0
      IOTHER=0
      DO 50 INEL=1,NEL
          LND =LANDUS(INEL)
      IF(LND.EQ.1) IFOR=IFOR+1
      IF(LND.EQ.2) IGRAS=IGRAS+1
      IF(LND.EQ.3) ISAGE=ISAGE+1
      IF(LND.EQ.4) IWHEAT=IWHEAT+1
      IF(LND.EQ.5.OR.LND.EQ.6) IDRY=IDRY+1
      IF(LND.EQ.7) IORCHD=IORCHD+1
      IF(LND.EQ.8) IALF=IALF+1
      IF(LND.EQ.9) IRAW=IRAW+1
      IF(LND.EQ.10) IWAT=IWAT+1
      IF(LND.EQ.11) ICORN=ICORN+1
      IF(LND.EQ.12) IPOTA=IPOTA+1
      IF(LND.EQ.13) ISAND=ISAND+1
      IF(LND.EQ.14) IPEALN=IPEALN+1
      IF(LND.EQ.15) ISPWHT=ISPWHT+1
      IF(LND.LT.1.OR.LND.GT.15) IOTHER=IOTHER+1
50    CONTINUE
C
```

```
      NTOT=IRAW+IDRY+IPOTA+IGRAS+ISAGE+IWAT+IFOR+ISAND+ICORN+IPEALN+
     .     ISPWHT+IALF+IORCHD+IWHEAT
           WRITE(IOT1,10) IFOR,IGRAS,ISAGE,IWHEAT,IDRY,IORCHD,IALF,IRAW,
     .                    IWAT,ICORN,IPOTA,ISAND,IPEALN,ISPWHT
           WRITE(IOT1,11) IOTHER,NEL
C
10       FORMAT(' NUMBER OF FOREST      = ',I4,/
     .          ' NUMBER OF GRASSLAND   = ',I4,/
     .          ' NUMBER OF SAGEBRUSH   = ',I4,/
     .          ' NUMBER OF IRR-WHEAT   = ',I4,/
     .          ' NUMBER OF WN-WHEAT    = ',I4,/
     .          ' NUMBER OF ORCHARDS    = ',I4,/
     .          ' NUMBER OF ALFALFA     = ',I4,/
     .          ' NUMBER OF ROW CROPS   = ',I4,/
     .          ' NUMBER OF WATERS      = ',I4,/
     .          ' NUMBER OF CORN        = ',I4,/
     .          ' NUMBER OF POTATO      = ',I4,/
     .          ' NUMBER SAND-BARREN    = ',I4,/
     .          ' NUMBER OF PEA-LEN     = ',I4,/
     .          ' NUMBER OF SP-WHEAT    = ',I4,/
     .          '                         -------',/
     .          '      TOTAL               ',I4)
11      FORMAT(//,'NUMBER OF OTHERS=',I5,' NEL= ',I4,//)
C
      RETURN
      END
```

```
      SUBROUTINE ORCHRD (IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C....LANDUSE # 7 ORCHARD-DECIDUOUS TREES
C
      REAL  MXI,MXNT
      DIMENSION CRP(11),JDATE(11)
      DATA CRP/.61,.66,.98,1.10,1.13,1.12,1.09,1.00,.90,.65,.60/
      DATA JDATE/1,25,105,140,161,186,212,253,288,344,366/
      CRPMX=1.13
      IF(RDMX.LT.0.00001)RDMX=60.0
      IF(FCMX.LT.0.00001)FCMX=0.65
C.....ASSUME SAME AS DECIDUOUS FOREST =.05 (+.05 FOR GRASS GROUND COVER)
C.....AFTER ZINKE.
      IF(MXI.LT.0.00001)MXI=0.1
      DO 100 JJ=2,11
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
         J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=RDMX
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE PEALEN(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE # 14-PEAS AND/OR LENTILS
C
      DIMENSION CRP(10),JDATE(10)
      REAL MXI,MXNT
      DATA CRP/0.0,0.0,0.50,0.81,1.11,1.12,1.11,0.96,0.0,0.0/
      DATA JDATE/1,121,125,152,176,186,191,225,228,366/
      CRPMX=1.12
      IF(RDMX.LT.0.0001)RDMX=42.0
      IF(FCMX.LT.0.0001)FCMX=1.0
C.....MXI=0.16 FROM LINSLEY, ETC.
      IF(MXI.LT.0.0001)MXI=0.16
C
C .....INTERPOLATE BLANNEY-CRIDDLE CROP COEFFICIENTS TO IDAY
C
C.....AS MODIFIED BY WELUM ON 1-30-86 TO SIMULATE
C.....PEAS AND LENTILS EVERY YEAR
C
 80   DO 100 JJ=2,10
      IF(IDAY.GT.JDATE(JJ))  GO TO 100
        J=JJ
      GO TO 110
100   CONTINUE
  110 CRPT=CRP(J)
      CRPY=CRP(J-1)
      CP=CRPY+(IDAY-JDATE(J-1))*(CRPT-CRPY)/(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=RDMX*FACT
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IDAY.LT.186.OR.IDAY.GT.225) GO TO 120
      RD=RDMX
      FC=FCMX
      MXNT=MXI
120   IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
C
```

```
      SUBROUTINE PETBLK(INEL,NMO,IDAY,TXNE,TNNE,TAV,ETP)
      COMMON/GRID/   AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      COMMON/BLKPET/ ALTBLK(BLKS),SLPBLK(BLKS),ASPECT(BLKS),CTBLK(BLKS),
     .    TXBLK(BLKS),TXJAVB(BLKS),TNJAVB(BLKS),IBLOCK(BLKS)
      COMMON/POLATT/ DISTT(NODES,NVLT),NEART(NODES,NVLT),NVALT
      COMMON/SIZE/ NEL,NIJ,ICOL,IROW
      COMMON/NWSTEM/ TN(NWST),TX(NWST),XT(NWST),YT(NWST),NWST
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
      COMMON/WINTER/ SBLMTE,PETMIN(6),KMCOEF
      REAL KMCOEF
      DOUBLE PRECISION GX,GY,XT,YT
C
C .....SUBROUTINE COMPUTES THE PET FOR CURRENT BLOCK FOR CURRENT DAY AND
C .....IS CALLED FROM MAIN. THE PET MIGHT BE INTERPOLATED OR ELSE
C .....COMPUTED, DEPENDING ON THE VALUE OF: IFTEMP(<0 MEANS COMPUTE
C .....FOR NT NUMBER OF BLOCKS)
C
      IF(NT.EQ.0)   GO TO 200
      IF(NT.EQ.NEL) GO TO 100
      DO 50  J=1,NT
      K=IBLOCK(J)
      IF(K.NE.INEL) GO TO 50
C
C .....THIS IS A BLOCK WHERE PET WILL BE CALCULATED AT
C
      IF(IDAY.LT.2) CALL JHCOEF(TNJAVB(J),TXJAVB(J),ALTBLK(J),TXBLK(J),
     .                          CTBLK(J))
      IF(TAV.LE.32.0) GO TO 45
      CALL POTET(IDAY,AVELAT,TXNE,TNNE,ASUN,BSUN,TXBLK(J),CTBLK(J),
     .           SLPBLK(J),ASPECT(J),ETP)
      IF(ETP.LT.PETMIN(6)) ETP=PETMIN(6)
45    IF(NMO.GT.9.OR.NMO.LT.4) CALL MINPET(ETP,PETMIN,NMO)
      GO TO 300
50    CONTINUE
      GO TO 200
100   IF(IDAY.LT.2) CALL JHCOEF(TNJAVB(INEL),TXJAVB(INEL),ALTBLK(INEL),
     .                          TXBLK(INEL),CTBLK(INEL))
      IF(TAV.LE.32.0) GO TO 150
      CALL POTET(IDAY,AVELAT,TXNE,TNNE,ASUN,BSUN,TXBLK(INEL),CTBLK(INEL)
     .           ,SLPBLK(INEL),ASPECT(INEL),ETP)
      IF(ETP.LT.PETMIN(6)) ETP=PETMIN(6)
150   IF(NMO.GT.9.OR.NMO.LT.4) CALL MINPET(ETP,PETMIN,NMO)
      RETURN
C
C .....INTERPOLATE SINCE WILL NOT CALCULATE AT THIS BLOCK
C
200   AVE=0
```

```
      DO 250  I=1,4
      WT=0
      PW=0
      DO 225  N=1,NVALT
      NDE=NGB(I,INEL)
      NW=NEART(NDE,N)
      IF(NW.EQ.0)  GO TO 250
      D=DISTT(NDE,N)
      D=1./D
      PW=PW+POT(NW)*D
      WT=WT+D
225   CONTINUE
250   AVE=AVE+PW/WT
      ETP=AVE*.25
      IF(ETP.LT.PETMIN(6)) ETP=PETMIN(6)
      IF(NMO.GT.9.OR.NMO.LT.4) CALL MINPET(ETP,PETMIN,NMO)
300   RETURN
      END
```

```
      SUBROUTINE PLNTET (IBLK,NMO,IDAY,IROOT)
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     . RDMX, RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
C
C .....ADJUST PLNTPT (POTENTIAL OF ALFALFA FOR THE AMOUNT OF FOLIAR
C .....COVER PRESENT) TO THE CURRENT GROWTH STAGE OF THE ACTUAL CROP
C .....PRESENT USING BLANEY-CRIDDLE KC CURVES (TO OBTAIN VALUE OF CP)
C
      CROPPT=PLNTPT*CP/1.13
      CROPMX=CROPPT
      IF(CROPPT.LT.0.00000001)  GO TO 100
C ...    1.13 IS MAX CP VALUE ON BL-CR ALFALFA KC CURVE
      IF(CROPPT.GT.PLNTPT) GO TO 50
      SNK=SNK+PLNTPT-CROPPT
50    IPOS=9
      CALL MASBAL(IBLK,CROPPT,IPOS,NMO,IDAY)
C
C .....FIND SOIL TYPE
C
      IT=0
      IS=ST
      IF(IS.GT.1)  IT=1
C
C .....FIND PORTION OF SOIL THAT IS SAND,LOAM,CLAY (R1,R2), WHERE:
C .....                     R1 IS PORTION OF MAJOR SOIL PARTICLE SIZE
C .....                     R2 IS PORTION OF MINOR SOIL PARTICLE SIZE
C
      R1=2.0-ST+IT
      R2=1.0-R1
      I1=1+IT
      NLR=(RD/6.)+.5
      IF(NLR.LT.1) NLR=1
      ANLR=NLR
      DO 75  N=1,NLR
      WGT=1.0
      IF(IROOT.GT.0)
     .   WGT=1.016*(EXP(-4.16*((N-1)/ANLR))-EXP(-4.16*(N/ANLR)))
      WS=SM(N)/WC(N)
      IF(I1.GT.1)  GO TO 60
      EP1=WS*.52*R1
      IF(EP1.GT.0.13)EP1=R1
      EP2=WS*R2
      IF(EP2.GT.0.5) EP2=R2
      GO TO 70
60    EP1=WS*R1
```

```
      IF(EP1.GT.0.5) EP1=R1
      EP2=WS*R2*.44
      IF(WS.GT.0.32) EP2=WS*R2
      IF(EP2.GT.0.7) EP2=R2
70    EP=EP1+EP2
      FACTOR=WGT*EP*CROPPT
      IF(FACTOR.GT.SM(N)) FACTOR=SM(N)
      SM(N)=SM(N)-FACTOR
      IF(IROOT.LT.1) CROPPT=CROPPT-FACTOR
75    ACTPLT=ACTPLT+FACTOR
      SNK=CROPMX-ACTPLT+SNK
100   CONTINUE
C
C....SNK (THE AMOUNT OF UNUSED PET) IS NOT NOW PUT IN MAS-BAL, INSTEAD
C....THE SNOW SUBLIMATION IS INPUT THERE,IPOS=8=SUBLIMATION, CODE IS
C....STILL HERE IN CASE USER WANTS TO USE IT FOR INFORMATIONAL PURPOSES
C
C      IPOS=8
C      CALL MASBAL(IBLK,SNK,IPOS,NMO,IDAY)
      IPOS=10
      CALL MASBAL(IBLK,ACTPLT,IPOS,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE POTATO(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE#12-POTATOES
C
      REAL MXI,MXNT
      DIMENSION CRP(13),JDATE(13)
      DATA CRP/0,0,.6,.78,1.1,1.24,1.32,1.36,1.37,1.35,1.23,0,0/
      DATA JDATE/1,164,197,206,224,234,243,251,258,271,294,295,366/
      CRPMX=1.37
      IF(RDMX.LT.0.0001)RDMX=48.0
      IF(FCMX.LT.0.0001)FCMX=1.0
      IF(MXI.LT.0.0001)MXI=0.15
      DO 100 JJ=2,13
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
        J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=FACT*RDMX
      FC=FACT*FCMX
      MXNT=MXI*FACT
      IF(IDAY.LT.259.OR.IDAY.GT.294) GO TO 120
      RD=RDMX
      FC=FCMX
      MXNT=MXI
120   IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
C
```

```
      SUBROUTINE POTET(IDAY,AVLAT,TMX,TMN,ASUN,BSUN,TX,CT,SLP,ASP,ETP)
C
C ....COMPUTE POTENTIAL ET FOR EACH BLOCK WHEN CALLED
C
C ....RSO=117.12 LANGLEYS/HOUR
C
      RSO=117.12
      W=0.26179939
      ADAY=IDAY
      DECL=23.5*SIN(.017214*(284.+ADAY))
      R2=0.999847+0.001406*DECL
      SLOP=0.017453*SLP
      ASPT=0.017453*ASP
      AVLATT=0.017453*AVLAT
      DECL=DECL*0.017453
      SNDECL=ABS(DECL)/DECL
C
C.....EQUIVALENT LATITUDE:
C
      ARG1=(SIN(SLOP)*COS(ASPT)*COS(AVLATT)+COS(SLOP)*SIN(AVLATT))
      EQLT=ASIN(ARG1)
C
C.....LONGITUDINAL CORRECTION OF HOUR ANGLE
C
      DELTHR=ATAN((SIN(ASPT)*SIN(SLOP)/(COS(SLOP)*COS(AVLATT)-
     .       COS(ASPT)*SIN(SLOP)*SIN(AVLATT))))
      IF(ASP.GT.180.0.AND.ASP.LT.360.0) GO TO 40
      IF(DELTHR.LT.0.0) DELTHR=DELTHR+3.141592654
      GO TO 50
   40 CONTINUE
      IF(DELTHR.GT.0.0)DELTHR=DELTHR-3.141592654
   50 CONTINUE
      IF(ASP.GT.0.0) GO TO 55
      DUM=ABS(AVLAT)+SLP
      IF(DUM.LE.90.0)DELTHR=0.0
      IF(DUM.GT.90.0)DELTHR=3.141592654
   55 CONTINUE
C
C ....... EQUIVALENT HOUR ANGLE OF SUNRISE-SUNSET-HORIZONTAL SURFACE
C
      ABSUM=ABS(AVLATT)+ABS(DECL)
      IF(ABSUM.LT.1.57079633) GO TO 60
      SNAVLT=ABS(AVLATT)/AVLATT
      SNDIF=ABS(SNAVLT-SNDECL)
      IF(SNDIF.LT.0.0000001) WTHOR=3.141592654
      IF(SNDIF.GE.0.0000001) WTHOR=0.0
      GO TO 70
   60 CONTINUE
```

```
      ARG2=(-TAN(AVLATT)*TAN(DECL))
      WTHOR=ACOS(ARG2)
   70 CONTINUE
C
C....EQUIVALENT HOUR ANGLE OF SUNRISE-SUNSET-EQUIVALENT SURFACE
C
      DLMNWT=DELTHR-WTHOR
      DLPLWT=DELTHR+WTHOR
      ABSUM=ABS(EQLT)+ABS(DECL)
      IF(ABSUM.LT.1.57079633)GO TO 90
      SNEQLT=ABS(EQLT)/EQLT
      SNDIF=ABS(SNEQLT-SNDECL)
      IF(SNDIF.LT.0.0000001)WTSLOP=3.141592654
      IF(SNDIF.GE.0.0000001)WTSLOP=0.0
      GO TO 95
   90 ARG3=(-TAN(EQLT)*TAN(DECL))
      WTSLOP=ACOS(ARG3)
   95 CONTINUE
C
C ........TIMES OF SUNRISE AND SUNSET FOR EQUIVALENT SURFACE
C
      IF(DLMNWT.GE.WTSLOP) GO TO 100
      TSR=AMAX1(DLMNWT,-WTSLOP)/W
      TSS=AMIN1(DLPLWT,WTSLOP)/W
C
C ........COMPUTE DAILY IRRADIANCE FACTOR
C
      RADFAC=(TSS-TSR)*SIN(EQLT)*SIN(DECL)+(12.0/3.1416)*COS(EQLT)*
     .          COS(DECL)*(SIN(W*TSS)-SIN(W*TSR))
      RADFAC=RADFAC/R2
C
C.....CORRELATE MAX-MIN TEMP. TO PERCENT POSSIBLE SUNSHINE AND
C     COMPUTE RADIATION.
C
      PPS=(ASUN+BSUN*(TMX-TMN))/100.
      IF(PPS.GT.1.)  PPS=1.0
      IF(PPS.LT.0.0) PPS=0.0
      RS=RSO*RADFAC*(.23+.48*PPS)
C
C.....COMPUTE POTENTIAL EVAPOTRANSPIRATION
C
      T=(TMN+TMX)/2.0
      ETP=CT*(T-TX)*RS*.000673
      IF(T.LT.TX) ETP=0.0
      RETURN
100   ETP=0.0
      RETURN
      END
```

```
      SUBROUTINE PREVAL (NWSP,IN1,IOT1)
      COMMON/PRCPVL/ APRENW(NWSP),ANPBLK(BLKS) .
      COMMON /SIZE/  NEL,NIJ,ICOL,IROW
C
C .....READ LONG TERM ANNUAL PRECP VALUES AT NWS SITES
C
      READ (IN1,5000) APRENW
C
C .....READ NP PARAMETER, IF NP<1 MEANS ANNUAL PRECP WILL BE READ IN
C .....FOR ALL BLOCKS, IF NP>0 THEN INTERPOLATION SCHEME WILL ACCOUNT
C .....FOR ANNUAL VALUES AT NP BLOCKS ONLY, E.G., IN AN AREA W/LARGE
C .....TOPOGRAPHIC CHANGES AND FEW WEATHER STATIONS
C
      READ (IN1,5001) NP,IN4
      WRITE (IOT1,6001) NP,IN4
C
C .....ZERO ARRAY
C
      DO 5  I=1,NEL
5     ANPBLK(I)=0.0
      IF (NP.LT.1.OR.NP.EQ.NEL) GO TO 3
C
C .....ONLY READING NP ANNUAL VALUES FOR NP BLOCKS AND REST OF BLOCKS
C .....WILL INVOLVE STRAIGHT INTERPOLATION OF PRECP VALUES WITHOUT
C .....ADJUSTMENT FOR ANNUAL VALUES, IBLOCK IS BLOCK NUMBER OF ANNUAL
C .....VALUE AND ALL OTHERS NOT READ ,SET=0.0
C
      DO 2  I=1,NP
2     READ (IN4,5002) IBLC,ANPBLK(IBLC)
      GO TO 50
C
C .....READ ANNUAL PREC VALUE FOR ALL BLOCKS
C
3     READ (IN4,5000) ANPBLK
50     RETURN
C
C
C .....ANPVAL IS CALLED FROM TOGRID SUBROUTINE
C
      ENTRY ANPVAL (NE,NWS,RATIO)
C
C
      R1=ANPBLK(NE)
      IF (R1.LT.0.000001)  GO TO 10
      R2=APRENW(NWS)
      RATIO=R1/R2
      GO TO 15
10    RATIO=1
```

```
15    RETURN
C
C .....FORMATS
C
5000  FORMAT (10F8.0)
5001  FORMAT(10I4)
5002  FORMAT(I4,F5.0)
6001  FORMAT (3X,'IFPREC>0, CALLED PREVAL, AND HAVE READ NP,=',I4,
     .' AND HAVE READ IN4 =',I4,/4X,'IN4 IS INPUT UNIT FOR AVERAGE ANNUA
     .L PRECIPITATION VALUES FOR THE NP NUMBER OF BLOCKS',//)
      END
```

```
      SUBROUTINE RECHOT (RECH,AREA,NEL,IDYS,IRECR)
      COMMON/INOUT/ NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .MAPEL,ARRRY(MAPIJ)
      DIMENSION RECH(NEL),AREA(NEL)
C
C .....IFLUX>0 AND IRECH>0 THEN MAP AND SAVE ANNUAL RECHARGE AS
C .....VOLUMETERIC FLUX (I.E.,NOT AS IN/YR BUT AS FT3/SEC)
C
      IF(IFLUX.LT.1)  GO TO 50
      CONVRT=1036800.*IDYS
      DO 10  I=1,NEL
10    RECH(I)=RECH(I)*AREA(I)/CONVRT
C
C .....MAP ANNUAL VOLUMETRIC FLUX DISTRIBUTION
C
      IRECR=1
      WRITE (IPRNT,6000)
      CALL ANNUAL(RECH,0)
50    WRITE (IRECH) RECH
6000  FORMAT (//2X,'THE FOLLOWING DISTRIBUTION ON NEXT PAGE IS A VOLUMET
     .RIC FLUX (FT*3/SEC)')
      RETURN
      END
```

```
      SUBROUTINE ROFACT(NMO,IDAY)
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON/GRID/   AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      COMMON/WEATHR/ PRECP(BLKS),TMAX(BLKS),TMIN(BLKS),TMXYST(BLKS)
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .  RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
      DOUBLE PRECISION GX,GY
      INTEGER RODATA,BSDATA
C
C  THIS SUBROUTINE COMPUTES APPORTIONING FACTORS FOR BLOCKS TO APPORTION
C  MEASURED STREAM DISCHARGE MINUS BASEFLOW.  THE FACTORS ARE COMPUTED
C  BASED ON THE EHRHYM MODEL PREDICTED DISCHARGE (SUBROUTINE RUNOFF)
C
C      READ IN STREAMFLOW FOR THIS DAY, SUBTRACT BASEFLOW, AND CONVERT FROM
C      CFS TO IN/DAY
C
      READ(RODATA,1000) DISCH
1000  FORMAT(F8.0)
      DISCH=BSNFAC*(DISCH-BSFLW(NMO))
      IF(DISCH.LE.0.0) RETURN
C
C.....CHECK THAT THERE IS NON-ZERO PRECIP FOR DAY FOR BASIN, OTHERWISE
C     ALL CNFAC WILL BE SET TO 0.
      SMPRCP=0.0
      DO 50 I=1,NEL
50    SMPRCP=SMPRCP+PRECP(I)
      SMALL=0.001*NEL
      IF(SMPRCP.LT.SMALL) RETURN
C
C            CACULATE EHRHYM RUNOFF FOR ALL BLOCKS
C
      DSCHCN=0.0
      ACUM=0.0
      DO 100 I=1,NEL
      CALL LOOKUP(I,NMO,IDAY,0)
      IF(LNDUS.EQ.10) THEN
       RO=PPT
       GO TO 90
      END IF
      CALL SNWPCK(I,NMO,IDAY,0)
      CALL RUNOFF(I,NMO,IDAY)
90    EHRMRO(I)=RO
      DSCHCN=DSCHCN+RO*AREA(I)
100   ACUM=ACUM+AREA(I)
```

```
C
      DSCHCN=DSCHCN/ACUM
      IF(DSCHCN.LT.0.00000001)  RETURN
C
      DO 105 I=1,NEL
105   CNFAC(I)=EHRMRO(I)/DSCHCN
      RETURN
      END
```

```
      SUBROUTINE ROW(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                    IRSRT1,IREND1,IRSRT2,IREND2,
     .                    IRSCD,SUMCP)
C
C.....LANDUSE # 9-ROW CROPS, UNDIFFERENTIATED
C
      REAL MXI,MXNT
      DIMENSION CRP(12),JDATE(12)
      DATA CRP/0.0,0.0,.35,.39,.53,.66,.91,1.0,.79,.37,0.0,0.0/
      DATA JDATE/1,59,75,105,135,166,196,227,258,288,304,366/
C.....COMPOSITE CROP CURVE MADE BY AVERAGING BEANS PEAS AND ALFALFA
      CRPMX=1.0
      IF(RDMX.LT.0.00001)RDMX=30.
      IF(FCMX.LT.0.00001)FCMX=0.8
C.....MXI=0.1 INTERPOLATED FROM LINSLEY, ETC
      IF(MXI.LT.0.00001)MXI=0.1
      DO 100 JJ=2,12
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
        J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
      (JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=FACT*RDMX
      FC=FACT*FCMX
      MXNT=MXI*FACT
      IF(IDAY.LT.227.OR.IDAY.GT.303) GO TO 120
      RD=RDMX
      FC=FCMX
      MXNT=MXI
120   IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE RUNOFF(IBLK,NMO,IDAY)
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .  RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
      INTEGER RODATA,BSDATA
C
C .....COMPUTE RUNOFF USING ERHYM MODEL METHOD
C .....PRECIP VALUES NOT YET ADJUSTED FOR INTERCEPTION, BECAUSE SCS
C .....CN # TAKES INTERCEPTION INTO ACCOUNT
C
      RO=0.0
      AVLPPT=PPT+SNM
      IF (AVLPPT.LT.0.00000001)  RETURN
      IF (TAV.LE.32.0)           RETURN
      CN=-16.91+1.348*CN-0.01379*(CN**2)+0.000177*(CN**3)
      SMX=1000.0/CN-10.0
      S=0.0
      ANLR=NL
C
C .....COMPUTE RUNOFFF
C
      DO 30  N=1,NL
      WI=1.016*EXP(-4.16*(N-1)/ANLR)-1.016*EXP(-4.16*N/ANLR)
      S=S+WI*SM(N)/WC(N)
30    CONTINUE
      S=SMX-S*SMX
      IF(RODATA.GT.0) GO TO 35
      IF(S.LT.0.1) S=.1
35    IF(S.LT.0.0) S=0.0
      S2=0.2*S
      IF(AVLPPT.LT.S2) RETURN
      S8=0.8*S
      RO=(AVLPPT-S2)**2 /(AVLPPT+S8)
      PR=AVLPPT-RED
      IF(RO.GT.PR) RO=PR
C .....     PUT RUNOFF INTO MASS BALANCE
      IPOS=15
      CALL MASBAL(IBLK,RO,IPOS,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE RUNTRU(IBLK,NMO,IDAY)
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .  RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
      INTEGER RODATA,BSDATA
C
C   THIS SUBROUTINE USES APPORTIONING FACTORS COMPUTED IN ROFACT, AND APPLIES
C   THESE NUMBERS TO THE OBSERVED DAILY DISCHARGE MINUS BASEFLOW TO ARRIVE AT
C   THE RUNOFF QUANTITY FOR THIS BLOCK, THIS SUBROUTINE ONLY ENTERED WHEN THERE
C   IS OBSERVED RUNOFF FOR THIS DAY (RODATA>0) AND LANDUSE IS NOT WATER
C
      RO=CNFAC(IBLK)*DISCH
      IPOS=4
      CALL MASBAL(IBLK,RO,IPOS,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE SAGE (IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP)
C
.....LANDUSE # 3-SAGEBRUSH AND ASSOCIATED SCRUB

      REAL MXI,MXNT
      DIMENSION CRP(10),JDATE(10)
      DATA CRP/.7,.63,1.35,1.08,.90,.67,.63,.78,.90,.75/
      DATA JDATE/1,15,46,74,100,140,212,319,349,366/
C
C .....NO PUBLISHED CROP CURVES FOR SAGE. USE GRASS CROP CURVE
C.....TIMES RATIOS AS PRESENTED IN OLD BATELLE RECHARGE STUDY.
C.....SUMMER RATIOS NO GOOD, USE WINTER RATIOS AND INTERPOLATE
C.....THROUGH SUMMER.
C
C
      CRPMX=1.35
C.....ROOT DEPTH FROM BATELLE RECHARGE REPORT.
      IF(RDMX.LT.0.00001)RDMX=55.22
C.....FCMAX=.35, MXI=.06 FROM PERS. COMM. GEORGE LEAVSLY, AND AFTER
C.....ZINKE, RESPECTIVELY.
      IF(FCMX.LT.0.00001)FCMX=0.35
      IF(MXI.LT.0.00001)MXI=0.06
      DO 100 JJ=2,16
      IF(IDAY.GT.JDATE(JJ)) GO TO 100
          J=JJ
      GO TO 110
  100 CONTINUE
  110 CP=CRP(J-1)+(IDAY-JDATE(J-1))*(CRP(J)-CRP(J-1))/
     .(JDATE(J)-JDATE(J-1))
      RD=RDMX
      FC=FCMX
      MXNT=MXI
      RETURN
      END
```

```
      SUBROUTINE SAND(IDAY,RDMX,RD,FC,MXNT,CP,APMULT)
C
C.....LANDUSE # 13-SAND DUNES, BARE GROUND
C
      REAL MXI,MXNT
C
C.....THIS SUBROUTINE MERELY SETS FC,CP,AND APMULT TO ZERO.
C.....THE ASSUMTION IS THERE IS NO VEGETATION.
C..... RD AND RDMX ARE SET TO 1.0 FEET SO THAT RUNOFF, SOIL EVAPORATION
C....  AND SOIL MOISTURE ARE STILL DONE, EVAP AND MOISTURE ARE DONE
C....  FOR THE COMPLETE PROFILE WHILE RUNOFF IS COMPUTED BASED ON THE
C....  UPPER ONE (1.0) FOOT OF SOIL
      CP=0.0
      RD=12.0
      RDMX=RD
      FC=0.0
      MXNT=0.0
      APMULT=0.0
      RETURN
      END
C
```

```
      SUBROUTINE SAVE(IBLK,NMO,IDAY,NL,SNO,REMINT)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/FLOWS/  SNOW(BLKS),SMS(BLKS,10),REMAIN(BLKS)
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/SOIL1/  WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
      COMMON/DAYVAL/ SM(10),WC(10)
C
C .....THIS SUBROUTINE SAVES COMPUTED VALUES OF SOIL MOISTURE, REMAINING
C .....INTERCEPTED MOISTURE, AND SNOW ACCUMULATION. THESE VALUES NEEDED
C .....FOR NEXT DAY'S COMPUTATIONS IBLK=CURRENT BLOCK NUMBER,NL=NUMBER
C .....6 IN. SOIL LAYRS IN THIS BLOCK
C
      REMAIN(IBLK)=REMINT
      CHNGSM=0.0
      DO 20 N=1,NL
      CHNGSM=CHNGSM+SM(N)-SMS(IBLK,N)
20    SMS(IBLK,N)=SM(N)
      IPOS=11
      CALL MASBAL(IBLK,CHNGSM,IPOS,NMO,IDAY)
40    SNOW(IBLK)=SNO
      RETURN
      END
```

```
      SUBROUTINE SAVSMS
      COMMON/INOUT/  NSB(NSMBLK),IOT1,IOT2,IN1,IPRNT,ISTS,MAPREC,IAPUNT,
     .       IRDSNO,IRTSNO,MAPET,ICN,IRECH,IFLUX,NSMBLK,IAPPLY,
     .       MAPEL,ARRRY(MAPIJ)
      COMMON/SOIL2/  CN2(BLKS),NSOIL(BLKS)
      COMMON/FLOWS/  SNOW(BLKS),SMS(BLKS,10),REMAIN(BLKS)
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/SOIL1/  WATCAP(24,10),SOLTYP(24),NLAYER(24),NSOLAS
C
C ..... PURPOSE OF THIS SUBROUTINE IS TO SAVE SOIL MOISTURE
C ..... AND SNOWPACK AT END OF YEAR
C
      WRITE (ISTS)  SMS
      RETURN
      ENTRY SAVSNO
      WRITE(IRTSNO) SNOW
      RETURN
      END
```

```
      SUBROUTINE SNWPCK(IBLK,NMO,IDAY,IIN)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .  RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      COMMON/WINTER/ SBLMTE,PETMIN(6),KMCOEF
      REAL MXNT,KMCOEF,KMCOF
      DIMENSION T(4)
      SNOYST=SNO
C.....IF AVERAGE TEMP LESS THAN 32 ASSUME ALL PRECIP IS SNOW
      IF(TAV.LE.32.) SNO=SNO+PPT
      IF(SNO.LT.0.000001) RETURN
C
C ...  COMPUTE SNOWMELT-SUBLIMATION  (SNM,SUB)
C
C...       FIRST DISAGGREGATE TEMPS TO 6-HR VALUES (ANDERSON,1973)
C
      TMNPST=TMN+TMXPRE-TMX
      T(1)=0.95*TMN+0.05*TMXPRE
      T(2)=0.40*TMN+0.60*TMX
      T(3)=0.925*TMX+0.025*TMN+0.05*TMNPST
      T(4)=0.33*TMX+0.67*TMNPST
C
C....  NOW FIND COEFFICIENT,BASED ON VARIATION WITH JULIAN DAY
C...   (MALE AND GRANGER,1978,PROCEEDINGS MODELING SNOW COVER RUNOFF,CRREL)
C
      IY=IDAY
      IF(IDAY.GT.185) IY=(367-IDAY)
      KMCOF=KMCOEF
      IF(IY.LT.75) GO TO 105
      KMCOF=.0014*(IY-75)+KMCOEF
C
C...   NOW ACCUMULATE SNM AND SUBLIMATION OVER THE FOUR 6-HR PERIODS
C...    SUBLIMATE ONLY FROM 6AM-6PM
C
105   DO 110 I=1,4
      SUBTMP=0.0
      IF(I.GT.1.AND.I.LT.4) CALL SUBLAT(SBLMTE,SUBTMP)
      IF(SUBTMP.GT.SNO) SUBTMP=SNO
      SNO=SNO-SUBTMP
      SUB=SUB+SUBTMP
      IF(SNO.LT.0.0000001) THEN
       SNO=0.0
       GO TO 120
      END IF
      SNMLT= KMCOF*.555555556*(T(I)-34.0)
      IF(SNMLT.LT.0.0) SNMLT=0.0
      IF(SNMLT.GT.SNO) SNMLT=SNO
      SNM=SNM+SNMLT
```

```
      SNO=SNO-SNMLT
      IF(SNO.LT.0.0000001) THEN
       SNO=0.0
       GO TO 120
      END IF
110   CONTINUE
      IF(TAV.LE.32.0) GO TO 120
C.......COMPUTE SNOWMELT FROM PRECIPITATION
      IF(PPT.GT.0.00000001) SNMLT=(TAV-32.)*0.55555556*(0.029+PPT
     .*0.0028)
      IF(SNMLT.GT.SNO) SNMLT=SNO
      SNO=SNO-SNMLT
      SNM=SNM+SNMLT
120   CHGSNO=SNO-SNOYST
      IF(IIN.GT.0) CALL MASBAL(IBLK,CHGSNO,13,NMO,IDAY)
      IF(IIN.GT.0) CALL MASBAL(IBLK,SUB,8,NMO,IDAY)
C      CALL MASBAL(IBLK,SNO,13,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE SOILEV (IBLK,NMO,IDAY)
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .  RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
C
C .....COMPUTE EVAPORATION FROM BARE SOIL
C
C .....THE PORTION OF REMAINING PET THAT ACTS UPON BARE SOIL IS
C .....PROPORTIONAL TO THE AMOUNT OF GROUND NOT SHADED OR COVERED
C .....WITH SNOW
C
      IF(SNO.GT.0.005) RETURN
      SOLPEV=ETP*(1.0-FC)
      IF(SOLPEV.LT.0.00000001) RETURN
C
C .....COMPUTE ACTUAL EVAP BASED ON A RELATIONSHIP THAT IS ASSUMED
C .....TO HOLD FOR ALL SOILS AND IS BASED ON % VOLUME OF SOIL MOISTURE
C .....IN UPPERMOST FOOT
C
C .....COMPUTE EVAPORATION FROM BARE SOIL
C
C .....THE PORTION OF REMAINING PET THAT ACTS UPON BARE SOIL IS
C .....PROPORTIONAL TO THE AMOUNT OF GROUND NOT SHADED OR COVERED
C .....WITH SNOW
C
      IF(SNO.GT.0.005) RETURN
      SOLPEV=ETP*(1.0-FC)
      IF(SOLPEV.LT.0.00000001) RETURN
C
C .....COMPUTE ACTUAL EVAP BASED ON A RELATIONSHIP THAT IS ASSUMED
C ....TO HOLD FOR ALL SOILS AND IS BASED ON % VOLUME OF SOIL MOISTURE
C .....IN UPPERMOST FOOT
C
      IF(NL.LT.2) THEN
       SM(2)=0.0
       WC(2)=0.0
      ELSE
      END IF
      SOLAY1=SM(1)
      SOLAY2=SM(2)
      SOLTOT=SOLAY1+SOLAY2
      SMF=(SOLTOT)/(WC(1)+WC(2))
      RATIO=0.0
      IF(SMF.GT.0.25) RATIO=(SMF-0.25)*6.6
      IF(SMF.GT.0.40) RATIO=1.0
      ACTEV=RATIO*SOLPEV
```

```
      IF(ACTEV.GT.SOLTOT) ACTEV=SOLTOT
      IF(ACTEV.LT.0.00000001) GO TO 10
      ACTLY1=ACTEV*SOLAY1/SOLTOT
      ACTLY2=ACTEV*SOLAY2/SOLTOT
      SM(1)=SM(1)-ACTLY1
      SM(2)=SM(2)-ACTLY2
10    IPOS=6
      CALL MASBAL(IBLK,SOLPEV,IPOS,NMO,IDAY)
      IF(ACTEV.LT.0.00000001) RETURN
      IPOS=7
      CALL MASBAL(IBLK,ACTEV,IPOS,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE SOILMS (IBLK,NMO,IDAY)
      COMMON/STRFLW/ RODATA,DISCH,BSFLW(12),BSNFAC,CNFAC(BLKS),BSDATA,
     .               EHRMRO(BLKS)
      COMMON/DAYVAL/ SM(10),WC(10)
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     .RDMX, RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
      INTEGER RODATA,BSDATA
C
C .....THIS SUBROUTINE DOES SOIL MOISTURE ACCOUNTING FOR EACH SOIL LAYR
C
C.....CHECK FOR SURPLUS MOISTURE (SUR) TO GO INTO SOIL
C
      SUR=PPT-CHGSNO-RED-RO-SUB
      IF(SUR.LT.0.00000001) GO TO 60
C
C ....DIFFERENCE BETWEEN CURRENT SOIL MOISTURE CONTENT,SM,AND
C.....AVAILABLE WATER CAPACITY,WC,
C ... IS AMOUNT OF WATER THAT CAN BE TAKEN FROM SUR AND ADDED
C ....TO LAYERS. EXCESS GOES TO DEEP PERCOLATION.
C
      DO 40 N=1,NL
      WS=WC(N)-SM(N)
      SUR=SUR-WS
      IF(SUR.LT.0.00000001) GO TO 20
      SM(N)=WC(N)
      GO TO 40
20    SM(N)=SM(N)+SUR+WS
      GO TO 50
40    CONTINUE
50    CONTINUE
      IF(SUR.LT.0.00000001) RETURN
      RECR=SUR
C .....  PUT RECHARGE INTO MASS BALANCE
      IPOS=5
      CALL MASBAL(IBLK,RECR,IPOS,NMO,IDAY)
      RETURN
C
60    IF(RODATA.LT.1)      RETURN
      IF(RO.LT.0.00000001) RETURN
C
C.....IF THERE IS RUNOFF IN EXCESS OF PRECIP+SNOWMELT-INTERCEPTION
C.....REMOVE WATER FROM EACH LAYER PROPORTIONAL TO CURRENT
C.....FRACTION GREATER THAN 50% ABOVE WILTING POINT OF LAYER
C.....OF TOTAL SOIL MOISTURE ABOVE 50% IN ALL LAYERS.
C.....IF LAYERS WOULD GO LESS THAN 50% PUT DEFICIT INTO SEPARATE ARRAY.
      DEFCIT=0.0
```

```
      TOTLSM=0.0
      ROEX=-SUR
      DO 70 N=1,NL
      EMPTY=0.5*WC(N)
      IF(SM(N).LT.EMPTY) GO TO 70
      TOTLSM=TOTLSM+SM(N)-EMPTY
70    CONTINUE
      IF(TOTLSM.LE.0.0) DEFCIT=ROEX
      IF(TOTLSM.LE.0.0)GO TO 85
      DO 80 N=1,NL
      SMOLD=SM(N)
      EMPTY=0.5*WC(N)
      IF(SMOLD.LT.EMPTY) GO TO 80
      SM(N)=SMOLD-(SMOLD-EMPTY)*ROEX/TOTLSM
      IF(SM(N).GT.EMPTY) GO TO 80
      DEFCIT=DEFCIT+EMPTY-SM(N)
      SM(N)=EMPTY
80    CONTINUE
85    DEFCIT=-DEFCIT
      CALL MASBAL(IBLK,DEFCIT,16,NMO,IDAY)
90    RETURN
      END
```

```
      SUBROUTINE SPRGWT(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE # 15-SPRING WHEAT
C
      DIMENSION CRP(9),JDATE(9)
      REAL MXI,MXNT
      DATA CRP/0.0,0.0,0.28,1.25,1.31,1.25,1.10,0.0,0.0/
      DATA JDATE/0,90,91,160,172,185,195,244,366/
      CRPMX=1.5
      IF(RDMX.LT.0.0001)RDMX=42.0
      IF(FCMX.LT.0.0001)FCMX=1.0
C.....MXI=0.16 FROM LINSLEY, ETC.
      IF(MXI.LT.0.0001)MXI=0.16
C
C .....INTERPOLATE BLANNEY-CRIDDLE CROP COEFFICIENTS TO IDAY
C
C......AS MODIFIED BY WELUM ON 1-30-86 TO SIMULATE
C......SPRING WHEAT, NO FALLOW HERE
C
 80   DO 100 JJ=2,9
      IF(IDAY.GT.JDATE(JJ))  GO TO 100
        J=JJ
      GO TO 110
100   CONTINUE
  110 CRPT=CRP(J)
      CRPY=CRP(J-1)
      CP=CRPY+(IDAY-JDATE(J-1))*(CRPT-CRPY)/(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
      FACT=CP/CRPMX
      RD=RDMX*FACT
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IDAY.LT.172.OR.IDAY.GT.195) GO TO 120
      RD=RDMX
      FC=FCMX
      MXNT=MXI
120   IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE SRFWTR(IBLK,NMO,IDAY,PPT,TMX,TMN,TAV,ETP,IIN)
C
C.....LANDUSE # 10-SURFACE WATER (RIVERS, LAKES, ETC.)
C
C
C.....THIS SUBROUTINE PUTS VALUES OF RUNOFF AND ETP INTO MASBAL
C.....SINCE ALL MOISTURE AND ENERGY COMPUTATIONS ARE BYPASSED FOR
C.....THIS LANDUSE.
C
      RO=PPT
      IF(IIN.GT.0) CALL MASBAL(IBLK,RO,4,NMO,IDAY)
      CALL PETBLK(IBLK,NMO,IDAY,TMX,TMN,TAV,ETP)
      IF(IIN.GT.0) CALL MASBAL(IBLK,ETP,2,NMO,IDAY)
C       SNK=ETP
C       IF(IIN.GT.0) CALL MASBAL(IBLK,SNK,8,NMO,IDAY)
      RETURN
      END
```

```
      SUBROUTINE SUBLAT(SBLMTE,SUBTMP)
C
C.....THIS SUBROUTINE MERELY APPLIES THE DAILY ESTIMATED RATE FOR
C.....SNOW PACK SUBLIMATION, IT IS DONE IN THIS ROUTINE SO THAT
C.....A SUBROUTINE IS RESERVED FOR THESE CALCULATIONS IF A USER
C.....DESIRES TO SUBSTITUTE IN A PHYSICALLY BASED SUBLIMATION
C.....PROCESS PACKAGE OR IF SOME EMPIRCAL FUNCTION IS AVAILABLE
C.....THE DAILY RATE IS APPLIED OVER THE 2 SIX-HOUR PERIODS FROM
C.....6AM TO 6PM, THUS DAILY VALUE MULTIPLIED BY 0.5
C
      SUBTMP=SBLMTE*0.5
      RETURN
      END
```

```
      SUBROUTINE TMPVAL(IN1,IOT1)
      COMMON/BLKPET/ ALTBLK(BLKS),SLPBLK(BLKS),ASPECT(BLKS),CTBLK(BLKS),
     .    TXBLK(BLKS),TXJAVB(BLKS),TNJAVB(BLKS),IBLOCK(BLKS)
      COMMON/SIZE/   NEL,NIJ,ICOL,IROW
      COMMON/LRATES/ RATEMN(12),RATEMX(12),ILAPSE
      COMMON/JENHAZ/ ALTWS(NWST),TNJAVG(NWST),TXJAVG(NWST),TXX(NWST),ASUN,BSUN,
     .               CTT(NWST),POT(NWST),AVELAT,IFTEMP,IFTMPN,IFTMPX,NT
C
C .....THIS SUBROUTINE READS IN ALTITUDES FOR THOSE BLOCKS WHERE
C .....MAX AND MIN TEMPS ARE TO BE DETERMINED BY APPLYING A LAPSE RATE
C .....TO THE TEMPERATURES OF THE NEARBY WEATHER STATIONS.
C .....FOR THESE BLOCKS PET WILL BE CALCULATED USING SLOPE/ASPECT DATA
C .....HOWEVER, THESE VALUES CAN BE READ IN OR LEFT BLANK, IF LEFT
C .....BLANK THEN PET WILL BE CALCULATED AS IF ON HORZNTAL SURFACE
C .....ALSO READ 'ILAPSE', IF ILAPSE>0 THEN:
C .....READ REGIONAL LAPSE RATE FOR EACH MONTH FOR TMIN AND TMAX
C .....                    IF ILAPSE<1 THEN:
C .....THE LAPSE RATES NOT READ , IN THIS WAY PET WILL BE STILL
C .....COMPUTED AT EACH BLOCK, BUT THE TEMPERATURES AT THOSE BLOCKS WILL BE
C .....INTERPOLATED VALUES WITHOUT THE USE OF LAPSE RATES.  USE THIS METHOD IF
C .....THERE IS NO GOOD REGIONAL RELATIONSHIP IN LAPSE RATES
C
C .....SUBROUTINE CALLED FROM DATAIN
C ....     NT PARAMETER: IF NT=NEL ALTITUDES  READ IN FOR ALL BLOCKS
C .....IF NT>0 AND <NEL ALTITUDES ARE READ IN FOR NT BLOCKS
C
C .....FIRST READ NT VALUE (NUMBER OF BLOCKS TO READ IN DATA FOR)
C .....       AND INALT, WHICH IS UNIT NUMBER ALTITUDES,SLOPES,ASPECTS
C .....ARE STORED ON.
C .....               ****NOTE******
C .....     IF NT=NEL DATA IS UNFORMATTED ON UNIT INALT
C .....     IF NT<NEL DATA IS FORMATTED DATA ON UNIT INALT
C .....     IF NT=NEL AND INALT=IN1 DATA IS FORMATTED
C
      READ(IN1,5001)    NT,INALT
      WRITE(IOT1,6000)  NT,INALT
C
C ....    ZERO ALL ARRAYS
C
      DO 5 I=1,NT
      SLPBLK(I)=0.0
      ASPECT(I)=0.0
5     ALTBLK(I)=0.0
      IF(NT.EQ.NEL.AND.INALT.NE.IN1) GO TO 15
C
C .....READ ALTITUDES AT SPECFIED BLOCKS ONLY
C
      DO 10  I=1,NT
```

```
10    READ (INALT,5001) IBLOCK(I),ALTBLK(I),SLPBLK(I),ASPECT(I)
      GO TO 25
C
C .....READ ALTITUDE FOR ALL BLOCKS, VALUES ARE UNFORMATTED AND # OF
C .....VALUES =NEL (THE NUMBER OF BLOCKS) , NT IS = NEL
C
15    DO 20  I=1,NEL
20    READ (INALT) ALTBLK(I),SLPBLK(I),ASPECT(I)
C
C ....IF ALL LAPSE RATES =0.0 READ IN ILAPSE=0 TO AVOID
C ....UNNECCESARY COMPUTATIONS.
C
25    READ(IN1,5001)   ILAPSE
      WRITE(IOT1,6003) ILAPSE
      IF(ILAPSE.LT.1)  RETURN
C
C .....READ IN LAPSE RATES (MONTHLY)
C
      READ (IN1,5002)  RATEMN
      WRITE(IOT1,6002) RATEMN
      READ(IN1,5002)   RATEMX
      WRITE(IOT1,6001) RATEMX
      RETURN
C
C .....FORMATS
C
5000  FORMAT (20F4.0)
5001  FORMAT (I4,19F4.0)
5002  FORMAT (12F5.2)
6000  FORMAT (//2X,  'THE NT PARAMETER WHICH DETERMINES WHICH BLOCKS OR
     .ALL BLOCKS WILL HAVE AN ALTITUDE READ IN IS =',I4,/2X,
     .         'IF NT = NEL, THEN ALL BLOCKS HAVE ALTITUDE READ IN',/2X,
     .'THE INPUT UNIT FOR ALTITUDE,SLOPE,AND ASPECT OF NT BLOCKS HAS JUS
     .T BEEN READ IN AND IS (INALT)=',I4,//)
6002  FORMAT(2X,'THE MONTHLY MINIMUM LAPSE RATES ARE: JAN  FEB  MAR  APR
     . MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC',/40X,12(F3.1,2X),/)
6001  FORMAT (2X,'THE MONTHLY MAXIMUM LAPSE RATES ARE:  JAN  FEB  MAR
     .APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC',/40X,12(F3.1,2X),//)
6003  FORMAT(2X,'THE PARAMETER ILAPSE WAS READIN AND (ILAPSE=)',I4,/5X,
     .'IF ILAPSE < 1, DO NOT READ IN LAPSE RATES (ASSUME=0.0)',/5X,'IF I
     .LAPSE > 0, READ IN MONTHLY MAX-MIN LAPSE RATES (DEGREE-FAR/1000 FT
     .',//)
C
      END
```

```
      SUBROUTINE TOGRID (A,B,NVLS,DIST,NEAR,IFCHK,NMO,NT)
      COMMON/GRID/ AREA(BLKS),GX(NODES),GY(NODES),TOTARA,NGB(4,BLKS)
      DIMENSION A(*),B(*),DIST(NODES,*),NEAR(NODES,*)
      COMMON/SIZE/ NEL,NIJ,ICOL,IROW
      COMMON/LRATES/RATEMN(12),RATEMX(12),ILAPSE
      DOUBLE PRECISION GX,GY
C
C .....PURPOSE OF THIS SUBROUTINE IS TO INTERPOLATE DAILY VALUES OF
C .....PRECP,TEMP, AND PET (PET IS OPTIONAL-CAN COMPUTE FOR EACH
C .....BLOCK IF DESIRED) FROM NWS WEATHER STATIONS TO GRID SYSTEM. MTH IS METHOD
C .....OF INTERPOLATION,>0 USES 1/DIST AS WEIGHT FOR EACH NWS STATION
C .....                    USED
C .....                 <1 USES 1/DIST*DIST AS WEIGHT
C .....   MTH IS ALREADY BUILT INTO DISTANCE(DIST) FROM INTRPO SUBRTN
C .....  THE DIST HAS ALREADY BEEN COMPUTED IN SUBROUTINE INTRPO
C ...... AND THE NUMBER OF STATIONS USED TO INTERPOLATE IS=NVLS
C
      DO 10  NE=1,NEL
      AVE=0.0
      DO 5  I=1,4
      WT=0.0
      PW=0.0
      DO 1  N=1,NVLS
      FACT=1.
      NDE=NGB(I,NE)
      NWS=NEAR(NDE,N)
      IF (NWS.EQ.0)    GO TO 1
      D=DIST(NDE,N)
      D=1./D
      IF (IFCHK.LT.0)  GO TO 3
      IF (IFCHK.GT.0) CALL ANPVAL(NE,NWS,FACT)
      PW=PW+A(NWS)*D*FACT
      GO TO 4
3     TMPDIF=0
      IF(ILAPSE.LT.1)  GO TO 2
      CALL ANTVAL (NE,NWS,NMO,TMPDIF,IFCHK)
2     PW=PW+(A(NWS)+TMPDIF)*D
4     WT=WT+D
1     CONTINUE
5     AVE=AVE+PW/WT
10    B(NE)=AVE*.25
      RETURN
      END
```

```
      SUBROUTINE TRNSFR
      COMMON/BLKVAL/ PPT,TMN,TMX,TAV,CP,NL,NS,CN,ST,RD,MXNT,SNO,RED,SNM,
     . RDMX,RO,RECR,REMINT,ETP,AETFC,SOLPEV,ACTEV,PLNTPT,ACTPLT,SNK,FC,
     .  TMXPRE,CHGSNO,LNDUS,SUB
      REAL MXNT
C
C .....THIS SUBROUTINE TAKES THE PORTION OF SOLPEV NOT USED TO
C .....EVAPORATE BARE SOIL MOISTURE,SA,AND ADDS PART OF IT TO PLNTPT
C .....THE AMOUNT ADDED IS BASED ON THE AMOUNT OF FOLIAR COVER
C
      SA=SOLPEV-ACTEV
      TRNS=1.0
      IF(FC.LT.0.60) TRNS=1.6666*FC
      PLNTPT=ETP*FC+TRNS*SA
      SNK=(SA-TRNS*SA)
      RETURN
      END
```

```
      SUBROUTINE WWALYR (IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                   IRSRT1,IREND1,IRSRT2,IREND2,IRSCD,SUMCP)
C
C.....LANDUSE # 4-WINTER WHEAT, HARVESTED AND PLANTED EACH YEAR
C
      DIMENSION CRP(13),JDATE(13)
      REAL MXI,MXNT
      DATA CRP/1.36,1.36,1.36,1.34,1.3,1.18,0.,0.,.34,.45,.85,1.36,1.36/
      DATA JDATE/1,87,99,117,137,146,186,248,256,261,273,305,366/
      CRPMX=1.36
      IF(RDMX.LT.0.00001)RDMX=48.0
      IF(FCMX.LT.0.00001)FCMX=1.0
C.....MXI=0.16 FROM LINSLEY, ETC.
      IF(MXI.LT.0.00001)MXI=0.16
C .....INTERPOLATE BLANNEY-CRIDDLE CROP COEFFICIENTS TO IDAY
 80   DO 100 JJ=2,13
      IF(IDAY.GT.JDATE(JJ))  GO TO 100
        J=JJ
      GO TO 110
100   CONTINUE
  110 CRPT=CRP(J)
      CRPY=CRP(J-1)
      CP=CRPY+(IDAY-JDATE(J-1))*(CRPT-CRPY)/(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
C
C...APPROX 70 DAYS FROM 45 DEGREE MEAN TEMP DAY IN SPRING (DAY=87)
C...TO FULLY GROWN WHEAT. ASSUME 33% GROWN BEFORE WINTER DORMANCY.
C.. HARVESTED DAY# 186.
      FACT=.33
      IF(IDAY.GT.87.AND.IDAY.LT.158) FACT=0.67*(IDAY-87)/70.0+0.33
      IF(IDAY.GT.157.AND.IDAY.LT.187) FACT=1.0
C
C.....NON GROWING PERIOD DURING MIDDLE SUMMER.
      IF( IDAY.GT.186.AND.IDAY.LT.251) FACT=0.0
C
C...APPROX 55 DAYS TO 45 DEG. MEAN TEMP DAY IN FALL (DAY=305)
C...FROM PLANTING (DAY=250). ASSUME WHEAT GROWS TO 33% OF FULL
C...SIZE BY DAY=305
      IF(IDAY.GT.250.AND.IDAY.LT.306) FACT=.33*(IDAY-250)/55.0
      IF(IDAY.GT.305) FACT=0.33
C
      RD=RDMX*FACT
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
```

```
IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
RETURN
END
```

```
      SUBROUTINE WWAUTM(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE # 6-WINTER WHEAT, GROWN ON TWO YEAR CYCLE
C.....THIS SUBROUTINE FOR FIRST CALENDAR YEAR OF CYCLE (FALLOW,PLANTED)
C
      DIMENSION CRP(7),JDATE(7)
      REAL MXI,MXNT
      DATA CRP/0.,0.,.34,.45,.85,1.36,1.36/
      DATA JDATE/1,248,256,261,273,305,366/
      CRPMX=1.36
      IF(RDMX.LT.0.00001)RDMX=48.0
      IF(FCMX.LT.0.00001)FCMX=1.0
C.....MXI=0.16 FROM LINSLEY, ETC.
      IF(MXI.LT.0.00001)MXI=0.16
C
C .....INTERPOLATE BLANNEY-CRIDDLE CROP COEFFICIENTS TO IDAY
 80   DO 100 JJ=2,13
      IF(IDAY.GT.JDATE(JJ))  GO TO 100
        J=JJ
      GO TO 110
100   CONTINUE
  110 CRPT=CRP(J)
      CRPY=CRP(J-1)
      CP=CRPY+(IDAY-JDATE(J-1))*(CRPT-CRPY)/(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
C
C...APPROX 55 DAYS TO 45 DEG. MEAN TEMP DAY IN FALL (DAY=305)
C...FROM PLANTING (DAY=250). ASSUME WHEAT GROWS TO 33% OF FULL
C...SIZE BY DAY=305
      FACT=0.0
      IF(IDAY.GT.250.AND.IDAY.LT.306) FACT=.33*(IDAY-250)/55.0
      IF(IDAY.GT.305) FACT=.33
C
      RD=RDMX*FACT
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```

```
      SUBROUTINE WWSPRG(IDAY,RDMX,FCMX,MXI,RD,FC,MXNT,CP,APMULT,
     .                  IRSRT1,IREND1,IRSRT2,IREND2,
     .                  IRSCD,SUMCP)
C
C.....LANDUSE # 5-WINTER WHEAT, GROWN ON TWO YEAR CYCLE
C.....THIS SUBROUTINE FOR SECOND CALENDAR YEAR OF CYCLE (HARVEST,FALLOW)
C
      DIMENSION CRP(8),JDATE(8)
      REAL MXI,MXNT
      DATA CRP/1.36,1.36,1.36,1.34,1.3,1.18,0.,0./
      DATA JDATE/1,87,99,117,137,146,186,366/
      CRPMX=1.36
      IF(RDMX.LT.0.00001)RDMX=48.0
      IF(FCMX.LT.0.00001)FCMX=1.0
C.....MXI=0.16 FROM LINSLEY, ETC.
      IF(MXI.LT.0.00001)MXI=0.16
C
C .....INTERPOLATE BLANNEY-CRIDDLE CROP COEFFICIENTS TO IDAY
 80   DO 100 JJ=2,13
      IF(IDAY.GT.JDATE(JJ))  GO TO 100
        J=JJ
      GO TO 110
100   CONTINUE
  110 CRPT=CRP(J)
      CRPY=CRP(J-1)
      CP=CRPY+(IDAY-JDATE(J-1))*(CRPT-CRPY)/(JDATE(J)-JDATE(J-1))
      IF(SUMCP.LT.0.0) RETURN
C
C...APPROX 70 DAYS FROM 45 DEGREE MEAN TEMP DAY IN SPRING (DAY=87)
C...TO FULLY GROWN WHEAT. ASSUME 33% GROWN BEFORE FIRST OF YEAR.
      FACT=.33
      IF(IDAY.GT.87.AND.IDAY.LT.158) FACT=0.67*(IDAY-87)/70.0+0.33
      IF(IDAY.GT.157.AND.IDAY.LT.187) FACT=1.0
C.....FALLOW FOR REST OF YEAR
      IF(IDAY.GT.186) FACT=0.0
C
      RD=RDMX*FACT
      FC=FCMX*FACT
      MXNT=MXI*FACT
      IF(IRSRT1.EQ.0) RETURN
      IF(IDAY.LT.IRSRT1.OR.IDAY.GT.IREND2) RETURN
      IF(IDAY.LT.IRSRT2.AND.IDAY.GT.IREND1) RETURN
      IF(IRSCD.EQ.1) APMULT=CP/SUMCP
      IF(IRSCD.EQ.0) APMULT=1.0/(IREND1-IRSRT1+IREND2-IRSRT2+2)
      RETURN
      END
```


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