NOAA Technical Memorandum NWS HYDRO 37

DERIVATION OF INITIAL SOIL MOISTURE ACCOUNTING PARAMETERS FROM SOIL PROPERTIES FOR THE NATIONAL WEATHER SERVICE RIVER FORECAST SYSTEM

Office of Hydrology
Silver Spring, Md.
March 1978
Reprinted November 1980

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

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National Weather Service, Office of Hydrology Series

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WBTM HYDRO 11 Joint Probability Method of Tide Frequency Analysis Applied to Atlantic City and Long Beach Island, N.J. Vance A. Myers, April 1970, 109 pp. (PB192745)

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NWS HYDRO 12 Direct Search Optimization in Mathematical Modeling and a Watershed Model Application. John C. Monro, April 1971, 52 pp. (COM-71-00616)

NWS HYDRO 13 Time Distribution of Precipitation in 4- to 10-Day Storms--Ohio River Basin. John F. Miller and Ralph H. Frederick, July 1972, 41 pp. (COM-72-11139)

NWS HYDRO 14 National Weather Service River Forecast System Forecast Procedures. Staff, Hydrologic Research Laboratory, December 1972, 7 chapters plus appendixes A through I. (COM-73-10517)

(Continued on inside back cover)

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Bobby L. Armstrong

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Juanita M. Kreps, Secretary

NATIONAL OCEANIC AND
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Richard A. Frank, Administrator

National Weather
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DERIVATION OF INITIAL SOIL MOISTURE ACCOUNTING PARAMETERS FROM SOIL PROPERTIES FOR THE NATIONAL WEATHER SERVICE RIVER FORECAST SYSTEM

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ABSTRACT. The method developed in this research will provide the initial soil moisture accounting parameters for the National Weather Service River Forecast System. The parameters will be physically consistent between basins and subareas of basins. In this study, each parameter used in the conceptual runoff model is investigated, and a computational procedure relating to soil properties is developed. Parameters are derived (for Council Creek near Stillwater, Okla.) and used in a computer verification program.

This study demonstrates a practical and useful solution for obtaining soil moisture accounting parameters from soil properties. The effectiveness of this procedure can be increased by using it in conjunction with the parameters derived from basin hydrographs. Although the parameters derived from soil properties produce an excellent initial simulation, the optimum parameters may be found only by a trial and error approach that must be computerized because of the complexity of the model. By the use of this method, the number of trial and error attempts will be greatly decreased, and a considerable savings of man-hours and computer time will result.

I. INTRODUCTION

A. Background

The basic and probably the most important component of a river forecasting procedure is the rainfall-runoff relation that converts precipitation amounts to the volume of water observed in the stream channel. The maximum benefit derived from an accurate river forecast that predicts flooding occurs when the time between forecast issuance and flood is the greatest since this gives the maximum reaction time to take protective measures to save lives and property. A good rainfall-runoff relation will provide the maximum possible benefit since it will be possible to issue a forecast as soon as the rainfall is observed and reported. If it is necessary to adjust the forecast hydrograph by the use of observed river stages, the reaction time can be greatly reduced.

A number of methods have been developed to convert rainfall to runoff. The philosophy to use the simplest procedure that will give good results has often been followed especially before the widespread use of computers. Operational rainfall-runoff relations ranged from a procedure that would give runoff as a percentage of rainfall to coaxial relationships which would include such input as week of the year, duration of rainfall, antecedent precipitation index, and amount of rainfall.

Runoff values derived from soil moisture models that are conceptual in nature relate to actual processes in nature. They are designed to reproduce all components of flow and generate continuous hydrographs. Models of this type are complex since a considerable number of parameters are used. The parameters can be approximated from hydrographs or from observed basin characteristics. By the use of soil moisture models, forecasts can be prepared for water quality, water supply, and soil moisture levels for agriculture as well as for floods. Parameters to forecast a basin are usually developed by computer programs that analyze a given period of record with a given set of soil moisture accounting parameters. The basis of the approach is that past responses of the river are keys to the future responses. It is very important that a full range of soil moisture conditions be observed over the selected period of record which usually has a dura-

Table 1.--Nomenclature*

AD	Total area of "D" Classification soils (mi^2)
ADIMC	Additional impervious contents (mm)
ADIMP	Additional impervious parameter (%)
AWC	Available water capacity (in./in.)
BA	Total basin area (mi^2)
CFS	Cubic feet per second
D	Average distance from edge of basin to nearest stream (ft)
DEFR	Lower zone soil moisture deficiency (%)
ET	Evapotranspiration (mm/day)
I	Infiltration (in./hr)
KI	Coefficient for saturated area along stream
Kp	Coefficient of permeability(gpd/ft^2)
LZ	Lower zone
LZFPC	Lower zone primary contents (mm)
LZFSC	Lower zone supplemental contents(mm)
LZFPM	Lower zone primary maximum (mm)
LZFSM	Lower zone supplemental maximum (mm)
LZP	Permeability of LZFSM thickness (in./hr)
LZPK	Lower zone primary drainage rate (%/day)
LZSK	Lower zone supplemental drainage rate (%/day)
LZTWC	Lower zone tension water contents (mm)
LZTWM	Lower zone tension water maximum(mm)
N	Average number of days interflow observed
NWS	National Weather Service
NWSRFS	National Weather Service River Forecast System
P	Permeability (in./hr)
PBASE	Maximum flow lower free water zones produce (mm/day)
PCTIN	Percent impervious (%)
PFREE	Percolation water percentage to lower free water zones (%)
RA	Area of riparian vegetation (mi^2)
REXP	Percolation exponent
RSERV	Lower free water reserved (%)
SA	Average surface area of stream (mi^2)
SARVA	Fraction of basin covered by water and riparian vegetation (%)
SAW	Area of basin covered by streams and lakes (mi^2)
SCS	Soil Conservation Service
SCST	Supplemental computed soil thickness (in.)
SIDE	Ratio of unobserved to observed base flow (%)
SSOUT	Flow lost from total channel flow (m^3/s)
TSPT	Total soil profile thickness (in.)
UCST	Upper computed soil thickness (in.)
USDA	United States Department of Agriculture
UZFWC	Upper zone free water contents (mm)
UZFWM	Upper zone free water maximum (mm)
UZK	Upper zone drainage rate (%/day)
UZP	Permeability of UZFWM thickness (in./hr)
UZTWC	Upper zone tension water contents (mm)
UZTWM	Upper zone tension water maximum(mm)
ZPERC	Percolation factor (%)

*Pertinent terms are included. The interested reader should contact the author for any term not listed above.

tion of several years. After a simulated hydrograph set is produced from the initially selected parameters, it is compared to the observed hydrograph set. Differences between the hydrograph sets are noted, and manual changes are made in the soil moisture accounting parameters to improve the correlation; then another computer run is made with revised parameters. This procedure is complex; it must be repeated many times until an optimum fit between the observed and simulated hydrographs is obtained. Obviously, the closer the initial parameters are to the optimum, the quicker the basin can be modeled. Hence, computer time and many man-hours are saved. Also, if all the initial parameters are realistic, there is a greater probability that all of the optimum parameters will be conceptually correct. Modeling of a basin not only consists of changes in the soil moisture accounting parameters but also may include the histogram, routing, evapotranspiration, and precipitation.

The U.S. National Weather Service (NWS) in 1972 developed a river forecast system (NWSRFS) that will be used by their River Forecast Centers in making operational forecasts. (See table 1.) The system (Staff, Hydrologic Research Laboratory, 1972) includes a catchment model that uses a soil moisture accounting system. In 1974, the moisture accounting system used in the NWSRFS was changed to the catchment model developed at the NWS Sacramento, Calif., River Forecast Center by Burnash et al. (1973). The system has the proven capability of producing top quality forecasts. The Sacramento system shown in figure 1 defines two layers, upper and lower, with each layer consisting of free water and tension water storages. A percolation equation that moves water from the upper to lower zone is an important component of the system. A total of 17 soil moisture accounting parameters are used to simulate streamflow. Many of the parameters are interrelated. To produce a hydrograph, the model uses a histogram that can have areal zones assigned to specific histogram elements. It is, therefore, possible to select a set of parameters for each areal zone that consists of different hydrologic characteristics. Since the parameters have been developed to simulate high and low flows, the model should perform equally well on streamflows of all magnitudes. The operational use of the model is dependent on the availability of high speed computers since the numerous and time-consuming calculations that are performed for each basin cannot be done manually on a real-time basis with procedures now available.

Since the modeling of a basin is an extremely time-consuming process and the area to be modeled is extensive, any method to decrease the time spent on each basin would be extremely valuable. One of the best approaches is to obtain a set of initial parameters as conceptually valid as possible. The method (Peck 1976) to obtain beginning parameters from an observed hydrograph set over a period of record as long as 10 yr has been used with some success, but it has several drawbacks. The hydrograph method is dependent on the lower zones being totally saturated within the selected period of record, which rarely occurs in some regions. Also, it is necessary to have streamflow records available to even get started, and it is not really possible to deal with discontinuities across the basin. By the development and use of a physical characteristic method, similar basins can be modeled with similar parameters. Consequently, the division of gaged basins to conform with definite discontinuities is possible as well as obtaining parameters for basins that are totally ungaged.

The most available source of measurements for a physical characteristic model is the estimated engineering soil properties derived by the U.S. Soil Conservation Service (SCS). Published soil surveys on a county basis are often available. Soil survey interpretations for specific soils are also available. The most apparent soil properties that are applicable to conceptual models are permeability, available water capacity, infiltration, USDA texture, and shrink-swell potential.

The soil property derivation method was developed and tested in Oklahoma and Kansas. There were no radical changes in climate, topography, or land use within the area of development. The developed method was not intended to replace or even supersede the derivation of parameters from a hydrograph set (Peck 1976). The separation of hydrograph components is and always has been an important phase of hydrologic analysis. Remember that there will be a parameter set available from the soil property computations for the first calibration run (semilog plot). The soil property parameter set can then be compared to the observed hydrographs, and such parameters as LZPK and LZSK can be calculated quickly for the second run. Hence, there is a place for the use of both methods if streamflow records are available. The two methods are the most applicable to headwater basins.

B. Objectives

The objectives of this research are to relate the soil moisture accounting parameters used in the NWSRFS to the engineering soil properties that are readily available in SCS soil surveys, to provide a numerical procedure to derive initial soil moisture parameters for use in modeling a basin, and to apply a derived parameter set to an actual basin. The soil derivation method is the first attempt of this type; it points a direction rather than defining the ultimate solution.

In section II, the overall theory of the NWSRFS Catchment Model is supported by the hydrologic literature. The work previously done to obtain initial soil moisture accounting parameters is defined. In section III, the SCS soil properties used for the parameter derivations and the soil moisture accounting parameters are discussed. The equations that have been developed to compute the parameters in this research are

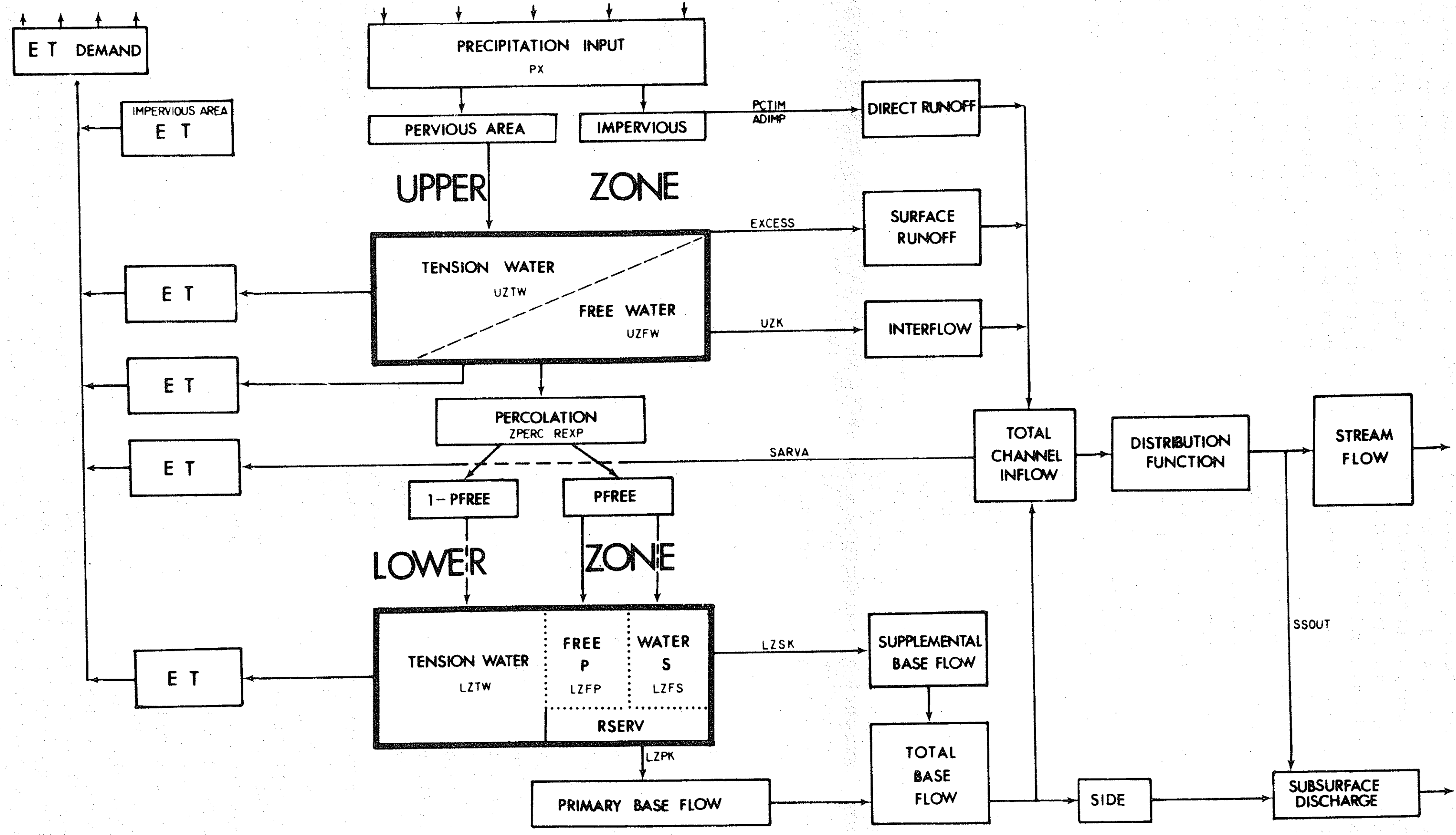

Figure 1.--Flow diagram of the NWSRFS catchment model (from Peck 1976)

presented in section IV. In section V is a demonstration of the use of the derived equations and the application of the derived parameters on an actual basin. The computer listing of the NWSRFS Soil Moisture Accounting Subroutine in appendix I contains the equations used in the computation of runoff increments and the contents of the model zones. Any question on a specific process can be ultimately answered after following it through the computer program.

II. Review of Literature

Methods of converting rainfall to runoff have changed from single event approaches described by Linsley et al. (1958) to the present conceptual models that became practical with the advent of modern high-speed computers. The present soil moisture accounting system used by the National Weather Service in the NWSRFS was developed at the Sacramento River Forecast Center in Sacramento, Calif.

In 1971, Burnash and Ferral were developing a river forecast system that would represent streamflow in a physically consistent manner. A hydrologic model by Burnash et al. (1973) was presented (giving simplified approximations of natural processes) that was consistent with soil moisture profiles determined by experimental studies (Hanks et al. 1969 and Green et al. 1970). The system was to correspond with observed characteristics of moisture movement through the soil mantle that included the formation and transmission of the wetting front.

The NWSRFS is basically a two-level model. Todd (1959) described soil water zones that included the profile from the surface through the major root zone and an intermediate zone which was the profile from the lower edge of the soil water zone to the upper limit of the capillary zone of the water table. Both zones include capillary, gravitational, and hygroscopic water.

Evapotranspiration is limited to the depth that roots will penetrate. George et al. (1957) reported that, in an area of 22.5 in. of annual rainfall, 97.3% of the roots of all plants were growing in the upper 4 ft of soil. Richards and Richards (1957) reported that the roots of most plants would not enter wet saturated soils and high water tables limit root penetration and even kill roots which had penetrated below the current water table level before it experienced an upward movement. The removal of water from the tension water zones in the NWSRFS conceptual model is accomplished through evapotranspiration. Hence, the zones should be limited to the depth of root penetration.

Peck (1976) presented a procedure that expanded upon the previous method to derive initial parameters from an observed hydrograph set and then applied the parameters to a basin. Four parameters were said to be readily computed, six parameters were considered more difficult to derive, one parameter could be estimated from maps, two paramaters would be substituted from a nearby basin, and nominal starting values were used for three.

The conceptual model used by the NWSRFS should relate to the engineering soil properties of a basin. The actual use of soil properties in deriving parameters for the model has not been described in the literature.

III. INITIAL PARAMETER DERIVATION COMPONENTS

The Soil Conservation Service (SCS) estimated engineering properties of soils will be used to derive the initial NWSRFS soil moisture accounting parameters. All components must be defined and evaluated before a procedure to relate the components will be meaningful.

A. Soil Conservation Service
Soil Survey Estimated Engineering Properties

Soil profiles are divided into layers that are significantly different for purposes of soil engineering. Engineering soil properties are given for each layer.

Soil texture is given in standard USDA terms. It relates to the relative percentage of sand, loam, and clay.

Available water capacity (AWC) is defined as the ability of soils to hold water for use by most plants. The value of AWC is considered to be the difference between the amount of water at field capacity and the amount at the wilting point of most crop plants. Units commonly used are inches of water per inch of soil. Hence, an AWC of 0.17 would mean that 0.17 of an inch of water would wet the soil to a depth of 1 in. AWC values are given in many county soil surveys and soil survey interpretations.

Shrink-swell potential is the extent to which the soil shrinks as it dries out and swells when it gets wet. A high shrink-swell potential will greatly reduce the downward movement of water if the layer is wet.

Permeability is the quality of a soil that enables it to transmit water or air. Values do not take into account lateral seepage or such transient features as plowpans and surface crusts. Units commonly used are inches of soil that the water moves through per hour.

Infiltration rate is defined as the minimum rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. Infiltra-

Table 2.--SCS infiltration rates

Soil type	Inches of water per hour
A	0.45-0.30
B	.30- .15
C	.15- .05
D	.05- .00

tion rates are widely used by the SCS in estimating runoff from rainfall for watershed planning. Table 2 relates soil type to infiltration with the lower limit being used for clays, the average value for loam, and the upper limit for sand. Original SCS classifications were made from rainfall-runoff data obtained from small watersheds or infiltrometer plots. The majority of the soils classified are compared to profiles already classified to determine the soil type. The theory is that similar soils will produce the same amount of runoff during heavy rainfall. Assumptions made in the classification are that the soil surfaces were bare, maximum swelling had taken place, and rainfall rates exceeded surface intake rates. The SCS (1964) has given group classifications to more than 4,000 soils in the United States and Puerto Rico.

Soil type A is defined as soils (low runoff potential) having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained soils or gravels. The soils have a high rate of water transmission. Soil type B is defined as soils (moderately low runoff potential) having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse texture. The soils have a moderate rate of water transmission. Soil type C is defined as soils (moderately high runoff potential) having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water, soils with moderately fine to fine texture, or soils with moderate water tables. The soils are somewhat poorly drained. Soil type D is defined as soils (high runoff potential) having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious materials.

B. National Weather Service River Forecast System Soil Moisture Accounting Parameters

Description

Percent impervious (PCTIM) is the permanently impervious fraction of the basin contiguous to the stream channel. Manmade impervious areas such as paved parking lots with direct drainage to the stream, areas of impervious rock formation outcrops near the stream, and the actual surface area of the stream would be considered to be the basin area to be assigned to PCTIM. This component of runoff referred to as impervious runoff will be produced from a given rainfall regardless of the dryness of the soil and is computed as a percentage of the rainfall. A small rise in the stream following a prolonged dry spell would be composed of PCTIM runoff.

Additional impervious (ADIMP) is the fraction of the basin that becomes impervious as all tension water requirements are met. This parameter relates to an increase of impervious area as the saturated area of the basin increases. A small stream rise after a very wet period and after the upper zones have dried enough to intake additional rainfall would be composed of ADIMP runoff.

Upper zone tension water maximum (UZTWM) is the depth of water that must be filled in the nonimpervious area before any water is available to other storages. Water retained as capillary water as well as surface detention would be included in this storage. Since this zone must be filled before there is any response by the stream, a specific amount of rainfall could be computed from rainfall amounts that occurred and did not produce a stream response any greater than the impervious contribution.

Upper zone free water maximum (UZFWM) is the depth of water that would be filled over the nonimpervious portion of the basin in excess of UZTWM. The content of this zone is made available for interflow after percolation and evaporation requirements are fulfilled. Any overflow of this zone is surface runoff. Derivation of the parameter from a hydrograph set is not feasible. It is usually determined through trial and error.

Drainage rate (UZK) is the upper zone lateral drainage rate that is expressed as the ratio of the daily withdrawal to the available contents of the upper zone free water. The parameter value is related to the length of time that interflow occurs after a storm of considerable runoff. UZK cannot be directly determined from a hydrograph analysis. It has been suggested that a rough estimate of UZK can be determined by

$$0.10=(1-UZK)^N \qquad (1)$$

where N is the average number of days that interflow is observed.

Lower zone tension water maximum (LZTWM) is the maximum capacity of the lower zone tension water. This parameter is very difficult to extract from the hydrograph set. LZTWM would be the capillary water retained in the lower zone that does not become streamflow but is removed through evapotranspiration. It, therefore, represents the water that will be removed by existing plants during dry periods.

Lower zone supplemental maximum (LZFSM) is the maximum capacity of the lower zone free water storage. The flow from this storage is the supplemental base flow and is the faster response component of the base flow. This parameter may be derived from the hydrograph set if the zone is saturated during the period of record being modeled.

Lower zone supplemental drainage rate (LZSK) is the lateral drainage rate of the lower zone supplemental free water expressed as a fraction of contents per day. LZSK may be derived from the hydrograph set.

Lower zone primary maximum (LZFPM) is the maximum capacity of the lower zone primary free water storage. The flow from this storage is the primary base flow and is the slower response component of the base flow. This parameter may be derived from the hydrograph set if the lower zone is saturated during the period of record being modeled.

Lower zone primary drainage rate (LZPK) is the lateral drainage rate of the lower zone primary free water expressed as a fraction of contents per day. This parameter may be derived from the hydrograph set. Variations in daily evaporation during base-flow conditions, especially during days of high temperatures, will sometimes cause problems in deriving the rate from the observed base flow.

PBASE is the maximum flow that the subsurface zones are capable of producing as base flow. If the lower zones are saturated, PBASE would be the maximum percolation. PBASE, an important component of the percolation equation, is not an input parameter but is computed from

$$PBASE=(LZFPM \cdot LZPK+LZFSM \cdot LZSK). \qquad (2)$$

DEFR is the lower zone soil moisture deficiency. The number, used in the percolation equation, is not an input parameter but is computed from

$$DEFR=1-\left(\frac{LZTWC+LZFPC+LZFSC}{LZTWM+LZFPM+LZFSM}\right) \qquad (3)$$

where LZTWC is the contents of the lower zone tension water; LZFPC, the contents of the lower zone primary water; and LZFSC, the contents of the lower zone supplemental water.

Percolation factor (ZPERC) is a value used to define the proportional increase in percolation from a saturated to a dry condition. The initial value of ZPERC is usually estimated.

Percolation exponent (REXP) determines the rate at which the percolation demand changes from the dry condition to the saturated condition. The initial value of REXP is usually estimated.

Percolation water percentage (PFREE) is the percentage of percolation water that directly enters the lower zone free water without a prior claim by lower zone tension water. If the hydrographs at a basin return quickly to the same base flow that was present before the rise, a small value of PFREE would be indicated.

Lower free water reserved (RSERV) is the fraction of lower zone free water not available for resupplying lower zone tension water. The initial value is estimated.

SARVA is the fraction of the basin covered by water and riparian vegetation areas.

SIDE is the ratio of unobserved to observed base flow. This parameter represents the ground water that does not appear at the river gage. The value is usually 0.

SSOUT is a fixed rate of discharge lost from the total channel flow. The value is usually 0.

Interrelation

The interrelation of parameters in the model greatly increases the complexity of reaching the optimum parameters. A conceptual model that truly relates to nature with the many interactions which take place must contain such an interrelationship. The heart of the conceptual model is the percolation equation, and a complete understanding of the equation is important to successfully model a basin. There are eight model parameters that affect the percolation equation; and by changing any one of them, the percolation curve (fig. 2) will change. The equation controls the movement of water in both the upper and lower zones and is influenced by the movement of water in all parts of the profile. The parameters directly involved

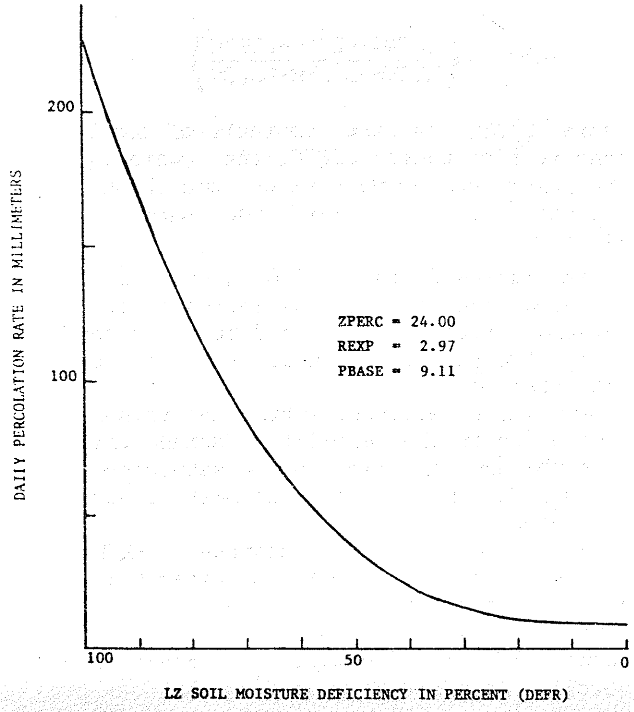

Figure 2.--Daily percolation rate curve

in the formula are LZFPM, LZPK, LZFSM, LZSK, ZPERC, LZTWM, REXP, and UZFWM. The percolation equation is

$$\text{daily percolation rate}=\text{PBASE} \times(1+\text{ZPERC}\cdot\text{DEFR}^{\text{REXP}}). \qquad (4)$$

The shape of the percolation curve is determined by the REXP parameter that will influence the percolation between 0 and 100% deficiencies. The maximum percolation will occur at 100% deficiency and is defined by

$$\text{max. percolation rate}=(1+\text{ZPERC})\cdot\text{PBASE}. \qquad (5)$$

The minimum percolation occurs at zero deficiency and is equal to PBASE. By determining the value of DEFR (eq 3) at the beginning of a storm and plotting the point in relation to the percolation curve (fig. 2), the percolation to the lower zones may be increased or decreased to yield the desired amount of runoff necessary to produce the best fit with the observed hydrograph. If the simulated hydrograph crest is too high, the percolation should be increased; or if the hydrograph crest is too low, the percolation should be decreased. By increasing or decreasing percolation, the volume of water to be dealt with in the lower zones will also be changed. Each hydrograph rise throughout the entire simulation period should in turn be plotted in relation to the percolation curves so a decision can be made as to how the parameters should be changed to produce the best fit with the percolation curve. It is important that a full range of DEFR values be found in the given simulation period since it would be difficult to adjust the curves with values at one extreme or the other. The derivation of the optimum parameters for a basin will depend heavily on the use of the percolation curve.

IV. DERIVATION OF EQUATIONS TO COMPUTE SOIL MOISTURE PARAMETERS

A priority need of the highest order is a method of determining parameter values so they will be physically consistent between basins and subareas of basins. The goal of a conceptual model is to relate to the physical processes in nature. Hence, a source of physical soil properties must be found that is available for most areas. The source used is the SCS engineering soil properties found in their county soil surveys or soil survey interpretations. Figure 3 is an example of the format of a typical soil survey interpretation and shows the information usually presented.

Equations to compute 12 of the 17 parameters required by the model were developed in this research. The equations and procedures are defined in this section. A 13th parameter is found by using table 5. The computed parameters, which are initial values, will not be the optimum because of the obvious variations in nature, the lack of available soil properties for the computational need of each parameter, and the probable inability of the model equations to exactly and realistically reproduce every possible flow component. The derivation procedure will attempt to use the measurements readily available in a realistic manner. Since past experiences in engineering are considered in making the estimates, recent SCS county soil surveys (Swafford 1967) rather than the SCS soil survey interpretations should be used whenever possible. Remember that the magnitude of UZTWM, LZTWM, and the evapotranspiration curve could be strongly influenced if the rainfall input does not describe the true basin precipitation. All thicknesses must be converted to millimeters (25.4 mm/in.) for use in the available computer programs.

UZTWM by definition is closely related to available water capacity. UZTWM must be filled before any water is available for free water (gravity water), and the water is ultimately removed only through evapotranspiration. Available water capacity is the maximum amount of water held in the soil after gravitational water has drained away and after the rate of downward movement of water has materially decreased. An obvious

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ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-8	C	CL, CH	A-6, A-7-6	0	95-100	90-100	90-100	80-98	38-60	20-38
0-8	CL	CL	A-6, A-7-6	0	95-100	90-100	90-100	70-95	35-50	17-30
8-21	C	CL, CH	A-6, A-7-6	0	95-100	90-100	90-100	80-98	38-60	20-38
21-60	SH-C	CL, CH	A-6, A-7-6	0-5	90-100	85-100	65-100	65-95	30-60	15-38

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-8	<0.06	0.10-0.17	7.9-8.4	-	HIGH	HIGH	LOW	.32	2	4
0-8	0.06-0.2	0.12-0.17	7.9-8.4	-	HIGH	HIGH	LOW	.32	2	6
8-21	<0.06	0.10-0.15	7.9-8.4	-	HIGH	HIGH	LOW	.32		
21-60	<0.06	0.-0.10	7.9-8.4	-	HIGH	HIGH	LOW	.32		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		D	-

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY
SEWAGE LAGOON AREAS	1-2%: SLIGHT 2-7%: MODERATE-SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-TOO CLAYEY
SANITARY LANDFILL (AREA)	1-8%: SLIGHT 8-12%: MODERATE-SLOPE
DAILY COVER FOR LANDFILL	POOR-TOO CLAYEY

COMMUNITY DEVELOPMENT (B)

SHALLOW EXCAVATIONS	SEVERE-TOO CLAYEY
DWELLINGS WITHOUT BASEMENTS	SEVERE-LOW STRENGTH,SHRINK-SWELL
DWELLINGS WITH BASEMENTS	SEVERE-LOW STRENGTH,SHRINK-SWELL
SMALL COMMERCIAL BUILDINGS	1-8%: SEVERE-LOW STRENGTH,SHRINK-SWELL 8+%: SEVERE-SHRINK-SWELL,LOW STRENGTH,SLOPE
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH,SHRINK-SWELL
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL (B)

ROADFILL	POOR-SHRINK-SWELL,LOW STRENGTH
SAND	UNSUITED-EXCESS FINES
GRAVEL	UNSUITED-EXCESS FINES
TOPSOIL	1-8% CL: FAIR-TOO CLAYEY 8-12% CL: FAIR-TOO CLAYEY,SLOPE C: POOR-TOO CLAYEY

WATER MANAGEMENT

POND RESERVOIR AREA	SLIGHT
EMBANKMENTS DIKES AND LEVEES	MODERATE-HARD TO PACK
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	SLOW INTAKE,PERCS SLOWLY,DROUGHTY
TERRACES AND DIVERSIONS	FAVORABLE
GRASSED WATERWAYS	DROUGHTY,PERCS SLOWLY,SLOPE

REGIONAL INTERPRETATIONS

Figure 3.--Soil survey interpretation

problem must be resolved before a solution can be determined. The use of a standard thickness was considered, but a given zone would obviously not be thick enough for soils of high permeability and not thin enough for soils of very low permeability. Also, the soil profile changes with a subsequent change in permeability so an approach to the problem is apparent. Since the drainage rates used in the model are in daily increments, the permeability (in./hr) times 24 hr is a logical approach. Exception would be a layer of moderate to high shrink-swell potential within the computed depth; thus the zone thickness is the calculated thickness or the depth to a moderate to high shrink-swell potential layer whichever is less. If the computed zone thickness exceeds the depth of the entire soil profile, then the soil profile thickness will be used. If the soil profile or areal coverage consists of soils of different characteristics, the computations must contain the correct percentage of each to obtain an overall correct parameter. The computation equation is

$$\mathrm{UZTWM}=(25.4)(\mathrm{AWC})(\mathrm{UCST}) \qquad (6)$$

where UZTWM is the upper zone tension water maximum (mm); AWC, the available water capacity (in./in.); and UCST, the upper computed soil thickness (in.).

LZTWM is the capillary water retained in the lower zone that is not available to the free water of the lower zones. Water is removed only through evapotranspiration; consequently, the zone would be restricted to the depth of root penetration. The thickness of the zone is considered to be the soil profile below the upper zone tension water computed depth. If the zone includes a thick clay layer with a high shrink-swell potential, the computed value will tend to be much too high since the total thickness would not be saturated by percolated water. The computation equation is

$$\mathrm{LZTWM}=(25.4)(\mathrm{AWC})(\mathrm{TSPT}-\mathrm{UCST}) \qquad (7)$$

where LZTWM is the lower zone tension water maximum (mm); AWC, the available water capacity (in./in.); TSPT, the total soil profile thickness (in.); and UCST, the upper computed soil thickness (in.).

UZFWM is related to the gravitational water in the soil that drains away after the available water capacity is full. The volume as used in the model must first fill the percolation requirements of the lower zones; and then the remaining volume is removed to satisfy the daily interflow requirement. If the water remaining exceeds the capacity of the zone, it is the computed surface runoff. The same UCST as used in the UZTWM is used in the UZFWM equation. The equation to compute UZFWM uses a ratio of the infiltration rate of rainfall to the permeability. If the ratio approaches a value of 1, a maximum free water volume for the computed soil thickness would be indicated. A ratio of 1 or greater would indicate a quick response of interflow, and the ratio volume must be set at 1 in the equation. As the ratio becomes smaller and smaller, the free water in the soil would approach a minimum value. The computation equation is

$$\mathrm{UZFWM}=[25.4][\left(\frac{I}{P}\right)(\mathrm{UCST})] \qquad (8)$$

in which UZFWM is the upper zone free water maximum (mm); I, the infiltration (in. of water/hr); P, the permeability (movement of water through in. of soil/hr); and UCST, the upper computed soil thickness (in.). A range of values are usually given for permeability. The smallest value is used for a high shrink-swell potential and the largest value for a low shrink-swell potential.

UZK must be derived from parameters that indicate vertical flow rather than lateral flow so a relationship must be attempted. The daily volume of interflow will be equal to water present in the upper zone free water times UZK; accordingly, a value of UZK that is larger than the actual will tend to give a large component of interflow and decrease surface runoff. The ratio of infiltration to permeability was used since the larger the value, the larger the component of interflow. The value of UZK computed would tend to be the maximum to be expected. UZK should never be greater than 1. The computation equation is

$$\mathrm{UZK}=\frac{\text{infiltration}}{\text{permeability}} \qquad (9)$$

where UZK is the upper zone drainage rate (%/day).

LZFSM should be computed with the same approach as that used for the UZFWM. The thickness (SCST) should be computed by multiplying the permeability from the computed UCST downward by 24 hr or the thickness to a higher shrink-swell potential layer whichever is less. The computation equation is

$$\mathrm{LZFSM}=[25.4][\left(\frac{\text{infiltration}}{\text{permeability}}\right)(\mathrm{SCST})] \qquad (10)$$

where LZFSM is the lower zone supplemental maximum (mm) and SCST is the supplemental computed soil thickness (in.).

LZSK is the daily lateral drainage rate from the lower zone supplemental free water storage that produces a component of base flow in the stream. The flow has been defined as having a source of flow different from the primary flow and is observed on the hydrograph as the recession immediately following the surface runoff and the interflow. The LZFSM flow could be visualized as the flow that would emerge through the surface zone as the upper zone volume was depleted. This would give the necessary lag to the flow and would be most logical if the supplemental zone were limited by a moderate to high shrink-swell zone. By definition, the upper zone is considered to be depleted when the capacity has decreased to 10% of the maximum, which is an estimate of hygroscopic water that cannot be removed naturally. Hence, a constant to relate to the upper zone depletion and the subsequent flow from the lower zone can be found. The computation equation is

$$\text{LZSK}=\frac{\text{UZK}}{1.9+(0.9)\left(\frac{\text{UZP}}{\text{LZP}}\right)} \qquad (11)$$

where LZSK is the lower zone supplemental drainage rate (%/day); UZP, the permeability of the UZFWM thickness (in./hr); and LZP, the permeability of the LZFSM thickness (in./hr).

LZFPM is the storage that supplies the volume for base flow in the stream. Since the interrelationship of all the natural processes is very complex, a logical approach to the maximum volume in the zone is needed. If a high water table level is to remain constant, there must be a balance between inflow and outflow of the aquifer. Specific yield is the ratio of water that will drain freely from the material to the total volume of the formation. The specific yield (Linsley et al. 1958) of clay is 3% and sand is 25%. Table 3 was developed by interpolating the values. An approach will be taken that the lower zone storage is equal to the specific yield of the lower zone thickness. The layer thickness for LZFPM is the total soil profile minus the upper zone and supplemental zone thicknesses. The computation equation is

$$\begin{aligned}\text{LZFPM}=&[25.4][(\text{TSPT-UCST-SCST})\\ &\times(\text{specific yield})\end{aligned} \qquad (12)$$

where LZFPM is the lower zone primary maximum (mm); TSPT, the total soil profile thickness (in.); UCST, the upper computed soil thickness (in.); and SCST, the supplemental computed soil thickness (in.).

LZPK is a parameter that through definition will be computed with difficulty from the soil properties available. In areas of a relatively shallow soil profile, the lateral drainage rate is related to the coefficient of permeability (Kp) that is defined in Linsley et al. (1958) as the discharge in gallons per day (gpd) through an area of 1 ft² under a gradient of 1 ft/ft at 60°F. By considering the lower zone thickness, the lateral rate of flow may be determined. Table 4 was developed by interpolating the coefficients of permeability (Walton 1970) for clay and sand.

LZPK is computed by determining the ratio of the coefficient of permeability to the average distance from the edge of the basin to the nearest tributary of the stream. The soil classification can be determined from the soil profile and the correct Kp value selected. It has been noted that the LZPK computed by the developed equation will tend to be the minimum limit. The computational equation is

$$\text{LZPK}=\frac{(\text{Kp})(0.134)}{\text{D}} \qquad (13)$$

where LZPK is the lower zone primary drainage rate (%/day); D, the average distance from the edge of the basin to the nearest tributary (ft); and Kp, the coefficient of permeability (gpd/ft²).

ZPERC may be calculated from parameters already computed. Note that, if any of the five parameters used in the equation are unrealistic, the computed ZPERC value may be in error by a rather large amount. The maximum percolation is believed to take place when the upper zones are full and the lower

Table 3.--Specific yields

Soil classification	Specific yield (%)
Clay	3
Silt loam	9
Loam	14
Sandy loam	20
Sand	25

Table 4.--Coefficients of permeability

Soil classification	Kp (gpd/ft²)
Clay	2
Silty loam	750
Loam	1,500
Sandy loam	2,250
Sand	3,000

zones are empty. It, therefore, will be assumed that the maximum daily percolation will be the maximum contents of the lower zones. By substitution into the maximum percolation rate equation and assuming 100% deficiency in the lower zones, the computation equation is

$$ZPERC=\frac{LZTWM+LZFSM+LZFPM-PBASE}{PBASE} \quad (14)$$

where ZPERC is the percolation factor (%).

REXP is the exponent determining the rate of change of percolation from a dry condition to a saturated condition of the lower zones. The value of REXP may be related to the soil classification of the soil profile at the base of the upper zone. The minimum permissible REXP value of 1.0 would indicate an almost constant decrease of percolation as the lower zone deficiencies decrease and would relate to a sand. A large REXP would indicate a rapid decrease of percolation as the zones become saturated such as is expected in a clay. REXP values (table 5) have been estimated for each soil classification.

PCTIM is the impervious area of the basin and would obviously consist of the surface area of the stream. Impervious areas of the basin adjacent to the stream such as paved parking lots and possibly urbanized areas should be added. A value of 0.001 is a good initial value for headwater basins without known impervious areas greater than the surface area of the stream. If the surface area of the stream is known, the computation equation is

$$PCTIM=KI\left(\frac{SA}{BA}\right) \quad (15)$$

where PCTIM is the percent impervious (%); KI, the coefficient for estimated additional area adjacent to the stream that is saturated at all times; SA, the average surface area of the stream (mi^2); and BA, the total basin area (mi^2).

Table 5.--Percolation exponents

Soil classification	REXP
Sand	1.0
Sandy loam	1.5
Loam	2.0
Silty loam	3.0
Clay, silt	4.0

ADIMP is the additional area of the basin that becomes impervious as the tension water requirements are met. Peck (1976) suggested that remote sensing techniques using radiation measurements (infrared) could define the area of the basin to be assigned as ADIMP. Since measurements of this type are not readily available, another system has been devised. The soils of the basin with a hydrologic soil classification of D have a minimum saturation infiltration value of 0 that would indicate an impervious area when saturated. An obvious approach would be to consider the area of D soils as the ADIMP area. Since clays have a minimal specific yield of 3%, a value of 0.03 is subtracted from the D soil percentage of the total area. Thus,

$$ADIMP=\left(\frac{AD}{BA}\right)-0.03 \quad (16)$$

where ADIMP is the additional impervious parameter (%); AD, the total area of D soils (mi^2); and BA, the total basin area (mi^2).

SARVA provides for the removal of water from the stream by evapotranspiration. If the riparian vegetation area of the basin is not known, an estimate could be made. Consequently,

$$SARVA=\frac{RA+SAW}{BA} \quad (17)$$

in which SARVA is the fraction of the basin covered by water and riparian vegetation; RA, the area of riparian vegetation (mi^2); BA, the total basin area (mi^2); and SAW, the area of the basin covered by streams and lakes (mi^2).

PFREE is the percentage of water that bypasses the lower zone tension water requirements and is placed directly in the lower zone free water. The component apparently is the water that follows paths through fissures, cracks, faults, or along an impervious layer to escape the capillary demands of the soil. Since a logical manner of derivation of PFREE is not apparent, a nominal value of 0.30 is assumed.

RSERV is the fraction of the lower zone free water that is not available for resupplying tension water. Since a logical manner of deriving RSERV is not apparent, a nominal value of 0.30 is assumed.

SIDE and SSOUT are usually assumed to be zero as an initial value. If obvious channel losses are evident, a value could be determined from known volume losses.

V. BASIN APPLICATION

A set of parameters will be derived from the developed equations for Council Creek near Stillwater, Okla. The parameters for a gaged basin are intended to be the initial soil moisture accounting parameters that will be used in a trial and error computer program to develop the optimum parameters. If a basin is not gaged, the parameters should give adequate results. Optimum parameters developed for another basin with the same engineering soil properties could be used successfully, but it is important that the original parameters be as conceptually correct as possible to avoid proliferating a number game.

Council Creek is located in Payne County and is a tributary of the Cimarron River. The area is in the undulating to rolling prairie area of North-Central Oklahoma. The prevailing climate is of continental origin, but relatively temperate. Pronounced seasonal variations in both temperature and precipitation are characteristic of the area. Spring is the season of the heaviest rains with a secondary maximum in early fall. The area averages about 53 thunderstorms per year. Average annual rainfall is 32.5 in. The basin is in the great grassland area of the United States. Post and blackjack oaks are found on the ridgetops. Trees such as cottonwood, elm, and hackberry grow in narrow fringes along the creek.

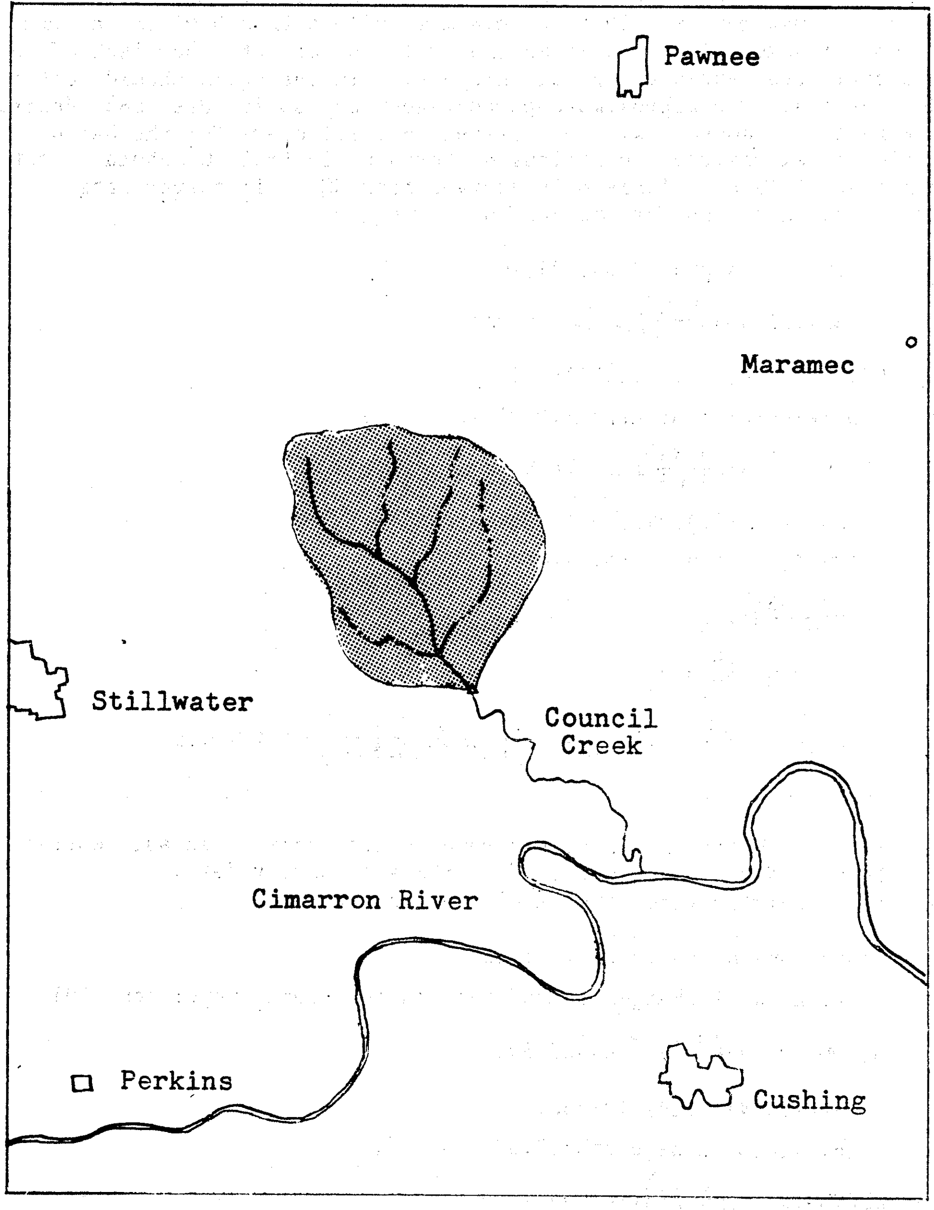

Figure 4.--Test basin map

Table 6.--Renfrow estimated engineering soil properties
(soil classification D)

USDA texture	Depth (in.)	Permeability (in./hr)	Available water capacity (in./in.)	Shrink-swell
Silt loam	0-12	<0.05	0.14	Low
Clay	12-42	< .05	.17	High

The Council Creek basin (fig. 4) has a drainage area of 13 mi^2. The gage is a water-stage recorder with a concrete control. Datum of the gage is 838.28 ft. Bankfull stage is 10 ft, which is a flow of 2,200 CFS. On October 2, 1959, a crest of 25,000 CFS (18.9 ft) was observed.

The area is underlain by interbedded sandstone and clay beds. The soils are susceptible to erosion damage, and good range management is necessary to prevent damage. The soil association of the basin is the Renfrow-Zaneis-Vernon. The soils vary from C to D type. The permeability ranges from a maximum of 0.50 to a minimum of less than 0.05 in./hr, and available water capacity from a minimum of 0.14 to a maximum 0.17 in. of water per inch of soil. The variations of the estimated engineering soil properties in the basin should test the efficiency of the derivations. The approximate percentages of soils are 58% Renfrow, 30% Zaneis, and 12% Vernon. Parameters will be derived in millimeters for the basin.

The Renfrow series is extensively distributed through central Oklahoma, south-central Kansas, and north-central Texas. Table 6 is derived from SCS soil survey data.

The soil parameter calculations for the Renfrow series are:

$$\text{upper zone depth}=(0.03)(24)=0.72,$$

$$\text{UZFWM}=(25.4)\left(\frac{0.03}{0.03}\right)(0.72)=18.29,$$

$$\text{UZTWM}=(25.4)(0.14)(0.72)=2.56,$$

$$\text{supplemental zone depth}=(0.03)(24)=0.72,$$

$$\text{LZFSM}=(25.4)\left(\frac{0.03}{0.03}\right)(0.72)=18.29,$$

$$\text{LZFPM}=[25.4][(0.09)(10.6)+(0.03)(30)]=47.09,$$

$$\text{LZTWM}=[25.4][(0.14)(11.3)+(0.17)(30)]=169.72,$$

$$\text{UZK}=\left(\frac{0.03}{0.03}\right)=1.0,$$

$$\text{LZSK}=\frac{1.0}{(1.9)+(0.9)(1)}=0.357,$$

$$\text{LZPK}=\left[\frac{(10.6)(750)}{40.6}+\frac{(30.0)(1)}{40.6}\right]\left[\frac{0.134}{(0.6)(5280)}\right]=0.008, \text{ and}$$

$$\text{REXP}=3.0.$$

The Zaneis soil is distributed extensively through south-central Kansas, central Oklahoma, and north-central Texas. Table 7 is derived from SCS soil survey data.

The soil parameter calculations for the Zaneis series are:

$$\text{upper zone depth}=(0.50)(24)=12$$

(shrink-swell changes to moderate in the depth, upper zone=10),

$$\text{UZFWM}=(25.4)\left(\frac{0.10}{0.50}\right)(10)=50.80,$$

$$\text{UZTWM}=(25.4)(0.14)(10)=35.56,$$

$$\text{supplemental zone depth}=(0.50)(24)=12,$$

$$\text{LZFSM}=(25.4)\left(\frac{0.10}{0.50}\right)(12)=60.96,$$

$$\text{LZFPM}=(25.4)(0.09)(25)=57.15,$$

Table 7.--Zaneis estimated engineering soil properties (soil classification C)

USDA texture	Depth (in.)	Permeability (in./hr)	Available water capacity (in./in.)	Shrink-swell
Loam	0-10	0.50	0.14	Low
Clay loam	10-47	.50	.17	Moderate

Table 8.--Vernon estimated engineering soil properties (soil classification D)

USDA texture	Depth (in.)	Permeability (in./hr)	Available water capacity (in./in.)	Shrink-swell
Clay	0-10	<0.05	0.17	Moderate-high

$$LZTWM=(25.4)(0.17)(37)=159.77,$$

$$UZK=\frac{0.10}{0.50}=0.20,$$

$$LZSK=\frac{0.20}{1.9+(0.9)(1)}=0.071,$$

$$LZPK=\frac{(750)(0.134)}{(0.6)(5280)}=0.0317, \text{ and}$$

$$REXP=2.5.$$

The Vernon soil is moderately distributed in west-central Texas and western Oklahoma. Table 8 is derived from SCS soil survey data.

The soil parameter calculations for the Vernon series are:

$$\text{upper zone depth}=(0.03)(24)=0.72,$$

$$UZFWM=(25.4)\left(\frac{0.03}{0.03}\right)(0.72)=18.29,$$

$$UZTWM=(25.4)(0.17)(0.72)=3.11,$$

$$\text{supplemental zone depth}=(0.03)(24)=0.72,$$

$$LZFSM=(25.4)\left(\frac{0.03}{0.03}\right)(0.72)=18.29,$$

$$\text{primary zone depth}=10-0.72-0.72=8.56,$$

$$LZFPM=(25.4)(0.03)(8.6)=6.55,$$

$$LZTWM=(25.4)(0.17)(9.3)=40.16,$$

$$UZK=\frac{0.03}{0.03}=1.00,$$

$$LZSK=\frac{1.00}{1.9+(0.9)(1)}=0.357,$$

$$LZPK=\frac{(1)(0.134)}{(0.6)(5280)}=0.00004, \text{ and}$$

$$REXP=4.0.$$

The basin soil moisture accounting parameters may now be calculated with the contribution of each soil type equal to its areal distribution. The basin soil parameters are:

$\mathrm{UZFWM}=(0.58)(18.29)+(0.30)(50.80)+(0.12)(18.29)=28.04$,

$\mathrm{UZTWM}=(0.58)(2.56)+(0.30)(35.56)+(0.12)(3.11)=12.52$,

$\mathrm{LZFSM}=(0.58)(18.29)+(0.30)(60.96)+(0.12)(18.29)=31.09$,

$\mathrm{LZFPM}=(0.58)(47.09)+(0.30)(57.15)+(0.12)(6.55)=45.24$,

$\mathrm{LZTWM}=(0.58)(169.72)+(0.30)(159.77)+(0.12)(40.16)=151.19$,

$\mathrm{UZK}=(0.58)(1.00)+(0.30)(0.20)+(0.12)(1.00)=0.760$,

$\mathrm{LZSK}=(0.58)(0.357)+(0.30)(0.071)+(0.12)(0.357)=0.271$,

$\mathrm{LZPK}=(0.58)(0.008)+(0.30)(0.0317)+(0.12)(0.00004)=0.0151$,

$\mathrm{REXP}=(0.58)(3.0)+(0.30)(2.5)+(0.12)(4.0)=2.97$,

$\mathrm{ZPERC}=\dfrac{31.09+45.24+151.19-9.11}{9.11}=24$,

$\mathrm{PBASE}=(31.09)(0.271)+(45.24)(0.0151)=9.11$, and

$\mathrm{ADIMP}=0.58+0.12-0.03=0.67$.

Nominal values are:

$\mathrm{PFREE}=0.30$,

$\mathrm{RSERV}=0.30$,

$\mathrm{SIDE}-0.00$,

$\mathrm{SSOUT}=0.00$,

$\mathrm{SARVA}=0.001$, and

$\mathrm{PCTIM}=0.001$.

The Verification Program Output for Council Creek that follows shows a comparison between the observed hydrographs represented by a "0" and the simulated hydrographs represented by an "*." The hydrograph sets are printed on the same time base so that they can be compared easily. The simulated and observed flows in cubic feet per second as well as the rainfall in inches are printed on the right-hand side of the hydrograph pages for each day. The statistics for the verification run are printed on the last page.

The simulated hydrograph set produced by the derived parameters is an excellent initial run. The parameters derived could be used successfully for the basin if it were not gaged since none of the parameter derivations were dependent on rainfall or streamflow records. The number of trial and error computer runs required to obtain an optimum solution should be minimal.

A. Council Creek Verification Program Output

```
                             COUNCIL CREEK NR STILLWATER OKLA

         COUNCIL CREEK NEAR STILLWATER OKLA

                                                      FLOW-POINT PARAMETERS

         NO.      FLOW-POINT NAME       AREA-SQ KM     K  SSOUT OBSER COMPAR SIXIN  HISTOGRAMS
           1   COUNCIL CR                    80.30  6.00  0.00      1      1     0  TIME-DELAY .931 .068 .001
                                                                                    GAGE AREA     1    1    1



SOIL-MOISTURE ACCOUNTING PARAMETERS     COUNCIL CREEK NR STILLWATER OKLA

COUNCIL CREEK NEAR STILLWATER OKLA

     CONTENT AND CAPACITY VALUES ARE IN MM.

                                         UPPER ZONE AND IMPERVIOUS AREA PARAMETERS

AREA NO.   AREA I.D.            AREA NAME    PX-ADJ  PE-ADJ   UZTWM   UZFWM    UZK   PCTIM   ADIMP   SARVA
    1   MBP 1        COUNCIL CREEK            1.000   1.000    13.     28.    .760    .001    .670    .001

                                        PERCOLATION AND LOWER ZONE PARAMETERS

AREA NO.   PBASE   ZPERC    REXP  LZTWM  LZFSM   LZFPM    LZSK    LZPK  PFREE   RSERV    SIDE
    1        9.1    24.0    2.97  151.     31.     45.   .2710   .0151    .30     .30    0.00

                              PE-ADJUSTMENT OR ET-DEMAND FOR THE 16TH OF EACH MONTH

AREA NO.                         1     2     3     4     5     6     7     8     9    10    11    12      I.D. OF PE DATA
    1   PE-ADJUSTMENT         1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00        STILLWATER

                                        INITIAL STORAGE CONTENTS

AREA NO.   UZTWC   UZFWC   LZTWC   LZFSC   LZFPC   ADIMC
    1         0.      0.     10.      0.      0.     11.
```

```
MEAN DAILY FLOW PLOT     COUNCIL CR              WATER YEAR 1959        *=SIMULATED    O=OBSERVED    UNITS-CFSD
OCT-NOV     200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0      SIM.     OBS. RAIN+MELT
  1 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0    .02
  2 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  3 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  4 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  5 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  6 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  7 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  8 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  9 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 10 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 11 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 12 *         .         .         .         .         .         .         .         .         .         .      .1      0.0    .28
 13 *         .         .         .         .         .         .         .         .         .         .      .0      0.0   0.00
 14 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0    .00
 15 *         .         .         .         .         .         .         .         .         .         .      .2      0.0    .26
 16 *         .         .         .         .         .         .         .         .         .         .      .0      0.0    .00
 17 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 18 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 19 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 20 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 21 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 22 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 23 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 24 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 25 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 26 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 27 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0    .01
 28 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 29 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 30 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 31 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  1 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  2 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  3 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  4 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  5 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  6 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  7 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  8 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
  9 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 10 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 11 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 12 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0   0.00
 13 *         .         .         .         .         .         .         .         .         .         .      .1      0.0    .13
 14 *         .         .         .         .         .         .         .         .         .         .      .0      0.0    .00
 15 *         .         .         .         .         .         .         .         .         .         .     0.0      0.0    .00
 16 *         .         .         .         .         .         .         .         .         .         .      .2       .3    .35
 17 *         .         .         .         .         .         .         .         .         .         .      .8      1.5    .35
 18 *         .         .         .         .         .         .         .         .         .         .     1.8       .9   0.00
 19 *         .         .         .         .         .         .         .         .         .         .     1.4       .1   0.00
 20 *         .         .         .         .         .         .         .         .         .         .     1.1       .1   0.00
 21 *         .         .         .         .         .         .         .         .         .         .      .8       .1   0.00
 22 *         .         .         .         .         .         .         .         .         .         .      .6       .1   0.00
 23 *         .         .         .         .         .         .         .         .         .         .      .4       .1   0.00
 24 *         .         .         .         .         .         .         .         .         .         .      .3       .1   0.00
 25 *         .         .         .         .         .         .         .         .         .         .      .3       .1   0.00
 26 *         .         .         .         .         .         .         .         .         .         .      .2       .1   0.00
 27 *         .         .         .         .         .         .         .         .         .         .      .2       .1    .09
 28 *         .         .         .         .         .         .         .         .         .         .      .2       .1    .08
 29 *         .         .         .         .         .         .         .         .         .         .      .1       .1   0.00
 30 *         .         .         .         .         .         .         .         .         .         .      .1       .1   0.00
```

```
DEC-JAN  200.0       400.0       600.0       800.0      1000.0      1200.0      1400.0      1600.0      1800.0      2000.0      SIM.      OBS. RAIN+MELT
  1 *       .           .           .           .           .           .           .           .           .           .         .1        .1   .03
  2 *       .           .           .           .           .           .           .           .           .           .         .1        .1  0.00
  3 *       .           .           .           .           .           .           .           .           .           .         .1        .1  0.00
  4 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
  5 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
  6 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
  7 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
  8 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
  9 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
 10 *       .           .           .           .           .           .           .           .           .           .         .1        .1  0.00
 11 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
 12 *       .           .           .           .           .           .           .           .           .           .         .2        .2   .29
 13 *       .           .           .           .           .           .           .           .           .           .         .1        .1   .00
 14 *       .           .           .           .           .           .           .           .           .           .         .1        .1  0.00
 15 *       .           .           .           .           .           .           .           .           .           .         .1        .1  0.00
 16 *       .           .           .           .           .           .           .           .           .           .         .0        .1  0.00
 17 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 18 *       .           .           .           .           .           .           .           .           .           .         .0        .3  0.00
 19 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 20 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 21 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 22 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 23 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 24 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 25 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 26 *       .           .           .           .           .           .           .           .           .           .         .1        .2   .06
 27 *       .           .           .           .           .           .           .           .           .           .         .1        .2  0.00
 28 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 29 *       .           .           .           .           .           .           .           .           .           .         .1        .2   .06
 30 *       .           .           .           .           .           .           .           .           .           .         .2        .3   .25
 31 *       .           .           .           .           .           .           .           .           .           .         .2        .6   .09
  1 *       .           .           .           .           .           .           .           .           .           .         .0        .5  0.00
  2 *       .           .           .           .           .           .           .           .           .           .         .0        .5  0.00
  3 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
  4 *       .           .           .           .           .           .           .           .           .           .         .1        .1   .03
  5 *       .           .           .           .           .           .           .           .           .           .         .0       0.0  0.00
  6 *       .           .           .           .           .           .           .           .           .           .         .0        .1  0.00
  7 *       .           .           .           .           .           .           .           .           .           .         .0        .5  0.00
  8 *       .           .           .           .           .           .           .           .           .           .         .0        .6  0.00
  9 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 10 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 11 *       .           .           .           .           .           .           .           .           .           .         .0        .3  0.00
 12 *       .           .           .           .           .           .           .           .           .           .         .0        .3  0.00
 13 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 14 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 15 *       .           .           .           .           .           .           .           .           .           .         .1        .3   .03
 16 *       .           .           .           .           .           .           .           .           .           .         .0        .3  0.00
 17 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 18 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 19 *       .           .           .           .           .           .           .           .           .           .         .0        .3  0.00
 20 *       .           .           .           .           .           .           .           .           .           .         .1        .4   .05
 21 *       .           .           .           .           .           .           .           .           .           .         .1        .4   .03
 22 *       .           .           .           .           .           .           .           .           .           .         .0        .2   .00
 23 *       .           .           .           .           .           .           .           .           .           .         .0        .2  0.00
 24 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 25 *       .           .           .           .           .           .           .           .           .           .         .0        .5  0.00
 26 *       .           .           .           .           .           .           .           .           .           .         .0        .5  0.00
 27 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 28 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 29 *       .           .           .           .           .           .           .           .           .           .         .0        .3  0.00
 30 *       .           .           .           .           .           .           .           .           .           .         .0        .4  0.00
 31 *       .           .           .           .           .           .           .           .           .           .         .0        .5   .04
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```
FEB-MAR       200.0      400.0      600.0      800.0     1000.0     1200.0     1400.0     1600.0     1800.0     2000.0    SIM.   OBS. RAIN+MELT
  1 *           .          .          .          .          .          .          .          .          .          .       .0     .4  0.00
  2 *           .          .          .          .          .          .          .          .          .          .       .0     .4   .00
  3 *           .          .          .          .          .          .          .          .          .          .       .1     .6   .06
  4 *           .          .          .          .          .          .          .          .          .          .       .0     .6  0.00
  5 *           .          .          .          .          .          .          .          .          .          .       .1     .5   .07
  6 *           .          .          .          .          .          .          .          .          .          .       .0     .4   .01
  7 *           .          .          .          .          .          .          .          .          .          .       .0     .4  0.00
  8 *           .          .          .          .          .          .          .          .          .          .       .0     .6  0.00
  9 *           .          .          .          .          .          .          .          .          .          .       .4    1.0   .62
 10 *           .          .          .          .          .          .          .          .          .          .      1.8    1.7  0.00
 11 *           .          .          .          .          .          .          .          .          .          .      1.8     .7  0.00
 12 *           .          .          .          .          .          .          .          .          .          .      1.4     .5   .03
 13 *           .          .          .          .          .          .          .          .          .          .      1.0     .5  0.00
 14 *           .          .          .          .          .          .          .          .          .          .       .8     .5   .00
 15 *           .          .          .          .          .          .          .          .          .          .       .6     .5  0.00
 16 *           .          .          .          .          .          .          .          .          .          .       .5     .5  0.00
 17 *           .          .          .          .          .          .          .          .          .          .       .4     .5  0.00
 18 *           .          .          .          .          .          .          .          .          .          .       .3     .4  0.00
 19 *           .          .          .          .          .          .          .          .          .          .       .3     .4  0.00
 20 *           .          .          .          .          .          .          .          .          .          .       .2     .4  0.00
 21 *           .          .          .          .          .          .          .          .          .          .       .2     .4  0.00
 22 *           .          .          .          .          .          .          .          .          .          .       .2     .5  0.00
 23 *           .          .          .          .          .          .          .          .          .          .       .1     .5  0.00
 24 *           .          .          .          .          .          .          .          .          .          .       .1     .5  0.00
 25 *           .          .          .          .          .          .          .          .          .          .       .1     .5  0.00
 26 *           .          .          .          .          .          .          .          .          .          .       .1     .6  0.00
 27 *           .          .          .          .          .          .          .          .          .          .       .3     .7   .56
 28 *           .          .          .          .          .          .          .          .          .          .      1.2    1.4   .01
  1 *           .          .          .          .          .          .          .          .          .          .      1.1     .7   .00
  2 *           .          .          .          .          .          .          .          .          .          .       .8     .5  0.00
  3 *           .          .          .          .          .          .          .          .          .          .       .6     .3  0.00
  4 *           .          .          .          .          .          .          .          .          .          .       .5     .3   .11
  5 *           .          .          .          .          .          .          .          .          .          .       .7     .9   .28
  6 *           .          .          .          .          .          .          .          .          .          .       .3    1.0  0.00
  7 *           .          .          .          .          .          .          .          .          .          .       .2     .9  0.00
  8 *           .          .          .          .          .          .          .          .          .          .       .2     .6  0.00
  9 *           .          .          .          .          .          .          .          .          .          .       .2     .5  0.00
 10 *           .          .          .          .          .          .          .          .          .          .       .2     .4  0.00
 11 *           .          .          .          .          .          .          .          .          .          .       .1     .4  0.00
 12 *           .          .          .          .          .          .          .          .          .          .       .1     .4  0.00
 13 *           .          .          .          .          .          .          .          .          .          .       .1     .4  0.00
 14 *           .          .          .          .          .          .          .          .          .          .       .1     .4  0.00
 15 *           .          .          .          .          .          .          .          .          .          .       .1     .2  0.00
 16 *           .          .          .          .          .          .          .          .          .          .       .1     .3  0.00
 17 *           .          .          .          .          .          .          .          .          .          .       .1     .5  0.00
 18 *           .          .          .          .          .          .          .          .          .          .       .1     .5  0.00
 19 *           .          .          .          .          .          .          .          .          .          .       .1     .5  0.00
 20 *           .          .          .          .          .          .          .          .          .          .      2.3    3.8  1.07
 21 *           .          .          .          .          .          .          .          .          .          .      6.1    6.2   .02
 22 *           .          .          .          .          .          .          .          .          .          .      4.3    1.4  0.00
 23 *           .          .          .          .          .          .          .          .          .          .      3.2     .9  0.00
 24 *           .          .          .          .          .          .          .          .          .          .      2.5     .8  0.00
 25 *O          .          .          .          .          .          .          .          .          .          .      3.0   22.0   .56
 26 *O          .          .          .          .          .          .          .          .          .          .      2.8   11.0  0.00
 27 *           .          .          .          .          .          .          .          .          .          .      2.1    1.5  0.00
 28 *           .          .          .          .          .          .          .          .          .          .      1.7    1.0   .03
 29 *           .          .          .          .          .          .          .          .          .          .      1.3     .9   .03
 30 *           .          .          .          .          .          .          .          .          .          .      1.1    1.0   .04
 31 *O          .          .          .          .          .          .          .          .          .          .       .9   12.0   .06
```

```
APR-MAY     200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
  1 *         .         .         .         .         .         .         .         .         .         .         .9     4.8    .19
  2 *         .         .         .         .         .         .         .         .         .         .         .6     2.1   0.00
  3 *         .         .         .         .         .         .         .         .         .         .         .6     1.1   0.00
  4 *         .         .         .         .         .         .         .         .         .         .         .5      .8   0.00
  5 *         .         .         .         .         .         .         .         .         .         .         .5      .7   0.00
  6 *         .         .         .         .         .         .         .         .         .         .         .4      .8   0.00
  7 *         .         .         .         .         .         .         .         .         .         .         .4      .8   0.00
  8 *         .         .         .         .         .         .         .         .         .         .        5.8     7.7    .88
  9 *         .         .         .         .         .         .         .         .         .         .        3.6     4.3   0.00
 10 *         .         .         .         .         .         .         .         .         .         .        2.7     1.5    .02
 11 *         .         .         .         .         .         .         .         .         .         .        2.1     1.1   0.00
 12 *         .         .         .         .         .         .         .         .         .         .        1.6      .9   0.00
 13 *         .         .         .         .         .         .         .         .         .         .        1.3      .7   0.00
 14 *         .         .         .         .         .         .         .         .         .         .        1.1      .6   0.00
 15 *         .         .         .         .         .         .         .         .         .         .         .9      .5   0.00
 16 *         .         .         .         .         .         .         .         .         .         .         .8      .6   0.00
 17 *         .         .         .         .         .         .         .         .         .         .         .9     1.0    .28
 18 *         .         .         .         .         .         .         .         .         .         .        6.3     4.2    .95
 19 .*        .         .         .         .         .         .         .         .         .         .       17.4    30.0    .01
 20 *         .         .         .         .         .         .         .         .         .         .        5.2     2.7   0.00
 21 *         .         .         .         .         .         .         .         .         .         .        3.9     1.4   0.00
 22 *         .         .         .         .         .         .         .         .         .         .        3.0     1.0   0.00
 23 *         .         .         .         .         .         .         .         .         .         .        2.4      .9   0.00
 24 *         .         .         .         .         .         .         .         .         .         .        1.9      .8   0.00
 25 *         .         .         .         .         .         .         .         .         .         .        1.6      .7   0.00
 26 *         .         .         .         .         .         .         .         .         .         .        1.3      .7   0.00
 27 *         .         .         .         .         .         .         .         .         .         .        1.2      .6   0.00
 28 *         .         .         .         .         .         .         .         .         .         .        1.0      .5   0.00
 29 *         .         .         .         .         .         .         .         .         .         .         .9      .4   0.00
 30 *         .         .         .         .         .         .         .         .         .         .         .8      .4   0.00
  1 *         .         .         .         .         .         .         .         .         .         .         .8      .4   0.00
  2 *         .         .         .         .         .         .         .         .         .         .         .8      .3    .05
  3 *         .         .         .         .         .         .         .         .         .         .         .7      .2   0.00
  4 *         .         .         .         .         .         .         .         .         .         .         .7      .2   0.00
  5 *         .         .         .         .         .         .         .         .         .         .        3.7     1.3    .88
  6 *O        .         .         .         .         .         .         .         .         .         .        7.4    12.0   0.00
  7 *         .         .         .         .         .         .         .         .         .         .        3.7     1.1   0.00
  8 *         .         .         .         .         .         .         .         .         .         .        9.7      .7   1.03
  9 .   * O   .         .         .         .         .         .         .         .         .         .       85.7   128.0    .73
 10 .*        .         .         .         .         .         .         .         .         .         .       15.9    23.0    .32
 11 *O        .         .         .         .         .         .         .         .         .         .        9.4    28.0   0.00
 12 *         .         .         .         .         .         .         .         .         .         .        7.0     3.5   0.00
 13 *         .         .         .         .         .         .         .         .         .         .        5.4     2.0   0.00
 14 *         .         .         .         .         .         .         .         .         .         .        4.3     1.1   0.00
 15 *         .         .         .         .         .         .         .         .         .         .        3.5     1.0    .00
 16 *         .         .         .         .         .         .         .         .         .         .        3.0     1.1    .11
 17 *         .         .         .         .         .         .         .         .         .         .        2.5     1.3    .19
 18 *         .         .         .         .         .         .         .         .         .         .        2.2     1.0    .01
 19 *         .         .         .         .         .         .         .         .         .         .        1.9      .7   0.00
 20 *         .         .         .         .         .         .         .         .         .         .        1.7      .4   0.00
 21 *         .   O     .         .         .         .         .         .         .         .         .        1.7   289.0    .30
 22 .*    O   .         .         .         .         .         .         .         .         .         .       28.0   115.0    .65
 23 *O        .         .         .         .         .         .         .         .         .         .        6.7    12.0   0.00
 24 *         .         .         .         .         .         .         .         .         .         .        4.3     4.2    .02
 25 *         .         .         .         .         .         .         .         .         .         .        3.5     3.2   0.00
 26 .    *    . O       .         .         .         .         .         .         .         .         .      102.8   245.0   1.42
 27 .*        .         .         .         .         .         .         .         .         .         .       22.5    26.0   0.00
 28 *         .         .         .         .         .         .         .         .         .         .        8.4     6.0   0.00
 29 *         .         .         .         .         .         .         .         .         .         .        6.5     3.2   0.00
 30 *         .         .         .         .         .         .         .         .         .         .        5.2     2.1   0.00
 31 *         .         .         .         .         .         .         .         .         .         .        4.2     1.8    .01
```

```
JUN-JUL    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 .*        .         .  0      .         .         .         .         .         .         .         .      29.7   451.0   .72
 2 *0        .         .         .         .         .         .         .         .         .         .       6.1    16.0  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       4.4     6.0  0.00
 4 . *     0 .         .         .         .         .         .         .         .         .         .      42.9   161.0   .85
 5 .*        .         .         .         .         .         .         .         .         .         .      12.8    25.0  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       5.4     8.1  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       4.3     4.2  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       3.6     2.9  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       3.1     2.9  0.00
10 *         .         .         .         .         .         .         .         .         .         .       2.7     3.2  0.00
11 *         .         .         .         .         .         .         .         .         .         .       9.2     2.9   .68
12 0*        .         .         .         .         .         .         .         .         .         .      21.8    10.0   .03
13 *         .         .         .         .         .         .         .         .         .         .       4.6     2.9  0.00
14 *         .         .         .         .         .         .         .         .         .         .       3.6     2.5  0.00
15 *         .         .         .         .         .         .         .         .         .         .       3.1     2.1  0.00
16 *         .         .         .         .         .         .         .         .         .         .       2.7     1.8  0.00
17 *         .         .         .         .         .         .         .         .         .         .       2.4     1.7  0.00
18 *         .         .         .         .         .         .         .         .         .         .       2.2     1.5   .01
19 *         .         .         .         .         .         .         .         .         .         .       2.1     1.4   .03
20 *         .         .         .         .         .         .         .         .         .         .       1.9     1.3  0.00
21 *         .         .         .         .         .         .         .         .         .         .       1.8     1.1   .05
22 *         .         .         .         .         .         .         .         .         .         .       4.4     1.1   .51
23 *         .         .         .         .         .         .         .         .         .         .       2.3     1.4   .03
24 *         .         .         .         .         .         .         .         .         .         .       2.0     1.3   .14
25 *         .         .         .         .         .         .         .         .         .         .       1.8     1.1  0.00
26 . *    0  .         .         .         .         .         .         .         .         .         .      35.8   132.0  1.22
27 .   *     . 0       .         .         .         .         .         .         .         .         .      86.3   249.0  0.00
28 *         .         .         .         .         .         .         .         .         .         .       9.5     7.0  0.00
29 *         .         .         .         .         .         .         .         .         .         .       6.5     3.5  0.00
30 *         .         .         .         .         .         .         .         .         .         .       5.2     2.3   .26
 1 *         .         .         .         .         .         .         .         .         .         .       8.0     2.7   .24
 2 *         .         .         .         .         .         .         .         .         .         .       4.0     2.1  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       3.3     1.7  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       2.8     1.7  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       2.5     1.5  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       2.3     1.4  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       2.1     1.3  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       5.9     1.0   .65
 9 .*  0     .         .         .         .         .         .         .         .         .         .      29.5    81.0   .13
10 *         .         .         .         .         .         .         .         .         .         .       5.0     3.5  0.00
11 *         .         .         .         .         .         .         .         .         .         .       3.7     1.8  0.00
12 *         .         .         .         .         .         .         .         .         .         .       3.1     1.3   .00
13 .       * .     0   .         .         .         .         .         .         .         .         .     162.8   324.0  1.79
14 . 0  *    .         .         .         .         .         .         .         .         .         .      98.9    40.0   .23
15 .         .         .         .     *   .         .   0     .         .         .         .         .     711.8  1070.0  2.42
16 .  0    * .         .         .         .         .         .         .         .         .         .     159.4    53.0   .01
17 .*        .         .         .         .         .         .         .         .         .         .      24.0    17.0   .28
18 .0  *     .         .         .         .         .         .         .         .         .         .      70.7    13.0   .21
19 0*        .         .         .         .         .         .         .         .         .         .      17.1     8.1   .11
20 0*        .         .         .         .         .         .         .         .         .         .      10.3     6.0  0.00
21 0         . *       .         .         .         .         .         .         .         .         .     245.2     8.9  1.28
22 .         .         .         .0 *      .         .         .         .         .         .         .     663.6   619.0  1.42
23 . 0   *   .         .         .         .         .         .         .         .         .         .     125.8    47.0   .00
24 .*        .         .         .         .         .         .         .         .         .         .      20.2    14.0  0.00
25 0*        .         .         .         .         .         .         .         .         .         .      11.8     9.3  0.00
26 .    0    .         .    *    .         .         .         .         .         .         .         .     490.5    97.0  3.07
27 .         .         .         .         .     0   .         .     *   .         .         .         .    1320.9   927.0   .28
28 . 0 *     .         .         .         .         .         .         .         .         .         .      70.0    35.0  0.00
29 .*        .         .         .         .         .         .         .         .         .         .      16.4    15.0  0.00
30 0*        .         .         .         .         .         .         .         .         .         .      10.6    10.0  0.00
31 *         .         .         .         .         .         .         .         .         .         .       8.5     8.1  0.00
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```
AUG-SEP    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0     SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .       7.0    7.0  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       6.0    6.0  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       5.2    5.1  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       4.6    4.7  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       4.2    3.8  0.00
 6 .   *     .         O         .         .         .         .         .         .         .         .      84.9  400.0  1.36
 7 .         .       * .   O     .         .         .         .         .         .         .         .     363.0  478.0  1.21
 8 .O        .       * .         .         .         .         .         .         .         .         .     361.3   11.0  0.00
 9 O *       .         .         .         .         .         .         .         .         .         .      32.8    8.1  0.00
10 O*        .         .         .         .         .         .         .         .         .         .      11.9    6.5  0.00
11 *         .         .         .         .         .         .         .         .         .         .       8.8    5.1  0.00
12 *         .         .         .         .         .         .         .         .         .         .       7.3    4.2  0.00
13 *         .         .         .         .         .         .         .         .         .         .       6.1    3.8  0.00
14 *         .         .         .         .         .         .         .         .         .         .       5.3    3.8  0.00
15 *         .         .         .         .         .         .         .         .         .         .       4.7    3.5  0.00
16 *         .         .         .         .         .         .         .         .         .         .       4.2    3.5  0.00
17 *         .         .         .         .         .         .         .         .         .         .       3.9    3.2  0.00
18 *         .         .         .         .         .         .         .         .         .         .       3.8    2.9   .33
19 *         .         .         .         .         .         .         .         .         .         .       3.5    2.9  0.00
20 *         .         .         .         .         .         .         .         .         .         .       3.2    2.5  0.00
21 *         .         .         .         .         .         .         .         .         .         .       3.1    2.3  0.00
22 *         .         .         .         .         .         .         .         .         .         .       3.0    2.1  0.00
23 *         .         .         .         .         .         .         .         .         .         .       2.9    1.8  0.00
24 *         .         .         .         .         .         .         .         .         .         .       2.8    1.8  0.00
25 *         .         .         .         .         .         .         .         .         .         .       2.8    1.7  0.00
26 *         .         .         .         .         .         .         .         .         .         .       2.7    1.7  0.00
27 *         .         .         .         .         .         .         .         .         .         .       2.7    1.5   .08
28 *         .         .         .         .         .         .         .         .         .         .       2.7    1.5   .13
29 *         .         .         .         .         .         .         .         .         .         .       2.6    1.5  0.00
30 *         .         .         .         .         .         .         .         .         .         .       2.5    1.4  0.00
31 *         .         .         .         .         .         .         .         .         .         .       2.5    1.4  0.00
 1 O*        .         .         .         .         .         .         .         .         .         .      14.0    2.1   .81
 2 O *       .         .         .         .         .         .         .         .         .         .      39.9    4.5  0.00
 3 O *       .         .         .         .         .         .         .         .         .         .      49.6    2.5   .54
 4 O*        .         .         .         .         .         .         .         .         .         .      13.9    1.8  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       6.2    1.4  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       5.1    1.3  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       4.3    1.0  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       3.8     .9  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       4.4    3.4   .52
10 *         .         .         .         .         .         .         .         .         .         .       5.9    3.9  0.00
11 *         .         .         .         .         .         .         .         .         .         .       3.2    1.0  0.00
12 *         .         .         .         .         .         .         .         .         .         .       2.9     .8  0.00
13 *         .         .         .         .         .         .         .         .         .         .       2.7     .8  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.5     .8  0.00
15 *         .         .         .         .         .         .         .         .         .         .       2.4    1.0  0.00
16 *         .         .         .         .         .         .         .         .         .         .       2.3    1.0  0.00
17 *         .         .         .         .         .         .         .         .         .         .       2.2     .8   .00
18 *         .         .         .         .         .         .         .         .         .         .       2.2     .8  0.00
19 *         .         .         .         .         .         .         .         .         .         .       2.1    1.0  0.00
20 *         .         .         .         .         .         .         .         .         .         .       2.1    1.3  0.00
21 *         .         .         .         .         .         .         .         .         .         .       2.0    1.3  0.00
22 *         .         .         .         .         .         .         .         .         .         .       2.0    1.3  0.00
23 .    *   O.         .         .         .         .         .         .         .         .         .      99.5  174.0  2.59
24 .         .         .         .         . *       .         .      O  .         .         .         .     848.0 1340.0  3.01
25 .         .         .         .         .         .*        .         .O        .         .         .    1027.8 1430.0   .94
26 .O   *    .         .         .         .         .         .         .         .         .         .     108.0   30.0  0.00
27 .*        .         .         .         .         .         .         .         .         .         .      29.2   12.0  0.00
28 O*        .         .         .         .         .         .         .         .         .         .      19.4    8.1  0.00
29 O*        .         .         .         .         .         .         .         .         .         .      15.0    6.5   .10
30 .         .       O . *       .         .         .         .         .         .         .         .     435.6  365.0  1.33
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MEAN DAILY FLOW PLOT    COUNCIL CR              WATER YEAR 1960     *=SIMULATED    0=OBSERVED    UNITS-CFSD
OCT-NOV    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 .      0  .         *         .         .         .         .         .         .         .         .     399.0   143.0  1.26
 2 .         .         .         .         .         .         .         .         .         .         *    5788.0 11000.0  7.83
 3 .         .       0 .         .         .         *         .         .         .         .         .    1008.9   370.0  1.09
 4 .         .         .         .         .         . *       0         .         .         .         .    1031.2  1200.0  1.50
 5 .      0 *.         .         .         .         .         .         .         .         .         .     188.5   140.0   .00
 6 . *       .         .         .         .         .         .         .         .         .         .      37.0    38.0   .00
 7 .*        .         .         .         .         .         .         .         .         .         .      16.0    24.0   .21
 8 .*        .         .         .         .         .         .         .         .         .         .      13.0    17.0   .06
 9 .*        .         .         .         .         .         .         .         .         .         .      10.3    15.0  0.00
10 *0        .         .         .         .         .         .         .         .         .         .       8.6    13.0  0.00
11 *0        .         .         .         .         .         .         .         .         .         .       7.4    11.0   .02
12 *0        .         .         .         .         .         .         .         .         .         .       6.5    11.0  0.00
13 .      * 0.         .         .         .         .         .         .         .         .         .     133.2   176.0   .64
14 .*        .         .         .         .         .         .         .         .         .         .      27.4    24.0  0.00
15 *0        .         .         .         .         .         .         .         .         .         .       8.1    11.0  0.00
16 *         .         .         .         .         .         .         .         .         .         .       5.6     9.3  0.00
17 *         .         .         .         .         .         .         .         .         .         .       4.9     8.1  0.00
18 *         .         .         .         .         .         .         .         .         .         .       4.6     7.6  0.00
19 *         .         .         .         .         .         .         .         .         .         .       4.3     7.0  0.00
20 *         .         .         .         .         .         .         .         .         .         .       4.1     6.5  0.00
21 *         .         .         .         .         .         .         .         .         .         .       3.9     6.0  0.00
22 *         .         .         .         .         .         .         .         .         .         .       3.8     6.0  0.00
23 *         .         .         .         .         .         .         .         .         .         .       3.7     5.6  0.00
24 *         .         .         .         .         .         .         .         .         .         .       3.6     5.1  0.00
25 *         .         .         .         .         .         .         .         .         .         .       3.5     5.1  0.00
26 *         .         .         .         .         .         .         .         .         .         .       3.4     6.0  0.00
27 *         .         .         .         .         .         .         .         .         .         .       3.4     5.6  0.00
28 *         .         .         .         .         .         .         .         .         .         .       3.3     5.1  0.00
29 *         .         .         .         .         .         .         .         .         .         .       3.2     5.1  0.00
30 0*        .         .         .         .         .         .         .         .         .         .      25.6     9.3   .58
31 *         .         .         .         .         .         .         .         .         .         .       9.0     8.1  0.00
 1 *         .         .         .         .         .         .         .         .         .         .       3.8     6.5  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       3.3     6.0  0.00
 3 0*        .         .         .         .         .         .         .         .         .         .      27.3     8.7   .43
 4 0*        .         .         .         .         .         .         .         .         .         .      20.0     9.3  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       4.7     5.6  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       3.5     5.1  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       3.2     4.7  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       3.1     5.1  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       3.0     5.1  0.00
10 *         .         .         .         .         .         .         .         .         .         .       2.9     5.1  0.00
11 *         .         .         .         .         .         .         .         .         .         .       2.8     5.1  0.00
12 *         .         .         .         .         .         .         .         .         .         .       2.7     5.1  0.00
13 *         .         .         .         .         .         .         .         .         .         .       2.7     5.1  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.6     4.7  0.00
15 *         .         .         .         .         .         .         .         .         .         .       2.6     4.7  0.00
16 *         .         .         .         .         .         .         .         .         .         .       2.5     5.1  0.00
17 *         .         .         .         .         .         .         .         .         .         .       2.5     4.7  0.00
18 *         .         .         .         .         .         .         .         .         .         .       2.4     4.7  0.00
19 *         .         .         .         .         .         .         .         .         .         .       2.4     4.2  0.00
20 *         .         .         .         .         .         .         .         .         .         .       2.3     3.8  0.00
21 *         .         .         .         .         .         .         .         .         .         .       2.3     3.5  0.00
22 *         .         .         .         .         .         .         .         .         .         .       2.3     3.2  0.00
23 *         .         .         .         .         .         .         .         .         .         .       2.2     3.2  0.00
24 *         .         .         .         .         .         .         .         .         .         .       2.2     2.9  0.00
25 *         .         .         .         .         .         .         .         .         .         .       2.2     2.9  0.00
26 *         .         .         .         .         .         .         .         .         .         .       2.1     2.9   .01
27 *         .         .         .         .         .         .         .         .         .         .       2.1     2.7  0.00
28 *         .         .         .         .         .         .         .         .         .         .       2.1     2.7  0.00
29 *         .         .         .         .         .         .         .         .         .         .       2.0     2.7  0.00
30 *         .         .         .         .         .         .         .         .         .         .       2.0     3.2  0.00
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DEC-JAN    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .       2.0     3.5  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.9     3.2  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       1.9     3.2  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       1.9     3.8  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       1.8     3.5  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       1.8     3.5  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       1.8     3.5  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       1.8     3.5  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       1.7     3.2  0.00
10 *         .         .         .         .         .         .         .         .         .         .       1.8     3.5   .13
11 *         .         .         .         .         .         .         .         .         .         .       1.7     4.2  0.00
12 *         .         .         .         .         .         .         .         .         .         .       1.7     3.8  0.00
13 *         .         .         .         .         .         .         .         .         .         .       1.6     3.2  0.00
14 *         .         .         .         .         .         .         .         .         .         .       1.6     3.2  0.00
15 *         .         .         .         .         .         .         .         .         .         .       1.6     3.2   .01
16 *         .         .         .         .         .         .         .         .         .         .       1.9     3.8   .41
17 .      0 *.         .         .         .         .         .         .         .         .         .     178.0   137.0  1.20
18 .  0*     .         .         .         .         .         .         .         .         .         .      77.3    52.0  0.00
19 *0        .         .         .         .         .         .         .         .         .         .       9.6    11.0  0.00
20 *         .         .         .         .         .         .         .         .         .         .       6.5     8.1  0.00
21 *         .         .         .         .         .         .         .         .         .         .       5.2     6.5  0.00
22 *         .         .         .         .         .         .         .         .         .         .       4.3     6.5   .11
23 *         .         .         .         .         .         .         .         .         .         .       3.7     7.6   .03
24 *         .         .         .         .         .         .         .         .         .         .       3.1     6.5  0.00
25 *         .         .         .         .         .         .         .         .         .         .       2.7     6.0  0.00
26 *         .         .         .         .         .         .         .         .         .         .       2.5     6.5   .24
27 *         .         .         .         .         .         .         .         .         .         .       2.4     9.3   .00
28 *         .         .         .         .         .         .         .         .         .         .       2.1     6.0  0.00
29 *         .         .         .         .         .         .         .         .         .         .       2.0     4.7  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.9     4.2  0.00
31 *         .         .         .         .         .         .         .         .         .         .       1.8     4.2   .00
 1 *         .         .         .         .         .         .         .         .         .         .       1.7     4.2  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.7     4.2  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       1.6     3.8  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       1.6     3.5  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       1.7     4.2   .13
 6 *         .         .         .         .         .         .         .         .         .         .       1.6     4.7  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       1.5     5.6  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       1.5     5.6  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       1.5     5.1  0.00
10 *         .         .         .         .         .         .         .         .         .         .       1.4     5.6  0.00
11 *         .         .         .         .         .         .         .         .         .         .       1.4     5.1  0.00
12 *         .         .         .         .         .         .         .         .         .         .       1.6     6.5   .25
13 *         .         .         .         .         .         .         .         .         .         .       1.4     6.0  0.00
14 .0 *      .         .         .         .         .         .         .         .         .         .      63.3    11.0   .34
15 0*        .         .         .         .         .         .         .         .         .         .      10.7     7.0  0.00
16 *         .         .         .         .         .         .         .         .         .         .       5.7     4.2   .06
17 0 *       .         .         .         .         .         .         .         .         .         .      40.8     5.6   .13
18 *         .         .         .         .         .         .         .         .         .         .       5.8     6.5  0.00
19 *         .         .         .         .         .         .         .         .         .         .       3.2     3.2  0.00
20 *         .         .         .         .         .         .         .         .         .         .       2.7     2.9  0.00
21 *         .         .         .         .         .         .         .         .         .         .       2.3     3.2  0.00
22 *         .         .         .         .         .         .         .         .         .         .       2.1     3.2  0.00
23 *         .         .         .         .         .         .         .         .         .         .       1.9     3.2  0.00
24 *         .         .         .         .         .         .         .         .         .         .       1.7     3.[illegible]  0.00
25 *         .         .         .         .         .         .         .         .         .         .       1.6     4.2  0.00
26 *         .         .         .         .         .         .         .         .         .         .       1.5     5.6  0.00
27 *         .         .         .         .         .         .         .         .         .         .       1.4     6.0  0.00
28 *         .         .         .         .         .         .         .         .         .         .       1.4     4.7  0.00
29 *         .         .         .         .         .         .         .         .         .         .       1.3     4.2  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.3     4.2  0.00
31 *         .         .         .         .         .         .         .         .         .         .       1.3     4.7   .00
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```
FEB-MAR    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0     SIM.   OBS. RAIN+MELT
  1 *         .         .         .         .         .         .         .         .         .         .       1.2     4.7   .01
  2 *         .         .         .         .         .         .         .         .         .         .       1.2     4.7  0.00
  3 0 *       .         .         .         .         .         .         .         .         .         .      37.0     7.5   .75
  4 .         . *0      .         .         .         .         .         .         .         .         .     243.0   254.0   .43
  5 .*        .         .         .         .         .         .         .         .         .         .      21.5    29.0  0.00
  6 *0        .         .         .         .         .         .         .         .         .         .       5.9    12.0  0.00
  7 *         .         .         .         .         .         .         .         .         .         .       4.4     9.3  0.00
  8 *         .         .         .         .         .         .         .         .         .         .       3.6     8.7  0.00
  9 *         .         .         .         .         .         .         .         .         .         .       3.0     9.3  0.00
 10 *         .         .         .         .         .         .         .         .         .         .       2.6     7.6  0.00
 11 *         .         .         .         .         .         .         .         .         .         .       2.2     5.6  0.00
 12 *         .         .         .         .         .         .         .         .         .         .       2.0     5.1  0.00
 13 *         .         .         .         .         .         .         .         .         .         .       1.6     5.6  0.00
 14 *         .         .         .         .         .         .         .         .         .         .       1.7     5.6  0.00
 15 *         .         .         .         .         .         .         .         .         .         .       7.7     6.5   .28
 16 *         .         .         .         .         .         .         .         .         .         .       2.7     8.1  0.00
 17 *         .         .         .         .         .         .         .         .         .         .       1.6     9.3  0.00
 18 *         .         .         .         .         .         .         .         .         .         .       1.4     6.5  0.00
 19 *         .         .         .         .         .         .         .         .         .         .       1.4     6.0  0.00
 20 *         .         .         .         .         .         .         .         .         .         .       1.4     6.0   .09
 21 *         .         .         .         .         .         .         .         .         .         .       1.3     7.0  0.00
 22 *         .         .         .         .         .         .         .         .         .         .       1.2     6.0  0.00
 23 *         .         .         .         .         .         .         .         .         .         .       1.3     6.0   .12
 24 *         .         .         .         .         .         .         .         .         .         .       1.2     4.7  0.00
 25 *         .         .         .         .         .         .         .         .         .         .       1.1     4.2   .00
 26 *         .         .         .         .         .         .         .         .         .         .       1.1     4.7  0.00
 27 0 *       .         .         .         .         .         .         .         .         .         .      37.1     4.7   .43
 28 0 *       .         .         .         .         .         .         .         .         .         .      30.2     5.6   .01
 29 *         .         .         .         .         .         .         .         .         .         .       3.4     5.6   .00
  1 *         .         .         .         .         .         .         .         .         .         .       2.2     5.6   .10
  2 0  *      .         .         .         .         .         .         .         .         .         .      50.2     6.0   .19
  3 0*        .         .         .         .         .         .         .         .         .         .      11.0     6.5  0.00
  4 *         .         .         .         .         .         .         .         .         .         .       2.8     6.0  0.00
  5 *         .         .         .         .         .         .         .         .         .         .       2.2     5.6  0.00
  6 *         .         .         .         .         .         .         .         .         .         .       1.9     5.6  0.00
  7 *         .         .         .         .         .         .         .         .         .         .       1.6     6.5  0.00
  8 *0        .         .         .         .         .         .         .         .         .         .       1.5    14.0   .04
  9 *     0   .         .         .         .         .         .         .         .         .         .       1.4   121.0  0.00
 10 *  0      .         .         .         .         .         .         .         .         .         .       1.3    54.0   .01
 11 *0        .         .         .         .         .         .         .         .         .         .       1.2    20.0  0.00
 12 *0        .         .         .         .         .         .         .         .         .         .       1.1    12.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .       1.1    10.0  0.00
 14 *         .         .         .         .         .         .         .         .         .         .       1.1    10.0   .11
 15 *0        .         .         .         .         .         .         .         .         .         .       1.1    27.0   .14
 16 *0        .         .         .         .         .         .         .         .         .         .       1.0    29.0  0.00
 17 *0        .         .         .         .         .         .         .         .         .         .       1.0    11.0  0.00
 18 *         .         .         .         .         .         .         .         .         .         .        .9    10.0  0.00
 19 *         .         .         .         .         .         .         .         .         .         .        .9     8.7  0.00
 20 *         .         .         .         .         .         .         .         .         .         .        .9     7.6  0.00
 21 *         .         .         .         .         .         .         .         .         .         .        .9     7.0  0.00
 22 *         .         .         .         .         .         .         .         .         .         .        .9     7.0  0.00
 23 *         .         .         .         .         .         .         .         .         .         .        .8     6.0  0.00
 24 *         .         .         .         .         .         .         .         .         .         .        .8     6.0   .00
 25 *         .         .         .         .         .         .         .         .         .         .        .8     6.0  0.00
 26 *         .         .         .         .         .         .         .         .         .         .        .8     6.0  0.00
 27 *         .         .         .         .         .         .         .         .         .         .        .8     6.0  0.00
 28 *         .         .         .         .         .         .         .         .         .         .        .8     6.0  0.00
 29 *         .         .         .         .         .         .         .         .         .         .        .8     5.6   .15
 30 *         .         .         .         .         .         .         .         .         .         .        .8     5.6  0.00
 31 *         .         .         .         .         .         .         .         .         .         .        .8     5.1   .25
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APR-MAY    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .        .8     5.1  0.00
 2 *         .         .         .         .         .         .         .         .         .         .        .6     4.2  0.00
 3 *         .         .         .         .         .         .         .         .         .         .        .6     3.8  0.00
 4 *         .         .         .         .         .         .         .         .         .         .        .6     3.8  0.00
 5 *         .         .         .         .         .         .         .         .         .         .        .6     3.8  0.00
 6 *         .         .         .         .         .         .         .         .         .         .        .6     4.2  0.00
 7 *         .         .         .         .         .         .         .         .         .         .        .6     4.2  0.00
 8 *         .         .         .         .         .         .         .         .         .         .        .6     4.7   .12
 9 *         .         .         .         .         .         .         .         .         .         .        .5     5.1  0.00
10 *         .         .         .         .         .         .         .         .         .         .        .5     4.7  0.00
11 *         .         .         .         .         .         .         .         .         .         .        .5     4.7  0.00
12 *         .         .         .         .         .         .         .         .         .         .        .5     5.1  0.00
13 *         .         .         .         .         .         .         .         .         .         .        .8     6.7   .46
14 .O*       .         .         .         .         .         .         .         .         .         .      32.2    16.0   .42
15 *         .         .         .         .         .         .         .         .         .         .       6.3     7.0   .30
16 *       O .         .         .         .         .         .         .         .         .         .       3.3   162.0   .15
17 *O        .         .         .         .         .         .         .         .         .         .       1.9    18.0  0.00
18 *         .         .         .         .         .         .         .         .         .         .       1.5     8.7  0.00
19 *         .         .         .         .         .         .         .         .         .         .       1.2     7.6  0.00
20 *         .         .         .         .         .         .         .         .         .         .       1.0     7.0  0.00
21 *         .         .         .         .         .         .         .         .         .         .        .9     7.0  0.00
22 *         .         .         .         .         .         .         .         .         .         .        .8     6.5  0.00
23 *         .         .         .         .         .         .         .         .         .         .        .7     6.0  0.00
24 *         .         .         .         .         .         .         .         .         .         .        .6     5.6  0.00
25 *         .         .         .         .         .         .         .         .         .         .        .6     5.1  0.00
26 *         .         .         .         .         .         .         .         .         .         .        .6     5.1  0.00
27 *         .         .         .         .         .         .         .         .         .         .        .7     4.7   .25
28 *         .         .         .         .         .         .         .         .         .         .        .7     5.6   .23
29 *         .         .         .         .         .         .         .         .         .         .       5.5     6.5   .38
30 *         .         .         .         .         .         .         .         .         .         .       2.8     6.5  0.00
 1 *         .         .         .         .         .         .         .         .         .         .       1.3     5.6  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.1     5.1  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       2.1     5.1   .47
 4 O*        .         .         .         .         .         .         .         .         .         .      13.3     8.1   .47
 5 .   *     .         .         .         .         .  O      .         .         .         .         .      88.5  1060.0  1.13
 6 .     *   .        O.         .         .         .         .         .         .         .         .     111.1   376.0   .06
 7 .*        .         .         .         .         .         .         .         .         .         .      11.9    27.0  0.00
 8 *O        .         .         .         .         .         .         .         .         .         .       7.5    18.0  0.00
 9 *O        .         .         .         .         .         .         .         .         .         .       5.8    14.0  0.00
10 *O        .         .         .         .         .         .         .         .         .         .       4.5    11.0  0.00
11 *         .         .         .         .         .         .         .         .         .         .       3.6     9.3  0.00
12 *         .         .         .         .         .         .         .         .         .         .       2.9     8.1  0.00
13 *         .         .         .         .         .         .         .         .         .         .       2.4     7.6  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.1     7.6  0.00
15 *         .         .         .         .         .         .         .         .         .         .       1.8     7.6  0.00
16 *         .         .         .         .         .         .         .         .         .         .       1.6     7.0   .05
17 *         .         .         .         .         .         .         .         .         .         .       6.4     6.0   .64
18 .O    *   .         .         .         .         .         .         .         .         .         .     111.5    29.0  1.24
19 . O    *  .         .         .         .         .         .         .         .         .         .     139.6    37.0   .40
20 .       * .         .         .         .         .         .         .         .         .         .     154.4   152.0   .38
21 .*        .         .         .         .         .         .         .         .         .         .      18.3    15.0  0.00
22 *         .         .         .         .         .         .         .         .         .         .       9.3     8.7  0.00
23 *         .         .         .         .         .         .         .         .         .         .       7.2     7.0  0.00
24 *         .         .         .         .         .         .         .         .         .         .       5.7     6.0   .17
25 .*        .         .         .         .         .         .         .         .         .         .      10.3    18.0   .31
26 *         .         .         .         .         .         .         .         .         .         .       4.3     6.5  0.00
27 O*        .         .         .         .         .         .         .         .         .         .      10.1     5.6   .50
28 O   *     .         .         .         .         .         .         .         .         .         .      89.6     9.3  1.04
29 .        O.*        .         .         .         .         .         .         .         .         .     212.2   179.0   .07
30 .*        .         .         .         .         .         .         .         .         .         .      16.3    12.0  0.00
31 *         .         .         .         .         .         .         .         .         .         .       7.6     8.1   .02
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JUN-JUL    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *O        .         .         .         .         .         .         .         .         .         .       6.2    11.0   .23
 2 *         .         .         .         .         .         .         .         .         .         .       4.9     7.6   .03
 3 *         .         .         .         .         .         .         .         .         .         .       4.1     6.5  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       3.5     5.6  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       3.0     4.7   .05
 6 *         .         .         .         .         .         .         .         .         .         .       3.0     5.1   .44
 7 *O        .         .         .         .         .         .         .         .         .         .       2.6    20.0   .14
 8 *         .         .         .         .         .         .         .         .         .         .       2.3     8.1   .01
 9 *         .         .         .         .         .         .         .         .         .         .       2.1     5.1   .01
10 *         .         .         .         .         .         .         .         .         .         .       2.0     3.8  0.00
11 *         .         .         .         .         .         .         .         .         .         .       1.9     3.2   .04
12 *         .         .         .         .         .         .         .         .         .         .       1.8     2.7   .06
13 *         .         .         .         .         .         .         .         .         .         .       1.9     2.9   .19
14 *         .         .         .         .         .         .         .         .         .         .       1.7     2.7  0.00
15 *         .         .         .         .         .         .         .         .         .         .       1.6     2.7  0.00
16 *         .         .         .         .         .         .         .         .         .         .       1.6     2.3   .07
17 *         .         .         .         .         .         .         .         .         .         .       1.6     2.0  0.00
18 *         .         .         .         .         .         .         .         .         .         .       1.5     1.8  0.00
19 *         .         .         .         .         .         .         .         .         .         .       1.5     1.7  0.00
20 *         .         .         .         .         .         .         .         .         .         .       1.7     1.7   .37
21 *         .         .         .         .         .         .         .         .         .         .       1.5     2.1  0.00
22 *         .         .         .         .         .         .         .         .         .         .       1.4     1.8  0.00
23 *         .         .         .         .         .         .         .         .         .         .       1.4     1.7  0.00
24 *         .         .         .         .         .         .         .         .         .         .       1.5     1.4   .19
25 *         .         .         .         .         .         .         .         .         .         .       1.4     1.4   .01
26 *         .         .         .         .         .         .         .         .         .         .       1.3     1.4   .00
27 *         .         .         .         .         .         .         .         .         .         .       1.3     1.4   .00
28 *         .         .         .         .         .         .         .         .         .         .       1.3     1.4  0.00
29 *         .         .         .         .         .         .         .         .         .         .       1.3     1.0  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.2      .9  0.00
 1 *         .         .         .         .         .         .         .         .         .         .       1.2      .8  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.2      .7  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       2.1      .6   .59
 4 .    O    .         .         .  *      .         .         .         .         .         .         .     654.9   102.0  2.79
 5 O  *      .         .         .         .         .         .         .         .         .         .      53.1     3.8  0.00
 6 O*        .         .         .         .         .         .         .         .         .         .      15.9     2.1   .09
 7 O*        .         .         .         .         .         .         .         .         .         .      11.8     1.8  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       9.2     1.7   .00
 9 *         .         .         .         .         .         .         .         .         .         .       7.3     1.5  0.00
10 *         .         .         .         .         .         .         .         .         .         .       5.9     1.3   .07
11 *         .         .         .         .         .         .         .         .         .         .       4.9     1.0  0.00
12 *         .         .         .         .         .         .         .         .         .         .       4.1      .8   .01
13 *         .         .         .         .         .         .         .         .         .         .       3.5      .8   .01
14 *         .         .         .         .         .         .         .         .         .         .       3.1      .8   .00
15 *         .         .         .         .         .         .         .         .         .         .       2.8      .8  0.00
16 *         .         .         .         .         .         .         .         .         .         .       2.6      .7  0.00
17 O   *     .         .         .         .         .         .         .         .         .         .      85.1      .5  1.56
18 O     *   .         .         .         .         .         .         .         .         .         .     121.4      .7  0.00
19 O*        .         .         .         .         .         .         .         .         .         .      12.3      .6  0.00
20 *         .         .         .         .         .         .         .         .         .         .       8.1      .4  0.00
21 *         .         .         .         .         .         .         .         .         .         .       6.5      .2   .08
22 O         .*        .         .         .         .         .         .         .         .         .     219.6     1.1  1.54
23 O  *      .         .         .         .         .         .         .         .         .         .      64.3     2.0   .08
24 O*        .         .         .         .         .         .         .         .         .         .      12.8     1.4   .00
25 *         .         .         .         .         .         .         .         .         .         .       8.7     1.0  0.00
26 *         .         .         .         .         .         .         .         .         .         .       7.0      .6  0.00
27 * O       .         .         .         .         .         .         .         .         .         .       6.1    50.0   .42
28 *         .         .         .         .         .         .         .         .         .         .       4.9     2.1   .08
29 *       O .         .         .         .         .         .         .         .         .         .       4.4   163.0   .36
30 *    O    .         .         .         .         .         .         .         .         .         .       3.8   105.0  0.00
31 *         .         .         .         .         .         .         .         .         .         .       3.3     3.2  0.00
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```
AUG-SEP     200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0      SIM.  OBS. RAIN+MELT
  1 *         .         .         .         .         .         .         .         .         .         .         3.0     1.7  0.00
  2 *         .         .         .         .         .         .         .         .         .         .         2.8     1.3  0.00
  3 *         .         .         .         .         .         .         .         .         .         .         2.6     1.0  0.00
  4 *         .         .         .         .         .         .         .         .         .         .         2.5      .7  0.00
  5 *         .         .         .         .         .         .         .         .         .         .         2.4      .4  0.00
  6 *         .         .         .         .         .         .         .         .         .         .         2.3      .2  0.00
  7 *         .         .         .         .         .         .         .         .         .         .         2.2      .1  0.00
  8 *         .         .         .         .         .         .         .         .         .         .         2.2      .1   .02
  9 *         .         .         .         .         .         .         .         .         .         .         2.1      .1  0.00
 10 *         .         .         .         .         .         .         .         .         .         .         2.1      .1   .01
 11 *         .         .         .         .         .         .         .         .         .         .         2.0     0.0  0.00
 12 *         .         .         .         .         .         .         .         .         .         .         2.0     0.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .         1.9     0.0  0.00
 14 *         .         .         .         .         .         .         .         .         .         .         1.9     0.0  0.00
 15 *         .         .         .         .         .         .         .         .         .         .         1.9     0.0  0.00
 16 *         .         .         .         .         .         .         .         .         .         .         1.8     0.0  0.00
 17 *         .         .         .         .         .         .         .         .         .         .         4.1     0.0   .63
 18 0 *       .         .         .         .         .         .         .         .         .         .        44.2     0.0   .32
 19 *         .         .         .         .         .         .         .         .         .         .         6.9      .1  0.00
 20 *         .         .         .         .         .         .         .         .         .         .         4.6      .1   .00
 21 *         .         .         .         .         .         .         .         .         .         .         3.8     0.0   .01
 22 *         .         .         .         .         .         .         .         .         .         .         3.3     0.0  0.00
 23 *         .         .         .         .         .         .         .         .         .         .         2.9     0.0  0.00
 24 0*        .         .         .         .         .         .         .         .         .         .        18.6     0.0   .77
 25 0*        .         .         .         .         .         .         .         .         .         .        10.2     0.0  0.00
 26 .  0      . *       .         .         .         .         .         .         .         .         .       246.3    55.0  1.64
 27 0*        .         .         .         .         .         .         .         .         .         .        28.9     2.1  0.00
 28 0*        .         .         .         .         .         .         .         .         .         .        11.9      .6  0.00
 29 *         .         .         .         .         .         .         .         .         .         .         9.2      .2  0.00
 30 *         .         .         .         .         .         .         .         .         .         .         7.3      .1  0.00
 31 *         .         .         .         .         .         .         .         .         .         .         6.0     0.0  0.00
  1 *         .         .         .         .         .         .         .         .         .         .         5.0     0.0  0.00
  2 *         .         .         .         .         .         .         .         .         .         .         4.2     0.0  0.00
  3 *         .         .         .         .         .         .         .         .         .         .         3.7     0.0  0.00
  4 *         .         .         .         .         .         .         .         .         .         .         3.3     0.0  0.00
  5 *         .         .         .         .         .         .         .         .         .         .         2.9     0.0  0.00
  6 *         .         .         .         .         .         .         .         .         .         .         2.7     0.0  0.00
  7 *         .         .         .         .         .         .         .         .         .         .         2.5     0.0  0.00
  8 *         .         .         .         .         .         .         .         .         .         .         2.4     0.0  0.00
  9 *         .         .         .         .         .         .         .         .         .         .         2.3     0.0   .03
 10 *         .         .         .         .         .         .         .         .         .         .         2.2     0.0  0.00
 11 *         .         .         .         .         .         .         .         .         .         .         2.1     0.0  0.00
 12 *         .         .         .         .         .         .         .         .         .         .         2.1     0.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .         2.0     0.0  0.00
 14 *         .         .         .         .         .         .         .         .         .         .         2.0     0.0  0.00
 15 *         .         .         .         .         .         .         .         .         .         .         1.9     0.0  0.00
 16 *         .         .         .         .         .         .         .         .         .         .         1.9     0.0  0.00
 17 *         .         .         .         .         .         .         .         .         .         .         1.8     0.0  0.00
 18 *         .         .         .         .         .         .         .         .         .         .         1.8     0.0  0.00
 19 *         .         .         .         .         .         .         .         .         .         .         1.8     0.0   .00
 20 *         .         .         .         .         .         .         .         .         .         .         1.8     0.0   .07
 21 *         .         .         .         .         .         .         .         .         .         .         1.8     0.0   .09
 22 *         .         .         .         .         .         .         .         .         .         .         1.7     0.0  0.00
 23 *         .         .         .         .         .         .         .         .         .         .         1.8      .2   .30
 24 *         .         .         .         .         .         .         .         .         .         .         1.7     7.9   .03
 25 *         .         .         .         .         .         .         .         .         .         .         1.6      .1   .00
 26 *         .         .         .         .         .         .         .         .         .         .         1.7     0.0   .13
 27 *         .         .         .         .         .         .         .         .         .         .         1.6     0.0  0.00
 28 *         .         .         .         .         .         .         .         .         .         .         1.5     0.0  0.00
 29 *         .         .         .         .         .         .         .         .         .         .         1.5     0.0  0.00
 30 *         .         .         .         .         .         .         .         .         .         .         1.5     0.0  0.00
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MEAN DAILY FLOW PLOT    COUNCIL CR              WATER YEAR 1961     *=SIMULATED    O=OBSERVED    UNITS-CFSD
OCT-NOV    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .       1.5     0.0  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.4     0.0  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       1.4     0.0  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       1.4     0.0  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       1.4     0.0  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       1.4     0.0  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       1.3     0.0  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       1.3     0.0  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       1.3     0.0  0.00
10 *         .         .         .         .         .         .         .         .         .         .       1.3     0.0  0.00
11 *         .         .         .         .         .         .         .         .         .         .       1.3     0.0  0.00
12 *         .         .         .         .         .         .         .         .         .         .       1.2     0.0  0.00
13 *         .         .         .         .         .         .         .         .         .         .       1.5     0.0   .49
14 *         .         .         .         .         .         .         .         .         .         .       1.3     0.0  0.00
15 *         .         .         .         .         .         .         .         .         .         .       1.2     0.0  0.00
16 *         .         .         .         .         .         .         .         .         .         .       1.2     0.0  0.00
17 *         .         .         .         .         .         .         .         .         .         .       1.2     0.0   .03
18 .   0     *         .         .         .         .         .         .         .         .         .     201.7    83.0  2.59
19 0  *      .         .         .         .         .         .         .         .         .         .      52.2     4.3   .01
20 0*        .         .         .         .         .         .         .         .         .         .      15.2      .6   .00
21 0*        .         .         .         .         .         .         .         .         .         .      11.3      .3  0.00
22 *         .         .         .         .         .         .         .         .         .         .       8.8      .2  0.00
23 *         .         .         .         .         .         .         .         .         .         .       7.0      .1  0.00
24 *         .         .         .         .         .         .         .         .         .         .       5.6      .1  0.00
25 *         .         .         .         .         .         .         .         .         .         .       4.9      .1   .31
26 *         .         .         .         .         .         .         .         .         .         .       4.0      .2  0.00
27 *         .         .         .         .         .         .         .         .         .         .       3.4      .4   .00
28 *         .         .         .         .         .         .         .         .         .         .       3.1      .4   .10
29 .         .  *      .         .         .         .         .         .         .         .         .     256.5   252.0  2.22
30 .0        .  *      .         .         .         .         .         .         .         .         .     266.8    27.0   .31
31 0 *       .         .         .         .         .         .         .         .         .         .      45.5     5.1  0.00
 1 0*        .         .         .         .         .         .         .         .         .         .      14.2     2.5  0.00
 2 0*        .         .         .         .         .         .         .         .         .         .      10.6     1.5  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       8.4     1.5  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       6.8     1.8  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       5.7     1.5  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       4.8     1.7  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       4.2     1.5  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       3.7     1.7  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       3.3     1.7  0.00
10 *         .         .         .         .         .         .         .         .         .         .       3.1     1.4  0.00
11 *         .         .         .         .         .         .         .         .         .         .       2.9     1.5  0.00
12 *         .         .         .         .         .         .         .         .         .         .       2.7     1.3  0.00
13 *         .         .         .         .         .         .         .         .         .         .       2.6      .9  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.5     1.0   .01
15 *         .         .         .         .         .         .         .         .         .         .       2.7     3.0   .36
16 *         .         .         .         .         .         .         .         .         .         .       2.4     4.8  0.00
17 *         .         .         .         .         .         .         .         .         .         .       2.3     1.8  0.00
18 *         .         .         .         .         .         .         .         .         .         .       2.2     1.4  0.00
19 *         .         .         .         .         .         .         .         .         .         .       2.2     1.3  0.00
20 *         .         .         .         .         .         .         .         .         .         .       2.1     1.1  0.00
21 *         .         .         .         .         .         .         .         .         .         .       2.1     1.1  0.00
22 *         .         .         .         .         .         .         .         .         .         .       2.1     1.1  0.00
23 *         .         .         .         .         .         .         .         .         .         .       2.0     1.3  0.00
24 *         .         .         .         .         .         .         .         .         .         .       2.0     1.3  0.00
25 *         .         .         .         .         .         .         .         .         .         .       2.0     1.1  0.00
26 *         .         .         .         .         .         .         .         .         .         .       1.9     1.1  0.00
27 *         .         .         .         .         .         .         .         .         .         .       1.9     1.1   .16
28 *         .         .         .         .         .         .         .         .         .         .       2.0     1.5  0.00
29 *         .         .         .         .         .         .         .         .         .         .       1.8     1.8  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.8     1.3  0.00
```

```
DEC-JAN    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .        1.8     1.0  0.00
 2 *         .         .         .         .         .         .         .         .         .         .        1.8      .6  0.00
 3 *         .         .         .         .         .         .         .         .         .         .        1.7      .6  0.00
 4 O*        .         .         .         .         .         .         .         .         .         .       18.7    10.0   .56
 5 .*        .         .         .         .         .         .         .         .         .         .       10.5    15.0  0.00
 6 *         .         .         .         .         .         .         .         .         .         .        3.1     1.7  0.00
 7 *         .         .         .         .         .         .         .         .         .         .        2.6     1.0  0.00
 8 *         .         .         .         .         .         .         .         .         .         .        2.4      .8   .01
 9 *         .         .         .         .         .         .         .         .         .         .        2.2      .7   .04
10 .    O  * .         .         .         .         .         .         .         .         .         .      153.6    98.0  1.02
11 .  O *    .         .         .         .         .         .         .         .         .         .       90.3    59.0   .09
12 .*        .         .         .         .         .         .         .         .         .         .       10.9    18.0  0.00
13 *         .         .         .         .         .         .         .         .         .         .        6.6     3.8   .00
14 *         .         .         .         .         .         .         .         .         .         .        5.3     2.9   .05
15 *         .         .         .         .         .         .         .         .         .         .        4.4     2.7  0.00
16 *         .         .         .         .         .         .         .         .         .         .        3.7     2.0  0.00
17 *         .         .         .         .         .         .         .         .         .         .        3.2     1.7  0.00
18 *         .         .         .         .         .         .         .         .         .         .        2.8     1.5  0.00
19 *         .         .         .         .         .         .         .         .         .         .        2.5     1.4  0.00
20 *         .         .         .         .         .         .         .         .         .         .        2.3     1.3  0.00
21 *         .         .         .         .         .         .         .         .         .         .        2.1     1.1  0.00
22 *         .         .         .         .         .         .         .         .         .         .        2.0     1.1   .01
23 *         .         .         .         .         .         .         .         .         .         .        1.9     1.1  0.00
24 *         .         .         .         .         .         .         .         .         .         .        1.8     1.4  0.00
25 *         .         .         .         .         .         .         .         .         .         .        1.8     1.4  0.00
26 *         .         .         .         .         .         .         .         .         .         .        1.7     1.4  0.00
27 *         .         .         .         .         .         .         .         .         .         .        1.7     1.3   .05
28 *         .         .         .         .         .         .         .         .         .         .        1.7     1.3   .03
29 *         .         .         .         .         .         .         .         .         .         .        1.6     1.4   .01
30 *         .         .         .         .         .         .         .         .         .         .        1.6     1.4  0.00
31 *         .         .         .         .         .         .         .         .         .         .        1.8     1.8   .28
 1 *         .         .         .         .         .         .         .         .         .         .        1.5     2.0  0.00
 2 *         .         .         .         .         .         .         .         .         .         .        1.5     1.5  0.00
 3 *         .         .         .         .         .         .         .         .         .         .        1.5     1.3  0.00
 4 *         .         .         .         .         .         .         .         .         .         .        1.4     1.3  0.00
 5 *         .         .         .         .         .         .         .         .         .         .        1.4     1.3  0.00
 6 *         .         .         .         .         .         .         .         .         .         .        1.4     1.4  0.00
 7 *         .         .         .         .         .         .         .         .         .         .        1.4     1.4  0.00
 8 *         .         .         .         .         .         .         .         .         .         .        1.3     1.3  0.00
 9 *         .         .         .         .         .         .         .         .         .         .        1.3     1.3  0.00
10 *         .         .         .         .         .         .         .         .         .         .        1.3     1.4  0.00
11 *         .         .         .         .         .         .         .         .         .         .        1.3     1.4  0.00
12 *         .         .         .         .         .         .         .         .         .         .        1.3     1.4  0.00
13 *         .         .         .         .         .         .         .         .         .         .        1.2     1.4  0.00
14 *         .         .         .         .         .         .         .         .         .         .        1.2     1.5   .01
15 *         .         .         .         .         .         .         .         .         .         .        1.2     1.5  0.00
16 *         .         .         .         .         .         .         .         .         .         .        1.2     1.4  0.00
17 *         .         .         .         .         .         .         .         .         .         .        1.2     1.3  0.00
18 *         .         .         .         .         .         .         .         .         .         .        1.1     1.3  0.00
19 *         .         .         .         .         .         .         .         .         .         .        1.1     1.1  0.00
20 *         .         .         .         .         .         .         .         .         .         .        1.1     1.1  0.00
21 *         .         .         .         .         .         .         .         .         .         .        1.1      .9  0.00
22 *         .         .         .         .         .         .         .         .         .         .        1.1     1.0  0.00
23 *         .         .         .         .         .         .         .         .         .         .        1.0     1.1  0.00
24 *         .         .         .         .         .         .         .         .         .         .        1.0     1.1  0.00
25 *         .         .         .         .         .         .         .         .         .         .        1.0      .9  0.00
26 *         .         .         .         .         .         .         .         .         .         .        1.0      .9  0.00
27 *         .         .         .         .         .         .         .         .         .         .        1.0      .9  0.00
28 *         .         .         .         .         .         .         .         .         .         .        1.0      .9  0.00
29 *         .         .         .         .         .         .         .         .         .         .        1.0     1.0  0.00
30 *         .         .         .         .         .         .         .         .         .         .         .9     1.1  0.00
31 *         .         .         .         .         .         .         .         .         .         .         .9     1.3  0.00
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```
FEB-MAR    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .         .9     1.5  0.00
 2 *         .         .         .         .         .         .         .         .         .         .         .9     1.5  0.00
 3 *         .         .         .         .         .         .         .         .         .         .         .9     1.4  0.00
 4 *         .         .         .         .         .         .         .         .         .         .         .9     1.3   .01
 5 *         .         .         .         .         .         .         .         .         .         .         .9     1.1   .03
 6 *         .         .         .         .         .         .         .         .         .         .         .9     1.3   .11
 7 *         .         .         .         .         .         .         .         .         .         .         .9     1.5   .08
 8 *         .         .         .         .         .         .         .         .         .         .         .8     1.5   .00
 9 *         .         .         .         .         .         .         .         .         .         .         .8     1.5  0.00
10 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
11 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
12 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
13 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
14 *         .         .         .         .         .         .         .         .         .         .         .7     1.4  0.00
15 *         .         .         .         .         .         .         .         .         .         .         .7     1.3  0.00
16 *         .         .         .         .         .         .         .         .         .         .         .7     1.4  0.00
17 0 *       .         .         .         .         .         .         .         .         .         .       40.1     2.0  1.29
18 0     *   .         .         .         .         .         .         .         .         .         .      112.1     4.7  0.00
19 *         .         .         .         .         .         .         .         .         .         .        8.6     2.3  0.00
20 *         .         .         .         .         .         .         .         .         .         .        5.3     1.7   .11
21 0*        .         .         .         .         .         .         .         .         .         .       13.4     2.0   .13
22 *         .         .         .         .         .         .         .         .         .         .        4.3     2.1   .00
23 *         .         .         .         .         .         .         .         .         .         .        3.1     2.1  0.00
24 *         .         .         .         .         .         .         .         .         .         .        2.5     1.8   .01
25 *         .         .         .         .         .         .         .         .         .         .        2.1     1.5  0.00
26 *         .         .         .         .         .         .         .         .         .         .        1.8     1.7  0.00
27 *         .         .         .         .         .         .         .         .         .         .        1.6     1.7  0.00
28 *         .         .         .         .         .         .         .         .         .         .        1.4     1.4  0.00
 1 *         .         .         .         .         .         .         .         .         .         .        1.3     1.4  0.00
 2 *         .         .         .         .         .         .         .         .         .         .        1.2     1.4  0.00
 3 *         .         .         .         .         .         .         .         .         .         .        1.1     1.5  0.00
 4 *         .         .         .         .         .         .         .         .         .         .        1.0     1.7  0.00
 5 *         .         .         .         .         .         .         .         .         .         .        1.0     1.8   .05
 6 *0        .         .         .         .         .         .         .         .         .         .        1.0    15.0  0.00
 7 *         .         .         .         .         .         .         .         .         .         .         .9     2.5  0.00
 8 *         .         .         .         .         .         .         .         .         .         .         .9     1.8  0.00
 9 *         .         .         .         .         .         .         .         .         .         .         .9     1.4  0.00
10 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
11 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
12 *         .         .         .         .         .         .         .         .         .         .         .8     1.7  0.00
13 *         .         .         .         .         .         .         .         .         .         .         .8     1.7  0.00
14 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
15 *         .         .         .         .         .         .         .         .         .         .         .8     1.4  0.00
16 *         .         .         .         .         .         .         .         .         .         .         .8     1.5   .04
17 *         .         .         .         .         .         .         .         .         .         .        3.6     2.3   .63
18 *         .         .         .         .         .         .         .         .         .         .        8.7     6.5   .03
19 *         .         .         .         .         .         .         .         .         .         .        1.9     2.9   .03
20 *         .         .         .         .         .         .         .         .         .         .        1.6     2.5   .21
21 *         .         .         .         .         .         .         .         .         .         .        1.3     3.5  0.00
22 *         .         .         .         .         .         .         .         .         .         .        1.1     2.5  0.00
23 *         .         .         .         .         .         .         .         .         .         .        1.0     2.0  0.00
24 *         .         .         .         .         .         .         .         .         .         .         .9     1.8  0.00
25 *         .         .         .         .         .         .         .         .         .         .         .9     1.8   .04
26 *         .         .         .         .         .         .         .         .         .         .        1.5     2.0   .45
27 *         .         .         .         .         .         .         .         .         .         .        2.1     2.3  0.00
28 *         .         .         .         .         .         .         .         .         .         .         .9     2.1  0.00
29 *         .         .         .         .         .         .         .         .         .         .        3.3     2.0   .37
30 0*        .         .         .         .         .         .         .         .         .         .       13.2     5.4   .44
31 . * 0     .         .         .         .         .         .         .         .         .         .       48.0    75.0   .26
```

```
APR-MAY     200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0      SIM.   OBS. RAIN+MELT
  1 *0        .         .         .         .         .         .         .         .         .         .      6.2   14.0   .00
  2 *         .         .         .         .         .         .         .         .         .         .      4.1    5.6   .00
  3 *         .         .         .         .         .         .         .         .         .         .      3.2    3.8  0.00
  4 *         .         .         .         .         .         .         .         .         .         .      2.6    2.9  0.00
  5 *         .         .         .         .         .         .         .         .         .         .      2.1    2.9  0.00
  6 *         .         .         .         .         .         .         .         .         .         .      1.8    2.7  0.00
  7 *         .         .         .         .         .         .         .         .         .         .      1.5    2.5  0.00
  8 *         .         .         .         .         .         .         .         .         .         .      1.5    2.9   .25
  9 *         .         .         .         .         .         .         .         .         .         .      1.2    4.2  0.00
 10 *         .         .         .         .         .         .         .         .         .         .      1.1    3.2  0.00
 11 *0        .         .         .         .         .         .         .         .         .         .      1.1   13.0   .21
 12 *0        .         .         .         .         .         .         .         .         .         .      1.0   27.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .       .9    4.2  0.00
 14 *         .         .         .         .         .         .         .         .         .         .       .8    3.2   .01
 15 *         .         .         .         .         .         .         .         .         .         .       .8    2.5   .05
 16 *         .         .         .         .         .         .         .         .         .         .       .8    2.1  0.00
 17 *         .         .         .         .         .         .         .         .         .         .       .7    2.1  0.00
 18 *         .         .         .         .         .         .         .         .         .         .       .7    2.0  0.00
 19 *         .         .         .         .         .         .         .         .         .         .       .7    2.0  0.00
 20 *         .         .         .         .         .         .         .         .         .         .       .7    2.0  0.00
 21 *         .         .         .         .         .         .         .         .         .         .       .7    2.0  0.00
 22 *         .         .         .         .         .         .         .         .         .         .       .6    1.8  0.00
 23 *         .         .         .         .         .         .         .         .         .         .       .6    1.7  0.00
 24 *         .         .         .         .         .         .         .         .         .         .       .6    1.7  0.00
 25 *         .         .         .         .         .         .         .         .         .         .       .6    1.7  0.00
 26 *         .         .         .         .         .         .         .         .         .         .       .6    1.5  0.00
 27 *         .         .         .         .         .         .         .         .         .         .       .6    1.5  0.00
 28 *         .         .         .         .         .         .         .         .         .         .       .6    1.5  0.00
 29 *         .         .         .         .         .         .         .         .         .         .       .5    1.4  0.00
 30 *         .         .         .         .         .         .         .         .         .         .       .5    1.4  0.00
  1 *         .         .         .         .         .         .         .         .         .         .       .5    1.5  0.00
  2 *         .         .         .         .         .         .         .         .         .         .       .5    1.5  0.00
  3 *         .         .         .         .         .         .         .         .         .         .       .6    1.5   .18
  4 .*0       .         .         .         .         .         .         .         .         .         .     10.8   32.0  1.10
  5 . * 0     .         .         .         .         .         .         .         .         .         .     32.3   76.0   .01
  6 *         .         .         .         .         .         .         .         .         .         .      6.2    5.6   .00
  7 *         .         .         .         .         .         .         .         .         .         .      4.7    2.9   .24
  8 .   *0    .         .         .         .         .         .         .         .         .         .     84.2   91.0  1.10
  9 .*        .         .         .         .         .         .         .         .         .         .     18.9   15.0  0.00
 10 *         .         .         .         .         .         .         .         .         .         .      7.7    4.7  0.00
 11 *         .         .         .         .         .         .         .         .         .         .      5.9    2.7  0.00
 12 *         .         .         .         .         .         .         .         .         .         .      4.6    2.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .      3.7    1.7  0.00
 14 *         .         .         .         .         .         .         .         .         .         .      3.0    1.4  0.00
 15 *         .         .         .         .         .         .         .         .         .         .      2.5    1.0  0.00
 16 *         .         .         .         .         .         .         .         .         .         .      2.1    1.0   .10
 17 *         .         .         .         .         .         .         .         .         .         .      1.9    1.3   .02
 18 *         .         .         .         .         .         .         .         .         .         .      1.6    1.4  0.00
 19 *         .         .         .         .         .         .         .         .         .         .      1.5    1.1   .02
 20 *         .         .         .         .         .         .         .         .         .         .      1.4     .9  0.00
 21 .     0*  .         .         .         .         .         .         .         .         .         .    132.3  127.0  2.13
 22 .   *     .         .         .         .         .         .         .         .         .         .     88.8   89.0  0.00
 23 0*        .         .         .         .         .         .         .         .         .         .     12.4    8.1  0.00
 24 *         .         .         .         .         .         .         .         .         .         .      8.7    4.2  0.00
 25 * 0       .         .         .         .         .         .         .         .         .         .      6.8   45.0   .01
 26 * 0       .         .         .         .         .         .         .         .         .         .      5.4   40.0  0.00
 27 *         .         .         .         .         .         .         .         .         .         .      4.4    4.2  0.00
 28 *         .         .         .         .         .         .         .         .         .         .      3.6    2.7  0.00
 29 *         .         .         .         .         .         .         .         .         .         .      3.1    2.3  0.00
 30 *         .         .         .         .         .         .         .         .         .         .      2.7    1.8  0.00
 31 *         .         .         .         .         .         .         .         .         .         .      2.4    1.5  0.00
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JUN-JUL    200.0     400.0     600.0     800.0    1000.0    12(0.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .       2.1     1.3  0.00
 2 0 *       .         .         .         .         .         .         .         .         .         .      35.7     5.0  1.42
 3 .     *0  .         .         .         .         .         .         .         .         .         .     123.2   137.0   .12
 4 .         .         .         . *  0    .         .         .         .         .         .         .     638.1   705.0  2.45
 5 . 0  *    .         .         .         .         .         .         .         .         .         .     107.2    48.0   .04
 6 .*        .         .         .         .         .         .         .         .         .         .      19.0    18.0   .07
 7 .*  0     .         .         .         .         .         .         .         .         .         .      22.6    74.0   .35
 8 .* 0      .         .         .         .         .         .         .         .         .         .      25.8    66.0   .24
 9 *0        .         .         .         .         .         .         .         .         .         .       9.7    13.0  0.00
10 *         .         .         .         .         .         .         .         .         .         .       7.2     7.6  0.00
11 *         .         .         .         .         .         .         .         .         .         .       5.9     5.6  0.00
12 *         .         .         .         .         .         .         .         .         .         .       5.0     4.2  0.00
13 *         .         .         .         .         .         .         .         .         .         .       4.3     3.5  0.00
14 .         .         .  *      .         . 0       .         .         .         .         .         .     452.8   835.0  1.90
15 . *       .         .         .         .         .         .         .         .         .         .      47.0    32.0  0.00
16 .*        .         .         .         .         .         .         .         .         .         .      11.7    15.0  0.00
17 *         .         .         .         .         .         .         .         .         .         .       8.6    10.0  0.00
18 *         .         .         .         .         .         .         .         .         .         .       7.0     8.7  0.00
19 *         .         .         .         .         .         .         .         .         .         .       5.8     7.0  0.00
20 *         .         .         .         .         .         .         .         .         .         .       5.0     6.0  0.00
21 *         .         .         .         .         .         .         .         .         .         .       4.3     5.1  0.00
22 *         .         .         .         .         .         .         .         .         .         .       3.8     4.2  0.00
23 *         .         .         .         .         .         .         .         .         .         .       3.5     3.5  0.00
24 *         .         .         .         .         .         .         .         .         .         .       3.2     2.9  0.00
25 *         .         .         .         .         .         .         .         .         .         .       3.0     2.9   .01
26 *         .         .         .         .         .         .         .         .         .         .       2.8     2.7  0.00
27 *         .         .         .         .         .         .         .         .         .         .       2.7     2.5  0.00
28 *         .         .         .         .         .         .         .         .         .         .       2.6     2.3  0.00
29 *         .         .         .         .         .         .         .         .         .         .       2.5     2.1  0.00
30 *         .         .         .         .         .         .         .         .         .         .       2.4     2.5  0.00
 1 *         .         .         .         .         .         .         .         .         .         .       2.3     2.0  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       2.3     1.8  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       2.2     1.8  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       2.2     1.7  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       2.1     1.5  0.00
 6 0  *      .         .         .         .         .         .         .         .         .         .      65.3     2.5  1.90
 7 .      0  .         *         .         .         .         .         .         .         .         .     401.7   149.0   .76
 8 0 *       .         .         .         .         .         .         .         .         .         .      35.1     6.0  0.00
 9 0*        .         .         .         .         .         .         .         .         .         .      14.2     2.7  0.00
10 0*        .         .         .         .         .         .         .         .         .         .      10.9     2.0  0.00
11 *         .         .         .         .         .         .         .         .         .         .       8.6     1.7   .01
12 0 *       .         .         .         .         .         .         .         .         .         .      44.5     5.7   .72
13 .   * 0   .         .         .         .         .         .         .         .         .         .      84.2   126.0  1.23
14 .         .   0*    .         .         .         .         .         .         .         .         .     306.6   272.0   .54
15 .  *      .0        .         .         .         .         .         .         .         .         .      69.0   215.0   .17
16 .*        .         .         .         .         .         .         .         .         .         .      15.8    26.0  0.00
17 0*        .         .         .         .         .         .         .         .         .         .      10.0     7.6  0.00
18 *         .         .         .         .         .         .         .         .         .         .       8.1     4.7  0.00
19 *         .         .         .         .         .         .         .         .         .         .       6.7     3.2  0.00
20 *         .         .         .         .         .         .         .         .         .         .       5.8     3.5   .24
21 . 0 *     .         .         .         .         .         .         .         .         .         .      84.9    38.0   .84
22 .0 *      .         .         .         .         .         .         .         .         .         .      58.5    28.0   .46
23 .*        .         .         .         .         .         .         .         .         .         .      24.7    19.0  0.00
24 *         .         .         .         .         .         .         .         .         .         .       7.2     6.0  0.00
25 *         .         .         .         .         .         .         .         .         .         .       5.7     3.5  0.00
26 *         .         .         .         .         .         .         .         .         .         .       4.9     2.7  0.00
27 *         .         .         .         .         .         .         .         .         .         .       4.3     2.1  0.00
28 *         .         .         .         .         .         .         .         .         .         .       3.9     2.0  0.00
29 *         .         .         .         .         .         .         .         .         .         .       3.5     1.7  0.00
30 *         .         .         .         .         .         .         .         .         .         .       3.3     1.4  0.00
31 *         .         .         .         .         .         .         .         .         .         .       3.1     1.1  0.00
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 AUG-SEP    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.    OBS. RAIN+MELT
  1 *         .         .         .         .         .         .         .         .         .         .       2.9     1.1  0.00
  2 *         .         .         .         .         .         .         .         .         .         .       2.8      .9  0.00
  3 *         .         .         .         .         .         .         .         .         .         .       2.7      .9   .04
  4 *         .         .         .         .         .         .         .         .         .         .       2.6     1.0  0.00
  5 *         .         .         .         .         .         .         .         .         .         .       2.6     1.1   .05
  6 *         .         .         .         .         .         .         .         .         .         .       2.5     1.3   .01
  7 *         .         .         .         .         .         .         .         .         .         .       2.4      .7  0.00
  8 *         .         .         .         .         .         .         .         .         .         .       2.4      .6  0.00
  9 *         .         .         .         .         .         .         .         .         .         .       2.3      .5  0.00
 10 *         .         .         .         .         .         .         .         .         .         .       2.3      .4  0.00
 11 *         .         .         .         .         .         .         .         .         .         .       2.3      .3  0.00
 12 *         .         .         .         .         .         .         .         .         .         .       2.3      .5   .21
 13 0*        .         .         .         .         .         .         .         .         .         .      21.2      .8   .75
 14 0      *  .         .         .         .         .         .         .         .         .         .     139.9     1.3   .85
 15 0*        .         .         .         .         .         .         .         .         .         .      25.0     1.3   .16
 16 *         .         .         .         .         .         .         .         .         .         .       9.5     1.1  0.00
 17 *         .         .         .         .         .         .         .         .         .         .       7.4      .9  0.00
 18 *         .         .         .         .         .         .         .         .         .         .       6.1      .6  0.00
 19 *         .         .         .         .         .         .         .         .         .         .       5.1      .4  0.00
 20 *         .         .         .         .         .         .         .         .         .         .       4.3      .4  0.00
 21 *         .         .         .         .         .         .         .         .         .         .       3.8      .2   .03
 22 *         .         .         .         .         .         .         .         .         .         .       3.6      .4   .24
 23 *         .         .         .         .         .         .         .         .         .         .       3.1      .4  0.00
 24 *         .         .         .         .         .         .         .         .         .         .       2.8      .3  0.00
 25 *         .         .         .         .         .         .         .         .         .         .       2.6      .2  0.00
 26 *         .         .         .         .         .         .         .         .         .         .       2.5      .1  0.00
 27 *         .         .         .         .         .         .         .         .         .         .       2.4      .1  0.00
 28 *         .         .         .         .         .         .         .         .         .         .       2.3     0.0  0.00
 29 *         .         .         .         .         .         .         .         .         .         .       2.2     0.0  0.00
 30 *         .         .         .         .         .         .         .         .         .         .       2.2     0.0   .11
 31 *         .         .         .         .         .         .         .         .         .         .       2.1     0.0  0.00
  1 *         .         .         .         .         .         .         .         .         .         .       2.0     0.0  0.00
  2 *         .         .         .         .         .         .         .         .         .         .       2.0     0.0  0.00
  3 0 *       .         .         .         .         .         .         .         .         .         .      33.7     0.0  1.41
  4 0     *   .         .         .         .         .         .         .         .         .         .     126.4     4.7   .18
  5 0*        .         .         .         .         .         .         .         .         .         .      13.1     1.0  0.00
  6 *         .         .         .         .         .         .         .         .         .         .       8.1      .4  0.00
  7 0*        .         .         .         .         .         .         .         .         .         .      12.6      .9   .47
  8 *         .         .         .         .         .         .         .         .         .         .       8.6     2.4  0.00
  9 *         .         .         .         .         .         .         .         .         .         .       5.1      .4  0.00
 10 *         .         .         .         .         .         .         .         .         .         .       4.3      .1  0.00
 11 *         .         .         .         .         .         .         .         .         .         .       3.7      .1   .00
 12 .0       *.         .         .         .         .         .         .         .         .         .     170.7    20.0  2.33
 13 .         .         .         .         .         .       ) .         .         .       * .         .    1766.7  1170.0  2.62
 14 .0   *    .         .         .         .         .         .         .         .         .         .     105.9    22.0  0.00
 15 0*        .         .         .         .         .         .         .         .         .         .      21.2     8.7  0.00
 16 0*        .         .         .         .         .         .         .         .         .         .      14.7     6.0  0.00
 17 0*        .         .         .         .         .         .         .         .         .         .      11.5     5.1  0.00
 18 *         .         .         .         .         .         .         .         .         .         .       9.2     4.2  0.00
 19 *         .         .         .         .         .         .         .         .         .         .       7.5     3.5  0.00
 20 0 *       .         .         .         .         .         .         .         .         .         .      48.8     5.6   .73
 21 0*        .         .         .         .         .         .         .         .         .         .      14.2     5.6  0.00
 22 *         .         .         .         .         .         .         .         .         .         .       6.0     3.2  0.00
 23 *         .         .         .         .         .         .         .         .         .         .       5.1     2.5  0.00
 24 *         .         .         .         .         .         .         .         .         .         .       4.5     2.7   .22
 25 *         .         .         .         .         .         .         .         .         .         .       4.1     4.8  0.00
 26 *         .         .         .         .         .         .         .         .         .         .       3.7     2.3  0.00
 27 .0       *.         .         .         .         .         .         .         .         .         .     184.6    11.0  1.20
 28 0  *      .         .         .         .         .         .         .         .         .         .      64.0     8.3  0.00
 29 *         .         .         .         .         .         .         .         .         .         .       9.4     3.2  0.00
 30 . 0  *    .         .         .         .         .         .         .         .         .         .      98.4    43.0   .59
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MEAN DAILY FLOW PLOT    COUNCIL CR              WATER YEAR 1962     *=SIMULATED    0=OBSERVED    UNITS-CFSD
OCT-NOV    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 0*        .         .         .         .         .         .         .         .         .         .      23.8     5.1   .00
 2 *         .         .         .         .         .         .         .         .         .         .       7.2     2.5   .07
 3 *         .         .         .         .         .         .         .         .         .         .       5.7     2.1  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       4.9     2.0  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       4.3     1.8  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       3.9     1.7  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       3.5     1.5  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       3.3     1.4  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       3.2     1.5   .48
10 .       0 .   *     .         .         .         .         .         .         .         .         .     282.2   164.0  1.12
11 . 0*      .         .         .         .         .         .         .         .         .         .      67.8    39.0  0.00
12 0*        .         .         .         .         .         .         .         .         .         .      10.4     7.6  0.00
13 *         .         .         .         .         .         .         .         .         .         .       7.2     5.6  0.00
14 *         .         .         .         .         .         .         .         .         .         .       6.0     4.2  0.00
15 *         .         .         .         .         .         .         .         .         .         .       5.1     3.2  0.00
16 *         .         .         .         .         .         .         .         .         .         .       4.4     2.7  0.00
17 *         .         .         .         .         .         .         .         .         .         .       3.9     2.7  0.00
18 *         .         .         .         .         .         .         .         .         .         .       3.5     2.5  0.00
19 *         .         .         .         .         .         .         .         .         .         .       3.3     2.3  0.00
20 *         .         .         .         .         .         .         .         .         .         .       3.0     2.3  0.00
21 *         .         .         .         .         .         .         .         .         .         .       2.9     2.3  0.00
22 *         .         .         .         .         .         .         .         .         .         .       2.7     2.3  0.00
23 *         .         .         .         .         .         .         .         .         .         .       2.6     2.3   .00
24 *         .         .         .         .         .         .         .         .         .         .       2.6     2.3  0.00
25 *         .         .         .         .         .         .         .         .         .         .       2.5     2.5   .00
26 *         .         .         .         .         .         .         .         .         .         .       2.4     2.1  0.00
27 *         .         .         .         .         .         .         .         .         .         .       2.4     2.0  0.00
28 *         .         .         .         .         .         .         .         .         .         .       2.3     2.3  0.00
29 *         .         .         .         .         .         .         .         .         .         .       2.3     2.5   .03
30 *         .         .         .         .         .         .         .         .         .         .       2.4     2.5   .29
31 *         .         .         .         .         .         .         .         .         .         .       2.4     2.5   .12
 1 0 *       .         .         .         .         .         .         .         .         .         .      44.1     2.7   .86
 2 .         .         . *       .  0      .         .         .         .         .         .         .     439.4   661.0  1.05
 3 . *       .         .         .         .         .         .         .         .         .         .      44.0    31.0  0.00
 4 .*        .         .         .         .         .         .         .         .         .         .      11.8    11.0  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       8.8     8.1  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       7.1     7.0  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       5.8     6.5  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       4.9     6.0  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       4.2     6.0  0.00
10 *         .         .         .         .         .         .         .         .         .         .       3.8     6.0   .04
11 *         .         .         .         .         .         .         .         .         .         .       3.4     6.0  0.00
12 *         .         .         .         .         .         .         .         .         .         .       3.1     5.6  0.00
13 *         .         .         .         .         .         .         .         .         .         .       2.9     5.1  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.7     4.7   .00
15 .   0     *         .         .         .         .         .         .         .         .         .     202.6    80.0  1.16
16 .0*       .         .         .         .         .         .         .         .         .         .      46.4    25.0  0.00
17 *         .         .         .         .         .         .         .         .         .         .       7.6     7.6  0.00
18 *         .         .         .         .         .         .         .         .         .         .       5.5     6.5   .07
19 *         .         .         .         .         .         .         .         .         .         .       4.7     6.5   .01
20 *         .         .         .         .         .         .         .         .         .         .       4.0     5.6   .00
21 .        *. 0      .         .         .         .         .         .         .         .         .     181.3   241.0   .84
22 .  0*     .         .         .         .         .         .         .         .         .         .      70.7    61.0   .01
23 *0        .         .         .         .         .         .         .         .         .         .       9.0    18.0  0.00
24 *         .         .         .         .         .         .         .         .         .         .       5.7    10.0  0.00
25 *         .         .         .         .         .         .         .         .         .         .       4.8     8.7  0.00
26 *         .         .         .         .         .         .         .         .         .         .       4.1     8.1  0.00
27 *         .         .         .         .         .         .         .         .         .         .       3.6     7.6  0.00
28 *         .         .         .         .         .         .         .         .         .         .       3.2     7.0  0.00
29 *         .         .         .         .         .         .         .         .         .         .       3.0     6.5  0.00
30 *         .         .         .         .         .         .         .         .         .         .       2.8     6.5  0.00
```

```
DEC-JAN    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *         .         .         .         .         .         .         .         .         .         .       2.6     6.5  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       2.5     6.5  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       2.4     6.5  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       2.3     6.5   .07
 5 *         .         .         .         .         .         .         .         .         .         .       2.2     6.0  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       2.2     5.6  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       2.1     4.7  0.00
 8 .0*       .         .         .         .         .         .         .         .         .         .      45.1    21.0   .64
 9 .   *     .         .         .         .         .         .         .         .         .         .      73.4    83.0   .03
10 .*        .         .         .         .         .         .         .         .         .         .      10.7    16.0   .05
11 0*        .         .         .         .         .         .         .         .         .         .      23.4     8.1   .10
12 *         .         .         .         .         .         .         .         .         .         .       7.1     6.5  0.00
13 *         .         .         .         .         .         .         .         .         .         .       3.3     5.1  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.9     6.5  0.00
15 *         .         .         .         .         .         .         .         .         .         .       2.6     7.0  0.00
16 .      0* .         .         .         .         .         .         .         .         .         .     152.9   137.0   .52
17 .*0       .         .         .         .         .         .         .         .         .         .      26.9    32.0   .00
18 *0        .         .         .         .         .         .         .         .         .         .       5.2    16.0  0.00
19 *         .         .         .         .         .         .         .         .         .         .       3.8     9.3  0.00
20 *         .         .         .         .         .         .         .         .         .         .       3.3     7.6  0.00
21 *         .         .         .         .         .         .         .         .         .         .       2.9     7.6  0.00
22 *         .         .         .         .         .         .         .         .         .         .       2.6     7.0  0.00
23 *         .         .         .         .         .         .         .         .         .         .       2.4     6.0  0.00
24 *         .         .         .         .         .         .         .         .         .         .       2.2     5.6  0.00
25 *         .         .         .         .         .         .         .         .         .         .       2.1     6.0  0.00
26 *         .         .         .         .         .         .         .         .         .         .       2.0     6.5  0.00
27 *         .         .         .         .         .         .         .         .         .         .       1.9     5.6  0.00
28 *         .         .         .         .         .         .         .         .         .         .       1.9     4.7  0.00
29 *         .         .         .         .         .         .         .         .         .         .       1.8     4.2  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.8     4.7  0.00
31 *         .         .         .         .         .         .         .         .         .         .       1.7     4.7  0.00
 1 *         .         .         .         .         .         .         .         .         .         .       1.7     4.7  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.6     4.7  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       1.6     5.1  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       1.6     6.0   .00
 5 *         .         .         .         .         .         .         .         .         .         .       1.7     8.1   .25
 6 *         .         .         .         .         .         .         .         .         .         .       1.5     5.6  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       1.5     6.0  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       1.5     5.6   .03
 9 *         .         .         .         .         .         .         .         .         .         .       1.5     4.2   .00
10 *         .         .         .         .         .         .         .         .         .         .       1.4     2.9  0.00
11 *         .         .         .         .         .         .         .         .         .         .       1.4     2.9  0.00
12 *         .         .         .         .         .         .         .         .         .         .       1.4     3.2  0.00
13 *         .         .         .         .         .         .         .         .         .         .       1.4     4.2  0.00
14 *         .         .         .         .         .         .         .         .         .         .       1.3     6.0   .01
15 *         .         .         .         .         .         .         .         .         .         .       1.3     5.1  0.00
16 *         .         .         .         .         .         .         .         .         .         .       1.3     4.2  0.00
17 *         .         .         .         .         .         .         .         .         .         .       1.3     3.5  0.00
18 *         .         .         .         .         .         .         .         .         .         .       1.4     4.7   .21
19 *         .         .         .         .         .         .         .         .         .         .       1.3     4.2  0.00
20 *         .         .         .         .         .         .         .         .         .         .       1.2     3.5  0.00
21 *         .         .         .         .         .         .         .         .         .         .       1.2     4.2  0.00
22 *         .         .         .         .         .         .         .         .         .         .       1.2     4.2  0.00
23 *         .         .         .         .         .         .         .         .         .         .       1.1     3.2  0.00
24 *         .         .         .         .         .         .         .         .         .         .       1.1     5.1  0.00
25 *         .         .         .         .         .         .         .         .         .         .       1.2     7.6   .13
26 *0        .         .         .         .         .         .         .         .         .         .       1.2    13.0  0.00
27 *         .         .         .         .         .         .         .         .         .         .       1.1     8.1  0.00
28 *         .         .         .         .         .         .         .         .         .         .       1.1     5.6  0.00
29 *         .         .         .         .         .         .         .         .         .         .       1.0     5.1  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.0     5.1  0.00
31 *         .         .         .         .         .         .         .         .         .         .       1.0     4.7  0.00
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```
FEB-MAR    200.0       400.0       600.0       800.0      1000.0      120(.0      1400.0      1600.0      1800.0      2000.0     SIM.    OBS. RAIN+MELT
 1 *          .           .           .           .           .           .           .           .           .           .       1.0       4.7  0.00
 2 *          .           .           .           .           .           .           .           .           .           .       1.0       4.2  0.00
 3 *          .           .           .           .           .           .           .           .           .           .       1.0       4.2  0.00
 4 *          .           .           .           .           .           .           .           .           .           .        .9       4.2  0.00
 5 *          .           .           .           .           .           .           .           .           .           .        .9       3.8  0.00
 6 *          .           .           .           .           .           .           .           .           .           .        .9       3.2  0.00
 7 *          .           .           .           .           .           .           .           .           .           .        .9       3.5  0.00
 8 *          .           .           .           .           .           .           .           .           .           .        .9       3.8  0.00
 9 *          .           .           .           .           .           .           .           .           .           .        .9       4.2  0.00
10 *          .           .           .           .           .           .           .           .           .           .        .9       3.8  0.00
11 *          .           .           .           .           .           .           .           .           .           .        .8       4.2  0.00
12 *          .           .           .           .           .           .           .           .           .           .        .8       4.2  0.00
13 *          .           .           .           .           .           .           .           .           .           .        .8       4.2  0.00
14 *          .           .           .           .           .           .           .           .           .           .        .8       3.8  0.00
15 *          .           .           .           .           .           .           .           .           .           .       1.1       6.0   .33
16 *          .           .           .           .           .           .           .           .           .           .        .8       5.1  0.00
17 *          .           .           .           .           .           .           .           .           .           .        .8       4.7  0.00
18 *          .           .           .           .           .           .           .           .           .           .        .7       3.8  0.00
19 *          .           .           .           .           .           .           .           .           .           .        .7       3.2  0.00
20 *          .           .           .           .           .           .           .           .           .           .        .7       2.9   .01
21 *          .           .           .           .           .           .           .           .           .           .        .7       3.8  0.00
22 *          .           .           .           .           .           .           .           .           .           .        .7       3.2  0.00
23 *          .           .           .           .           .           .           .           .           .           .        .7       3.5   .06
24 *          .           .           .           .           .           .           .           .           .           .        .7       3.2  0.00
25 *          .           .           .           .           .           .           .           .           .           .        .7       2.9   .03
26 *          .           .           .           .           .           .           .           .           .           .        .7       3.5  0.00
27 *          .           .           .           .           .           .           .           .           .           .        .8       2.9   .18
28 *          .           .           .           .           .           .           .           .           .           .        .6       2.5  0.00
 1 *          .           .           .           .           .           .           .           .           .           .        .6       2.7  0.00
 2 *          .           .           .           .           .           .           .           .           .           .        .6       3.2  0.00
 3 *          .           .           .           .           .           .           .           .           .           .        .6       4.2  0.00
 4 *          .           .           .           .           .           .           .           .           .           .        .6       4.2  0.00
 5 *          .           .           .           .           .           .           .           .           .           .        .5       2.9  0.00
 6 *          .           .           .           .           .           .           .           .           .           .        .5       2.7  0.00
 7 *          .           .           .           .           .           .           .           .           .           .        .5       3.2  0.00
 8 *          .           .           .           .           .           .           .           .           .           .        .5       3.5  0.00
 9 *          .           .           .           .           .           .           .           .           .           .        .5       3.2  0.00
10 *          .           .           .           .           .           .           .           .           .           .        .5       2.9  0.00
11 *          .           .           .           .           .           .           .           .           .           .        .5       2.9  0.00
12 *          .           .           .           .           .           .           .           .           .           .        .5       2.5  0.00
13 *          .           .           .           .           .           .           .           .           .           .        .5       2.1  0.00
14 *          .           .           .           .           .           .           .           .           .           .        .4       2.1  0.00
15 *          .           .           .           .           .           .           .           .           .           .        .4       2.1  0.00
16 *          .           .           .           .           .           .           .           .           .           .        .4       2.5  0.00
17 *          .           .           .           .           .           .           .           .           .           .        .4       2.5  0.00
18 *          .           .           .           .           .           .           .           .           .           .        .4       2.7  0.00
19 *          .           .           .           .           .           .           .           .           .           .        .4       2.9  0.00
20 *          .           .           .           .           .           .           .           .           .           .       3.6       6.0   .59
21 *          .           .           .           .           .           .           .           .           .           .       1.0       6.0  0.00
22 *          .           .           .           .           .           .           .           .           .           .        .7       3.5  0.00
23 *          .           .           .           .           .           .           .           .           .           .        .6       3.2  0.00
24 .*0        .           .           .           .           .           .           .           .           .           .      23.0      45.0   .73
25 .  *0      .           .           .           .           .           .           .           .           .           .      43.4      61.0   .27
26 *0         .           .           .           .           .           .           .           .           .           .       6.1      14.0  0.00
27 *          .           .           .           .           .           .           .           .           .           .       4.0       7.6  0.00
28 *          .           .           .           .           .           .           .           .           .           .       3.1       6.0  0.00
29 *          .           .           .           .           .           .           .           .           .           .       2.4       5.1  0.00
30 *          .           .           .           .           .           .           .           .           .           .       1.9       4.2  0.00
31 *          .           .           .           .           .           .           .           .           .           .       1.6       3.8  0.00
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```
APR-MAY    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 *          .         .         .         .         .         .         .         .         .         .      1.3    3.5  0.00
 2 *          .         .         .         .         .         .         .         .         .         .      1.1    3.2  0.00
 3 *          .         .         .         .         .         .         .         .         .         .      1.0    3.2  0.00
 4 *          .         .         .         .         .         .         .         .         .         .       .9    3.5   .10
 5 *          .         .         .         .         .         .         .         .         .         .       .9    4.7   .08
 6 *          .         .         .         .         .         .         .         .         .         .       .8    5.1   .05
 7 *          .         .         .         .         .         .         .         .         .         .       .7    4.7  0.00
 8 *          .         .         .         .         .         .         .         .         .         .       .8    5.1   .17
 9 *          .         .         .         .         .         .         .         .         .         .       .6    4.2  0.00
10 .*         .         .         .         .         .         .         .         .         .         .     15.9   24.0   .65
11 *O         .         .         .         .         .         .         .         .         .         .      3.9   15.0   .03
12 *          .         .         .         .         .         .         .         .         .         .      2.2    7.0   .00
13 *          .         .         .         .         .         .         .         .         .         .      1.7    5.6  0.00
14 *          .         .         .         .         .         .         .         .         .         .      1.4    5.1  0.00
15 *          .         .         .         .         .         .         .         .         .         .      1.2    5.1  0.00
16 *          .         .         .         .         .         .         .         .         .         .      1.0    4.2  0.00
17 *          .         .         .         .         .         .         .         .         .         .       .9    3.8  0.00
18 *          .         .         .         .         .         .         .         .         .         .       .8    3.5  0.00
19 *          .         .         .         .         .         .         .         .         .         .       .7    3.5  0.00
20 *          .         .         .         .         .         .         .         .         .         .       .8    3.2   .10
21 *          .         .         .         .         .         .         .         .         .         .       .6    2.9   .00
22 *          .         .         .         .         .         .         .         .         .         .       .7    2.9   .10
23 *          .         .         .         .         .         .         .         .         .         .       .6    2.9  0.00
24 *          .         .         .         .         .         .         .         .         .         .       .6    2.9  0.00
25 *          .         .         .         .         .         .         .         .         .         .       .5    3.2  0.00
26 *          .         .         .         .         .         .         .         .         .         .       .5    2.9   .04
27 *          .         .         .         .         .         .         .         .         .         .       .7    7.5   .27
28 * O        .         .         .         .         .         .         .         .         .         .       .5   32.0   .03
29 *          .         .         .         .         .         .         .         .         .         .       .5    5.1  0.00
30 *          .         .         .         .         .         .         .         .         .         .       .4    3.2  0.00
 1 *          .         .         .         .         .         .         .         .         .         .       .4    2.7   .03
 2 *          .         .         .         .         .         .         .         .         .         .       .4    2.3  0.00
 3 *          .         .         .         .         .         .         .         .         .         .       .4    2.1  0.00
 4 *          .         .         .         .         .         .         .         .         .         .       .4    2.0  0.00
 5 *          .         .         .         .         .         .         .         .         .         .       .4    1.8  0.00
 6 *          .         .         .         .         .         .         .         .         .         .       .3    1.7  0.00
 7 *          .         .         .         .         .         .         .         .         .         .       .3    1.8  0.00
 8 *          .         .         .         .         .         .         .         .         .         .       .3    1.7  0.00
 9 *          .         .         .         .         .         .         .         .         .         .       .3    1.5  0.00
10 *          .         .         .         .         .         .         .         .         .         .       .3    1.4  0.00
11 *          .         .         .         .         .         .         .         .         .         .       .3    1.3  0.00
12 *          .         .         .         .         .         .         .         .         .         .       .3    1.3  0.00
13 *          .         .         .         .         .         .         .         .         .         .       .3    1.1  0.00
14 *          .         .         .         .         .         .         .         .         .         .       .3    1.0  0.00
15 *          .         .         .         .         .         .         .         .         .         .       .3     .9  0.00
16 *          .         .         .         .         .         .         .         .         .         .       .3     .8  0.00
17 *          .         .         .         .         .         .         .         .         .         .       .3     .8  0.00
18 *          .         .         .         .         .         .         .         .         .         .       .3     .7  0.00
19 *          .         .         .         .         .         .         .         .         .         .       .3     .6  0.00
20 *          .         .         .         .         .         .         .         .         .         .       .3     .5  0.00
21 *          .         .         .         .         .         .         .         .         .         .       .3     .4  0.00
22 *          .         .         .         .         .         .         .         .         .         .       .3     .3  0.00
23 *          .         .         .         .         .         .         .         .         .         .       .2     .2  0.00
24 *          .         .         .         .         .         .         .         .         .         .       .2     .2  0.00
25 *          .         .         .         .         .         .         .         .         .         .       .3     .2   .32
26 *          .         .         .         .         .         .         .         .         .         .       .4     .4   .03
27 *          .         .         .         .         .         .         .         .         .         .       .3     .4   .05
28 .  *     O .         .         .         .         .         .         .         .         .         .     51.5  186.0  2.42
29 .    *     .         .         .         .         .         .         .         .         .         .     99.0   94.0   .00
30 O*         .         .         .         .         .         .         .         .         .         .     15.3    3.5  0.00
31 O*         .         .         .         .         .         .         .         .         .         .     10.6    1.8  0.00
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```
 JUN-JUL    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.  OBS. RAIN+MELT
  1 .   *     .    0    .         .         .         .         .         .         .         .         .      84.7   300.0  1.45
  2 .       * .         .         0         .         .         .         .         .         .         .     164.8   591.0   .37
  3 .  *   0  .         .         .         .         .         .         .         .         .         .      56.3   132.0  0.00
  4 .*        .         .         .         .         .         .         .         .         .         .      14.3    22.0  0.00
  5 .*        .         .         .         .         .         .         .         .         .         .      10.6    11.0  0.00
  6 *         .         .         .         .         .         .         .         .         .         .       8.2     6.5   .00
  7 .         * 0       .         .         .         .         .         .         .         .         .     202.4   242.0  1.27
  8 . * 0     .         .         .         .         .         .         .         .         .         .      46.5    78.0   .36
  9 .         .         .      0  .       * .         .         .         .         .         .         .     758.1   539.0  2.15
 10 .  0*     .         .         .         .         .         .         .         .         .         .      76.4    57.0   .01
 11 .*0       .         .         .         .         .         .         .         .         .         .      17.9    31.0   .01
 12 .*        .         .         .         .         .         .         .         .         .         .      12.6    11.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .       9.9     9.3  0.00
 14 *         .         .         .         .         .         .         .         .         .         .       8.0     8.1  0.00
 15 *         .         .         .         .         .         .         .         .         .         .       6.5     8.7  0.00
 16 *         .         .         .         .         .         .         .         .         .         .       5.8     7.6  0.00
 17 *         .         .         .         .         .         .         .         .         .         .       4.7     5.0  0.00
 18 *         .         .         .         .         .         .         .         .         .         .       4.2     4.2   .05
 19 *         .         .         .         .         .         .         .         .         .         .       3.7     2.9   .01
 20 *         .         .         .         .         .         .         .         .         .         .       3.4     2.5  0.00
 21 *         .         .         .         .         .         .         .         .         .         .       3.3     2.3   .22
 22 0 *       .         .         .         .         .         .         .         .         .         .      30.6     3.5   .79
 23 .0     *  .         .         .         .         .         .         .         .         .         .     144.6    23.0   .37
 24 0*        .         .         .         .         .         .         .         .         .         .      14.4     2.9  0.00
 25 *         .         .         .         .         .         .         .         .         .         .       6.8     2.6  0.00
 26 *         .         .         .         .         .         .         .         .         .         .       5.4     2.3  0.00
 27 *         .         .         .         .         .         .         .         .         .         .       4.6     2.5   .01
 28 *         .         .         .         .         .         .         .         .         .         .       4.0     2.3  0.00
 29 *         .         .         .         .         .         .         .         .         .         .       3.6     2.1   .02
 30 *         .         .         .         .         .         .         .         .         .         .       3.3     2.1  0.00
  1 *         .         .         .         .         .         .         .         .         .         .       3.0     2.0  0.00
  2 *         .         .         .         .         .         .         .         .         .         .       2.8     1.7  0.00
  3 *         .         .         .         .         .         .         .         .         .         .       2.7     1.4  0.00
  4 *         .         .         .         .         .         .         .         .         .         .       2.5     1.1  0.00
  5 *         .         .         .         .         .         .         .         .         .         .       2.5     1.3   .02
  6 *         .         .         .         .         .         .         .         .         .         .       2.4     1.0  0.00
  7 *         .         .         .         .         .         .         .         .         .         .       2.3      .7  0.00
  8 *         .         .         .         .         .         .         .         .         .         .       2.4      .6   .29
  9 0     *   .         .         .         .         .         .         .         .         .         .     123.4     5.7  1.49
 10 0         .*        .         .         .         .         .         .         .         .         .     217.2     9.9   .43
 11 0*        .         .         .         .         .         .         .         .         .         .      21.3     1.5  0.00
 12 0*        .         .         .         .         .         .         .         .         .         .      11.0     1.0  0.00
 13 *         .         .         .         .         .         .         .         .         .         .       8.6      .8  0.00
 14 *         .         .         .         .         .         .         .         .         .         .       7.0      .5  0.00
 15 *         .         .         .         .         .         .         .         .         .         .       5.8     1.0   .11
 16 *         .         .         .         .         .         .         .         .         .         .       4.8     9.9   .00
 17 .     0 * .         .         .         .         .         .         .         .         .         .     159.9   128.0  1.13
 18 0*        .         .         .         .         .         .         .         .         .         .      17.1     2.9  0.00
 19 *         .         .         .         .         .         .         .         .         .         .       7.6     1.7  0.00
 20 *         .         .         .         .         .         .         .         .         .         .       6.3     1.1  0.00
 21 *         .         .         .         .         .         .         .         .         .         .       5.3     1.0  0.00
 22 *         .         .         .         .         .         .         .         .         .         .       4.5      .7  0.00
 23 *         .         .         .         .         .         .         .         .         .         .       3.9      .7  0.00
 24 .0     *  .         .         .         .         .         .         .         .         .         .     131.9    19.0  1.28
 25 0*        .         .         .         .         .         .         .         .         .         .      27.7     5.0  0.00
 26 *         .         .         .         .         .         .         .         .         .         .       7.8     1.4  0.00
 27 *         .         .         .         .         .         .         .         .         .         .       6.2     1.0   .03
 28 *         .         .         .         .         .         .         .         .         .         .       5.2     1.1   .09
 29 *         .         .         .         .         .         .         .         .         .         .       4.4     1.4  0.00
 30 *         .         .         .         .         .         .         .         .         .         .       3.9     1.7   .06
 31 *         .         .         .         .         .         .         .         .         .         .       3.6     2.7   .23
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```
AUG-SEP    200.0     400.0     600.0     800.0    1000.0    1200.0    1400.0    1600.0    1800.0    2000.0    SIM.   OBS. RAIN+MELT
 1 .0*       .         .         .         .         .         .         .         .         .         .      46.0    20.0   .61
 2 *         .         .         .         .         .         .         .         .         .         .       7.0     4.0  0.00
 3 *         .         .         .         .         .         .         .         .         .         .       4.6     2.0  0.00
 4 *         .         .         .         .         .         .         .         .         .         .       4.0     1.8  0.00
 5 *         .         .         .         .         .         .         .         .         .         .       3.5     1.7  0.00
 6 *         .         .         .         .         .         .         .         .         .         .       3.2     1.0  0.00
 7 *         .         .         .         .         .         .         .         .         .         .       2.9      .9  0.00
 8 *         .         .         .         .         .         .         .         .         .         .       2.7      .9  0.00
 9 *         .         .         .         .         .         .         .         .         .         .       2.6      .9  0.00
10 *         .         .         .         .         .         .         .         .         .         .       2.4      .8  0.00
11 *         .         .         .         .         .         .         .         .         .         .       2.3      .6  0.00
12 *         .         .         .         .         .         .         .         .         .         .       2.2      .5  0.00
13 *         .         .         .         .         .         .         .         .         .         .       2.2      .4  0.00
14 *         .         .         .         .         .         .         .         .         .         .       2.1      .4  0.00
15 *         .         .         .         .         .         .         .         .         .         .       2.1      .4  0.00
16 *         .         .         .         .         .         .         .         .         .         .       2.0      .3  0.00
17 *         .         .         .         .         .         .         .         .         .         .       2.0      .3  0.00
18 *         .         .         .         .         .         .         .         .         .         .       1.9      .2  0.00
19 *         .         .         .         .         .         .         .         .         .         .       1.9      .2  0.00
20 *         .         .         .         .         .         .         .         .         .         .       1.9      .2  0.00
21 *         .         .         .         .         .         .         .         .         .         .       1.8      .2  0.00
22 *         .         .         .         .         .         .         .         .         .         .       1.8      .1  0.00
23 *         .         .         .         .         .         .         .         .         .         .       1.8      .1  0.00
24 *         .         .         .         .         .         .         .         .         .         .       2.1      .1   .49
25 *         .         .         .         .         .         .         .         .         .         .       1.8      .1  0.00
26 *         .         .         .         .         .         .         .         .         .         .       1.7      .1  0.00
27 *         .         .         .         .         .         .         .         .         .         .       1.7     0.0  0.00
28 *         .         .         .         .         .         .         .         .         .         .       1.7     0.0  0.00
29 *         .         .         .         .         .         .         .         .         .         .       1.6     0.0  0.00
30 *         .         .         .         .         .         .         .         .         .         .       1.6     0.0  0.00
31 *         .         .         .         .         .         .         .         .         .         .       1.7     0.0   .14
 1 *         .         .         .         .         .         .         .         .         .         .       1.6     0.0  0.00
 2 *         .         .         .         .         .         .         .         .         .         .       1.6     0.0   .03
 3 .     0   .    *    .         .         .         .         .         .         .         .         .     309.2   114.0  2.86
 4 0 *       .         .         .         .         .         .         .         .         .         .      48.9     4.1   .12
 5 0*        .         .         .         .         .         .         .         .         .         .      16.7      .9  0.00
 6 0*        .         .         .         .         .         .         .         .         .         .      12.6      .4   .03
 7 0*        .         .         .         .         .         .         .         .         .         .      13.1      .6   .42
 8 0*        .         .         .         .         .         .         .         .         .         .      29.0     1.0   .12
 9 0*        .         .         .         .         .         .         .         .         .         .      12.6      .8   .12
10 *         .         .         .         .         .         .         .         .         .         .       6.8      .7  0.00
11 *         .         .         .         .         .         .         .         .         .         .       5.5      .8  0.00
12 *         .         .         .         .         .         .         .         .         .         .       4.6      .7  0.00
13 *         .         .         .         .         .         .         .         .         .         .       4.0      .5  0.00
14 *         .         .         .         .         .         .         .         .         .         .       3.6      .2   .03
15 .         .  0      .   *     .         .         .         .         .         .         .         .     470.0   257.0  2.14
16 0 *       .         .         .         .         .         .         .         .         .         .      43.0     5.1   .00
17 0*        .         .         .         .         .         .         .         .         .         .      13.3     1.5   .01
18 0*        .         .         .         .         .         .         .         .         .         .      10.1      .9  0.00
19 0 *       .         .         .         .         .         .         .         .         .         .      43.2      .7   .76
20 0     *   .         .         .         .         .         .         .         .         .         .     117.5    10.0   .05
21 0*        .         .         .         .         .         .         .         .         .         .      12.5     1.8   .06
22 *         .         .         .         .         .         .         .         .         .         .       7.5     1.0  0.00
23 *         .         .         .         .         .         .         .         .         .         .       6.2      .9  0.00
24 *         .         .         .         .         .         .         .         .         .         .       5.3     1.3   .11
25 *         .         .         .         .         .         .         .         .         .         .       4.6     1.7  0.00
26 *         .         .         .         .         .         .         .         .         .         .       4.0     1.4  0.00
27 *         .         .         .         .         .         .         .         .         .         .       3.6     1.4  0.00
28 *         .         .         .         .         .         .         .         .         .         .       3.4     1.3  0.00
29 *         .         .         .         .         .         .         .         .         .         .       3.1     1.1  0.00
30 *         .         .         .         .         .         .         .         .         .         .       3.0     1.1   .11
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                              MULTIYEAR STATISTICAL SUMMARY

                  FLOWPOINT = COUNCIL CR              WATER YEARS 1959 TO 1962

                                     BIAS                 1ST MOMENT                            PERCENT                   BEST FIT LINE
               SIMULATED  OBSERVED (SIM MEAN  PERCENT   (SIM)-1ST    MAXIMUM   STANDARD   STANDARD       CORREL.   OBS = A + B *SIM
 MONTH            MEAN      MEAN   -OBS MEAN)   BIAS    MOMENT(OBS)   ERROR      ERROR      ERROR         COEFF        A           B
...........................................................................................................................................

OCTOBER          2.322     3.186     -.865   -27.132       1.816  -147.587      4.777    149.927          .985     -1.056       1.827
NOVEMBER          .327      .345     -.018    -5.337        .283    -6.275       .569    164.981          .949      -.077       1.293
DECEMBER          .247      .237      .011     4.575       -.822     1.574       .135     57.009          .975       .050        .755
JANUARY           .057      .082     -.025   -30.948       -.767     1.481       .065     78.945          .382       .074        .142
FEBRUARY          .168      .158      .010     6.256       2.179     3.040       .317    200.702          .682       .021        .818
MARCH             .077      .203     -.126   -61.950       1.257    -3.388       .378    186.320          .456       .133        .911
APRIL             .053      .171     -.118   -68.930       -.781    -4.493       .423    248.069          .206       .125        .864
MAY               .475      .886     -.411   -46.412       4.531   -27.509      2.684    303.006          .490       .188       1.470
JUNE              .869     1.267     -.398   -31.436       1.290   -12.069      2.091    165.053          .831       .320       1.090
JULY             1.777     1.148      .629    54.759      -1.135    15.656      2.251    196.131          .832      -.112        .709
AUGUST            .412      .252      .160    63.332       4.985     9.920      1.269    503.079          .591      -.009        .634
SEPTEMBER        1.608     1.218      .390    31.987      -3.015    16.897      2.462    202.103          .909      -.252        .914
...........................................................................................................................................
WATER YEAR        .703      .767     -.064    -8.390      81.935  -147.587      2.939    382.907          .940      -.351       1.591
...........................................................................................................................................



**NOTE...SUM OF (SIM-OBS)**2 =              25809......ROOT MEAN OF SUM OF (SIM-OBS)**2 =       4.203...**



              NUMBER                                                                   PERCENT                  BEST FIT LINE
    FLOW    OF CASES OBSERVED SIMULATED             PERCENT    MAXIMUM   STANDARD    STANDARD       CORREL.   OBS = A + B *SIM
  INTERVAL  OBSERVED   MEAN      MEAN       BIAS      BIAS       ERROR      ERROR       ERROR        COEFF       A           B
...........................................................................................................................................

   0 -     1  1369     .105      .191       .086     82.640      9.920       .132     126.653        .330       .090        .074
   1 -     1     4    1.076     2.332      1.256    116.686      2.907       .015       1.361       -.682      1.106       -.013
   1 -     1     9    1.290     1.727       .437     33.874      2.230      0.000       0.000       1.000      1.279        .006
   1 -     2    14    1.877     2.215       .338     17.982      5.417       .273      14.548       -.236      1.951       -.033
   2 -     4    22    3.238     4.357      1.119     34.550     15.656       .528      16.309       -.180      3.336       -.022
   4 -     7    15    5.195     4.417      -.778    -14.979      7.249       .938      18.059       -.215      5.459       -.060
   7 -    11    12    8.750     7.674     -1.076    -12.297     18.091      1.483      16.945        .201      8.436        .041
  11 -    19     6   15.758    11.414     -4.344    -27.568    -12.069      1.924      12.211        .419     14.359        .123
  19 -    30     5   26.034    18.191     -7.843    -30.126    -27.509      3.863      14.838       -.163     27.055       -.056
  ABOVE   30     5   91.407    59.249    -32.158    -35.181   -147.587     20.332      22.244        .983    -29.333       2.038
...........................................................................................................................................
  ABOVE    4    43   20.109    14.280     -5.829    -28.988   -147.587     14.598      72.597        .948     -4.300       1.709
...........................................................................................................................................
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VI. CONCLUSIONS

The derivation of the initial NWSRFS soil moisture accounting parameters by the use of SCS estimated engineering soil properties is an effort to provide a practical and useful method. The SCS soil properties are readily available for many areas, and the NWSRFS verification computer program can quickly check the validity of the derived parameters. The derivation method will be readily adaptable to a computer solution; hence, the total parameter set could be computed easily. The computed zone parameters have a definite bias toward being larger than the optimum value; thus, all values should always be evaluated as to rationality. The derived parameters will be closely related to the physical characteristics of the basin, and the substitution of the parameters to basins with similar characteristics should be valid. The use of this procedure should result in a considerable savings in man-hours and computer time.

As operational rainfall measurements from radar, automated gages, and high density networks come into being, the need for procedures to delineate changes in runoff-producing characteristics will be in demand, and SCS soil properties will be available for as small an areal distribution as is required. The procedure for parameter derivations presented in this study could be the answer.

A. Recommendations for Future Work

Since there are many possible combinations of soil characteristics within a soil profile as well as aerially across a basin, the derivation procedures should be tested on a large number of widely scattered basins. An investigation of soil properties available from other sources should be pursued. The use of topography, climate, vegetative cover, and other pertinent physical basin characteristics to compute or adjust the parameters should be considered. Adjustments and additional variations in the rules for the computation of parameters will most likely be needed. After the procedures are widely tested and finalized, a computer program to reference a data file of SCS properties for all soils in a region will be a step toward greater efficiency.

ACKNOWLEDGMENTS

Thanks are due to Victor W. Hoffman, Hydrologist in Charge, for his encouragement during the author's basic research in relating physical parameters to a rainfall-runoff system while assigned to the Fort Worth River Forecast Center. Appreciation is also expressed to John M. Yates, past Hydrologist in Charge of the Tulsa River Forecast Center, for his support and to Richard N. DeVries, the author's advisor at Oklahoma State University, for his assistance in the preparation of the basic text.

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APPENDIX I. COMPUTER PROGRAM LISTING OF A NWSRFS SOIL MOISTURE ACCOUNTING SUBROUTINE

```
      SUBROUTINE LAND(ID1.IP1.ID2.IP2,MOSM,ICOUNT,IRG)
C
C
C***********************************************************************
C
C
C      NWSRFS SOIL MOISTURE ACCOUNTING PROCEDURE
C      BASED ON SOIL MOISTURE ACCOUNTING IN THE SACRAMENTO MODEL
C
C
C***********************************************************************
C
C
C      LAND VARIABLES
C
      REAL LZTWC.LZFPC.LZFSC.LZTWC1.LZFPC1.LZFSC1.LZTWM.LZFPM,LZFSM,LZPK
     1.LZSK
C
      DIMENSION MOSM(8.2).EPDIST(4)
C
C GENERAL PROGRAM VARIABLES
C
      INTEGER ROUTE.SNOW.SNOWA.YRIN.YR1.STORE.YEAR.PLT6HR.SAVEFW.COMPAR,
     1PTEST.PLOT.CTEST.SIXIN.OBSER.STDA.STP6.YR2.STAT.PEG
      REAL INFRO
C
      COMMON /G/ MONTH.MOIN.LAST.ROUTE.NGAGES.SNOW,SNOWA(12),YRIN,NPEGS,
     1YR1.NPTS.STORE.BASIN(20).YEAR.SSF(3.12).SOF(3.12),PLT6HR,SAVEFW,
     2COMPAR(3).PTEST.PLOT(3).LINEP,INFRO(20).PLOTMX(3),CTEST,FSFLOW(3),
     3PEG(5).STAT.YR2.AREA(6).SIXIN(3).OBSER(3).STDA(2.10),STP6(2.10),
     4IYEAR1(3),IPT.METRIC(3).NQ24.NQ6.NPTSUP,IQ24IN(3),IQ6IN(3)
C
C  SOIL MOISTURE ACCOUNTING VARIABLES.
C
      COMMON/SOIL/BAL(5),BL(5.18).VL(5.6).SL(5,10).E(5.12.31)
C
C TIME SERIES IDENTIFICATI JNS AND DESCRIPTIONS.
C
      COMMON /TSID/ AID(5.3).ANAME(5.5).PEID(3,3),FPNAME(3.5),FPID(3,3),
     1Q24ID(3.3).Q6ID(3,3),UPFWID(3.3),PXID(5,3)
C
C BASIC DATA ARRAYS
C
      COMMON /BD/ PX(5.4,31).TA(5.4,31).PE(3.31).RO(5.4.31).UFW6(3,4,31)
     1.SFW6(3.4.31),UFW6(3,4,31).UFW24(3.31)
C
C SNOW AND LAND COMMON BLOCK
C
      COMMON/SL/COVER(5.31).EFC(5).PXADJ(5).NTAG.NWEG
      DATA EPDIST/0.0.0.33.0.67.0.0/
C
C***********************************************************************
C
C
      IPRINT=0
      IF((MONTH.EQ.MOSM(ICOUNT.1)).AND.(YEAR.EQ.MOSM(ICOUNT,2)))IPRINT=1
      IF(IPRINT.EQ.0) GO TO 200
C
      PRINT 900,MONTH,YEAR.(ANAME(IRG.I).I=1,5)
  900 FORMAT(1H1.33HSIX-HOUR SOIL MOISTURE OUTPUT FOR,1X.I2.1H/.I4,2X.5A
     14,20X,39HUNITS OF ALL QUANTITIES ARE MILLIMETERS)
C
      PRINT 902
  902 FORMAT(1H .5X.19HPERC IS PERCULATION,5X.31HBASEFW IS THE CHANNEL C
     1OMPONENT,5X,67HTOTAL-RO IS CHANNEL INFLOW MINUS ET FROM THE AREA D
     2EFINED BY SARVA.)
C
      PRINT 901
  901 FORMAT(1H .3HDAY.1X.2HPD.2X.5HUZTWC.2X,5HUZFWC,2X.5HLZTWC,2X,5HLZF
     1SC.2X.5HLZFPC.2X,5HADIMC.4X.4HPERC.1X,7HIMPV-RO.2X,6HDIRECT,2X,6HS
     2UR-RO.1X.7HINTERFW,2X,6HBASEFW,1X,8HTOTAL-RO.1X,7HET-DEMD.1X,6HACT
     3-ET,2X,9HRAIN+MELT)
C
```

```
C.............................................................
C
  200 SROT=0.0
      SIMPVT=0.0
      SRODT=0.0
      SROST=0.0
      SINTFT=0.0
      SGWFT=0.0
      SRECHT=0.0
      SETT=0.0
      SPRT=0.0
      SPET=0.0
C
C     INTIAL VALUES OF VARIABLES
C
      UZTWC=VL(IRG,1)
      UZFWC=VL(IRG,2)
      LZTWC=VL(IRG,3)
      LZFPC=VL(IRG,5)
      LZFSC=VL(IRG,4)
      ADIMC=VL(IRG,6)
      UZTWC1=UZTWC
      UZFWC1=UZFWC
C
      LZTWC1=LZTWC
      LZFPC1=LZFPC
      LZFSC1=LZFSC
C
      ADIMC1=ADIMC
C
C     INITIAL VALUES OF PARAMETERS
C
      PPADJ=PL(IRG,1)
      PEADJ=PL(IRG,2)
      UZTWM=PL(IRG,3)
      UZFWM=PL(IRG,4)
      UZK=PL(IRG,5)
      ZPERC=PL(IRG,9)
      REXP=PL(IRG,10)
      PCTIM=PL(IRG,6)
      ADIMP=PL(IRG,7)
      SARVA=PL(IRG,8)
      LZTWM=PL(IRG,11)
      LZFPM=PL(IRG,13)
      LZFSM=PL(IRG,12)
      LZPK=PL(IRG,15)
      LZSK=PL(IRG,14)
      PFREE=PL(IRG,16)
      RSERV=PL(IRG,17)
      SIDE=PL(IRG,18)
C
      WATSF=SARVA
      SARRA=0.0
C
      IF(SARVA.LE.PCTIM) GO TO 201
      WATSF=PCTIM
      SARRA=SARVA-PCTIM
C
  201 IGPE=PEG(IRG)
      EFCT=EFC(IRG)
      SAVED=RSERV*(LZFPM+LZFSM)
      PAREA=1.0-PCTIM-ADIMP
      IP6=IP1
      IDA=ID1
      GO TO 204
C
C**********************************************************************
C
```

```
C
C      BEGINNING OF 6 HOUR AND DAY LOOP
C
C**************************************************************
C
  205 IF(IP6.NE.1) GO TO 210
  204 IF(IGPE.GT.0) GO TO 206
C
C      NO PE INPUT, THUS PE IS OBTAIN FROM MEAN SEASONAL CURVE.
C
      EP=E(IRG,MONTH,IDA)
      GO TO 207
C
C      DAILY PE TIME SERIES IS AVAILABLE
C
  206 EP=PE(IGPE,IDA)
      EP=EP*E(IRG,MONTH,IDA)
  207 EP=EP*PEADJ
      SPET=SPET+EP
C
      IF(SNOW.EQ.1) EP=EFCT*EP+(1.0-EFCT)*(1.0-COVER(IRG,IDA))*EP
  210 IF((SNOW.EQ.1).AND.(SNOWA(MONTH).EQ.1)) GO TO 219
      PX6 = PX(IRG,IP6,IDA)*PPADJ
      GO TO 215
C
C      IF SNOW IS BEING CONSIDERED, PXADJ HAS ALREADY BEEN APPLIED
C
  219 PX6 = PX(IRG,IP6,IDA)
  215 SPRT=SPRT+PX6
C
C      PX6 IS THE SIX HOUR RAINFALL OR SNOW COVER OUTFLOW
C
C**************************************************************
C
C
C      EDMND IS SIX-HOUR EVAPORATION DEMAND
C
      EDMND=EP*EPDIST(IP6)
C
C..............................................................
C
      E1=EDMND*(UZTWC/UZTWM)
      RED=EDMND-E1
C
C      RED IS RESIDUAL EVAP DEMAND
C
      UZTWC=UZTWC-E1
      E2=0.0
      IF(UZTWC.GE.0.) GO TO 220
C
C      E1 CAN NOT EXCEED UZTWC
C
      E1=E1+UZTWC
      UZTWC=0.0
      RED=EDMND-E1
      IF(UZFWC.GE.RED) GO TO 221
C
C..............................................................
C
C      E2 IS EVAP FROM UZFWC.
C
      E2=UZFWC
      UZFWC=0.0
      RED=RED-E2
      GO TO 225
C
  221 E2=RED
      UZFWC=UZFWC-E2
      RED=0.0
C
  220 IF((UZTWC/UZTWM).GE.(UZFWC/UZFWM)) GO TO 225
C
```

```
C.......................................................................
C
C     UPPER ZONE FREE WATER RATIO EXCEEDS UPPER ZONE
C     TENSION WATER RATIO, THUS TRANSFER FREE WATER TO TENSION
C
      UZRAT=(UZTWC+UZFWC)/(UZTWM+UZFWM)
      UZTWC=UZTWM*UZRAT
      UZFWC=UZFWM*UZRAT
C
C.......................................................................
C
C     COMPUTE ET FROM ADIMP AREA.-E5
C
  225 E5=E1+(RED+E2)*((ADIMC-E1-UZTWC)/(UZTWM+LZTWM))
C
C.......................................................................
C
C     COMPUTE ET FROM LZTWC (E3)
C
      E3=RED*(LZTWC/(UZTWM+LZTWM))
      LZTWC=LZTWC-E3
      IF(LZTWC.GE.0.0) GO TO 226
C
C     E3 CAN NOT EXCEED LZTWC
C
      E3=E3+LZTWC
      LZTWC=0.0
C
C.......................................................................
C
  226 RATLZT=LZTWC/LZTWM
      RATLZ=(LZTWC+LZFPC+LZFSC-SAVED)/(LZTWM+LZFPM+LZFSM-SAVED)
      IF(RATLZT.GE.RATLZ) GO TO 230
C
C     RESUPPLY LOWER ZONE TENSION WATER FROM LOWER
C     ZONE FREE WATER IF MORE WATER AVAILABLE THERE.
C
      DEL=(RATLZ-RATLZT)*LZTWM
C
C     TRANSFER FROM LZFSC TO LZTWC.
C
      LZTWC=LZTWC+DEL
      LZFSC=LZFSC-DEL
      IF(LZFSC.GE.0.0) GO TO 230
C
C     IF TRANSFER EXCEEDS LZFSC THEN REMAINDER COMES FROM LZFPC
C
      LZFPC=LZFPC+LZFSC
      LZFSC=0.0
C
C......................................................................
C
  230 ROIMP=PX6*PCTIM
C
C      ROIMP IS RUNOFF FROM THE MINIMUM IMPERVIOUS AREA.
C
      SIMPVT=SIMPVT+ROIMP
C
C      ADJUST ADIMC,ADDITIONAL IMPERVIOUS AREA STORAGE, FOR EVAPORATION.
C
      ADIMC=ADIMC-E5
      IF(ADIMC.GE.0.0) GO TO 231
C
C......................................................................
C
C     E5 CAN NOT EXCEED ADIMC.
C
      E5=E5+ADIMC
      ADIMC=0.0
  231 E5=E5*ADIMP
C
C     E5 IS ET FROM THE AREA ADIMP.
C
      PAV=PX6+UZTWC-UZTWM
C
C     PAV IS THE PERIOD AVAILABLE MOISTURE IN EXCESS
C     OF UZTW REQUIREMENTS.
C
```

```
      IF(PAV.GE.0.0) GO TO 232
C
C     ALL MOISTURE HELD IN UZTW--NO EXCESS.
C
      UZTWC=UZTWC+PX6
      PAV=0.0
      GO TO 233
C
C      MOISTURE AVAILABLE IN EXCESS OF UZTW STORAGE.
C
  232 UZTWC=UZTWM
  233 ADIMC=ADIMC+PX6-PAV
C
C
C**********************************************************
C
      SBF=0.0
      SSUR=0.0
      SIF=0.0
      SPERC=0.0
      SDRO=0.0
C
      NINC=1.0+0.2*(UZFWC+PAV)
C
C     NINC=NUMBER OF TIME INCREMENTS THAT THE SIX
C     HOUR PERIOD IS DIVIDED INTO FOR FURTHER
C     SOIL-MOISTURE ACCOUNTING.  NO ONE PERIOD
C     WILL EXCEED 5.0 MILLIMETERS OF UZFWC+PAV
C
      DINC=(1.0/NINC)*0.25
C
C     DINC=LENGTH OF EACH INCREMENT IN DAYS.
C
      PINC=PAV/NINC
C
C     PINC=AMOUNT OF AVAILABLE MOISTURE FOR EACH INCREMENT.
C      COMPUTE FREE WATER DEPLETION FRACTIONS FOR
C     THE TIME INTERVAL BEING USED-BASIC DEPLETIONS
C      ARE FOR ONE DAY
C
      DUZ=1.0-((1.0-UZK)**DINC)
      DLZP=1.0-((1.0-LZPK)**DINC)
      DLZS=1.0-((1.0-LZSK)**DINC)
C
C
C..........................................................
C
C
      DO 240 IC=1,NINC
C
      PAV=PINC
      ADSUR=0.0
      RATIO=(ADIMC-UZTWC)/LZTWM
      ADDRO=PINC*(RATIO**2)
      SDRO=SDRO+ADDRO*ADIMP
C
C     ADDRO IS THE AMOUNT OF DIRECT RUNOFF FROM
C     THE AREA ADIMP-SDRO IS THE SIX HOUR SUMMATION
C     COMPUTE BASEFLOW AND KEEP TRACK OF SIX-HOUR SUM.
C
      BF=LZFPC*DLZP
      LZFPC=LZFPC-BF
C
      IF (LZFPC.GT.0.0001) GO TO 234
C
      BF=BF+LZFPC
      LZFPC=0.0
C
  234 SBF=SBF+BF
      BF=LZFSC*DLZS
      LZFSC=LZFSC-BF
C
      IF(LZFSC.GT.0.0001) GO TO 235
C
```

```
      BF=BF+LZFSC
      LZFSC=0.0
C
  235 SBF=SBF+BF
C
C...............................................................
C
C       COMPUTE PERCOLATION-IF NO WATER AVAILABLE THEN SKIP
C
      IF((PINC+UZFWC).GT.0.01) GO TO 251
C
      UZFWC=UZFWC+PINC
      GO TO 249
C
  251 PERCM=LZFPM*DLZP+LZFSM*DLZS
      PERC=PERCM*(UZFWC/UZFWM)
      DEFR=1.0-((LZTWC+LZFPC+LZFSC)/(LZTWM+LZFPM+LZFSM))
C
C      DEFR IS THE LOWER ZONE MOISTURE DEFICIENCY RATIO
C
      PERC=PERC*(1.0+ZPERC*(DEFR**REXP))
C
C      NOTE...PERCOLATION OCCURS FROM UZFWC BEFORE PAV IS ADDED.
C
      IF(PERC.LT.UZFWC) GO TO 241
C
C       PERCOLATION RATE EXCEEDS UZFWC.
C
      PERC=UZFWC
      UZFWC=0.0
      GO TO 247
C
C      PERCOLATION RATE IS LESS THAT UZFWC.
C
  241 UZFWC=UZFWC-PERC
C
C      CHECK TO SEE IF PERCOLATION EXCEEDS LOWER ZONE DEFICIENCY.
C
      CHECK=LZTWC+LZFPC+LZFSC+PERC-LZTWM-LZFPM-LZFSM
C
      IF(CHECK.LE.0.0) GO TO 242
      PERC=PERC-CHECK
      UZFWC=UZFWC+CHECK
  242 SPERC=SPERC+PERC
C
C      SPERC IS THE SIX HOUR SUMMATION OF PERC
C
C..............................................................
C
C      COMPUTE INTERFLOW AND KEEP TRACK OF SIX HOUR SUM.
C      NOTE...PAV HAS NOT YET BEEN ADDED.
C
      DEL=UZFWC*DUZ
      SIF=SIF+DEL
      UZFWC=UZFWC-DEL
C
C..............................................................
C
C      DISTRIBE PERCOLATED WATER INTO THE LOWER ZONES
C      TENSION WATER MUST BE FILLED FIRST EXCEPT FOR THE PFREE AREA.
C
  247 VPERC=PERC
      PERC=PERC*(1.0-PFREE)
C
      IF((PERC+LZTWC).GT.LZTWM) GO TO 243
      LZTWC=LZTWC+PERC
      PERC=0.0
      GO TO 244
C
  243 PERC=PERC+LZTWC-LZTWM
      LZTWC=LZTWM
C
C       DISTRIBUTE PERCOLATION IN EXCESS OF TENSION
C       REQUIREMENTS AMONG THE FREE WATER STORAGES.
C
```

```
  244 PERC=PERC+VPERC*PFREE
      IF(PERC.FQ.0.0) GO TO 245
      HPL=LZFPM/(LZFPM+LZFSM)
C
C     HRL IS THE RELATIVE SIZE OF THE PRIMARY STORAGE
C     AS COMPARED WITH TOTAL LOWER ZONE FREE WATER STORAGE.
C
      RATLP=LZFPC/LZFPM
      RATLS=LZFSC/LZFSM
C
C     RATLP AND RATLS ARE CONTENT TO CAPACITY RATIOS. OR
C     IN OTHER WORDS, THE RELATIVE FULLNESS OF EACH STORAGE
C
C
      PERCP=PERC*((HPL*2.0*(1.0-RATLP))/((1.0-RATLP)+(1.0-RATLS)))
      PERCS=PERC-PERCP
C
C     PERCP AND PERCS ARE THE AMOUNT OF THE EXCESS
C     PERCOLATION GOING TO PRIMARY AND SUPPLEMENTAL
C      STORGES,RESPECTIVELY.
C
      LZFSC=LZFSC+PERCS
C
      IF(LZFSC.LE.LZFSM) GO TO 246
      PERCS=PERCS-LZFSC+LZFSM
      LZFSC=LZFSM
C
  246 LZFPC=LZFPC+(PERC-PERCS)
C
C................................................................
C
C      DISTRIBUTE PAV BETWEEN UZFWC AND SURFACE RUNOFF.
C
  245 IF(PAV.EQ.0.0) GO TO 249
C
C     CHECK IF PAV EXCEEDS UZFWM
C
      IF((PAV+UZFWC).GT.UZFWM) GO TO 248
C
C     NO SURFACE RUNOFF
C
      UZFWC=UZFWC+PAV
      GO TO 249
C
C................................................................
C
C     COMPUTE SURFACE RUNOFF AND KEEP TRACK OF SIX HOUR SUM
C
  248 PAV=PAV+UZFWC-UZFWM
      UZFWC=UZFWM
      SSUR=SSUR+PAV*PAREA
      ADSUR=PAV*(1.0-ADDRO/PINC)
C
C     ADSUR IS THE AMOUNT OF SURFACE RUNOFF WHICH COMES
C     FROM THAT PORTION OF ADIMP WHICH IS NOT
C     CURRENTLY GENERATING DIRECT RUNOFF.  ADDRU/PINC
C     IS THE FRACTION OF ADIMP CURRENTLY GENERATING
C     DIRECT RUNOFF.
C
      SSUR=SSUR+ADSUR*ADIMP
  249 ADIMC=ADIMC+PINC-ADDRO-ADSUR
C
  240 CONTINUE
C
C...............................................................
C
C     END OF INCREMENTAL DO LOOP.
C
C
C******************************************************************
C
```

```
C     COMPUTE SUMS AND ADJUST RUNOFF AMOUNTS BY THE AREA OVER
C     WHICH THEY ARE GENERATED.
C
      EUSED=E1+E2+E3
C
C     EUSED IS THE ET FROM PAREA WHICH IS 1.0-ADIMP-PCTIM
C
      SIF=SIF*PAREA
C
C     SEPARATE CHANNEL COMPONENT OF BASEFLOW
C     FROM THE NON-CHANNEL COMPONENT
C
      TBF=SBF*PAREA
C
C     TBF IS TOTAL BASEFLOW
C
      BFCC=TBF*(1.0/(1.0+SIDE))
C
C     BFCC IS BASEFLOW, CHANNEL COMPONENT
      BFNCC=TBF-BFCC
C
C     BFNCC IS BASEFLOW,NON-CHANNEL COMPONENT
C
C
C.............................................................
C
C     ADD TO MONTHLY SUMS.
C
      SINTFT=SINTFT+SIF
      SGWFT=SGWFT+BFCC
      SRECHT=SRECHT+BFNCC
      SROST=SROST+SSUR
      SRODT=SRODT+SDRO
C
C
C     COMPUTE TOTAL CHANNEL INFLOW FOR THE SIX-HOUR PERIOD.
C
      TCI=ROIMP+SDRO+SSUR+SIF+BFCC
C
C     COMPUTE E4-ET FROM STREAM SURFACES AND RIPARIAN VEGETATION.
C
      E4=EDMND*WATSF+(EDMND-EUSED)*SARRA
C
C     SUBTRACT E4 FROM CHANNEL INFLOW
C
      TCI=TCI-E4
      IF(TCI.GE.0.0) GO TO 250
      E4=E4+TCI
      TCI=0.0
C
C     COMPUTE TOTAL EVAPOTRANSPIRATION-TET
C
  250 EUSED=EUSED*PAREA
      TET=EUSED+E5+E4
      SETT=SETT+TET
C
C
C.............................................................
C
      RO(IRG,IP6,IDA) = TCI
C
C.............................................................
C
      SROT=SROT+TCI
C
C      PRINT SIX-HOUR ACCOUNTING VALUES IF REQUESTED.
C
      IF(IPRINT.EQ.1) PRINT 903,IDA,IP6,UZTWC,UZFWC,LZTWC,LZFSC,LZFPC,AD
     1IMC,SPERC,ROIMP,SDRO,SSUR,SIF,BFCC,TCI,EDMND,TET,PX6
  903 FORMAT(1H ,2I3,6F7.1,7F8.2,3F8.1)
C
      IF((IDA.EQ.ID2).AND.(IP6.EQ.IP2)) GO TO 270
      IP6=IP6+1
C
```

```
      IF(IP6.LE.4) GO TO 205
C
      IP6=1
      IDA=IDA+1
      GO TO 205
C
C
C***********************************************************************
C
C      END OF SIX HOUR AND DAY LOOP
C
C***********************************************************************
C
  270 IF(IRG.NE.NGAGES) GO TO 271
      IF((IPRINT.EQ.1).AND.(ICOUNT.LT.8)) ICOUNT=ICOUNT+1
  271 IPRINT=0
C
C
C     COMPUTE MONTHLY WATER BALANCE FOR AREAL SOIL MOISTURE ACCOUNTING.
C
      BAL(IRG)=(UZTWC+UZFWC+LZTWC+LZFPC+LZFSC-UZTWC1-UZFWC1-LZTWC1-LZFPC
     11-LZFSC1)*PARFA+(ADIMC-ADIMC1)*ADIMP+SROT+SRECHT+SETT-SPRT
C
C
C.......................................................................
C
      SL(IRG,1)=SROT
      SL(IRG,2)=SIMPVT
      SL(IRG,3)=SRODT
      SL(IRG,4)=SROST
      SL(IRG,5)=SINTFT
      SL(IRG,6)=SGWFT
      SL(IRG,7)=SRECHT
      SL(IRG,8)=SPRT
      SL(IRG,9)=SPET
      SL(IRG,10)=SETT
      VL(IRG,1)=UZTWC
      VL(IRG,2)=UZFWC
      VL(IRG,3)=LZTWC
      VL(IRG,5)=LZFPC
      VL(IRG,4)=LZFSC
      VL(IRG,6)=ADIMC
C
C
      RETURN
C
      END
```

(Continued from inside front cover)

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