SIMULATION OF RAIN FLOODS ON WILLOW CREEK, VALLEY COUNTY, MONTANA

by Charles Parrett

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CONVERSION FACTORS

For those readers who may prefer to use the International System of units (SI) rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

Multiply inch-pound unit	By	To obtain SI unit
acre	0.4047	hectare
acre-foot	1,233	cubic meter
cubic foot per second	0.02832	cubic meter per second
foot	0.3048	meter
inch	25.40	millimeter
mile	1.609	kilometer
square foot	0.09290	square meter
square mile	2.590	square kilometer

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) by the equation:

$$°C = 5/9\ (°F - 32)$$

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ABSTRACT

The Hydrologic Engineering Center-1 (HEC-1) rainfall-runoff simulation model was used to assess the effects of a system of reservoirs and waterspreaders located in the 550-square-mile Willow Creek basin in northeastern Montana. For simulation purposes, the basin was subdivided into 100 subbasins containing 84 reservoirs and 14 waterspreaders. Precipitation input to the model was a 24-hour duration, 100-year-frequency synthetic rainstorm developed from National Weather Service data. Infiltration and detention losses were computed using the U.S. Soil Conservation Service Curve Number concept, and the dimensionless unit hydrograph developed by the U.S. Soil Conservation Service was used to compute runoff. Channel and reservoir flow routing was based on the modified Puls storage routing procedure. Waterspreaders were simulated by assuming that each dike in a spreader system functions as a reservoir, with only an emergency spillway discharging directly into the next dike. Waterspreader and reservoir volumes were calculated from surface areas measured on maps.

The first simulation was made with no structures in place, and resulted in a 100-year-frequency peak at the mouth of Willow Creek of 22,700 cubic feet per second. With all structures in place, the 100-year-frequency peak was decreased by 74 percent to 5,870 cubic feet per second.

INTRODUCTION

Background

Willow Creek, an intermittent tributary to the Milk River, drains about 550 square miles in northeastern Montana (fig. 1). Most of the drainage is located on public land administered by the U.S. Bureau of Land Management. In the early 1950's, the Bureau began an extensive conservation program aimed at controlling runoff and sediment yield within the basin. By 1967, 190 reservoirs with a cumulative storage capacity of about 48,000 acre-feet had been constructed (Frickel, 1972). By 1980, the total number of reservoirs was more than 200 with a total storage capacity of more than 50,000 acre-feet (Dan Muller, U.S. Bureau of Land Management, oral commun., 1985). In addition to the large number of reservoirs, several large waterspreader systems comprised of numerous low-level dikes have been constructed to intercept tributary runoff.

Although the vast system of conservation measures has undoubtedly decreased peak outflows from the basin, a quantitative evaluation of the effectiveness of the system has not been attempted. No streamflow records are available before the

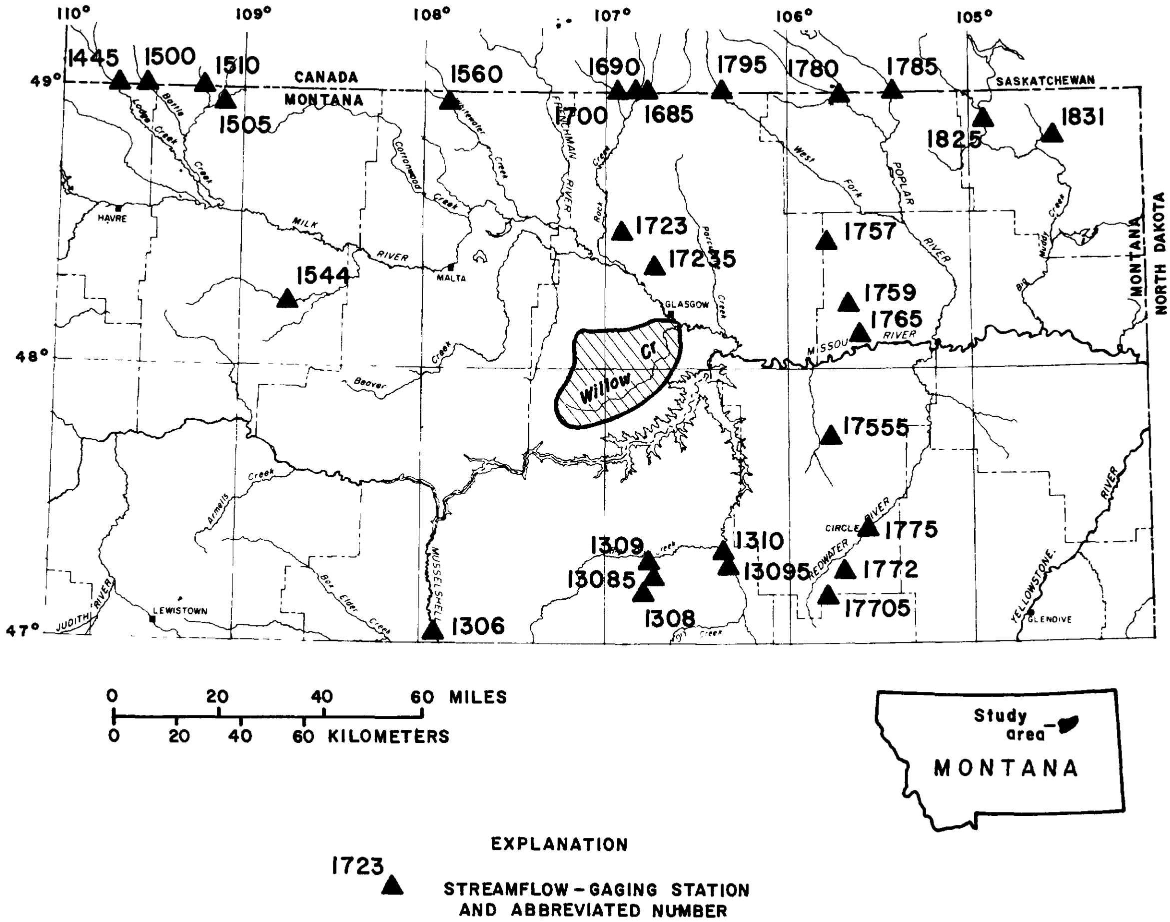


Figure 1.--Location of Willow Creek study area and selected nearby streamflow-gaging stations.

period of reservoir construction, so the flow regimen cannot be compared "before and after." Some reservoir and runoff data were collected by the U.S. Geological Survey in the 1960's; Frickel (1972) was able to use these data to estimate that the conservation measures in place at the time decreased the peak discharge of a large flood in 1962 by about 45 percent. The decrease in discharge resulting from any single storage structure or spreader system was not possible to determine, however. Likewise, determination was not possible of the cumulative effects of the conservation measures on any storm other than the one for which data had been collected.

Because of rising construction and maintenance costs, a methodology for rationally evaluating the individual and cumulative flood damage reduction benefits of the conservation measures became imperative. Accordingly, a cooperative program between the U.S. Geological Survey and the U.S. Bureau of Land Management was initiated in 1981 to calibrate and apply a streamflow simulation model to the Willow Creek basin. The original purpose of the cooperative program was to establish a rainfall and streamflow data-collection network within the basin and to use data obtained over several years to calibrate a peak discharge model capable of simulating the effects of numerous reservoirs and waterspreaders. A data-collection network consisting of 5 seasonal streamflow-gaging stations, 2 water-level recording gages on reservoirs, and 12 rain gages subsequently was established. A continuous-record streamflow-gaging station (station 06174000) has been operated at the mouth of Willow Creek since 1953.

Unfortunately, rain-caused runoff was scanty throughout northeastern Montana from 1980 to 1985, and no meaningful runoff record suitable for calibration purposes has been collected in the Willow Creek basin. Nevertheless, because of various management directives and considerations, the Bureau of Land Management was required to develop a management plan for the Willow Creek basin by 1985. Thus, it was decided to select and use a streamflow model to investigate various plans of basin development and their effects on the 100-year-frequency peak discharge of Willow Creek without the benefit of site-by-site calibration.

Purpose and scope

The purpose of this report is to describe the model used and the results of the various streamflow simulations made for the Willow Creek basin. The model used to make the analysis was the Hydrologic Engineering Center-1 (HEC-1) flood hydrograph model developed by the U.S. Army Corps of Engineers (1981). The model computes the runoff response of a basin to a specified precipitation input, routes the computed runoff through channels and reservoirs, and combines the resultant discharge hydrograph with discharge hydrographs from other basins where channels intersect. Large watersheds with many channels and reservoirs can be simulated with the HEC-1 model. Because of the lack of onsite calibration data, a single synthetic storm hyetograph based on National Weather Service data was used to generate 100-year-frequency peak discharges throughout the basin. The model was calibrated by adjusting the precipitation depth-drainage area relationship so that computed, unregulated 100-year-frequency peak discharges plotted reasonably close to a regression line through 100-year-frequency peak discharges at nearby gaging stations.

STUDY AREA

Willow Creek is a sparsely populated basin comprised of rolling uplands interspersed with flat valleys and a well-defined drainage system. The relief is low to moderate with elevations ranging from 2,000 to about 2,800 feet above sea level. The basin is underlain by the easily eroded Upper Cretaceous Bearpaw Shale. The Bearpaw is overlain by the relatively more resistant sandstone of the Upper Cretaceous Fox Hills Sandstone and Hell Creek Formation along the rim of the basin (Frickel, 1972). Soils in the basin generally reflect the characteristics of their parent formations. Thus, the valley alluvium, which is derived primarily from the Bearpaw Shale, is fine grained and relatively impermeable. The alluvial soils produce little vegetation and copious amounts of runoff from moderate rainfall. Soils derived from the Fox Hills and Hell Creek Formations are sandier and produce more forage than does the valley floor alluvium. Vegetation is generally typical of the High Plains with nuttall saltbush, big sagebrush, sandberg bluegrass, blue grama, western wheatgrass, and black greasewood being the predominant species (Frickel, 1972).

The climate of the Willow Creek basin is typically continental with cold dry winters and hot summers. Temperatures at Glasgow, Montana, about 4 miles north of the mouth of Willow Creek, range from a mean daily maximum of 85 °F in July to a mean daily minimum of 0 °F in January. The average annual precipitation at Glasgow is 12.3 inches with more than 8 inches occurring from April through August. June is the wettest month with an average of 3.0 inches, and February is the driest with an average of 0.4 inch (U.S. Environmental Data Service, 1971).

Because of the sparse precipitation and lack of a mountain snowpack to sustain base flows, Willow Creek is an intermittent stream that commonly flows only when the prairie snow cover melts or in response to intense summer rainstorms. The largest flows occur as a result of intense summer rainstorms, but, because of the large network of reservoirs and waterspreaders, rain-caused streamflow occurs relatively infrequently at the mouth.

DESCRIPTION OF THE HYDROLOGIC ENGINEERING CENTER-1 MODEL

The HEC-1 model is designed to simulate the surface-runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. Each component simulates an aspect of the precipitation-runoff process within a part of the basin, commonly referred to as a subbasin. A component may represent a surface runoff entity, a stream channel, or a reservoir. Representation of a component requires a set of variables that specify the particular characteristics of the component and mathematical relations, which describe the physical processes. The result of the modeling process is the computation of streamflow hydrographs at desired locations in the river basin.

The procedure for developing an adequate stream network model requires the following:

(1) Delineate the study area,
(2) subdivide the study area into the required number of subbasins, and
(3) define and link together the components required, using a schematic diagram, so that all subbasins are hydraulically connected.

Topographic maps are used to delineate the river basin study area. Then, the study area is segmented into a number of subbasins based on the study purpose and the variability of hydrologic and basin characteristics. The study purpose defines various points of interest within the basin where hydrographs may be desired, and hence, where subbasin boundaries are needed. Likewise, basins need to be segmented where hydrologic processes or basin characteristics change. The model is based on basin-wide averages of precipitation and infiltration; if such averages are inappropriate the basin is to be divided into smaller, more homogeneous subbasins. Each subbasin is comprised of one or more hydrologic components, and the linking together of the various components constitutes the final stream model.

A simple, typical river basin map and a complementary schematic diagram (fig. 2) show how the various hydrologic components are combined for the HEC-1 model. The arrangement of the schematic diagram in figure 2 implies that streamflow computations are to proceed in a downstream direction. Thus, for example, a subbasin runoff hydrograph is first computed for subbasin 10 before that hydrograph is routed through a reservoir. Likewise, at the combination points two or more previously computed hydrographs are added together before any subsequent hydrographs are routed.

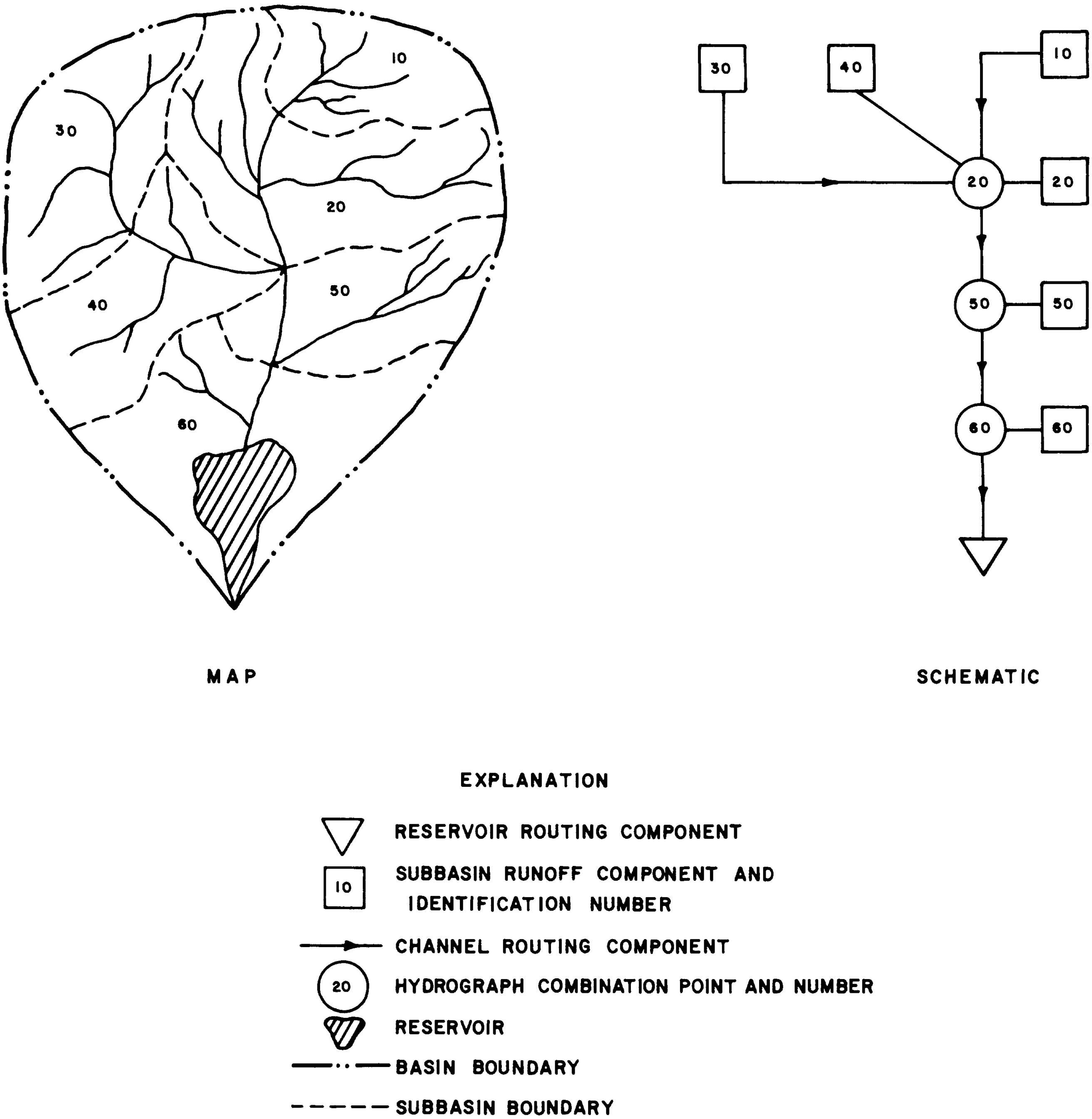


Figure 2.--Map and schematic showing typical stream basin.

The following section of the report describes the individual hydrologic components in more detail. Although several alternative procedures for computing streamflow are possible within each component, only the procedures used in the Willow Creek simulation study are described.

Subbasin runoff component

Runoff from the various subbasins, such as subbasin 10 shown in figure 2, is computed by routing an amount of precipitation excess to the subbasin outlet using unit hydrograph techniques. The precipitation excess is the subbasin average precipitation input minus the infiltration and detention losses. For this study, the precipitation input was a basin-wide synthetic 100-year-frequency storm obtained from depth-duration data compiled by the National Weather Service (Miller and others, 1973).

Infiltration and detention losses were computed using the Curve Number approach developed by the U.S. Soil Conservation Service (1972). This method requires that an experienced soil scientist or engineer assign a Curve Number to each subbasin that characterizes its ability to absorb precipitation. A Curve Number of 0 implies that all precipitation is absorbed so that no runoff occurs, and a Curve Number of 100 implies that no absorption or detention occurs and that all precipitation is runoff. The Curve Number is a function of soil type and condition, vegetative cover, and land use. For average soil-moisture conditions prior to the beginning of a storm, the relationship between Curve Number (CN), total storm precipitation in inches (P), and total precipitation excess in inches (PE) is:

$$PE = (P - 0.2 \cdot S)/(P + 0.8 \cdot S) \qquad (1)$$

where

$$S = (1{,}000 - 10 \cdot CN)/CN.$$

The synthetic unit hydrograph technique used to compute a streamflow hydrograph from some amount of precipitation excess was the dimensionless unit hydrograph developed by the U.S. Soil Conservation Service (1972). This particular unit hydrograph was selected because it was originally developed for use with the Curve Number infiltration approach, and because it has been used in previous studies by the Bureau of Land Management. As depicted in figure 3, the amount of precipitation excess producing the unit hydrograph is 1 inch for some unit duration (D). The unit duration is an optimum duration for producing runoff and is commonly chosen to be between one-fourth and one-half of the lag time (L) for the subbasin. The lag time, in turn, is the time in hours between the center of mass of the precipitation excess and the peak rate of runoff (QP). For a subbasin with a drainage area of A square miles, the peak runoff in cubic feet per second resulting from 1 inch of precipitation excess can be expressed as:

$$QP = 484 \cdot A/(D/2 + L) \qquad (2)$$

The lag time for a given subbasin is estimated from the equation:

$$L = h^{0.8}\,(1000/CN - 9)^{0.7}/(1900 \cdot Y^{0.5}) \qquad (3)$$

where

h is hydraulic length of the subbasin, in feet;
CN is subbasin Curve Number; and
Y is subbasin average land slope, in percent.

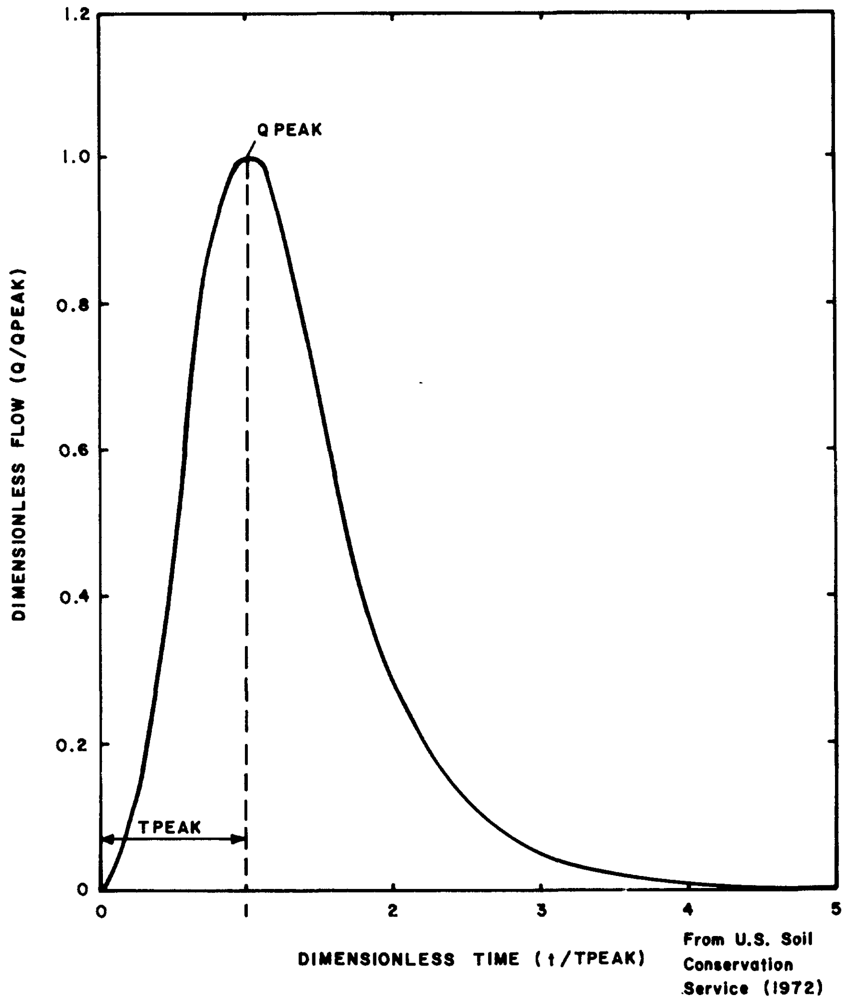


Figure 3.--U.S. Soil Conservation Service dimensionless unit hydrograph.

Channel routing component

A second hydrologic process to be simulated is the change in a streamflow hydrograph that results when the streamflow is routed through a channel reach. The routing technique used in this study was the modified Puls storage routing procedure described by Chow (1959). This technique is based on the assumption that the attenuation of a flood peak as it moves downstream is primarily the result of the storage effects of the channel so that the following simple form of the continuity equation is applicable:

$$\text{Inflow volume} - \text{Outflow volume} = \text{Change in storage} \qquad (4)$$

or if expressed in finite time intervals:

$$(I_1 + I_2)/2 - (O_1 + O_2)/2 = (S_1 - S_2)/\Delta t \qquad (5)$$

where the subscripts indicate the routing periods; Δt is the time interval between period 1 and period 2; and I, O, and S are instantaneous values of inflow, outflow, and storage, respectively, at the beginning of the routing periods indicated.

In practice, flow and storage values are obtained from channel characteristics using the Manning equation for uniform flow. Thus, surveyed channel cross sections at the upstream and downstream ends of a routing reach together with estimates of friction slope (Manning's roughness) and energy slope are used to develop tables of discharge versus stream stage. Likewise, tables of storage versus stage are developed from the cross-sectional areas multiplied by the reach lengths.

Reservoir routing component

The modified Puls routing technique also is used to route streamflow hydrographs through uncontrolled reservoirs. In this instance, tables of storage versus stage and discharge versus stage are unique functions of the reservoir and spillway geometries. For the Willow Creek study, these tables were developed manually for the individual reservoirs and supplied to the HEC-1 model. Otherwise, reservoir routing using the modified Puls procedure is equivalent to channel routing described above. Discharge from Willow Creek reservoirs may be from reservoir pipes (principal spillways) or from emergency spillways constructed on the reservoir embankments.

DATA REQUIREMENTS FOR WILLOW CREEK

Willow Creek network

Following the sequence just described for development of an adequate simulation model, the study area was defined to include the entire Willow Creek basin upstream from the U.S. Geological Survey streamflow-gaging station located near the mouth of Willow Creek. Simulated streamflows then could be compared directly with recorded flows. The delineation of the various subbasins was based largely on the number of significant reservoirs in the basin. A subbasin was delineated upstream from every reservoir that was believed to have a possible significant effect on streamflow. Results from earlier HEC-1 simulations made by the author for just a part of the Willow Creek basin indicated that all reservoirs with drainage areas less than about 1 percent of the total study area had less than a 10-percent cumulative effect on basin outflow. It was concluded that a conservative lower limit on subbasin size for this study would be about 0.5 square mile (about 0.1 percent of total study area). As a result, 84 reservoirs and 14 waterspreaders were included in the simulations and about 100 small reservoirs draining smaller subbasins were excluded. The 84 reservoirs used in the analysis contain more than 90 percent of the total reservoir storage of the basin. The total surface area of the 84 reservoirs at full-pool elevation is about 6 square miles, or about 1 percent of the total basin area.

Delineated subbasins of the Willow Creek study area are shown in figure 4. Also shown is the location of each data-collection site established for the Willow Creek study. The subbasins were assigned unique four-digit identification numbers by the Bureau of Land Management similar to the hydrologic unit numbers used by the U.S. Geological Survey (Seaber and others, 1984). The first two digits identify the location of the subbasin relative to four major watersheds in the Willow Creek basin:

(1) Upper Willow Creek, identification numbers beginning with 01;
(2) Lone Tree Creek, identification numbers beginning with 02;
(3) Beaver Creek, identification numbers beginning with 03; and
(4) Lower Willow Creek, identification numbers beginning with 08.

The last two digits form a downstream-order sequence, starting with 10 and proceeding downstream by tens to a reservoir or a major tributary confluence. At each tributary, the numbering sequence begins at the mainstem number plus one and proceeds generally downstream. For example, in the upper Willow Creek basin, the subbasin numbers increase from 0110 to 0140 by tens. In the 0140 subbasin two tributaries join the mainstem. Subbasins in the tributary drainages are thus numbered 0141 through 0146. Deviations from the numbering sequence occur in the Lone Tree Creek basin where the subbasins were numbered by the Bureau of Land Management before the sequence was completely devised.

The schematic diagram corresponding to the delineated subbasin boundaries is shown in figure 5. Each subbasin identification number is shown within the box identifying a subbasin. Similarly, the actual reservoir name is shown beside each reservoir symbol in figure 5. Channel routings are indicated by symbol, but no identifying numbers for routings are used on the schematic. The symbols for hydrograph combination points are numbered for identification purposes starting with 10 and proceeding downstream by tens.

Two component symbols shown in figure 5 that were not previously discussed in the HEC-1 model description are those for a waterspreader and for a spillway flow diversion. As used in the Willow Creek basin, a waterspreader is a series of low-level dams or dikes constructed across and perpendicular to the stream channel as shown in figure 6. For HEC-1 simulation purposes, each waterspreader was considered to be a series of reservoirs, with the output from each reservoir being the input to the next identical reservoir. How the reservoir data were obtained and linked together will be described in a subsequent section. The spillway flow diversion component represents a reservoir whose emergency spillway discharge is diverted to a different location than the principal spillway discharge. The diversion component symbol in figure 5 shows the destination of the diverted discharge.

Subbasin runoff component

As shown in figure 4, 100 subbasins were delineated, and the following physical variables were determined for each subbasin:

(1) drainage area,
(2) Curve Number,
(3) hydraulic length, and
(4) subbasin slope.

The first three variables were all measured from maps at a scale of 1:100,000. First, the drainage area, in square miles, was measured using an electronic digitizer. Next, Curve Numbers were determined by soil scientists and hydrologists of the U.S. Bureau of Land Management using the latest available soil surveys and established procedures of the Soil Conservation Service (Dan Muller, written commun., 1984). Then, the hydraulic length, in feet, was measured by tracing the distance of the longest flow path in the subbasin from the subbasin divide to the outlet. Finally, the subbasin slope was approximated by subtracting the lowest elevation in the subbasin from the highest elevation along the subbasin divide and dividing the result by the hydraulic length. The subbasin slope was used to compute subbasin lag time using equation 3. A complete listing of all measured subbasin variables is provided in table 1 at the end of the report. Also, the complete input stream of computer card-images for the HEC-1 model as used in the Willow Creek basin is provided in table 2 at the end of the report.

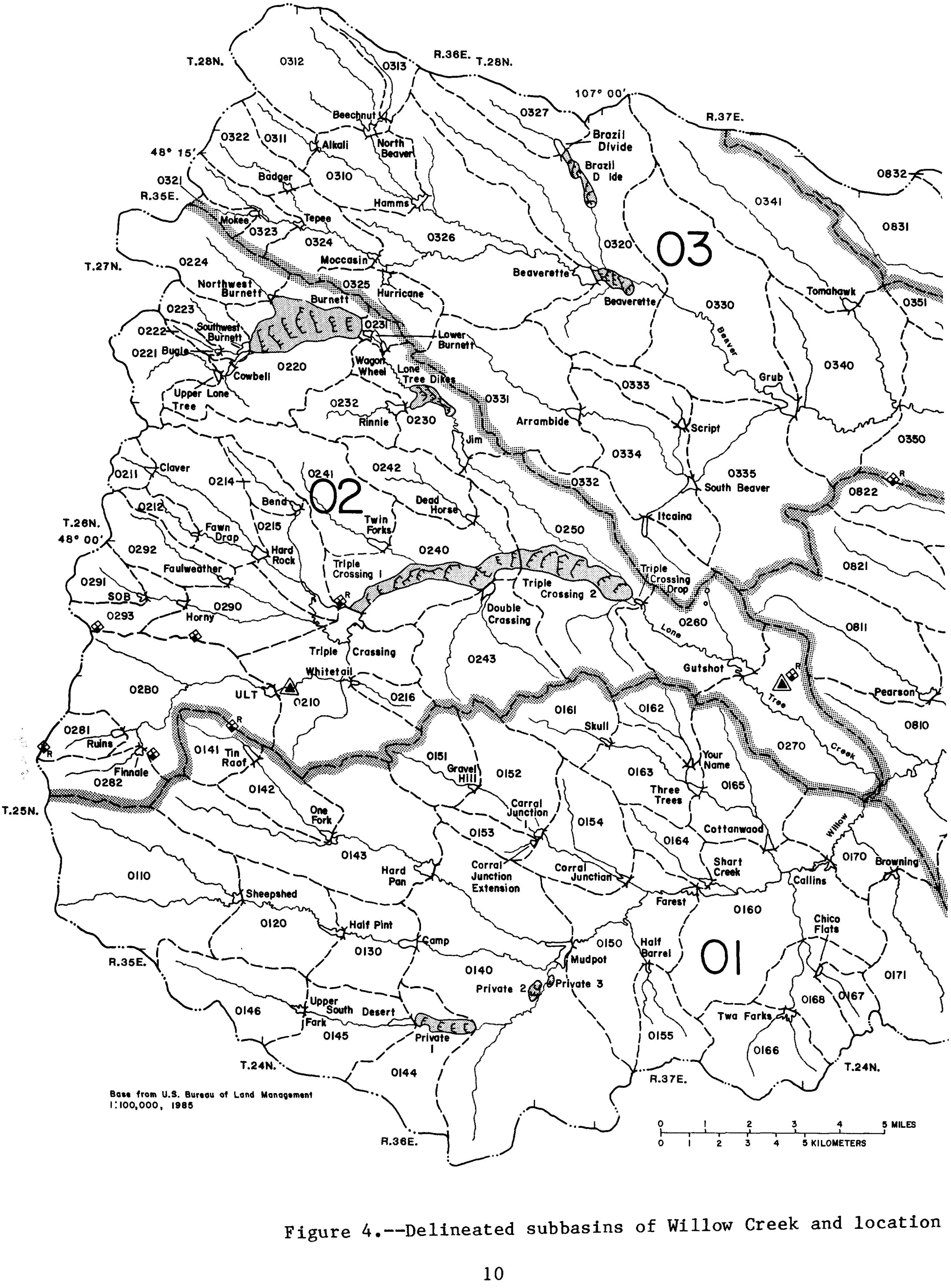
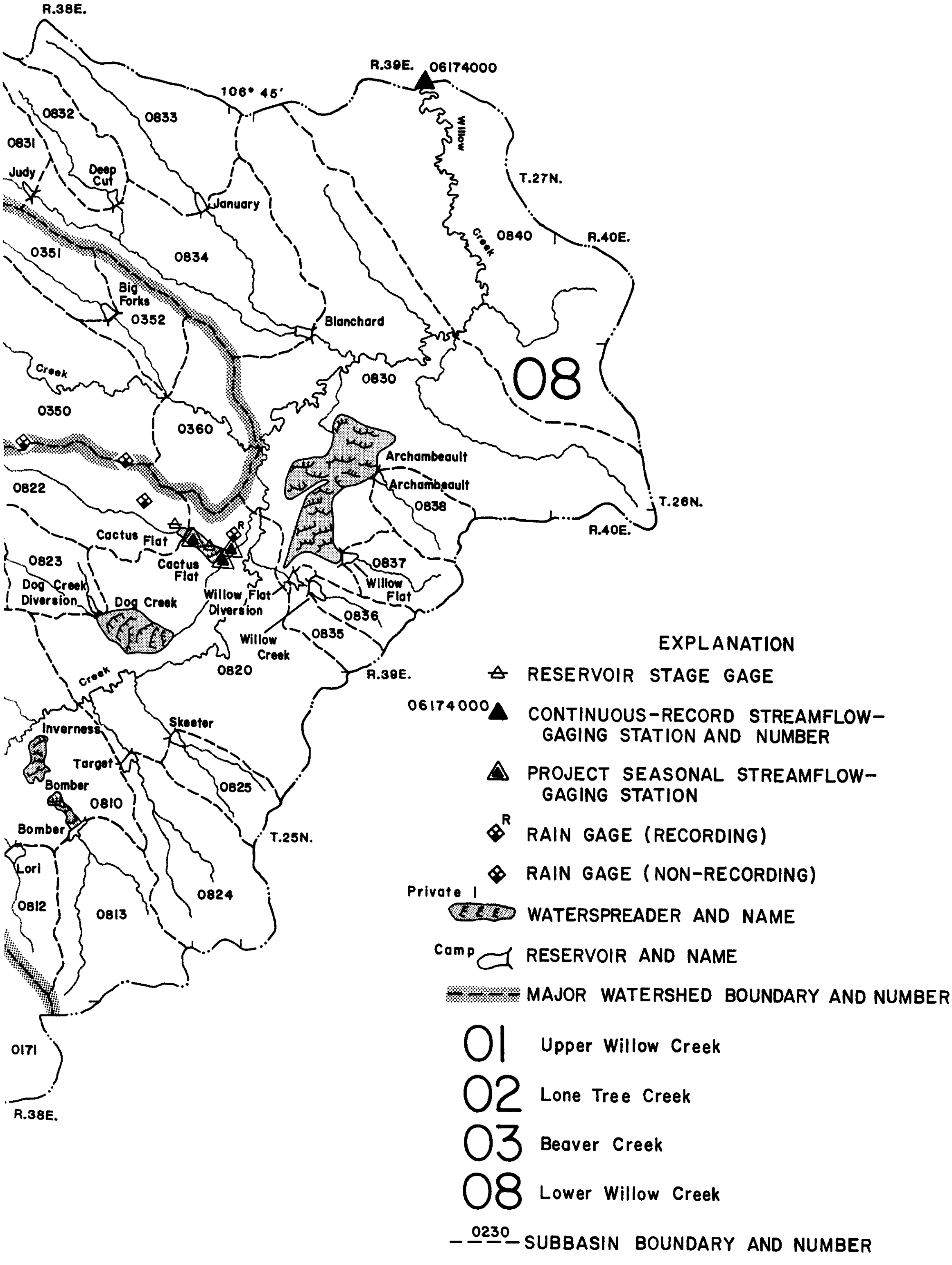
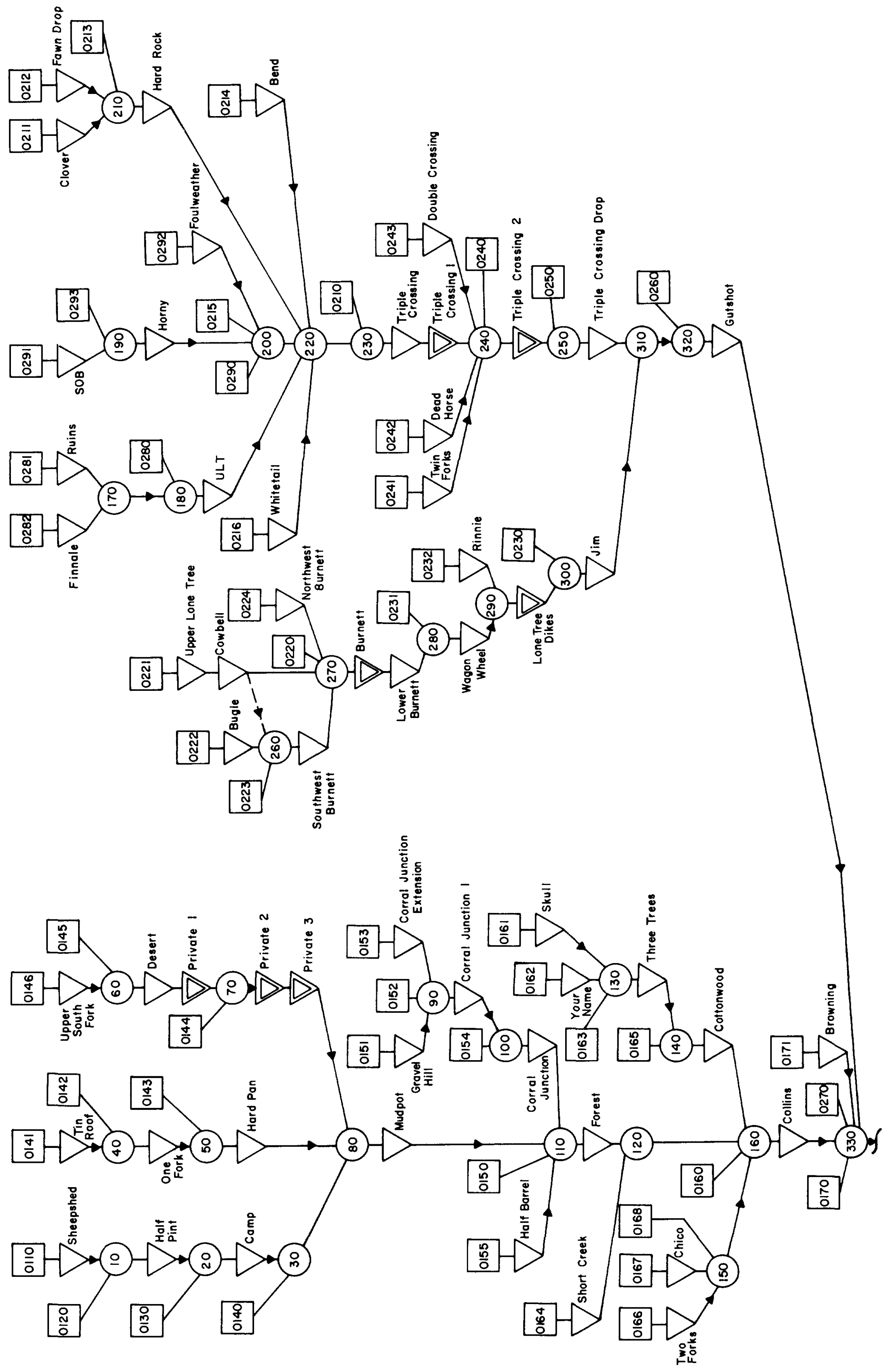


Figure 4.--Delineated subbasins of Willow Creek and location



of data-collection sites.


Fawn Drop
0213
0212
0211
210
Hard Rock
Clover
0214
Bend
Foulweather
0292
Double Crossing
0243
0293
0291
190
Horny
SOB
0215
200
0290
220
0210
230
Triple Crossing
Triple Crossing 1
0240
240
Triple Crossing 2
0250
250
Triple Crossing Drop
310
0260
320
Gutshot
0281
Ruins
0282
Finnale
170
0280
180
ULT
0216
Whitetail
0242
Dead Horse
0241
Twin Forks
Upper Lone Tree
0221
Cowbell
0224
Northwest Burnett
0220
270
Burnett
0231
280
0232
Rinnie
290
0230
300
Jim
Lone Tree Dikes
Wagon Wheel
Lower Burnett
0222
Bugle
260
0223
Southwest Burnett
0153
Corral Junction Extension
Corral Junction 1
0152
90
0151
Gravel Hill
0154
100
Corral Junction
0161
Skull
0162
130
Three Trees
Your Name
0163
0165
140
Cottonwood
0146
Upper South Fork
0145
60
Desert
Private 1
70
Private 2
Private 3
0144
0142
0141
Tin Roof
40
0143
50
One Fork
Hard Pan
80
Mudpot
110
0150
Forest
120
160
0160
Collins
0171
Browning
0270
330
0170
0110
Sheepshed
10
0120
Half Pint
20
0130
Camp
30
0140
0155
Half Barrel
0164
Short Creek
0168
0167
Chico
150
0166
Two Forks

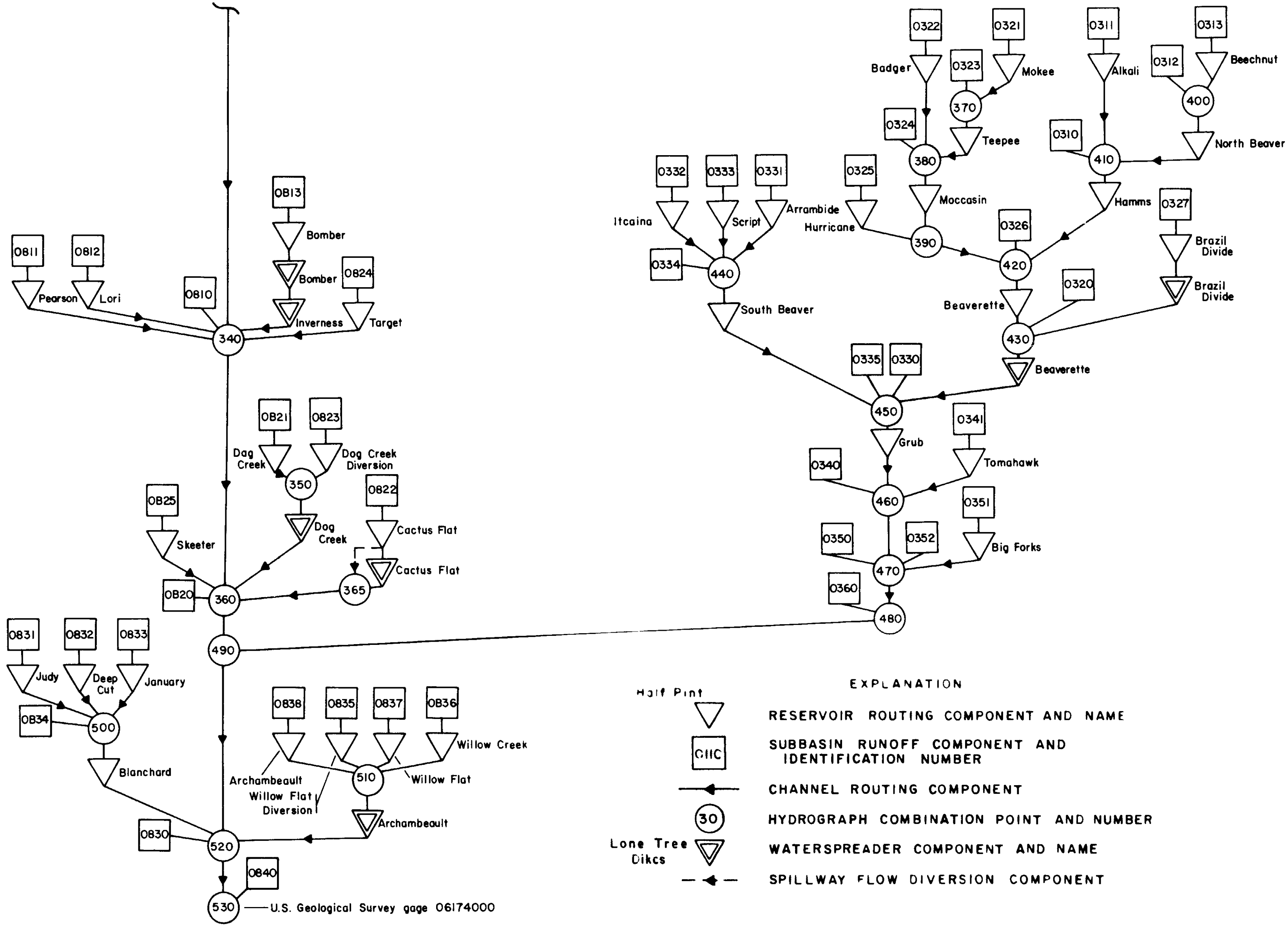


Figure 5.--Schematic diagram of Willow Creek Basin.

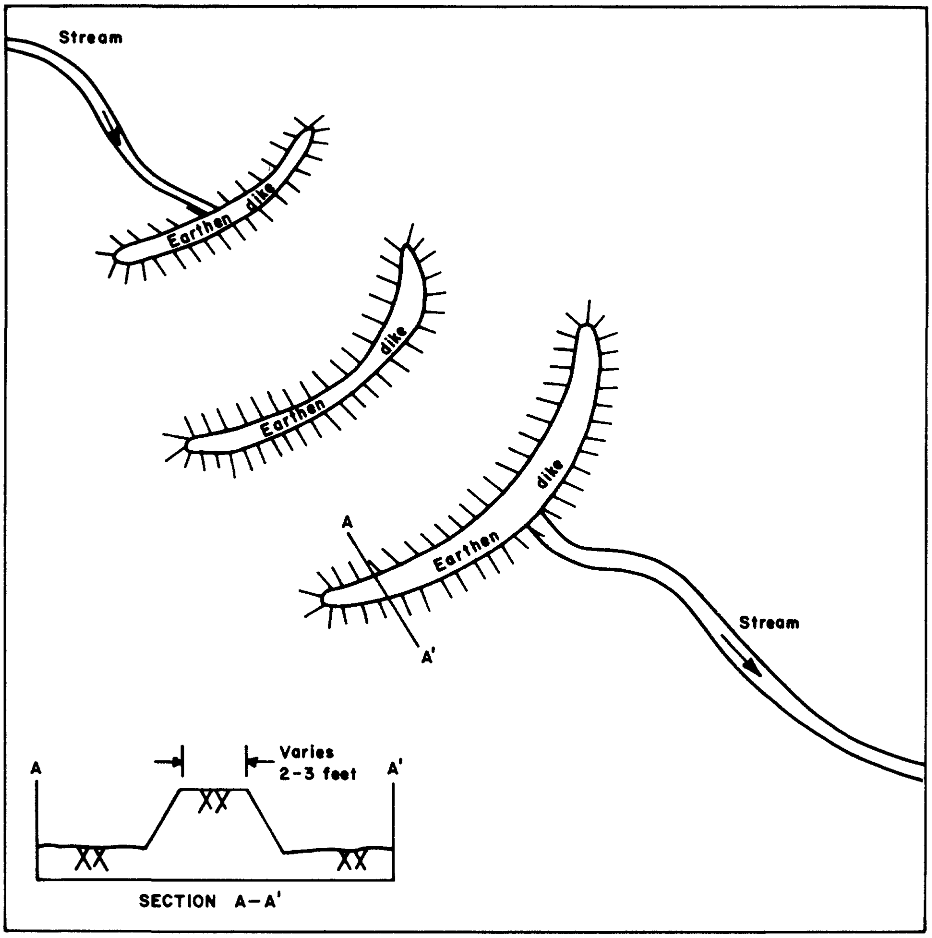


Figure 6.--Sketch of typical waterspreader.

Channel routing component

Characterization of each channel routing component required determinations of reach length, slope of the energy grade line, channel cross section, and estimates of the Manning's roughness coefficient. The reach lengths for all channel routing components were measured on maps using the electronic digitizer. The channel slope of each reach length was assumed to be equal to the slope of the energy grade line. The channel slope was determined by subtracting the channel bed elevation at the downstream end of the routing reach from the channel bed elevation at the upstream end of the reach and dividing the difference by the reach length.

The channel cross sections were obtained from onsite surveys made by Bureau of Land Management hydrologists and technicians at selected, representative channel locations. About 40 channel sections were surveyed and divided into four groups based on size and stream order. All sections within each group were plotted and superimposed on a single graph so that a single, average cross section could be drawn for each group. The average section for each group finally was adjusted to provide an eight-point section in the HEC-1 format previously described. Thus, one of four standard, representative sections was input for each channel routing component in the study area, with the smallest section being used in the headwater areas, the largest section being used in the lower Willow Creek mainstem, and the two mid-sized sections being used everywhere else. Each of the four standard sections is illustrated in figure 7.

The Manning's roughness coefficients shown in figure 7 were selected by the author from color photographs taken at the time of the channel surveys. Various HEC-1 simulations previously made by the author indicated that channel routing results were relatively insensitive to changes in the Manning coefficient, so a single set of coefficients was used for all four standard sections.

Reservoir routing component

The 84 reservoirs included in the simulation model are shown on the Willow Creek schematic (fig. 5). For the reservoir routing component, tables of reservoir storage volume and reservoir outlet discharge versus water-surface elevation were required for each reservoir. Detailed project design data had this information only for three of the largest reservoirs. Onsite surveys by personnel from the Bureau of Land Management were required to obtain the reservoir geometry data at the remaining 81 reservoirs.

Determining reservoir volumes for such a large number of reservoirs using conventional surveying procedures would have been prohibitively expensive, so the following approximate technique was used. First, Bureau of Land Management technicians measured the surface area of each reservoir from aerial photographs. The surface area generally was determined at the full reservoir elevation (principal spillway elevation). Onsite surveys then were used to obtain the minimum and maximum reservoir elevations, the elevations and sizes of all reservoir outlet pipes, and a cross-sectional survey of the emergency spillway.

Reservoir volume (V) at any elevation was calculated from the equation:

$$V = (SA + SA_{MIN})/2 \cdot (E - E_{MIN}) \quad (6)$$

where

- SA is surface area, in acres, for elevation E;
- SA_{MIN} is surface area, in acres, for the lowest stage of the reservoir;
- E is water-surface elevation, in feet; and
- E_{MIN} is minimum reservoir elevation (lowest stage of the reservoir), in feet.

The surface areas at the lowest stage of the reservoir and at any elevation E were calculated using the following procedures. First, the diameter of a circle with a surface area equal to that measured from the aerial photographs was calculated from the equation:

$$D = (55{,}462 \cdot SA)^{1/2} \quad (7)$$

where D is diameter, in feet, of a circle with an area of SA, in acres. Assuming that each reservoir was in the shape of an inverted, truncated cone as shown in figure 8, the following equation was used to calculate the diameter of the circle at the minimum reservoir elevation:

$$D_{MIN} = D_{MAX} - (E_{MAX} - E_{MIN})\cdot 2\cdot S \quad (8)$$

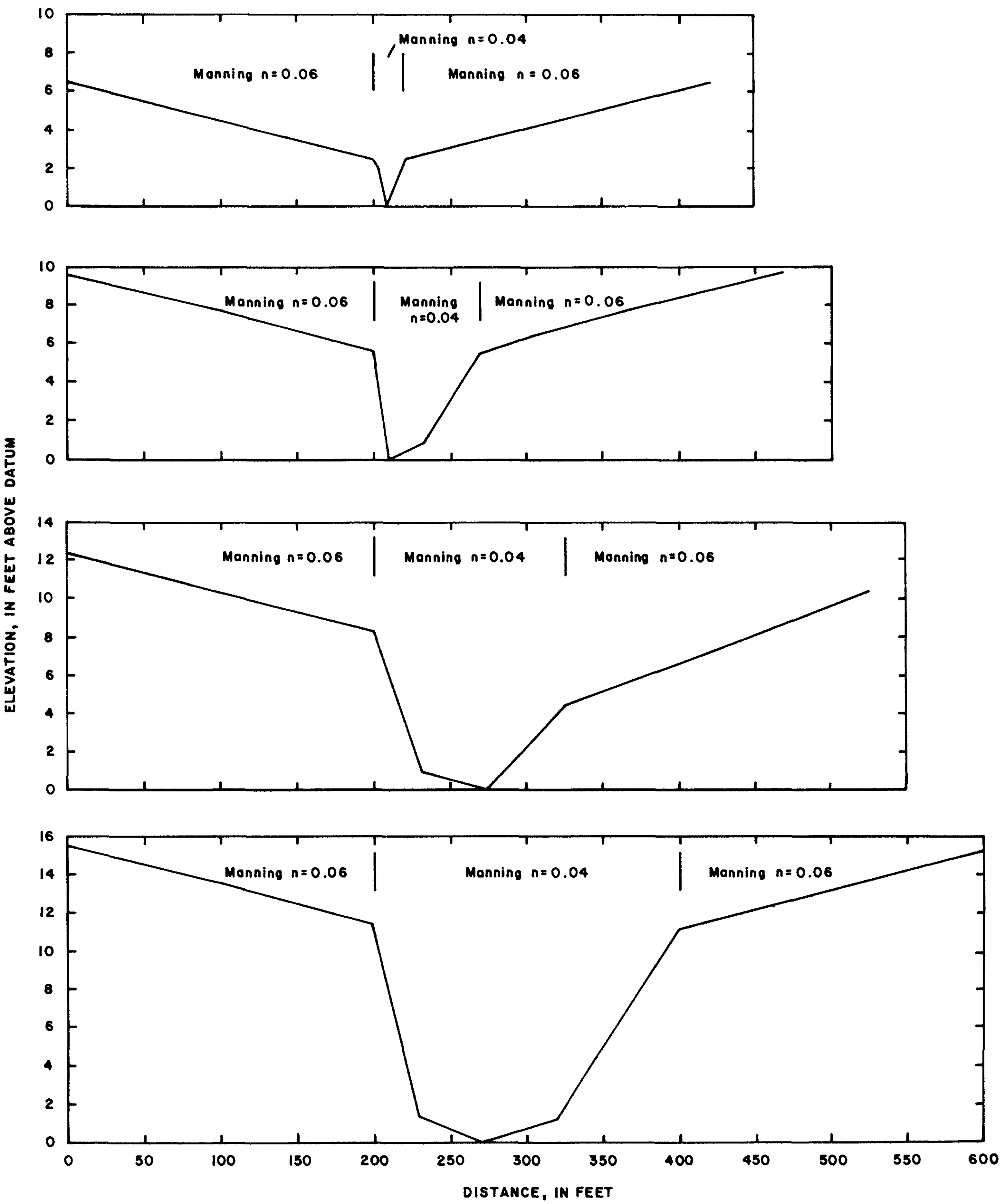


Figure 7.--Four standard cross sections for channel routing.

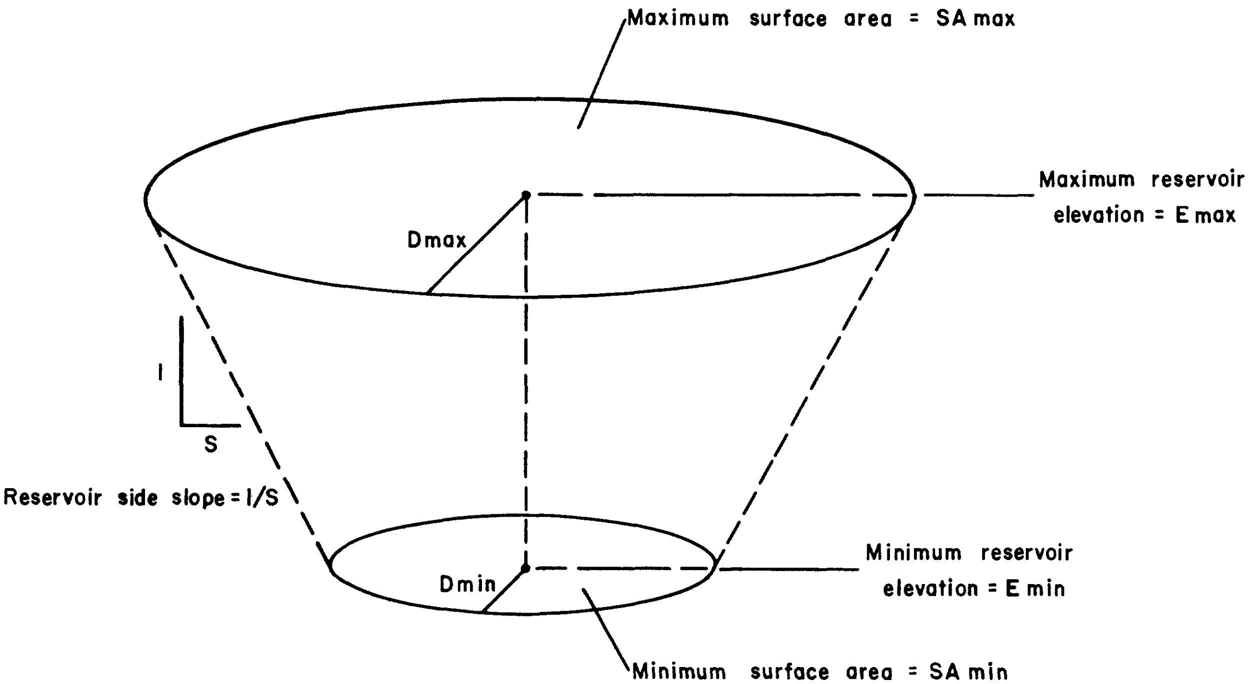


Figure 8.--Approximating reservoir elevation-volume relation.

where

D_{MIN} is diameter of the circle at minimum reservoir elevation (E_{MIN}),
D_{MAX} is diameter of the circle at maximum reservoir elevation (E_{MAX}), and
S is the reciprocal of side-slope of the reservoir.

Based on tests made on reservoirs with known elevation-volume relationships, S was assumed to be 50 for all Willow Creek reservoirs. Next, the surface area at the minimum reservoir elevation was calculated from the following form of equation 7:

$$SA_{MIN} = (D_{MIN}/235.5)^2 \quad (9)$$

where all terms are as previously defined.

Finally, for any elevation E greater than E_{MIN}, the following sequence of equations was used to determine surface area:

$$D = (E - E_{MIN}) \cdot 2 \cdot S + D_{MIN} \quad (10)$$

$$SA = (D/235.5)^2 \quad (11)$$

where all terms are as previously defined.

The computation of reservoir discharge versus elevation was based on a simple orifice flow equation for reservoir outlet pipes (principal spillways) without vertical drops, a more complicated combination pipe-and-weir flow equation for outlet pipes with drops, and a broad-crested weir flow equation for emergency spillways. The orifice-flow equation used was:

$$Q = 0.5 \cdot A \cdot (64.4 \cdot H)^{1/2} \quad (12)$$

where

Q is outlet-pipe discharge, in cubic feet per second;
A is cross-sectional area of the outlet pipe, in square feet; and
H is difference between the reservoir water-surface elevation and the elevation of the center of the outlet pipe, in feet.

For reservoirs with vertical-drop outlet pipes as shown in figure 9, flow is initially controlled by the size of the vertical drop pipe. In this instance, the drop-pipe entrance functions as a weir, and the following weir-flow equation is applicable:

$$Q = C \cdot L \cdot H^{3/2} \tag{13}$$

where

Q is outlet-pipe discharge, in cubic feet per second;
C is a weir coefficient that varies with head (H) and drop-pipe diameter (D_1);
L is length of weir and is equal to the circumference of the drop pipe ($\pi \cdot D_1$); and
H is hydraulic head or difference, in feet, between the water-surface elevation and the drop pipe.

When the water-surface elevation in the drop pipe rises above the critical-depth elevation for weir flow (d_c), weir flow is drowned out, and the following pipe flow equation was assumed to be applicable (U.S. Bureau of Reclamation, 1977):

$$Q = 6.303 \cdot D \cdot (H_1/(2.0 + f \cdot L / D)^{1/2} \tag{14}$$

where f is a friction factor that is a function of pipe material and diameter, and was obtained from a table, and all other variables are as previously defined or as shown in figure 9.

Flow over the emergency spillway at each reservoir was calculated from the general broad-crested rectangular weir flow equation:

$$Q = C \cdot B \cdot H^{3/2} \tag{15}$$

where

Q is discharge, in cubic feet per second;
C is a weir coefficient that is a function of the hydraulic head (H);
B is effective length of the weir, in feet; and
H is hydraulic head, in feet, which is approximated by the difference between the water-surface elevation and the elevation of the crest of the weir.

Because the spillway cross sections were commonly irregular sections, as shown in figure 10, the following form of equation 13 was used for most surveyed spillway sections:

$$Q = C\sum_{i=2}^{n} b \cdot \overline{H}^{3/2} \tag{16}$$

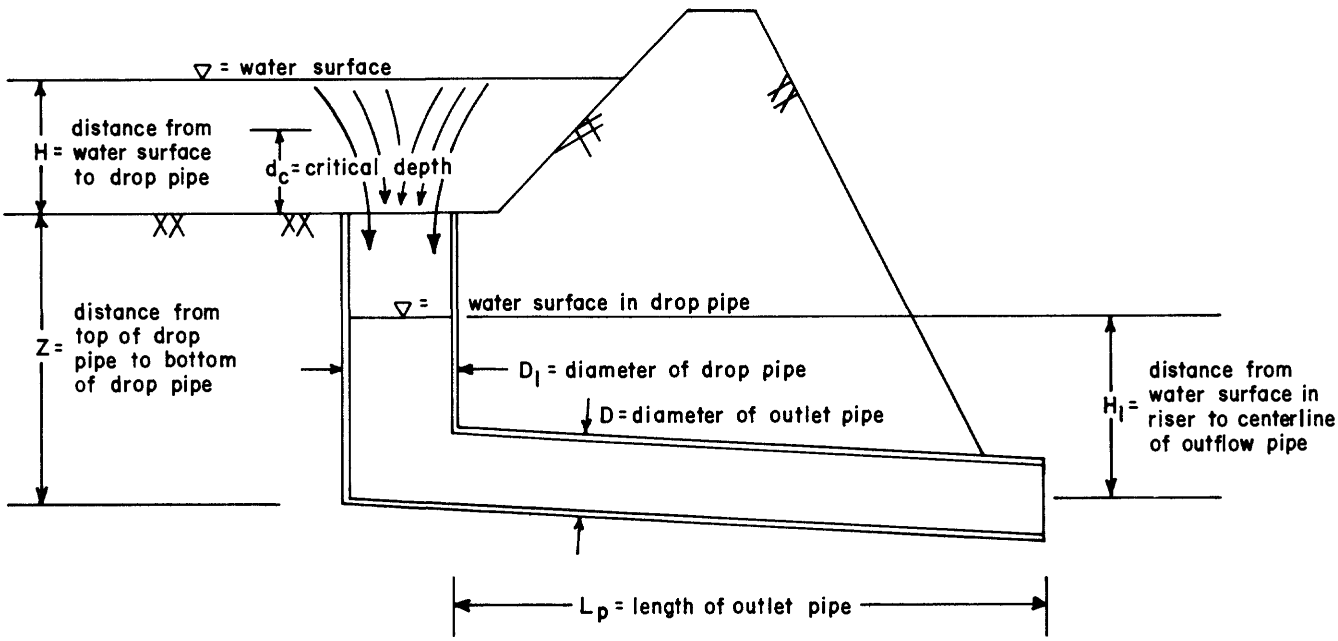


Figure 9.--Drop-pipe spillway. All distances and lengths are in feet.

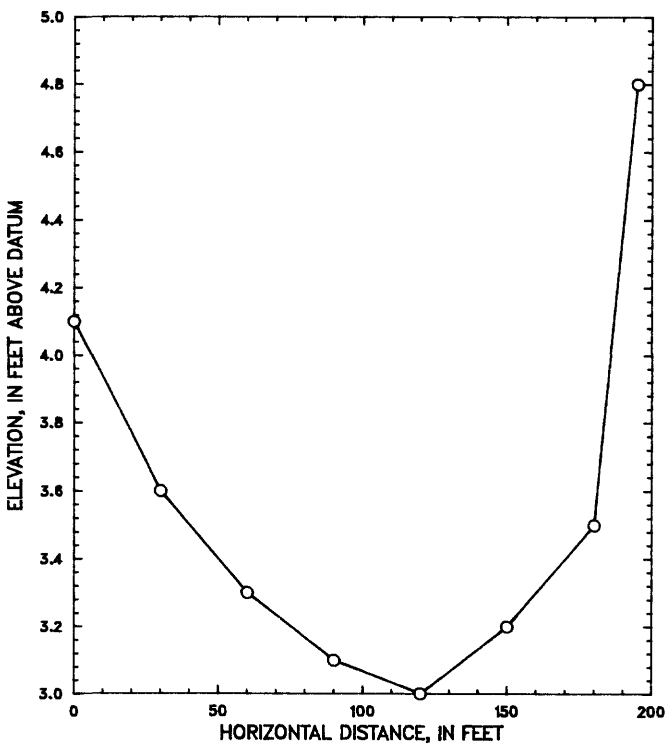


Figure 10.--Typical reservoir spillway cross section.

where

Q is discharge, in cubic feet per second;
b is horizontal distance, in feet, between the surveyed ground elevation at i and at i-1;
$\bar{H}$ is average of the differences between the water surface and the ground elevation, in feet, at points i and i-1;
C is weir coefficient for the head (H); and
n is number of surveyed ground elevations in the emergency spillway section.

Waterspreader component

As previously indicated, a hydrologic component required for the Willow Creek study that is not considered in the standard HEC-1 simulation procedure is the waterspreader. Each dike of the waterspreader was assumed to function as a reservoir, with its emergency spillway discharge being the streamflow input to the next dike (reservoir) downstream. Aerial photographs were used to determine the number of dikes and areal extent of each waterspreader. Although the number and length of the individual dikes vary from waterspreader to waterspreader, the dimensions of each dike are about equal. Thus, the spillway flow section on each dike was presumed to be approximated by the same rectangular and trapezoidal-shaped section as shown in figure 11. Even though the spillway cross section shown in figure 11 is

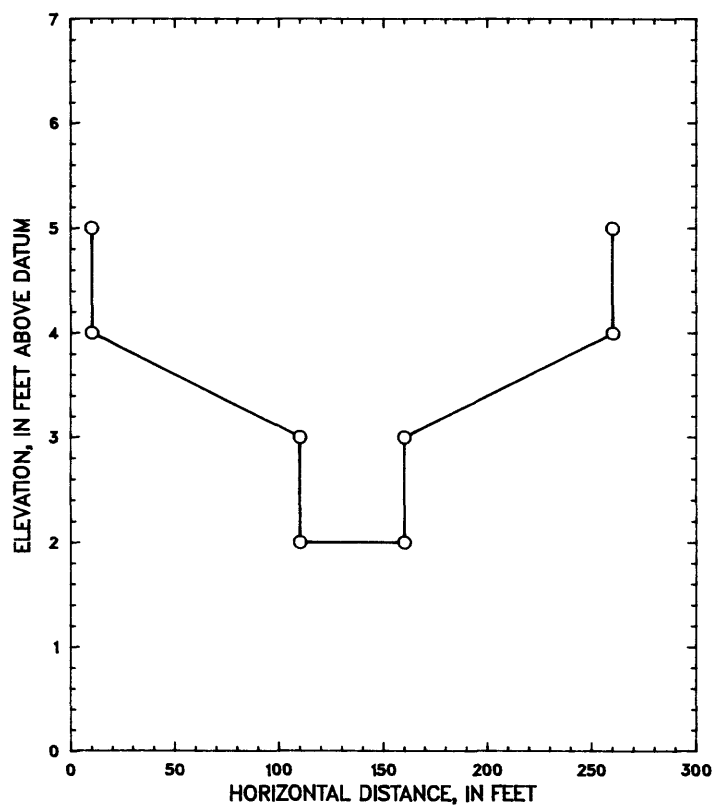


Figure 11.--Assumed waterspreader spillway cross section.

arbitrary, it was chosen by U.S. Bureau of Land Management hydrologists as a reasonable approximation of the average flow section on all Willow Creek waterspreaders. A table of discharge versus waterspreader water-surface elevation thus was prepared for each dike using the spillway geometry shown in figure 11 and the emergency spillway discharge calculation procedure described previously.

To determine the required table of storage volume versus water-surface elevation for each reservoir (dike) within a waterspreader, the total area of the waterspreader was divided by the number of dikes. The resulting area was considered to be the reservoir surface area for each dike, and the procedure previously described was used to calculate a table of reservoir volume versus water-surface elevation. For each waterspreader, flow was simulated by routing through n consecutive, identical reservoirs, where n is the number of dikes in the waterspreader. The number of dikes and volumes within the various waterspreaders in the Willow Creek basin are listed in table 3 at the end of the report.

SYNTHETIC STORM HYETOGRAPH

To simulate the 100-year-frequency peak discharge from Willow Creek, a synthetic 100-year-frequency storm was constructed from precipitation depth-duration data obtained from the National Weather Service (Miller and others, 1973). The procedure used to construct the synthetic storm is contained within the HEC-1 program and is a standard design procedure used by the Corps of Engineers. To develop the synthetic storm, 100-year-frequency precipitation depths for storm durations from 5 minutes to 24 hours were input to the model as cumulative storm amounts, and incremental amounts of precipitation at 10-minute intervals subsequently were calculated. The synthetic storm hyetograph then was constructed by arranging the incremental precipitation depths so that the largest value occurred at the center of the storm, the second largest value preceded the largest value, the third largest value followed the largest value, the fourth largest preceded the second largest, and so forth. The resultant 24-hour duration storm hyetograph for a point within the Willow Creek basin has 72 ordinates and is shown in figure 12.

The construction of a simple, 6-hour duration storm hyetograph using 1-hour time increments is illustrated in figure 13. In this instance, the resultant example storm hyetograph has only 6 ordinates rather than the 72 ordinates used for the Willow Creek basin.

The synthetic-storm construction technique used in this study results in high intensity, short duration rainfall occurring near the center of the storm duration with significantly lower intensity rainfall occurring at the beginning and end of the storm. This time pattern of rainfall distribution may not be typical of storms that produce 100-year-frequency runoff from drainage areas as large as the entire Willow Creek basin. It is, however, probably typical of storms that produce 100-year-frequency runoff from smaller drainage areas such as the subbasins comprising the Willow Creek basin. Using any single storm distribution to generate 100-year-frequency runoff from drainage areas ranging from about 1 square mile to about 500 square miles will result in non-typical storm distributions for some drainage areas. By using a standard design procedure such as the Corps of Engineers' synthetic storm, it was believed that large errors in computed runoff resulting from an inappropriate time-distribution of rainfall would be minimized. Errors that did result from using a single precipitation distribution were accounted for in the calibration phase by adjusting the precipitation depth-drainage area relationship.

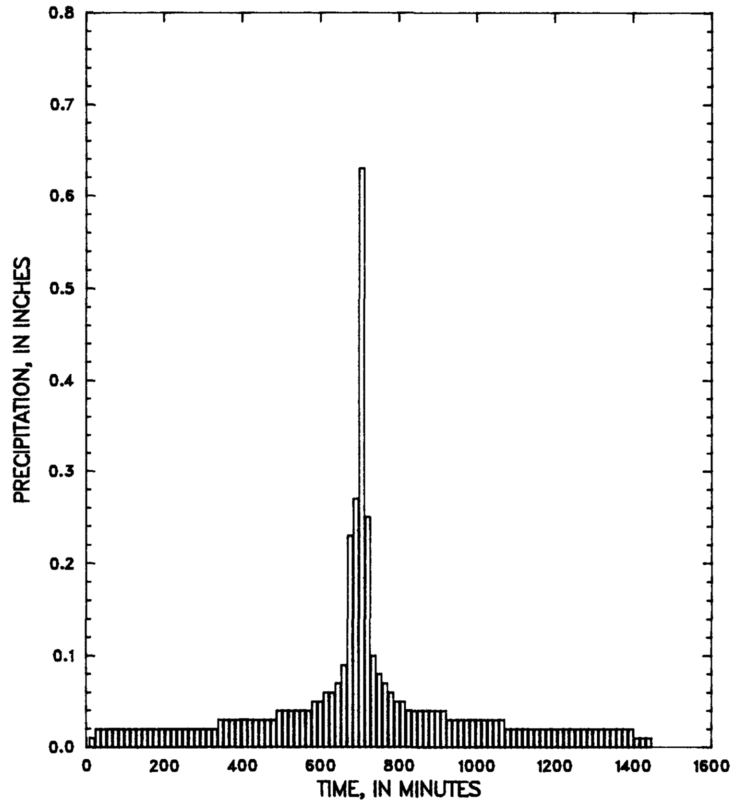


Figure 12.--Synthetic rainfall hyetograph for 100-year-frequency, 24-hour duration storm in Willow Creek basin.

Because the average depth of precipitation over an area generally decreases with the size of area, precipitation depths for storms of any frequency and duration must be adjusted for varying areas of coverage. The depth-area relationship used by the National Weather Service is shown in figure 14. Thus, to simulate the 100-year peak discharge at numerous points within a basin, each with a different drainage area, the 100-year-storm hyetograph must be revised using a depth-area adjustment similar to that shown in figure 14. Further, at combination points within the basin where hydrographs are added, the combined hydrograph must be adjusted to produce a 100-year-frequency runoff hydrograph consistent with the combined drainage areas of the contributing subbasins.

Within HEC-1, hydrographs consistent with the sizes of the contributing drainage areas are generated throughout the basin by interpolation from a set of index hydrographs that are simulated at each point for different total storm depths. To illustrate, figure 15 shows a schematic of a basin where 100-year-frequency runoff hydrographs are required for subbasin A and subbasin B, and at the confluence of stream A and stream B. The rainfall depth-drainage area relationship for a 100-year-frequency storm of some specified duration is shown by the table on the schematic. For example, the 100-year-frequency rainfall total for a drainage area of 100 square miles in this illustrative example is 15 inches. Similarly, the 100-year-frequency rainfall totals for drainage areas of 200, 500, and 1,000 square miles are 13, 10, and 8 inches, respectively.

Storm duration, in hours	100-year-frequency storm depth, in inches	Incremental (hourly) precipitation, in inches	Arranged incremental precipitation, in inches
1	2.13	2.13	0.14
2	2.35	.22	.15
3	2.55	.20	.22
4	2.70	.15	2.13
5	2.85	.15	.20
6	2.99	.14	.15

Resultant Storm Hyetograph

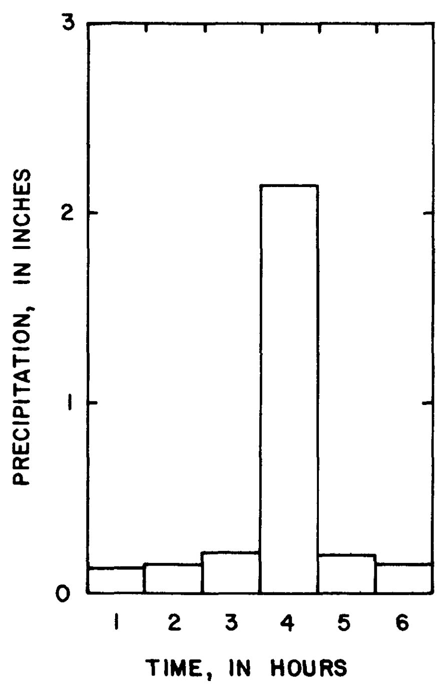
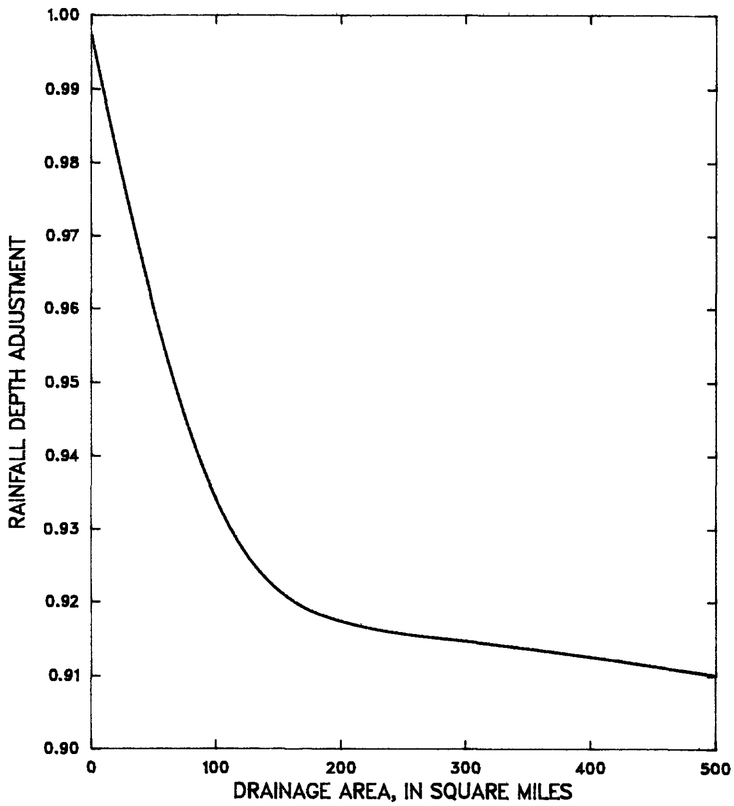


Figure 13.--Construction of an example 6-hour duration storm hyetograph.

The simulation model then is run for each of the four different storm depths to produce four different hydrographs at each required location. The 100-year-frequency runoff hydrograph at each location then is interpolated from among the four hydrographs according to drainage area, as shown in figure 15. Thus, the hydrograph at the mouth of subbasin A, where the drainage area is 130 square miles, is determined by interpolating between the index hydrograph for 100 square miles and the index hydrograph for 200 square miles. Likewise, the hydrograph at the mouth of basin B, where the drainage area is 250 square miles, is determined by interpolating between the index hydrograph for 200 square miles and index hydrograph for



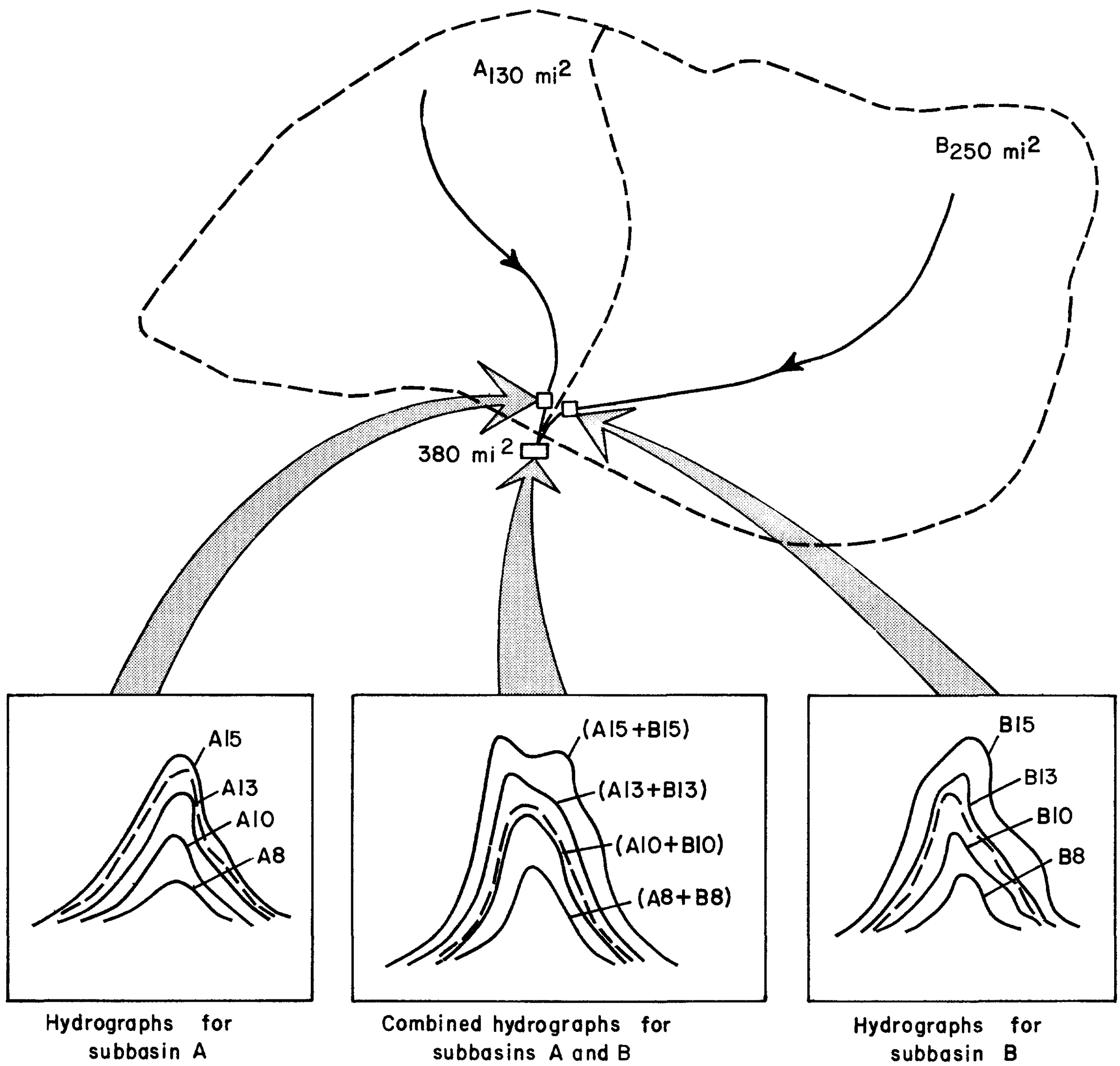
From Miller and others (1973)

Figure 14.--National Weather Service rainfall depth-drainage area adjustment.

500 square miles. At the combination point where hydrographs from basins A and B are added together, the total contributing drainage area is 380 square miles. The hydrograph at the combination point thus is determined by interpolating between the combined index hydrographs for 200 square miles and the combined index hydrographs for 500 square miles.

CALIBRATION BY ADJUSTING THE DEPTH-AREA RELATION

To adjust the 100-year-frequency precipitation depths for different drainage areas in the Willow Creek basin, the relationship developed by the National Weather Service (fig. 14) was used first. As a check on the validity of this adjustment, the HEC-1 simulation model was run on the Willow Creek watershed without any reservoirs or waterspreaders included. The resultant 100-year-frequency flood peaks for different subbasin sizes then were compared with 100-year-frequency flood peaks determined from nearby gaging-station data. The results of the comparison are shown in figure 16, where a best-fit regression line through the gaging-station data is compared with a best-fit regression line through the HEC-1 simulated data using the National Weather Service precipitation depth-area adjustment. The slope of the regression line through the HEC-1 simulated data is steeper than the slope of the regression line through the gaging-station data, indicating that the simulated peaks for the larger drainage areas are too large. To adjust the slope of



100-YEAR RAINFALL DEPTH-DRAINAGE AREA FUNCTION

AREA, IN SQUARE MILES	RAINFALL, IN INCHES
100	15
200	13
500	10
1000	8

EXPLANATION

□ DESIRED LOCATION FOR HYDROGRAPH

STREAM CHANNEL AND DIRECTION OF FLOW

DRAINAGE BOUNDARY

A130 mi2 SUBBASIN LABEL AND DRAINAGE AREA, IN SQUARE MILES

A15 INDEX HYDROGRAPH FOR GIVEN PRECIPITATION

INTERPOLATED HYDROGRAPH

Figure 15.--Example interpolation of streamflow hydrographs from index hydrographs.

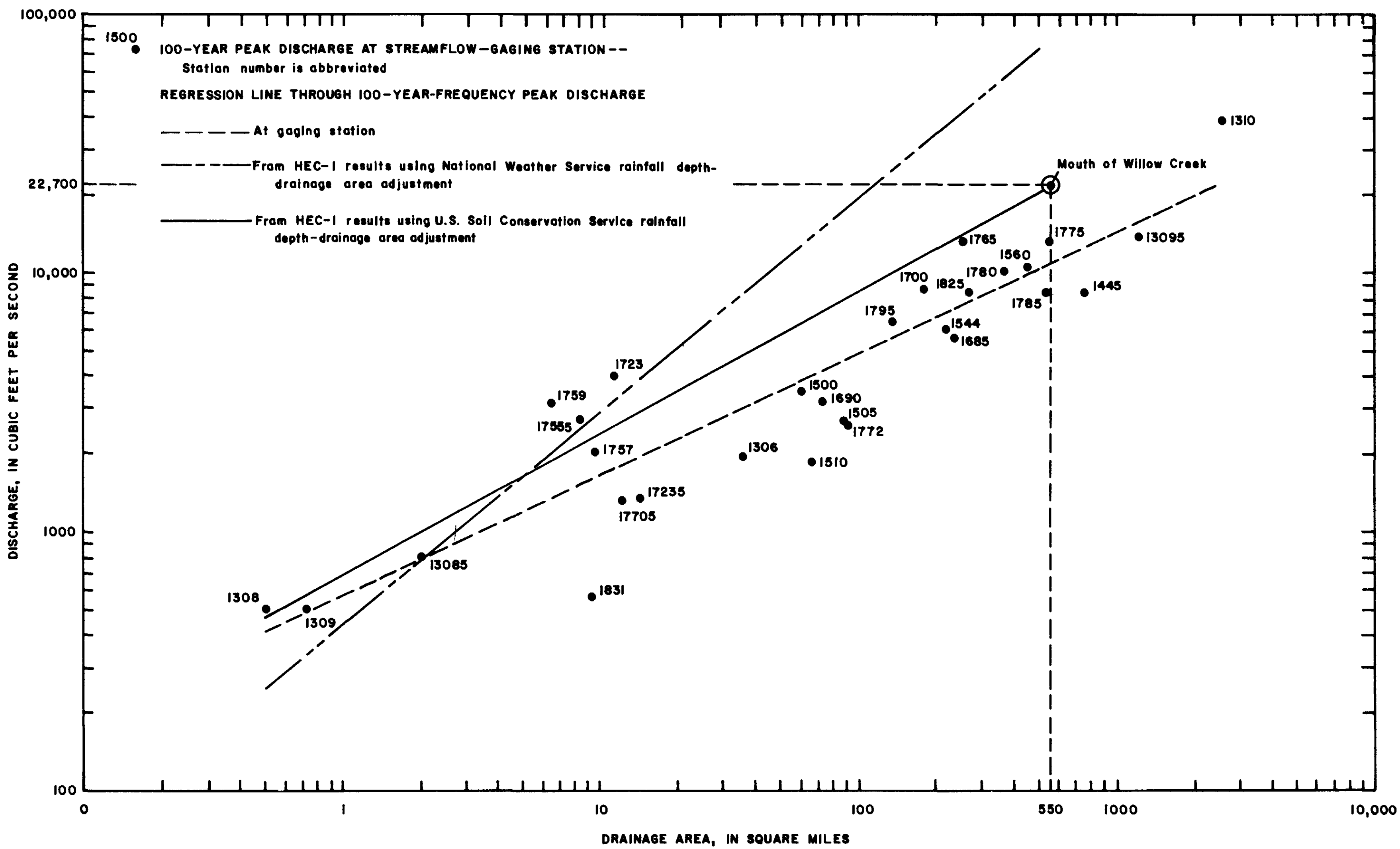


Figure 16.--Comparison of Hydrologic Engineering Center-1 results with gage data.

the regression line through the HEC-1 data, the synthetic storm rainfall distribution could have been changed or the precipitation depth-drainage area adjustment could have been changed. The rainfall distribution was retained because it is a standardized HEC-1 design procedure and the precipitation depth-drainage area adjustment was modified.

For reservoir design on small watersheds, the Soil Conservation Service uses a precipitation depth-drainage area adjustment curve as shown in figure 17. Because this adjustment is applicable only to drainage areas of less than 100 square miles, the curve was arbitrarily extended as shown to be usable for the entire Willow Creek basin. Using the adjustment curve shown in figure 17, the HEC-1 simulation results for the Willow Creek basin without any structures included were much closer to the best-fit line through the gaging-station data (fig. 16). The Soil Conservation Service precipitation depth-drainage area adjustment thus was used for all subsequent simulations in the Willow Creek basin.

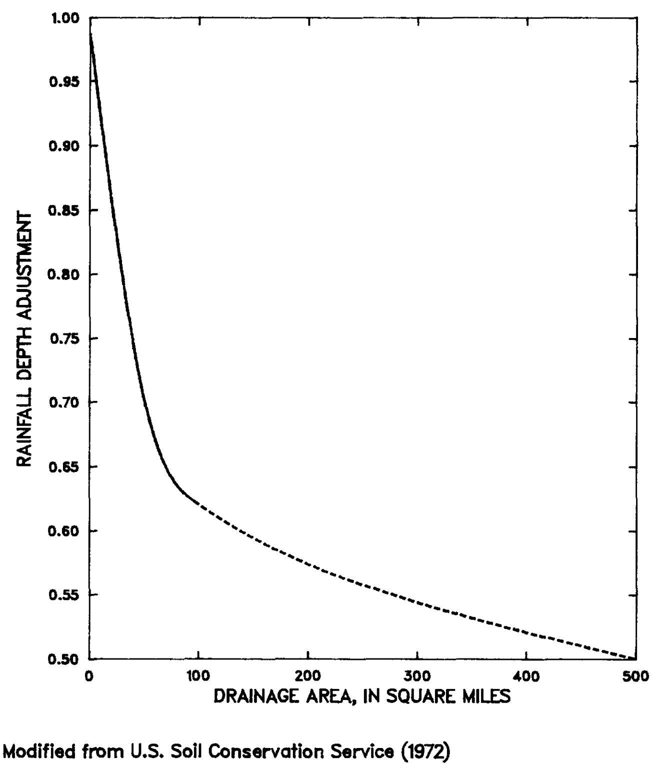


Figure 17.--U.S. Soil Conservation Service rainfall depth-drainage area adjustment. Dashed line indicates extension of original curve.

SIMULATION RESULTS

The simulation for Willow Creek without any structures constitutes a "natural flow" condition. As just described, the results of this simulation are reasonably close to the 100-year-frequency flood peaks at nearby, unregulated, gaged streams. In figure 16, the best-fit line through the simulated peaks in the Willow Creek basin plots above the best-fit line through the gage data for all drainage area sizes. Simulated peaks thus range from about 12 percent larger than the best-fit line through the gage data for a drainage area of 0.5 square mile to about 109 percent larger for a drainage area of 530 square miles. At the mouth of Willow Creek, the 100-year peak discharge for the natural-flow condition is 22,700 cubic feet per second. The largest peak discharge recorded in 30 years at the gaging station at this site is 12,400 cubic feet per second. The simulated 100-year-frequency peak thus appears to be reasonable, although comparisons are tenuous because of the increased construction of reservoirs and waterspreaders over the period of gaged record.

The next simulation for the Willow Creek watershed was run with all reservoirs and waterspreaders in place. This simulation represents present conditions in the Willow Creek basin with all structures operating normally (therefore, no structure failures due to flooding). For this simulation, all reservoirs were assumed to be full at the beginning of the 100-year-frequency storm. This assumption represents a conservative approach that obviously results in larger simulated peaks than if reservoirs are assumed to be initially empty. The conservative approach was considered reasonable because of the likelihood of reservoirs being filled by spring snowmelt or early summer rains before the occurrence of a 100-year-frequency rainstorm. The simulation with all structures in place and operating normally resulted in a 100-year-frequency peak discharge at the mouth of Willow Creek (station 06174000) of 5,870 cubic feet per second. Comparison with the simulated peak under natural-flow conditions shows that the cumulative effect of the present system of structures in the basin is a 74-percent decrease in 100-year-frequency peak discharge at the mouth. The cumulative effect of upstream structures can be similarly determined for any other point in the basin by comparing the 100-year-frequency peak discharges for natural-flow and existing conditions. A schematic diagram of the Willow Creek basin (fig. 18) shows the 100-year-frequency peak discharges for both natural-flow and existing conditions for each reservoir and waterspreader.

At the gaging station at the mouth, peak discharges greater than 5,870 cubic feet per second have occurred three times since 1953. The largest peak occurred in 1962 (peak discharge of 12,400 cubic feet per second), before several major structures had been built. The last two peak discharges greater than 5,870 cubic feet per second occurred in 1969 (peak discharge of 12,000 cubic feet per second) and in 1974 (peak discharge of 8,800 cubic feet per second) when virtually all major structures were already in place in the Willow Creek basin. On this basis, the simulated 100-year-frequency peak discharge with all structures in operation may be too small. However, damage reports from the 1969 and 1974 floods (Dan Muller, written commun., 1983) indicate that several structures failed or suffered severe damage during both floods. Thus, it appears that structure failure at least partly contributed to the large peaks in both years. Also, reported rainfall amounts for both the 1969 and 1974 storms exceeded the 100-year-frequency, 24-hour duration totals, at least in certain locations in the Willow Creek basin. Therefore, even though the simulated 100-year-frequency peak discharge with all structures in place has been exceeded twice in the last 15 years, the simulated peak

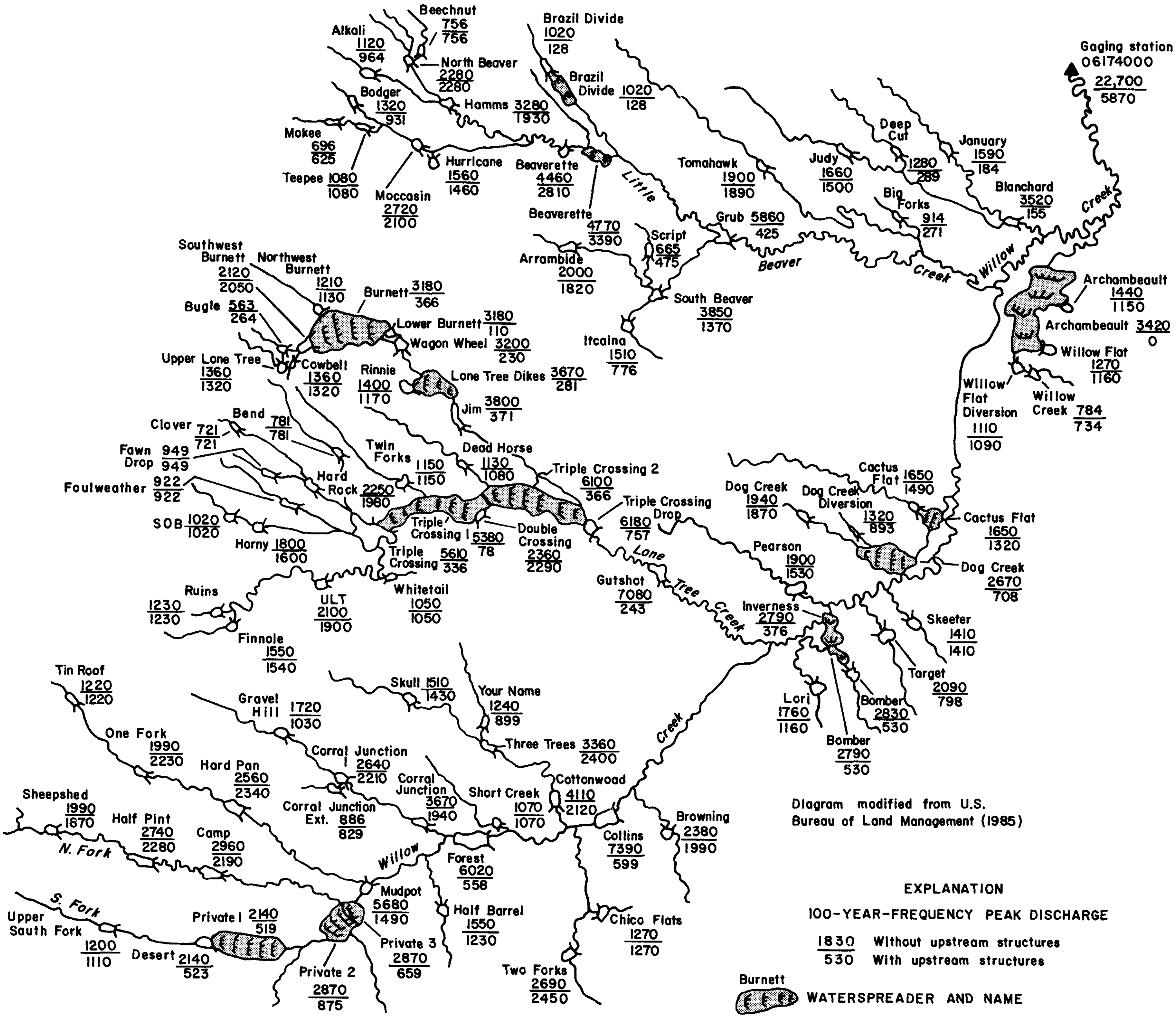


Figure 18.--Schematic diagram showing 100-year-frequency discharges at Willow Creek structures.

discharge may still be a reasonable estimate, given that no structures fail during the 100-year flood. The long-term validity of the simulated 100-year-frequency peak discharge can be verified only by continued rainfall and discharge data collection.

A third simulation was run with all structures removed except for certain key structures that showed the most substantial decrease in 100-year-frequency peak discharge. Several preliminary runs were made wherein reservoirs and waterspreaders having little effect on peak discharges were successively eliminated to help select the key structures. The final determination of key structures resulted in the elimination of 78 reservoirs and 13 waterspreaders. Removing these structures from the analysis resulted in a simulated peak discharge at the mouth of 8,820 cubic feet per second--a value 52 percent larger than the simulated peak with all structures in place. The key structures identified in the simulation analysis were Archambeault waterspreader and the following reservoirs: Collins, Forest, Grub, Gutshot, Mudpot, and Triple Crossing.

Discharge hydrographs for the three different simulations are presented in figure 19. The hydrographs were computed for Collins Reservoir, Gutshot Reservoir, and the mouth of Willow Creek for three conditions: natural flow, all structures in place, and only key structures in place. At the Collins Reservoir, the simulated peak discharges for the three different simulations were 7,390, 599, and 2,310 cubic feet per second, respectively. At Gutshot Reservoir, the simulated peak discharges were 7,080, 243, and 2,510 cubic feet per second, respectively. As previously discussed, the peak discharges at the mouth of Willow Creek for the three simulation runs were 22,700, 5,870, and 8,820 cubic feet per second, respectively.

LIMITATIONS OF THE SIMULATION ANALYSIS

Because of the lack of recorded rainfall and runoff data, the HEC-1 simulation model could be used in the Willow Creek basin with only a synthetic storm distribution. The model thus could not be calibrated or verified using actual rainfall-runoff data. For this reason, the measured and estimated physical variables describing the hydrologic components were fixed and assumed to be correct. For the simulation of natural-flow conditions, the variables having the largest effects on simulated peak discharges are probably those comprising the runoff component, namely Curve Number and lag time. A previous limited sensitivity analysis by the author indicated that peak discharge was particularly sensitive to changes in Curve Number. This earlier analysis also indicated that peak discharge was relatively insensitive to changes in channel routing variables such as channel section geometry, slope, and Manning's roughness coefficient. Consequently, any error in simulated discharge resulting from error in the measurement or estimation of hydrologic variables is believed to be largely attributable to Curve Number. Simulation results for the natural-flow condition nonetheless are considered to be reasonable because of the comparison with nearby gaging-station data (fig. 16). On this basis, calibration data would not appear to result in significant adjustments to Curve Numbers or any other runoff or channel routing variable.

For the simulations with structures in place, the results are subject to considerably more error. The technique previously described for estimating reservoir volume, for example, is a generalization that may substantially overestimate or underestimate some reservoir volumes. Likewise, the assumption that waterspreader

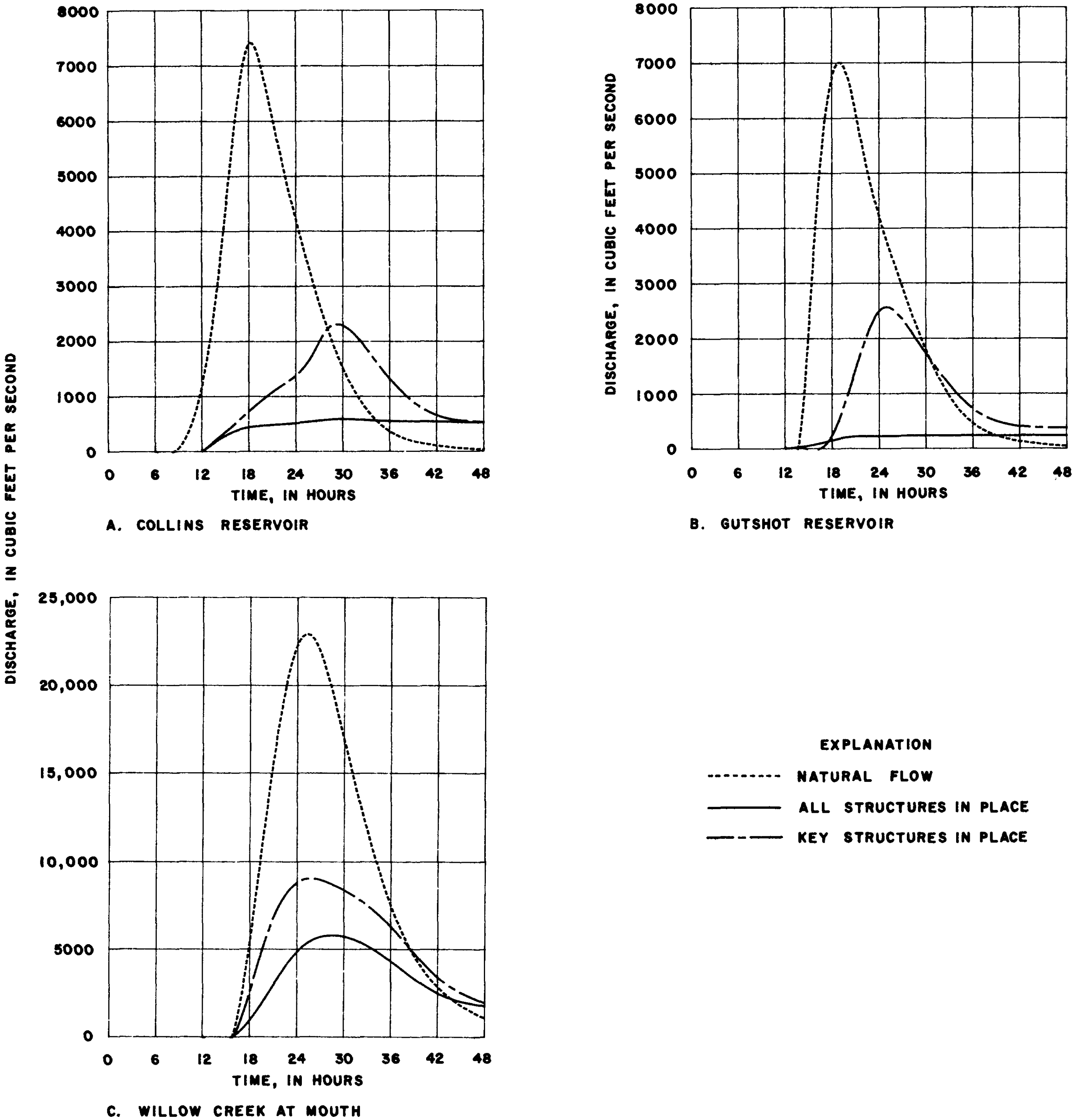


Figure 19.--Simulated 100-year-frequency hydrographs at three locations.

dikes function as identical reservoirs with arbitrarily sized spillways may be seriously in error. In addition, the simulation results cannot be checked for reasonableness because of the lack of recorded flood-frequency data for any similar, regulated watershed systems.

Although the error due to imprecise reservoir volume determination and waterspreader simulation can be quantified only with additional calibration data, the relative effects of the errors can be investigated with the simulation model. Thus, to investigate the effects of reservoir volume, the HEC-1 model was run with all reservoirs and waterspreaders in place, but with different reservoir elevation-volume relationships. Successive model runs were made with reservoir volumes increased by 10 percent, increased by 30 percent, decreased by 10 percent, and decreased by 30 percent. The reservoir volume changes resulted in significantly smaller percentage changes in the simulated 100-year-frequency peak at the mouth of Willow Creek. As shown in figure 20, an increase of 30 percent to all reservoir volumes resulted in only a 3.4-percent decrease in 100-year peak discharge. Similarly, a 30-percent decrease in all reservoir volumes resulted in a 5.2-percent increase in 100-year peak discharge. If the technique for estimating reservoir volumes indeed has a 30-percent error, the error is likely to be relatively unbiased and to result in some volumes being overestimated and some volumes being underestimated. In that instance, the error in simulated 100-year-frequency peak discharge would be between -3.4 and +5.2 percent.

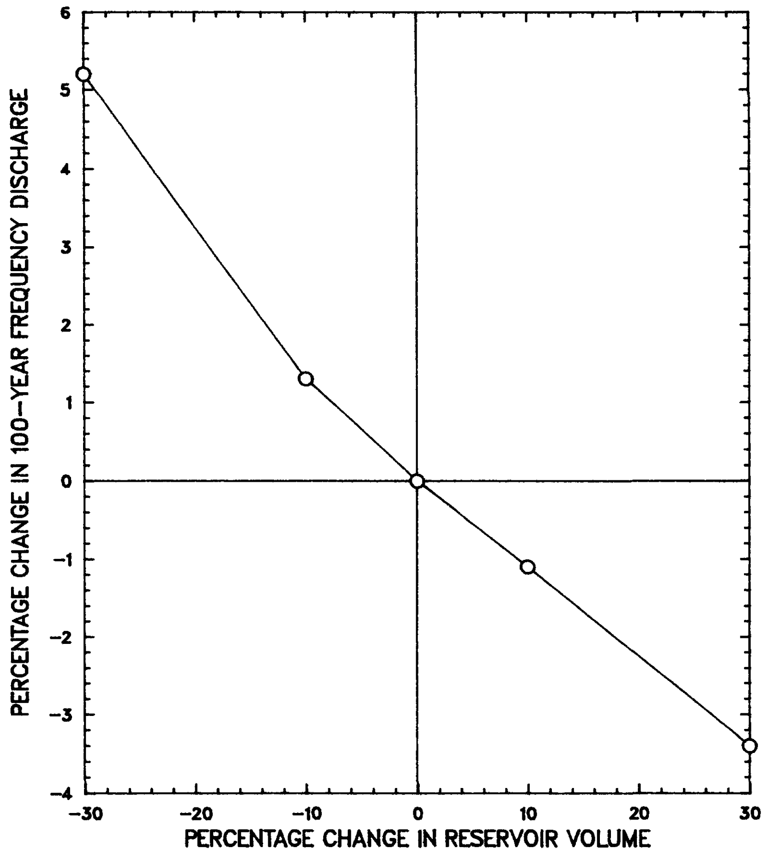


Figure 20.--Effects of reservoir volume change on computed 100-year-frequency discharge of Willow Creek.

A similar analysis was made for different assumed waterspreader hydraulic characteristics. Simulations were run with spreader volumes increased 10 percent, increased 30 percent, decreased 10 percent, and decreased 30 percent. The resultant percentage changes in simulated peak discharge were insignificant, as shown in figure 21. Simulations were run with waterspreader spillway discharges increased 10 percent, increased 30 percent, decreased 10 percent, and decreased 30 percent. The percentage changes in simulated peak discharge were all zero with these conditions. As with reservoir volume, errors in waterspreader discharge and volume are believed to be unbiased, with some discharges and volumes being overestimated and others underestimated. If so, percentage changes in simulated peak discharge would be even less than indicated in figure 21.

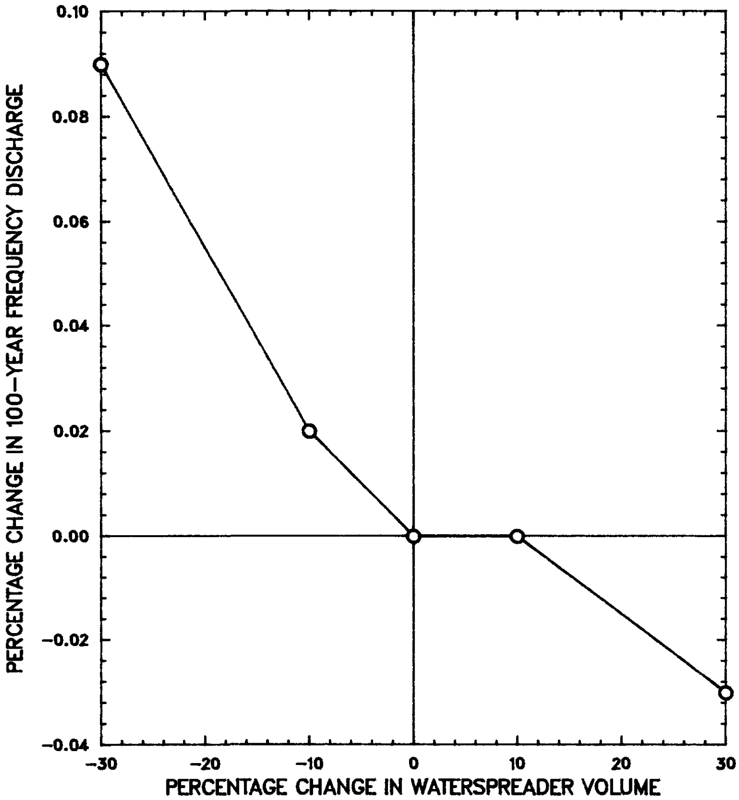


Figure 21.--Effects of waterspreader volume change on computed 100-year-frequency discharge of Willow Creek.

Because all simulations were made with a single, standardized synthetic storm distribution, a final sensitivity analysis was made by varying the most severe rainfall intensities. As discussed earlier, the synthetic storm used in the Willow Creek basin had high, short-duration intensities in the middle of the storm that might not be typical of 100-year-frequency storms covering basins as large as Willow Creek. Accordingly, an HEC-1 run was made by decreasing by 50 percent the 100-year-frequency, 5-minute and 15-minute duration rainfall depths input to the model. The resultant 100-year peak discharge at the mouth of Willow Creek was unchanged from that produced by the standard synthetic storm. Model results thus do not appear to be overly sensitive to the maximum rainfall intensity occurring in the middle of the storm.

Perhaps more significant than the errors due to imprecise measurement of reservoir volume, incorrect assumptions about waterspreader hydraulic characteristics, or incorrect rainfall distribution is the likelihood that one or more structures will fail during a basin-wide 100-year-frequency storm. With such a large system of reservoirs and waterspreaders, all probably will not function properly during such a large, rare storm. The sudden failure of a full reservoir or waterspreader could result in a peak discharge at the failure location many times larger than would normally occur from storm runoff. Although such failures can be simulated with the HEC-1 model, it is not known where and when the failures might occur. To analyze all possible combinations of failures would be extremely impractical. Thus, the hydrologic consequences of various structural and management alternatives require the presumption that all structures will function equally well.

SUMMARY AND CONCLUSIONS

The HEC-1 runoff simulation model was used to evaluate the effectiveness of a complex system of reservoirs and waterspreaders in the 550-square-mile Willow Creek basin in northeastern Montana. Willow Creek is a sparsely populated basin, composed mostly of rolling uplands interspersed with flat valleys and a well-defined drainage system. Most of the basin is publicly owned and has been managed by the U.S. Bureau of Land Management for conservation purposes. Since the early 1950's, more than 200 reservoirs have been constructed in the basin.

For simulation purposes, the basin was delineated into 100 subbasins that included 84 reservoirs and 14 waterspreaders. The subbasins were linked together by channel reaches and combination points where runoff from two or more subbasins could be added together. Runoff from the subbasins was simulated by routing a synthetic, 100-year-frequency rainfall excess to the subbasin outlets using the U.S. Soil Conservation Service unit hydrograph technique. Rainfall excess was computed by subtracting infiltration and detention losses as determined from the U.S. Soil Conservation Service Curve Number approach. Runoff from the subbasins was routed through the channel reaches and reservoirs using the modified Puls storage-routing technique. The waterspreaders, which are a series of low-level dikes constructed perpendicular to and across the stream channels, were simulated by routing runoff through each dike as if it were a reservoir with only a fixed-dimension emergency spillway.

Data for computing reservoir volumes and stage-discharge relations were obtained from aerial photographs and limited field surveys. Volumes were approximated by using the equation for the volume of a truncated cone. Discharges through pipe outlets were calculated from orifice-flow and combined weir-flow and pipe-flow equations. Discharges through emergency spillways were calculated from broad-crested weir-flow equations.

A rainfall depth-drainage area adjustment developed by the U.S. Soil Conservation Service was used to ensure that consistent 100-year frequency hydrographs were produced from the different sized subbasins. In addition, consistent hydrographs were generated at combination points where hydrographs were added together by interpolation between index hydrographs computed for different drainage areas.

The simulation model was calibrated for the Willow Creek basin by first routing a 100-year-frequency flood through the basin with no structures in place. This run constituted a "natural flow" condition whose results could be compared to 100-

year-frequency flood peaks at nearby streamflow-gaging stations. The comparison showed reasonably good agreement between the simulated 100-year-frequency peaks for various subbasins in the Willow Creek basin and the 100-year-frequency peaks at the gaging stations (12 to 109 percent larger) when a rainfall depth-drainage area relation developed by the U.S. Soil Conservation Service was used. The simulated peak at the mouth of Willow Creek for the natural-flow condition was 22,700 cubic feet per second.

Simulation results with all structures in place produced a peak discharge at the mouth of 5,870 cubic feet per second. For this run, all reservoirs were presumed to be initially full (up to the elevation of the principal spillway), and all structures were presumed to operate normally with no washouts or overtopping failures. Thus, the cumulative effect of all structures in the Willow Creek basin is a 74-percent decrease in the 100-year peak discharge at the mouth of Willow Creek.

Although the simulated 100-year peak discharge with all structures in place has been exceeded twice in the last 15 years, structure failures during those floods may have contributed to the large recorded peaks. Until more rainfall-runoff data become available, the simulated 100-year peak discharge based on no structure failure is presumed to be reasonable.

Additional simulation runs were made to identify the structures that produced the most significant reductions in peak discharge. Six key reservoirs and one key waterspreader were thus identified. Eliminating all structures but these seven resulted in a 100-year-frequency peak discharge at the mouth of Willow Creek of 8,820 cubic feet per second.

The greatest limitation of the simulation results is the lack of rainfall-runoff data for additional calibration and verification. Based upon the comparison of the simulated results for the natural flow condition with 100-year-frequency peak discharges at nearby gaging stations, the parameters for the subbasin runoff component and the channel routing component appear reasonable. The results of the simulation results with all reservoirs and waterspreaders in place are subject to more error. The technique for estimating reservoir storage volumes and the assumption that waterspreaders function as a series of fixed-dimension reservoirs may not be correct.

To test the effects that errors in reservoir and waterspreader storage could have on simulated peak discharges, all reservoir and waterspreader volumes were changed in successive simulation runs by -30, -10, +10, and +30 percent. The changes in reservoir storage volume produced changes in the simulated 100-year-frequency peak discharge at the mouth of Willow Creek ranging from +5 to -3 percent. Similarly, the changes in waterspreader volume produced negligible changes in the simulated 100-year-frequency discharge at the mouth of Willow Creek. Thus, although the assumptions made concerning the reservoir and waterspreader volumes may not be correct, the resultant errors in simulated peak discharge are less than the errors in computed volumes.

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SUPPLEMENTAL DATA

Table 1.--*Subbasin variables for the Willow Creek basin*

Sub-basin No.	Drainage area (A) (square miles)	Curve No. (CN)	Hydraulic length (h) (feet)	Subbasin slope (Y) (percent)	Lag time (L) (hours)
0110	11.1	81	36,200	1.40	4.60
0120	4.80	86	30,000	1.10	3.77
0130	3.80	83	20,000	1.80	2.36
0140	20.9	85	39,000	.82	5.58
0141	2.10	85	12,200	.98	2.01
0142	2.80	85	18,800	.96	2.87
0143	10.5	85	45,900	1.00	5.75
0144	4.00	81	20,700	1.80	2.59
0145	4.30	80	20,400	2.40	2.29
0146	4.40	78	23,200	1.70	3.21
0150	7.60	84	39,800	1.30	4.66
0151	3.00	86	13,600	1.20	1.92
0152	4.30	85	24,600	.81	3.88
0153	1.30	86	14,100	1.30	1.89
0154	4.50	86	18,300	.98	2.69
0155	2.50	80	13,700	3.10	1.46
0160	10.7	85	35,500	1.20	4.28
0161	3.10	86	15,600	1.00	2.34
0162	2.00	86	14,400	1.30	1.93
0163	3.40	86	16,600	1.10	2.35
0164	1.90	86	16,400	1.20	2.22
0165	5.30	85	20,800	.86	3.29
0166	4.30	83	13,600	2.80	1.39
0167	1.12	85	11,100	3.60	.97
0168	3.19	85	16,300	2.68	1.53
0170	7.15	85	33,400	.81	2.74
0171	7.56	84	25,400	1.60	2.93
0210	7.47	85	29,300	.75	4.64
0211	.61	85	7,700	1.70	1.06
0212	1.11	86	12,500	1.80	1.46
0213	4.83	86	24,600	1.10	3.21
0214	1.11	86	13,300	1.20	1.88
0215	2.89	85	20,600	.87	3.48
0216	1.31	86	10,800	1.30	1.53
0220	6.60	84	27,500	.84	3.82

Table 1.--*Subbasin variables for the Willow Creek basin*--Continued

Sub-basin No.	Drainage area (A) (square miles)	Curve No. (CN)	Hydraulic length (h) (feet)	Subbasin slope (Y) (percent)	Lag time (L) (hours)
0221	3.00	86	20,800	1.30	2.59
0222	.40	86	8,000	2.10	.94
0223	1.60	86	13,300	1.60	1.63
0224	4.70	85	25,000	.60	4.57
0230	4.45	85	31,600	.60	5.51
0231	.46	85	6,000	1.00	1.13
0232	2.66	85	16,400	1.40	2.13
0240	7.76	85	34,100	.47	6.62
0241	5.68	85	39,800	.75	5.93
0242	3.07	85	22,600	1.00	3.26
0243	6.67	85	20,300	1.20	2.73
0250	10.7	85	40,600	.59	6.79
0260	7.15	85	37,500	.69	5.69
0270	7.15	85	33,400	.81	4.95
0280	9.17	85	40,600	.64	6.52
0281	1.71	83	12,700	1.49	1.49
0282	2.31	84	15,000	2.40	1.57
0290	4.08	85	28,600	.77	4.49
0291	1.41	86	13,700	1.50	1.72
0292	2.21	85	21,700	1.10	3.01
0293	2.21	86	19,400	1.30	2.45
0310	3.80	85	16,600	.66	3.14
0311	1.30	86	11,400	1.70	1.40
0312	6.40	86	23,600	.85	3.54
0313	1.40	86	18,000	1.10	2.50
0320	14.1	85	46,300	.54	7.88
0321	.60	86	8,300	1.60	1.12
0322	2.40	86	14,800	1.10	2.14
0323	1.90	86	19,000	.79	3.08
0324	3.10	86	19,800	1.00	2.83
0325	2.40	85	11,600	1.30	1.68
0326	11.8	85	48,000	.38	9.67
0327	2.80	85	20,700	.82	3.36
0330	11.5	85	48,100	.50	8.45
0331	7.70	85	24,600	.81	3.88

Table 1.--*Subbasin variables for the Willow Creek basin*--Continued

Sub-basin No.	Drainage area (A) (square miles)	Curve No. (CN)	Hydraulic length (h) (feet)	Subbasin slope (Y) (percent)	Lag time (L) (hours)
0332	3.50	86	20,400	1.20	2.65
0333	1.60	85	18,300	.71	3.27
0334	6.40	85	23,800	.71	4.04
0335	8.80	85	35,300	.68	5.65
0340	9.30	84	27,200	.96	4.00
0341	10.0	86	37,000	.70	5.58
0350	10.8	85	31,000	.81	4.67
0351	3.40	85	25,000	.56	4.73
0352	2.40	85	18,300	.87	2.96
0360	4.30	84	23,500	1.00	3.49
0810	12.6	86	62,500	.42	7.17
0811	7.42	86	29,500	.88	4.16
0812	2.57	86	16,600	2.40	1.59
0813	5.93	86	21,500	2.30	2.00
0820	17.0	86	51,000	.51	12.1
0821	4.88	86	19,600	1.10	2.68
0822	7.79	86	36,200	.77	5.23
0823	2.67	86	18,000	1.20	2.40
0824	5.88	85	27,200	1.80	2.82
0825	2.13	86	15,000	1.70	1.74
0830	27.3	85	61,600	.23	15.7
0831	7.02	86	28,300	.64	4.71
0832	3.11	85	19,800	1.10	2.80
0833	6.10	85	26,000	.77	4.16
0834	9.49	85	39,800	.50	7.26
0835	1.43	86	13,100	1.70	1.56
0836	1.10	87	13,400	1.10	1.91
0837	2.06	86	16,400	1.60	1.93
0838	2.04	87	15,400	1.80	1.86
0840	18.8	85	82,000	.34	15.7

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID     *** WILLOW CREEK WATERSHED **  ***** ** ALL RESERV IN PLACE
  2       IT       15       0       0     300
  3       IO        4
  4       JD      4.5     1.0
  5       PH       1.       0     .62    1.21    2.13    2.35    2.55      3.     3.7     4.5
  6       JD     3.04     50.
  7       JD     2.85    100.
  8       JD     2.45    300.
  9       JD     2.25    500.

 10       KK     0141 SUB-BASIN 0141
 11       BA      2.1
 12       LS        0     85.
 13       UD     2.01

 14       KK     0141TIN ROOF RESERVOIR
 15       RS        1    ELEV    100.
 16       SV        0    9.86   19.88   30.06   40.41   50.93   61.61   72.47   83.49   94.70
 17       SV   106.08  117.64  129.38  141.30
 18       SE     100.    101.    102.    103.    104.    105.    106.    107.    108.    109.
 19       SE     110.    111.    112.    113.
 20       SQ     11.2    12.0    12.8    13.5    14.2    14.9    15.5    16.1    16.9   107.3
 21       SQ    499.9  1427.5  2810.1   3000.

 22       KK     0141ROUTE TO ONE FORK
 23       RS        2    FLOW      -1
 24       RC      .06     .04     .06   13295   .0075
 25       RX        0     100     200     210     234     268     368     468
 26       RY      9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

 27       KK     0142SUB-BASIN 0142
 28       BA      2.8
 29       LS        0     85.
 30       UD     2.87

 31       KK     0142COMBINE 0141 AND 0142
 32       HC        2

 33       KK     0142ONE FORK RESERVOIR
 34       RS        1    ELEV    100.
 35       SV        0   33.60   67.51  101.71  136.21  171.01  206.12  223.78  241.53  259.35
 36       SV   277.25  295.23  313.28  324.16
 37       SE    100.0   101.0   102.0   103.0   104.0   105.0   106.0   106.5   107.0   107.5
 38       SE    108.0   108.5   109.0   109.3
 39       SL    100.8    7.07      .5      .5
 40       SS    106.5     38.     2.8     1.5

 41       KK     0142ROUTE TO HARD PAN
 42       RS        2    FLOW      -1
 43       RC      .06     .04     .06   15100   .0075
 44       RX        0     100     200     210     234     268     368     468
 45       RY      9.7     7.7     5.7       0     0.9     5.5     7.5     9.5
 46       KK     0143SUB-BASIN 0143
 47       BA     10.5
 48       LS        0     85.
 49       UD     5.75

 50       KK     0143COMBINE 0143 AND 0142
 51       HC        2

 52       KK     0143HARD PAN RESERVOIR
 53       RS        1    ELEV    100.
 54       SV        0   58.82  147.78  207.58  267.77  328.37  389.36  450.76  512.57  574.78
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  55      SV  700.43
  56      SE    97.5    98.5   100.0   101.0   102.0   103.0   104.0   105.0   106.0   107.0
  57      SE   109.0
  58      SQ       0       0       0    27.2    35.7    36.8    37.9    38.9    39.9   128.8
  59      SQ  2095.7

  60      KK    0143ROUTE TO MUDPOT
  61      RS       2    FLOW      -1
  62      RC     .06     .04     .06   21004   .0060
  63      RX       0     100     200     232     273     325     425     525
  64      RY    12.2    10.2     8.2     1.1      .0     4.3     7.3    10.3

  65      KK    0110SUB-BASIN 0110
  66      BA    11.1
  67      LS       0     81.
  68      UD    4.60

  69      KK    0110SHEEPSHED RESERVOIR
  70      RS       1    ELEV     92.
  71      SV       0   72.45  129.72  138.68  161.25  184.06  207.12  230.43  254.00  277.82
  72      SV  301.90  326.23  350.83  375.69  400.82  426.21  504.01  557.25
  73      SE    85.6    89.0    91.6    92.0    93.0    94.0    95.0    96.0    97.0    98.0
  74      SE    99.0   100.0   101.0   102.0   103.0   104.0   107.0   109.0
  75      SQ       0       0       0     4.0    14.1    14.8    15.4    16.0    16.6    17.2
  76      SQ    17.7    18.2    32.9    35.9    37.6    39.5   179.2  1311.9

  77      KK    0110ROUTE TO HALFPINT
  78      RS       2    FLOW      -1
  79      RC     .06     .04     .06   17637   .0075
  80      RX       0     100     200     210     234     268     368     468
  81      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

  82      KK    0120SUB-BASIN 0120
  83      BA     4.8
  84      LS       0     86.
  85      UD    3.77

  86      KK    0120COMBINE 0120 ABD 0110
  87      HC       2
  88      KK    0120HALFPINT RESERVOIR
  89      RS       8    ELEV    100.
  90      SV       0   28.60   77.06  126.54  177.05  202.70  228.61  254.79  281.24  307.95
  91      SV  334.94  362.20  389.74  417.55  445.64  474.02  520.01  560.85  590.00
  92      SE    92.8    94.0    96.0    98.0   100.0   101.0   102.0   103.0   104.0   105.0
  93      SE   106.0   107.0   108.0   109.0   110.0   111.0   112.0   114.0   115.0
  94      SQ       0       0       0       0       0    32.4    55.8    57.0    58.2    59.4
  95      SQ    60.6    61.7    62.9    64.0    65.0    66.1    67.1   380.3   887.4

  96      KK    0120ROUTE TO CAMP
  97      RS       2    FLOW      -1
  98      RC     .06     .04     .06    9768   .0075
  99      RX       0     100     200     210     234     268     368     468
 100      RY     9.7     7.7     5.7      .0     0.9     5.5     7.5     9.5

 101      KK    0130SUB-BASIN 0130
 102      BA     3.8
 103      LS       0     83.
 104      UD    2.36

 105      KK    0130COMBINE 0130 AND 0120
 106      HC       2

 107      KK    0130CAMP RESERVOIR
 108      RS       1    ELEV    100.
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
109	SV	0	95.92	193.25	217.81	267.20	316.95	367.06	417.54	468.39	519.61
110	SV	571.20	623.16	675.50	728.22	781.32					
111	SE	95.5	97.5	99.5	100.0	101.0	102.0	103.0	104.0	105.0	106.0
112	SE	107.0	108.0	109.0	110.0	111.0					
113	SQ	0	0	0	0	32.4	84.7	143.0	168.0	171.0	175.0
114	SQ	179.0	182.0	223.0	799.1	2109.5					
115	KK	0130ROUTE TO MUDPOT									
116	RS	2	FLOW	-1							
117	RC	.06	.04	.06	23027	.0060					
118	RX	0	100	200	232	273	325	425	525.		
119	RY	12.2	10.2	8.2	1.1	0	4.3	7.3	10.3		
120	KK	0146SUB-BASIN 0146									
121	BA	4.4									
122	LS	0	78.								
123	UD	3.21									
124	KK	0146 UPPER SOUTH FORK RESERVOIR									
125	RS	1	ELEV	100.							
126	SV	.0	3.2	9.7	16.7	24.1	29.9	38.0	46.5	55.5	65.0
127	SV	75.0	87.0								
128	SE	99.0	100.0	102.	104.	106.	108.	110.	112.	114.	116.
129	SE	118.	120.								
130	SL	101.	7.1	.5	.5						
131	SS	116.	69.	2.8	1.5						
132	KK	0146 ROUTE TO DESERT									
133	RS	2	FLOW	-1							
134	RC	.06	.04	.06	12500	.0075					
135	RX	.0	100.	200.	210.	234.	268.	368.	468.		
136	RY	9.7	7.7	5.7	.0	.9	5.5	7.5	9.5		
137	KK	0145 SUB-BASIN 0145									
138	BA	4.3									
139	LS	0	80.								
140	UD	2.29									
141	KK	0145 COMBINE 0146 AND 0145									
142	HC	2									
143	KK	0145 DESERT RESERVIOR									
144	RS	1	ELEV	87.5							
145	SV	.0	94.7	190.9	288.4	387.5	487.9	589.9	667.3	771.9	878.0
146	SV	985.6	1094.7	1205.5	1267.1	1374.6	1489.3	1605.6	1723.6	1789.2	
147	SE	86.5	88.5	90.5	92.5	94.5	96.5	98.5	100.0	102.	104.
148	SE	106.0	108.	110.	111.1	113.	115.	117.	119.	120.1	
149	SQ	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
150	SQ	.0	.0	.0	.0	119.	336.	617.	950.	1135.0	
151	KK	WSAA01 PRIVATE NO. 1									
152	RS	1	ELEV	0.0							
153	SV	.0	5.97	12.07	18.29	24.64	31.13				
154	SE	0.	1.	2.	3.	4.	5.				
155	SQ	0.	0.	142.	614.	1869.	3626.				
156	KK	WSAA02 PRIVATE NO. 1									
157	RS	1	ELEV	0.0							
158	SV	.0	5.97	12.07	18.29	24.64	31.13				
159	SE	0.	1.	2.	3.	4.	5.				
160	SQ	0.	0.	142.	614.	1869.	3626.				
161	KK	WSAA03 PRIVATE NO. 1									
162	RS	1	ELEV	0.0							
163	SV	.0	5.97	12.07	18.29	24.64	31.13				

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 164      SE       0.       1.       2.       3.       4.       5.
 165      SQ       0.       0.     142.     614.    1869.    3626.

 166      KK   WSAA04 PRIVATE NO. 1
 167      RS        1    ELEV     0.0
 168      SV       .0    5.97   12.07    18.29    24.64    31.13
 169      SE       0.       1.       2.       3.       4.       5.
 170      SQ       0.       0.     142.     614.    1869.    3626.

 171      KK   WSAA05 PRIVATE NO. 1
 172      RS        1    ELEV     0.0
 173      SV       .0    5.97   12.07    18.29    24.64    31.13
 174      SE       0.       1.       2.       3.       4.       5.
 175      SQ       0.       0.     142.     614.    1869.    3626.
 176      KK   WSAA06 PRIVATE NO. 1
 177      RS        1    ELEV     0.0
 178      SV       .0    5.97   12.07    18.29    24.64    31.13
 179      SE       0.       1.       2.       3.       4.       5.
 180      SQ       0.       0.     142.     614.    1869.    3626.

 181      KK   WSAA07 PRIVATE NO. 1
 182      RS        1    ELEV     0.0
 183      SV       .0    5.97   12.07    18.29    24.64    31.13
 184      SE       0.       1.       2.       3.       4.       5.
 185      SQ       0.       0.     142.     614.    1869.    3626.

 186      KK   WSAA08 PRIVATE NO. 1
 187      RS        1    ELEV     0.0
 188      SV       .0    5.97   12.07    18.29    24.64    31.13
 189      SE       0.       1.       2.       3.       4.       5.
 190      SQ       0.       0.     142.     614.    1869.    3626.

 191      KK   WSAA09 PRIVATE NO. 1
 192      RS        1    ELEV     0.0
 193      SV       .0    5.97   12.07    18.29    24.64    31.13
 194      SE       0.       1.       2.       3.       4.       5.
 195      SQ       0.       0.     142.     614.    1869.    3626.

 196      KK   WSAA10 PRIVATE NO. 1
 197      RS        1    ELEV     0.0
 198      SV       .0    5.97   12.07    18.29    24.64    31.13
 199      SE       0.       1.       2.       3.       4.       5.
 200      SQ       0.       0.     142.     614.    1869.    3626.

 201      KK   WSAA11 PRIVATE NO. 1
 202      RS        1    ELEV     0.0
 203      SV       .0    5.97   12.07    18.29    24.64    31.13
 204      SE       0.       1.       2.       3.       4.       5.
 205      SQ       0.       0.     142.     614.    1869.    3626.

 206      KK   WSAA12 PRIVATE NO. 1
 207      RS        1    ELEV     0.0
 208      SV       .0    5.97   12.07    18.29    24.64    31.13
 209      SE       0.       1.       2.       3.       4.       5.
 210      SQ       0.       0.     142.     614.    1869.    3626.

 211      KK   WSAA13 PRIVATE NO. 1
 212      RS        1    ELEV     0.0
 213      SV       .0    5.97   12.07    18.29    24.64    31.13
 214      SE       0.       1.       2.       3.       4.       5.
 215      SQ       0.       0.     142.     614.    1869.    3626.

 216      KK   WSAA14 PRIVATE NO. 1
 217      RS        1    ELEV     0.0
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8
218	SV	.0	5.97	12.07	18.29	24.64	31.13		
219	SE	0.	1.	2.	3.	4.	5.		
220	SQ	0.	0.	142.	614.	1869.	3626.		
221	KK	0144SUB-BASIN 0144							
222	BA	4.							
223	LS	0	81.						
224	UD	2.59							
225	KK	0144 COMBINE 0145 AND 0144							
226	HC	2							
227	KK	0144 ROUTE TO MUDPOT							
228	RS	2	FLOW	-1					
229	RC	.06	.04	.06	18139.	.0060			
230	RX	.0	100.	200.	232.	273.	325.	425.	525.
231	RY	12.2	10.2	8.2	1.1	.0	4.3	7.3	10.3
232	KK	WSAA01 PRIVATE NO. 2							
233	RS	1	ELEV	0.0					
234	SV	.0	4.91	9.94	15.09	20.35	25.73		
235	SE	0.	1.	2.	3.	4.	5.		
236	SQ	0.	0.	142.	614.	1869.	3626.		
237	KK	WSAA02 PRIVATE NO. 2							
238	RS	1	ELEV	0.0					
239	SV	.0	4.91	9.94	15.09	20.35	25.73		
240	SE	0.	1.	2.	3.	4.	5.		
241	SQ	0.	0.	142.	614.	1869.	3626.		
242	KK	WSAA03 PRIVATE NO. 2							
243	RS	1	ELEV	0.0					
244	SV	.0	4.91	9.94	15.09	20.35	25.73		
245	SE	0.	1.	2.	3.	4.	5.		
246	SQ	0.	0.	142.	614.	1869.	3626.		
247	KK	WSAA04 PRIVATE NO. 2							
248	RS	1	ELEV	0.0					
249	SV	.0	4.91	9.94	15.09	20.35	25.73		
250	SE	0.	1.	2.	3.	4.	5.		
251	SQ	0.	0.	142.	614.	1869.	3626.		
252	KK	WSAA05 PRIVATE NO. 2							
253	RS	1	ELEV	0.0					
254	SV	.0	4.91	9.94	15.09	20.35	25.73		
255	SE	0.	1.	2.	3.	4.	5.		
256	SQ	0.	0.	142.	614.	1869.	3626.		
257	KK	WSAA06 PRIVATE NO. 2							
258	RS	1	ELEV	0.0					
259	SV	.0	4.91	9.94	15.09	20.35	25.73		
260	SE	0.	1.	2.	3.	4.	5.		
261	SQ	0.	0.	142.	614.	1869.	3626.		
262	KK	WSAA07 PRIVATE NO. 2							
263	RS	1	ELEV	0.0					
264	SV	.0	4.91	9.94	15.09	20.35	25.73		
265	SE	0.	1.	2.	3.	4.	5.		
266	SQ	0.	0.	142.	614.	1869.	3626.		
267	KK	WSAA08 PRIVATE NO. 2							
268	RS	1	ELEV	0.0					
269	SV	.0	4.91	9.94	15.09	20.35	25.73		
270	SE	0.	1.	2.	3.	4.	5.		
271	SQ	0.	0.	142.	614.	1869.	3626.		

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 272       KK   WSAA09 PRIVATE NO. 2
 273       RS        1    ELEV     0.0
 274       SV       .0    4.91    9.94   15.09   20.35   25.73
 275       SE       0.      1.      2.      3.      4.      5.
 276       SQ       0.      0.    142.    614.   1869.   3626.

 277       KK   WSAA10 PRIVATE NO. 2
 278       RS        1    ELEV     0.0
 279       SV       .0    4.91    9.94   15.09   20.35   25.73
 280       SE       0.      1.      2.      3.      4.      5.
 281       SQ       0.      0.    142.    614.   1869.   3626.

 282       KK   WSAA11 PRIVATE NO. 2
 283       RS        1    ELEV     0.0
 284       SV       .0    4.91    9.94   15.09   20.35   25.73
 285       SE       0.      1.      2.      3.      4.      5.
 286       SQ       0.      0.    142.    614.   1869.   3626.

 287       KK   WSAA12 PRIVATE NO. 2
 288       RS        1    ELEV     0.0
 289       SV       .0    4.91    9.94   15.09   20.35   25.73
 290       SE       0.      1.      2.      3.      4.      5.
 291       SQ       0.      0.    142.    614.   1869.   3626.

 292       KK   WSAA13 PRIVATE NO. 2
 293       RS        1    ELEV     0.0
 294       SV       .0    4.91    9.94   15.09   20.35   25.73
 295       SE       0.      1.      2.      3.      4.      5.
 296       SQ       0.      0.    142.    614.   1869.   3626.

 297       KK   WSAA14 PRIVATE NO. 2
 298       RS        1    ELEV     0.0
 299       SV       .0    4.91    9.94   15.09   20.35   25.73
 300       SE       0.      1.      2.      3.      4.      5.
 301       SQ       0.      0.    142.    614.   1869.   3626.

 302       KK   WSAA15 PRIVATE NO. 2
 303       RS        1    ELEV     0.0
 304       SV       .0    4.91    9.94   15.09   20.35   25.73
 305       SE       0.      1.      2.      3.      4.      5.
 306       SQ       0.      0.    142.    614.   1869.   3626.
 307       KK   WSAA01 PRIVATE NO. 3
 308       RS        1    ELEV     0.0
 309       SV       .0    4.30    8.71   13.23   17.86   22.61
 310       SE       0.      1.      2.      3.      4.      5.
 311       SQ       0.      0.    142.    614.   1869.   3626.

 312       KK   WSAA02 PRIVATE NO. 3
 313       RS        1    ELEV     0.0
 314       SV       .0    4.30    8.71   13.23   17.86   22.61
 315       SE       0.      1.      2.      3.      4.      5.
 316       SQ       0.      0.    142.    614.   1869.   3626.

 317       KK   WSAA03 PRIVATE NO. 3
 318       RS        1    ELEV     0.0
 319       SV       .0    4.30    8.71   13.23   17.86   22.61
 320       SE       0.      1.      2.      3.      4.      5.
 321       SQ       0.      0.    142.    614.   1869.   3626.

 322       KK   WSAA04 PRIVATE NO. 3
 323       RS        1    ELEV     0.0
 324       SV       .0    4.30    8.71   13.23   17.86   22.61
 325       SE       0.      1.      2.      3.      4.      5.
 326       SQ       0.      0.    142.    614.   1869.   3626.
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 327      KK  WSAA05 PRIVATE NO. 3
 328      RS       1    ELEV     0.0
 329      SV      .0    4.30    8.71   13.23   17.86   22.61
 330      SE      0.      1.      2.      3.      4.      5.
 331      SQ      0.      0.    142.    614.   1869.   3626.

 332      KK  WSAA06 PRIVATE NO. 3
 333      RS       1    ELEV     0.0
 334      SV      .0    4.30    8.71   13.23   17.86   22.61
 335      SE      0.      1.      2.      3.      4.      5.
 336      SQ      0.      0.    142.    614.   1869.   3626.

 337      KK  WSAA07 PRIVATE NO. 3
 338      RS       1    ELEV     0.0
 339      SV      .0    4.30    8.71   13.23   17.86   22.61
 340      SE      0.      1.      2.      3.      4.      5.
 341      SQ      0.      0.    142.    614.   1869.   3626.

 342      KK    0140 SUB-BASIN 0140
 343      BA    20.9
 344      LS       0     85.
 345      UD    5.58

 346      KK    0140 COMBINE 0140 AND 0143 AND 0130 AND 0144
 347      HC       4
 348      KK    0140 MUDPOT RESERVOIR
 349      RS       1    ELEV    100.
 350      SV      .0   202.7   406.2   610.4   815.2  1021.0  1227.4  1434.5  1642.4  1851.0
 351      SV  2060.3  2270.4  2481.3  2692.8  2905.2  3118.3
 352      SE    99.0    100.    101.    102.    103.    104.    105.    106.    107.    108.
 353      SE    109.    110.    111.    112.    113.    114.
 354      SQ      .0      .0    41.8    100.    112.    123.    133.    142.    151.    159.
 355      SQ    166.    174.    181.    349.   1135.   2411.

 356      KK    0140 ROUTE TO FOREST
 357      RS       2    FLOW      -1
 358      RC     .06     .04     .06  22544.   .0060
 359      RX      .0    100.    200.    232.    273.    325.    425.    525.
 360      RY    12.2    10.2     8.2     1.1      .0     4.3     7.3    10.3

 361      KK    0151 SUB-BASIN 0151
 362      BA      3.
 363      LS       0     86.
 364      UD    1.92

 365      KK    0151 GRAVEL HILL RESERVOIR
 366      RS       1    ELEV    100.
 367      SV      .0    31.2    67.6    92.3   117.1   167.7   194.4   219.3
 368      SE    97.2    98.5   100.0    101.    102.    104.    105.    106.
 369      SQ      .0      .0      .0    19.6    20.1    39.4   118.3   260.8

 370      KK    0151 ROUTE TO CORRAL JUNCTION NO 1
 371      RS       2    FLOW      -1
 372      RC     .06     .04     .06  10045.   .0075
 373      RX      .0    100.    200.    210.    234.    268.    368.    468.
 374      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

 375      KK    0152 SUB-BASIN 0152
 376      BA     4.3
 377      LS       0     85.
 378      UD    3.88

 379      KK    0153 SUB-BASIN 0153
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
380	BA	1.3									
381	LS	0	86.								
382	UD	1.89									
383	KK	0153 CORRAL JUNCTION EXT RESERVOIR									
384	RS	1	ELEV	100.							
385	SV	.0	3.2	9.7	16.7	24.1	38.0	46.5	55.5	65.0	87.0
386	SE	99.0	100.0	102.	104.	106.	109.	111.5	113.5	115.5	119.8
387	SL	101.	3.14	.5	.5						
388	SS	103.7	45.	2.8	1.5						
389	KK	0152 COMBINE 0153 AND 0151 AND 0152									
390	HC	3									
391	KK	0152 CORRAL JUNCTION NO 1 RESERVOIR									
392	RS	1	ELEV	100.							
393	SV	.0	47.4	76.2	104.9	133.9	163.2	192.8	222.6	283.1	313.0
394	SE	99.3	101.0	102.0	103.	104.	105.	106.	107.	109.	110.
395	SQ	.0	32.4	34.2	35.2	36.2	41.6	232.9	854.1	3364.1	5159.9
396	KK	0152 ROUTE TO CORRAL JUNCTION									
397	RS	2	FLOW	-1							
398	RC	.06	.04	.06	12690.	.0075					
399	RX	.0	100.	200.	210.	234.	268.	368.	468.		
400	RY	9.7	7.7	5.7	.0	.9	5.5	7.5	9.5		
401	KK	0154 SUB-BASIN 0154									
402	BA	4.5									
403	LS	.0	86.								
404	UD	2.69									
405	KK	0154 COMBINE 0154 AND 0152									
406	HC	2									
407	KK	0154 CORRAL JUNCTION RESERVOIR									
408	RS	1	ELEV	100.							
409	SV	.0	49.7	99.7	150.1	251.9	355.3	460.1	513.1	566.4	
410	SE	100.	101.	102.	103.	105.	107.	109.	110.	111.	
411	SQ	.0	41.8	86.8	90.4	97.4	104.	135.9	293.6	604.5	
412	KK	0155 SUB-BASIN 0155									
413	BA	2.5									
414	LS	0	80.0								
415	UD	1.46									
416	KK	0155 HALF BARREL RESERVOIR									
417	RS	1	ELEV	100.							
418	SV	.0	17.6	35.4	53.4	71.6	90.0	108.7	127.6	146.7	221.5
419	SE	100.	101.	102.	103.	104.	105.	106.	107.	108.	111.8
420	SL	101.3	4.91	.5	.5						
421	SS	107.5	48.	2.8	1.5						
422	KK	0155 ROUTE TO FOREST									
423	RS	2	FLOW	-1							
424	RC	.06	.04	.06	19498.	.0075					
425	RX	.0	100.	200.	210.	234.	268.	368.	468.		
426	RY	9.7	7.7	5.7	.0	.9	5.5	7.5	9.5		
427	KK	0150 SUB-BASIN 0150									
428	BA	7.6									
429	LS	0	84.0								
430	UD	4.66									
431	KK	0150 COMBINE 0150 AND 0154 AND 0155 AND 0140									
432	HC	4									

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
433	KK	0150	FOREST RESERVOIR								
434	RS	1	ELEV	100.							
435	SV	.0	67.6	262.1	458.6	657.2	857.8	1060.5	1316.8	1472.1	1681.1
436	SE	100.	103.	105.	107.	109.	111.	113.	115.	117.	119.
437	SL	102.2	15.2	.5	.5						
438	SS	117.4	124.	2.8	1.5						
439	KK	0164	SUB-BASIN 0164								
440	BA	1.9									
441	LS	0	86.0								
442	UD	2.22									
443	KK	0164	SHORTCREEK RESERVOIR								
444	RS	1	ELEV	100.							
445	SV	.0	11.8	23.7	35.8	48.1	60.6				
446	SE	100.	101.	102.	103.	104.	105.				
447	SQ	.0	19.8	21.9	23.8	318.9	1219.1				
448	KK	0150	COMBINE 0150 AND 0164								
449	HC	2									
450	KK	0150	ROUTE TO COLLINS								
451	RS	2	FLOW	-1							
452	RC	.06	.04	.06	19990.	.0060					
453	RX	.0	100.	200.	232.	273.	325.	425.	525.		
454	RY	12.2	10.2	8.2	1.1	.0	4.3	7.3	10.3		
455	KK	0161	SUB-BASIN 0161								
456	BA	3.1									
457	LS	0	86.								
458	UD	2.34									
459	KK	0161	SKULL RESERVOIR								
460	RS	1	ELEV	86.5							
461	SV	.0	78.5	139.4	155.1	171.1	187.2				
462	SE	83.5	89.0	93.	94.	95.	96.				
463	SQ	.0	.0	.0	85.4	313.0	656.				
464	KK	0161	ROUTE TO THREE TREE								
465	RS	2	FLOW	-1							
466	RT	.06	.04	.06	14815.	.0075					
467	RX	.0	100.	200.	210.	234.	268.	368.	468.		
468	RY	9.7	7.7	5.7	.0	.9	5.5	7.5	9.5		
469	KK	0162	SUB-BASIN 0162								
470	BA	2.0									
471	LS	0	86.								
472	UD	1.93									
473	KK	0162	YOUR NAME RESERVOIR								
474	RS	1	ELEV	100.							
475	SV	.0	.0	23.9	68.0	90.4	113.1	136.0	169.0	218.2	259.2
476	SE	100.	102.	108.	110.	111.	112.	113.	114.	116.5	118.2
477	SQ	.0	25.2	66.7	75.6	79.7	83.6	120.	138.0	840.	1530.
478	KK	0163	SUB-BASIN 0163								
479	BA	3.4									
480	LS	0	86.0								
481	UD	2.35									
482	KK	0163	COMBINE 0163 AND 0161 AND 0162								
483	HC	3									
484	KK	0163	THREE TREE RESERVOIR								
485	RS	1	ELEV	100.							

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 486      SV      .0    15.0    33.9    72.4   111.8   152.1   193.4   244.0   261.0
 487      SE    99.2   100.0   101.0    103.    105.    107.    109.    111.    112.
 488      SQ      .0      .0    41.8    70.1    79.5    87.9    95.6   127.2   338.4

 489      KK    0163 ROUTE TO COTTONWOOD
 490      RS       2    FLOW      -1
 491      RC     .06     .04     .06  12692.   .0075
 492      RX      .0    100.    200.    210.    234.    268.    368.    468.
 493      RY     9.7     7.7     5.7      .0      .9     5.5     7.5     9.5

 494      KK    0165 SUB-BASIN 0165
 495      BA     5.3
 496      LS       0    85.0
 497      UD    3.29

 498      KK    0165 COMBINE 0165 AND 0163
 499      HC       2

 500      KK    0165 COTTONWOOD RESERVOIR
 501      RS       1    ELEV    100.
 502      SV      .0    13.6   104.8   197.4   291.3   386.8   532.6   581.9
 503      SE    100.    101.    103.    105.    107.    109.    112.    113.
 504      SQ      .0    50.4    107.    119.    131.    141.   248.3   513.9

 505      KK    0166 SUB-BASIN 0166
 506      BA     4.3
 507      LS       0     83.
 508      UD    1.39

 509      KK    0166 TWO FORKS RESERVOIR
 510      RS       1    ELEV    100.
 511      SV       0    64.7   144.6   158.1   174.5   199.2   226.9   254.8   283.1
 512      SE    94.5    97.0   100.0   100.5   101.1   102.0    103.    104.    105.
 513      SL   100.8    2.95      .5      .5
 514      SS   101.1   115.0     2.8     1.5
 515      KK    0166 ROUTE TO MOUTH OF 0168
 516      RS       2    FLOW      -1
 517      RC     .06     .04     .06   9653.   .0080
 518      RX      .0    100.    200.    203.    209.    222.    322.    422.
 519      RY     6.5     4.5     2.5     2.0     0.0     2.5     4.5     6.5

 520      KK    0167 SUB-BASIN 0167
 521      BA    1.12
 522      LS       0     85.
 523      UD     .97

 524      KK    0167 CHICO RESERVOIR
 525      RS       1    ELEV    100.
 526      SV      .0    11.7    23.7    35.7    48.0    60.4    73.1    86.0    98.9   112.1
 527      SE    100.   101.0    102.    103.    104.    105.    106.    107.    108.    109.
 528      SQ      .0     15.    18.3    18.9    19.4    19.9    20.5    20.9    227.   854.7

 529      KK    0168 SUB-BASIN 0168
 530      BA    3.19
 531      LS       0     85.
 532      UD    1.53

 533      KK    0168 COMBINE 0168 AND 0167 AND 0166
 534      HC       3

 535      KK    0168 ROUTE TO COLLINS
 536      RS       2    FLOW      -1
 537      RC     .06     .04     .06  15558.   .0075
 538      RX      .0    100.    200.    210.    234.    268.    368.    468.
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 539      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

 540      KK    0160 SUB-BASIN 0160
 541      BA   10.71
 542      LS       0     85.
 543      UD    4.28

 544      KK    0160 COMBINE 0160 AND 0165 AND 0150 AND 0168
 545      HC       4

 546      KK    0160 COLLINS RESERVOIR
 547      RS       1    ELEV    100.
 548      SV      .0   125.3   251.2   377.6   760.4  1018.5  1278.9  1541.7  1674.0  1806.8
 549      SE    100.    101.    102.    103.    106.    108.    110.    112.    113.   114.0
 550      SQ      .0    58.4    183.    333.    466.    481.    495.   577.8    858.  1356.2

 551      KK    0160 ROUTE TO LONE TREE CREEK
 552      RS       2    FLOW      -1
 553      RC     .06     .04     .06  15497.   .0034
 554      RX      .0    100.    200.    230.    270.    320.    400.    600.
 555      RY    15.6    13.6    11.6     1.3      .0     1.2    11.2    15.2
 556      KK    0171 SUB-BASIN 0171
 557      BA    7.56
 558      LS       0    84.0
 559      UD    2.93

 560      KK    0171 BROWNING RESERVOIR
 561      RS       1    ELEV    100.
 562      SV      .0     .01    32.7    98.8   166.2   234.8   375.6   484.5   558.7   630.3
 563      SE    100.    101.    102.    104.    106.    108.    112.    115.    117.   118.9
 564      SL   101.5    7.07      .5      .5
 565      SS   116.1    100.     2.8     1.5

 566      KK    0171 ROUTE TO LONE TREE CREEK
 567      RS       2    FLOW      -1
 568      RC     .06     .04     .06  29154.   .0060
 569      RX      .0    100.    200.    232.    273.    325.    425.    525.
 570      RY    12.2    10.2     8.2     1.1      .0     4.3     7.3    10.3

 571      KK    0170 SUB-BASIN 0170
 572      BA    4.15
 573      LS       0     85.
 574      UD    2.74

 575      KK    0160 COMBINE 0160 AND 0171
 576      HC       3
          * ****************** END OF PAGE 1-- BUT 0200 BASIN NOT COMBINED.
          * ****************** START OF PAGE 2.

 577      KK    0282 SUB-BASIN 0282
 578      BA    2.31
 579      LS       0     84.
 580      UD    1.57

 581      KK    0282 FINNALE RESERVOIR
 582      RS       1    ELEV    94.0
 583      SV     7.3    35.7    55.4    75.8    96.9   118.6   141.1
 584      SE    87.0    90.0    92.0    94.0    96.0    98.0   100.0
 585      SQ      .0      .0      .0      .0    417.   1931.   4400.

 586      KK    0281 SUB-BASIN 0281
 587      BA    1.71
 588      LS       0     83.
 589      UD    1.49
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
590	KK	0281 RUINS RESERVOIR									
591	RS	1	ELEV	92.4							
592	SV	11.0	19.5	24.2	28.9	38.3	48.7				
593	SE	92.4	94.0	95.0	96.0	98.0	100.0				
594	SQ	.0	24.5	32.1	108.0	1930.0	6370.0				
595	KK	0281A COMBINE FINNALE AND RUINS OUTFLOW									
596	HC	2									
597	KK	0281B ROUTE TO ULT									
598	RS	2	FLOW	-1							
599	RC	.06	.04	.06	25539.	.0075					
600	RX	.0	100.	200.	210.	234.	268.	368.	468.		
601	RY	9.7	7.7	5.7	0.0	0.9	5.5	7.5	9.5		
602	KK	0280 SUB-BASIN 0280									
603	BA	9.17									
604	LS	0	85.								
605	UD	6.52									
606	KK	0280A COMBINE 0280 AND ROUTED FLOW FROM FINNALE/RUINS									
607	HC	2									
608	KK	0280 ULT RESERVOIR									
609	RS	1	ELEV	95.6	.0						
610	SV	.0	68.0	85.1	128.2	171.6	215.3	259.4	303.8		
611	SE	94.0	95.6	96.0	97.0	98.0	99.0	100.0	101.0		
612	SQ	.0	.0	38.4	425.0	1578.0	3310.0	5830.0	8950.0		
613	KK	0280B ROUTE TO TC									
614	RS	2	FLOW	-1							
615	RC	.06	.04	.06	21100.	.0075					
616	RX	.0	100.	200.	210.	234.	268.	368.	468.		
617	RY	9.7	7.7	5.7	.0	.9	5.5	7.5	9.5		
618	KK	0216 SUB-BASIN 0216									
619	BA	1.31									
620	LS	0	86.								
621	UD	1.53									
622	KK	0216 WHITETAIL RESERVOIR									
623	RS	1	ELEV	100.	.0						
624	SV	.0	13.2	20.8	36.3	52.4	60.7	69.1	77.7	86.5	95.4
625	SE	95.2	97.0	98.0	100.0	102.0	103.0	104.0	105.0	106.0	107.0
626	SQ	.0	.0	.0	.0	56.3	57.8	59.1	60.6	215.0	701.0
627	KK	0216A ROUTE TO JUNCTION WITH SO FORK LONE TREE									
628	RS	2	FLOW	-1							
629	RC	.06	.04	.06	9928.	.0080					
630	RX	.0	100.	200.	203.	209.	222.	322.	422.		
631	RY	6.5	4.5	2.5	2.0	.0	2.5	4.5	6.5		
632	KK	0280C COMBINE WITH SO FORK FLOW									
633	HC	2									
634	KK	0291 SUB-BASIN 0291									
635	BA	1.41									
636	LS	0	86.0								
637	UD	1.72									
638	KK	0291 SOB RESERVOIR									
639	RS	1	ELEV	100.0							
640	SV	.0	9.1	26.1	43.7	62.0	80.8	100.4	110.4	120.6	
641	SE	96.9	98.3	100.0	102.0	104.0	106.0	108.0	109.0	110.0	
642	SQ	.0	.0	.0	55.7	58.4	61.4	64.2	312.0	932.0	

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
643	KK	0291A ROUTE TO HORNY									
644	RS	2	FLOW	-1							
645	RC	.06	.04	.06	5223.0	.008					
646	RX	.0	100.	200.	203.0	209.	222.	322.	422.		
647	RY	6.5	4.5	2.5	2.0	.0	2.5	4.5	6.5		
648	KK	0293 SUB-BASIN 0293									
649	BA	2.21									
650	LS	0	86.0								
651	UD	2.45									
652	KK	0291B COMBINE 0293 AND ROUTED FLOW FROM SOB									
653	HC	2									
654	KK	0291 HORNY RESERVOIR									
655	RS	1	ELEV	100.0							
656	SV	.0	9.8	22.1	34.7	47.4	60.3	73.4	86.7	100.0	107.0
657	SE	97.2	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0
658	SQ	.0	.0	.0	.0	36.8	114.0	146.0	150.0	237.0	444.0
659	KK	0291C ROUTE TO JUNCTION WITH FOULWEATHER OUTFLOW									
660	RS	2	FLOW	-1							
661	RC	.06	.04	.06	22163.	.0075					
662	RX	.0	100.	200.	210.	234.	268.	368.	468.		
663	RY	9.7	7.7	5.7	.0	.9	5.5	7.5	9.5		
664	KK	0292M SUB-BASIN 0292									
665	BA	2.21									
666	LS	0	85.								
667	UD	3.01									
668	KK	0292 FOULWEATHER RESERVOIR									
669	RS	1	ELEV	100.0							
670	SV	.0	13.5	32.0	51.5	70.9	91.4	113.0	134.0	146.0	
671	SE	98.5	100.0	102.0	104.	106.0	108.0	110.0	112.0	113.0	
672	SQ	.0	.0	57.4	60.9	64.3	67.7	71.0	789.0	1600.0	
673	KK	0292A ROUTE TO JUNCTION WITH HORNY OUTFLOW									
674	RS	2	FLOW	-1							
675	RC	.06	.04	.06	16695.	.0080					
676	RX	.0	100.	200.	203.	209.	222.	322.	422.		
677	RY	6.5	4.5	2.5	2.0	.0	2.5	4.5	6.5		
678	KK	029A COMBINE ROUTED FLOW FROM HORNY W ROUTED FLOW FROM FOULWEATHER									
679	HC	2									
680	KK	0290 SUB-BASIN 0290									
681	BA	4.08									
682	LS	0	85.0								
683	UD	4.49									
684	KK	0290A COMBINE 0290 WITH COMBINED FLOW FROM HORNY AND FOULWEATHER									
685	HC	2									
686	KK	0211 SUB-BASIN 0211									
687	BA	.61									
688	LS	0	85.								
689	UD	1.06									
690	KK	0211 CLOVER RESERVOIR									
691	RS	1	ELEV	100.0							
692	SV	.0	7.5	12.4	17.3	22.4	27.6	32.9	38.4	43.9	49.6
693	SE	95.4	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0
694	SQ	.0	.0	.0	.0	.0	24.5	45.2	47.0	169.0	600.0

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 695      KK   0211A ROUTE TO HARDROCK
 696      RS       2    FLOW      -1
 697      RC     .06     .04     .06   17831    .008
 698      RX      .0    100.    200.    203.    209.    222.    322.    422.
 699      RY     6.5     4.5     2.5     2.0      .0     2.5     4.5     6.5

 700      KK    0213 SUB-BASIN 0213
 701      BA    4.83
 702      LS       0     86.
 703      UD    3.21

 704      KK   0213A COMBINE 0213 AND ROUTED FLOW FROM CLOVER
 705      HC       2

 706      KK    0212 SUB-BASIN 0212
 707      BA    1.11
 708      LS       0     86.
 709      UD    1.46

 710      KK    0212 FAWN RESERVOIR
 711      RS       1    ELEV   100.0
 712      SV     3.9     6.4     9.1    11.8    14.6    17.5    20.4    23.5
 713      SE    100.    101.    102.    103.    104.    105.    106.    107.
 714      SQ      .0    41.8    121.    139.    182.    400.    900.   1800.

 715      KK   0212A ROUTE TO HARDROCK
 716      RS       2    FLOW      -1
 717      RC     .06     .04     .06    8856   .0080
 718      RX      .0    100.    200.    203.    209.    222.    322.    422.
 719      RY     6.5     4.5     2.5      2.      .0     2.5     4.5     6.5
 720      KK   0212B COMBINE WITH ROUTED FLOW FROM CLOVER
 721      HC       2

 722      KK    0212 HARDROCK RESERVOIR
 723      RS       1    ELEV    100.
 724      SV     1.4    15.5    29.8    58.9    88.8   119.6   151.1
 725      SE    98.0    99.0   100.0    102.   104.0   106.0   108.0
 726      SQ      .0      .0      .0    152.   248.0   265.0   499.0

 727      KK   0212C ROUTE TO TC
 728      RS       2    FLOW      -1
 729      RC     .06     .04     .06  13818.   .0080
 730      RX      .0    100.    200.    203.    209.    222.    322.    422.
 731      RY     6.5     4.5     2.5     2.0      .0     2.5     4.5     6.5

 732      KK    0214 SUB-BASIN 0214
 733      BA    1.11
 734      LS       0     86.
 735      UD    1.88

 736      KK    0214 BEND RESERVOIR
 737      RS       1    ELEV    100.
 738      SV     5.5     28.    51.1     75.    99.6    125.    138.
 739      SE     96.     98.    100.    102.    104.    106.    107.
 740      SQ      .0      .0      .0    44.3    47.8     54.    346.

 741      KK   0214A ROUTE TO TC
 742      RS       2    FLOW      -1
 743      RC     .06     .04     .06  17714.   .0080
 744      RX      .0    100.    200.    203.    209.    222.    322.    422.
 745      RY     6.5     4.5     2.5     2.0      .0     2.5     4.5     6.5

 746      KK   0214A COMBINE WITH ROUTED FLOW FROM HARDROCK
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 747      HC       2

 748      KK      TC COMBINE FLOW FROM 3 MAJOR TRIBS INTO TC RESERVOIR
 749      HC       3

 750      KK    0210 SUB-BASIN 0210
 751      BA    7.47
 752      LS       0      85.
 753      UD    4.64

 754      KK      TC COMBINE 0210 WITH TRIB INFLOW TO TC
 755      HC       2

 756      KK      TC TC RESERVOIR
 757      KM        TC RESERVOIR WITH IRRIG PIPE AS PRINCIPAL SPILLWAY
 758      RS       1    STOR      .0
 759      SV      .0    16.9    97.0   219.7   367.5   540.9   750.4   998.0  1280.6  1597.6
 760      SV  1957.1  2565.0  3115.0  3565.0  4065.0  4615.0  5215.0  5815.0
 761      SE   578.0   578.5   579.5   580.5   581.5   582.5   583.5   584.5   585.5   586.5
 762      SE   587.5   589.0   590.0   591.0   592.0   593.0   594.0   595.0
 763      SQ      .0     20.     67.    112.    128.    135.    142.    149.    155.    161.

 765      KK   TCWS1 TC WATERSPREADER 1
 766      RS       1    ELEV     0.0
 767      SV     0.0    55.3   111.0   167.0   223.5   280.3
 768      SE     0.0     1.0     2.0     3.0     4.0     5.0
 769      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0

 770      KK   TCWS1 TC WATERSPREADER 1
 771      RS       1    ELEV     0.0
 772      SV     0.0    55.3   111.0   167.0   223.5   280.3
 773      SE     0.0     1.0     2.0     3.0     4.0     5.0
 774      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0

 775      KK   TCWS1 TC WATERSPREADER 1
 776      RS       1    ELEV     0.0
 777      SV     0.0    55.3   111.0   167.0   223.5   280.3
 778      SE     0.0     1.0     2.0     3.0     4.0     5.0
 779      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0

 780      KK   TCWS1TC WATERSPREADER 1
 781      RS       1    ELEV     0.0
 782      SV     0.0    55.3   111.0   167.0   223.5   280.3
 783      SE     0.0     1.0     2.0     3.0     4.0     5.0
 784      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0

 785      KK   TCWS1 TC WATERSPREADER 1
 786      RS       1    ELEV     0.0
 787      SV     0.0    55.3   111.0   167.0   223.5   280.3
 788      SE     0.0     1.0     2.0     3.0     4.0     5.0
 789      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0

 790      KK   TCWS1 TC WATERSPREADER 1
 791      RS       1    ELEV     0.0
 792      SV     0.0    55.3   111.0   167.0   223.5   280.3
 793      SE     0.0     1.0     2.0     3.0     4.0     5.0
 794      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0

 795      KK   TCWS1 TC WATERSPREADER 1--DIKE 7
 796      RS       1    ELEV     0.0
 797      SV     0.0    55.3   111.0   167.0   223.5   280.3
 798      SE     0.0     1.0     2.0     3.0     4.0     5.0
 799      SQ     0.0     0.0   142.0   614.0  1869.0  3262.0
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 800      KK   TCWS1 TC WATERSPREADER 1--DIKE 8
 801      RS       1     ELEV     0.0
 802      SV     0.0     55.3   111.0   167.0   223.5   280.3
 803      SE     0.0      1.0     2.0     3.0     4.0     5.0
 804      SQ     0.0      0.0   142.0   614.0  1869.0  3262.0
 805      KK   TCWS1 TC WATERSPREADER 1--DIKE 9
 806      RS       1     ELEV     0.0
 807      SV     0.0     55.3   111.0   167.0   223.5   280.3
 808      SE     0.0      1.0     2.0     3.0     4.0     5.0
 809      SQ     0.0      0.0   142.0   614.0  1869.0  3262.0

 810      KK   TCWS1 TC WATERSPREADER 1--DIKE 10
 811      RS       1     ELEV     0.0
 812      SV     0.0     55.3   111.0   167.0   223.5   280.3
 813      SE     0.0      1.0     2.0     3.0     4.0     5.0
 814      SQ     0.0      0.0   142.0   614.0  1869.0  3262.0

 815      KK   TCWS1 TC WATERSPREADER 1--DIKE 11
 816      RS       1     ELEV     0.0
 817      SV     0.0     55.3   111.0   167.0   223.5   280.3
 818      SE     0.0      1.0     2.0     3.0     4.0     5.0
 819      SQ     0.0      0.0   142.0   614.0  1869.0  3262.0

 820      KK   TCWS1 TC WATERSPREADER 1--DIKE12
 821      RS       1     ELEV     0.0
 822      SV     0.0     55.3   111.0   167.0   223.5   280.3
 823      SE     0.0      1.0     2.0     3.0     4.0     5.0
 824      SQ     0.0      0.0   142.0   614.0  1869.0  3262.0

 825      KK    0241 SUB-BASIN 0241
 826      BA    5.68
 827      LS       0      85.
 828      UD    5.93

 829      KK    0241 TWIN FORKS RESERVOIR
 830      RS       1     ELEV    100.
 831      SV    2.29     48.6    95.8   144.1   193.4   243.7   295.1   347.6
 832      SE    100.     102.    104.    106.    108.    110.    112.    114.
 833      SQ      .0     48.4    53.2    57.6    61.6    65.4   225.1   1207.

 834      KK   0241A ROUTE TO TC SPREADER I
 835      RS       2     FLOW      -1
 836      RC     .06      .04     .06   6088.   .0075
 837      RX      .0     100.    200.    210.    234.    268.    368.    468.
 838      RY     9.7      7.7     5.7     0.0      .9     5.5     7.5     9.5

 839      KK   TCWSI COMBINE ROUTED FLOW FROM TC WITH ROUTED FLOW FROM TWIN FORKS
 840      HC       2

 841      KK    0242 SUB-BASIN 0242
 842      BA    3.07
 843      LS       0      85.
 844      UD    3.26
 845      KK    0242 DEAD HORSE RESERVOIR
 846      RS       1     ELEV    100.
 847      SV     2.9     22.2    42.2    62.9    84.3    95.2   117.6   129.1
 848      SE   100.0     102.    104.    106.    108.    109.    111.    112.
 849      SQ      .0     33.2    38.1    42.5    46.4    48.3    99.0    301.

 850      KK   0242A ROUTE TO TC SPREADER 2
 851      RS       2     FLOW     -1.
 852      RC     .06      .04     .06   6132.   .0080
 853      RX      .0     100.    200.    203.    209.    222.    322.    422.
 854      RY     6.5      4.5     2.5     2.0      .0     2.5     4.5     6.5
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9. ....10

 855       KK   TCWSI COMBINE ROUTED FLOW FROM DEAD HORSE W ROUTED FLOW FROM TC
 856       HC       2

 857       KK    0240 SUB-BASIN 0240
 858       BA    7.76
 859       LS       0      85.
 860       UD    6.62

 861       KK   TCWSI COMBINE 0240 W TCWSI INFLOW
 862       HC       2

 863       KK    0243 SUB-BASIN 0243
 864       BA    6.67
 865       LS       0      85.
 866       UD    2.73

 867       KK    0243 DOUBLE CROSS DETENTION RESERVOIR
 868       RS       1    ELEV   100.0
 869       SV    26.6   116.3   207.3   299.7   346.5   393.6   441.0   488.8   537.0   586.0
 870       SE   100.0   102.0   104.0   106.0   107.0   108.0   109.0   110.0   111.0   112.0
 871       SQ     0.0    64.2    71.2    77.6    80.6   187.0   746.0  1700.0  2937.0  4436.0

 872       KK   0243A ROUTE TO TCWSI
 873       RS       2    FLOW      -1
 874       RC     .06     .04     .06   1240.   .0080
 875       RX      .0    100.    200.    203.    209.    222.    322.    422.
 876       RY     6.5     4.5     2.5     2.0     0.0     2.5     4.5     6.5

 877       KK   TCWSI COMBINE ROUTED FLOW FROM DOUBLE CROSS W TCWSI INFLOW
 878       HC       2

 879       KK  WSAA01 DOUBLE CROSS
 880       RS       1    ELEV     0.0
 881       SV      .0   53.40   107.2   161.3   215.8   270.8
 882       SE      0.      1.      2.      3.      4.      5.
 883       SQ      0.      0.    142.    614.   1869.   3626.
 884       KK  WSAA02 DOUBLE CROSS
 885       RS       1    ELEV     0.0
 886       SV      .0   53.40   107.2   161.3   215.8   270.8
 887       SE      0.      1.      2.      3.      4.      5.
 888       SQ      0.      0.    142.    614.   1869.   3626.

 889       KK  WSAA03 DOUBLE CROSS
 890       RS       1    ELEV     0.0
 891       SV      .0   53.40   107.2   161.3   215.8   270.8
 892       SE      0.      1.      2.      3.      4.      5.
 893       SQ      0.      0.    142.    614.   1869.   3626.

 894       KK  WSAA04 DOUBLE CROSS
 895       RS       1    ELEV     0.0
 896       SV      .0   53.40   107.2   161.3   215.8   270.8
 897       SE      0.      1.      2.      3.      4.      5.
 898       SQ      0.      0.    142.    614.   1869.   3626.

 899       KK  WSAA05 DOUBLE CROSS
 900       RS       1    ELEV     0.0
 901       SV      .0   53.40   107.2   161.3   215.8   270.8
 902       SE      0.      1.      2.      3.      4.      5.
 903       SQ      0.      0.    142.    614.   1869.   3626.

 904       KK  WSAA06 DOUBLE CROSS
 905       RS       1    ELEV     0.0
 906       SV      .0   53.40   107.2   161.3   215.8   270.8
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 907      SE      0.      1.      2.      3.      4.      5.
 908      SQ      0.      0.    142.    614.   1869.   3626.

 909      KK  WSAA07 DOUBLE CROSS
 910      RS       1    ELEV     0.0
 911      SV      .0   53.40   107.2   161.3   215.8   270.8
 912      SE      0.      1.      2.      3.      4.      5.
 913      SQ      0.      0.    142.    614.   1869.   3626.

 914      KK  WSAA08 DOUBLE CROSS
 915      RS       1    ELEV     0.0
 916      SV      .0   53.40   107.2   161.3   215.8   270.8
 917      SE      0.      1.      2.      3.      4.      5.
 918      SQ      0.      0.    142.    614.   1869.   3626.

 919      KK  WSAA09 DOUBLE CROSS
 920      RS       1    ELEV     0.0
 921      SV      .0   53.40   107.2   161.3   215.8   270.8
 922      SE      0.      1.      2.      3.      4.      5.
 923      SQ      0.      0.    142.    614.   1869.   3626.

 924      KK  WSAA10 DOUBLE CROSS
 925      RS       1    ELEV     0.0
 926      SV      .0   53.40   107.2   161.3   215.8   270.8
 927      SE      0.      1.      2.      3.      4.      5.
 928      SQ      0.      0.    142.    614.   1869.   3626.
 929      KK  WSAA11 DOUBLE CROSS
 930      RS       1    ELEV     0.0
 931      SV      .0   53.40   107.2   161.3   215.8   270.8
 932      SE      0.      1.      2.      3.      4.      5.
 933      SQ      0.      0.    142.    614.   1869.   3626.

 934      KK  WSAA12 DOUBLE CROSS
 935      RS       1    ELEV     0.0
 936      SV      .0   53.40   107.2   161.3   215.8   270.8
 937      SE      0.      1.      2.      3.      4.      5.
 938      SQ      0.      0.    142.    614.   1869.   3626.

 939      KK    0250 SUB-BASIN 0250
 940      BA    10.7
 941      LS       0     85.
 942      UD    6.79

 943      KK   TCWS2 COMBINE 0250 WITH ROUTED FLOW FROM TCWSI
 944      HC       2

 945      KK   TCDRP TC DROP RESERVOIR
 946      RS       1    ELEV    100.
 947      SV    23.0    28.7    34.0    40.4    46.4
 948      SE   100.0   101.0   102.0   103.0   104.0
 949      SQ      .0    58.4   183.0   251.0   462.0
          * *********************** START PAGE 5

 950      KK    0221 SUB-BASIN 0221
 951      BA     3.0
 952      LS       0     86.
 953      UD    2.59

 954      KK    0221 UPPER LONE TREE RESERVOIR
 955      RS       1    ELEV    100.
 956      SV     0.0    8.67    17.5    26.5    44.9    63.9    83.7   104.0   114.5   140.2
 957      SE   100.0   101.0   102.0   103.0   105.0   107.0   109.0   111.0   112.0   114.0
 958      SL   101.0    3.14      .5      .5
 959      SS   111.5    48.0     2.8     1.5
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 960      KK     0225 COWBELL RESERVOIR
 961      RS        1     ELEV     100.
 962      SV      0.0      2.9      6.1      9.6     13.3     17.3     19.5
 963      SE    100.0    102.0    104.0    106.0    108.0    110.0    111.0
 964      SQ      0.0     12.6     28.9     39.3     69.9     854.    1632.

 965      KK     0225 DIVERT SPILLWAY FLOWS INTO SW BURNETT
 966      DT   DIVERT
 967      DI     28.9     39.3     69.9     854.    1632.
 968      DQ      7.1     11.1     36.6     816.    1592.
          * ****************************************************
 969      KK     0222 SUB-BASIN 0222
 970      BA      0.4
 971      LS        0      86.
 972      UD     0.94

 973      KK     0222 BUGLE RESERVOIR
 974      RS        1     ELEV     100.
 975      SV       0.      1.8      7.2     12.9     19.0     25.5     32.4     37.8
 976      SE     99.3    100.0    102.0    104.0    106.0    108.0    110.0    111.5
 977      SQ      0.0      0.0     25.2     66.6     96.1    118.0    327.0    605.0

 978      KK     0223 SUB-BASIN 0223
 979      BA     1.60
 980      LS        0      86.
 981      UD     1.63

 982      KK     0225 RETRIEVE FLOW DIVERTED FROM COWBELL
 983      DR   DIVERT

 984      KK     0223 COMBINE 0222 AND 0223 AND DIVERT FLOW
 985      HC        3

 986      KK     0223 SW BURNETT RESERVOIR
 987      RS        1     ELEV     100.
 988      SV       0.     26.0     52.8     80.3    108.6    148.1
 989      SE     100.     102.     104.     106.     108.    110.7
 990      SL    101.5     7.07       .5       .5
 991      SS    108.9      45.      2.8      1.5

 992      KK     0223 COMBINE 0223 AND 0225 (NON-SPILL FLOW FROM COWBELL)
 993      HC        2

 994      KK     0224SUB-BASIN 0224
 995      BA     4.70
 996      LS        0      85.
 997      UD     4.57

 998      KK     0224 NW BURNETT RESERVOIR
 999      RS        1     ELEV     100.
1000      SV     3.65     77.3    152.1    228.2    305.6    344.8
1001      SE     100.    102.0    104.0    106.0    108.0    109.0
1002      SQ      0.0     50.4     87.3    113.0    767.0   1307.0

1003      KK     0224 COMBINE 0224 AND 0223
1004      HC        2

1005      KK     0220 SUB-BASIN 0220
1006      BA     6.60
1007      LS        0      84.
1008      UD     3.82
1009      KK     0220 COMBINE 0220 AND 0224
1010      HC        2
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
1011	KK	WSAA01	BURNETT								
1012	RS	1	ELEV	0.0							
1013	SV	.0	59.48	119.36	179.64	240.31	301.38				
1014	SE	0.	1.	2.	3.	4.	5.				
1015	SQ	0.	0.	142.	614.	1869.	3626.				
1016	KK	WSAA02	BURNETT								
1017	RS	1	ELEV	0.0							
1018	SV	.0	59.48	119.36	179.64	240.31	301.38				
1019	SE	0.	1.	2.	3.	4.	5.				
1020	SQ	0.	0.	142.	614.	1869.	3626.				
1021	KK	WSAA03	BURNETT								
1022	RS	1	ELEV	0.0							
1023	SV	.0	59.48	119.36	179.64	240.31	301.38				
1024	SE	0.	1.	2.	3.	4.	5.				
1025	SQ	0.	0.	142.	614.	1869.	3626.				
1026	KK	WSAA04	BURNETT								
1027	RS	1	ELEV	0.0							
1028	SV	.0	59.48	119.36	179.64	240.31	301.38				
1029	SE	0.	1.	2.	3.	4.	5.				
1030	SQ	0.	0.	142.	614.	1869.	3626.				
1031	KK	WSAA05	BURNETT								
1032	RS	1	ELEV	0.0							
1033	SV	.0	59.48	119.36	179.64	240.31	301.38				
1034	SE	0.	1.	2.	3.	4.	5.				
1035	SQ	0.	0.	142.	614.	1869.	3626.				
1036	KK	WSAA06	BURNETT								
1037	RS	1	ELEV	0.0							
1038	SV	.0	59.48	119.36	179.64	240.31	301.38				
1039	SE	0.	1.	2.	3.	4.	5.				
1040	SQ	0.	0.	142.	614.	1869.	3626.				
1041	KK	WSAA07	BURNETT								
1042	RS	1	ELEV	0.0							
1043	SV	.0	59.48	119.36	179.64	240.31	301.38				
1044	SE	0.	1.	2.	3.	4.	5.				
1045	SQ	0.	0.	142.	614.	1869.	3626.				
1046	KK	WSAA08	BURNETT								
1047	RS	1	ELEV	0.0							
1048	SV	.0	59.48	119.36	179.64	240.31	301.38				
1049	SE	0.	1.	2.	3.	4.	5.				
1050	SQ	0.	0.	142.	614.	1869.	3626.				
1051	KK	WSAA09	BURNETT								
1052	RS	1	ELEV	0.0							
1053	SV	.0	59.48	119.36	179.64	240.31	301.38				
1054	SE	0.	1.	2.	3.	4.	5.				
1055	SQ	0.	0.	142.	614.	1869.	3626.				
1056	KK	WSAA10	BURNETT								
1057	RS	1	ELEV	0.0							
1058	SV	.0	59.48	119.36	179.64	240.31	301.38				
1059	SE	0.	1.	2.	3.	4.	5.				
1060	SQ	0.	0.	142.	614.	1869.	3626.				
1061	KK	WSAA11	BURNETT								
1062	RS	1	ELEV	0.0							
1063	SV	.0	59.48	119.36	179.64	240.31	301.38				
1064	SE	0.	1.	2.	3.	4.	5.				

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1065      SQ      0.      0.    142.    614.   1869.   3626.

1066      KK   WSAA12 BURNETT
1067      RS       1    ELEV     0.0
1068      SV      .0   59.48  119.36  179.64  240.31  301.38
1069      SE      0.      1.      2.      3.      4.      5.
1070      SQ      0.      0.    142.    614.   1869.   3626.

1071      KK   WSAA13 BURNETT
1072      RS       1    ELEV     0.0
1073      SV      .0   59.48  119.36  179.64  240.31  301.38
1074      SE      0.      1.      2.      3.      4.      5.
1075      SQ      0.      0.    142.    614.   1869.   3626.

1076      KK   WSAA14 BURNETT
1077      RS       1    ELEV     0.0
1078      SV      .0   59.48  119.36  179.64  240.31  301.38
1079      SE      0.      1.      2.      3.      4.      5.
1080      SQ      0.      0.    142.    614.   1869.   3626.

1081      KK   WSAA15 BURNETT
1082      RS       1    ELEV     0.0
1083      SV      .0   59.48  119.36  179.64  240.31  301.38
1084      SE      0.      1.      2.      3.      4.      5.
1085      SQ      0.      0.    142.    614.   1869.   3626.

1086      KK   WSAA16 BURNETT
1087      RS       1    ELEV     0.0
1088      SV      .0   59.48  119.36  179.64  240.31  301.38
1089      SE      0.      1.      2.      3.      4.      5.
1090      SQ      0.      0.    142.    614.   1869.   3626.

1091      KK   WSAA17 BURNETT
1092      RS       1    ELEV     0.0
1093      SV      .0   59.48  119.36  179.64  240.31  301.38
1094      SE      0.      1.      2.      3.      4.      5.
1095      SQ      0.      0.    142.    614.   1869.   3626.
1096      KK     0220 LOWER BURNETT HEADCUT RESERVOIR
1097      RS       1    ELEV     96.
1098      SV    19.0   146.2   210.5   275.1   405.7   537.9   671.8
1099      SE    96.0    98.0    99.0   100.0   102.0   104.0   106.0
1100      SQ     0.0    50.0    76.1   122.0   253.0   809.0  1741.0
          * ******************* END OF PAGE 5 -- RETURN TO PAGE 2

1101      KK     0231 SUB-BASIN 0231
1102      BA    0.46
1103      LS       0     85.
1104      UD    1.13

1105      KK     0220 COMBINE FLOW FROM BENNETT WITH FLOW FROM 0231
1106      HC       2

1107      KK     0231 WAGON WHEELS RESERVOIR
1108      RS       1    ELEV   100.0
1109      SV    6.21    14.1    22.1    30.3    38.6
1110      SE   100.0   101.0   102.0   103.0   104.0
1111      SL   100.5    1.48      .5      .5
1112      SS   101.3     50.     2.8     1.5

1113      KK    0231A ROUTE TO LONE TREE DIKES
1114      RS       2    FLOW      -1
1115      RC     .06     .04     .06   7800.   .0075
1116      RX     0.0    100.    200.    210.    234.    268.    368.    468.
1117      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


1118      KK    0232 SUB-BASIN 0232
1119      BA    2.66
1120      LS       0     85.
1121      UD    2.13

1122      KK    0232 RINNIE RESERVOIR
1123      RS       1    ELEV    87.4
1124      SV     0.0    25.6    72.8   121.0   170.3   182.8   195.3   207.9   220.6   246.2
1125      SE    87.4    91.0    93.0    95.0    97.0    97.5    98.0    98.5    99.0   100.0
1126      SL    87.4    4.91      .5      .5
1127      SS    97.1    50.0     2.8     1.5

1128      KK    0232 COMBINE FLOW FROM RINNIE WITH ROUTED FLOW FROM WAGON WHEELS
1129      HC       2

1130      KK  WSAA01 LONE TREE
1131      RS       1    ELEV     0.0
1132      SV      .0    8.95   18.05   27.31   36.72   46.30
1133      SE      0.      1.      2.      3.      4.      5.
1134      SQ      0.      0.    142.    614.   1869.   3626.
1135      KK  WSAA02 LONE TREE
1136      RS       1    ELEV     0.0
1137      SV      .0    8.95   18.05   27.31   36.72   46.30
1138      SE      0.      1.      2.      3.      4.      5.
1139      SQ      0.      0.    142.    614.   1869.   3626.

1140      KK  WSAA03 LONE TREE
1141      RS       1    ELEV     0.0
1142      SV      .0    8.95   18.05   27.31   36.72   46.30
1143      SE      0.      1.      2.      3.      4.      5.
1144      SQ      0.      0.    142.    614.   1869.   3626.

1145      KK  WSAA04 LONE TREE
1146      RS       1    ELEV     0.0
1147      SV      .0    8.95   18.05   27.31   36.72   46.30
1148      SE      0.      1.      2.      3.      4.      5.
1149      SQ      0.      0.    142.    614.   1869.   3626.

1150      KK  WSAA05 LONE TREE
1151      RS       1    ELEV     0.0
1152      SV      .0    8.95   18.05   27.31   36.72   46.30
1153      SE      0.      1.      2.      3.      4.      5.
1154      SQ      0.      0.    142.    614.   1869.   3626.

1155      KK  WSAA06 LONE TREE
1156      RS       1    ELEV     0.0
1157      SV      .0    8.95   18.05   27.31   36.72   46.30
1158      SE      0.      1.      2.      3.      4.      5.
1159      SQ      0.      0.    142.    614.   1869.   3626.

1160      KK  WSAA07 LONE TREE
1161      RS       1    ELEV     0.0
1162      SV      .0    8.95   18.05   27.31   36.72   46.30
1163      SE      0.      1.      2.      3.      4.      5.
1164      SQ      0.      0.    142.    614.   1869.   3626.

1165      KK  WSAA08 LONE TREE
1166      RS       1    ELEV     0.0
1167      SV      .0    8.95   18.05   27.31   36.72   46.30
1168      SE      0.      1.      2.      3.      4.      5.
1169      SQ      0.      0.    142.    614.   1869.   3626.

1170      KK  WSAA09 LONE TREE
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1171      RS       1    ELEV     0.0
1172      SV      .0    8.95   18.05   27.31   36.72   46.30
1173      SE      0.      1.      2.      3.      4.      5.
1174      SQ      0.      0.    142.    614.   1869.   3626.

1175      KK  WSAA10 LONE TREE
1176      RS       1    ELEV     0.0
1177      SV      .0    8.95   18.05   27.31   36.72   46.30
1178      SE      0.      1.      2.      3.      4.      5.
1179      SQ      0.      0.    142.    614.   1869.   3626.
1180      KK  WSAA11 LONE TREE
1181      RS       1    ELEV     0.0
1182      SV      .0    8.95   18.05   27.31   36.72   46.30
1183      SE      0.      1.      2.      3.      4.      5.
1184      SQ      0.      0.    142.    614.   1869.   3626.

1185      KK  WSAA12 LONE TREE
1186      RS       1    ELEV     0.0
1187      SV      .0    8.95   18.05   27.31   36.72   46.30
1188      SE      0.      1.      2.      3.      4.      5.
1189      SQ      0.      0.    142.    614.   1869.   3626.

1190      KK    0230 SUB-BASIN 0230
1191      BA    4.45
1192      LS       0     85.
1193      UD    5.51

1194      KK    0230 COMBINE 0230 WITH FLOW FROM LONE TREE DIKES
1195      HC       2

1196      KK    0230 JIM DETENT RESERVOIR
1197      RS       1    ELEV    100.
1198      SV   123.8   172.1   220.7   269.7   319.1   368.8   418.8   520.1   571.2
1199      SE   100.0   101.0   102.0   103.0   104.0   105.0   106.0   108.0   109.0
1200      SQ      .0    50.4   154.0   202.0   209.0   215.0   221.0   250.0   344.0

1201      KK   TCWS2 ROUTE TO TC WSPREADER 2
1202      RS       2    FLOW      -1
1203      RC     .06     .04     .06  30619.   .0075
1204      RX      .0    100.    200.    210.    234.    269.    368.    468.
1205      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

1206      KK   TCWS2 COMBINE WITH FLOW FROM TC WATERSPREADER 1
1207      HC       2

1208      KK    GUTS ROUTE TO GUTSHOT
1209      RS       2    FLOW      -1
1210      RC     .06     .04     .06  20977.   .0075
1211      RX     0.0    100.    200.    232.    273.    325.    425.    525.
1212      RY    12.2    10.2     8.2     1.1     0.0     4.3     7.3    10.3

1213      KK    0260 SUB-BASIN 0260
1214      BA    7.15
1215      LS       0     85.
1216      UD    4.95

1217      KK    GUTS COMBINE 0260 WITH FLOW ROUTED TO GUTSHOT
1218      HC       2
1219      KK    GUTS GUTSHOT RESERVOIR
1220      RS       1    ELEV   100.0
1221      SV   421.2   687.5   956.2  1227.2  1500.7  1776.6  2054.9  2194.9  2618.8  3048.3
1222      SE   100.0   102.0   104.0   106.0   108.0   110.0   112.0   113.0   116.0   119.0
1223      SQ     0.0   183.0   211.0   221.0   231.0   240.0   249.0   253.0   468.6   2430.
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1224      KK     0200 ROUTE TO CONFLUENCE WITH COLLINS RESER OUTFLOW
1225      RS        2     FLOW       -1
1226      RC      .06      .04      .06  27035.     0060
1227      RX      0.0     100.     200.    232.     273.     325.     425.     525.
1228      RY     12.2     10.2      8.2     1.1      0.0      4.3      7.3     10.3

1229      KK     0270 SUB-BASIN 0270
1230      BA     7.15
1231      LS        0      85.
1232      UD     4.95

1233      KK     0270 COMBINE 0270 WITH ROUTED FLOW FROM GUTSHOT AND COLLINS
1234      HC        3

1235      KK     T010 ROUTE TO COMBINE POINT 10
1236      RS        2     FLOW       -1
1237      RC      .06      .04      .06  24470.    .0034
1238      RX      0.0     100.     200.    230.     270.     320.     400.     600.
1239      RY     15.6     13.6     11.6     1.3      0.0      1.2     11.2     15.2

1240      KK     0811 SUB-BASIN 0811
1241      BA     7.42
1242      LS        0      86.
1243      UD     4.16

1244      KK     0811 PEARSON DETENT RESERVOIR
1245      RS        1     ELEV    100.0
1246      SV      0.0     11.9     31.9    72.1    112.6    153.4    194.5    277.8    362.4
1247      SE     100.    101.5    102.0   103.0    104.0    105.0    106.0    108.0    110.0
1248      SQ       0.      0.0     54.9    57.1     59.3     61.3     63.3     67.2    589.0

1249      KK    0811A ROUTE TO COMBINE POINT 10
1250      RS        2     FLOW       -1
1251      RC      .06      .04      .06  13130.    .0075
1252      RX       0.     100.     200.    210.     234.     268.     368.     468.
1253      RY      9.7      7.7      5.7     0.0      0.9      5.5      7.5      9.5

1254      KK      10A COMBINE WITH ROUTED FLOW FROM COLLINS
1255      HC        2

1256      KK     0812 SUB-BASIN 0812
1257      BA     2.57
1258      LS        0      86.
1259      UD     1.59
1260      KK     0812 LORI RESERVOIR
1261      RS        1     ELEV     100.
1262      SV     64.4    107.8    151.5   195.6    239.9    284.7    329.7    375.2
1263      SE    100.0    101.0    102.0   103.0    104.0    105.0    106.0    107.0
1264      SQ      0.0     27.2     38.6    39.9     41.1    147.0    632.0   1429.0

1265      KK     0812 ROUTE TO COMBINE POINT 10
1266      RS        2     FLOW       -1
1267      RC      .06      .04      .06  24900.     .008
1268      RX       .0     100.     200.    203.     209.     222.     322.     422.
1269      RY      6.5      4.5      2.5     2.0      0.0      2.5      4.5      6.5

1270      KK      10A COMBINE WITH FLOW AT POINT 10
1271      HC        2

1272      KK     0813 SUB-BASIN 0813
1273      BA     5.93
1274      LS        0      86.
1275      UD     2.00
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
1276	KK	0813 BOMBER DETENTION RESERVOIR									
1277	KO	2	2								
1278	RS	1	ELEV	100.							
1279	SV	.0	.01	62.2	131.7	272.1	414.1	557.9	703.5	776.9	925.1
1280	SE	100.	103.1	104.0	105.0	107.0	109.0	111.0	113.0	114.0	116.0
1281	SQ	0.0	51.4	64.7	93.4	153.0	190.0	221.0	248.0	271.0	694.0
1282	KK	WSAA01 BOMBER									
1283	KO	2	2								
1284	RS	1	ELEV	0.0							
1285	SV	.0	2.22	4.52	6.90	9.36	11.91				
1286	SE	0.	1.	2.	3.	4.	5.				
1287	SQ	0.	0.	142.	614.	1869.	3626.				
1288	KK	WSAA02 BOMBER									
1289	KO	2	2								
1290	RS	1	ELEV	0.0							
1291	SV	.0	2.22	4.52	6.90	9.36	11.91				
1292	SE	0.	1.	2.	3.	4.	5.				
1293	SQ	0.	0.	142.	614.	1869.	3626.				
1294	KK	WSAA03 BOMBER									
1295	KO	2	2								
1296	RS	1	ELEV	0.0							
1297	SV	.0	2.22	4.52	6.90	9.36	11.91				
1298	SE	0.	1.	2.	3.	4.	5.				
1299	SQ	0.	0.	142.	614.	1869.	3626.				
1300	KK	WSAA04 BOMBER									
1301	RS	1	ELEV	0.0							
1302	SV	.0	2.22	4.52	6.90	9.36	11.91				
1303	SE	0.	1.	2.	3.	4.	5.				
1304	SQ	0.	0.	142.	614.	1869.	3626.				
1305	KK	WSAA05 BOMBER									
1306	RS	1	ELEV	0.0							
1307	SV	.0	2.22	4.52	6.90	9.36	11.91				
1308	SE	0.	1.	2.	3.	4.	5.				
1309	SQ	0.	0.	142.	614.	1869.	3626.				
1310	KK	WSAA06 BOMBER									
1311	RS	1	ELEV	0.0							
1312	SV	.0	2.22	4.52	6.90	9.36	11.91				
1313	SE	0.	1.	2.	3.	4.	5.				
1314	SQ	0.	0.	142.	614.	1869.	3626.				
1315	KK	WSAA07 BOMBER									
1316	RS	1	ELEV	0.0							
1317	SV	.0	2.22	4.52	6.90	9.36	11.91				
1318	SE	0.	1.	2.	3.	4.	5.				
1319	SQ	0.	0.	142.	614.	1869.	3626.				
1320	KK	WSAA08 BOMBER									
1321	RS	1	ELEV	0.0							
1322	SV	.0	2.22	4.52	6.90	9.36	11.91				
1323	SE	0.	1.	2.	3.	4.	5.				
1324	SQ	0.	0.	142.	614.	1869.	3626.				
1325	KK	WSAA09 BOMBER									
1326	RS	1	ELEV	0.0							
1327	SV	.0	2.22	4.52	6.90	9.36	11.91				
1328	SE	0.	1.	2.	3.	4.	5.				
1329	SQ	0.	0.	142.	614.	1869.	3626.				
1330	KK	WSAA10 BOMBER									

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1331      RS        1    ELEV     0.0
1332      SV       .0    2.22    4.52    6.90    9.36   11.91
1333      SE       0.      1.      2.      3.      4.      5.
1334      SQ       0.      0.    142.    614.   1869.   3626.

1335      KK   WSAA11 BOMBER
1336      RS        1    ELEV     0.0
1337      SV       .0    2.22    4.52    6.90    9.36   11.91
1338      SE       0.      1.      2.      3.      4.      5.
1339      SQ       0.      0.    142.    614.   1869.   3626.

1340      KK   WSAA12 BOMBER
1341      RS        1    ELEV     0.0
1342      SV       .0    2.22    4.52    6.90    9.36   11.91
1343      SE       0.      1.      2.      3.      4.      5.
1344      SQ       0.      0.    142.    614.   1869.   3626.

1345      KK   WSAA13 BOMBER
1346      RS        1    ELEV     0.0
1347      SV       .0    2.22    4.52    6.90    9.36   11.91
1348      SE       0.      1.      2.      3.      4.      5.
1349      SQ       0.      0.    142.    614.   1869.   3626.
1350      KK   WSAA14 BOMBER
1351      RS        1    ELEV     0.0
1352      SV       .0    2.22    4.52    6.90    9.36   11.91
1353      SE       0.      1.      2.      3.      4.      5.
1354      SQ       0.      0.    142.    614.   1869.   3626.

1355      KK   WSAA15 BOMBER
1356      RS        1    ELEV     0.0
1357      SV       .0    2.22    4.52    6.90    9.36   11.91
1358      SE       0.      1.      2.      3.      4.      5.
1359      SQ       0.      0.    142.    614.   1869.   3626.

1360      KK   WSAA16 BOMBER
1361      RS        1    ELEV     0.0
1362      SV       .0    2.22    4.52    6.90    9.36   11.91
1363      SE       0.      1.      2.      3.      4.      5.
1364      SQ       0.      0.    142.    614.   1869.   3626.

1365      KK   WSAA17 BOMBER
1366      RS        1    ELEV     0.0
1367      SV       .0    2.22    4.52    6.90    9.36   11.91
1368      SE       0.      1.      2.      3.      4.      5.
1369      SQ       0.      0.    142.    614.   1869.   3626.

1370      KK   WSAA18 BOMBER
1371      RS        1    ELEV     0.0
1372      SV       .0    2.22    4.52    6.90    9.36   11.91
1373      SE       0.      1.      2.      3.      4.      5.
1374      SQ       0.      0.    142.    614.   1869.   3626.

1375      KK   WSAA19 BOMBER
1376      RS        1    ELEV     0.0
1377      SV       .0    2.22    4.52    6.90    9.36   11.91
1378      SE       0.      1.      2.      3.      4.      5.
1379      SQ       0.      0.    142.    614.   1869.   3626.

1380      KK   WSAA20 BOMBER
1381      RS        1    ELEV     0.0
1382      SV       .0    2.22    4.52    6.90    9.36   11.91
1383      SE       0.      1.      2.      3.      4.      5.
1384      SQ       0.      0.    142.    614.   1869.   3626.
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1385      KK  WSAA21 BOMBER
1386      RS       1    ELEV     0.0
1387      SV      .0    2.22    4.52    6.90    9.36   11.91
1388      SE      0.      1.      2.      3.      4.      5.
1389      SQ      0.      0.    142.    614.   1869.   3626.

1390      KK  WSAA22 BOMBER
1391      RS       1    ELEV     0.0
1392      SV      .0    2.22    4.52    6.90    9.36   11.91
1393      SE      0.      1.      2.      3.      4.      5.
1394      SQ      0.      0.    142.    614.   1869.   3626.
1395      KK  WSAA23 BOMBER
1396      RS       1    ELEV     0.0
1397      SV      .0    2.22    4.52    6.90    9.36   11.91
1398      SE      0.      1.      2.      3.      4.      5.
1399      SQ      0.      0.    142.    614.   1869.   3626.

1400      KK  WSAA24 BOMBER
1401      KO       2       2
1402      RS       1    ELEV     0.0
1403      SV      .0    2.22    4.52    6.90    9.36   11.91
1404      SE      0.      1.      2.      3.      4.      5.
1405      SQ      0.      0.    142.    614.   1869.   3626.

1406      KK  WSAA01 INVER SPREADER
1407      RS       1    ELEV     0.0
1408      SV      .0   21.27   42.77   64.51   86.49  108.71
1409      SE      0.      1.      2.      3.      4.      5.
1410      SQ      0.      0.    142.    614.   1869.   3626.

1411      KK  WSAA02 INVER SPREADER
1412      RS       1    ELEV     0.0
1413      SV      .0   21.27   42.77   64.51   86.49  108.71
1414      SE      0.      1.      2.      3.      4.      5.
1415      SQ      0.      0.    142.    614.   1869.   3626.

1416      KK  WSAA03 INVER SPREADER
1417      RS       1    ELEV     0.0
1418      SV      .0   21.27   42.77   64.51   86.49  108.71
1419      SE      0.      1.      2.      3.      4.      5.
1420      SQ      0.      0.    142.    614.   1869.   3626.

1421      KK  WSAA04 INVER SPREADER
1422      RS       1    ELEV     0.0
1423      SV      .0   21.27   42.77   64.51   86.49  108.71
1424      SE      0.      1.      2.      3.      4.      5.
1425      SQ      0.      0.    142.    614.   1869.   3626.

1426      KK  WSAA05 INVER SPREADER
1427      RS       1    ELEV     0.0
1428      SV      .0   21.27   42.77   64.51   86.49  108.71
1429      SE      0.      1.      2.      3.      4.      5.
1430      SQ      0.      0.    142.    614.   1869.   3626.

1431      KK  WSAA06 INVER SPREADER
1432      RS       1    ELEV     0.0
1433      SV      .0   21.27   42.77   64.51   86.49  108.71
1434      SE      0.      1.      2.      3.      4.      5.
1435      SQ      0.      0.    142.    614.   1869.   3626.
1436      KK  WSAA07 INVER SPREADER
1437      RS       1    ELEV     0.0
1438      SV      .0   21.27   42.77   64.51   86.49  108.71
1439      SE      0.      1.      2.      3.      4.      5.
1440      SQ      0.      0.    142.    614.   1869.   3626.
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


1441      KK   0813A ROUTE TO COMBINE POINT 10
1442      RS       2    FLOW      -1
1443      RC     .06     .04     .06   7480.   .0075
1444      RX     0.0    100.    200.    210.    234.    268.    368.    468.
1445      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

1446      KK     10C COMBINE WITH FLOW AT POINT 10
1447      HC       2

1448      KK    0824 SUB-BASIN 0824
1449      BA    5.88
1450      LS       0     85.
1451      UD    2.82

1452      KK    0824 TARGET RESERVOIR
1453      RS       1    ELEV    100.
1454      SV     0.0    38.3   102.5   167.1   297.5   429.6   563.4   630.9
1455      SE   100.0   101.0   102.0   103.0   105.0   107.0   109.0   110.0
1456      SQ     0.0    32.4   121.0   146.0   183.0   212.0   318.0   519.0

1457      KK   0824A ROUTE TO COMBINE POINT 10
1458      RS       2    FLOW      -1
1459      RC     .06     .04     .06   6950.   .0075
1460      RX     0.0    100.    200.    210.    234.    268.    368.    468.
1461      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

1462      KK     10A COMBINE WITH FLOW AT POINT 10
1463      HC       2

1464      KK   10T20 ROUTE TO COMBINE POINT 20
1465      RS       2    FLOW      -1
1466      RC     .06     .04     .06  44748.   .0034
1467      RX     0.0    100.    200.    230.    270.    320.    400.    600.
1468      RY    15.6    13.6    11.6     1.3     0.0     1.2    11.2    15.2

1469      KK    0825 SUB-BASIN 0825
1470      BA    2.13
1471      LS       0     86.
1472      UD    1.74

1473      KK    0825 SKEETER DETENTION RESERVOIR
1474      RS       1    ELEV    100.
1475      SV    18.6    37.4    56.4    75.7    95.2   114.9   134.8   154.0   175.4   196.1
1476      SE   100.0   101.0   102.0   103.0   104.0   105.0   106.0   107.0   108.0   109.0
1477      SQ     0.0    21.4    28.0    28.9    29.8    30.7    31.5    32.9   228.0   838.0
1478      KK   0825A ROUTE TO COMBINE POINT 20
1479      RS       2    FLOW      -1
1480      RC     .06     .04     .06  40590.   .0080
1481      RX     0.0    100.    200.    203.    209.    222.    322.    422.
1482      RY     6.5     4.5     2.5     2.0     0.0     2.5     4.5     6.5

1483      KK     20A COMBINE ROUTED FLOW FROM SKEETER WITH ROUTED FLOW FROM 10
1484      HC       2

1485      KK    0821 SUB-BASIN 0821
1486      BA    4.88
1487      LS       0     86.
1488      UD    2.68

1489      KK    0821 DOG CREEK DETENTION RESERVOIR
1490      RS       1    ELEV    100.
1491      SV     0.0    15.7    32.0    48.9    66.4    84.5   113.0   132.7
1492      SE   100.0   102.0   104.0   106.0   108.0   110.0   113.0   115.0
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1493      SL    101.5     7.07       .5        .5
1494      SS    113.0      60.      2.8       1.5

1495      KK     0823 SUB-BASIN 0823
1496      BA     2.67
1497      LS        0     86.0
1498      UD     2.40

1499      KK     0823 COMBINE 0823 AND 0821
1500      KO        2        2
1501      HC        2

1502      KK   WSAA01 DOG CREEK
1503      KO        2        2
1504      RS        1     ELEV      0.0
1505      SV       .0    18.78    37.78    57.00    76.45    96.13
1506      SE       0.       1.       2.       3.       4.       5.
1507      SQ       0.       0.     142.     614.    1869.    3626.

1508      KK   WSAA02 DOG CREEK
1509      RS        1     ELEV      0.0
1510      SV       .0    18.78    37.78    57.00    76.45    96.13
1511      SE       0.       1.       2.       3.       4.       5.
1512      SQ       0.       0.     142.     614.    1869.    3626.

1513      KK   WSAA03 DOG CREEK
1514      RS        1     ELEV      0.0
1515      SV       .0    18.78    37.78    57.00    76.45    96.13
1516      SE       0.       1.       2.       3.       4.       5.
1517      SQ       0.       0.     142.     614.    1869.    3626.
1518      KK   WSAA04 DOG CREEK
1519      RS        1     ELEV      0.0
1520      SV       .0    18.78    37.78    57.00    76.45    96.13
1521      SE       0.       1.       2.       3.       4.       5.
1522      SQ       0.       0.     142.     614.    1869.    3626.

1523      KK   WSAA05 DOG CREEK
1524      RS        1     ELEV      0.0
1525      SV       .0    18.78    37.78    57.00    76.45    96.13
1526      SE       0.       1.       2.       3.       4.       5.
1527      SQ       0.       0.     142.     614.    1869.    3626.

1528      KK   WSAA06 DOG CREEK
1529      KO        2        2
1530      RS        1     ELEV      0.0
1531      SV       .0    18.78    37.78    57.00    76.45    96.13
1532      SE       0.       1.       2.       3.       4.       5.
1533      SQ       0.       0.     142.     614.    1869.    3626.

1534      KK   WSAA07 DOG CREEK
1535      RS        1     ELEV      0.0
1536      SV       .0    18.78    37.78    57.00    76.45    96.13
1537      SE       0.       1.       2.       3.       4.       5.
1538      SQ       0.       0.     142.     614.    1869.    3626.

1539      KK   WSAA08 DOG CREEK
1540      RS        1     ELEV      0.0
1541      SV       .0    18.78    37.78    57.00    76.45    96.13
1542      SE       0.       1.       2.       3.       4.       5.
1543      SQ       0.       0.     142.     614.    1869.    3626.

1544      KK   WSAA09 DOG CREEK
1545      RS        1     ELEV      0.0
1546      SV       .0    18.78    37.78    57.00    76.45    96.13
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1547      SE      0.      1.      2.      3.      4.      5.
1548      SQ      0.      0.    142.    614.   1869.   3626.

1549      KK  WSAA10 DOG CREEK
1550      KO       2       2
1551      RS       1    ELEV     0.0
1552      SV      .0   18.78   37.78   57.00   76.45   96.13
1553      SE      0.      1.      2.      3.      4.      5.
1554      SQ      0.      0.    142.    614.   1869.   3626.

1555      KK  WSAA11 DOG CREEK
1556      RS       1    ELEV     0.0
1557      SV      .0   18.78   37.78   57.00   76.45   96.13
1558      SE      0.      1.      2.      3.      4.      5.
1559      SQ      0.      0.    142.    614.   1869.   3626.
1560      KK  WSAA12 DOG CREEK
1561      RS       1    ELEV     0.0
1562      SV      .0   18.78   37.78   57.00   76.45   96.13
1563      SE      0.      1.      2.      3.      4.      5.
1564      SQ      0.      0.    142.    614.   1869.   3626.

1565      KK  WSAA13 DOG CREEK
1566      RS       1    ELEV     0.0
1567      SV      .0   18.78   37.78   57.00   76.45   96.13
1568      SE      0.      1.      2.      3.      4.      5.
1569      SQ      0.      0.    142.    614.   1869.   3626.

1570      KK  WSAA14 DOG CREEK
1571      RS       1    ELEV     0.0
1572      SV      .0   18.78   37.78   57.00   76.45   96.13
1573      SE      0.      1.      2.      3.      4.      5.
1574      SQ      0.      0.    142.    614.   1869.   3626.

1575      KK  WSAA15 DOG CREEK
1576      RS       1    ELEV     0.0
1577      SV      .0   18.78   37.78   57.00   76.45   96.13
1578      SE      0.      1.      2.      3.      4.      5.
1579      SQ      0.      0.    142.    614.   1869.   3626.

1580      KK  WSAA16 DOG CREEK
1581      RS       1    ELEV     0.0
1582      SV      .0   18.78   37.78   57.00   76.45   96.13
1583      SE      0.      1.      2.      3.      4.      5.
1584      SQ      0.      0.    142.    614.   1869.   3626.

1585      KK  WSAA17 DOG CREEK
1586      RS       1    ELEV     0.0
1587      SV      .0   18.78   37.78   57.00   76.45   96.13
1588      SE      0.      1.      2.      3.      4.      5.
1589      SQ      0.      0.    142.    614.   1869.   3626.

1590      KK  WSAA18 DOG CREEK
1591      RS       1    ELEV     0.0
1592      SV      .0   18.78   37.78   57.00   76.45   96.13
1593      SE      0.      1.      2.      3.      4.      5.
1594      SQ      0.      0.    142.    614.   1869.   3626.

1595      KK  WSAA19 DOG CREEK
1596      RS       1    ELEV     0.0
1597      SV      .0   18.78   37.78   57.00   76.45   96.13
1598      SE      0.      1.      2.      3.      4.      5.
1599      SQ      0.      0.    142.    614.   1869.   3626.

1600      KK  WSAA20 DOG CREEK
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1601      RS       1    ELEV     0.0
1602      SV      .0   18.78   37.78   57.00   76.45   96.13
1603      SE      0.      1.      2.      3.      4.      5.
1604      SQ      0.      0.    142.    614.   1869.   3626.
1605      KK  WSAA21 DOG CREEK
1606      RS       1    ELEV     0.0
1607      SV      .0   18.78   37.78   57.00   76.45   96.13
1608      SE      0.      1.      2.      3.      4.      5.
1609      SQ      0.      0.    142.    614.   1869.   3626.

1610      KK     20A ROUTE TO COMBINE POINT 20
1611      RS       2    FLOW      -1
1612      RC     .06     .04     .06  17090.   .0075
1613      RX     0.0    100.    200.    210.    234.    268.    368.    468.
1614      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

1615      KK     20B COMBINE WITH FLOW AT POINT 20
1616      HC       2

1617      KK    0822 SUB-BASIN 0822
1618      BA    7.79
1619      LS       0     86.
1620      UD    5.23

1621      KK    0822 CACTUS FLATS DETENTION RESERVOIR
1622      RS       1    ELEV     97.
1623      SV     0.0     .01    8.39    37.0    79.2   104.8   140.0
1624      SE     97.    98.0   100.0   102.0   104.0   105.0   106.0
1625      SQ     0.0     2.7    11.6    36.0    99.0   123.0   417.0

1626      KK    0822 DIVERT SPILLWAY FLOWS AROUND SPREADERS
1627      DT  DIVERT
1628      DI    11.6    36.0    99.0   123.0   417.0
1629      DQ     0.0    11.5    65.0    85.0   375.0

1630      KK  WSAA01 CACTUS FLATS
1631      RS       1    ELEV     0.0
1632      SV      .0    7.96   10.04   15.23   20.55   25.98
1633      SE      0.      1.      2.      3.      4.      5.
1634      SQ      0.      0.    142.    614.   1869.   3626.

1635      KK  WSAA02 CACTUS FLATS
1636      RS       1    ELEV     0.0
1637      SV      .0    7.96   10.04   15.23   20.55   25.98
1638      SE      0.      1.      2.      3.      4.      5.
1639      SQ      0.      0.    142.    614.   1869.   3626.

1640      KK  WSAA03 CACTUS FLATS
1641      RS       1    ELEV     0.0
1642      SV      .0    7.96   10.04   15.23   20.55   25.98
1643      SE      0.      1.      2.      3.      4.      5.
1644      SQ      0.      0.    142.    614.   1869.   3626.
1645      KK  WSAA04 CACTUS FLATS
1646      RS       1    ELEV     0.0
1647      SV      .0    7.96   10.04   15.23   20.55   25.98
1648      SE      0.      1.      2.      3.      4.      5.
1649      SQ      0.      0.    1^2.    614.   1869.   3626.

1650      KK  WSAA05 CACTUS FLATS
1651      RS       1    ELEV     0.0
1652      SV      .0    7.96   10.04   15.23   20.55   25.98
1653      SE      0.      1.      2.      3.      4.      5.
1654      SQ      0.      0.    142.    614.   1869.   3626.
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID.......1	2	3	4	5	.......6.......7.......8.......9......10
1655	KK	WSAA06 CACTUS FLATS				
1656	RS	1	ELEV	0.0		
1657	SV	.0	7.96	10.04	15.23	20.55	25.98
1658	SE	0.	1.	2.	3.	4.	5.
1659	SQ	0.	0.	142.	614.	1869.	3626.
1660	KK	WSAA07 CACTUS FLATS				
1661	RS	1	ELEV	0.0		
1662	SV	.0	7.96	10.04	15.23	20.55	25.98
1663	SE	0.	1.	2.	3.	4.	5.
1664	SQ	0.	0.	142.	614.	1869.	3626.
1665	KK	WSAA08 CACTUS FLATS				
1666	RS	1	ELEV	0.0		
1667	SV	.0	7.96	10.04	15.23	20.55	25.98
1668	SE	0.	1.	2.	3.	4.	5.
1669	SQ	0.	0.	142.	614.	1869.	3626.
1670	KK	WSAA09 CACTUS FLATS				
1671	RS	1	ELEV	0.0		
1672	SV	.0	7.96	10.04	15.23	20.55	25.98
1673	SE	0.	1.	2.	3.	4.	5.
1674	SQ	0.	0.	142.	614.	1869.	3626.
1675	KK	WSAA10 CACTUS FLATS				
1676	RS	1	ELEV	0.0		
1677	SV	.0	7.96	10.04	15.23	20.55	25.98
1678	SE	0.	1.	2.	3.	4.	5.
1679	SQ	0.	0.	142.	614.	1869.	3626.
1680	KK	WSAA11 CACTUS FLATS				
1681	RS	1	ELEV	0.0		
1682	SV	.0	7.96	10.04	15.23	20.55	25.98
1683	SE	0.	1.	2.	3.	4.	5.
1684	SQ	0.	0.	142.	614.	1869.	3626.
1685	KK	WSAA12 CACTUS FLATS				
1686	RS	1	ELEV	0.0		
1687	SV	.0	7.96	10.04	15.23	20.55	25.98
1688	SE	0.	1.	2.	3.	4.	5.
1689	SQ	0.	0.	142.	614.	1869.	3626.
1690	KK	WSAA13 CACTUS FLATS				
1691	RS	1	ELEV	0.0		
1692	SV	.0	7.96	10.04	15.23	20.55	25.98
1693	SE	0.	1.	2.	3.	4.	5.
1694	SQ	0.	0.	142.	614.	1869.	3626.
1695	KK	WSAA14 CACTUS FLATS				
1696	RS	1	ELEV	0.0		
1697	SV	.0	7.96	10.04	15.23	20.55	25.98
1698	SE	0.	1.	2.	3.	4.	5.
1699	SQ	0.	0.	142.	614.	1869.	3626.
1700	KK	WSAA15 CACTUS FLATS				
1701	RS	1	ELEV	0.0		
1702	SV	.0	7.96	10.04	15.23	20.55	25.98
1703	SE	0.	1.	2.	3.	4.	5.
1704	SQ	0.	0.	142.	614.	1869.	3626.
1705	KK	WSAA16 CACTUS FLATS				
1706	RS	1	ELEV	0.0		
1707	SV	.0	7.96	10.04	15.23	20.55	25.98
1708	SE	0.	1.	2.	3.	4.	5.
1709	SQ	0.	0.	142.	614.	1869.	3626.

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


1710      KK   0822A RETRIEVE DIVERTED FLOW
1711      DR  DIVERT

1712      KK   0822B COMBINE DIVERTED FLOW AND SPREADER OUTFLOW
1713      HC       2

1714      KK   0822A ROUTE TO COMBINE POINT 20
1715      RS       2    FLOW      -1
1716      RC     .06     .04     .06   7130.   .0075
1717      RX     0.0    100.    200.    210.    234.    268.    368.    468.
1718      RY     9.7     7.7     5.7     0.0     0.9     5.5     7.5     9.5

1719      KK     20B COMBINE FLOW FROM CACTUS FLATS WITH FLOW AT 20
1720      HC       2

1721      KK   20T30 ROUTE TO COMBINE POINT 30
1722      RS       2    FLOW      -1
1723      RC     .06     .04     .06   9790.   .0034
1724      RX     0.0    100.    200.    230.    270.    320.    400.    600.
1725      RY    15.6    13.6    11.6     1.3     0.0     1.2    11.2    15.2
          * ********************* PAGE 4 STARTS HERE *****************

1726      KK    0321SUB-BASIN 0321
1727      BA     0.6
1728      LS       0      86
1729      UD    1.12
1730      KK    0321MOKEE RESERVOIR
1731      RS       1    ELEV    100.
1732      SV      .0    1.62   10.00   18.79   28.04   37.74   47.92   51.60
1733      SE    97.6    98.0   100.0   102.0   104.0   106.0   108.0   108.7
1734      SL   100.1     .79      .5      .5
1735      SS   100.2     30.     2.8     1.5

1736      KK    0321ROUTE TO TEEPEE
1737      RS       2    FLOW      -1
1738      RC     .06     .04     .06    5818   .0030
1739      RX       0     100     200     203     209     222     322     422
1740      RY     6.5     4.5     2.5     2.0       0     2.5     4.5     6.5

1741      KK    0323SUB-BASIN 0323
1742      BA     1.9
1743      LS       0      86
1744      UD    3.08

1745      KK    0323COMBINE 0323 AND 0321
1746      HC       2

1747      KK    0323TEEPEE RESERVOIR
1748      RS       1    ELEV    100.
1749      SV       0    9.86   19.88   30.07   40.42   61.63   83.52  106.11  132.97
1750      SE   100.0   101.0   102.0   103.0   104.0   106.0   108.0   110.0   112.3
1751      SL   100.8    1.77      .5      .5
1752      SS   108.6     37.     2.8     1.5

1753      KK    0323ROUTE TO MOCASSIN
1754      RS       2    FLOW      -1
1755      RC     .06     .04     .06   12412   .0075
1756      RX       0     100     200     210     234     268     368     468
1757      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

1758      KK    0322SUB-BASIN 0322
1759      BA     2.4
1760      LS       0      86
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
1761	UD	2.14									
1762	KK	0322BADGER RESERVOIR									
1763	RS	1	ELEV	100.							
1764	SV	0	19.8	34.20	48.78	78.53	109.09	140.47	172.68	205.75	239.69
1765	SE	98.6	100.0	101.0	102.0	104.0	106.0	108.0	110.0	112.0	114.0
1766	SL	100.8	1.77	.5	.5						
1767	SS	113.0	45.0	2.8	1.5						
1768	KK	0322ROUTE TO MOCASSIN									
1769	RS	2	FLOW	-1							
1770	RC	.06	.04	.06	14150	.0080					
1771	RX	0	100	200	203	209	222	322	422		
1772	RY	6.5	4.5	2.5	2.0	0	2.5	4.5	6.5		
1773	KK	0324SUB-BASIN 0324									
1774	BA	3.1									
1775	LS	0	86								
1776	UD	2.83									
1777	KK	0324COMBINE 0324 AND 0322 AND 0323									
1778	HC	3									
1779	KK	0324MOCASSIN RESERVOIR									
1780	RS	1	ELEV	100.							
1781	SV	0	66.60	85.12	103.85	142.01	181.07	221.07	262.02	282.85	303.92
1782	SE	96.3	100.0	101.0	102.0	104.0	106.0	108.0	110.0	111.0	112.0
1783	SQ	0	0	32.4	84.7	89.6	92.0	94.3	107.3	307.3	861.1
1784	KK	0325SUB-BASIN 0325									
1785	BA	2.4									
1786	LS	0	85								
1787	UD	1.68									
1788	KK	0325HURRICANE RESERVOIR									
1789	RS	1	ELEV	100.							
1790	SV	0	105.06	128.60	176.42	225.26	275.14	300.47	326.07	351.93	378.00
1791	SE	95.4	100.0	101.0	103.0	105.0	107.0	108.0	109.0	110.0	111.0
1792	SQ	0	0	15.0	18.7	19.6	20.5	97.3	493.5	1358.1	2506.5
1793	KK	0324COMBINE 0325 AND 0324									
1794	HC	2									
1795	KK	0324ROUTE TO BEAVERETT									
1796	RS	2	FLOW	-1							
1797	RC	.06	.04	.06	36135	.0075					
1798	RX	0	100	200	210	234	268	368	468		
1799	RY	9.7	7.7	5.7	0	0.9	5.5	7.5	9.5		
1800	KK	0313SUB-BASIN 0313									
1801	BA	1.4									
1802	LS	0	86								
1803	UD	2.50									
1804	KK	0313BEECHNUT RESERVOIR									
1805	RS	1	ELEV	100.							
1806	SV	0	10.45	21.07	31.85	48.34	59.56	70.94	82.51	93.06	
1807	SE	100.0	101.0	102.0	103.0	104.5	105.5	106.5	107.5	108.5	
1808	SL	100.8	1.77	.5	.5						
1809	SS	103.8	75.	2.8	1.5						
1810	KK	0312SUB-BASIN 0312									
1811	BA	6.4									
1812	LS	0	86								
1813	UD	3.54									

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1814      KK    0312COMBINE 0312 AND 0313
1815      HC       2

1816      KK    0312N. BEAVER RESERVOIR
1817      RS       1     ELEV    100.
1818      SV       0   25.94   52.15   78.62  132.35  187.15  243.05  271.41  300.05  319.00
1819      SE   100.0   101.0   102.0   103.0   105.0   107.0   109.0   110.0   111.0   112.0
1820      SQ       0    27.2    57.2    59.4    63.7    67.7   322.2   965.3  1976.1  3233.5

1821      KK    0312ROUTE TO HAMMS
1822      RS       2    FLOW      -1
1823      RC     .06     .04     .06   11479   .0075
1824      RX       0     100     200     210     234     268     368     468
1825      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

1826      KK    0311SUB-BASIN 0311
1827      BA     1.3
1828      LS       0      86
1829      UD    1.40

1830      KK    0311ALKALI RESERVOIR
1831      RS       1     ELEV    100.
1832      SV       0   10.90   21.96   33.20   44.61   56.20   79.90  104.34  116.83
1833      SE   100.0   101.0   102.0   103.0   104.0   105.0   107.0   109.0   110.0
1834      SL   100.8    1.77      .5      .5
1835      SS   106.9     35.     2.8     1.5

1836      KK    0311ROUTE TO HAMMS
1837      RS       2    FLOW      -1
1838      RC     .06     .04     .06   15725   .0075
1839      RX       0     100     200     210     234     268     368     468
1840      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

1841      KK    0311COMBINE 0311 AND 0312
1842      HC       2

1843      KK    0310SUB-BASIN 0310
1844      BA     3.8
1845      LS       0      85
1846      UD    3.14

1847      KK    0310COMBINE 0310 AND 0311
1848      HC       2

1849      KK    0310HAMMS RESERVOIR
1850      RS       1     ELEV    100.
1851      SV       0  127.24  228.75  296.96  365.59  434.65  504.13  609.17  750.73  807.85
1852      SE    98.1   100.0   101.5   102.5   103.5   104.5   105.5   107.0   109.0   109.8
1853      SL   101.5    7.07      .5      .5
1854      SS   104.6      60     2.8     1.5
1855      KK    0310ROUTE TO BEAVERETT
1856      RS       2    FLOW      -1
1857      RC     .06     .04     .06   30982   .0075
1858      RX       0     100     200     210     234     268     368     468
1859      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

1860      KK    0326SUB-BASIN 0326
1861      BA    11.8
1862      LS       0      85
1863      UD    9.67

1864      KK    0326COMBINE 0326 AND 0310 AND 0324
1865      HC       3
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1866      KK    0326BEAVERETT RESERVOIR
1867      RS       1    ELEV     99.
1868      SV       0  111.77  171.17  230.97  291.16  351.75  418.86
1869      SE    98.1   100.0   101.0   102.0   103.0   104.0   105.1
1870      SQ      .0     .01    25.2   434.0  1122.0  2000.0  3037.0

1871      KK    0327SUB-BASIN 0327
1872      BA     2.8
1873      LS       0      85
1874      UD    3.36

1875      KK    0327BRAZIL DIVIDE RESERVOIR
1876      RS       1    ELEV    100.
1877      SV       0  125.22  209.28  293.82  378.82  464.30  550.25  636.68  723.59  819.75
1878      SE    99.5   101.0   102.0   103.0   104.0   105.0   106.0   107.0   108.0   109.1
1879      SQ      .0     .01    39.0    64.4    81.9    96.2   149.0   255.0   392.0   554.0

1880      KK  WSAA01 BRAZIL
1881      RS       1    ELEV     0.0
1882      SV      .0    4.72    9.55   14.50   19.56   24.74
1883      SE      0.      1.      2.      3.      4.      5.
1884      SQ      0.      0.    142.    614.   1869.   3626.

1885      KK  WSAA02 BRAZIL
1886      RS       1    ELEV     0.0
1887      SV      .0    4.72    9.55   14.50   19.56   24.74
1888      SE      0.      1.      2.      3.      4.      5.
1889      SQ      0.      0.    142.    614.   1869.   3626.

1890      KK  WSAA03 BRAZIL
1891      RS       1    ELEV     0.0
1892      SV      .0    4.72    9.55   14.50   19.56   24.74
1893      SE      0.      1.      2.      3.      4.      5.
1894      SQ      0.      0.    142.    614.   1869.   3626.
1895      KK  WSAA04 BRAZIL
1896      RS       1    ELEV     0.0
1897      SV      .0    4.72    9.55   14.50   19.56   24.74
1898      SE      0.      1.      2.      3.      4.      5.
1899      SQ      0.      0.    142.    614.   1869.   3626.

1900      KK  WSAA05 BRAZIL
1901      RS       1    ELEV     0.0
1902      SV      .0    4.72    9.55   14.50   19.56   24.74
1903      SE      0.      1.      2.      3.      4.      5.
1904      SQ      0.      0.    142.    614.   1869.   3626.

1905      KK  WSAA06 BRAZIL
1906      RS       1    ELEV     0.0
1907      SV      .0    4.72    9.55   14.50   19.56   24.74
1908      SE      0.      1.      2.      3.      4.      5.
1909      SQ      0.      0.    142.    614.   1869.   3626.

1910      KK  WSAA07 BRAZIL
1911      RS       1    ELEV     0.0
1912      SV      .0    4.72    9.55   14.50   19.56   24.74
1913      SE      0.      1.      2.      3.      4.      5.
1914      SQ      0.      0.    142.    614.   1869.   3626.

1915      KK  WSAA08 BRAZIL
1916      RS       1    ELEV     0.0
1917      SV      .0    4.72    9.55   14.50   19.56   24.74
1918      SE      0.      1.      2.      3.      4.      5.
1919      SQ      0.      0.    142.    614.   1869.   3626.
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1920      KK  WSAA09 BRAZIL
1921      RS       1    ELEV     0.0
1922      SV      .0    4.72    9.55   14.50   19.56   24.74
1923      SE      0.      1.      2.      3.      4.      5.
1924      SQ      0.      0.    142.    614.   1869.   3626.

1925      KK  WSAA10 BRAZIL
1926      RS       1    ELEV     0.0
1927      SV      .0    4.72    9.55   14.50   19.56   24.74
1928      SE      0.      1.      2.      3.      4.      5.
1929      SQ      0.      0.    142.    614.   1869.   3626.

1930      KK  WSAA11 BRAZIL
1931      RS       1    ELEV     0.0
1932      SV      .0    4.72    9.55   14.50   19.56   24.74
1933      SE      0.      1.      2.      3.      4.      5.
1934      SQ      0.      0.    142.    614.   1869.   3626.

1935      KK  WSAA01 INVER DIKES
1936      RS       1    ELEV     0.0
1937      SV      .0    4.07    8.25   12.53   16.92   21.42
1938      SE      0.      1.      2.      3.      4.      5.
1939      SQ      0.      0.    142.    614.   1869.   3626.
1940      KK  WSAA02 INVER DIKES
1941      RS       1    ELEV     0.0
1942      SV      .0    4.07    8.25   12.53   16.92   21.42
1943      SE      0.      1.      2.      3.      4.      5.
1944      SQ      0.      0.    142.    614.   1869.   3626.

1945      KK  WSAA03 INVER DIKES
1946      RS       1    ELEV     0.0
1947      SV      .0    4.07    8.25   12.53   16.92   21.42
1948      SE      0.      1.      2.      3.      4.      5.
1949      SQ      0.      0.    142.    614.   1869.   3626.

1950      KK  WSAA04 INVER DIKES
1951      RS       1    ELEV     0.0
1952      SV      .0    4.07    8.25   12.53   16.92   21.42
1953      SE      0.      1.      2.      3.      4.      5.
1954      SQ      0.      0.    142.    614.   1869.   3626.

1955      KK  WSAA05 INVER DIKES
1956      RS       1    ELEV     0.0
1957      SV      .0    4.07    8.25   12.53   16.92   21.42
1958      SE      0.      1.      2.      3.      4.      5.
1959      SQ      0.      0.    142.    614.   1869.   3626.

1960      KK  WSAA06 INVER DIKES
1961      RS       1    ELEV     0.0
1962      SV      .0    4.07    8.25   12.53   16.92   21.42
1963      SE      0.      1.      2.      3.      4.      5.
1964      SQ      0.      0.    142.    614.   1869.   3626.

1965      KK  WSAA07 INVER DIKES
1966      RS       1    ELEV     0.0
1967      SV      .0    4.07    8.25   12.53   16.92   21.42
1968      SE      0.      1.      2.      3.      4.      5.
1969      SQ      0.      0.    142.    614.   1869.   3626.

1970      KK  WSAA08 INVER DIKES
1971      RS       1    ELEV     0.0
1972      SV      .0    4.07    8.25   12.53   16.92   21.42
1973      SE      0.      1.      2.      3.      4.      5.
1974      SQ      0.      0.    142.    614.   1869.   3626.
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


1975      KK   WSAA09 INVER DIKES
1976      RS        1     ELEV      0.0
1977      SV       .0     4.07     8.25    12.53    16.92    21.42
1978      SE       0.       1.       2.       3.       4.       5.
1979      SQ       0.       0.     142.     614.    1869.    3626.

1980      KK     0320SUB-BASIN 0320
1981      BA     14.1
1982      LS        0       85
1983      UD     7.88
1984      KK     0320COMBINE 0320 AND 0327 AND 0326 **BEAVERETT SPREADER FOLLOWS**
1985      HC        3

1986      KK   WSAA01 BEAVERETTE
1987      RS        1     ELEV      0.0
1988      SV       .0     7.71    15.55    23.55    31.68    39.97
1989      SE       0.       1.       2.       3.       4.       5.
1990      SQ       0.       0.     142.     614.    1869.    3626.

1991      KK   WSAA02 BEAVERETTE
1992      RS        1     ELEV      0.0
1993      SV       .0     7.71    15.55    23.55    31.68    39.97
1994      SE       0.       1.       2.       3.       4.       5.
1995      SQ       0.       0.     142.     614.    1869.    3626.

1996      KK   WSAA03 BEAVERETTE
1997      RS        1     ELEV      0.0
1998      SV       .0     7.71    15.55    23.55    31.68    39.97
1999      SE       0.       1.       2.       3.       4.       5.
2000      SQ       0.       0.     142.     614.    1869.    3626.

2001      KK   WSAA04 BEAVERETTE
2002      RS        1     ELEV      0.0
2003      SV       .0     7.71    15.55    23.55    31.68    39.97
2004      SE       0.       1.       2.       3.       4.       5.
2005      SQ       0.       0.     142.     614.    1869.    3626.

2006      KK   WSAA05 BEAVERETTE
2007      RS        1     ELEV      0.0
2008      SV       .0     7.71    15.55    23.55    31.68    39.97
2009      SE       0.       1.       2.       3.       4.       5.
2010      SQ       0.       0.     142.     614.    1869.    3626.

2011      KK   WSAA06 BEAVERETTE
2012      RS        1     ELEV      0.0
2013      SV       .0     7.71    15.55    23.55    31.68    39.97
2014      SE       0.       1.       2.       3.       4.       5.
2015      SQ       0.       0.     142.     614.    1869.    3626.

2016      KK   WSAA07 BEAVERETTE
2017      RS        1     ELEV      0.0
2018      SV       .0     7.71    15.55    23.55    31.68    39.97
2019      SE       0.       1.       2.       3.       4.       5.
2020      SQ       0.       0.     142.     614.    1869.    3626.

2021      KK   WSAA08 BEAVERETTE
2022      RS        1     ELEV      0.0
2023      SV       .0     7.71    15.55    23.55    31.68    39.97
2024      SE       0.       1.       2.       3.       4.       5.
2025      SQ       0.       0.     142.     614.    1869.    3626.
2026      KK   WSAA09 BEAVERETTE
2027      RS        1     ELEV      0.0
2028      SV       .0     7.71    15.55    23.55    31.68    39.97
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2029     SE       0.       1.       2.       3.       4.       5.
2030     SQ       0.       0.     142.     614.    1869.    3626.

2031     KK   WSAA10 BEAVERETTE
2032     RS        1     ELEV      0.0
2033     SV       .0     7.71    15.55    23.55    31.68    39.97
2034     SE       0.       1.       2.       3.       4.       5.
2035     SQ       0.       0.     142.     614.    1869.    3626.

2036     KK   WSAA11 BEAVERETTE
2037     RS        1     ELEV      0.0
2038     SV       .0     7.71    15.55    23.55    31.68    39.97
2039     SE       0.       1.       2.       3.       4.       5.
2040     SQ       0.       0.     142.     614.    1869.    3626.

2041     KK   WSAA12 BEAVERETTE
2042     RS        1     ELEV      0.0
2043     SV       .0     7.71    15.55    23.55    31.68    39.97
2044     SE       0.       1.       2.       3.       4.       5.
2045     SQ       0.       0.     142.     614.    1869.    3626.

2046     KK   WSAA13 BEAVERETTE
2047     RS        1     ELEV      0.0
2048     SV       .0     7.71    15.55    23.55    31.68    39.97
2049     SE       0.       1.       2.       3.       4.       5.
2050     SQ       0.       0.     142.     614.    1869.    3626.

2051     KK   WSAA14 BEAVERETTE
2052     RS        1     ELEV      0.0
2053     SV       .0     7.71    15.55    23.55    31.68    39.97
2054     SE       0.       1.       2.       3.       4.       5.
2055     SQ       0.       0.     142.     614.    1869.    3626.

2056     KK   WSAA15 BEAVERETTE
2057     RS        1     ELEV      0.0
2058     SV       .0     7.71    15.55    23.55    31.68    39.97
2059     SE       0.       1.       2.       3.       4.       5.
2060     SQ       0.       0.     142.     614.    1869.    3626.

2061     KK   WSAA16 BEAVERETTE
2062     RS        1     ELEV      0.0
2063     SV       .0     7.71    15.55    23.55    31.68    39.97
2064     SE       0.       1.       2.       3.       4.       5.
2065     SQ       0.       0.     142.     614.    1869.    3626.

2066     KK     0320ROUTE TO GRUB
2067     RS        2     FLOW       -1
2068     RC      .06      .04      .06    33630    .0060
2069     RX        0      100      200      232      273      325      425      525
2070     RY     12.2     10.2      8.2      1.1        0      4.3      7.3     10.3
2071     KK     0330SUB-BASIN 0330
2072     BA     11.5
2073     LS        0       85
2074     UD     8.45

2075     KK     0335SUB-BASIN 0335
2076     BA      8.8
2077     LS        0       85
2078     UD     5.65

2079     KK     0335COMBINE 0335 AND 0330 AND 0320
2080     HC        3

2081     KK     0332SUB-BASIN 0332
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2082      BA     3.5
2083      LS       0      86
2084      UD    2.65

2085      KK    0332ITCAINA RESERVOIR
2086      RS       1    ELEV    100.
2087      SV       0  202.78  344.73  416.35  488.41  560.91  633.85  707.23  781.05
2088      SE    95.1    98.0   100.0   101.0   102.0   103.0   104.0   105.0   106.0
2089      SQ      .0   .0001   .0002    15.0    17.4    18.0    18.9   167.8   623.6

2090      KK    0332ROUTE TO SOUTH BEAVER
2091      RS       2    FLOW      -1
2092      RC     .06     .04     .06    7283   .0075
2093      RX       0     100     200     210     234     268     368     468
2094      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

2095      KK    0333SUB-BASIN 0333
2096      BA     1.6
2097      LS       0      85
2098      UD    3.27

2099      KK    0333SCRIPT RESERVOIR
2100      RS       1    ELEV    100.
2101      SV       0   40.70   70.10   99.78  129.74  159.98  236.84  299.62  370.00
2102      SE    98.6   100.0   101.0   102.0   103.0   104.0   106.5   108.5   110.7
2103      SL   100.8    1.77      .5      .5
2104      SS   106.3     51.     2.8     1.5

2105      KK    0333ROUTE TO SOUTH BEAVER
2106      RS       2    FLOW      -1
2107      RC     .06     .04     .06   10147   .0075
2108      RX       0     100     200     210     234     268     368     468
2109      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

2110      KK    0333COMBINE 0333 AND 0332
2111      HC       2
2112      KK    0331SUB-BASIN 0331
2113      BA     7.7
2114      LS       0      85
2115      UD    3.88

2116      KK    0331ARRAMBIDE RESERVOIR
2117      RS       1    ELEV    100.
2118      SV       0   50.18  101.39  153.65  180.18  206.98  233.00  261.38  288.98
2119      SE    94.0    96.0    98.0   100.0   101.0   102.0   103.0   104.0   105.0
2120      SQ       0       0       0       0    21.4    32.3    33.7   101.5   413.2

2121      KK    0331ROUTE TO SOUTH BEAVER
2122      RS       2    FLOW      -1
2123      RC     .06     .04     .06   19129   .0075
2124      RX       0     100     200     210     234     268     368     468
2125      RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

2126      KK    0334SUB-BASIN 0334
2127      BA     6.4
2128      LS       0      85
2129      UD    4.04

2130      KK    0334COMBINE 0334 AND 0331 AND 0333
2131      HC       3

2132      KK    0334SOUTH BEAVER RESERVOIR
2133      RS       1    ELEV    100.
2134      SV       0   42.27  183.58  325.49  468.01  611.14  899.24 1189.81 1336.00
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE    ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2135    SE    99.7   100.0   101.0   102.0   103.0   104.0   106.0   108.0   109.0
2136    SQ       0       0    32.4    84.7    96.6    99.9   106.0   315.9  1009.1

2137    KK    0334ROUTE TO GRUB
2138    RS       2    FLOW      -1
2139    RC     .06     .04     .06   17562   .0060
2140    RX       0     100     200     232     273     325     425     525
2141    RY    12.2    10.2     8.2     1.1       0     4.3     7.3    10.3

2142    KK    0335COMBINE 0334 AND 0335
2143    HC       2

2144    KK    0335 SUB-BASIN 0335
2145    BA    8.81
2146    LS       0     85.
2147    UD    5.65

2148    KK    0330 SUB-BASIN 0330
2149    BA    11.5
2150    LS       0     85.
2151    UD    8.45
2152    KK    0330 COMBINE 0330 AND 0335 AND INFLOW TO GRUB
2153    HC       3

2154    KK    0335GRUB RESERVOIR
2155    RS       1    ELEV    100.
2156    SV       0 1397.33 1958.37 2520.63 3084.09 4214.67 5919.67 7062.45 7635.68 8210.00
2157    SE    97.5   100.0   101.0   102.0   103.0   105.0   108.0   110.0   111.0   112.0
2158    SQ       0       0    58.4   183.0   317.0   339.0   400.9   983.0  1517.0  2190.4

2159    KK    0325ROUTE TO MILLER COULEE CONFLUENCE
2160    RS       2    FLOW      -1
2161    RC     .06     .04     .06   20801   .0060
2162    RX       0     100     200     232     273     325     425     525
2163    RY    12.2    10.2     8.2     1.1       0     4.3     7.3    10.3

2164    KK    0341SUB-BASIN 0341
2165    BA    10.0
2166    LS       0      86
2167    UD    5.58

2168    KK    0341TOMAHAWK RESERVOIR
2169    RS       1    ELEV    100.
2170    SV       0   14.17   42.70   71.51  129.96  189.53  250.23  281.01  312.09  343.45
2171    SE    99.5   100.0   101.0   102.0   104.0   106.0   108.0   109.0   110.0   111.0
2172    SQ       0       0    32.4    76.0    81.1    85.8    90.4   294.5   957.6  2016.3

2173    KK    0341ROUTE TO MILLER COULEE CONFLUENCE
2174    RS       2    FLOW      -1
2175    RC     .06     .04     .06   15977   .0075
2176    RX       0     100     200     210     234     268     368     468
2177    RY     9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

2178    KK    0340SUB-BASIN 0340
2179    BA     9.3
2180    LS       0      84
2181    UD    4.00

2182    KK    0340COMBINE 0340 AND 0341 AND 0335
2183    HC       3

2184    KK    0340ROUTE TO BIG FORK CONFLUENCE
2185    RS       2    FLOW      -1
2186    RC     .06     .04     .06   33099   .0060
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2187      RX         0     100     200     232     273     325     425     525
2188      RY      12.2    10.2     8.2     1.1       0     4.3     7.3    10.3

2189      KK      0351SUB-BASIN 0351
2190      BA       3.4
2191      LS         0      85
2192      UD      4.73
2193      KK      0351BIGFORK RESERVOIR
2194      RS         1    ELEV    100.
2195      SV         0   61.86  124.12  249.85  377.22  506.23  571.36  636.91  702.87
2196      SE     100.0   101.0   102.0   104.0   106.0   108.0   109.0   110.0   111.0
2197      SQ         0    27.2    40.1    44.2    47.9    51.3   183.5   616.7  1260.0

2198      KK      0351ROUTE TO BIGFORK CONFLUENCE
2199      RS         2    FLOW      -1
2200      RC       .06     .04     .06    9613   .0075
2201      RX         0     100     200     210     234     268     368     468
2202      RY       9.7     7.7     5.7       0     0.9     5.5     7.5     9.5

2203      KK      0340COMBINE 0340 AND 0351
2204      HC         2

2205      KK      0350SUB-BASIN 0350
2206      BA      10.8
2207      LS         0      85
2208      UD      4.67

2209      KK      0352SUB-BASIN 0352
2210      BA       2.4
2211      LS         0      85
2212      UD      2.96

2213      KK      0350COMBINE 0350 AND 0352 AND 0340
2214      HC         3

2215      KK       350ROUTE TO WILLOW CREEK
2216      RS         5    FLOW      -1
2217      RC       .06     .04     .06   16204   .0060
2218      RX         0     100     200     232     273     325     425     525
2219      RY      12.2    10.2     8.2     1.1       0     4.3     7.3    10.3

2220      KK      0360SUB-BASIN 0360
2221      BA       4.3
2222      LS         0     84.
2223      UD      3.49

2224      KK      0360COMBINE 0360 AND 0350
2225      HC         2

2226      KK       30A COMBINE WITH FLOWS FROM BEAVER CREEK
2227      HC         2

2228      KK        30 ROUTE TO 30
2229      RS         2    FLOW      -1
2230      RC       .06     .04     .06  45830.   .0034
2231      RX       0.0    100.    200.    230.    270.    320.    400.    600.
2232      RY      15.6    13.6    11.6     1.3     0.0     1.2    11.2    15.2
          * ******************** END OF PAGE 4
          * ************************************
          * ******************** PAGE 3
2233      KK      0831 SUB-BASIN 0831
2234      BA      7.02
2235      LS         0     86.
2236      UD      4.71
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID	1	2	3	4	5	6	7	8	9	10
2237	KK	0831 JUDY RESERVOIR									
2238	RS	1	ELEV	100.							
2239	SV	69.5	139.3	209.6	280.4	351.5	423.1	495.2	567.7	640.6	695.0
2240	SE	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0	108.0	109.0
2241	SQ	0.0	32.4	54.1	56.4	58.5	60.6	62.6	199.4	1044.0	2376.0
2242	KK	0831A ROUTE TO BLANCHARD RESERVOIR									
2243	RS	2	FLOW	-1							
2244	RC	.06	.04	.06	35240.	.0075					
2245	RX	0.0	100.0	200.0	210.0	234.0	268.0	368.0	468.0		
2246	RY	9.7	7.7	5.7	0.0	0.9	5.5	7.5	9.5		
2247	KK	0832 SUB-BASIN 0832									
2248	BA	3.11									
2249	LS	0	85.								
2250	UD	2.80									
2251	KK	0832 DEEP CUT RESERVOIR									
2252	RS	1	ELEV	100.							
2253	SV	279.9	386.3	494.2	603.6	714.6	827.1	880.0			
2254	SE	100.0	102.0	104.0	106.0	108.0	110.0	111.0			
2255	SQ	0.0	34.1	36.1	38.0	39.9	371.0	1084.0			
2256	KK	0832A ROUTE TO BLANCHARD RESERVOIR									
2257	RS	2	FLOW	-1							
2258	RC	.06	.04	.06	27590.	.008					
2259	RX	0.0	100.	200.	203.	209.	222.	322.	422.		
2260	RY	6.5	4.5	2.5	2.0	0.0	2.5	4.5	6.5		
2261	KK	BLANC COMBINE WITH FLOW FROM JUDY									
2262	HC	2									
2263	KK	0833 SUB-BASIN 0833									
2264	BA	6.10									
2265	LS	0	85.								
2266	UD	4.16									
2267	KK	0833 JANUARY DETENT RESERVOIR									
2268	RS	1	ELEV	100.							
2269	SV	323.4	510.9	700.4	891.9	1085.4	1281.0	1488.5	1578.2	1678.3	
2270	SE	100.0	102.0	104.0	106.0	108.0	110.0	112.0	113.0	114.0	
2271	SQ	0.0	34.1	35.8	37.4	39.0	40.5	42.0	360.0	1276.0	
2272	KK	0833B ROUTE TO BLANCHARD									
2273	RS	2	FLOW	-1							
2274	RC	.06	.04	.06	18870.	.0075					
2275	RX	0.0	100.	200.	210.	234.	268.	368.	468.		
2276	RY	9.7	7.7	5.7	0.0	0.9	5.5	7.5	9.5		
2277	KK	BLANC COMBINE WITH FLOW WITH FLOW AT BLANCHARD									
2278	HC	2									
2279	KK	0834 SUB-BASIN 0834									
2280	BA	9.49									
2281	LS	0	85.								
2282	UD	7.26									
2283	KK	BLANC COMBINE WITH FLOW AT BLANCHARD									
2284	HC	2									
2285	KK	BLANC BLANCHARD DETENTION RESERVOIR									
2286	RS	1	ELEV	100.							
2287	SV	0.0	610.2	1224.0	1841.4	2462.4	3087.0	3400.7	3821.0	4664.4	
2288	SE	100.0	102.0	104.0	106.0	108.0	110.0	111.0	114.0	115.0	

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE     ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2289     SQ     0.0   121.0   135.0   150.0   163.0   175.0   181.0   555.0  1756.0

2290     KK     30B ROUTE TO COMBINE POINT 30
2291     RS       2    FLOW      -1
2292     RC     .06     .04     .06  26620.    .006
2293     RX     0.0   100.0   200.0   232.0   273.0   325.0   425.0   525.0
2294     RY    12.2    10.2     8.2     1.1     0.0     4.3     7.3    10.3

2295     KK     30B COMBINE WITH FLOW AT 30
2296     HC       2

2297     KK    0838 SUB-BASIN 0838
2298     BA    2.04
2299     LS       0     87.
2300     UD    1.67

2301     KK    0838 ARCHAMBEAULT RESERVOIR
2302     RS       1    ELEV    100.
2303     SV     0.0    42.9    86.8   131.7   154.5   196.1
2304     SE   100.0   102.0   104.0   106.0   107.0   108.8
2305     SL   101.5    7.07      .5      .5
2306     SS   103.0     30.     2.8     1.5

2307     KK    0837 SUB-BASIN 0837
2308     BA    2.06
2309     LS       0     86.
2310     UD    1.93

2311     KK    0837 WILLOW FLAT RESERVOIR
2312     RS       1    ELEV    100.
2313     SV     0.0     .01    27.6    65.3   103.8   143.2   167.3
2314     SE   100.0   102.0   104.0   106.0   108.0   110.0   111.2
2315     SQ     0.0    25.2    61.5    96.2   202.0   761.0  1145.0
2316     KK   0837A COMBINE WITH FLOW FROM ARCHAMBEAULT
2317     HC       2

2318     KK    0836 SUB-BASIN 0836
2319     BA    1.10
2320     LS       0     87.
2321     UD    1.91

2322     KK    0836 WILLOW CR RESERVOIR
2323     RS       1    ELEV    100.
2324     SV     0.0    22.3    46.5    71.3    97.0   110.0   126.0
2325     SE    98.1   100.0   102.0   104.0   106.0   107.0   108.2
2326     SL   101.5    7.07      .5      .5
2327     SS   105.3     30.     2.8     1.5

2328     KK   0837B COMBINE WITH FLOW FROM ARCH AND WILLOW FLAT
2329     HC       2

2330     KK    0835 SUB-BASIN 0835
2331     BA    1.43
2332     LS       0     86.
2333     UD    1.56

2334     KK    0835 WILLOW FLAT DIVERSION DAM
2335     RS [illegible]    ELEV    100.
2336     SV     0.0     6.1    18.5    43.8    69.8
2337     SE   100.0   101.0   102.0   104.0   106.0
2338     SQ     0.0    46.9   269.0  1200.0  2760.0

2339     KK   0837C COMBINE WITH FLOW FROM ARCH,WILLOW FLAT, AND WILLOW CR RES
2340     HC       2
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


2341      KK   WSAA01 ARCHAMBEAULT
2342      RS        1     ELEV     0.0
2343      SV       .0    40.84   82.00   123.5   165.3   207.5
2344      SE       0.       1.      2.      3.      4.      5.
2345      SQ       0.       0.    142.    614.   1869.   3626.

2346      KK   WSAA02 ARCHAMBEAULT
2347      RS        1     ELEV     0.0
2348      SV       .0    40.84   82.00   123.5   165.3   207.5
2349      SE       0.       1.      2.      3.      4.      5.
2350      SQ       0.       0.    142.    614.   1869.   3626.

2351      KK   WSAA03 ARCHAMBEAULT
2352      RS        1     ELEV     0.0
2353      SV       .0    40.84   82.00   123.5   165.3   207.5
2354      SE       0.       1.      2.      3.      4.      5.
2355      SQ       0.       0.    142.    614.   1869.   3626.
2356      KK   WSAA04 ARCHAMBEAULT
2357      RS        1     ELEV     0.0
2358      SV       .0    40.84   82.00   123.5   165.3   207.5
2359      SE       0.       1.      2.      3.      4.      5.
2360      SQ       0.       0.    142.    614.   1869.   3626.

2361      KK   WSAA05 ARCHAMBEAULT
2362      RS        1     ELEV     0.0
2363      SV       .0    40.84   82.00   123.5   165.3   207.5
2364      SE       0.       1.      2.      3.      4.      5.
2365      SQ       0.       0.    142.    614.   1869.   3626.

2366      KK   WSAA06 ARCHAMBEAULT
2367      RS        1     ELEV     0.0
2368      SV       .0    40.84   82.00   123.5   165.3   207.5
2369      SE       0.       1.      2.      3.      4.      5.
2370      SQ       0.       0.    142.    614.   1869.   3626.

2371      KK   WSAA07 ARCHAMBEAULT
2372      RS        1     ELEV     0.0
2373      SV       .0    40.84   82.00   123.5   165.3   207.5
2374      SE       0.       1.      2.      3.      4.      5.
2375      SQ       0.       0.    142.    614.   1869.   3626.

2376      KK   WSAA08 ARCHAMBEAULT
2377      RS        1     ELEV     0.0
2378      SV       .0    40.84   82.00   123.5   165.3   207.5
2379      SE       0.       1.      2.      3.      4.      5.
2380      SQ       0.       0.    142.    614.   1869.   3626.

2381      KK   WSAA09 ARCHAMBEAULT
2382      RS        1     ELEV     0.0
2383      SV       .0    40.84   82.00   123.5   165.3   207.5
2384      SE       0.       1.      2.      3.      4.      5.
2385      SQ       0.       0.    142.    614.   1869.   3626.

2386      KK   WSAA10 ARCHAMBEAULT
2387      RS        1     ELEV     0.0
2388      SV       .0    40.84   82.00   123.5   165.3   207.5
2389      SE       0.       1.      2.      3.      4.      5.
2390      SQ       0.       0.    142.    614.   1869.   3626.

2391      KK   WSAA11 ARCHAMBEAULT
2392      RS        1     ELEV     0.0
2393      SV       .0    40.84   82.00   123.5   165.3   207.5
2394      SE       0.       1.      2.      3.      4.      5.
```

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

LINE	ID.......1	2	3	4	5	6	7	8	9	10
2395	SQ 0.	0.	142.	614.	1869.	3626.				
2396	KK WSAA12	ARCHAMBEAULT								
2397	RS 1	ELEV	0.0							
2398	SV .0	40.84	82.00	123.5	165.3	207.5				
2399	SE 0.	1.	2.	3.	4.	5.				
2400	SQ 0.	0.	142.	614.	1869.	3626.				
2401	KK WSAA13	ARCHAMBEAULT								
2402	RS 1	ELEV	0.0							
2403	SV .0	40.84	82.00	123.5	165.3	207.5				
2404	SE 0.	1.	2.	3.	4.	5.				
2405	SQ 0.	0.	142.	614.	1869.	3626.				
2406	KK WSAA14	ARCHAMBEAULT								
2407	RS 1	ELEV	0.0							
2408	SV .0	40.84	82.00	123.5	165.3	207.5				
2409	SE 0.	1.	2.	3.	4.	5.				
2410	SQ 0.	0.	142.	614.	1869.	3626.				
2411	KK WSAA15	ARCHAMBEAULT								
2412	RS 1	ELEV	0.0							
2413	SV .0	40.84	82.00	123.5	165.3	207.5				
2414	SE 0.	1.	2.	3.	4.	5.				
2415	SQ 0.	0.	142.	614.	1869.	3626.				
2416	KK WSAA16	ARCHAMBEAULT								
2417	RS 1	ELEV	0.0							
2418	SV .0	40.84	82.00	123.5	165.3	207.5				
2419	SE 0.	1.	2.	3.	4.	5.				
2420	SQ 0.	0.	142.	614.	1869.	3626.				
2421	KK WSAA17	ARCHAMBEAULT								
2422	RS 1	ELEV	0.0							
2423	SV .0	40.84	82.00	123.5	165.3	207.5				
2424	SE 0.	1.	2.	3.	4.	5.				
2425	SQ 0.	0.	142.	614.	1869.	3626.				
2426	KK WSAA18	ARCHAMBEAULT								
2427	RS 1	ELEV	0.0							
2428	SV .0	40.84	82.00	123.5	165.3	207.5				
2429	SE 0.	1.	2.	3.	4.	5.				
2430	SQ 0.	0.	142.	614.	1869.	3626.				
2431	KK WSAA19	ARCHAMBEAULT								
2432	RS 1	ELEV	0.0							
2433	SV .0	40.84	82.00	123.5	165.3	207.5				
2434	SE 0.	1.	2.	3.	4.	5.				
2435	SQ 0.	0.	142.	614.	1869.	3626.				
2436	KK WSAA20	ARCHAMBEAULT								
2437	RS 1	ELEV	0.0							
2438	SV .0	40.84	82.00	123.5	165.3	207.5				
2439	SE 0.	1.	2.	3.	4.	5.				
2440	SQ 0.	0.	142.	614.	1869.	3626.				
2441	KK WSAA21	ARCHAMBEAULT								
2442	RS 1	ELEV	0.0							
2443	SV .0	40.84	82.00	123.5	165.3	207.5				
2444	SE 0.	1.	2.	3.	4.	5.				
2445	SQ 0.	0.	142.	614.	1869.	3626.				
2446	KK WSAA22	ARCHAMBEAULT								
2447	RS 1	ELEV	0.0							
2448	SV .0	40.84	82.00	123.5	165.3	207.5				
2449	SE 0.	1.	2.	3.	4.	5.				

TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2450      SQ       0.       0.     142.     614.    1869.    3626.

2451      KK   WSAA23 ARCHAMBEAULT
2452      RS        1     ELEV      0.0
2453      SV       .0    40.84    82.00    123.5    165.3    207.5
2454      SE       0.       1.       2.       3.       4.       5.
2455      SQ       0.       0.     142.     614.    1869.    3626.

2456      KK   WSAA24 ARCHAMBEAULT
2457      RS        1     ELEV      0.0
2458      SV       .0    40.84    82.00    123.5    165.3    207.5
2459      SE       0.       1.       2.       3.       4.       5.
2460      SQ       0.       0.     142.     614.    1869.    3626.

2461      KK   WSAA25 ARCHAMBEAULT
2462      RS        1     ELEV      0.0
2463      SV       .0    40.84    82.00    123.5    165.3    207.5
2464      SE       0.       1.       2.       3.       4.       5.
2465      SQ       0.       0.     142.     614.    1869.    3626.

2466      KK   WSAA26 ARCHAMBEAULT
2467      RS        1     ELEV      0.0
2468      SV       .0    40.84    82.00    123.5    165.3    207.5
2469      SE       0.       1.       2.       3.       4.       5.
2470      SQ       0.       0.     142.     614.    1869.    3626.

2471      KK   WSAA27 ARCHAMBEAULT
2472      RS        1     ELEV      0.0
2473      SV       .0    40.84    82.00    123.5    165.3    207.5
2474      SE       0.       1.       2.       3.       4.       5.
2475      SQ       0.       0.     142.     614.    1869.    3626.

2476      KK   WSAA28 ARCHAMBEAULT
2477      RS        1     ELEV      0.0
2478      SV       .0    40.84    82.00    123.5    165.3    207.5
2479      SE       0.       1.       2.       3.       4.       5.
2480      SQ       0.       0.     142.     614.    1869.    3626.

2481      KK   WSAA29 ARCHAMBEAULT
2482      RS        1     ELEV      0.0
2483      SV       .0    40.84    82.00    123.5    165.3    207.5
2484      SE       0.       1.       2.       3.       4.       5.
2485      SQ       0.       0.     142.     614.    1869.    3626.

2486      KK   WSAA30 ARCHAMBEAULT
2487      RS        1     ELEV      0.0
2488      SV       .0    40.84    82.00    123.5    165.3    207.5
2489      SE       0.       1.       2.       3.       4.       5.
2490      SQ       0.       0.     142.     614.    1869.    3626.
2491      KK   WSAA31 ARCHAMBEAULT
2492      RS        1     ELEV      0.0
2493      SV       .0    40.84    82.00    123.5    165.3    207.5
2494      SE       0.       1.       2.       3.       4.       5.
2495      SQ       0.       0.     142.     614.    1869.    3626.

2496      KK   WSAA32 ARCHAMBEAULT
2497      RS        1     ELEV      0.0
2498      SV       .0    40.84    82.00    123.5    165.3    207.5
2499      SE       0.       1.       2.       3.       4.       5.
2500      SQ       0.       0.     142.     614.    1869.    3626.

2501      KK   WSAA33 ARCHAMBEAULT
2502      RS        1     ELEV      0.0
2503      SV       .0    40.84    82.00    123.5    165.3    207.5
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TABLE 2.-- HYDROLOGIC ENGINEERING CENTER-1 INPUT FOR WILLOW CREEK STUDY (CONT.)

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2504      SE       0.       1.       2.       3.       4.       5.
2505      SQ       0.       0.     142.     614.    1869.    3626.

2506      KK  WSAA34 ARCHAMBEAULT
2507      RS       1    ELEV      0.0
2508      SV      .0   40.84    82.00    123.5    165.3    207.5
2509      SE       0.       1.       2.       3.       4.       5.
2510      SQ       0.       0.     142.     614.    1869.    3626.

2511      KK  WSAA35 ARCHAMBEAULT
2512      RS       1    ELEV      0.0
2513      SV      .0   40.84    82.00    123.5    165.3    207.5
2514      SE       0.       1.       2.       3.       4.       5.
2515      SQ       0.       0.     142.     614.    1869.    3626.

2516      KK     30C ROUTE TO COMBINE POINT 30
2517      RS       2    FLOW       -1
2518      RC     .06     .04      .06   19670.    .0075
2519      RX     0.0    100.     200.     210.     234.     268.     368.     468.
2520      RY     9.7     7.7      5.7      0.0      0.9      5.5      7.5      9.5

2521      KK     30C COMBINE WITH OTHER ROUTED FLOWS AT 30
2522      HC       2

2523      KK    0830 SUB-BASIN 0830
2524      BA    27.3
2525      LS       0      85.
2526      UD    15.7

2527      KK     30C COMBINE WITH FLOW AT POINT 30
2528      HC       2

2529      KK     30C ROUTE TO USGS GAGE
2530      RS       2    FLOW       -1
2531      RC     .06     .04      .06   53610.    .0034
2532      RX     0.0    100.     200.     230.     270.     320.     400.     600.
2533      RY    15.6    13.6     11.6      1.3      0.0      1.2     11.2     15.2
2534      KK    0840 SUB-BASIN 0840
2535      BA    18.8
2536      LS       0      85.
2537      UD    15.7

2538      KK     100 COMBINE WITH ROUTED FLOW AT USGS GAGE
2539      KO       2       2
2540      HC       2
2541      ZZ
```

Table 3.--*Waterspreader characteristics*

Waterspreader name	Number of dikes	Total storage volume (acre-feet)
Archambeault	35	7,260
Beaverette	16	640
Bomber	24	286
Brazil Divide	20	465
Burnett	17	5,120
Cactus Flat	16	416
Dog Creek	21	2,020
Inverness	7	761
Lone Tree Dikes	12	556
Private 1	14	436
Private 2	15	386
Private 3	7	158
Triple Crossing 1	12	3,360
Triple Crossing 2	12	3,250

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