Hydrology Report

DECEMBER 1989

16923-HPH

RODGER CREEK
FLOODPLAIN DELINEATION STUDY
FCD 89-15

Registered Professional Engineer
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Date signed 12/11/89
ARIZONA, U.S.A.

Prepared for

Flood Control District
of
Maricopa County

Submitted by

Baker Engineers

Michael Baker, Jr., Inc
Phoenix, Arizona

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Hydrology Report

Rodger Creek
Floodplain Delineation Study
for the
Flood Control District of Maricopa County

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16923-E10.4-R16

HYDROLOGY REPORT
RODGER CREEK
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1.0 Introduction

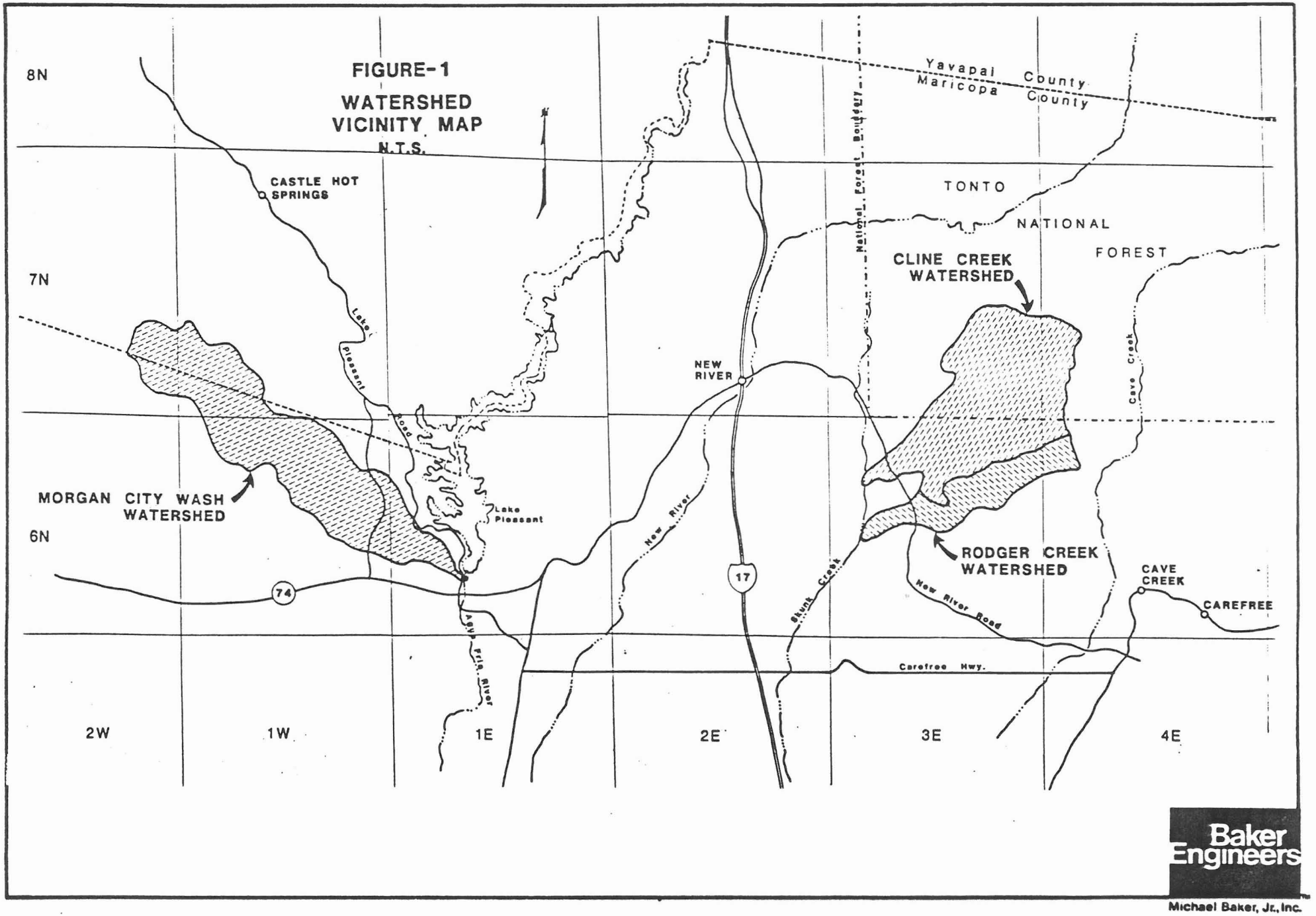
This report presents the results of a hydrologic analysis of the Rodger Creek watershed in northern Maricopa County, Arizona. The hydrologic analysis is part of a floodplain delineation study of Rodger Creek being conducted by Baker Engineers for the Flood Control District of Maricopa County. The Rodger Creek watershed location is shown in Figure 1.

1.1 Purpose of the Study

The hydrologic and hydraulic analysis of the Rodger Creek watershed is being completed to determine 100-year peak discharges and associated floodplain and floodway limits. Water-surface profiles will be computed for Rodger Creek to established base flood elevations. This information will be combined into a floodway and floodplain map which will be submitted by the Flood Control District to the Federal Emergency Management Agency (FEMA) for approval. Upon approval by FEMA, the maps will be used in establishing flood insurance rates and flood plain management requirements.

1.2 Authority for Study

This study was authorized by a contract for floodplain delineation services (FCD 89-15) with the Flood Control District of Maricopa County dated June 5, 1989.



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1.3 Watershed Description

The Rodger Creek watershed is comprised of approximately 5.13 square miles of land within the unincorporated area of northern Maricopa County. Rodger Creek is tributary to Skunk Creek. The watershed is in the high desert and is comprised of a small valley and adjacent foothill slopes. Rodger Creek is approximately 5 miles in length with no major tributaries. Runoff reaches Rodger Creek via minor desert washes or direct runoff from the foothill slopes. Direction of flow is westerly. Elevations in the watershed range from 1,900 feet at Skunk Creek to 3,600 feet on Elephant Mountain. Within the 5 mile study reach slopes along Rodger Creek range from approximately 1% to 2%. Foothill slopes range up to approximately 30%.

Soils in the watershed are alluvial deposits eroded from the foothill rock outcrops which are volcanic in origin. Soils are shallow but well drained, predominantly gravelly clay loam. Significant areas of the hill slopes are exposed rock outcrop. The creek bed is comprised primarily of very coarse gravels, cobbles and boulders.

Although residential use areas exist in the western half of the watershed, these are large acreages set in the existing desert environment. Most of the watershed remains in a near-natural state. Vegetation is high desert brush with heavy desert riparian vegetation along most of Rodger Creek. The only drainage structure is a pipe culvert where New River Road crosses Rodger Creek.

1.4 Previous Studies

An approximate study was completed in January, 1979 by Harris-Toups Associates. The study was prepared for the U.S. Department of Housing and Urban Development, Federal Insurance Administration and resulted in the Zone A mapping reflected on the effective Flood Insurance Rate Map (FIRM) for Maricopa County. The approximate study is incorporated in the effective Flood Insurance Study for Maricopa County, Arizona and Incorporated Areas. [1]

2.0 Engineering Methodology

The HEC-1 computer program of the U.S. Army Corps of Engineers [2] was used in the hydrologic analysis of the Rodger Creek watershed. The program produces an incremental time-based record of storm runoff from a watershed. The watershed may be modeled as a series of sub-basins connected by the watershed stream system. Hydrographs may be computed for precipitation runoff from the sub-basins, as additions of several hydrographs at stream junctions and as hydrographs routed through stream reaches or reservoirs. Sub-basins are selected of nearly-equal size (time of concentration) in order that the single value of time interval chosen for computations produces accurate results with a reasonable amount of output. The Watershed Boundary Map (Figure 2) shows the sub-basins used for the Rodger Creek hydrology.

The HEC-1 option utilizing the Soil Conservation Service (SCS) dimensionless hydrograph in combination with initial and uniform loss rate methodology was selected for computing sub-basin runoff. The Muskingum routing option was used for routing of flood hydrographs downstream through the various channel reaches of the watershed. The development of the various input parameters for the HEC-1 watershed model is presented in the following paragraphs.

2.1 Rainfall

Floodplains in Maricopa County are delineated for a peak 100-year flow. Runoff is simulated for storm durations of 2, 6 and 24 hours. The maximum peak flow from among the three storms is used for floodplain delineation of a stream segment. The source of precipitation depths is NOAA Atlas 2 [3]. The storm total precipitation values for this study are given in Table 1.

TABLE 1 Rodger Creek 100-Year Storm Total Point Precipitation	
Duration (hours)	Precipitation (inches)
2	2.79
6	3.50
24	4.80

The SCS 100-year Type II Rainfall Distributions included in Appendix D were used to define temporal distribution for the three precipitation events (see Figure 3). Cumulative point precipitation at 15 minute intervals presented in Table 2 was used for the HEC-1 input. The Rodger Creek watershed area of approximately 5 square miles is small enough that point precipitation may be considered average precipitation for the entire watershed under Flood Control District criteria.

Development of precipitation input data for the HEC-1 hydrology model is presented in Appendix E.

FIGURE 3

RODGER CREEK, 100 YEAR STORM

SCS TYPE II PRECIPITATION DISTRIBUTION

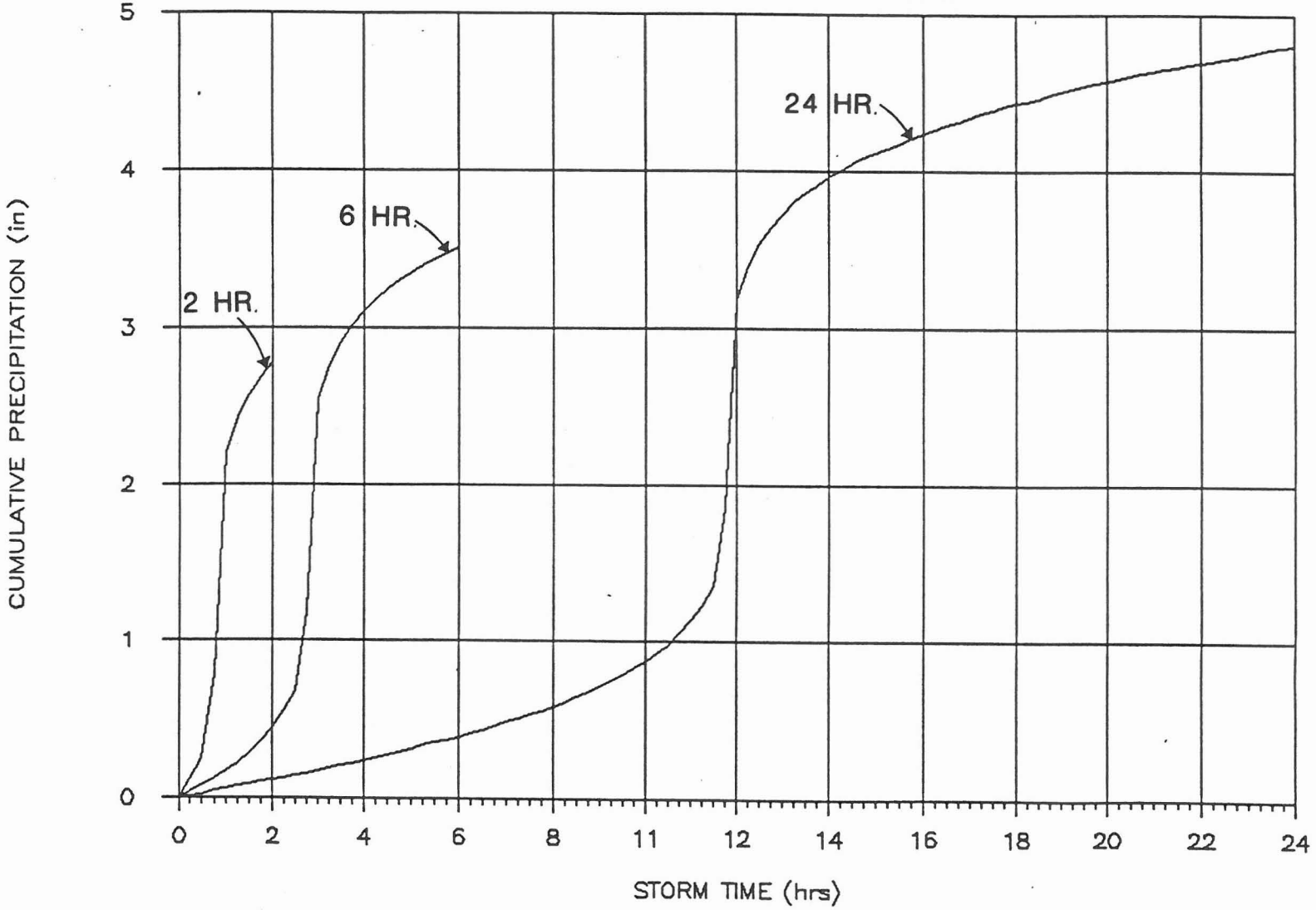

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TABLE - 2

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY - FLOOD PLAIN DELINATION STUDY

RODGER CREEK AND CLINE CREEK BAKER ENGINEERS PROJECT NUMBER 16923-HPH

100-YEAR POINT RAINFALL: 2 HR., 6 HR., & 24 HR.

SCS TYPE II PRECIPITATION DISTRIBUTION

STORM TIME (hrs.)	STORM-PRECIPITATION 2 HR. (in.)	6 HR. (in.)	24 HR. (in.)	STORM TIME (cont.)	24 HR. (cont.)
0.00	0.00	0.00	0.00	12.25	3.39
0.25	0.11	0.04	0.01	12.50	3.53
0.50	0.24	0.08	0.02	12.75	3.64
0.75	0.78	0.12	0.04	13.00	3.72
1.00	2.21	0.17	0.05	13.25	3.80
1.25	2.43	0.22	0.07	13.50	3.86
1.50	2.58	0.28	0.08	13.75	3.91
1.75	2.70	0.35	0.10	14.00	3.96
2.00	2.79	0.44	0.11	14.25	4.00
2.25		0.54	0.12	14.50	4.04
2.50		0.67	0.14	14.75	4.08
2.75		1.19	0.15	15.00	4.11
3.00		2.55	0.17	15.25	4.14
3.25		2.77	0.18	15.50	4.17
3.50		2.91	0.20	15.75	4.20
3.75		3.02	0.21	16.00	4.23
4.00		3.11	0.23	16.25	4.26
4.25		3.18	0.25	16.50	4.29
4.50		3.24	0.27	16.75	4.31
4.75		3.30	0.29	17.00	4.33
5.00		3.35	0.31	17.25	4.36
5.25		3.39	0.33	17.50	4.38
5.50		3.43	0.35	17.75	4.41
5.75		3.47	0.36	18.00	4.43
6.00		3.50	0.38	18.25	4.44
6.25			0.41	18.50	4.46
6.50			0.43	18.75	4.48
6.75			0.46	19.00	4.50
7.00			0.48	19.25	4.52
7.25			0.50	19.50	4.54
7.50			0.53	19.75	4.56
7.75			0.55	20.00	4.57
8.00			0.58	20.25	4.59
8.25			0.60	20.50	4.60
8.50			0.64	20.75	4.62
8.75			0.67	21.00	4.63
9.00			0.71	21.25	4.65
9.25			0.74	21.50	4.66
9.50			0.78	21.75	4.68
9.75			0.83	22.00	4.69
11.00			0.87	22.25	4.70
10.25			0.92	22.50	4.72
10.50			0.97	22.75	4.73
10.75			1.05	23.00	4.75
11.00			1.13	23.25	4.76
11.25			1.23	23.50	4.78
11.50			1.36	23.75	4.79
11.75			1.86	24.00	4.80
12.00			3.18		

2.2 Soil Losses

The SCS Aguila - Carefree Soil Survey [5] was used to determine soil characteristics and infiltration properties within the Rodger Creek watershed. The watershed boundary and sub-basin locations were plotted on the soils maps, and the area of each soil group within the sub-basins was determined, (see Figure 4).

Soils were classified by their texture using data from the Aguila - Carefree Soil Survey [5] and loss rate correlations provided by the Flood Control District contained in Appendix D. The Initial and Uniform Loss Rate option of the HEC-1 computer program was selected to determine rainfall excess. Values of initial losses, uniform loss rates and percent impervious were computed for each sub-basin using the soil texture classifications and ground cover. Table 3 lists the soils groups found within the Rodger Creek Watershed and percentages of each soil group within each sub-basin. Initial and uniform loss rate parameter values for each sub-basin are listed in Table 4. Loss rate and impervious area calculations are presented in Appendix F.

TABLE 3
Rodger Creek Watershed Soil Groups

SCS Group No.	SCS Group Name	Area (acres)	Percent of Sub-Basin
Sub Basin R-1			
26	Continental Cobbly Clay Loam	365	36.5
66	Greyeagle Suncity Variant Complex	8	0.8
72	Lehmans - Rock Outcrop Complex	566	56.7
95	Ohaco gravelly loam	55	5.5
96	Pinaleno - Tres Hermanos Complex	5	0.5
		999	100.0
Sub-Basin R-2			
26	Continental Cobbly Clay Loam	275	21.6
66	Greyeagle Suncity Variant Complex	248	19.5
72	Lehmans - Rock Outcrop Complex	583	45.9
93	Nickel - Cave Complex	10	0.8
95	Ohaco Gravelly Loam	138	10.9
96	Pinaleno - Tres Hermanos Complex	16	1.3
		1270	100.0
Sub Basin R-3			
12	Carefree Cobbly Clay Loam	8	0.8
26	Continental Cobbly Clay Loam	40	3.9
44	Ebon Very Gravelly Loam	33	3.3
52	Gachado - Lomitas Rock Outcrop Complex	43	4.2
66	Greyeagle Suncity Variant Complex	7	0.7
68	Gunsight - Cipriano Complex	6	0.6
72	Lehmans Rock Outcrop Complex	649	63.8
96	Pinaleno - Tres Hermanos Complex	53	5.2
98	Pinamt - Tremant Complex	99	9.7
110	Suncity - Cipriano Complex	79	7.8
		1017	100.0

2.3 Sub-Basin Lag Time Determinations

For the dimensionless unit hydrograph option HEC-1 requires the input of the lag time for each sub-basin. Lag time for each sub-basin was computed using the longest water course within the sub-basin. Sheet flow and shallow concentrated flow velocities were calculated using procedures in Chapter 3 of SCS's TR-55 [6]. Velocities in tributary wash reaches were calculated by an adaptation of the TR-55 procedure and velocities in Rodger Creek were calculated using parameters from cross-section output data of a preliminary HEC-2 [7] computer run for Rodger Creek. Copies of TR-55 Chapter 3 and the HEC-2 output are included in Appendix G to provide detailed theory.

Sheet Flow - The upstream reach of each water course was designated Range (natural), Manning's n = 0.13.

Shallow Concentrated Flow - Velocities were calculated using the "unpaved watercourse" graph.

Channel Flow - Channel velocity estimates were made by two methods depending on type of channel. Reaches designated "UP" represent the upstream portion of the water course in each sub-basin which appeared to have a low-flow channel within a broader floodplain. Considering apparent depth and shape of the channel and floodplain, a value of average hydraulic radius for the reach was estimated based on experience and engineering judgment. Velocity was calculated by Manning's equation.

Reaches designated "DN" are the reaches of Rodger Creek within each of the sub-basins. Velocities were calculated from cross-section parameters in a preliminary HEC-2 water surface profile calculation. A cross-section selected as typical was used for approximate calculation of hydraulic radius, substituting top width of flow for wetted perimeter. The flow rates for the HEC-2 calculations were taken from preliminary HEC-1 calculations.

Manning's "n" - The most subjective variable in computing lag times has always been the "n" factor. These values were estimated based on engineering judgment, experience and field review.

Unit hydrograph parameters for the Rodger Creek sub-basins are listed in Table 4. Computations of sub-basins lag time are presented in Appendix G.

TABLE 4
Rodger Creek Watershed Hydrologic Parameters

Sub-Basin	Area (miles^2)	Uniform Loss Rate CNSTL (in./hr.)	Inital Loss STRTL (inches)	Lag Time (hours)
R-1	1.56	0.16	0.85	0.37
R-2	1.98	0.22	0.88	0.46
R-3	1.59	0.23	0.90	0.44
	5.13			

2.4 Streamflow Routing

Hydrographs from upper watershed sub-basins were routed through the watershed stream system using the Muskingum Routing option of HEC-1. Muskingum routing is a stream storage method which calculates reach outflow based on inflow and a previous value of outflow. A stream reach is divided into a number sub-reaches calculated to avoid negative routing coefficients, which are internally generated. Input parameters are: travel time through a channel reach, (AMSKK); a weighting factor to account for the relative effect of inflow and outflow on stream storage, (X); and the number of sub-reaches, (NSTPS).

The travel time (AMSKK) determination followed the same TR55 procedures [6] as were used to determine sub-basin lag times. The value of the Muskingum "X" has a theoretical mathematical range of 0.0 to 0.5. For the relatively steep channel reaches of Rodger Creek, a value of X = 0.3 was estimated to give significant weight to reach inflows in determining stream storage. This reflects a judgment that: 1. backwater curves probably do not extend very far upstream and 2. rapid changes in flow can cause significant wedge storage to exist in a reach. Muskingum channel routing parameters are listed in Table 5. Travel time calculations are included in Appendix G following sub-basin lag time calculations. Calculations to determine the number of sub-reaches are presented in Appendix H.

TABLE 5
Rodger Creek Watershed
Muskingum Channel Routing Parameters

Routing Reach	NSTPS*	AMSKK (hours)	X
RO-1	4	0.3	0.3
RO-2	5	0.4	0.3

* NSTPS based on computation interval of 5 minutes.

2.5 HEC-1 Model Sequence

Since Rodger Creek has no major tributaries, the linear watershed dividied most logically into a series of three sub-basins. The sequence is very straight-forward as shown in the HEC-1 Schematic Drawing, Figure 5.

3.0 Summary and Conclusions

3.1 Summary

Using the HEC-1 SCS dimensionless hydrograph option, hydrology was simulated for the 2, 6 and 24 hour storms on the Rodger Creek watershed. Hydrographs were computed for the 3 sub-basins that comprise the watershed, for 2 combination points and for 2 stream flow routing reaches.

The computation interval of 5 minutes was chosen for convenience of review. This interval fails by about one hour to accommodate the outflow hydrograph resulting from a 24 hour storm. However, flows are minimal during the last hour.

Watershed conditions were modeled which reflect the relatively natural high desert conditions in the watershed. Precipitation losses were simulated by initial and uniform loss rates and percent impervious areas. Likewise, routing parameters were estimated based on existing conditions, a naturally occurring combination of cobble-bed channel and desert riparian overbanks.

3.2 Results of the HEC-1 Model

Peak discharges for the 2, 6 and 24 hour 100 year events are listed in Table 6. Flows are tabulated for the 3 sub-basins and 2 combination points shown in the schematic (Figure 5). Copies of the HEC-1 output for the 2, 6 and 24 hour events are presented in Appendices A, B and C, respectively.

TABLE 6
Rodger Creek Watershed 100-Year Runoff Summary

Location	EVENT	Peak Discharge (cfs)		
		2 Hour	6 Hour	24 Hour
Sub-basin R-1		2,568	2,854	2,889
Sub-basin R-2		2,676	3,046	3,149
Combination Point 1		4,746	5,276	5,445
Sub-basin R-3		2,258	2,522	2,589
Watershed Outlet (Skunk Creek)		5,285	5,927	6,167

3.3 Conclusions

By comparison of peak flows for the 2, 6 and 24 hour events (Table 6), it is seen that the 24 hour event produces the maximum peak runoff from each sub-basin and at each combination point in the watershed.

Two factors favor maximum peak runoff from the 24 hour storm on Rodger Creek. The first is an average initial loss of nearly 0.9 inch for the watershed. In the 24 hour storm early precipitation can completely satisfy the initial loss prior to the most intense precipitation, which results in a high percentage of runoff during the heaviest rainfall.

The second factor is that the peak 15 minute rainfall intensity for the SCS Type II 24 hour storm is only slightly less than the 15 minute peak intensities of the 2 and 6 hour storm distributions. Comparison of the graphs of the three precipitation distributions (Figure 3) shows the similarity of peak intensity. Since the 24 hour storm simulation produced the largest peaks throughout the watershed, all of the floodplain delineation flows were selected from the 24 hour flow values.

3.4 Floodplain Delineation Flows

The delineation of Rodger Creek Floodplains will be performed using the flows for the stream reaches shown in Table 7.

TABLE 7
Rodger Creek 100-Year Floodplain Delineation Discharges

Reach	Discharge (cfs)
Skunk Creek to 18th Street	6170
18th Street to 30th Street	5450
Upstream of 30th Street	2890

4.0 References

1. Flood Insurance Study, Flood Insurance Rate Maps; Flood Boundary and Floodway Maps, Federal Emergency Management Agency, Effective date - April 15, 1988.

2. United States Army Corps of Engineers, Hydrologic Engineering Center, "HEC-1 Flood Hydrograph Package Users Manual," March, 1987 and "Flood Hydrograph Package HEC-1 (IBM XT 512k Version) February 1, 1985.

3. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Atlas 2, "Precipitation Frequency Atlas of the Western United States, Volume 8, Arizona," 1973.

4. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NWS HYDRO-40, "Depth-Area Ratios in the Semi-Arid Southwest United States," August 1984.

5. U.S. Department of Agriculture, Soil Conservation Service, "Soil Survey of Aguila - Carefree Area, Parts of Maricopa and Pinal Counties, Arizona," April 1986.

6. U.S. Department of Agriculture, Soil Conservation Service, "Urban Hydrology for Small Watersheds, " Technical Release 55, June 1986.

7. U.S. Army Corps of Engineers, Hydrologic Engineering Center, "HEC-2 Water Surface Profile Users Manual", September 1982 and Water Surface Profiles, Version of November 1976, Updated May 1984, IBM-PC-XT Version, August 1985.

APPENDIX A

ROGER CREEK

HEC-1

100-YEAR 2 HOUR STORM

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

  1           ID                  FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
  2           ID
  3           ID                                FILE:    RC-02
  4           ID
  5           ID        HYDROLOGY FOR:    100-YEAR 2 HOUR EVENT
  6           ID
  7           ID        PURPOSE OF STUDY: DELINEATION OF THE 100-YEAR FLOODPLAIN OF
  8           ID                          RODGER CREEK ABOVE CONFLUENCE WITH SKUNK CREEK
  9           ID
 10           ID        METHODS OF STUDY: HEC-1   DIMENSIONLESS SCS HYDROGRAPH 5 MIN. INTERVALS
 11           ID                          PRECIPITATION- SCS TYPE II STORM BY 15 MIN. INCREMENTS
 12           ID                                      -AREAL REDUCTION NOT USED  < 10 SQ. MI.
 13           ID                          EXCESS PRECIPITATION- INITIAL AND UNIFORM LOSS RATES
 14           ID                                      &  PERCENT IMPERVIOUS
 15           ID                          STREAM ROUTING- MUSKINGUM METHOD
 16           ID
 17           ID        WATERSHED NAME: RODGER CREEK
 18           ID
 19           ID        CONTRACT NUMBER:  FCD 89-15
 20           ID
 21           ID        COMPUTED BY:      BAKER ENGINEERS          DATE:12/07/89
 22           ID                          COMP: SSO 12/07/89       CKD: BMG 12/11/89
              *DIAGRAM
 23           IT       5 01AUG89    1100      60
 24           IO       5

 25           KK   SUBR1
 26           KM        RUNOFF FROM SUBBASIN R-1
 27           BA    1.56
 28           IN      15
 29           PB    2.79
 30           PC      .0    .039    .087    .280    .791    .872    .924    .967   1.000
 31           LU     .85     .16    17.0
 32           UD     .37

 33           KK   RO-1
 34           KM        ROUTE R-1 THROUGH R-2
 35           RM       4      .3      .3

 36           KK   SUBR2
 37           KM        RUNOFF FROM SUBBASIN R-2
 38           BA    1.98
 39           LU     .88     .22    13.8
 40           UD     .46

 41           KK   CO-1
 42           KM        COMBINE RUNOFF FROM SUBBASINS R-1 AND R-2
 43           HC       2

 44           KK   RO-2
 45           KM        ROUTE R-1 AND R-2 THROUGH R-3
 46           RM       5      .4      .3
```

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

  47          KK   SUBR3
  48          KM        RUNOFF FROM SUBBASIN R-3
  49          BA    1.59
  50          LU     .90     .23    20.0
  51          UD     .44

  52          KK   CO-2
  53          KM        COMBINE RUNOFF FROM SUBBASINS R-1, R-2 AND R-3
  54          KO       1
  55          HC       2
  56          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

           (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  25        SUBR1
                V
                V
  33        RO-1
                .
                .
  36            .       SUBR2
                .           .
                .           .
  41        CO-1 ............
                V
                V
  44        RO-2
                .
                .
  47            .       SUBR3
                .           .
                .           .
  52        CO-2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
****

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FILE: RC-02

HYDROLOGY FOR: 100-YEAR 2 HOUR EVENT

PURPOSE OF STUDY: DELINEATION OF THE 100-YEAR FLOODPLAIN OF
RODGER CREEK ABOVE CONFLUENCE WITH SKUNK CREEK

METHODS OF STUDY: HEC-1 DIMENSIONLESS SCS HYDROGRAPH 5 MIN. INTERVALS
PRECIPITATION- SCS TYPE II STORM BY 15 MIN. INCREMENTS
-AREAL REDUCTION NOT USED < 10 SQ. MI.
EXCESS PRECIPITATION- INITIAL AND UNIFORM LOSS RATES
& PERCENT IMPERVIOUS
STREAM ROUTING- MUSKINGUM METHOD

WATERSHED NAME: RODGER CREEK

CONTRACT NUMBER: FCD 89-15

COMPUTED BY: BAKER ENGINEERS DATE:12/07/89
COMP: _____ CKD: _____

```
24 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     1AUG89  STARTING DATE
                  ITIME       1100  STARTING TIME
                     NQ         60  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     1AUG89  ENDING DATE
                 NDTIME       1555  ENDING TIME

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE    4.92 HOURS

      ENGLISH UNITS


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


         **************
         *            *
52 KK    *     CO-2   *
         *            *
         **************

   KO        OUTPUT CONTROL VARIABLES
                  IPRNT          1  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

55 HC        HYDROGRAPH COMBINATION
```

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

HYDROGRAPH AT STATION CO-2
SUM OF 2 HYDROGRAPHS

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1	AUG	1100	1	0.	1	AUG	1215	16	2511.	1	AUG	1330	31	1865.	1	AUG	1445	46	33.
1	AUG	1105	2	1.	1	AUG	1220	17	2962.	1	AUG	1335	32	1540.	1	AUG	1450	47	23.
1	AUG	1110	3	4.	1	AUG	1225	18	3391.	1	AUG	1340	33	1270.	1	AUG	1455	48	16.
1	AUG	1115	4	10.	1	AUG	1230	19	3835.	1	AUG	1345	34	1044.	1	AUG	1500	49	11.
1	AUG	1120	5	19.	1	AUG	1235	20	4288.	1	AUG	1350	35	852.	1	AUG	1505	50	8.
1	AUG	1125	6	32.	1	AUG	1240	21	4721.	1	AUG	1355	36	688.	1	AUG	1510	51	5.
1	AUG	1130	7	46.	1	AUG	1245	22	5083.	1	AUG	1400	37	545.	1	AUG	1515	52	4.
1	AUG	1135	8	66.	1	AUG	1250	23	5285.	1	AUG	1405	38	424.	1	AUG	1520	53	2.
1	AUG	1140	9	95.	1	AUG	1255	24	5239.	1	AUG	1410	39	323.	1	AUG	1525	54	2.
1	AUG	1145	10	136.	1	AUG	1300	25	4937.	1	AUG	1415	40	243.	1	AUG	1530	55	1.
1	AUG	1150	11	235.	1	AUG	1305	26	4445.	1	AUG	1420	41	180.	1	AUG	1535	56	1.
1	AUG	1155	12	443.	1	AUG	1310	27	3861.	1	AUG	1425	42	133.	1	AUG	1540	57	0.
1	AUG	1200	13	822.	1	AUG	1315	28	3269.	1	AUG	1430	43	96.	1	AUG	1545	58	0.
1	AUG	1205	14	1360.	1	AUG	1320	29	2726.	1	AUG	1435	44	69.	1	AUG	1550	59	0.
1	AUG	1210	15	1960.	1	AUG	1325	30	2257.	1	AUG	1440	45	48.	1	AUG	1555	60	0.

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	4.92-HR
5285.	1.83	(CFS)	1245.	1245.	1245.	1245.
		(INCHES)	1.849	1.849	1.849	1.849
		(AC-FT)	506.	506.	506.	506.

CUMULATIVE AREA = 5.13 SQ MI

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUBR1	2568.	1.25	393.	393.	393.	1.56		
ROUTED TO	RO-1	2403.	1.58	393.	393.	393.	1.56		
HYDROGRAPH AT	SUBR2	2674.	1.33	467.	467.	467.	1.98		
2 COMBINED AT	CO-1	4746.	1.50	860.	860.	860.	3.54		
ROUTED TO	RO-2	4439.	1.92	860.	860.	860.	3.54		
HYDROGRAPH AT	SUBR3	2258.	1.33	385.	385.	385.	1.59		
2 COMBINED AT	CO-2	5285.	1.83	1245.	1245.	1245.	5.13		

*** NORMAL END OF HEC-1 ***

APPENDIX B

ROGER CREEK

HEC-1

100-YEAR 6 HOUR STORM

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

  1           ID                  FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
  2           ID
  3           ID                              FILE:    RC-06
  4           ID
  5           ID       HYDROLOGY FOR:    100-YEAR 6 HOUR EVENT
  6           ID
  7           ID       PURPOSE OF STUDY: DELINEATION OF THE 100-YEAR FLOODPLAIN OF
  8           ID                         RODGER CREEK ABOVE CONFLUENCE WITH SKUNK CREEK
  9           ID
 10           ID       METHODS OF STUDY: HEC-1   DIMENSIONLESS SCS HYDROGRAPH 5 MIN. INTERVALS
 11           ID                         PRECIPITATION- SCS TYPE II STORM BY 15 MIN. INCREMENTS
 12           ID                                     -AREAL REDUCTION NOT USED  < 10 SQ. MI.
 13           ID                         EXCESS PRECIPITATION- INITIAL AND UNIFORM LOSS RATES
 14           ID                                     &  PERCENT IMPERVIOUS
 15           ID                         STREAM ROUTING- MUSKINGUM METHOD
 16           ID
 17           ID       WATERSHED NAME: RODGER CREEK
 18           ID
 19           ID       CONTRACT NUMBER:  FCD 89-15
 20           ID
 21           ID       COMPUTED BY:      BAKER ENGINEERS          DATE:12/07/89
 22           ID                         COMP: SSO 12/07/89       CKD: 12/9/89
              *DIAGRAM
 23           IT       5 01OCT89     900     100
 24           IO       5

 25           KK   SUBR1
 26           KM       RUNOFF FROM SUBBASIN R-1
 27           BA    1.56
 28           IN      15
 29           PB    3.50
 30           PC      .0    .011    .022    .035    .048    .062    .079    .100    .125    .155
 31           PC    .192    .339    .729    .791    .830    .862    .887    .908    .926    .942
 32           PC    .956    .969    .980    .990   1.000
 33           LU     .85     .16    17.0
 34           UD     .37

 35           KK   RO-1
 36           KM       ROUTE R-1 THROUGH R-2
 37           RM       4      .3      .3

 38           KK   SUBR2
 39           KM       RUNOFF FROM SUBBASIN R-2
 40           BA    1.98
 41           LU     .88     .22    13.8
 42           UD     .46

 43           KK   CO-1
 44           KM       COMBINE RUNOFF FROM SUBBASINS R-1 AND R-2
 45           HC       2
```

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

  46          KK   RO-2
  47          KM        ROUTE R-1 AND R-2 THROUGH R-3
  48          RM       5      .4      .3

  49          KK   SUBR3
  50          KM        RUNOFF FROM SUBBASIN R-3
  51          BA    1.59
  52          LU     .90     .23    20.0
  53          UD     .44

  54          KK   CO-2
  55          KM        COMBINE RUNOFF FROM SUBBASINS R-1, R-2 AND R-3
  56          KO       1
  57          HC       2
  58          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

           (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  25        SUBR1
                V
                V
  35        RO-1
                .
                .
  38            .       SUBR2
                .           .
                .           .
  43        CO-1 ............
                V
                V
  46        RO-2
                .
                .
  49            .       SUBR3
                .           .
                .           .
  54        CO-2 ............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
****

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FILE: RC-06

HYDROLOGY FOR: 100-YEAR 6 HOUR EVENT

PURPOSE OF STUDY: DELINEATION OF THE 100-YEAR FLOODPLAIN OF
RODGER CREEK ABOVE CONFLUENCE WITH SKUNK CREEK

METHODS OF STUDY: HEC-1 DIMENSIONLESS SCS HYDROGRAPH 5 MIN. INTERVALS
PRECIPITATION- SCS TYPE II STORM BY 15 MIN. INCREMENTS
-AREAL REDUCTION NOT USED < 10 SQ. MI.
EXCESS PRECIPITATION- INITIAL AND UNIFORM LOSS RATES
& PERCENT IMPERVIOUS
STREAM ROUTING- MUSKINGUM METHOD

WATERSHED NAME: RODGER CREEK

CONTRACT NUMBER: FCD 89-15

COMPUTED BY: BAKER ENGINEERS DATE:12/07/89
COMP: _____ CKD: _____

```
24 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     1OCT89  STARTING DATE
                  ITIME       0900  STARTING TIME
                     NQ        100  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     1OCT89  ENDING DATE
                 NDTIME       1715  ENDING TIME

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE    8.25 HOURS

      ENGLISH UNITS


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


         **************
         *            *
54 KK    *     CO-2   *
         *            *
         **************

   KO        OUTPUT CONTROL VARIABLES
                  IPRNT          1  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

57 HC        HYDROGRAPH COMBINATION
```

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

HYDROGRAPH AT STATION CO-2
SUM OF 2 HYDROGRAPHS

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
1 OCT 0900	1	0.	1 OCT 1105	26	125.	1 OCT 1310	51	4020.	1 OCT 1515	76	115.
1 OCT 0905	2	0.	1 OCT 1110	27	131.	1 OCT 1315	52	3371.	1 OCT 1520	77	104.
1 OCT 0910	3	1.	1 OCT 1115	28	139.	1 OCT 1320	53	2794.	1 OCT 1525	78	93.
1 OCT 0915	4	3.	1 OCT 1120	29	147.	1 OCT 1325	54	2307.	1 OCT 1530	79	82.
1 OCT 0920	5	7.	1 OCT 1125	30	156.	1 OCT 1330	55	1909.	1 OCT 1535	80	73.
1 OCT 0925	6	11.	1 OCT 1130	31	166.	1 OCT 1335	56	1586.	1 OCT 1540	81	64.
1 OCT 0930	7	16.	1 OCT 1135	32	179.	1 OCT 1340	57	1326.	1 OCT 1545	82	56.
1 OCT 0935	8	21.	1 OCT 1140	33	211.	1 OCT 1345	58	1115.	1 OCT 1550	83	48.
1 OCT 0940	9	26.	1 OCT 1145	34	279.	1 OCT 1350	59	943.	1 OCT 1555	84	41.
1 OCT 0945	10	32.	1 OCT 1150	35	443.	1 OCT 1355	60	802.	1 OCT 1600	85	34.
1 OCT 0950	11	39.	1 OCT 1155	36	747.	1 OCT 1400	61	684.	1 OCT 1605	86	27.
1 OCT 0955	12	46.	1 OCT 1200	37	1226.	1 OCT 1405	62	587.	1 OCT 1610	87	21.
1 OCT 1000	13	54.	1 OCT 1205	38	1841.	1 OCT 1410	63	505.	1 OCT 1615	88	16.
1 OCT 1005	14	61.	1 OCT 1210	39	2493.	1 OCT 1415	64	437.	1 OCT 1620	89	12.
1 OCT 1010	15	69.	1 OCT 1215	40	3096.	1 OCT 1420	65	380.	1 OCT 1625	90	9.
1 OCT 1015	16	75.	1 OCT 1220	41	3613.	1 OCT 1425	66	332.	1 OCT 1630	91	6.
1 OCT 1020	17	80.	1 OCT 1225	42	4113.	1 OCT 1430	67	292.	1 OCT 1635	92	5.
1 OCT 1025	18	85.	1 OCT 1230	43	4621.	1 OCT 1435	68	257.	1 OCT 1640	93	3.
1 OCT 1030	19	90.	1 OCT 1235	44	5115.	1 OCT 1440	69	227.	1 OCT 1645	94	3.
OCT 1035	20	95.	1 OCT 1240	45	5545.	1 OCT 1445	70	203.	1 OCT 1650	95	2.
OCT 1040	21	99.	1 OCT 1245	46	5842.	1 OCT 1450	71	183.	1 OCT 1655	96	1.
1 OCT 1045	22	103.	1 OCT 1250	47	5927.	1 OCT 1455	72	166.	1 OCT 1700	97	1.
1 OCT 1050	23	108.	1 OCT 1255	48	5739.	1 OCT 1500	73	152.	1 OCT 1705	98	1.
1 OCT 1055	24	113.	1 OCT 1300	49	5300.	1 OCT 1505	74	139.	1 OCT 1710	99	0.
1 OCT 1100	25	119.	1 OCT 1305	50	4692.	1 OCT 1510	75	127.	1 OCT 1715	100	0.

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	8.25-HR
5927.	3.83	(CFS)	1230.	898.	898.	898.
		(INCHES)	2.229	2.238	2.238	2.238
		(AC-FT)	610.	612.	612.	612.

CUMULATIVE AREA = 5.13 SQ MI

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUBR1	2854.	3.25	394.	287.	287.	1.56		
ROUTED TO	RO-1	2652.	3.58	393.	287.	287.	1.56		
HYDROGRAPH AT	SUBR2	3046.	3.33	459.	334.	334.	1.98		
2 COMBINED AT	CO-1	5276.	3.50	852.	621.	621.	3.54		
ROUTED TO	RO-2	4959.	3.83	852.	621.	621.	3.54		
HYDROGRAPH AT	SUBR3	2522.	3.33	379.	277.	277.	1.59		
2 COMBINED AT	CO-2	5927.	3.83	1230.	898.	898.	5.13		

*** NORMAL END OF HEC-1 ***

APPENDIX C

ROGER CREEK

HEC-1

100-YEAR 24 HOUR STORM

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

  1           ID                  FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
  2           ID
  3           ID                              FILE:    RC-24
  4           ID
  5           ID       HYDROLOGY FOR:    100-YEAR 24 HOUR EVENT
  6           ID
  7           ID       PURPOSE OF STUDY: DELINEATION OF THE 100-YEAR FLOODPLAIN OF
  8           ID                         RODGER CREEK ABOVE CONFLUENCE WITH SKUNK CREEK
  9           ID
 10           ID       METHODS OF STUDY: HEC-1   DIMENSIONLESS SCS HYDROGRAPH 5 MIN. INTERVALS
 11           ID                         PRECIPITATION- SCS TYPE II STORM BY 15 MIN. INCREMENTS
 12           ID                                    -AREAL REDUCTION NOT USED  < 10 SQ. MI.
 13           ID                         EXCESS PRECIPITATION- INITIAL AND UNIFORM LOSS RATES
 14           ID                                    &  PERCENT IMPERVIOUS
 15           ID                         STREAM ROUTING- MUSKINGUM METHOD
 16           ID
 17           ID       WATERSHED NAME: RODGER CREEK
 18           ID
 19           ID       CONTRACT NUMBER:  FCD 89-15
 20           ID
 21           ID       COMPUTED BY:      BAKER ENGINEERS          DATE:12/09/89
 22           ID                         COMP: SZO/12/1/89  CKD: BRD 12/9/89
 23           IT      5 01JAN89       0     300
 24           IO      5

 25           KK   SUBR1
 26           KM       RUNOFF FROM SUBBASIN R-1
 27           BA    1.56
 28           IN      15
 29           PB    4.80
 30           PC      .0     .01     .02     .04     .05     .07     .08     .10     .11     .12
 31           PC     .14     .15     .17     .18     .20     .21     .23     .25     .27     .29
 32           PC     .31     .33     .35     .36     .38     .41     .43     .46     .48     .50
 33           PC     .53     .55     .58     .60     .64     .67     .71     .74     .78     .83
 34           PC     .87     .92     .97    1.05    1.13    1.23    1.36    1.86    3.18    3.39
 35           PC    3.53    3.64    3.72    3.80    3.86    3.91    3.96    4.00    4.04    4.08
 36           PC    4.11    4.14    4.17    4.20    4.23    4.26    4.29    4.31    4.33    4.36
 37           PC    4.38    4.41    4.43    4.44    4.46    4.48    4.50    4.52    4.54    4.56
 38           PC    4.57    4.59    4.60    4.62    4.63    4.65    4.66    4.68    4.69    4.70
 39           PC    4.72    4.73    4.75    4.76    4.78    4.79    4.80
 40           LU     .85     .16    17.0
 41           UD     .37

 42           KK   RO-1
 43           KM       ROUTE R-1 THROUGH R-2
 44           RM      4      .3      .3

 45           KK   SUBR2
 46           KM       RUNOFF FROM SUBBASIN R-2
 47           BA    1.98
 48           LU     .88     .22    13.8
 49           UD     .46
```

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

  50          KK   CO-1
  51          KM        COMBINE RUNOFF FROM SUBBASINS R-1 AND R-2
  52          HC       2

  53          KK   RO-2
  54          KM        ROUTE R-1 AND R-2 THROUGH R-3
  55          RM       5      .4      .3

  56          KK   SUBR3
  57          KM        RUNOFF FROM SUBBASIN R-3
  58          BA    1.59
  59          LU     .90     .23    20.0
  60          UD     .44

  61          KK   CO-2
  62          KM        COMBINE RUNOFF FROM SUBBASINS R-1, R-2 AND R-3
  63          KO       1
  64          HC       2
  65          ZZ
```

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985
U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616
****

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FILE: RC-24

HYDROLOGY FOR: 100-YEAR 24 HOUR EVENT

PURPOSE OF STUDY: DELINEATION OF THE 100-YEAR FLOODPLAIN OF
RODGER CREEK ABOVE CONFLUENCE WITH SKUNK CREEK

METHODS OF STUDY: HEC-1 DIMENSIONLESS SCS HYDROGRAPH 5 MIN. INTERVALS
PRECIPITATION- SCS TYPE II STORM BY 15 MIN. INCREMENTS
-AREAL REDUCTION NOT USED < 10 SQ. MI.
EXCESS PRECIPITATION- INITIAL AND UNIFORM LOSS RATES
& PERCENT IMPERVIOUS
STREAM ROUTING- MUSKINGUM METHOD

WATERSHED NAME: RODGER CREEK

CONTRACT NUMBER: FCD 89-15

COMPUTED BY: BAKER ENGINEERS DATE:12/09/89
COMP: _____ CKD: _____

```
24 IO        OUTPUT CONTROL VARIABLES
                  IPRNT          5  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     1JAN89  STARTING DATE
                  ITIME       0000  STARTING TIME
                     NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     2JAN89  ENDING DATE
                 NDTIME       0055  ENDING TIME

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE   24.92 HOURS

      ENGLISH UNITS


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


         **************
         *            *
61 KK    *     CO-2   *
         *            *
         **************

   IO        OUTPUT CONTROL VARIABLES
                  IPRNT          1  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE

64 HC        HYDROGRAPH COMBINATION
```

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

HYDROGRAPH AT STATION CO-2
SUM OF 2 HYDROGRAPHS

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
1 JAN 0000	1	0.	1 JAN 0615	76	41.	1 JAN 1230	151	5259.	1 JAN 1845	226	46.
1 JAN 0005	2	0.	1 JAN 0620	77	41.	1 JAN 1235	152	5671.	1 JAN 1850	227	45.
1 JAN 0010	3	0.	1 JAN 0625	78	42.	1 JAN 1240	153	5990.	1 JAN 1855	228	43.
1 JAN 0015	4	1.	1 JAN 0630	79	42.	1 JAN 1245	154	6167.	1 JAN 1900	229	42.
1 JAN 0020	5	2.	1 JAN 0635	80	43.	1 JAN 1250	155	6143.	1 JAN 1905	230	41.
1 JAN 0025	6	3.	1 JAN 0640	81	43.	1 JAN 1255	156	5867.	1 JAN 1910	231	41.
1 JAN 0030	7	4.	1 JAN 0645	82	45.	1 JAN 1300	157	5366.	1 JAN 1915	232	41.
1 JAN 0035	8	5.	1 JAN 0650	83	46.	1 JAN 1305	158	4718.	1 JAN 1920	233	41.
1 JAN 0040	9	7.	1 JAN 0655	84	48.	1 JAN 1310	159	4025.	1 JAN 1925	234	42.
1 JAN 0045	10	9.	1 JAN 0700	85	50.	1 JAN 1315	160	3365.	1 JAN 1930	235	42.
1 JAN 0050	11	12.	1 JAN 0705	86	51.	1 JAN 1320	161	2785.	1 JAN 1935	236	43.
1 JAN 0055	12	14.	1 JAN 0710	87	52.	1 JAN 1325	162	2298.	1 JAN 1940	237	43.
1 JAN 0100	13	16.	1 JAN 0715	88	52.	1 JAN 1330	163	1899.	1 JAN 1945	238	43.
1 JAN 0105	14	19.	1 JAN 0720	89	52.	1 JAN 1335	164	1574.	1 JAN 1950	239	43.
1 JAN 0110	15	21.	1 JAN 0725	90	52.	1 JAN 1340	165	1311.	1 JAN 1955	240	43.
1 JAN 0115	16	23.	1 JAN 0730	91	52.	1 JAN 1345	166	1099.	1 JAN 2000	241	43.
1 JAN 0120	17	25.	1 JAN 0735	92	53.	1 JAN 1350	167	926.	1 JAN 2005	242	42.
1 JAN 0125	18	27.	1 JAN 0740	93	53.	1 JAN 1355	168	786.	1 JAN 2010	243	42.
1 JAN 0130	19	29.	1 JAN 0745	94	53.	1 JAN 1400	169	672.	1 JAN 2015	244	41.
JAN 0135	20	30.	1 JAN 0750	95	52.	1 JAN 1405	170	577.	1 JAN 2020	245	40.
JAN 0140	21	30.	1 JAN 0755	96	52.	1 JAN 1410	171	497.	1 JAN 2025	246	40.
1 JAN 0145	22	31.	1 JAN 0800	97	52.	1 JAN 1415	172	428.	1 JAN 2030	247	39.
1 JAN 0150	23	32.	1 JAN 0805	98	53.	1 JAN 1420	173	370.	1 JAN 2035	248	38.
1 JAN 0155	24	32.	1 JAN 0810	99	53.	1 JAN 1425	174	320.	1 JAN 2040	249	37.
1 JAN 0200	25	33.	1 JAN 0815	100	54.	1 JAN 1430	175	277.	1 JAN 2045	250	36.
1 JAN 0205	26	33.	1 JAN 0820	101	54.	1 JAN 1435	176	241.	1 JAN 2050	251	35.
1 JAN 0210	27	32.	1 JAN 0825	102	54.	1 JAN 1440	177	212.	1 JAN 2055	252	35.
1 JAN 0215	28	32.	1 JAN 0830	103	55.	1 JAN 1445	178	188.	1 JAN 2100	253	35.
1 JAN 0220	29	31.	1 JAN 0835	104	56.	1 JAN 1450	179	170.	1 JAN 2105	254	34.
1 JAN 0225	30	31.	1 JAN 0840	105	58.	1 JAN 1455	180	154.	1 JAN 2110	255	34.
1 JAN 0230	31	31.	1 JAN 0845	106	59.	1 JAN 1500	181	140.	1 JAN 2115	256	33.
1 JAN 0235	32	31.	1 JAN 0850	107	60.	1 JAN 1505	182	128.	1 JAN 2120	257	33.
1 JAN 0240	33	31.	1 JAN 0855	108	62.	1 JAN 1510	183	117.	1 JAN 2125	258	34.
1 JAN 0245	34	31.	1 JAN 0900	109	63.	1 JAN 1515	184	108.	1 JAN 2130	259	34.
1 JAN 0250	35	31.	1 JAN 0905	110	65.	1 JAN 1520	185	101.	1 JAN 2135	260	33.
1 JAN 0255	36	30.	1 JAN 0910	111	67.	1 JAN 1525	186	94.	1 JAN 2140	261	33.
1 JAN 0300	37	30.	1 JAN 0915	112	69.	1 JAN 1530	187	89.	1 JAN 2145	262	33.
1 JAN 0305	38	31.	1 JAN 0920	113	70.	1 JAN 1535	188	85.	1 JAN 2150	263	33.
1 JAN 0310	39	31.	1 JAN 0925	114	72.	1 JAN 1540	189	82.	1 JAN 2155	264	33.
1 JAN 0315	40	32.	1 JAN 0930	115	73.	1 JAN 1545	190	78.	1 JAN 2200	265	33.
1 JAN 0320	41	32.	1 JAN 0935	116	74.	1 JAN 1550	191	76.	1 JAN 2205	266	33.
1 JAN 0325	42	32.	1 JAN 0940	117	76.	1 JAN 1555	192	73.	1 JAN 2210	267	33.
1 JAN 0330	43	32.	1 JAN 0945	118	78.	1 JAN 1600	193	72.	1 JAN 2215	268	32.
1 JAN 0335	44	33.	1 JAN 0950	119	80.	1 JAN 1605	194	70.	1 JAN 2220	269	32.
1 JAN 0340	45	33.	1 JAN 0955	120	81.	1 JAN 1610	195	69.	1 JAN 2225	270	31.
1 JAN 0345	46	33.	1 JAN 1000	121	83.	1 JAN 1615	196	68.	1 JAN 2230	271	31.
1 JAN 0350	47	33.	1 JAN 1005	122	84.	1 JAN 1620	197	68.	1 JAN 2235	272	31.
JAN 0355	48	33.	1 JAN 1010	123	86.	1 JAN 1625	198	67.	1 JAN 2240	273	31.
1 JAN 0400	49	33.	1 JAN 1015	124	87.	1 JAN 1630	199	67.	1 JAN 2245	274	31.
1 JAN 0405	50	33.	1 JAN 1020	125	90.	1 JAN 1635	200	67.	1 JAN 2250	275	31.
1 JAN 0410	51	34.	1 JAN 1025	126	92.	1 JAN 1640	201	66.	1 JAN 2255	276	30.
1 JAN 0415	52	34.	1 JAN 1030	127	94.	1 JAN 1645	202	66.	1 JAN 2300	277	30.
1 JAN 0420	53	35.	1 JAN 1035	128	98.	1 JAN 1650	203	65.	1 JAN 2305	278	31.

1 JAN 0425	54	36.	*	1 JAN 1040	129	103.	*	1 JAN 1655	204	64.	*	1 JAN 2310	279	31.
1 JAN 0430	55	36.	*	1 JAN 1045	130	112.	*	1 JAN 1700	205	62.	*	1 JAN 2315	280	32.
1 JAN 0435	56	37.	*	1 JAN 1050	131	126.	*	1 JAN 1705	206	61.	*	1 JAN 2320	281	32.
1 JAN 0440	57	37.	*	1 JAN 1055	132	143.	*	1 JAN 1710	207	60.	*	1 JAN 2325	282	32.
1 JAN 0445	58	38.	*	1 JAN 1100	133	163.	*	1 JAN 1715	208	59.	*	1 JAN 2330	283	32.
JAN 0450	59	39.	*	1 JAN 1105	134	187.	*	1 JAN 1720	209	58.	*	1 JAN 2335	284	33.
1 JAN 0455	60	40.	*	1 JAN 1110	135	215.	*	1 JAN 1725	210	57.	*	1 JAN 2340	285	33.
1 JAN 0500	61	41.	*	1 JAN 1115	136	249.	*	1 JAN 1730	211	56.	*	1 JAN 2345	286	33.
1 JAN 0505	62	42.	*	1 JAN 1120	137	289.	*	1 JAN 1735	212	55.	*	1 JAN 2350	287	33.
1 JAN 0510	63	43.	*	1 JAN 1125	138	336.	*	1 JAN 1740	213	54.	*	1 JAN 2355	288	33.
1 JAN 0515	64	43.	*	1 JAN 1130	139	389.	*	1 JAN 1745	214	54.	*	2 JAN 0000	289	32.
1 JAN 0520	65	43.	*	1 JAN 1135	140	464.	*	1 JAN 1750	215	54.	*	2 JAN 0005	290	31.
1 JAN 0525	66	44.	*	1 JAN 1140	141	574.	*	1 JAN 1755	216	54.	*	2 JAN 0010	291	30.
1 JAN 0530	67	44.	*	1 JAN 1145	142	735.	*	1 JAN 1800	217	54.	*	2 JAN 0015	292	29.
1 JAN 0535	68	44.	*	1 JAN 1150	143	994.	*	1 JAN 1805	218	54.	*	2 JAN 0020	293	28.
1 JAN 0540	69	44.	*	1 JAN 1155	144	1368.	*	1 JAN 1810	219	54.	*	2 JAN 0025	294	26.
1 JAN 0545	70	43.	*	1 JAN 1200	145	1888.	*	1 JAN 1815	220	53.	*	2 JAN 0030	295	24.
1 JAN 0550	71	42.	*	1 JAN 1205	146	2527.	*	1 JAN 1820	221	51.	*	2 JAN 0035	296	22.
1 JAN 0555	72	42.	*	1 JAN 1210	147	3198.	*	1 JAN 1825	222	50.	*	2 JAN 0040	297	19.
1 JAN 0600	73	41.	*	1 JAN 1215	148	3810.	*	1 JAN 1830	223	49.	*	2 JAN 0045	298	17.
1 JAN 0605	74	41.	*	1 JAN 1220	149	4323.	*	1 JAN 1835	224	48.	*	2 JAN 0050	299	15.
1 JAN 0610	75	41.	*	1 JAN 1225	150	4801.	*	1 JAN 1840	225	47.	*	2 JAN 0055	300	12.
			*				*				*			

****

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
6167.	12.75	(CFS)	1365.	373.	360.	360.
		(INCHES)	2.473	2.705	2.706	2.706
		(AC-FT)	677.	740.	740.	740.

CUMULATIVE AREA = 5.13 SQ MI

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUBR1	2889.	12.25	438.	119.	115.	1.56		
ROUTED TO	RO-1	2690.	12.50	438.	119.	115.	1.56		
HYDROGRAPH AT	SUBR2	3149.	12.33	509.	138.	133.	1.98		
2 COMBINED AT	CO-1	5445.	12.42	948.	257.	248.	3.54		
ROUTED TO	RO-2	5170.	12.83	947.	257.	248.	3.54		
HYDROGRAPH AT	SUBR3	2589.	12.33	417.	116.	112.	1.59		
2 COMBINED AT	CO-2	6167.	12.75	1365.	373.	360.	5.13		

*** NORMAL END OF HEC-1 ***

APPENDIX D

ROGER CREEK

DATA SUPPLIED

BY

FLOOD CONTROL DISTRICT OF

MARICOPA COUNTY

SCS TYPE II DISTRIBUTION

2-HOUR DISTRIBUTION

Time Inc.(Hr)	Cumulative ppt
0.00	0.000
0.25	0.039
0.50	0.087
0.75	0.280
1.00	0.791
1.25	0.872
1.50	0.924
1.75	0.967
2.00	1.000

6-HOUR DISTRIBUTION

Time Inc.(Hr)	Cumulative ppt
0.00	0.000
0.25	0.011
0.50	0.022
0.75	0.035
1.00	0.048
1.25	0.062
1.50	0.079
1.75	0.100
2.00	0.125
2.25	0.155
2.50	0.192
2.75	0.339
3.00	0.729
3.25	0.791
3.50	0.830
3.75	0.862
4.00	0.887
4.25	0.908
4.50	0.926
4.75	0.942
5.00	0.956
5.25	0.969
5.50	0.980
5.75	0.990
6.00	1.000

24-HOUR DISTRIBUTION

Time Inc.(Hr)	Cumulative ppt	Time Inc.(Hr)	Cumulative ppt
0.00	0.000	12.00	0.663
0.25	0.002	12.25	0.707
0.50	0.005	12.50	0.735
0.75	0.008	12.75	0.758
1.00	0.011	13.00	0.776
1.25	0.014	13.25	0.791
1.50	0.017	13.50	0.804
1.75	0.020	13.75	0.815
2.00	0.023	14.00	0.825
2.25	0.026	14.25	0.834
2.50	0.029	14.50	0.842
2.75	0.032	14.75	0.849
3.00	0.035	15.00	0.856
3.25	0.038	15.25	0.863
3.50	0.041	15.50	0.869
3.75	0.044	15.75	0.875
4.00	0.048	16.00	0.881
4.25	0.052	16.25	0.887
4.50	0.056	16.50	0.893
4.75	0.060	16.75	0.898
5.00	0.064	17.00	0.903
5.25	0.068	17.25	0.908
5.50	0.072	17.50	0.913
5.75	0.076	17.75	0.918
6.00	0.080	18.00	0.922
6.25	0.085	18.25	0.926
6.50	0.090	18.50	0.930
6.75	0.095	18.75	0.934
7.00	0.100	19.00	0.938
7.25	0.105	19.25	0.942
7.50	0.110	19.50	0.946
7.75	0.115	19.75	0.950
8.00	0.120	20.00	0.953
8.25	0.126	20.25	0.956
8.50	0.133	20.50	0.959
8.75	0.140	20.75	0.962
9.00	0.147	21.00	0.965
9.25	0.155	21.25	0.968
9.50	0.163	21.50	0.971
9.75	0.172	21.75	0.974
10.00	0.181	22.00	0.977
10.20	0.191	22.25	0.980
10.50	0.203	22.50	0.983
10.75	0.218	22.75	0.986
11.00	0.236	23.00	0.989
11.25	0.257	23.25	0.992
11.50	0.283	23.50	0.995
11.75	0.387	23.75	0.998
		24.00	1.000

Red Lake
BAKER
Flood Control District
Maricopa County

TABLE 1

Surface retention loss for various land surfaces in Maricopa County (addition to STRTL for IL+ULR method and IA for Green and Ampt method)

Land-Use and/or Surface Cover	Surface Retention Loss inches
(1)	(2)
Natural	
Desert and rangeland, flat slope	.35
Hillslopes, Sonoran desert	.15
Mountain, brush	.25
Developed (Residential and Commercial)	
Lawn and turf	.20
Desert landscape	.10
Pavement	.05
Agricultural	
Tilled	1.00
Irrigated pasture	.50

TABLE 4

Initial Loss plus Uniform Loss Rate parameter values
for bare ground according to soil texture classification

Soil texture Classification	Uniform Loss Rate CNSTL	Initial Loss, In inches STRTL[1]		
		Dry	Normal	Saturated
(1)	(2)	(3)	(4)	(5)
sand	4.6	1.3	1.3	0
loamy sand	1.2	.8	.8	0
sandy loam	.4	.7	.6	0
loam	.15	.6	.5	0
silty loam	.25	.8	.7	0
sandy clay loam	.06	.6	.5	0
clay loam	.04	.5	.4	0
silty clay loam	.04	.6	.5	0
sandy clay	.02	.4	.3	0
silty clay	.02	.4	.3	0
clay	.01	.3	.2	0

[1] Selection of STRTL:

Dry - for nonirrigated lands such as desert and rangeland

Normal - for irrigated lawn, turf, and permanent pasture

Saturated - for irrigated agricultural land

APPENDIX E

ROGER CREEK

CALCULATIONS:

PRECIPITATION DATA

Baker Engineers

S.O. No. 16923-HPH

Subject: FCD Floodplain Delineation
Rodger Creek Hydrology
Input Data Summary

Sheet No. ___ of ___

Drawing No. ___

Computed by BD 10/17/89 Checked By TEK Date 10/18/89

Precipitation 100-year (IN.)	2 hr	6 hr	24 hr
	2.79	3.50	4.80

Sub-basin Data	Area (MI^2)	Loss Rates Uniform CNSTL (IN/HR)	Initial STRTL (IN)	Percent Impervious	Lag Time (HR.)
R-1	1.56	0.16	0.85	17.0	0.37
R-2	1.98	0.22	0.88	13.8	0.46
R-3	1.59	0.23	0.90	20.0	0.44

Routing Reach Data	Travel Time (HR)	Weighting Factor, X	Number of Sub-reaches
RO-1	0.30	0.3	4
RO-2	0.40	0.3	5

E 6

Baker Engineers

S.O. No.

Subject: FCD Flood Delin. Study
Precipitation - 2 Hour Storm
Point Precip. Values

Sheet No. ___ of ___

Drawing No.

Computed by BRJ 10-12-89 Checked By DRA Date 18 Oct 89

Rodger Creek - Cline Creek

NOAA Atlas 100-year Precipitation

* P-24 hr = 4.8"

** P-6hr = 3.5"

$$P\text{-}1hr = 0.494 + 0.755 \frac{(P\text{-}6hr)^2}{P\text{-}24hr}$$

$$= 2.42''$$

$$P\text{-}2\,hr = 0.341 * P\text{-}6hr + 0.659 * P\text{-}1hr$$

$$= \underline{\underline{2.79''}}$$

Morgan City Wash

* P-24hr = 4.5"

** P-6hr = 3.4"

$$P\text{-}1hr = 0.494 + 0.755 \frac{(3.4'')^2}{4.5''}$$

$$= 2.43''$$

$$P\text{-}2hr = 0.341 * 3.4'' + 0.659 * 2.43''$$

$$= 2.76''$$

*NOAA Atlas 2 Vol. VIII fig. 29

** " " " " " fig. 23

E 3

- to 6-hr).

00 ft had ratios

data and data
f Arizona. This
is over 6,000 ft
es were concen-
or just slightly
he data suggest
exclusively rain
ues from the
would likely
00-yr return
duration, differ-
0 percent at all
not indicate sig-
and the series

or

and 24-hr dura-
other durations
he 6- and 24-hr
lowing sections.
-, and 3-hr esti-
The procedures
and for 12-hr
nical Paper No.
tigation demon-
covered by this

Table 11. *Equations for estimating 1-hr values in Arizona with statistical parameters for each equation*

Equation	Corr. coeff.	No. of stations	Mean of computed stn. values (inches)	Standard error of estimate (inches)
$Y_2 = -0.011 + 0.942[(X_1)(X_1/X_2)]$	0.95	86	0.72	0.085
$Y_{100} = 0.494 + 0.755[(X_3)(X_3/X_4)]$	.90	85	1.96	.290

List of variables
Y_2 = 2-yr 1-hr estimated value
Y_{100} = 100-yr 1-hr estimated value
X_1 = 2-yr 6-hr value from precipitation-frequency maps
X_2 = 2-yr 24-hr value from precipitation-frequency maps
X_3 = 100-yr 6-hr value from precipitation-frequency maps
X_4 = 100-yr 24-hr value from precipitation-frequency maps

Procedures for estimating 1-hr (60-min) precipitation-frequency values. Multiple-regression screening techniques were used to develop equations for estimating 1-hr values. Factors considered in the screening process were restricted to those that could be determined easily from the maps of this Atlas or from generally available topographic maps.

The 11 western states were separated into several geographic regions. The regions were chosen on the basis of meteorological and climatological homogeneity and are generally combinations of river basins separated by prominent divides. Arizona is located wholly within a region that extends from the crest of the Continental Divide, the Sangre de Cristo Range, and the Sacramento Mountains in Colorado and New Mexico westward to southwestern California, the Virgin River Basin in Nevada, and the Wasatch divide in Utah. Equations to provide estimates for the 1-hr duration for 2- and 100-yr return periods are shown in table 11. Also listed are the statistical parameters associated with each equation. In these equations, the variable $[(X_1)(X_1/X_2)]$ or $[(X_3)(X_3/X_4)]$ can be regarded as the 6-hr value times the slope of the line connecting the 6- and 24-hr values for the appropriate return period.

Estimates of 1-hr precipitation-frequency values for return periods between 2 and 100 yrs. The 1-hr values for the 2- and 100-yr return periods can be plotted on the nomogram of figure 6 to obtain values for return periods greater than 2 yrs or less than 100 yrs. Draw a straight line connecting the 2- and 100-yr values and read the desired return-period value from the nomogram.

Estimates for 2- and 3-hr (120- and 180-min) precipitation-frequency values. To obtain estimates of precipitation-frequency values for 2 or 3 hrs, plot the 1- and 6-hr values from the Atlas on the appropriate nomogram of figure 15. Draw a straight line connecting the 1- and 6-hr values, and read the 2- and 3-hr values from the nomogram. This nomogram is independent of return period. It was developed using data from the same regions used to develop the 1-hr equations.

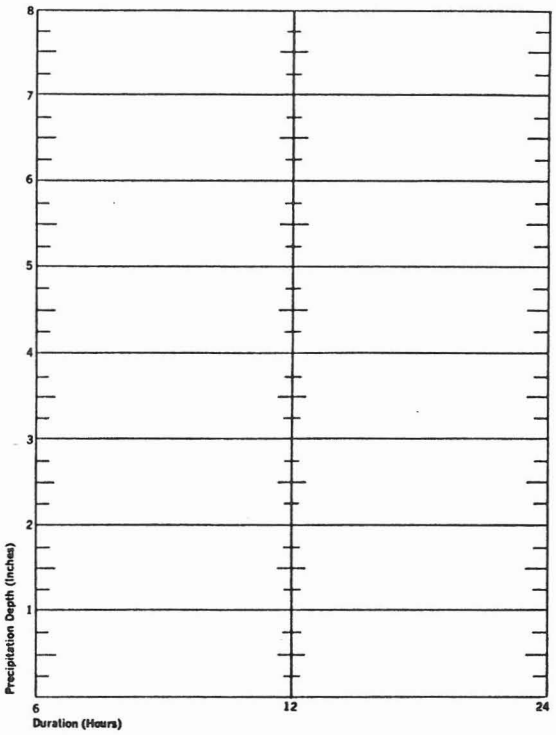


Figure 16. *Precipitation depth-duration diagram (6- to 24-hr).*

E 4

Table 12. *Adjustment fro*

Duration (min)	
Ratio to 1-hr	C

(Adopted from *U.S. W* 1961.)

The mathematical solution from the data used to develop figure 15 gives the following equations for estimating the 2- and 3-hr values in Arizona;

$$\text{2-hr} = 0.341\ (\text{6-hr}) + 0.659\ (\text{1-hr}) \quad (3)$$

$$\text{3-hr} = 0.569\ (\text{6-hr}) + 0.431\ (\text{1-hr}) \quad (4)$$

Estimates for 12-hr (720-min) precipitation-frequency values. To obtain estimates for the 12-hr duration, plot values from the 6- and 24-hr maps in figure 16. Read the 12-hr estimates at the intersection of the line connecting these points with the 12-hr duration line of the nomogram.

Estimates for less than 1 hr. To obtain estimates for durations of less than 1 hr, apply the values in table 12 to the 1-hr value for the return period of interest.

Illustration of Use of Precipitation-Frequency Maps, Diagrams, and Equations

To illustrate the use of these maps, values were read from figures 18 to 29 for the point at 34°00′ N. and 113°00′ W. These values are shown in boldface type in table 13. The values read from the maps should be plotted on the return-period diagram of figure 6 because (1) not all points are as easy to locate on a series of maps as are latitude-longitude intersections, (2) there may be some slight registration differences in printing, and (3) precise interpolation between isolines is difficult. This has been done for the 24-hr values in table 13 (fig. 17a) and a line of best fit has been drawn subjectively. On this nomogram, the 25-yr return-period value appears somewhat off the line, so the value read from the maps is corrected (as shown by the strikeout in table 13); such corrected values are adopted in preference to the original readings.

The 2- and 100-yr 1-hr values for the point were computed from the equations in table 11. The 2-yr 1-hr value is estimated at 1.08 in. (2-yr 6- and 24-hr values from table 13); the estimated 100-yr 1-hr value is 2.52 in. (100-yr 6- and 24-hr values from table 13). By plotting these 1-hr values on figure 6 and connecting them with a straight line, one can obtain estimates for return periods of 5, 10, 25, and 50 yrs.

The 2- and 3-hr values can be estimated by using the nomogram of figure 15 or equations (3) and (4). The 1- and 6-hr values for the desired return period are obtained as above. Plot these points on the nomogram of figure 15 and connect them with a straight line. Read the estimates for 2 and 3 hrs at the intersections of the connecting line and the 2- and 3-hr vertical lines. An example is shown in figure 17b for the 2-yr return period. The 2-yr 2-hr (1.17 in.) and 2-yr 3-hr (1.23 in.) values are in italics in table 13.

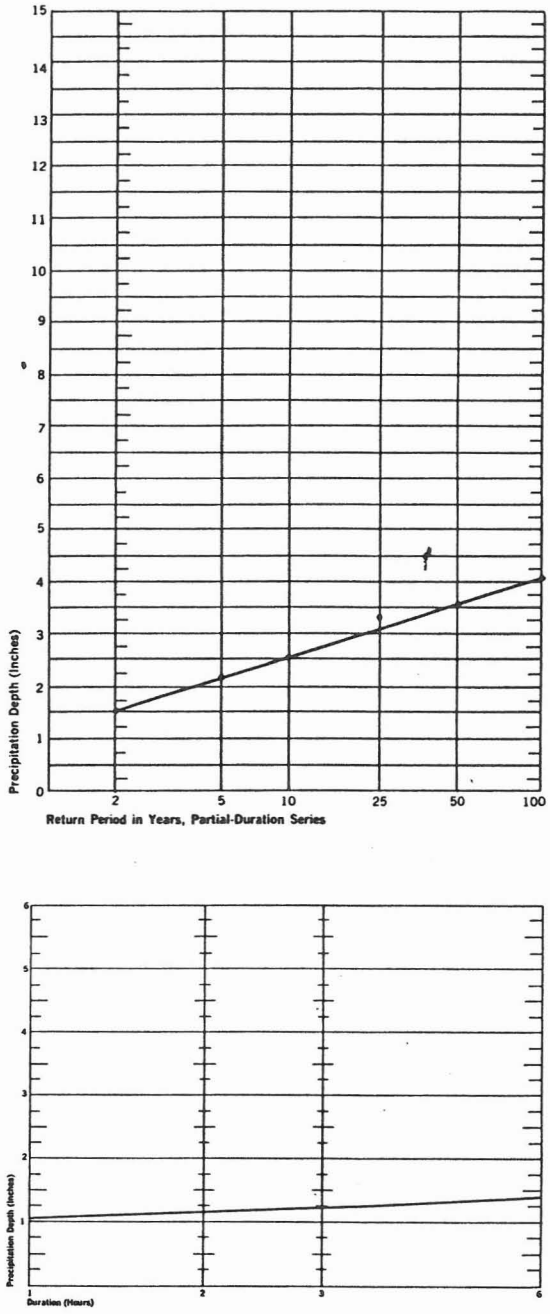


Figure 17. *Illustration of use of precipitation-frequency diagrams using values from precipitation-frequency maps and relations.*

Baker Engineers

S.O. No.

Subject: Project # 16923

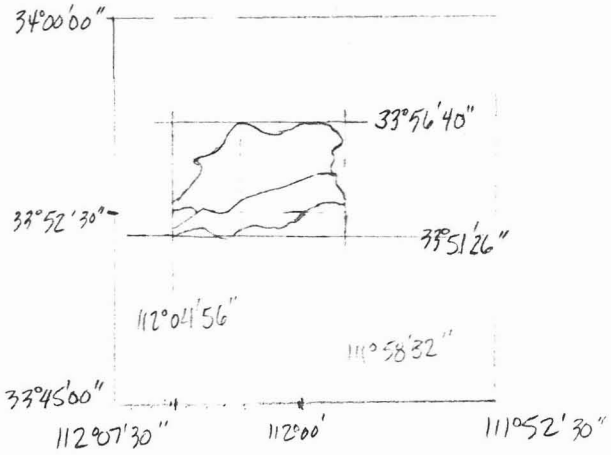
Sheet No. of

Drawing No.

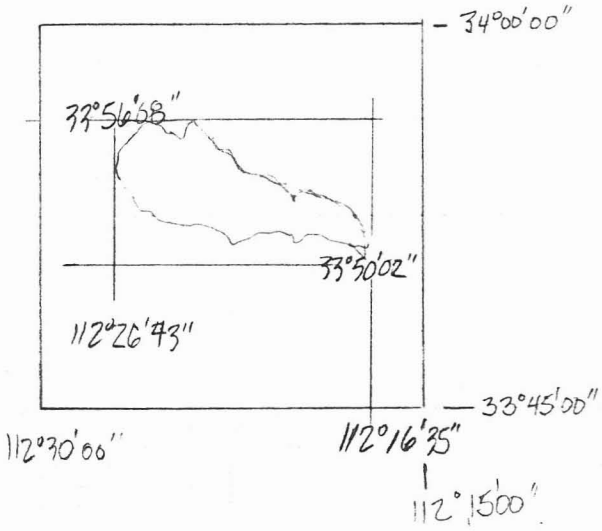
Computed by SAR Checked By 10-12-89 Date 6/16/89

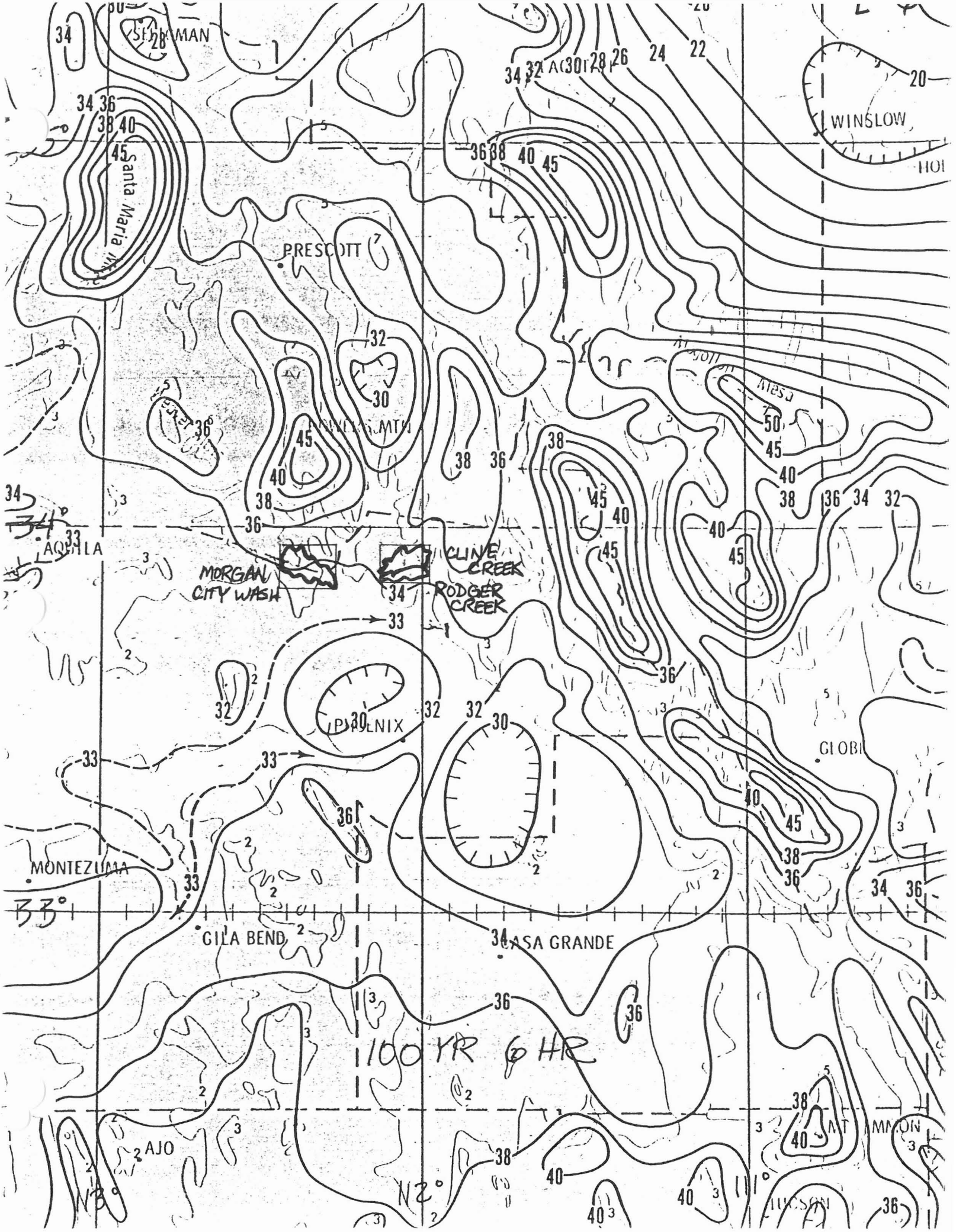
Cline Creek / Rodger Creek

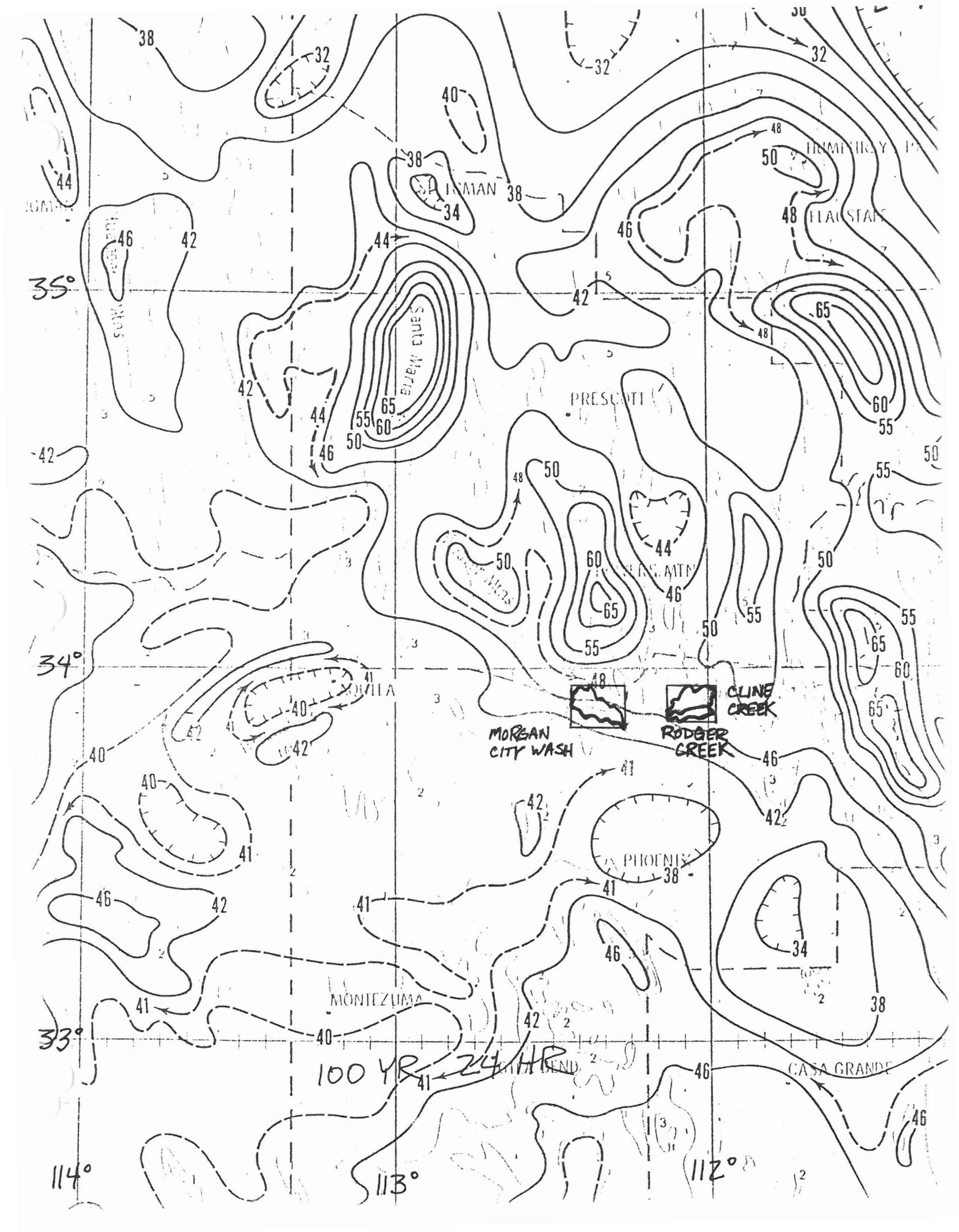
Exact Locations



Morgan City Wash




SEDMAN
WINSLOW
Santa Maria
PRESCOTT
Mesa
AQUILA
MORGAN CITY WASH
CLINE CREEK
RODGER CREEK
PHOENIX
GLOBE
MONTEZUMA
GILA BEND
CASA GRANDE
100 YR 6 HR
AJO
MT MAGON
TUCSON


35°
34°
33°
114°
113°
112°
PRESCOTT
PHOENIX
MONTEZUMA
CASA GRANDE
Santa Maria
MORGAN CITY WASH
RODGER CREEK
CLINE CREEK
100 YR 24 HR

APPENDIX F

ROGER CREEK

CALCULATIONS:

LOSS RATES AND

PERCENT IMPERVIOUS

Baker Engineers

S.O. No. 16923-04

Subject: Rodgers Creek

Sheet No. 3 of 13

Drawing No.

Computed by SAR Checked By [illegible] Date 08/10/89

Combine Sub R-1A & R-1B into R-1

Sub R-1 (Area = 999 Acres)

Soil Map Symbol	Uniform (CNSTL)	Initial (STRTL)	Area
26	.09	.53	365
66	.40	.70	8
72	.18	.64	566
95	.35	.69	55
96	.25	.66	5

$$CNSTL = \frac{(365)(.09)+(8)(.40)+(566)(.18)+(55)(.35)+(5)(.25)}{999}$$

$$= .16$$

$$STRTL' = \frac{(365)(.53)+(8)(.70)+(566)(.64)+(55)(.69)+(5)(.66)}{999}$$

$$= .60$$

$$STRTL = .60 + .25 = .85$$

Baker Engineers

S.O. No. 16923-04

Subject: Rodger Creek
Uniform & Initial Loss Rates
by new Soil Texture Classification

Sheet No. 4 of 13
~~Drawing No.~~ (2 of 3)

Computed by SAR Checked By CMJR Date 08/07/89

Sub R-2 (Area = 1270 Ac)

Soil Map Symbol	Uniform (CNSTL)	Initial (STRTL)	Area
✓26	.09	.53	16+73+101+148 = 275
66	.40	.70	132+8+65+43 = 248
72	.18	.64	296+287 = 583
93	.40	.70	10
95	.35	.69	138
96	.25	.66	16

$$CNSTL = \frac{(275)(.09)+(248)(.40)+(583)(.18)+(10)(.40)+(138)(.35)+(16)(.25)}{1270}$$

$$= .22$$

$$STRTL' = \frac{(275)(.53)+(248)(.70)+(583)(.64)+(10)(.70)+(138)(.69)+(16)(.66)}{1270}$$

$$= .63$$

$$STRTL = .63 + .25 = .88$$

Baker Engineers

S.O. No. 16923-04

Subject: Rodger Creek
Uniform & Initial Loss Rates by new Soil Texture Classification

Sheet No. 5 of 13
~~Drawing No.~~ (3 of 3)

Computed by SAR Checked By [illegible] Date 08/07/89

Sub R-3 (Area = 1017 Ac)

Soil Map Symbol	Uniform (CNSTL)	Initial (STRTL)	Area.
12	.04	.50	8
26	.09	.53	28+12 = 40
44	.33	.66	22+5+6 = 33
52	.40	.70	43
66	.40	.70	7
68	.40	.70	6
72	.18	.64	154 + 495 = 649
96	.25	.66	53
98	.40	.70	99
110	.40	.70	38+17+21+3 = 79

$$CNSTL = \frac{(8)(.04)+(40)(.09)+(33)(.33)+(43+7+6+99+79)(.40)+(649)(.18)+(53)(.25)}{1017}$$

$$= .23$$

$$STRTL' = \frac{(8)(.50)+(40)(.53)+(33)(.66)+(43+7+6+99+79)(.70)+(649)(.64)+(53)(.66)}{1017}$$

$$= .65$$

$$STRTL = .65 + .25 = .90$$

Baker Engineers

S.O. No. 16923-04

Subject: Rodger Creek

Sheet No. 8 of 13

~~Drawing No.~~ (1 of 1)

Computed by SAR Checked By [illegible] Date 08/09/89

Combined into R-1

Percent Impervious in each Sub-Basin:

Sub R-1A

Soil #72, 30% Impervious

Area of #72 = 421 Acres

(.30)(421) = 126 Acres

Percent impervious in Sub R-1A : $\frac{126}{824}$ = 15.3% = RTIMP

Sub R-1B

Soil #72, 30% Impervious.

Area of #72 = 145 Acres

RTIMP = $\frac{(.30)(145)}{175}$ = 24.9%

Sub R-2

Soil #72, 30% Impervious

Area of #72 = 583 Acres

RTIMP = $\frac{(.30)(583)}{1270}$ = 13.8%

Sub R-3

Soil #52, 20% Impervious, Soil #72, 30% Impervious

Area of #52 = 43 Acres, Area of #72 = 649 Acres.

RTIMP = $\frac{(.20)(43)+(.30)(649)}{1017}$ = 20.0%

Baker Engineers

Subject: Rodger Creek

S.O. No. 16923-04

Sheet No. 9 of 13

Drawing No.

Computed by SAC Checked By [illegible] Date 08/09/89

Combine R-1A & R-1B into R-1

Percent Impervious:

Soil #72, 30% Impervious

Area = 566 Acres

$$RTIMP = \frac{(.30)(566)}{999} = 17.0\%$$

APPENDIX G

ROGER CREEK

CALCULATIONS:

SUB-BASIN LAG TIMES,

ROUTING TRAVEL TIMES

USE MAIN STEM RODGER CREEK FOR Tc/Tlag Determinations

R-1

R-2

R-3

MEASURED REACHES DESIGNATED BTO 9-15-89

CHECKED: JPW 9/19/89

ACCOMPANIES TR-55 Tc Worksheets FOR RODGER CREEK SUB-BASINS

LEGEND

- WATERSHED BOUNDARY
- SUB-BASIN BOUNDARY
- PRIMARY WATERCOURSE
- (R-2) SUB-BASIN IDENTIFICATION

2000 0 2000 4000 6000 8000 10,000

Scale in Feet

PRELIMINARY

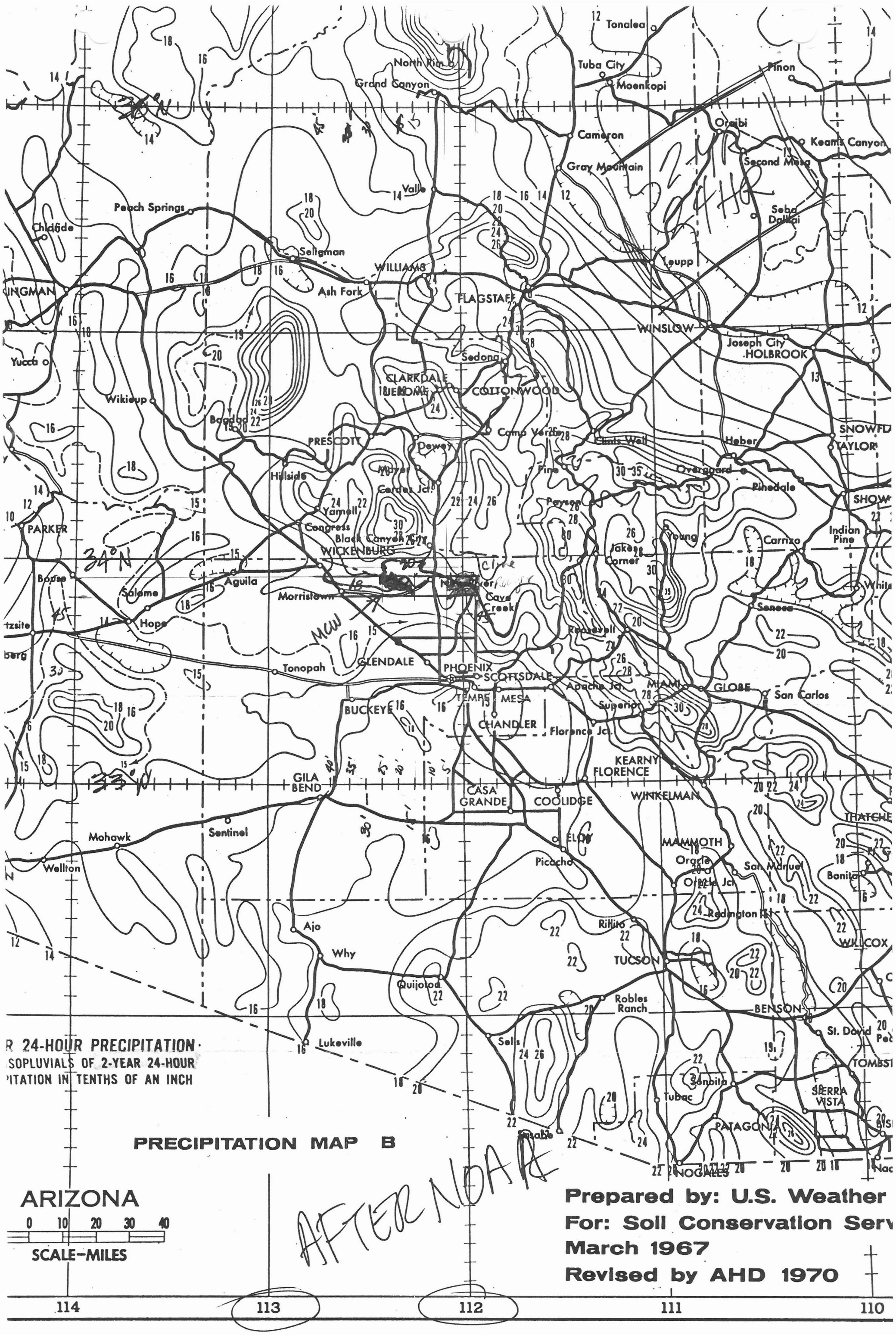
	NAME	DATE
DESIGN		
DRAWN		
CHECKED		

RODGER CREEK FLOODPLAIN DELINEATION STUDY

16923 - HPH

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WATERSHED BOUNDARY AND SUB-BASIN LOCATIONS


Tonalea
Tuba City
Moenkopi
Pinon
North Rim
Grand Canyon
Cameron
Oraibi
Keams Canyon
Second Mesa
Gray Mountain
Valle
Peach Springs
Seligman
WILLIAMS
Ash Fork
FLAGSTAFF
Leupp
Seba Dalkai
WINSLOW
Joseph City
HOLBROOK
Sedona
CLARKDALE
JEROME
COTTONWOOD
Wikieup
Bagdad
PRESCOTT
Dewey
Como Verde
Clints Well
Heber
Overgaard
Pinedale
Hillside
Cordes Jct.
Yarnell
Congress
Black Canyon City
WICKENBURG
Payson
Young
Carrizo
Indian Pine
Lake Corner
PARKER
Bouse
Salome
Aguila
Morristown
Cave Creek
Hope
Roosevelt
Seneca
Tonopah
GLENDALE
PHOENIX
SCOTTSDALE
TEMPE
MESA
Apache Jct.
MIAMI
GLOBE
San Carlos
Superior
BUCKEYE
CHANDLER
Florence Jct.
KEARNY
FLORENCE
GILA BEND
CASA GRANDE
COOLIDGE
WINKELMAN
Mohawk
Sentinel
Wellton
ELOY
Picacho
MAMMOTH
Oracle
San Manuel
Oracle Jct.
Bonita
Redington
Ajo
Why
Rillito
TUCSON
WILCOX
Quijotoa
Robles Ranch
BENSON
St. David
Lukeville
Sells
TOMBSTONE
Sonoita
Tubac
SIERRA VISTA
PATAGONIA
Sasabe
NOGALES
34°N
R 24-HOUR PRECIPITATION
SOPLUVIALS OF 2-YEAR 24-HOUR
ITATION IN TENTHS OF AN INCH
PRECIPITATION MAP B
ARIZONA
0 10 20 30 40
SCALE-MILES
Prepared by: U.S. Weather
For: Soil Conservation Serv
March 1967
Revised by AHD 1970
114
113
112
111
110

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project FCDMC Flood Delineation Study By BRG Date 9-15-89

Location Rodger Creek Checked TEK Date 9/19/89

Circle one: Present ~~Developed~~

Circle one: T_c ~~T_t through subarea~~ FOR SUBAREA R1

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	R1 SF		
1. Surface description (table 3-1)		OPEN RANGE		
2. Manning's roughness coeff., n (table 3-1) ..		0.13		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	2.0		
5. Land slope, s 60/300	ft/ft	0.20		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.18	+	= 0.18

3770
3710

Shallow concentrated flow	Segment ID	R1SCF		
7. Surface description (paved or unpaved)		UN		
8. Flow length, L	ft	4000'		
9. Watercourse slope, s 1070	ft/ft	0.27		
10. Average velocity, V (figure 3-1)	ft/s	8.4		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.13	+	= 0.13

3710
2640

Channel flow	Segment ID	R1 UP	R1 DN	
12. Cross sectional flow area, a	ft^2		305	SEC NO 201
13. Wetted perimeter, p_w	ft		130	USE TOPWID.
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	EST. ft	2.0	2.3	
15. Channel slope, s 2490 UP 150 / 3800 ; 2310 DN 180 / 6800	ft/ft	0.039	0.026	
16. Manning's roughness coeff., n ..... 0.055 BRG		~~0.040~~	0.040	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	8.5	10.5	
18. Flow length, L	ft	3800	6800	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.12	+ 0.18	= 0.30
20. Watershed or subarea T_c ~~or~~ (add T_t in steps 6, 11, and 19)	hr			0.61

2640 UP
2490

$T_L = 0.6 * T_c = 0.37$ hr

G 5

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project FCDMC FDS By [illegible] Date 9-16-89

Location Rodger Creek Checked [illegible] Date 9/19/89

Circle one: Present ~~Developed~~

Circle one: T_c ~~T_t through subarea~~ FOR SUBAREA R2

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	R2 SF		
1. Surface description (table 3-1)		OPEN RANGE		
2. Manning's roughness coeff., n (table 3-1) ..		0.13		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	2.0		
2800 2760 5. Land slope, s 40/300	ft/ft	0.075		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.26	+	= 0.26

Shallow concentrated flow	Segment ID	R2 SCF		
7. Surface description (paved or unpaved)		UN		
8. Flow length, L	ft	1300		
2760 2600 9. Watercourse slope, s 160/1300	ft/ft	0.12		
10. Average velocity, V (figure 3-1)	ft/s	5.6		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.06	+	= 0.06

Channel flow	Segment ID	R2 UP	R2 DN	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ..... EST	ft	2.0		
UP 2600 2270 330 7300 15. Channel slope, s ..... ~~2270 2120~~ N/A USE HEC-2 VELOCITY	ft/ft	0.045		
16. Manning's roughness coeff., n		0.055	0.040	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	9.1	10.1	V-AVG SECND 1.10 2.01 VCH
18. Flow length, L	ft	7300	8000	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.22	+ 0.22	= 0.44
20. Watershed or subarea T_c ~~T_t~~ (add T_t in steps 6, 11, and 19)	hr			0.76

$T_L = 0.6 * T_c = 0.46$ hr

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project FCDMC FDS By BDJ Date 9-16-89

Location Rodger Creek Checked [illegible] Date 9/19/89

Circle one: Present Developed

Circle one: T_c ~~T_t through subarea~~ FOR SUBAREA R-2

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	R3 SF		
1. Surface description (table 3-1)		OPEN RANGE		
2. Manning's roughness coeff., n (table 3-1) ..		0.13		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	2.0		
2520 2450 70/300 5. Land slope, s	ft/ft	0.23		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.17	+	- 0.17

Shallow concentrated flow	Segment ID	R3 SCF		
7. Surface description (paved or unpaved)		UN		
8. Flow length, L	ft	~~[illegible]~~ 1800		
2450 2200 250/1800 9. Watercourse slope, s	ft/ft	0.14		
10. Average velocity, V (figure 3-1)	ft/s	6.0		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.08	+	- 0.08

Channel flow	Segment ID	R3-UP	R3-DNS	BDJ 12/9/89
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ..... EST.	ft	1.0		
2200 2080 120/3300 15. Channel slope, s	ft/ft	0.036		
16. Manning's roughness coeff., n		0.055	0.040	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V 5.1	ft/s	~~0.036~~	11.0	$\bar{V}$ SECND 1105 1106 VCH
18. Flow length, L	ft	3300	12,300	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.18	+ 0.31	- 0.49
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			0.74

$T_L = 0.6 * T_c = 0.44$ hr

```
*****************************************************
WATER SURFACE PROFILES                              *
VERSION OF NOVEMBER 1976                            *
UPDATED MAY 1984                                    *
IBM-PC-XT VERSION AUGUST 1985                       *
RUN DATE  09-05-89   TIME  07:20:02                   *
*****************************************************
```

```
****************************************
* U.S. ARMY CORPS OF ENGINEERS
* THE HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET, SUITE D
* DAVIS, CALIFORNIA 95616
  * (916) 440-2105 (FTS) 448-2105
****************************************
```

```
X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
```

THIS RUN EXECUTED 09-05-89

```
**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION AUGUST 1985
**************************************************
```

```
1       HEC-2  PRELIMINARY  RUN  RODGER  CREEK  *** NOT DELINEATION RUN ***
2       FLOWS  PER  HEC-1  ROUTING  RC2-1  80/16/89
3       RODGER CREEK            FILE  RCH201   09/01/89

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

      0.       2.       0.        0.   .000000       .00       .0        0.  1934.000      .000


NC      .080      .080      .040      .300      .600      .000      .000      .000      .000      .000
JT     3.000  3470.000  4100.000  4875.000      .000      .000      .000      .000      .000      .000
X1     1.010     9.000  9980.000 10070.000      .000      .000      .000      .000      .000      .000
GR  1940.000  9690.000  1936.000  9800.000  1932.000  9980.000  1928.000  9990.000  1927.000 10000.000
GR  1928.000 10010.000  1932.000 10020.000  1936.000 10070.000  1940.000 10220.000      .000      .000

X1     1.020    11.000  9980.000 10040.000  1275.000  1275.000  1275.000      .000      .000      .000
C   1956.000  9730.000  1952.000  9870.000  1948.000  9980.000  1944.000  9990.000  1944.000 10000.000
GR  1944.000 10010.000  1948.000 10040.000  1952.000 10070.000  1952.000 10110.000  1952.000 10170.000
GR  1956.000 10290.000      .000      .000      .000      .000      .000      .000      .000      .000

X1     1.030     9.000  9970.000 10040.000  1240.000  1240.000  1240.000      .000      .000      .000
GR  1972.000  9770.000  1968.000  9810.000  1964.000  9900.000  1960.000  9970.000  1959.000 10000.000
GR  1960.000 10020.000  1964.000 10040.000  1968.000 10060.000  1972.000 10100.000      .000      .000

X1     1.040    12.000  9860.000 10020.000  1310.000  1310.000  1310.000      .000      .000      .000
GR  1988.000  9720.000  1984.000  9810.000  1980.000  9840.000  1980.000  9860.000  1982.000  9910.000
GR  1980.000  9960.000  1976.000  9990.000  1974.000 10000.000  1976.000 10010.000  1980.000 10020.000
GR  1984.000 10150.000  1988.000 10180.000      .000      .000      .000      .000      .000      .000

X1     1.050     7.000  9990.000 10040.000  1240.000  1240.000  1240.000      .000      .000      .000
GR  1996.000  9980.000  1992.000  9990.000  1988.000  9995.000  1987.000 10000.000  1988.000 10025.000
GR  1992.000 10040.000  1996.000 10080.000      .000      .000      .000      .000      .000      .000

X1     1.060     8.000  9920.000 10030.000  1170.000  1170.000  1170.000      .000      .000     1.000
GR  2016.000  9660.000  2012.000  9740.000  2012.000  9830.000  2008.000  9920.000  2004.000 10000.000
GR  2008.000 10030.000  2012.000 10050.000  2016.000 10190.000      .000      .000      .000      .000

X1     1.070     9.000  9990.000 10090.000  1200.000  1200.000  1200.000      .000      .000     1.000
GR  2028.000  9830.000  2024.000  9910.000  2020.000  9990.000  2018.000 10000.000  2020.000 10015.000
GR  2020.000 10090.000  2020.000 10110.000  2024.000 10170.000  2028.000 10240.000      .000      .000
```

1	1.080	9.000	9950.000	10050.000	1440.000	1440.000	1440.000	.000	.000	1.000
R	48.000	9830.000	2044.000	9890.000	2040.000	9950.000	2036.000	9970.000	2034.000	10000.000
R	2036.000	10020.000	2040.000	10050.000	2044.000	10070.000	2048.000	10090.000	.000	.000
1	1.090	9.000	9960.000	10030.000	1680.000	1680.000	1680.000	.000	.000	.000
R	2080.000	9760.000	2076.000	9780.000	2072.000	9870.000	2068.000	9960.000	2065.000	10000.000
R	2068.000	10020.000	2072.000	10030.000	2076.000	10050.000	2080.000	10130.000	.000	.000
1	1.100	7.000	9970.000	10040.000	1875.000	1875.000	1875.000	.000	.000	.000
R	2100.000	9960.000	2096.000	9970.000	2092.000	9975.000	2090.000	10000.000	2092.000	10030.000
R	2096.000	10040.000	2100.000	10140.000	.000	.000	.000	.000	.000	.000
T	3.000	2723.000	2723.000	2723.000	.000	.000	.000	.000	.000	.000
1	2.010	10.000	9910.000	10070.000	1590.000	1590.000	1590.000	.000	.000	.000
R	2140.000	9760.000	2136.000	9830.000	2132.000	9910.000	2128.000	9960.000	2124.000	10000.000
R	2128.000	10020.000	2128.000	10070.000	2132.000	10120.000	2136.000	10160.000	2140.000	10270.000
1	2.020	9.000	9970.000	10090.000	1800.000	1800.000	1800.000	.000	.000	.000
R	2164.000	9800.000	2160.000	9860.000	2160.000	9900.000	2160.000	9970.000	2156.000	9980.000
R	2153.000	10000.000	2156.000	10030.000	2160.000	10090.000	2164.000	10140.000	.000	.000
1	2.030	9.000	9950.000	10015.000	1920.000	1920.000	1920.000	.000	.000	.000
R	2200.000	9880.000	2196.000	9910.000	2192.000	9950.000	2188.000	9990.000	2187.000	10000.000
R	2188.000	10010.000	2192.000	10015.000	2196.000	10020.000	2200.000	10030.000	.000	.000
1	2.040	10.000	9990.000	10090.000	1800.000	1800.000	1800.000	.000	.000	.000
R	40.000	9940.000	2236.000	9970.000	2232.000	9980.000	2228.000	9990.000	2224.000	10000.000
R	2228.000	10020.000	2228.000	10090.000	2232.000	10110.000	2236.000	10160.000	2240.000	10200.000
1	2.050	7.000	9960.000	10030.000	1540.000	1540.000	1540.000	.000	.000	.000
R	2264.000	9900.000	2260.000	9960.000	2256.000	9980.000	2255.000	10000.000	2256.000	10020.000
R	2260.000	10030.000	2264.000	10050.000	.000	.000	.000	.000	.000	.000
1	2.060	15.000	9980.000	10040.000	1460.000	1460.000	1460.000	.000	.000	.000
R	2300.000	9870.000	2296.000	9940.000	2292.000	9970.000	2288.000	9980.000	2284.000	9995.000
R	2284.000	10000.000	2284.000	10005.000	2288.000	10015.000	2292.000	10040.000	2288.000	10130.000
R	2286.000	10145.000	2288.000	10155.000	2292.000	10180.000	2296.000	10300.000	2300.000	10340.000
J	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
^	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
.ME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CCHV= .300 CEHV= .600

*SECNO 1.010

3720 CRITICAL DEPTH ASSUMED

1.01	7.90	1934.90	1934.90	1934.00	1936.24	1.34	.00	.00	1932.00
3470.	493.	2977.	0.	189.	298.	0.	0.	0.	1936.00
.00	2.61	9.97	.00	.080	.040	.080	.000	1927.00	9849.55
.012036	0.	0.	0.	0	7	0	.00	206.69	10056.24

*SECNO 1.020

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.02	6.20	1950.20	1950.20	.00	1952.07	1.87	14.93	.32	1948.00
3470.	141.	3291.	38.	67.	292.	18.	13.	5.	1948.00
.03	2.11	11.27	2.10	.080	.040	.080	.000	1944.00	9919.46
.011404	1275.	1275.	1275.	3	15	0	.00	137.05	10056.51

*SECNO 1.030

3301 HV CHANGED MORE THAN HVINS

1.03	5.43	1964.43	.00	.00	1965.70	1.27	13.44	.18	1960.00
3470.	579.	2890.	0.	172.	295.	0.	25.	9.	1964.00
.07	3.37	9.80	.66	.080	.040	.080	.000	1959.00	9890.41
.010322	1240.	1240.	1240.	3	0	0	.00	151.72	10042.13

*SECNO 1.040

3265 DIVIDED FLOW

1.04	7.77	1981.77	1981.76	.00	1982.89	1.12	17.14	.05	1980.00
3470.	152.	3204.	114.	47.	365.	51.	39.	15.	1980.00
.12	3.23	8.79	2.24	.080	.040	.080	.000	1974.00	9826.72
.017126	1310.	1310.	1310.	7	14	0	.00	239.32	10077.53

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

ECNO 1.050

01 HV CHANGED MORE THAN HVINS

1.05	7.84	1994.84	.00	.00	1996.54	1.70	13.30	.35	1992.00
3470.	19.	3369.	81.	10.	317.	40.	50.	20.	1992.00
.15	1.92	10.62	2.01	.080	.040	.080	.000	1987.00	9982.89
.007343	1240.	1240.	1240.	5	0	0	.00	85.55	10068.44

ECNO 1.060
85 MINIMUM SPECIFIC ENERGY
20 CRITICAL DEPTH ASSUMED

1.06	5.17	2009.17	2009.17	.00	2010.67	1.50	11.95	.06	2008.00
3470.	25.	3440.	5.	15.	349.	3.	60.	23.	2008.00
.18	1.60	9.86	1.58	.080	.040	.080	.000	2004.00	9893.63
.015178	1170.	1170.	1170.	4	14	0	.00	142.23	10035.86

ECNO 1.070

CHANGED MORE THAN HVINS

1.07	5.28	2023.28	.00	.00	2024.07	.79	13.19	.21	2020.00
3470.	255.	2778.	437.	108.	354.	147.	74.	28.	2020.00
.23	2.36	7.85	2.98	.080	.040	.080	.000	2018.00	9924.26
.008327	1200.	1200.	1200.	5	0	0	.00	235.05	10159.31

SECNO 1.080

301 HV CHANGED MORE THAN HVINS

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

1.08	5.80	2039.80	2039.80	.00	2041.51	1.71	16.12	.55	2040.00
3470.	0.	3470.	0.	0.	331.	0.	89.	33.	2040.00
.27	.00	10.49	.00	.080	.040	.080	.000	2034.00	9950.98
.015838	1440.	1440.	1440.	4	8	0	.00	97.56	10048.53

SECNO 1.090
185 MINIMUM SPECIFIC ENERGY

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  SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
  Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
  :         VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
  SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


3720 CRITICAL DEPTH ASSUMED
    1.09      6.10   2071.10   2071.10       .00   2072.82      1.72     23.96       .00   2068.00
   3470.      306.     3164.       0.      108.      288.        0.      103.       38.   2072.00
     .31      2.83     10.98       .00      .080      .040      .080      .000   2065.00   9890.20
 .012909     1680.     1680.    1680.        10         8         0       .00    137.56  10027.76


*SECNO 1.100
    1.10      6.00   2096.00       .00       .00   2098.01      2.01     25.01       .18   2096.00
   3470.        0.     3470.       0.        0.      305.        0.      118.       42.   2096.00
     .36       .00     11.39       .00      .080      .040      .080      .000   2090.00   9970.00
 .013793     1875.     1875.    1875.         5         0         0       .00     69.99  10039.99


*SECNO 2.010

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    2.01      5.55   2129.55   2129.55       .00   2130.74      1.19     24.53       .25   2132.00
     23.        0.     2691.      32.        0.      306.       15.      130.       46.   2128.00
     .41       .00      8.80      2.10      .080      .040      .080      .000   2124.00   9940.61
 .017973     1590.     1590.    1590.        14        15         0       .00    148.78  10089.39


*SECNO 2.020
    2.02      5.92   2158.92       .00       .00   2160.24      1.32     29.42       .08   2160.00
   2723.        0.     2723.       0.        0.      295.        0.      143.       52.   2160.00
     .47       .00      9.22       .00      .080      .040      .080      .000   2153.00   9972.70
 .014926     1800.     1800.    1800.         6         0         0       .00    101.07  10073.78


*SECNO 2.030

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    2.03      6.06   2193.06   2193.06       .00   2194.90      1.84     28.60       .31   2192.00
   2723.        8.     2714.       1.        6.      249.        1.      155.       55.   2192.00
     .51      1.48     10.90      1.26      .080      .040      .080      .000   2187.00   9939.38
 .014861     1920.     1920.    1920.         4         5         0       .00     76.94  10016.33
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 SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
 ^        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
   E      VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
 SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


SECNO 2.040
185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED
    2.04     6.18  2230.18  2230.18      .00  2231.60     1.41    28.90      .13  2228.00
   2723.      15.    2678.      31.       6.     278.      12.     166.      59.   2228.00
     .57     2.47     9.62     2.56     .080     .040     .080     .000  2224.00  9984.54
 .017394    1800.    1800.    1800.       15        8        0      .00   116.38 10100.92


*SECNO 2.050
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    2.05     5.16  2260.16  2260.16      .00  2261.98     1.83    25.61      .25  2260.00
   2723.       0.    2723.       0.       0.     251.       0.     176.      63.   2260.00
     .61      .43    10.85      .02     .080     .040     .080     .000  2255.00  9957.66
 .015910    1540.    1540.    1540.        5       15        0      .00    73.13 10030.78


*SECNO 2.060

32  DIVIDED FLOW

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    2.06     6.45  2290.45  2290.45      .00  2291.82     1.37    21.70      .14  2288.00
   2723.      18.    2061.     644.       8.     195.     173.     186.      67.   2292.00
     .65     2.39    10.59     3.73     .080     .040     .080     .000  2284.00  9973.87
 .013919    1460.    1460.    1460.       11       11        0      .00   151.93 10170.32
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THIS RUN EXECUTED 09-05-89

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION AUGUST 1985
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1       HEC-2  PRELIMINARY  RUN  RODGER  CREEK  *** NOT DELINEATION RUN ***
2      FLOWS PER ADDED SUBAREA PEAKS   HEC-1 RC2-1 08/16/89 MAX POSSIBLE FLOW
3       RODGER CREEK            FILE  RCH201   09/01/89

1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

     0.        3.        0.        0.   .000000       .00        .0        0.  1934.500      .000

2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

    2.000      .000      .000      .000      .000      .000      .000      .000      .000      .000
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  SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     BANK ELEV
            QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     LEFT/RIGHT
  TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
  SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


*PROF 2

CCHV=    .300 CEHV=    .600
*SECNO 1.010
3720 CRITICAL DEPTH ASSUMED
    1.01      8.29  1935.29  1935.29  1934.50  1936.69      1.40       .00       .00  1932.00
   4100.      698.     3402.      0.     243.     329.       0.        0.        0.  1936.00
     .00      2.87     10.33     .00     .080     .040     .080      .000   1927.00  9832.00
 .012303        0.        0.      0.        0        7        0       .00    229.11 10061.11


*SECNO 1.020

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
    1.02      6.74  1950.74  1950.74      .00  1952.71      1.96     14.57       .34  1948.00
   4100.      245.     3789.     66.     103.     325.      28.       15.        6.  1948.00
     .03      2.36     11.67     2.35    .080     .040     .080      .000   1944.00  9904.56
    0636     1275.     1275.   1275.       4       11        0       .00    156.01 10060.57


*SECNO 1.030
    1.03      5.75  1964.75      .00      .00  1966.21      1.47     13.36       .15  1960.00
   4100.      738.     3361.      1.     199.     317.       1.       29.       10.  1964.00
     .07      3.71     10.59     .99     .080     .040     .080      .000   1959.00  9883.16
 .010914     1240.     1240.   1240.       5        0        0       .00    160.58 10043.74


*SECNO 1.040
    1.04      8.14  1982.14  1982.12      .00  1983.24      1.10     16.92       .11  1980.00
   4100.      206.     3714.    180.      60.     423.      75.       45.       17.  1980.00
     .11      3.43      8.79    2.42    .080     .040     .080      .000   1974.00  9823.94
 .015515     1310.     1310.   1310.       7       13        0       .00    265.65 10089.59


*SECNO 1.050

3301 HV CHANGED MORE THAN HVINS

    1.05      8.28  1995.28      .00      .00  1997.30      2.03     13.51       .56  1992.00
   4100.       30.     3946.    124.      13.     339.      54.       59.       22.  1992.00
     .14      2.21     11.64    2.31    .080     .040     .080      .000   1987.00  9981.80
   008067     1240.     1240.   1240.       5        0        0       .00     91.01 10072.80
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 SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
          QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
 TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN       SSTA
 SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID      ENDST


SECNO 1.060
185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED
   1.06     5.53  2009.53  2009.53      .00  2011.19     1.65    12.43      .11  2008.00
  4100.      50.     4039.      11.      26.     389.      6.      70.      25.   2008.00
    .18     1.88     10.39     1.86     .080     .040    .080     .000  2004.00  9885.51
 .014615   1170.     1170.    1170.        3       19       0      .00   152.15 10037.66


SECNO 1.070

301 HV CHANGED MORE THAN HVINS

   1.07     5.61  2023.61      .00      .00  2024.50     .89    13.08      .23  2020.00
  4100.     329.     3234.     537.     130.     386.    170.      85.      30.   2020.00
    .22     2.53      8.38     3.16     .080     .040    .080     .000  2018.00  9917.81
 .008442   1200.     1200.    1200.        6        0       0      .00   246.32 10164.14


*SECNO 1.080

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   1.08     6.22  2040.22  2040.22      .00  2042.11     1.89    16.09      .60  2040.00
  4100.       0.     4100.       0.       0.     372.      0.     103.      36.   2040.00
    .26      .52     11.03      .52     .080     .040    .080     .000  2034.00  9946.74
 .015477   1440.     1440.    1440.        3        8       0      .00   104.34 10051.08


*SECNO 1.090
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED
   1.09     6.50  2071.50  2071.50      .00  2073.40     1.90    23.93      .01  2068.00
  4100.     426.     3674.       0.    138.     315.      0.     119.      41.   2072.00
    .30     3.09     11.65      .00     .080     .040    .080     .000  2065.00  9881.22
 .013148   1680.     1680.    1680.       12        8       0      .00   147.53 10028.75


*SECNO 1.100
   1.10     6.47  2096.47  2096.35      .00  2098.76     2.28    25.12      .23  2096.00
  4100.       0.     4098.       2.       0.     338.      3.     136.      46.   2096.00
    .34      .78     12.13      .82     .080     .040    .080     .000  2090.00  9968.83
 .0[illegible]458   1875.     1875.    1875.        7        5       0      .00    82.87 10051.70
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 2.010

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

2.01	5.55	2129.55	2129.55	.00	2130.74	1.19	24.15	.33	2132.00
2723.	0.	2692.	31.	0.	305.	15.	148.	50.	2128.00
.39	.00	8.81	2.10	.080	.040	.080	.000	2124.00	9940.63
.018019	1590.	1590.	1590.	15	15	0	.00	148.73	10089.37

*SECNO 2.020

2.02	5.92	2158.92	.00	.00	2160.24	1.32	29.42	.07	2160.00
2723.	0.	2723.	0.	0.	296.	0.	160.	55.	2160.00
.45	.00	9.21	.00	.080	.040	.080	.000	2153.00	9972.70
.014893	1800.	1800.	1800.	6	0	0	.00	101.12	10073.81

*SECNO 2.030

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

2.03	6.06	2193.06	2193.06	.00	2194.90	1.84	28.54	.31	2192.00
2723.	8.	2714.	1.	6.	249.	1.	173.	59.	2192.00
.50	1.48	10.89	1.26	.080	.040	.080	.000	2187.00	9939.37
.014839	1920.	1920.	1920.	4	5	0	.00	76.96	10016.33

*SECNO 2.040
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

2.04	6.18	2230.18	2230.18	.00	2231.60	1.41	28.87	.13	2228.00
2723.	15.	2678.	31.	6.	278.	12.	184.	63.	2228.00
.55	2.47	9.62	2.56	.080	.040	.080	.000	2224.00	9984.54
.017394	1800.	1800.	1800.	15	8	0	.00	116.38	10100.92

*SECNO 2.050
7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST
2.05	5.16	2260.16	2260.16	.00	2261.98	1.83	25.61	.25	2260.00
2723.	0.	2723.	0.	0.	251.	0.	194.	67.	2260.00
.59	.43	10.85	.02	.080	.040	.080	.000	2255.00	9957.66
.015910	1540.	1540.	1540.	5	15	0	.00	73.13	10030.78

ECNO 2.060

265 DIVIDED FLOW

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

2.06	6.45	2290.45	2290.45	.00	2291.82	1.37	21.70	.14	2288.00
2723.	18.	2061.	644.	8.	195.	173.	204.	70.	2292.00
.64	2.39	10.59	3.73	.080	.040	.080	.000	2284.00	9973.87
.013919	1460.	1460.	1460.	11	11	0	.00	151.93	10170.32

THIS RUN EXECUTED 09-05-89

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**************************************************
 HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
 IBM-PC-XT VERSION AUGUST 1985
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1 HEC-2 PRELIMINARY RUN RODGER CREEK *** NOT DELINEATION RUN ***
2 ESTIMATE FLOWS - REACH RTE 2 SPILT DIFFERENCE FOR FIRST TWO RUNS RUN 2
3 RODGER CREEK FILE RCH201 09/01/89

1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	4.	0.	0.	.000000	.00	.0	0.	1929.000	.000
2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

```
 SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
 [illegible]  QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
 [illegible]  VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
 SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


PROF 3

CHV=    .300 CEHV=    .600
SECNO 1.010
[illegible]720 CRITICAL DEPTH ASSUMED
    1.01     8.76  1935.76  1935.76  1929.00  1937.17     1.41      .00      .00  1932.00
   4875.      988.    3887.       0.     318.     369.       0.       0.       0.  1936.00
     .00     3.11    10.54      .00     .080     .040     .080     .000  1927.00  9810.77
 .012050       0.       0.       0.        0       22        0      .00   256.24 10067.01


SECNO 1.020

[illegible]301 HV CHANGED MORE THAN HVINS

[illegible]185 MINIMUM SPECIFIC ENERGY
[illegible]720 CRITICAL DEPTH ASSUMED
    1.02     7.26  1951.26  1951.26      .00  1953.39     2.13    14.32      .44  1948.00
   4875.      386.    4385.      105.     146.     356.      40.      18.       6.  1948.00
     .03     2.64    12.32     2.62     .080     .040     .080     .000  1944.00  9890.28
 [illegible]92    1275.    1275.    1275.        3       11        0      .00   174.19 10064.47


*SECNO 1.030

3301 HV CHANGED MORE THAN HVINS

    1.03     6.18  1965.18  1964.95      .00  1966.81     1.63    13.27      .15  1960.00
   4875.      956.    3914.       5.     239.     348.       3.      34.      11.  1964.00
     .07     4.01    11.25     1.35     .080     .040     .080     .000  1959.00  9873.38
 .010912    1240.    1240.    1240.        7       15        0      .00   172.54 10045.92


*SECNO 1.040
    1.04     8.43  1982.43  1982.29      .00  1983.65     1.22    16.72      .12  1980.00
   4875.      259.    4366.      250.      71.     469.      96.      53.      18.  1980.00
     .11     3.65     9.30     2.60     .080     .040     .080     .000  1974.00  9821.75
 .015127    1310.    1310.    1310.        9       11        0      .00   277.32 10099.07


*SECNO 1.050
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
C	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
_	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

301 HV CHANGED MORE THAN HVINS

1.05	8.83	1995.83	1995.36	.00	1998.20	2.37	13.85	.69	1992.00
4875.	46.	4635.	194.	18.	366.	73.	68.	23.	1992.00
.14	2.53	12.65	2.65	.080	.040	.080	.000	1987.00	9980.43
.008589	1240.	1240.	1240.	9	6	0	.00	97.86	10078.29

SECNO 1.060

301 HV CHANGED MORE THAN HVINS

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

1.06	5.97	2009.97	2009.97	.00	2011.77	1.80	12.55	.17	2008.00
4875.	94.	4760.	21.	44.	437.	10.	81.	27.	2008.00
.17	2.16	10.90	2.13	.080	.040	.080	.000	2004.00	9875.69
.013762	1170.	1170.	1170.	2	19	0	.00	164.16	10039.85

1.070

301 HV CHANGED MORE THAN HVINS

1.07	5.95	2023.95	.00	.00	2024.97	1.01	12.96	.24	2020.00
4875.	426.	3786.	662.	156.	420.	196.	98.	33.	2020.00
.21	2.73	9.01	3.37	.080	.040	.080	.000	2018.00	9910.91
.008696	1200.	1200.	1200.	5	0	0	.00	258.41	10169.32

SECNO 1.080

301 HV CHANGED MORE THAN HVINS

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

1.08	6.71	2040.71	2040.71	.00	2042.78	2.07	15.84	.63	2040.00
4875.	4.	4869.	1.	4.	421.	1.	118.	39.	2040.00
.25	1.12	11.55	1.11	.080	.040	.080	.000	2034.00	9939.28
.014364	1440.	1440.	1440.	4	8	0	.00	114.29	10053.57

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
C	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
[illegible]	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

SECNO 1.090
185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

1.09	7.17	2072.17	2072.17	.00	2074.03	1.86	21.30	.06	2068.00
4875.	647.	4228.	0.	196.	362.	0.	137.	44.	2072.00
.29	3.30	11.68	.02	.080	.040	.080	.000	2065.00	9866.11
.011273	1680.	1680.	1680.	14	8	0	.00	164.76	10030.87

SECNO 1.100

301 HV CHANGED MORE THAN HVINS

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

1.10	7.02	2097.02	2097.02	.00	2099.59	2.57	22.95	.43	2096.00
4875.	2.	4855.	18.	1.	377.	13.	157.	50.	2096.00
.33	1.31	12.89	1.37	.080	.040	.080	.000	2090.00	9967.44
.013337	1875.	1875.	1875.	4	5	0	.00	98.14	10065.59

SECNO 2.010

301 HV CHANGED MORE THAN HVINS

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED

2.01	5.55	2129.55	2129.55	.00	2130.74	1.19	23.48	.41	2132.00
2723.	0.	2691.	32.	0.	306.	15.	170.	54.	2128.00
.38	.00	8.81	2.10	.080	.040	.080	.000	2124.00	9940.61
.017978	1590.	1590.	1590.	15	19	0	.00	148.78	10089.39

SECNO 2.020

2.02	5.92	2158.92	.00	.00	2160.24	1.32	29.42	.08	2160.00
2723.	0.	2723.	0.	0.	295.	0.	183.	60.	2160.00
.43	.00	9.22	.00	.080	.040	.080	.000	2153.00	9972.70
.014922	1800.	1800.	1800.	6	0	0	.00	101.08	10073.78

SECNO 2.030

```
 SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS    BANK ELEV
 [illegible]  QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
 [illegible]  VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
 SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


501 HV CHANGED MORE THAN HVINS

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED
   2.03     6.06  2193.06  2193.06      .00  2194.90     1.84    28.57      .31  2192.00
  2723.       8.    2714.       1.       6.     249.       1.     195.      63.   2192.00
    .48     1.48    10.89     1.26     .080     .040     .080     .000  2187.00  9939.37
 .014842    1920.    1920.    1920.        4        5        0      .00    76.96 10016.33


SECNO 2.040
185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED
   2.04     6.18  2230.18  2230.18      .00  2231.60     1.41    28.86      .13  2228.00
  2723.      15.    2678.      31.       6.     278.      12.     207.      67.   2228.00
    .54     2.47     9.62     2.56     .080     .040     .080     .000  2224.00  9984.54
 .017379    1800.    1800.    1800.       15        8        0      .00   116.38 10100.92


SE[illegible] 2.050
1[illegible]INIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED
   2.05     5.16  2260.16  2260.16      .00  2261.98     1.83    25.57      .25  2260.00
  2723.       0.    2723.       0.       0.     251.       0.     216.      71.   2260.00
    .58      .43    10.84      .02     .080     .040     .080     .000  2255.00  9957.62
 .015877    1540.    1540.    1540.        5       15        0      .00    73.17 10030.79


SECNO 2.060

265 DIVIDED FLOW

185 MINIMUM SPECIFIC ENERGY
720 CRITICAL DEPTH ASSUMED
   2.06     6.45  2290.45  2290.45      .00  2291.82     1.37    21.70      .14  2288.00
  2723.      18.    2061.     644.       8.     195.     173.     227.      75.   2292.00
    .62     2.39    10.60     3.73     .080     .040     .080     .000  2284.00  9973.88
 .013937    1460.    1460.    1460.       11       11        0      .00   151.87 10170.31
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THIS RUN EXECUTED 09-05-89

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HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
IBM-PC-XT VERSION AUGUST 1985

****

OTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

RODGER CREEK

UMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
*	1.010	.00	.00	.00	1927.00	3470.00	1934.90	1934.90	1936.24	120.36	9.97	487.56	316.29
*	1.010	.00	.00	.00	1927.00	4100.00	1935.29	1935.29	1936.69	123.03	10.33	572.52	369.64
*	1.010	.00	.00	.00	1927.00	4875.00	1935.76	1935.76	1937.17	120.50	10.54	687.05	444.09
*	1.020	1275.00	.00	.00	1944.00	3470.00	1950.20	1950.20	1952.07	114.04	11.27	376.91	324.94
*	1.020	1275.00	.00	.00	1944.00	4100.00	1950.74	1950.74	1952.71	106.36	11.67	456.28	397.56
*	1.020	1275.00	.00	.00	1944.00	4875.00	1951.26	1951.26	1953.39	104.92	12.32	542.03	475.94
	1.030	1240.00	.00	.00	1959.00	3470.00	1964.43	.00	1965.70	103.22	9.80	467.16	341.55
	1.030	1240.00	.00	.00	1959.00	4100.00	1964.75	.00	1966.21	109.14	10.59	517.46	392.45
	1.030	1240.00	.00	.00	1959.00	4875.00	1965.18	1964.95	1966.81	109.12	11.25	589.88	466.69
	1.040	1310.00	.00	.00	1974.00	3470.00	1981.77	1981.76	1982.89	171.26	8.79	462.64	265.15
	1.040	1310.00	.00	.00	1974.00	4100.00	1982.14	1982.12	1983.24	155.15	8.79	557.15	329.16
	1.040	1310.00	.00	.00	1974.00	4875.00	1982.43	1982.29	1983.65	151.27	9.30	636.33	396.37
	1.050	1240.00	.00	.00	1987.00	3470.00	1994.84	.00	1996.54	73.43	10.62	367.76	404.94
	1.050	1240.00	.00	.00	1987.00	4100.00	1995.28	.00	1997.30	80.67	11.64	406.29	456.48
	1.050	1240.00	.00	.00	1987.00	4875.00	1995.83	1995.36	1998.20	85.89	12.65	458.06	526.02
*	1.060	1170.00	.00	.00	2004.00	3470.00	2009.17	2009.17	2010.67	151.78	9.86	367.79	281.66
*	1.060	1170.00	.00	.00	2004.00	4100.00	2009.53	2009.53	2011.19	146.15	10.39	420.90	339.15
*	1.060	1170.00	.00	.00	2004.00	4875.00	2009.97	2009.97	2011.77	137.62	10.90	489.98	415.57
	1.070	1200.00	.00	.00	2018.00	3470.00	2023.28	.00	2024.07	83.27	7.85	608.54	380.25
	1.070	1200.00	.00	.00	2018.00	4100.00	2023.61	.00	2024.50	84.42	8.38	686.08	446.24
	1.070	1200.00	.00	.00	2018.00	4875.00	2023.95	.00	2024.97	86.96	9.01	773.23	522.77
*	1.080	1440.00	.00	.00	2034.00	3470.00	2039.80	2039.80	2041.51	158.38	10.49	330.68	275.73
*	1.080	1440.00	.00	.00	2034.00	4100.00	2040.22	2040.22	2042.11	154.77	11.03	372.18	329.57
*	1.080	1440.00	.00	.00	2034.00	4875.00	2040.71	2040.71	2042.78	143.64	11.55	426.55	406.76

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
1.090	1680.00	.00	.00	2065.00	3470.00	2071.10	2071.10	2072.82	129.09	10.98	396.44	305.41
1.090	1680.00	.00	.00	2065.00	4100.00	2071.50	2071.50	2073.40	131.48	11.65	453.30	357.56
1.090	1680.00	.00	.00	2065.00	4875.00	2072.17	2072.17	2074.03	112.73	11.68	558.11	459.14
1.100	1875.00	.00	.00	2090.00	3470.00	2096.00	.00	2098.01	137.93	11.39	304.78	295.46
1.100	1875.00	.00	.00	2090.00	4100.00	2096.47	2096.35	2098.76	136.58	12.13	340.77	350.82
1.100	1875.00	.00	.00	2090.00	4875.00	2097.02	2097.02	2099.59	133.37	12.89	391.04	422.13
2.010	1590.00	.00	.00	2124.00	2723.00	2129.55	2129.55	2130.74	179.73	8.80	320.72	203.11
2.010	1590.00	.00	.00	2124.00	2723.00	2129.55	2129.55	2130.74	180.19	8.81	320.43	202.86
2.010	1590.00	.00	.00	2124.00	2723.00	2129.55	2129.55	2130.74	179.78	8.81	320.68	203.08
2.020	1800.00	.00	.00	2153.00	2723.00	2158.92	.00	2160.24	149.26	9.22	295.45	222.89
2.020	1800.00	.00	.00	2153.00	2723.00	2158.92	.00	2160.24	148.93	9.21	295.70	223.13
2.020	1800.00	.00	.00	2153.00	2723.00	2158.92	.00	2160.24	149.22	9.22	295.47	222.91
2.030	1920.00	.00	.00	2187.00	2723.00	2193.06	2193.06	2194.90	148.61	10.90	255.34	223.37
2.030	1920.00	.00	.00	2187.00	2723.00	2193.06	2193.06	2194.90	148.39	10.89	255.47	223.54
2.030	1920.00	.00	.00	2187.00	2723.00	2193.06	2193.06	2194.90	148.42	10.89	255.45	223.51
2.040	1800.00	.00	.00	2224.00	2723.00	2230.18	2230.18	2231.60	173.94	9.62	296.21	206.46
2.040	1800.00	.00	.00	2224.00	2723.00	2230.18	2230.18	2231.60	173.94	9.62	296.21	206.46
2.040	1800.00	.00	.00	2224.00	2723.00	2230.18	2230.18	2231.60	173.79	9.62	296.30	206.56
2.050	1540.00	.00	.00	2255.00	2723.00	2260.16	2260.16	2261.98	159.10	10.85	251.18	215.88
2.050	1540.00	.00	.00	2255.00	2723.00	2260.16	2260.16	2261.98	159.10	10.85	251.18	215.88
2.050	1540.00	.00	.00	2255.00	2723.00	2260.16	2260.16	2261.98	158.77	10.84	251.34	216.10
2.060	1460.00	.00	.00	2284.00	2723.00	2290.45	2290.45	2291.82	139.19	10.59	374.76	230.80
2.060	1460.00	.00	.00	2284.00	2723.00	2290.45	2290.45	2291.82	139.19	10.59	374.76	230.80
2.060	1460.00	.00	.00	2284.00	2723.00	2290.45	2290.45	2291.82	139.37	10.60	374.54	230.66

ODGER CREEK

PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
1.010	3470.00	1934.90	.00	.00	.90	206.69	.00
1.010	4100.00	1935.29	.39	.00	.79	229.11	.00
1.010	4875.00	1935.76	.47	.00	6.76	256.24	.00
1.020	3470.00	1950.20	.00	15.30	.00	137.05	1275.00
1.020	4100.00	1950.74	.54	15.45	.00	156.01	1275.00
1.020	4875.00	1951.26	.52	15.50	.00	174.19	1275.00
1.030	3470.00	1964.43	.00	14.23	.00	151.72	1240.00
1.030	4100.00	1964.75	.32	14.00	.00	160.58	1240.00
1.030	4875.00	1965.18	.44	13.92	.00	172.54	1240.00
1.040	3470.00	1981.77	.00	17.34	.00	239.32	1310.00
1.040	4100.00	1982.14	.37	17.39	.00	265.65	1310.00
1.040	4875.00	1982.43	.29	17.25	.00	277.32	1310.00
1.050	3470.00	1994.84	.00	13.07	.00	85.55	1240.00
1.050	4100.00	1995.28	.44	13.14	.00	91.01	1240.00
1.050	4875.00	1995.83	.55	13.40	.00	97.86	1240.00
1.060	3470.00	2009.17	.00	14.34	.00	142.23	1170.00
1.060	4100.00	2009.53	.36	14.26	.00	152.15	1170.00
1.060	4875.00	2009.97	.44	14.14	.00	164.16	1170.00
1.070	3470.00	2023.28	.00	14.11	.00	235.05	1200.00
1.070	4100.00	2023.61	.33	14.08	.00	246.32	1200.00
1.070	4875.00	2023.95	.35	13.99	.00	258.41	1200.00
1.080	3470.00	2039.80	.00	16.52	.00	97.56	1440.00
1.080	4100.00	2040.22	.41	16.61	.00	104.34	1440.00
1.080	4875.00	2040.71	.50	16.76	.00	114.29	1440.00
1.090	3470.00	2071.10	.00	31.30	.00	137.56	1680.00
1.090	4100.00	2071.50	.40	31.28	.00	147.53	1680.00
1.090	4875.00	2072.17	.67	31.46	.00	164.76	1680.00
1.100	3470.00	2096.00	.00	24.89	.00	69.99	1875.00
1.100	4100.00	2096.47	.48	24.97	.00	82.87	1875.00
1.100	4875.00	2097.02	.55	24.85	.00	98.14	1875.00
2.010	2723.00	2129.55	.00	33.55	.00	148.78	1590.00
2.010	2723.00	2129.55	.00	33.08	.00	148.73	1590.00
2.010	2723.00	2129.55	.00	32.53	.00	148.78	1590.00
2.020	2723.00	2158.92	.00	29.37	.00	101.07	1800.00
2.020	2723.00	2158.92	.00	29.37	.00	101.12	1800.00
2.020	2723.00	2158.92	.00	29.37	.00	101.08	1800.00

G25

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
2.030	2723.00	2193.06	.00	34.14	.00	76.94	1920.00
2.030	2723.00	2193.06	.00	34.14	.00	76.96	1920.00
2.030	2723.00	2193.06	.00	34.14	.00	76.96	1920.00
2.040	2723.00	2230.18	.00	37.12	.00	116.38	1800.00
2.040	2723.00	2230.18	.00	37.12	.00	116.38	1800.00
2.040	2723.00	2230.18	.00	37.12	.00	116.38	1800.00
2.050	2723.00	2260.16	.00	29.97	.00	73.13	1540.00
2.050	2723.00	2260.16	.00	29.97	.00	73.13	1540.00
2.050	2723.00	2260.16	.00	29.97	.00	73.17	1540.00
2.060	2723.00	2290.45	.00	30.30	.00	151.93	1460.00
2.060	2723.00	2290.45	.00	30.30	.00	151.93	1460.00
2.060	2723.00	2290.45	.00	30.29	.00	151.87	1460.00

J. .Y OF ERRORS AND SPECIAL NOTES

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JTION  SECNO=    1.010  PROFILE= 1  CRITICAL DEPTH ASSUMED
JTION  SECNO=    1.010  PROFILE= 2  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.010  PROFILE= 3  CRITICAL DEPTH ASSUMED

UTION  SECNO=    1.020  PROFILE= 1  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.020  PROFILE= 1  MINIMUM SPECIFIC ENERGY
JTION  SECNO=    1.020  PROFILE= 2  CRITICAL DEPTH ASSUMED
JTION  SECNO=    1.020  PROFILE= 2  MINIMUM SPECIFIC ENERGY
JTION  SECNO=    1.020  PROFILE= 3  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.020  PROFILE= 3  MINIMUM SPECIFIC ENERGY

UTION  SECNO=    1.060  PROFILE= 1  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.060  PROFILE= 1  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    1.060  PROFILE= 2  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.060  PROFILE= 2  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    1.060  PROFILE= 3  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.060  PROFILE= 3  MINIMUM SPECIFIC ENERGY

UTION  SECNO=    1.080  PROFILE= 1  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.080  PROFILE= 1  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    1.080  PROFILE= 2  CRITICAL DEPTH ASSUMED
U      SECNO=    1.080  PROFILE= 2  MINIMUM SPECIFIC ENERGY
L   N  SECNO=    1.080  PROFILE= 3  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.080  PROFILE= 3  MINIMUM SPECIFIC ENERGY

UTION  SECNO=    1.090  PROFILE= 1  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.090  PROFILE= 1  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    1.090  PROFILE= 2  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.090  PROFILE= 2  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    1.090  PROFILE= 3  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.090  PROFILE= 3  MINIMUM SPECIFIC ENERGY

UTION  SECNO=    1.100  PROFILE= 3  CRITICAL DEPTH ASSUMED
UTION  SECNO=    1.100  PROFILE= 3  MINIMUM SPECIFIC ENERGY

UTION  SECNO=    2.010  PROFILE= 1  CRITICAL DEPTH ASSUMED
UTION  SECNO=    2.010  PROFILE= 1  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    2.010  PROFILE= 2  CRITICAL DEPTH ASSUMED
UTION  SECNO=    2.010  PROFILE= 2  MINIMUM SPECIFIC ENERGY
UTION  SECNO=    2.010  PROFILE= 3  CRITICAL DEPTH ASSUMED
UTION  SECNO=    2.010  PROFILE= 3  MINIMUM SPECIFIC ENERGY

AUTION  SECNO=   2.030  PROFILE= 1  CRITICAL DEPTH ASSUMED
AUTION  SECNO=   2.030  PROFILE= 1  MINIMUM SPECIFIC ENERGY
AUTION  SECNO=   2.030  PROFILE= 2  CRITICAL DEPTH ASSUMED
AUTION  SECNO=   2.030  PROFILE= 2  MINIMUM SPECIFIC ENERGY
AU      SECNO=   2.030  PROFILE= 3  CRITICAL DEPTH ASSUMED
A    N  SECNO=   2.030  PROFILE= 3  MINIMUM SPECIFIC ENERGY

AUTION  SECNO=   2.040  PROFILE= 1  CRITICAL DEPTH ASSUMED
AUTION  SECNO=   2.040  PROFILE= 1  MINIMUM SPECIFIC ENERGY
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AUTION  SECNO=    2.040  PROFILE= 2  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.040  PROFILE= 2  MINIMUM SPECIFIC ENERGY
AUTION  SECNO=    2.040  PROFILE= 3  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.040  PROFILE= 3  MINIMUM SPECIFIC ENERGY

AUTION  SECNO=    2.050  PROFILE= 1  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.050  PROFILE= 1  MINIMUM SPECIFIC ENERGY
AUTION  SECNO=    2.050  PROFILE= 2  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.050  PROFILE= 2  MINIMUM SPECIFIC ENERGY
AUTION  SECNO=    2.050  PROFILE= 3  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.050  PROFILE= 3  MINIMUM SPECIFIC ENERGY

AUTION  SECNO=    2.060  PROFILE= 1  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.060  PROFILE= 1  MINIMUM SPECIFIC ENERGY
AUTION  SECNO=    2.060  PROFILE= 2  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.060  PROFILE= 2  MINIMUM SPECIFIC ENERGY
AUTION  SECNO=    2.060  PROFILE= 3  CRITICAL DEPTH ASSUMED
AUTION  SECNO=    2.060  PROFILE= 3  MINIMUM SPECIFIC ENERGY
```

Chapter 3: Time of concentration and travel time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600\ V} \qquad \text{[Eq. 3-1]}$$

where

T_t = travel time (hr),
L = flow length (ft),
V = average velocity (ft/s), and
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[Eq. 3-2]}$$

where

T_c = time of concentration (hr) and
m = number of flow segments.

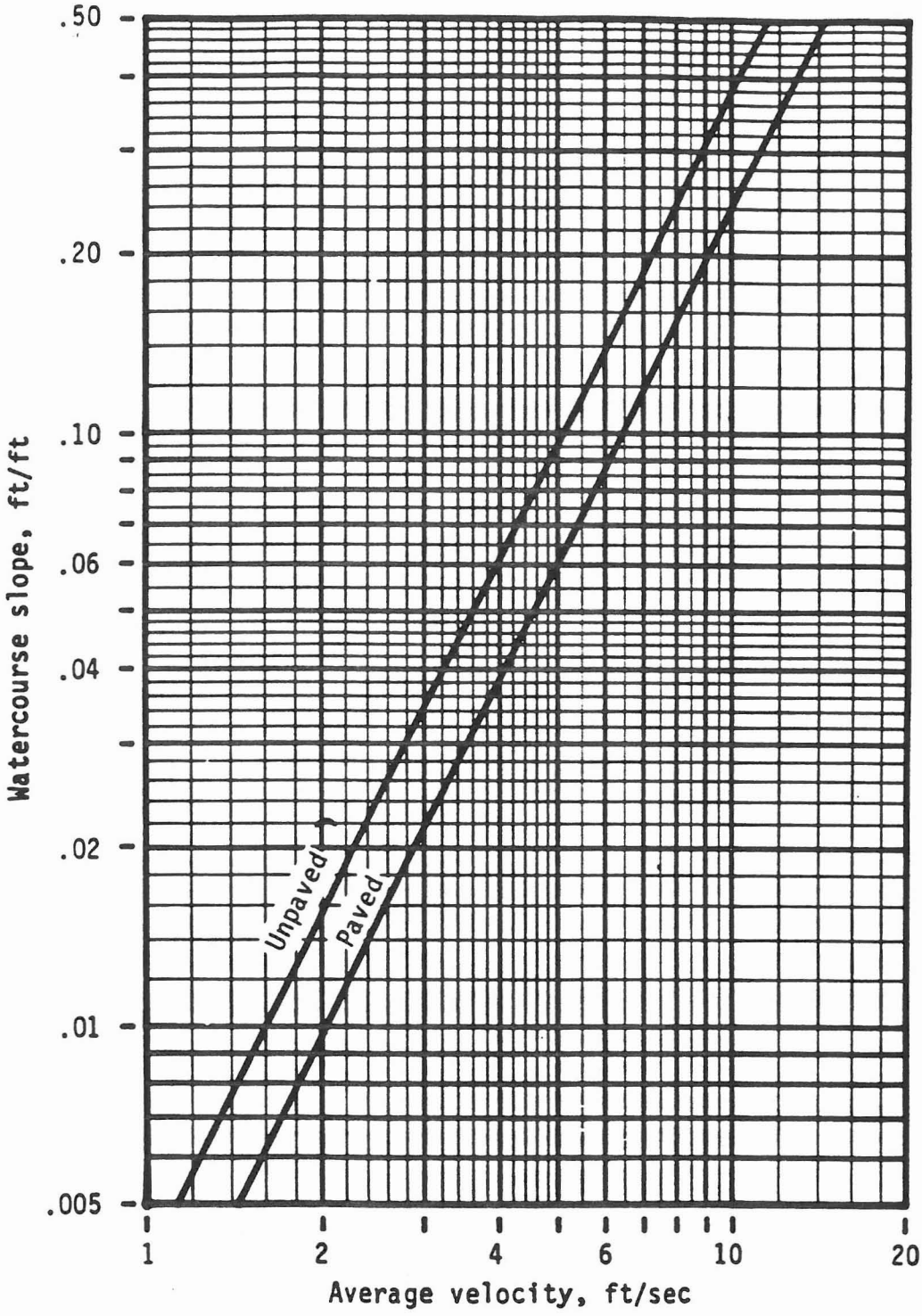

Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

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Manning's equation is

$$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n} \qquad \text{[Eq. 3-4]}$$

where

- V = average velocity (ft/s),
- r = hydraulic radius (ft) and is equal to a/p_w,
- a = cross sectional flow area (ft^2),
- p_w = wetted perimeter (ft),
- s = slope of the hydraulic grade line (channel slope, ft/ft), and
- n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

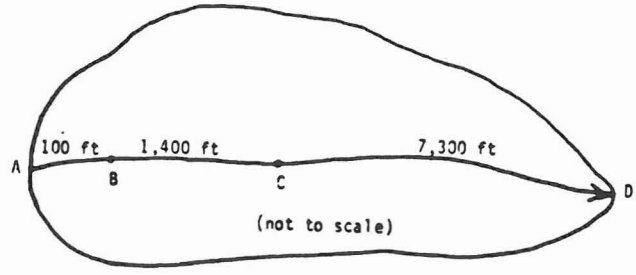
- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum T_c used in TR-55 is 0.1 hour.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB:	Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft.
Segment BC:	Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1400 ft.
Segment CD:	Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7300 ft.

See figure 3-2 for the computations made on worksheet 3.



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Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Heavenly Acres By DW Date 10/6/85

Location Dyer County, Tennessee Checked RW Date 10/8/85

Circle one: Present (Developed)

Circle one: (T_c) T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	AB		
1. Surface description (table 3-1)			DENSE GRASS		
2. Manning's roughness coeff., n (table 3-1) ..			0.24		
3. Flow length, L (total L ≤ 300 ft)	ft		100		
4. Two-yr 24-hr rainfall, P_2	in		3.6		
5. Land slope, s	ft/ft		0.01		
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr		0.30	+	= 0.30
Shallow concentrated flow		Segment ID	BC		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		1400		
9. Watercourse slope, s	ft/ft		0.01		
10. Average velocity, V (figure 3-1)	ft/s		1.6		
11. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		0.24	+	= 0.24
Channel flow		Segment ID	CD		
12. Cross sectional flow area, a	ft^2		27		
13. Wetted perimeter, p_w	ft		28.2		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft		0.957		
15. Channel slope, s	ft/ft		0.005		
16. Manning's roughness coeff., n			0.05		
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V	ft/s		2.05		
18. Flow length, L	ft		7300		
19. $T_t = \frac{L}{3600\,V}$ Compute T_t	hr		0.99	+	= 0.99
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				1.53

Figure 3-2.—Worksheet 3 for example 3-1.

APPENDIX H

RODGER CREEK

CALCULATIONS:

MUSKINGUM ROUTING

PARAMETERS

FDCMC FDS

BY: BLJ 9-13-89
CHECKED TFR 9/19/89

Rodger Creek Routing

Muskingum Method

Requires: Reach Travel Time AMSKK or K (hrs)
Computation interval NMIN or Δt (min)
Muskingum weighting factor X or X
Number of intermediate steps NSTPS or n
in routing reach

Δt has been selected at – $\Delta t = 5$ min.
X has been estimated as – X = 0.3

K may be estimated from HEC-2 Preliminary Run for Rodger Creek File RCH201 dated 9-5-89.

<u>Reach 1</u> is the channel within SUB R2. The reach begins midway between (HEC-2) SECNO's 1.10 and 2.01 an ends 700 l.f. upstream of SECNO 2.06. From the HEC-2 output value (Run 2) TIME difference between SECNO 1.10 and 2.06 K is estimated as – 0.62 - 0.33 = 0.29 K = 0.30 hrs

n must satisfy the inequality $\frac{1}{2(1-X)} \leq \frac{K \times 60}{n \times \Delta t} \leq \frac{1}{2X}$
or $0.714 \leq \left(\frac{3.6}{n}\right) \leq 1.67$

range of n, (integer values)
$3 \leq n \leq 5$ use n = 4

For RTE 1 RM record is <u>RM 4 0.3 0.3</u>

TSR 9/09/89

<u>Reach 2</u> is the channel in SUB R3. The reach begins 700'± downstream of SECNO 1.01 to midway between SECNO's 1.10 and 2.01. From HEC-2 run 2 TIME for SECNO 1.01 & 2.01 K is estimated as — 0.38 − 0.00 = 0.38 hrs, say K = 0.40 hr

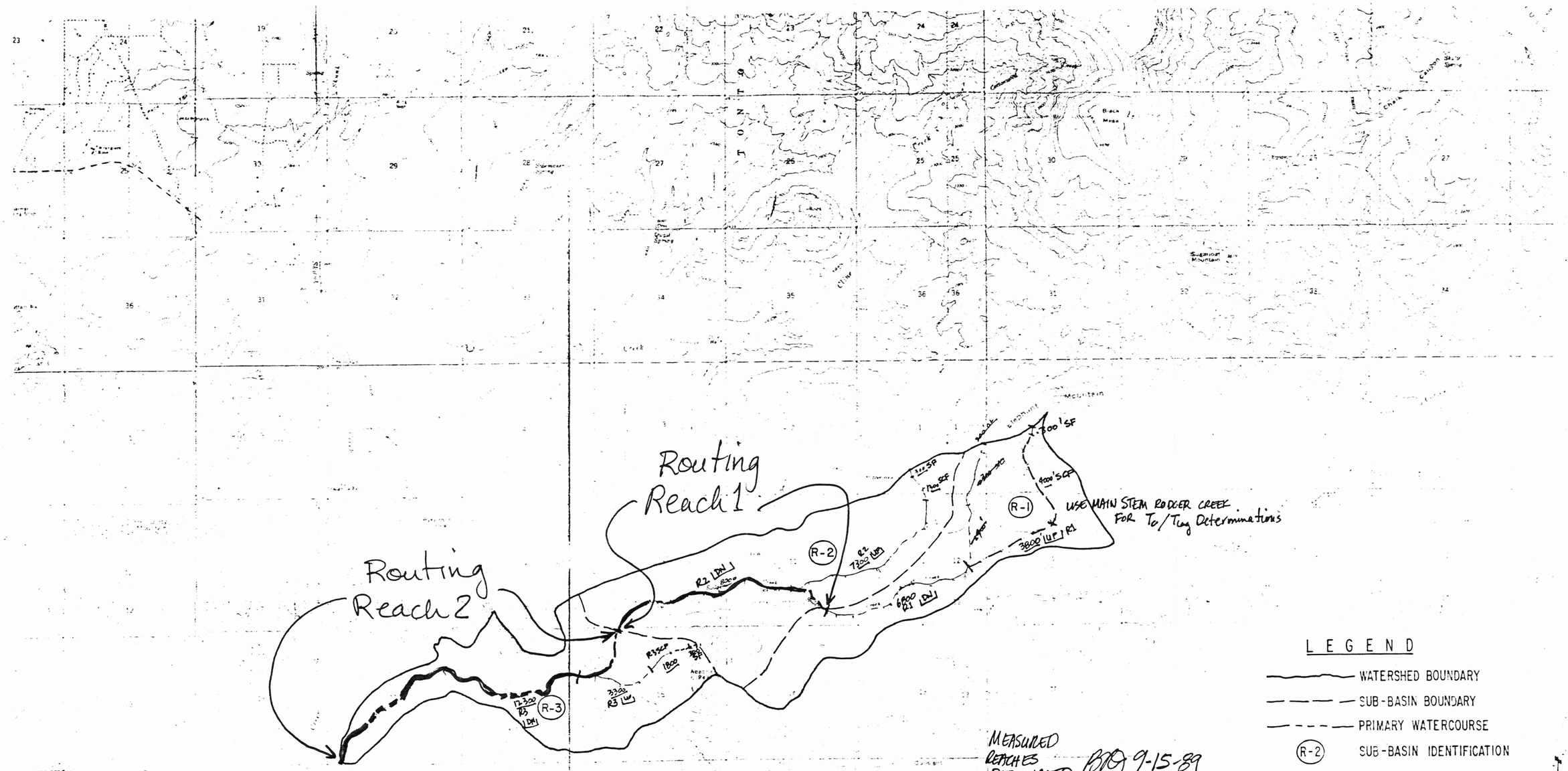
for n $\quad \frac{1}{2(1-x)} \leq \frac{K \times 60}{n \times \Delta t} \leq \frac{1}{2x}$

$$0.714 \leq \frac{4.8}{n} \leq 1.67$$

range of n, (integer value) $\quad 4 \leq n \leq 6$

use $n = 5$

For RTE2 RM record is RM 5 0.4 0.3



MEASURED REACHES DESIGNATED RTO 9-15-89

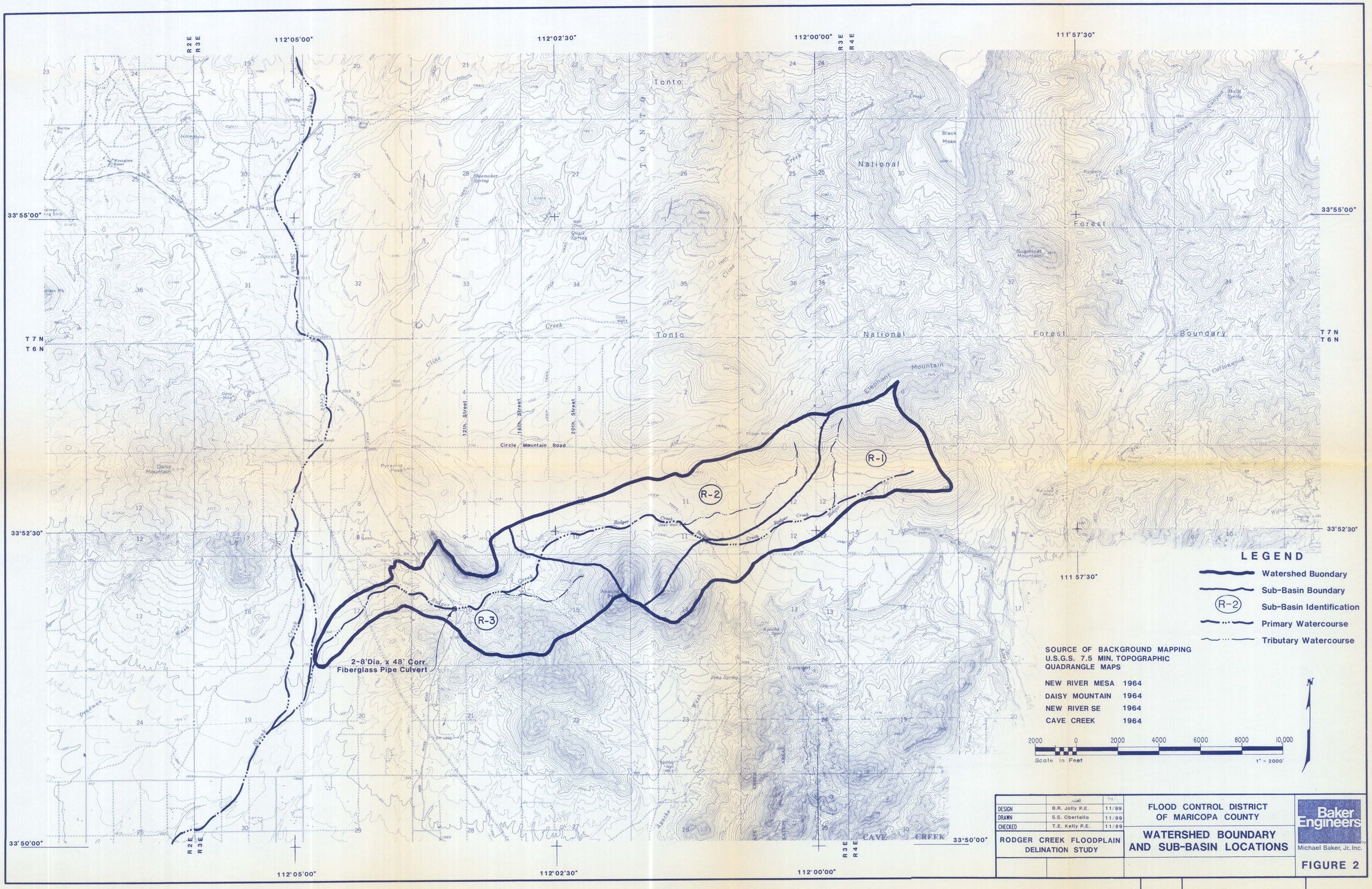
CHECKED: [illegible] 9/19/89

ACCOMPANIES TR-55 Tc Worksheets FOR RODGER CREEK SUB-BASINS

Scale in Feet

PRELIMINARY

DESIGN DRAWN CHECKED	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RODGER CREEK FLOODPLAIN DELINEATION STUDY	WATERSHED BOUNDARY AND SUB-BASIN LOCATIONS
16923 - HPH	FIGURE - 3


112°05'00"
112°02'30"
112°00'00"
111°57'30"
33°55'00"
33°52'30"
33°50'00"
T 7 N
T 6 N
R 2 E
R 3 E
R 4 E
Tonto
National
Forest
Boundary
Tonto
National
Forest
Mountain
Black Mesa
Sugarloaf Mountain
Shoemaker Spring
Ogden Spring
Cline Creek
Cottonwood Creek
Stephens Wash
Rodger Creek
Circle Mountain Road
12th Street
16th Street
20th Street
Daisy Mountain
Pyramid Peak
Shangri La Ranch
Wrangler's Roost
Borrow Pit
Deadman Wash
Apache Wash
Jima Spring
Gunsight
Cave Creek
R-1
R-2
R-3
2-8'Dia. x 48' Corr.
Fiberglass Pipe Culvert
LEGEND
Watershed Buondary
Sub-Basin Boundary
R-2 Sub-Basin Identification
Primary Watercourse
Tributary Watercourse
SOURCE OF BACKGROUND MAPPING
U.S.G.S. 7.5 MIN. TOPOGRAPHIC
QUADRANGLE MAPS
NEW RIVER MESA 1964
DAISY MOUNTAIN 1964
NEW RIVER SE 1964
CAVE CREEK 1964
2000 0 2000 4000 6000 8000 10,000
Scale in Feet
1" = 2000'
N
DESIGN B.R. Jolly P.E. 11/89
DRAWN S.S. Obertello 11/89
CHECKED T.E. Kelly P.E. 11/89
RODGER CREEK FLOODPLAIN DELINATION STUDY
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
WATERSHED BOUNDARY AND SUB-BASIN LOCATIONS
Baker Engineers
Michael Baker, Jr., Inc.
FIGURE 2

SCS SOIL MAP UNIT	SCS SOIL GROUP
12	Carefree Cobbly Clay Loam
16	Cellar-Rock Outcrop
26	Continental Cobbly Clay Loam
44	Ebon Very Gravelly Loam
52	Gachado-Lomitas-Rock Outcrop Complex
66	Greyeagle-Suncity Variant Complex
68	Gunsight-Cipriano Complex
72	Lehmans-Rock Outcrop Complex
95	Ohaco Gravelly Loam
96	Pinaleno-Tres Hermanos Complex
98	Pinamt-Tremant Complex
110	Suncity-Cipriano Complex

LEGEND

- WATERSHED BOUNDARY
- SUB-BASIN BOUNDARY
- (R-2) SUB-BASIN IDENTIFICATION
- S.C.S. SOIL GROUP BOUNDARY
- 26 S.C.S. SOILS MAP UNIT

N

2000 0 2000 4000 6000
SCALE 1" = 2000'

BASIS OF SOIL CLASSIFICATION:
Soil Survey of Aguila - Carefree Area,
Parts of Maricopa and Pinal County,
U.S. Department of Agriculture,
Soil Conservation Service, April 1986.

NO	DESCRIPTION OF REVISIONS	MADE BY	DATE
1			
2			
3			
4			

	NAME	DATE
DESIGN	B.R. Jolly P.E.	11/89
DRAWN	S.S. Obertello	11/89
CHECKED	T.E. Kelly P.E.	11/89

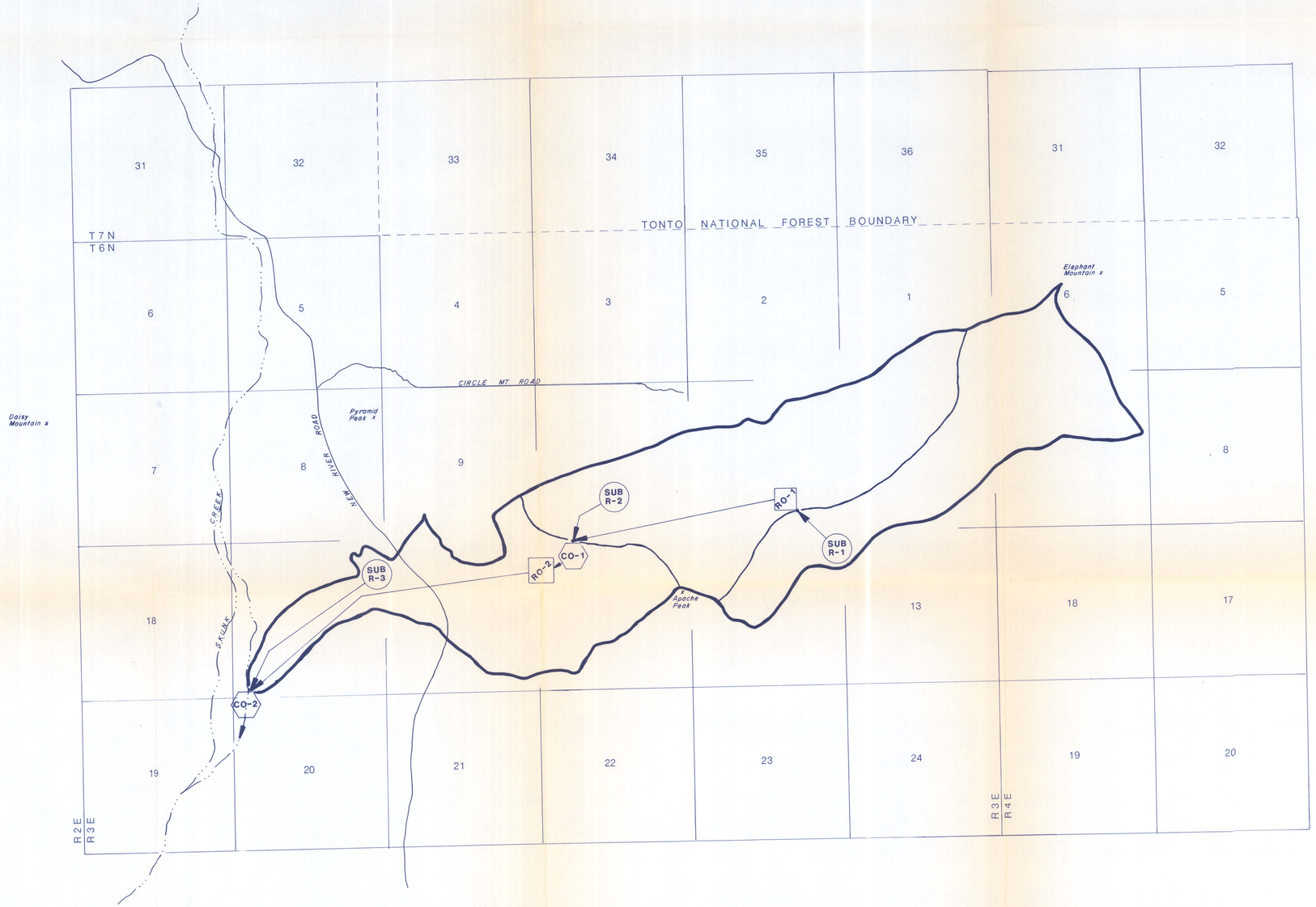
RODGER CREEK FLOODPLAIN DELINEATION STUDY

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WATERSHED SOILS MAP

Baker Engineers
Michael Baker, Jr., Inc.

FIGURE-4



2000 0 2000 4000 6000
SCALE 1" = 2000'

N

LEGEND

- SUB R-1 — SUB-AREA HYDROGRAPH
- RO-2 — ROUTE HYDROGRAPH
- CO-1 — COMBINED HYDROGRAPH
- WATERSHED BOUNDARY
- SUB-BASIN BOUNDARY

NO	DESCRIPTION OF REVISIONS	MADE BY	DATE
1			
2			
3			
4			

	NAME	DATE
DESIGN	B.R. Jolly P.E.	11/89
DRAWN	S.S. Obertello	11/89
CHECKED	T.E. Kelly P.E.	11/89

RODGER CREEK FLOODPLAIN DELINEATION STUDY

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

HEC-1 MODEL SCHEMATIC

Baker Engineers
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FIGURE-5