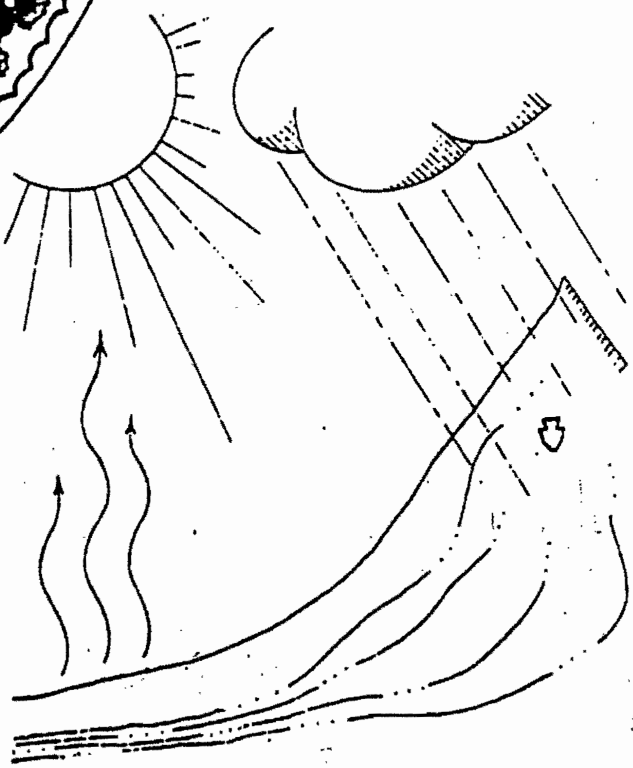
SAN BERNARDINO COUNTY

TEMPORARY COPY

HYDROLOGY MANUAL



COUNTY OF SAN BERNARDINO

HYDROLOGY MANUAL

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RCE #16032 Expires June 30, 1989

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Approved By

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RCE #18746 Expires March 24, 1987

AUGUST 1986

PREFACE

The County of San Bernardino Hydrology Manual was prepared by Williamson and Schmid, Civil Engineers as authorized by Purchase Order Nos. H5168R and J4869M.

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WILLIAMSON AND SCHMID, CIVIL ENGINEERS, IRVINE, CALIFORNIA

AUGUST, 1986

FOREWORD AND ACKNOWLEDGEMENTS

The revised County of San Bernardino Hydrology Manual (1986) represents an update of hydrologic modeling techniques and the incorporation of recent rainfall - runoff data synthesis and model calibration. Concurrent with this manual's update is the revision and calibration of the Orange County Hydrology Manual (1986), and the ongoing Los Angeles County Drainage Area (LACDA) study for the hydrologic planning of the Santa Ana River Basin by the U.S. Army Corps of Engineers, Los Angeles District Office.

Revisions include (i) an updated rational method, developed to better estimate peak flow rates obtained from rainfall-runoff relationships, (ii) revised unit hydrograph method loss rate calculations for the low loss fraction $\bar{Y}$, and revised depth-area curves, (iii) inclusion of hydrologic models for channel and pipeflow routing, and flow-by basin routing, (iv) extended design storms for detention basin testing, (v) link-node model guidelines, and (vi) desert hydrology criteria and parameter selection for the calculation of losses and the unit hydrograph.

Acknowledgements are paid to the San Bernardino County staff who directed the development of the 1983 manual and also the 1986 update (alphabetically), Bob Corchero, Alan Kielhold, Chuck Laird, Art Luther, and Dick Thompson.

Particular acknowledgements are paid to the Los Angeles District U.S. Army Corps of Engineers (COE) Chief of Hydrologic Engineering Section, Andy Sienkiewich; and Chief, Hydrologic Engineering Unit 1, John Pedersen, for their generous cooperation and contribution of time through the course of the several studies leading to this revised manual.

Other acknowledgements are paid to the Orange County Environmental Management Agency who have recently completed their hydrology manual update; Gary L. Guymon, Department of Civil Engineering, University of California, Irvine, and Bill Burchard, Williamson and Schmid, Irvine, for their preparation of the hydrologic soil group maps (1983 manual); and the several engineering firms and agencies who have participated in the overall work effort by either reviewing the manuscripts or by attending the various presentations.

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SECTION A

INTRODUCTION

A.1. PURPOSE

This manual provides the computational techniques and criteria for the estimation of runoff, discharges, and volumes for use in hydrology study submittals to the County of San Bernardino (hereinafter "Agency").

A.2. HYDROLOGIC PROTECTION LEVELS

It is the goal of the Agency to provide 100-year return frequency flood protection for all habitable structures and other non-floodproof structures. Consequently, all drainage plans must demonstrate this 100-year flood protection criteria.

Additionally, it is the design objective of the Agency to afford specific design criteria for the more frequent flood events. That is, flood protection levels for 10- and 25-year floods may be required for major street travelways, catch basin sump design, and other conditions. The design criteria may be obtained from the Agency.

A.3. PRESENTATION

Preciptation and loss information common to both the Rational Method and the unit hydrograph procedure for developing flowrates is contained in Sections B and C, respectively. Specific guidelines for application of the Rational Method are contained in Section D. Section E contains the procedures for developing runoff hydrographs using the unit hydrograph method and Sections F through I contain guidelines for application of various flood routing methods. The development of runoff hydrographs for small areas is discussed in Section J and watershed modeling guidelines are provided in Section K. The appendices provide additional discussion of various hydrology topics.

SECTION B

PRECIPITATION

B.1. CLASSIFICATION OF PRECIPITATION

In this manual, references are made to several types of storm precipitation mechanisms which may occur in San Bernardino County watersheds. The classification of storm precipitation is generally attributed to the mechanism which elevates the moisture laden air mass to be subsequently cooled. Frontal precipitation, for example, occurs when moisture laden warm air is elevated (along a frontal surface) over a region of cooler air. Likewise, nonfrontal precipitation implies that the storm precipitation is not attributed to fronts. Convective precipitation is caused by the upwards migration of warm air through dense cold air or, for example, thunderstorms over the desert. Related rainfall intensities range from light showers to catastrophic cloudbursts. Orographic precipitation describes the process of moisture laden air being cooled due to the elevation of the air mass over mountain barriers.

B.2. MECHANISMS FOR COOLING

Each of the above-discussed elevation mechanisms involves a cooling process which is also associated with the resulting precipitation. Cyclonic cooling, for example, is generally classified according to the association with frontal and nonfrontal effects.

The nonfrontal grouping is associated with the convergence and resulting elevation of air accompanied with a low pressure area. Nonfrontal cyclonic precipitation of extratropical origin is associated with rainfall (or snows) of moderate intensities and of long duration. This type of storm may last for a few days and deliver one to in excess of six inches of precipitation. In contrast, nonfrontal cyclonic precipitation of tropical origin may result in over double the rainfall in a period of half the duration.

Orographic cooling occurs when moisture laden air is elevated along a mountain barrier, allowing the air to expand and cool at the upper elevation lower pressure. Because of the mountain barrier, a "rain shadow" may occur on the lee side of the barrier. Generally, the windward sides of mountain barriers are more cloudy, have more precipitation and have smaller temperature ranges than the leeward side.

When vertical instability of moisture laden air is produced by surface heating, a convection current results. Convective precipitation is generally associated with very short duration events of high intensity, and can result in catastrophic flooding.

B.3. PRECIPITATION DEPTH-DURATION-FREQUENCY

Due to the apparent randomness of precipitation patterns and intensities, a strictly deterministic analysis of precipitation quantities is not possible and, consequently, a statistical evaluation is generally used. In the statistical analysis, the following definitions of precipitation depth, duration, and frequency are used:

Precipitation depth: the amount of precipitation occurring during a specified duration of storm time. Precipitation depth is usually expressed in units of inches.

Duration: the specified length of storm time under study. Duration may be expressed in any time unit such as seconds, minutes, hours, days or season.

Frequency: the frequency of occurrence of events with the specified precipitation depth and duration. This is expressed in terms of either the return period or exceedance probability, both of which are defined below.

Intensity-duration: dividing precipitation depth by duration, an average intensity for a specified duration is obtained.

Critical duration: the critical duration of a design storm event for a hydraulic structure is essentially the "time of concentration," which is the time for water deposited at the most remote part of a watershed to flow to the structure, outlet or spillway.

In hydrologic analysis, the rainfall intensity is usually the most important parameter. This value relates both precipitation volume to storm duration and also relates storm runoff to storm precipitation with the intensity being an upper bound to the watershed runoff rate. However, in order to provide a reasonable level of flood protection, the statistical concept of return frequency is utilized which aids in assigning a probabilistic meaning to a precipitation event. The following definitions are used in this hydrology manual:

Exceedance (cumulative) probability: the probability that a precipitation event of a specified depth and duration will be exceeded in one year.

Return period (recurrence interval): the long term average number of years between occurences of an event of a given depth and duration, either equaled or exceeded.

The exceedance probability (p) and return period (T) are related by

$$p = 1/T \tag{B.1}$$

From the above definitions it can be argued that a 100-year precipitation event, for example, will not necessarily occur once in every 100 years but actually has a finite probability that it will occur in several consecutive years.

B.4. MEASUREMENT AND SYNTHESIS OF PRECIPITATION DATA

Of interest for hydrologic studies are the maximum intensities of precipitation possible throughout a watershed. Given a long history of such maximum rainfall intensities for various durations of time, a reasonable statistical interpretation can be made of the data to determine estimates of maximum rainfall intensities or depths as a function of storm duration and of return frequency. The County of San Bernardino maintains and operates both automatic recording and standard (manual) rain gauges throughout the county and summarizes the data in its annual Hydrologic Data Report. Other sources of precipitation data include the U.S. Weather Bureau, U.S. Army Corps of Engineers, U.S. Geological Survey, and other private and governmental cooperative weather observers.

For each automatic recording rainfall gauge, the precipitation records are analyzed to determine the annual maximum rainfall depth for several durations of interest (e.g., 5-minutes, 10-minutes, 15-minutes, etc.). This data can then be arranged in an increasing order of magnitude for each storm duration for the history of the rain gauge, and plotted on normal probability paper. From this accumulation of rainfall depth-duration data, various statistical models can be applied to assign a return frequency (or period) to the known data values and to estimate maximum rainfall depth-duration values for typically unmeasured higher return frequencies (e.g., the 100-year return frequency). The resulting data for each rain gauge is generally termed "point precipitation" values to distinguish them from average values for large areas.

Because storm events seldom locate their peak intensities over rain gauges, and because the rain gauge network is widely distributed (allowing small intense rainfall events to miss the gauge network), and because of mechanical defects of the gauging devices and due to other unknown variables such as wind effects, the rainfall data can generally be assumed to underestimate the true maximum point rainfall intensities.

B.5. POINT PRECIPITATION

The County has prepared isohyetal maps (Figures B-1 through B-12) showing 2-year 6-and 24-hour, 10-year 1-hour, and 100-year 1-, 6-and 24-hour point precipitation values. These maps are based on the "NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume XI-California" published by the National Weather Service in 1973. A correlation to local rain gauge data and an interpretation of short duration precipitation data was prepared by the County of San Bernardino. Figures B-1 through B-12 can be found at the end of this section.

The isohyetal maps may be used to estimate the precipitation data needed to prepare rational method (Section D) or unit hydrograph (Section E) hydrology studies. However, the maps are to be considered only as an approximation of point precipitation values and should be verified against all available rainfall data sources, especially in the desert regions of the County. Any deviation in the use of the provided rainfall data must be approved by the Agency.

Point precipitation values for other return frequencies can be estimated using the diagram (NOAA Atlas 2) of Figure D-2.

B.6. RANDOM NATURE OF POINT-PRECIPITATION DATA

When rain gauge records are examined to identify relationships with respect to time, an extremely wide range of variations are found. These random variations are so great that they essentially obscure any long-term pattern or periodicity which may exist. To utilize point precipitation data, therefore, a combination of probabilistic and deterministic methods are needed. The duration and magnitude of individual storm events is assumed probabilistic, while the internal assemblage of the storm may be essentially deterministic. Additionally, the origin of such storm events (e.g., convective, orographic) adds to the difficulty of developing a comprehensive analysis.

B.7. EVENT DEPTH-DURATION

For most hydrologic study purposes, the important relationship is that of precipitation depth for any rainfall event of a given duration. As discussed in the NOAA Atlas 2, this relationship will include total precipitation from storms of the given duration, and will also include the depths from independent continuous partial storm durations. This information can be represented by event depth-duration curves which are constructed by ranking in the order of decreasing rainfall depth all storm events of some common duration from a subject rain gauge. From the position of a precipitation depth, an estimate can be made of the number of years during which the event (of a given duration) will be equaled or exceeded.

After constructing event depth-duration curves, a second set of precipitation depth-duration (or intensity-duration) curves can be developed which, for a given return frequency, represent the maximum precipitation depth (or intensity) which can occur from any storm as a function of duration.

B.8. INTENSITY-DURATION CURVES

Intensity-duration data is required for use with the rational method. This data is usually presented in the form of curves of rainfall intensity in inches per hour versus storm duration in minutes. Intensity-duration data for durations under 3 hours tends to plot in a straight line on log-log paper, and the curves for various return periods tend to run parallel to one another.

Intensity-duration curves can be developed for a watershed by estimating the appropriate area-averaged one-hour point precipitation values from the isohyetal maps. Intermediate return frequency point precipitation values can be estimated from Figure D-2.

Using Figure D-3, the one-hour point precipitation value is plotted and a straight line is drawn with the appropriate slope. Generally, a slope of 0.6

may be used for watersheds in the southwestern portions of the county and 0.7 is used in the desert and mountain areas. As with the point precipitation data, rainfall records should be examined to determine an appropriate slope of the intensity-duration plot. Since most rain gauge data interpretations are based on stations with few years of record, extreme care is needed to properly determine the intensity-duration curves. From Figure D-3, a minimum duration of 5 minutes is used for rational method studies.

B.9. SYNTHETIC 24-HOUR CRITICAL STORM PATTERN

The United States Department of Agriculture Soil Conservation Service (SCS) developed dimensionless critical storm patterns using the U.S. National Weather Service's (NWS) rainfall frequency atlases (ref. 2). The rainfall frequency data for areas less than 400 square miles, for durations to 24 hours, and for frequencies from 1 to 100 years were used.

These critical storm patterns are based on the generalized precipitation depth-duration-frequency relationships shown in technical publications of the NWS, and precipitation depths for durations from 1 minute to 24 hours were used to derive the storm patterns. Using increments of 30-minutes, incremental precipitation depths were determined. For example, the 30-minute depth was subtracted from the 1-hour depth and the 1-hour depth was subtracted from the 1.5-hour depth. The storm patterns were formed by arranging the 30-minute incremental depths such that the maximum 30-minute depth is contained within the maximum 1-hour depth, and the maximum 1-hour depth is contained within the maximum 1.5-hour depth and so forth. Because all of the critical precipitation depths are contained within the storm pattern, the critical storm patterns may be assumed appropriate for designs on both small and large watersheds (ref. 2).

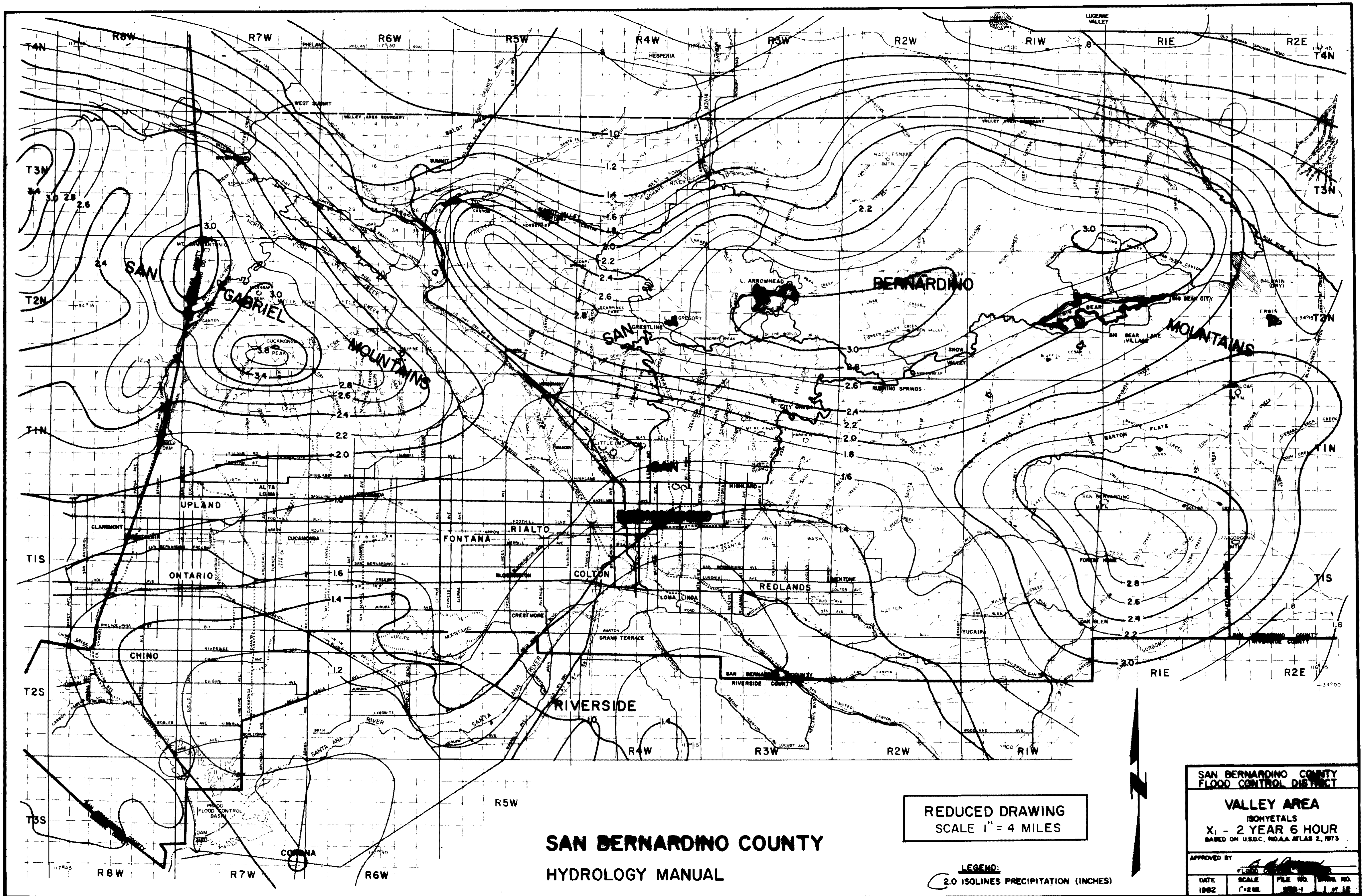
The agency's design storm pattern is based upon a modification of the SCS 24-hour storm pattern. The design storm pattern provides a representation of local precipitation depth-duration-frequency tendencies by constructing the several nested intervals to fit local recorded rainfall data. Additionally, the SCS storm pattern is further modified to include the necessary adjustments (reduction in shorter duration point precipitation values) due to watershed area effects. The procedures used to construct the 24-hour storm pattern and determine the associated rainfall depths adjusted for depth-area follow the U.S. Army Corps of Engineers methods as published in the HEC Training Document No. 15 (ref. 10). Details of the 24-hour storm pattern and the necessary adjustments for depth-area effects are contained in Section E.

B.10. LONGER DURATION RAINFALL DATA

The Agency's design storm criteria extends to a multiday design storm when needed to evaluate detention basin characteristics (sections F and G). The following tabulation provides a ratio of daily rainfalls to the peak 24-hour mass rainfall, and shall be used whenever rainfall data is inadequate to provide the quantities directly. (Table B.1 is an average relationship developed from the Claremont Pomona College and Lytle Creek PH rain gauges).

TABLE B.1. MULTIDAY RAINFALL MASS RATIOS

RAINFALL DURATION	RATIO TO PEAK 24-HOURS
PEAK 24-HOURS	1
(PEAK 48-HOURS)-(PEAK 24-HOURS)	0.36
(PEAK 72-HOURS)-(PEAK 48-HOURS)	0.19
(PEAK 96-HOURS)-(PEAK 72-HOURS)	0.15
(PEAK 120-HOURS)-(PEAK 96-HOURS)	0.10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SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
X1 - 2 YEAR 6 HOUR
BASED ON U.S.D.C., NOAA ATLAS 2, 1973
APPROVED BY
DATE
1982
SCALE
FILE NO.
DWG. NO.
1 of 12
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
UPLAND
CLAREMONT
ONTARIO
CHINO
CUCAMONGA
FONTANA
RIALTO
COLTON
LOMA LINDA
REDLANDS
YUCAIPA
CRESTMORE
GRAND TERRACE
RIVERSIDE
CORONA
HESPERIA
PHELAN
L. ARROWHEAD
CRESTLINE
BIG BEAR CITY
OAK GLEN
FOREST HOME
R8W
R7W
R6W
R5W
R4W
R3W
R2W
R1W
R1E
R2E
T4N
T3N
T2N
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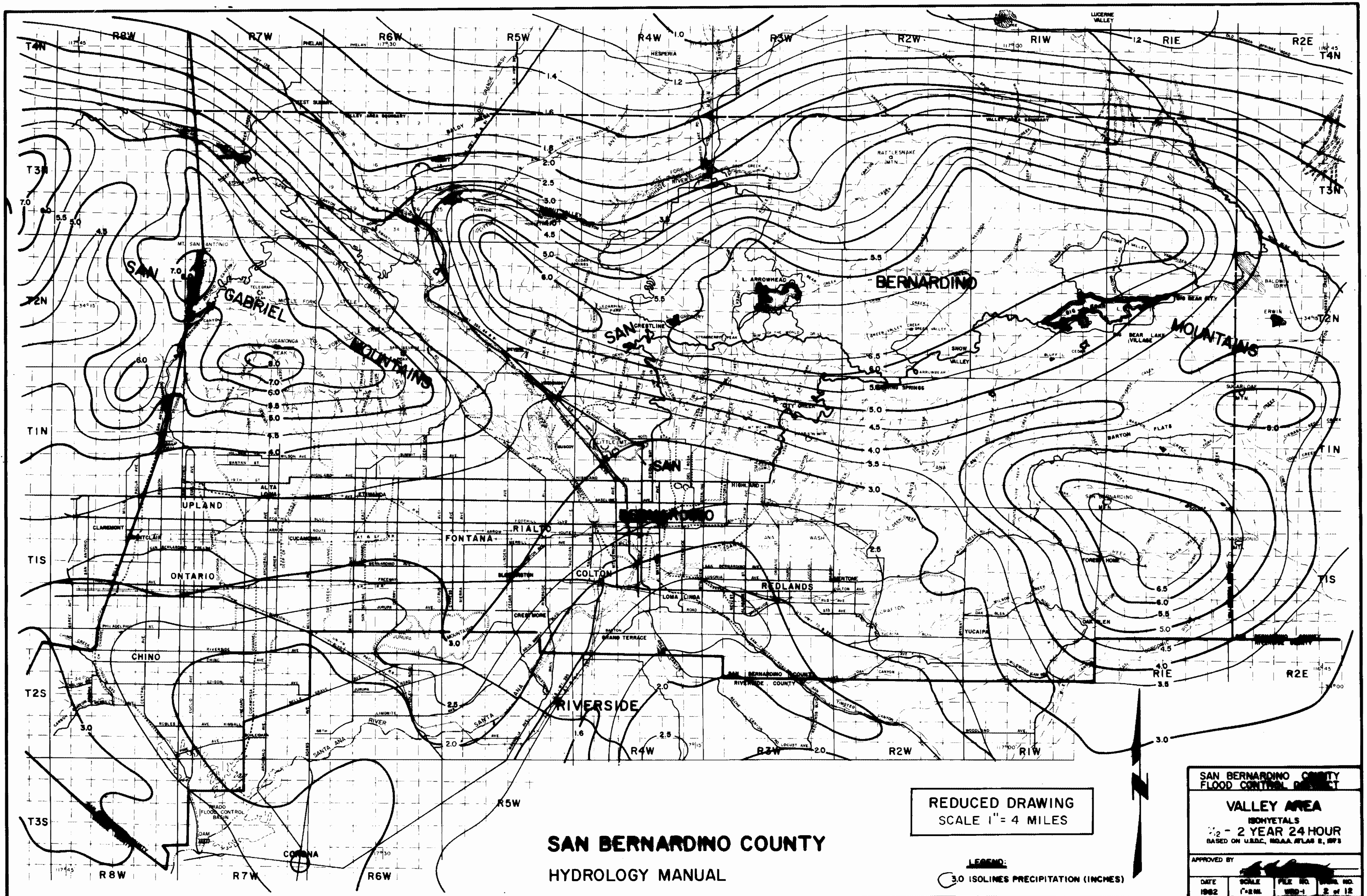
T1S
T2S
T3S

-9

FIGURE B-1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ISOHYETALS
2 YEAR 24 HOUR
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APPROVED BY
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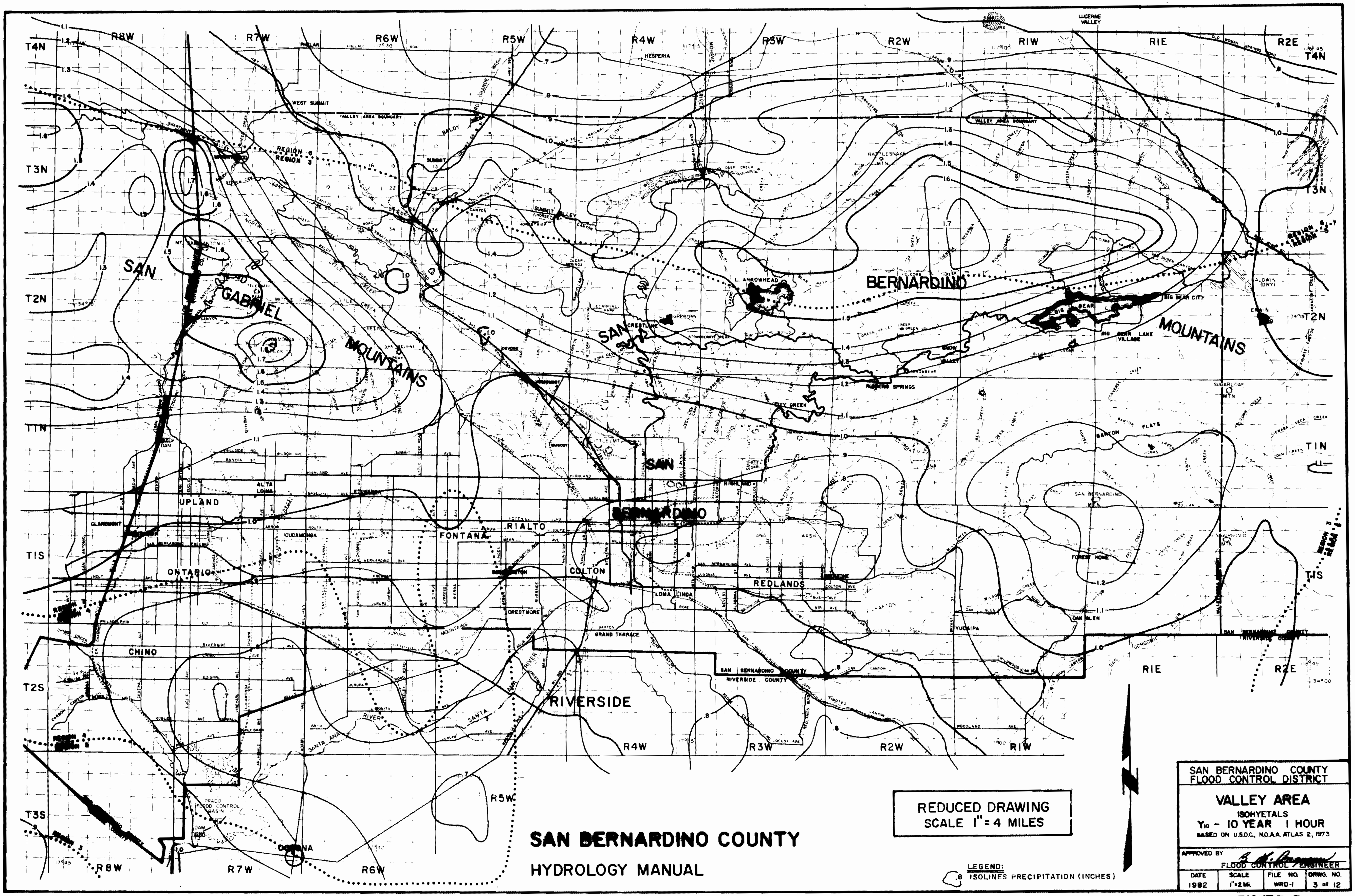
UPLAND
ONTARIO
CHINO
FONTANA
RIALTO
COLTON
REDLANDS
RIVERSIDE
YUCAIPA
CORONA
LOMA LINDA
CUCAMONGA
HESPERIA
BIG BEAR CITY
LAKE ARROWHEAD
CRESTLINE

FIGURE B-2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VALLEY AREA
ISOHYETALS
Y10 - 10 YEAR 1 HOUR
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APPROVED BY
FLOOD CONTROL ENGINEER
DATE
1982
SCALE
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DRWG. NO.
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LOMA LINDA
YUCAIPA
RIVERSIDE
CUCAMONGA
ALTA LOMA
CLAREMONT
CORONA
GRAND TERRACE
CRESTMORE
HIGHLAND
OAK GLEN
FOREST HOME
HESPERIA
LUCERNE VALLEY
L. ARROWHEAD
BIG BEAR LAKE
BIG BEAR CITY
CRESTLINE
R8W
R7W
R6W
R5W
R4W
R3W
R2W
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T3N
T2N
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T1S
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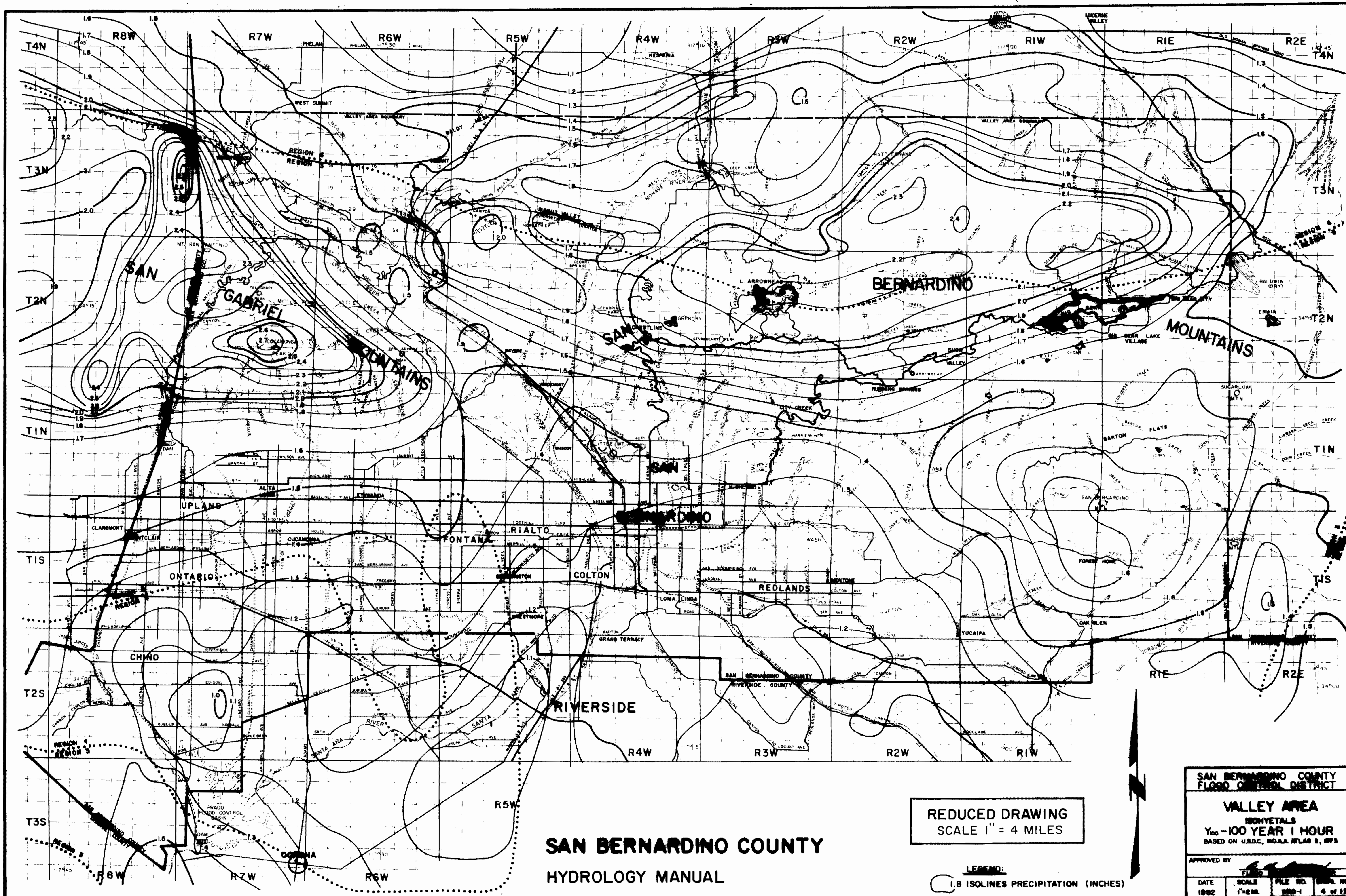
T3S
FIGURE B-3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FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
Y_{100} - 100 YEAR 1 HOUR
BASED ON U.S.D.C., NOAA ATLAS 2, 1973
APPROVED BY
DATE
1982
SCALE
1"=2MI.
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GRAND TERRACE
CLAREMONT
CUCAMONGA
ETIWANDA
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T2S
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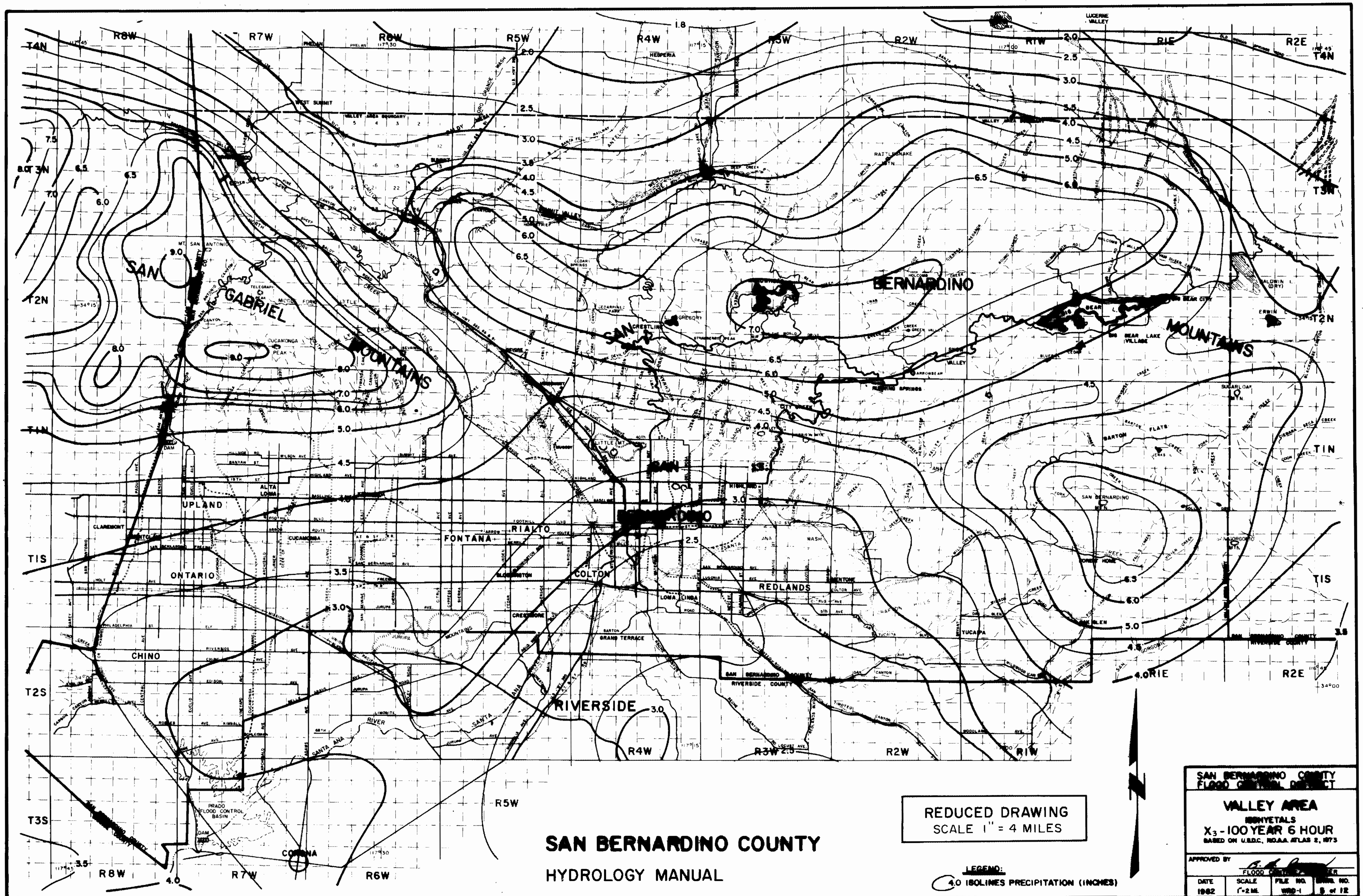
R1E
R2E

FIGURE B-4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VALLEY AREA
ISOHYETALS
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BASED ON U.S.D.C., NOAA ATLAS 2, 1973
APPROVED BY
DATE 1982
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FILE NO. WRD-1
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ONTARIO
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FONTANA
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REDLANDS
RIVERSIDE
CORONA
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LOMA LINDA
YUCAIPA
HESPERIA
LUCERNE VALLEY
PHELAN
CRESTLINE
BIG BEAR LAKE
BIG BEAR CITY
SAN BERNARDINO MTN.
CUCAMONGA PEAK
MT. SAN ANTONIO
PRADO FLOOD CONTROL BASIN
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T3N
T2N
T1N
T1S
T2S
T3S
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R7W
R6W
R5W
R4W
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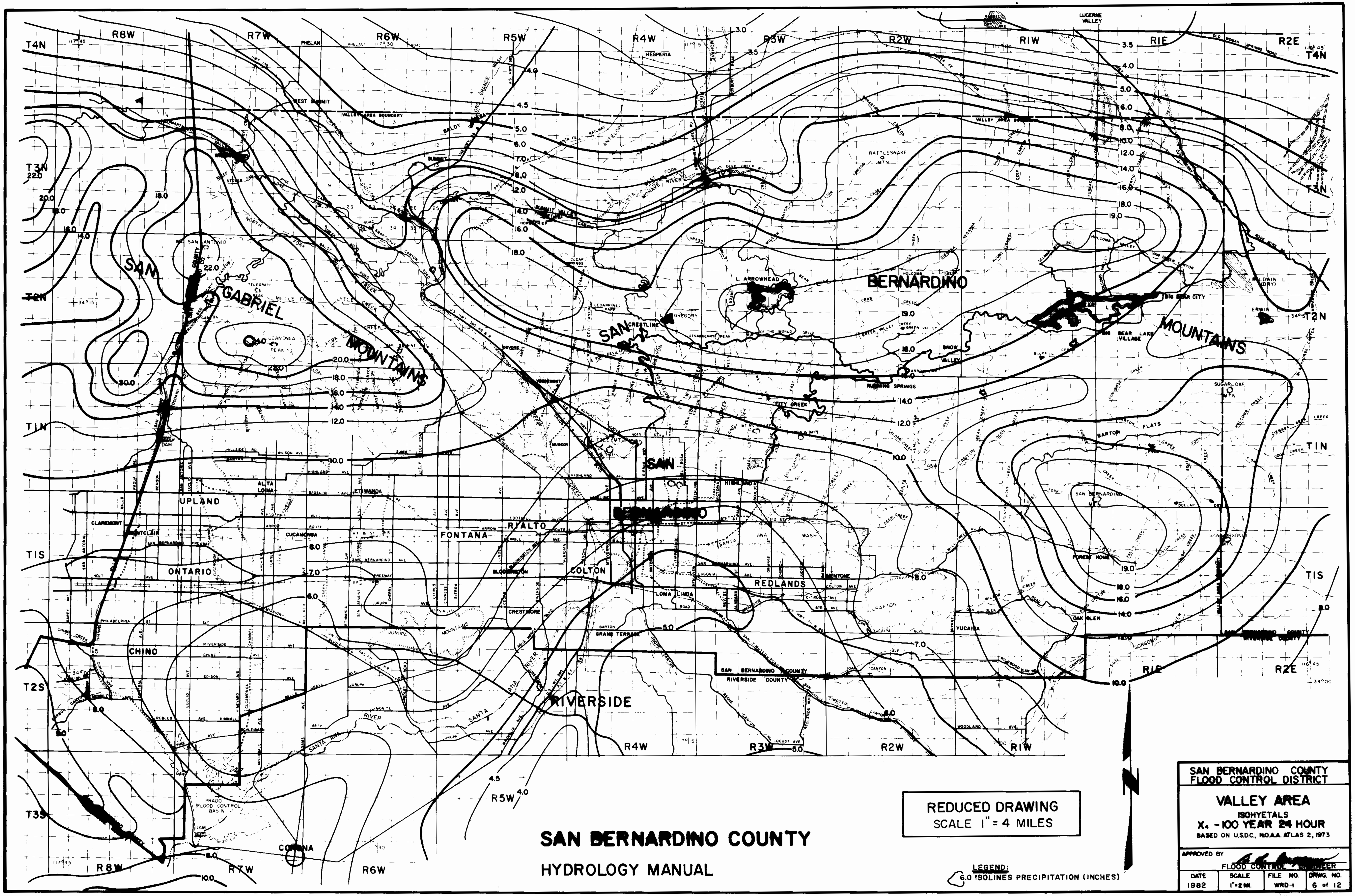
R1W
R1E
R2E

FIGURE B-5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VALLEY AREA
ISOHYETALS
X₄ -100 YEAR 24 HOUR
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APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
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DRWG. NO. 6 of 12
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LOMA LINDA
YUCAIPA
RIVERSIDE
CORONA
CLAREMONT
MONTCLAIR
CUCAMONGA
ALTA LOMA
ETIWANDA
BLOOMINGTON
GRAND TERRACE
CRESTMORE
MENTONE
OAK GLEN
FOREST HOME
CRESTLINE
L. ARROWHEAD
L. GREGORY
RUNNING SPRINGS
BIG BEAR CITY
BEAR LAKE VILLAGE
SUGARLOAF MTN
SAN BERNARDINO MTN.
HESPERIA
PHELAN
WEST SUMMIT
LUCERNE VALLEY
ERWIN
BALDWIN L. (DRY)
PRADO FLOOD CONTROL BASIN
VALLEY AREA BOUNDARY
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
T4N
T3N
T2N
T1N
T1S
T2S
T3S
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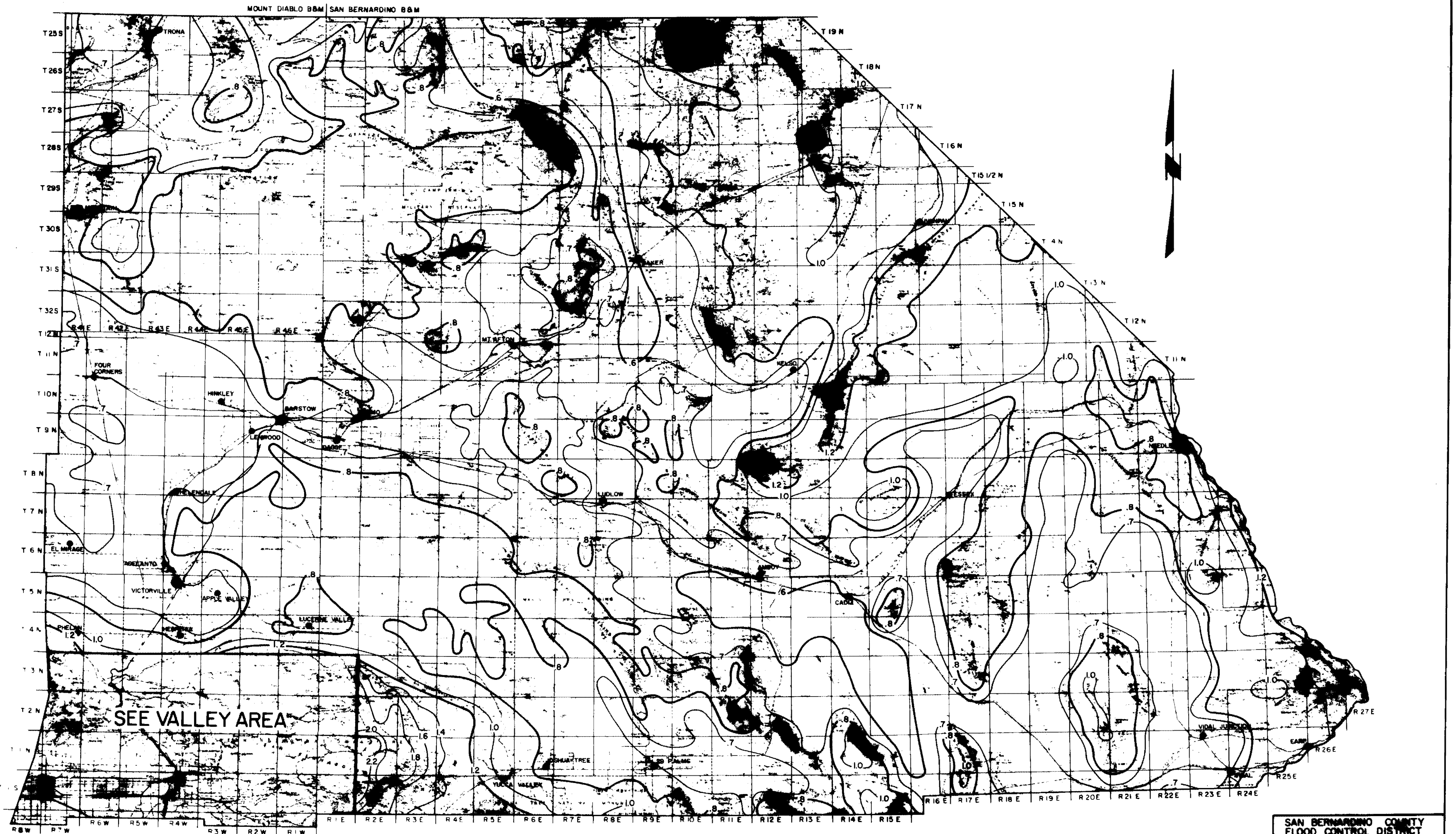
R1E
R2E

FIGURE B-6



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

REDUCED DRAWING

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3 INCHES ON ORIGINAL

LEGEND:

1.0 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_1 - 2 YEAR 6 HOUR

BASED ON U.S.D.C. N.O.A.A. ATLAS 2, 1973

APPROVED BY FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DWG. NO.
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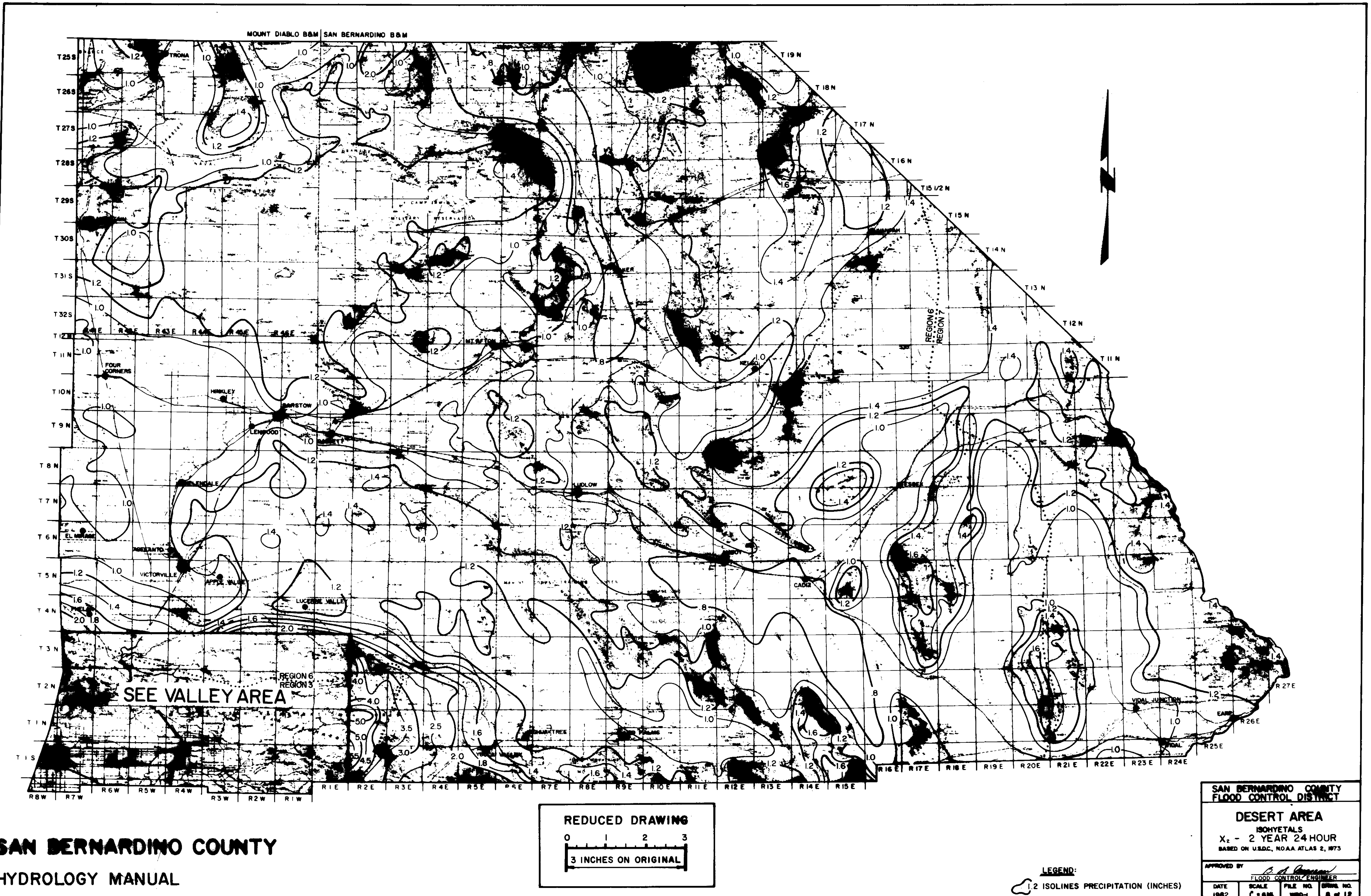
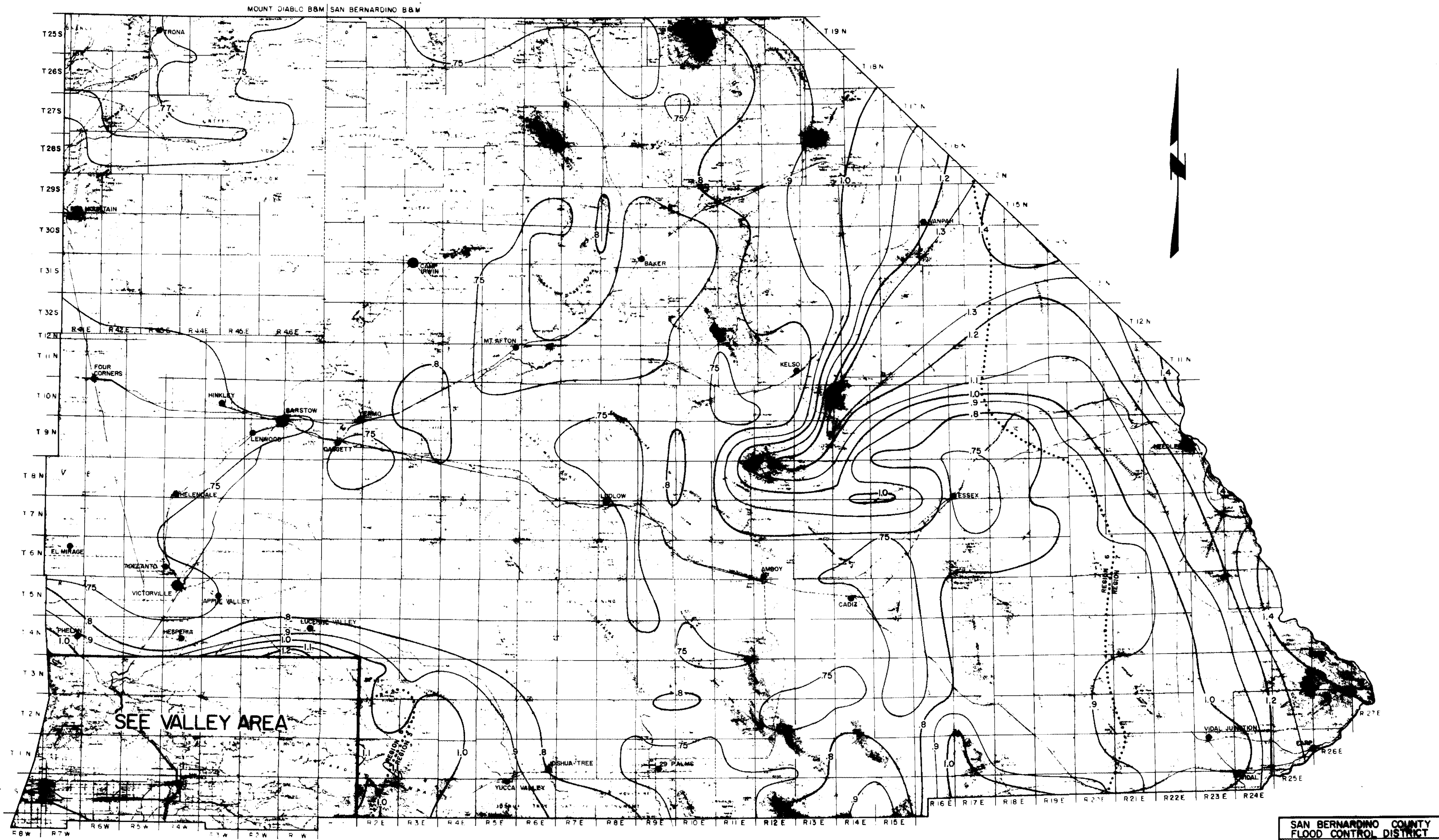
FIGURE B-7



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

FIGURE B-8



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3 INCHES ON ORIGINAL

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

Y_{10} - 10 YEAR 1 HOUR

BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973

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FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
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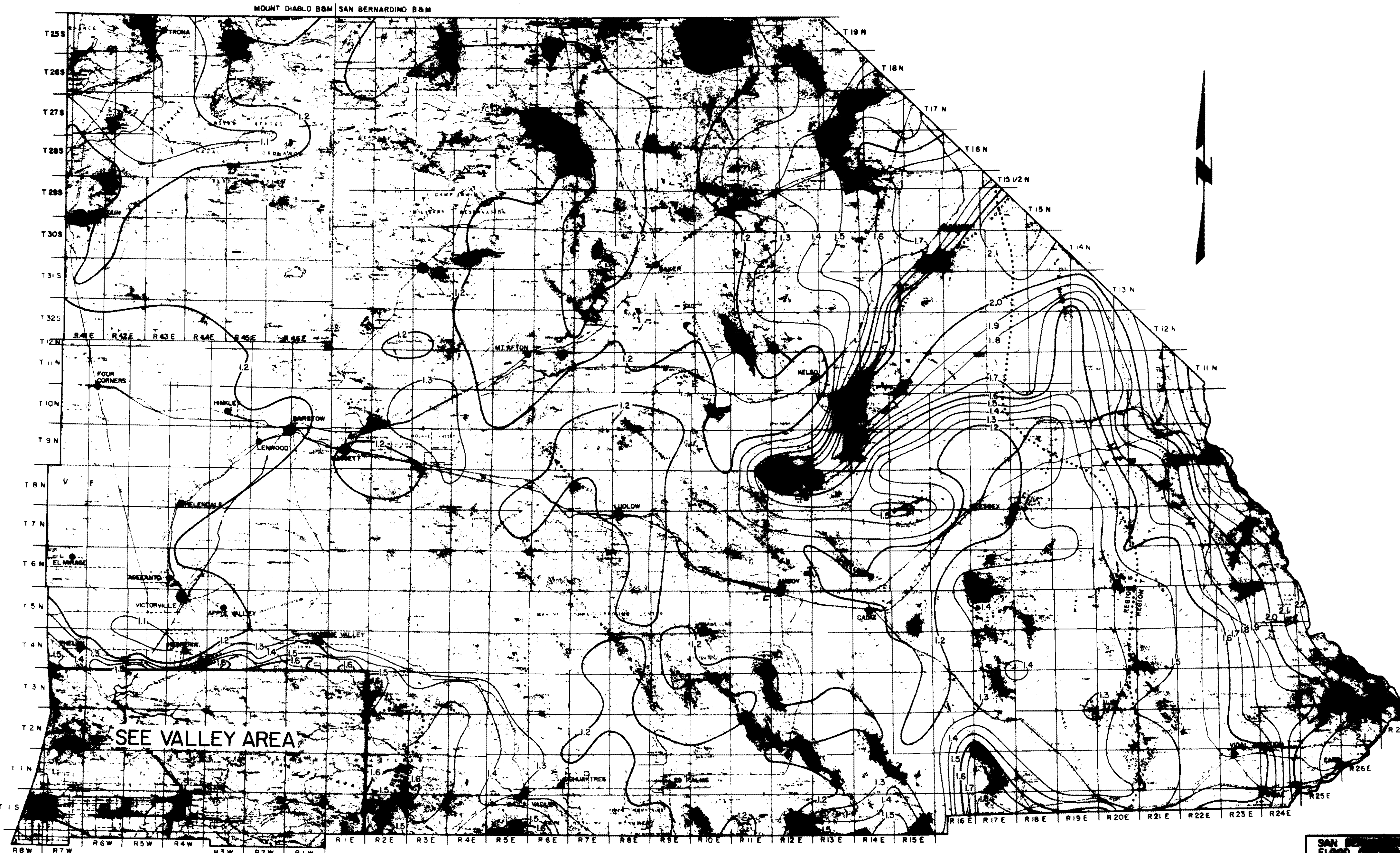
FIGURE B-9



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

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LEGEND:

1.2 ISOLINES PRECIPITATION (INCHES)

SAN [illegible] COUNTY
FLOOD [illegible]

DESERT AREA

ISOHYETALS

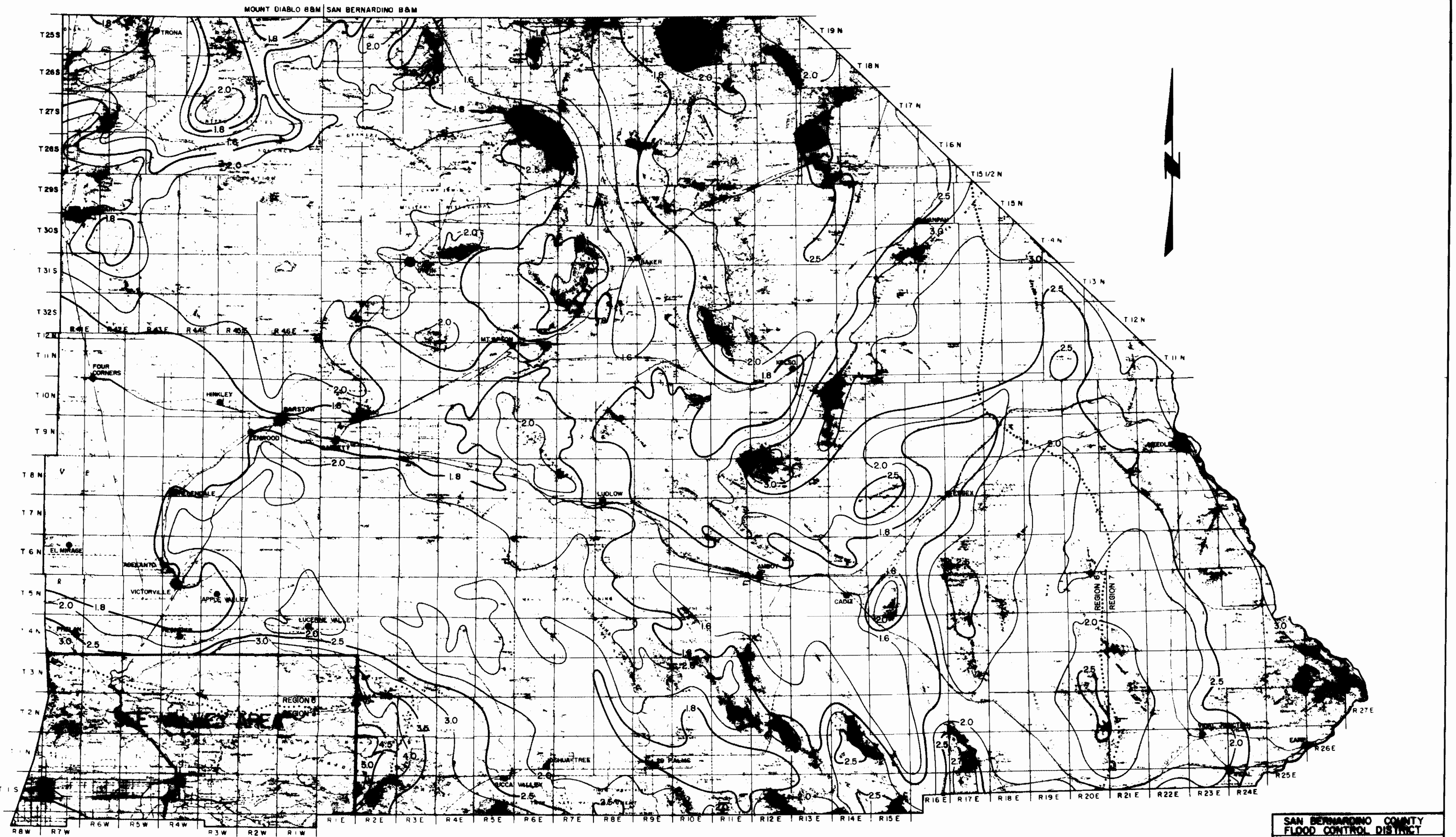
Y_{100}-100 YEAR 1 HOUR

BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973

APPROVED BY [illegible]

DATE 1982 | SCALE [illegible]

FIGURE B-10



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

REDUCED DRAWING

0 1 2 3

3 INCHES ON ORIGINAL

LEGEND:

2.0 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_3 -100 YEAR 6 HOUR

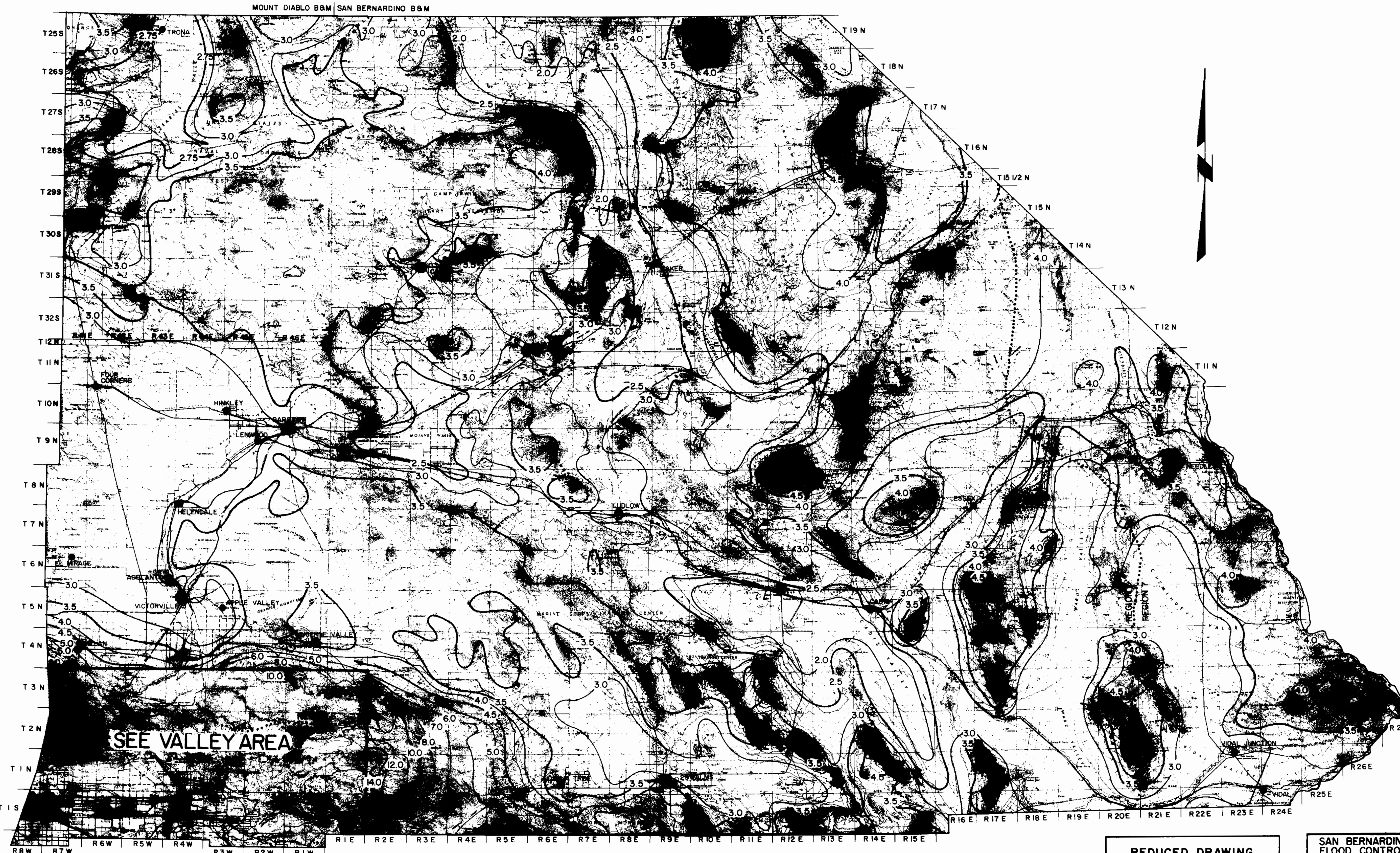
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973

APPROVED BY [signature]

FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
1982	1" = 6 MI.	WRO-1	11 of 12

FIGURE B-11



REDUCED DRAWING

0 1 2 3

3 INCHES ON ORIGINAL

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_4 -100 YEAR 24 HOUR

BASED ON U.S.D.C., NOAA ATLAS 2, 1973

APPROVED BY FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
1982	1" = 6 MI.	WRD-1	12 of 12

LEGEND:
3.5 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

FIGURE B-12

SECTION C

LOSSES

C.1. WATERSHED LOSSES

Watershed outflow is a function of precipitation, watershed losses, and routing processes. Watershed routing processes are presented in Sections D and E where the rational and unit hydrograph methods are presented in detail. Precipitation estimation procedures and data are presented in Section B. This section will present watershed loss computation methods and data.

Watershed losses are considered to be depression storage, vegetation interception and transpiration, minor amounts of evaporation, and infiltration. Infiltration is the process of water entering the soil surface and percolating downward into the soil where it is stored during a precipitation event. Subsequently, the stored soil water may be consumptively used by vegetation, percolate further downward to groundwater storage, or exit the soil surface as seeps or springs. Seepage from stream bank storage is the primary source of baseflow which is derived from prior precipitation events. For modeling purposes, watershed losses are grouped into two components: namely, (i) infiltration, and (ii) initial abstraction which includes all the losses except infiltration.

C.2. HYDROLOGIC SOIL GROUPS

The major factor affecting loss rates is the nature of the soil itself. The soil surface characteristics, its ability to transmit water to subsurface layers, and total storage capacity, are all major factors in controlling the infiltration rate and initial abstraction parameter values of a particular soil. Soils are classified into four hydrologic soil groups as follows (refs. 2,3):

GROUP A: Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well-drained sands or gravels. These soils have a high rate of water transmission.

GROUP B: Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained sandy-loam soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

GROUP C: Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of silty-loam soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

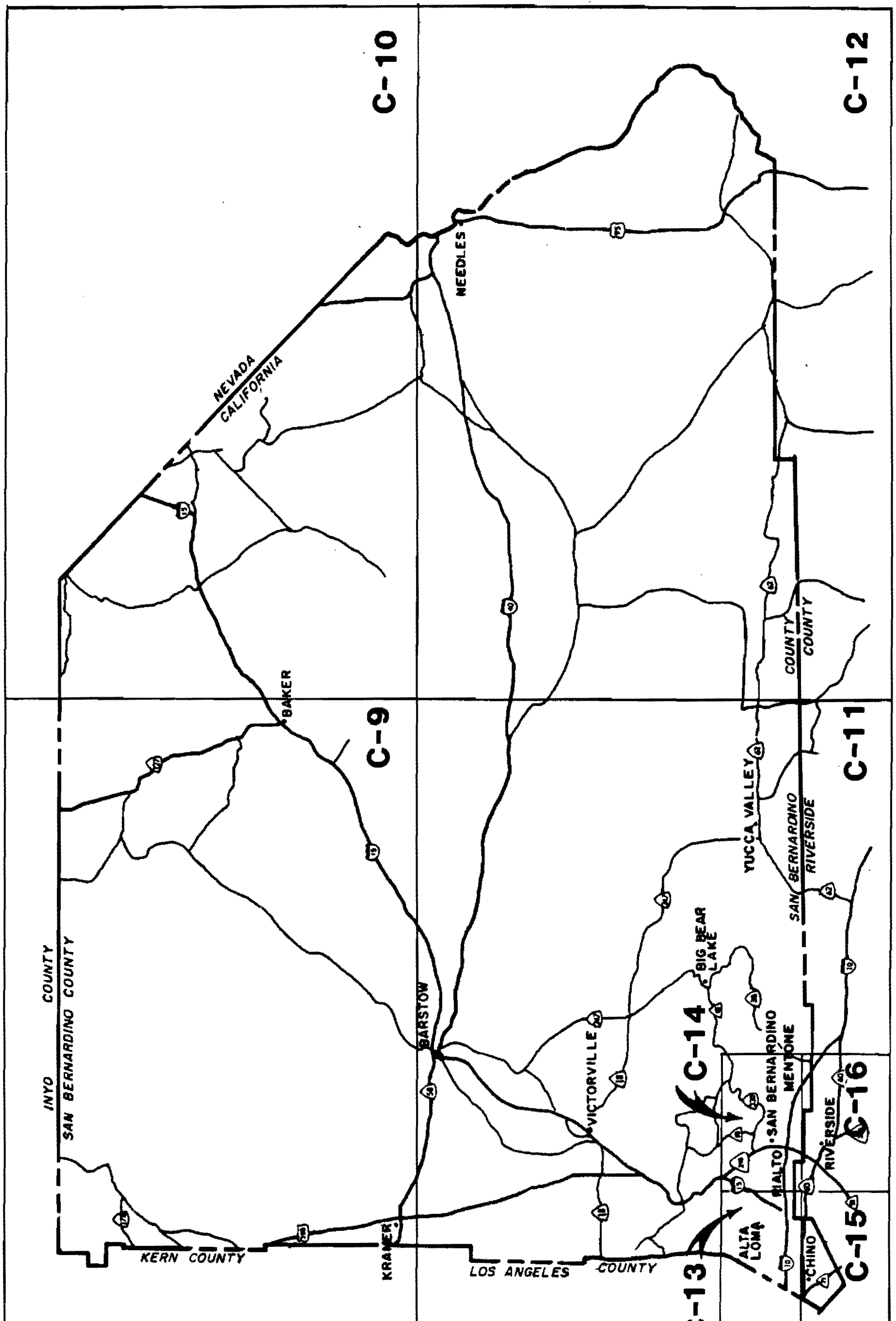
GROUP D: High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

C.2.1. Soil Maps

Maps have been prepared which designate the locations of the various soil groups within San Bernardino County (see Figure C-1 for index map) and are contained at the back of this section (Figures C-9 through C-16). Section C.8 contains details regarding soil map data and sources of information.

C.3. SOIL COVER AND HYDROLOGIC CONDITIONS

The type of vegetation or ground cover on a watershed, and the quality or density of that cover, have a major impact on the infiltration capacity of a given soil. Definitions of specific cover types are provided in Figure C-2. Further refinement in the cover type descriptions is provided by the definition of cover quality as follows:



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HYDROLOGY MANUAL

SAN BERNARDINO COUNTY
SOIL MAP INDEX

Figure C-1

Residential Landscaping (Lawn, Shrubs, etc.) - The pervious portions of commercial establishments, single and multiple family dwellings, trailer parks and schools where the predominant land cover is lawn, shrubbery and trees.

Row Crops - Lettuce, tomatoes, beets, tulips or any field crop planted in rows far enough apart that most of the soil surface is exposed to rainfall impact throughout the growing season. At plowing, planting and harvest times it is equivalent to fallow.

Small Grain - Wheat, oats, barley, flax, etc. planted in rows close enough that the soil surface is not exposed except during planting and shortly thereafter.

Legumes - Alfalfa, sweetclover, timothy, etc. and combinations are either planted in close rows or broadcast.

Fallow - Fallow land is land plowed but not yet seeded or tilled.

Woodland - grass - Areas with an open cover of broadleaf or coniferous trees usually live oak and pines, with the intervening ground space occupied by annual grasses or weeds. The trees may occur singly or in small clumps. Canopy density, the amount of ground surface shaded at high noon, is from 20 to 50 percent.

Woodland - Areas on which coniferous or broadleaf trees predominate. The canopy density is at least 50 percent. Open areas may have a cover of annual or perennial grasses or of brush. Herbaceous plant cover under the trees is usually sparse because of leaf or needle litter accumulation.

Chaparral - Land on which the principal vegetation consists of evergreen shrubs with broad, hard, stiff leaves such as manzonita, ceanothus and scrub oak. The brush cover is usually dense or moderately dense. Diffusely branched evergreen shrubs with fine needle-like leaves, such as chamise and redchank, with dense high growth are also included in this soil cover.

Annual Grass - Land on which the principal vegetation consists of annual grasses and weeds such as annual bromes, wild barley, soft chess, ryegrass and filaree.

Irrigated Pasture - Irrigated land planted to perennial grasses and legumes for production of forage and which is cultivated only to establish or renew the stand of plants. Dry land pasture is considered as annual grass.

Meadow - Land areas with seasonally high water table, locally called cienegas. Principal vegetation consists of sod-forming grasses interspersed with other plants.

Orchard (Deciduous) - Land planted to such deciduous trees as apples, apricots, pears, walnuts, and almonds.

Orchard (Evergreen) - Land planted to evergreen trees which include citrus and avocados and coniferous plantings.

Turf - Golf courses, parks and similar lands where the predominant cover is irrigated mowed close-grown turf grass. Parks in which trees are dense may be classified as woodland.

SCS COVER TYPE DESCRIPTIONS

Figure C-2

POOR: Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

FAIR: Moderate cover with 50 percent to 75 percent of the ground surface protected by vegetation.

GOOD: Heavy or dense cover with more than 75 percent of the ground surface protected by vegetation.

In most cases, watershed existing conditions cover type and quality can be readily determined by a field review of a watershed. In ultimate planned open spaces, the soil cover condition shall be considered as "good." Figure C-3 provides the CN values for various types and quality of ground cover. Impervious areas shall be assigned a CN of 98. It is noted that for ultimately developed conditions, the CN for urban landscaping (turf) is provided in Figure C-3.

C.4. WATERSHED DEVELOPMENT CONDITIONS

Ultimate development of the watershed should normally be assumed since watershed urbanization is reasonably likely within the expected life of most hydraulic facilities. Long range master plans for the County and incorporated cities should be reviewed to insure that reasonable land use assumptions are made for the ultimate development of the watershed. A field review shall also be made to confirm existing use and drainage patterns. Particular attention shall be paid to existing and proposed landscape practices, as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. Appropriate actual impervious percentages can then be selected from Figure C-4. It should be noted that the recommended values from these figures are for average conditions and, therefore, some adjustment for particular applications may be required.

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
AGRICULTURAL COVERS (Continued)					
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dryland (Annual grasses)	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Pasture, Irrigated (Legumes and perennial grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

Notes:

1. All curve numbers are for Antecedent Moisture Condition (AMC) II.
2. Quality of cover definitions:

   Poor-Heavily grazed, regularly burned areas, or areas of high burn potential. Less than 50 percent of the ground surface is protected by plant cover or brush and tree canopy.

   Fair-Moderate cover with 50 percent to 75 percent of the ground surface protected.

   Good-Heavy or dense cover with more than 75 percent of the ground surface protected.
3. See Figure C-2 for definition of cover types.

CURVE NUMBERS FOR PERVIOUS AREAS

ACTUAL IMPERVIOUS COVER

Land Use (1)	Range-Percent	Recommended Value For Average Conditions-Percent (2)
Natural or Agriculture	0 - 0	0
Public Park	10 - 25	15
School	30 - 50	40
Single Family Residential: (3)		
2.5 acre lots	5 - 15	10
1 acre lots	10 - 25	20
2 dwellings/acre	20 - 40	30
3-4 dwellings/acre	30 - 50	40
5-7 dwellings/acre	35 - 55	50
8-10 dwellings/acre	50 - 70	60
More than 10 dwellings/acre	65 - 90	80
Multiple Family Residential:		
Condominiums	45 - 70	65
Apartments	65 - 90	80
Mobile Home Park	60 - 85	75
Commercial, Downtown Business or Industrial	80 - 100	90

Notes:

1. Land use should be based on ultimate development of the watershed. Long range master plans for the County and incorporated cities should be reviewed to insure reasonable land use assumptions.

2. Recommended values are based on average conditions which may not apply to a particular study area. The percentage impervious may vary greatly even on comparable sized lots due to differences in dwelling size, improvements, etc. Landscape practices should also be considered as it is common in some areas to use ornamental gravels underlain by impervious plastic materials in place of lawns and shrubs. A field investigation of a study area shall always be made, and a review of aerial photos, where available, may assist in estimating the percentage of impervious cover in developed areas.

3. For typical equestrian subdivisions increase impervious area 5 percent over the values recommended in the table above.

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HYDROLOGY MANUAL

ACTUAL IMPERVIOUS COVER FOR DEVELOPED AREAS

C.5. ANTECEDENT MOISTURE CONDITION (AMC)

The definitions for the AMC classifications are:

AMC I: Lowest runoff potential. The watershed soils are dry enough to allow satisfactory grading or cultivation to take place.

AMC II: Moderate runoff potential; an average study condition.

AMC III: Highest runoff potential. The watershed is practically saturated from antecedent rains. Heavy rainfall or light rainfall and low temperatures have occurred within the last five days.

For runoff hydrograph studies based on this manual it is assumed that a low AMC index (high loss rates) will be used in developing short return period storms, and a moderate to high AMC index (low loss rates) will be used in developing longer return period storms (e.g., 100 year). For the purposes of design hydrology, AMC I will be used for the 2- and 5-year return frequency storms. For the case of 10-, 25-, 50-year return frequency design storms, AMC II will be used. For 100-year storm analysis, AMC III shall be used. In detention basin design studies, AMC III conditions shall be considered in order to identify any downstream flooding potential.

C.5.1. Adjustment of Curve Numbers (CN) for AMC

The CN values selected for a particular soil cover type and quality also depend upon the AMC condition assumed. The CN values listed in Figure C-3 correspond to AMC II and require adjustment in order to represent either AMC I or AMC III. Table C.1 provides the necessary CN adjustments to account for AMC changes for hydrologic studies in San Bernardino County.

TABLE C.1. CURVE NUMBER RELATIONSHIPS

CN for AMC Condition II	Corresponding CN for AMC Condition I	III
100	100	100
95	87	99
90	78	98
85	70	97
80	63	94
75	57	91
70	51	87
65	45	83
60	40	79
55	35	75
50	31	70
45	27	65
40	23	60
35	19	55
30	15	50
25	12	45
20	9	39
15	7	33
10	4	26
5	2	17
0	0	0

C.6. ESTIMATION OF LOSS RATES

In estimating loss rates for design hydrology, a watershed curve number (CN) is determined for each soil-cover complex within the watershed using Figure C-3. The working range of CN values is between 0 and 98, where a low CN indicates low runoff potential (high infiltration), and a high CN indicates high runoff potential (low infiltration). Selection of a CN takes into account the major factors affecting loss rates on pervious surfaces including the hydrologic soil group, cover type and quality, and antecedent moisture condition (AMC).

Also included in the CN selection are the effects of "initial abstraction" (Ia) which represents the combined effects of other effective rainfall losses including depression storage, vegetation interception, evaporation, and transpiration, among other factors.

C.6.1. Estimation of Initial Abstraction (Ia)

The initial abstraction (Ia) for an area is a function of land use, treatment, and condition; interception; infiltration; depression storage; and antecedent soil moisture. An estimate for Ia is given by the SCS as

$$Ia = 0.2S \tag{C.1}$$

where S is an estimate of total soil capacity given by

$$S = \frac{1000}{CN} - 10 \tag{C.2}$$

where CN is the area curve number.

C.6.2. Estimation of Storm Runoff Yield

Given the CN for a subarea A_j, the corresponding 24-hour storm runoff yield fraction, Y_j, is estimated by

$$Y_j = \frac{(P_{24} - Ia)^2}{(P_{24} - Ia + S)P_{24}} \tag{C.3}$$

where

Y_j	=	24-hour storm runoff yield fraction for subarea A_j
P_{24}	=	24-hour storm rainfall
Ia	=	initial abstraction from (C.1)
S	=	see (C.2)

It is noted that should Ia be greater than P_{24} in (C.3), then Y_j is defined to be zero. In this manual, the notation Y and Y_j will represent the runoff yield fraction, rather than the volume of runoff.

If the area under study contains several (say m) CN designations, then the yield, Y, for the total area must represent the net effect of the several curve numbers. By weighting each of the subarea yield values according to the respective areas,

$$Y = (Y_1A_1 + \cdots + Y_mA_m)/(A_1 + A_2 + \cdots + A_m) \qquad (C.4)$$

where each Y_j follows from (C.3).

C.6.3. Low Loss Rate, F*

In design storm runoff hydrograph studies, the following formula is used to estimate that portion of rainfall to be attributed to watershed losses:

$$\bar{Y} = 1 - Y \qquad (C.5)$$

where

$\bar{Y}$	=	catchment low loss fraction
Y	=	catchment 24-hour storm runoff yield fraction computed from (C.4)

Using the low loss fraction, $\bar{Y}$, the corresponding low loss rate, F*, is given by

$$F^* = \bar{Y} \cdot I \qquad (C.6)$$

where I is the rainfall intensity and F* has units of inches/hour. Use of F* enables the design storm 24-hour storm runoff yield to approximate the yield values obtained from the CN approach (see Figure C-5).

C.6.4. Infiltration Rates

Soil infiltration rates have been estimated for each of the soil groups by laboratory studies and measurements. These measurements show that an initially dry soil will have an associated infiltration rate which essentially decreases with time as the soil becomes wetted. As the soil is subjected to continual heavy rainfall, this infiltration rate approaches a minimum (usually within about 30 minutes) which represents the infiltration capacity of the soil.

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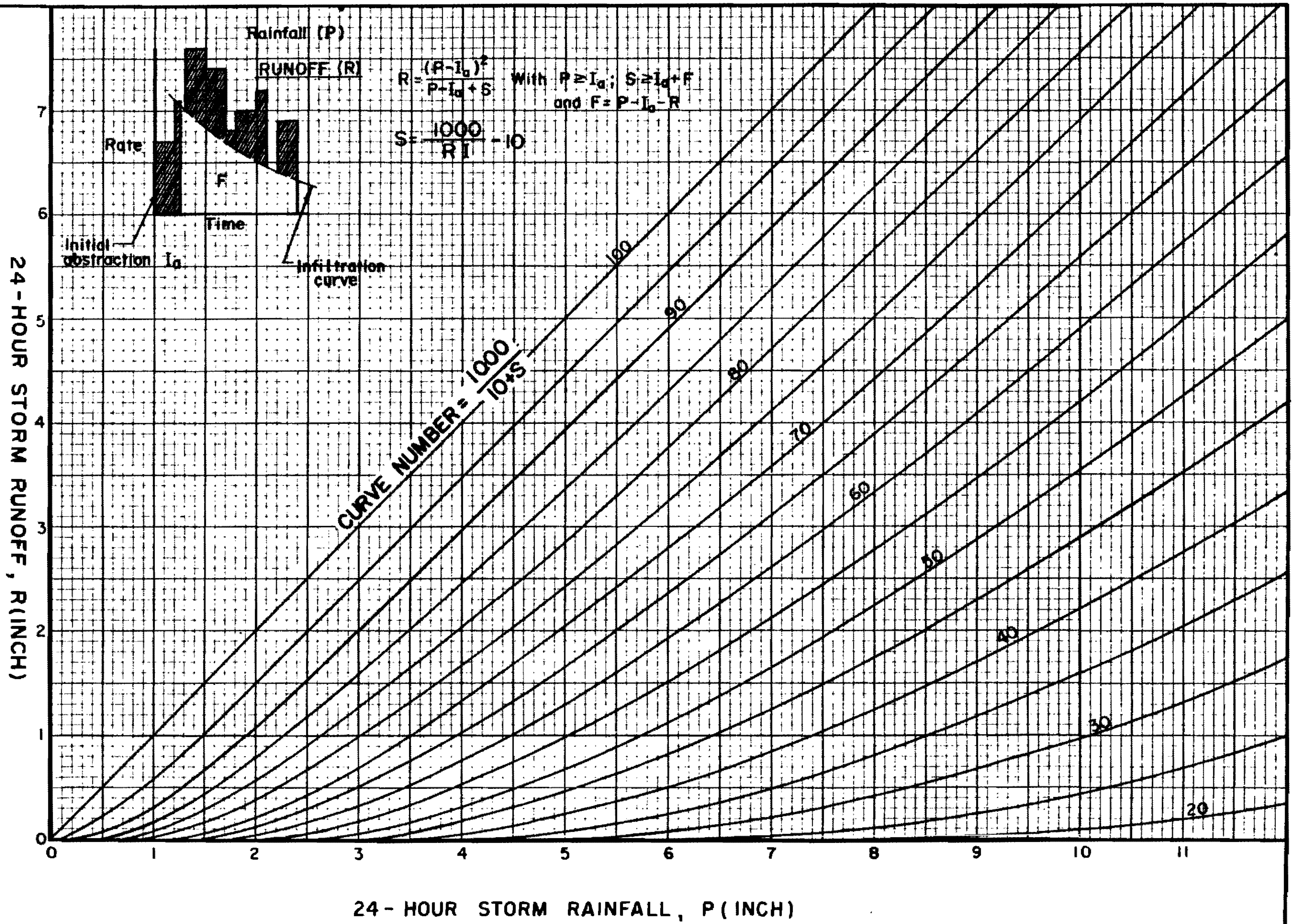


SCS 24-HOUR STORM RAINFALL-RUNOFF RELATIONSHIPS

Figure C-5

When sufficient stream gauge information is available, infiltration rates for unit hydrograph hydrology can be estimated from a study of rainfall-runoff relationships of major storms. Where such data is not available, infiltration rates for pervious areas as a function of CN can be estimated using Figures C-3 and C-6. Loss rates for pervious areas estimated from the Figure C-6 curves are generally consistent with values developed from rainfall-runoff reconstitution studies in San Bernardino County watersheds.

C.6.5. Estimation of Catchment Maximum Loss Rates, F_m

The infiltration rate selected from Figure C-6 applies to the pervious area fraction of the watershed. The infiltration rate assumed for an impervious surface is 0.0 inch/hour. The maximum loss rate, F_m, for a catchment is therefore given by

$$F_m = a_p F_p \qquad \text{(C.7)}$$

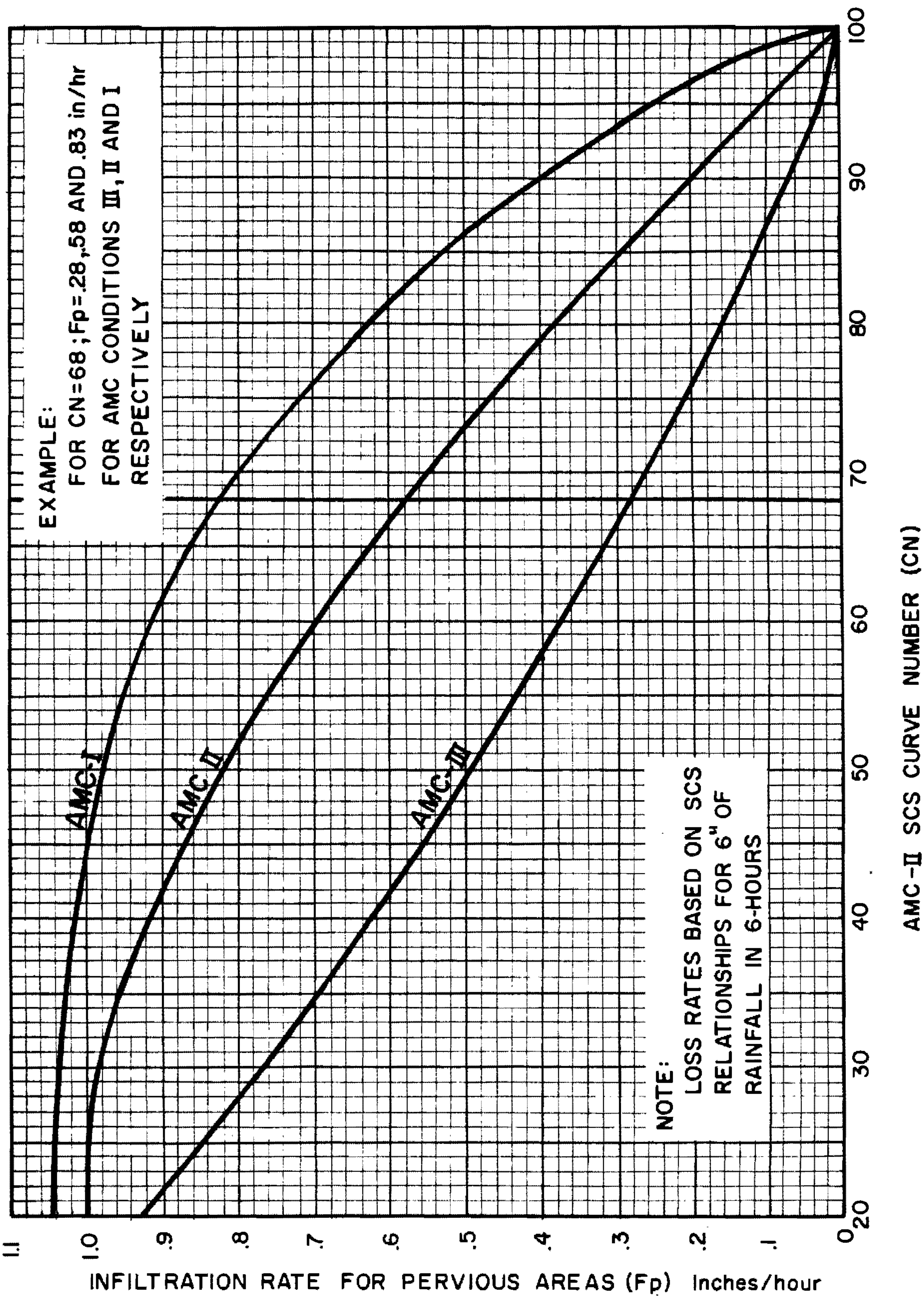
where a_p is the pervious area fraction, and F_p is the infiltration rate for the pervious area.

Should a catchment contain several F_p values, the composite F_m value is determined as a simple area average of the several F_m values. Table C.2 provides Fm values for a wide range of cover types and soil groups.

C.6.6. Design Storm Loss Rates

In design storm runoff hydrograph studies, a 24-hour duration storm pattern is used to develop the time distribution of effective rainfall over the watershed. The effective rainfall quantities are determined by subtracting the watershed losses from the design storm rainfall.

The loss rate used for a particular catchment is a combination of the maximum loss rate F_m and the low loss rate F^*. F^* is used as the loss rate unless F^* exceeds F_m, in which case F_m is used as the loss rate. That is, F_m serves as the maximum loss rate. Typically in 100-year storm studies, F^* serves as the loss rate for the entire storm pattern except for the most



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INFILTRATION RATE FOR PERVIOUS AREAS VERSUS SCS CURVE NUMBERS

Figure C-6

TABLE C.2. Fm (in/hr) VALUES
FOR TYPICAL COVER TYPES

COVER TYPE	SOIL GROUP A_p (1)	A	B	C	D
NATURAL:					
Barren	1.0	0.41	0.27	0.18	0.14
Row Crops (good)	1.0	0.59	0.41	0.29	0.22
Grass (fair)	1.0	0.82	0.56	0.40	0.31
Orchards (fair)	1.0	0.88	0.62	0.43	0.34
Woodland (fair)	1.0	0.95	0.69	0.50	0.40
URBAN:					
Residential (1 DU/AC)	0.80	0.78	0.60	0.45	0.37
Residential (2 DU/AC)	0.70	0.68	0.53	0.39	0.32
Residential (4 DU/AC)	0.60	0.58	0.45	0.34	0.28
Residential (10 DU/AC)	0.40	0.39	0.30	0.22	0.18
Condominium	0.35	0.34	0.26	0.20	0.16
Mobile Home Park	0.25	0.24	0.19	0.14	0.12
Apartments	0.20	0.19	0.15	0.11	0.09
Commercial/Industrial	0.10	0.10	0.08	0.06	0.05

NOTES:

(1) Recommended a_p values from Figure C-4

(2) AMC II assumed for all Fm values

(3) CN values obtained from Figure C-3

(4) DU/AC=dwelling unit per acre

intense rainfalls where F_m would apply. However for lower frequency storm studies such as the 5-year return event, F* often applies for the entire 24-hour storm pattern. The example problem of section E provides an illustration in the use of F* and F_m values. Figure C-7 illustrates the loss rate function used with the design storm.

C.7. DESERT HYDROLOGY LOSS RATES

For desert catchments, a field investigation will be required for most hydrologic studies to determine the pertinent drainage area characteristics. The extent of the required field study will depend on the size of the drainage area and the complexity of the drainage problem. Many features such as channel-flow pattern, flow distribution, channel diversions, and type and density of the vegetative cover may not be apparent from contour maps or air photos. The field study may also indicate the need for low level air photos to solve complex drainage problems.

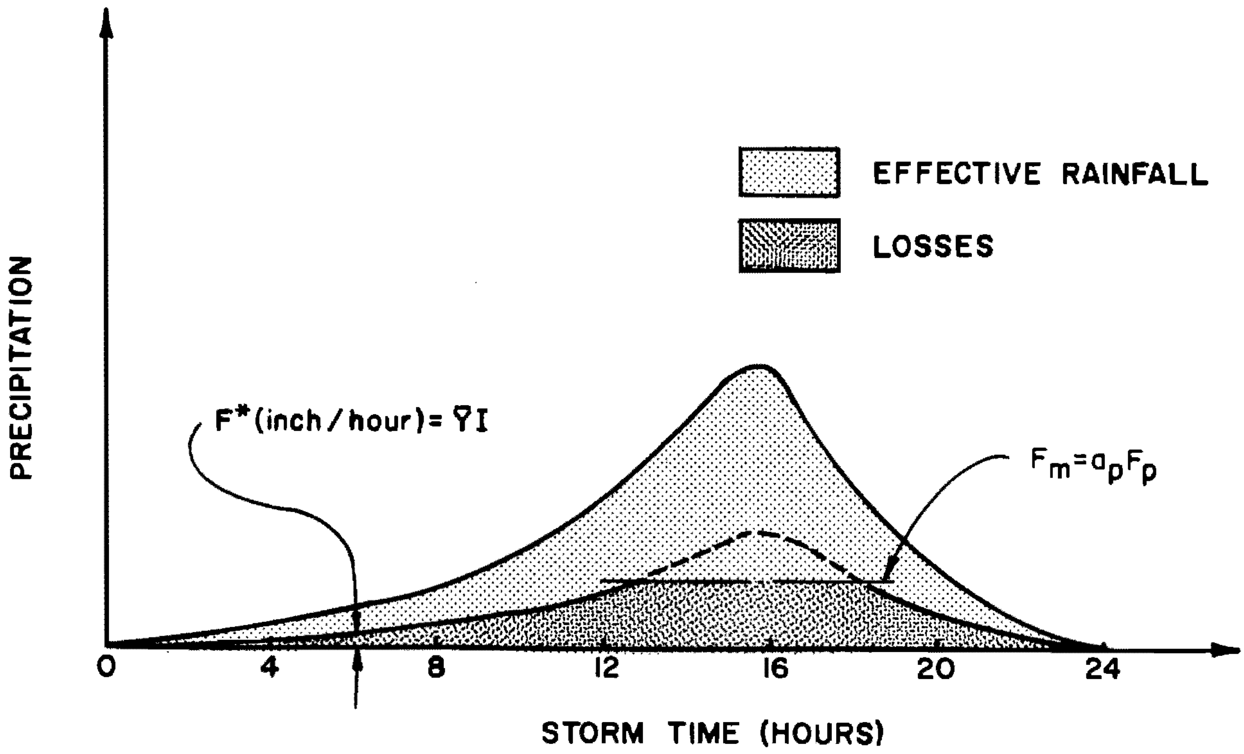
C.7.1. Hydrologic Soil-Cover Complex

A determination of vegetative cover types, hydrologic condition of cover types, and hydrologic soil group must be made for the drainage area. Ordinarily only broad categories of soils and cover types are delineated. Hydrologic soil cover complexes most commonly encountered in desert areas are given in Figure C-8 together with the associated curve numbers (CN). Curve numbers and, consequently, direct runoff varies with vegetation type, vegetative cover density, and hydrologic soil group.

C.7.2. Hydrologic Cover Types

Vegetative types are divided into the following groups:

Desert Brush: Includes such plants as mesquite, creosote bush, black bush, catclaw, cactus, etc. - desert brush is typical of lower elevations and low annual rainfall.



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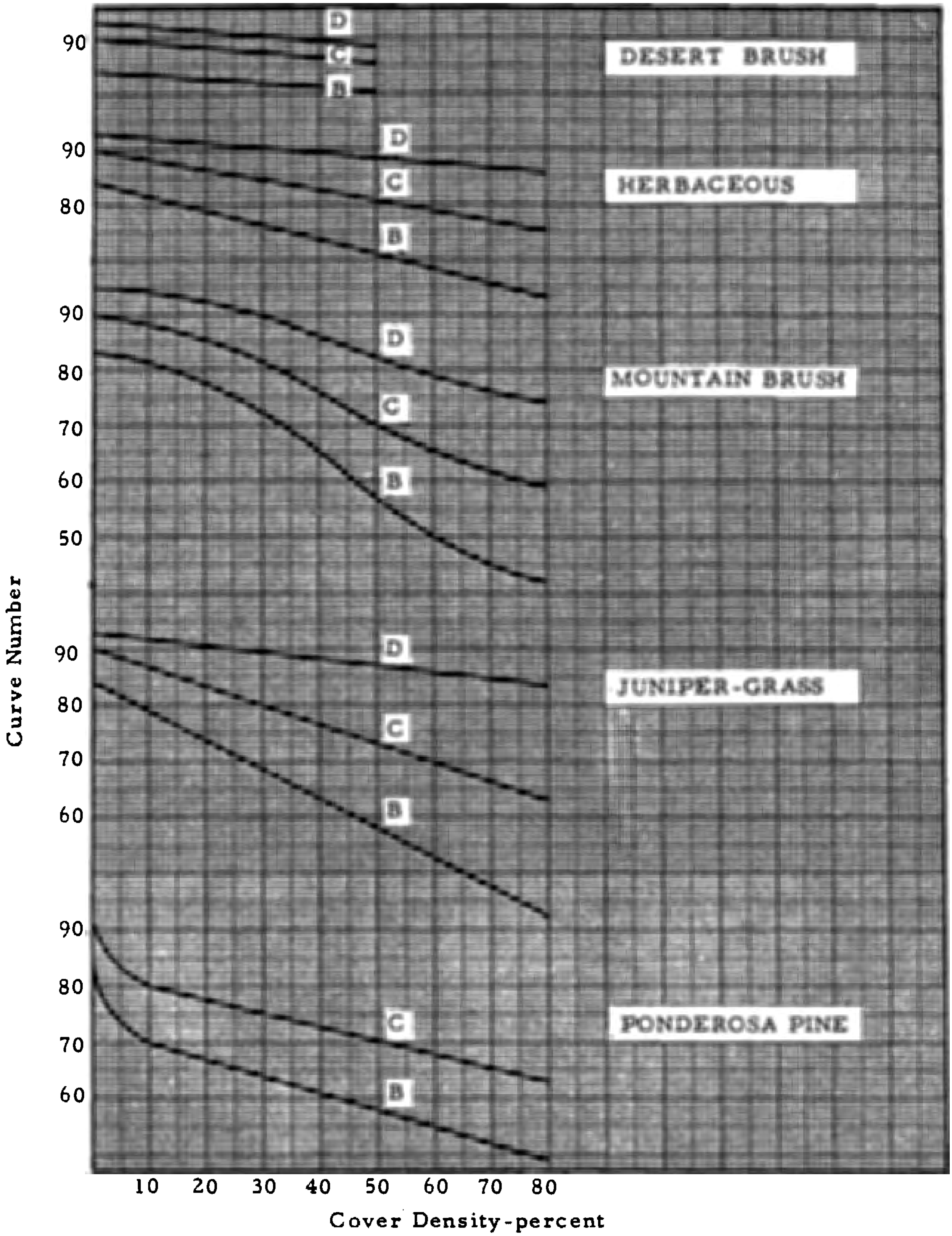
DESIGN STORM LOSS FUNCTION

Figure C-7



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HYDROLOGIC SOIL COVER COMPLEXES AND ASSOCIATED CURVE NUMBERS

Figure C-8

Herbaceous: includes short desert grasses with some brush - herbaceous is typical of intermediate elevations and higher annual rainfall than desert areas.

Mountain Brush: mountain brush mixtures of oak, aspen, mountain mahogany, manzanita, bitter brush, maple, etc. - mountain brush is typical of intermediate elevations and generally higher annual rainfall than herbaceous areas.

Juniper-Grass: juniper areas mixed with varying grass cover that is generally heavier than desert grasses due to higher annual precipitation -typical of higher elevations.

Ponderosa Pine: ponderosa pine forests typical of high elevations and high annual precipitation.

C.7.3. Hydrologic Cover Density

Hydrologic cover density is defined as the percent of the ground surface covered by the crown canopy of live plants and litter.

Three broad ranges of vegetative cover density have been established.

Poor: 0 - 20% Vegetative cover
Fair: 20% - 40% Vegetative cover
Good: Over 40% Vegetative cover

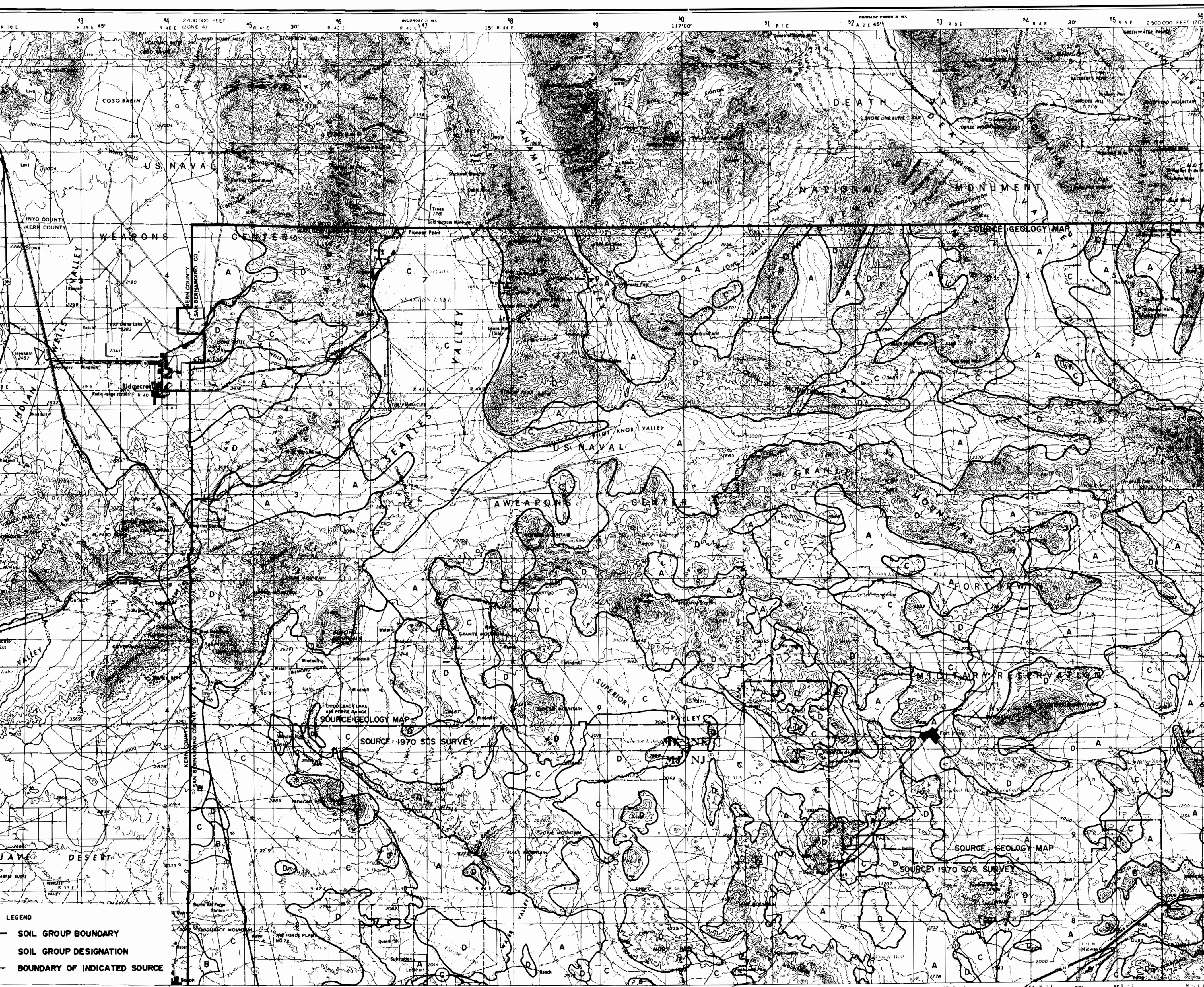
C.8. HYDROLOGIC SOIL GROUP MAPS

Hydrologic soil groups are determined from Figures C-9 through C-16. The figures are reduced from base plates prepared at two different scales: 1:250,000 for the northwestern, northeastern, southeastern, and southwestern portion of the County and 1:48,000 for the southern valley portion of the County. Copies of the base plates may be purchased from the San Bernardino County Surveyor's Office or the San Bernardino County Flood Control District, Water Resources Division.

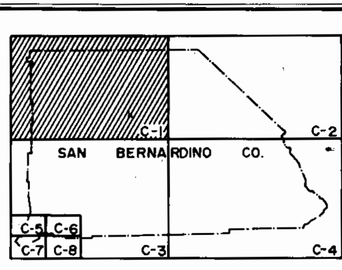
Soil groups are delineated for County areas on each of the figures. Only the southwestern portion of the county, south of the San Gabriel and San Bernardino Mountains have been recently surveyed by the SCS (Soil Survey of San Bernardino County, Southwestern Part, California, USDA, Soil Conservation Service, 1979). The survey that this report is based on was completed in 1971. An older survey is available for the southwestern desert area covering the Barstow, Victorville, Twenty-nine Palms areas (Southwestern Desert Area report and General Soil Map, USDA, Soil Conservation Service, 1970). The remaining areas of the County in the northern and western desert areas have not been surveyed. Hydrologic soil groups in this area were inferred from 1:250,000 scale geologic maps of California which are published by the State of California, Department of Natural Resources, Division of Mines. The various sources of information are delineated on the plates. Where geologic maps are used to infer hydrologic soil groups, additional surveys may be required.

As an additional aid in determining the hydrologic soil group, the SCS national soil group key has been reproduced and is included at the end of this Section as Table C.3. The source of this table is the National Engineering Handbook, Section 4, 1972.

As new soil data becomes available, the hydrologic soil group plates will be updated. Consequently, the County should be occasionally contacted to confirm whether updates to the soil map data have been prepared.



O COUNTY



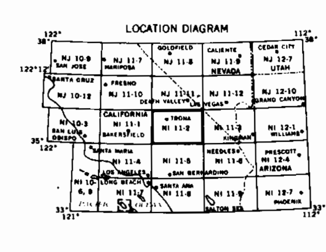
INDEX MAP

Scale 1:250,000

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

BASE MAP REPRODUCED FROM U.S.G.S. "TRONA" TOPOGRAPHIC MAP

SCALE REDUCED BY 1/2



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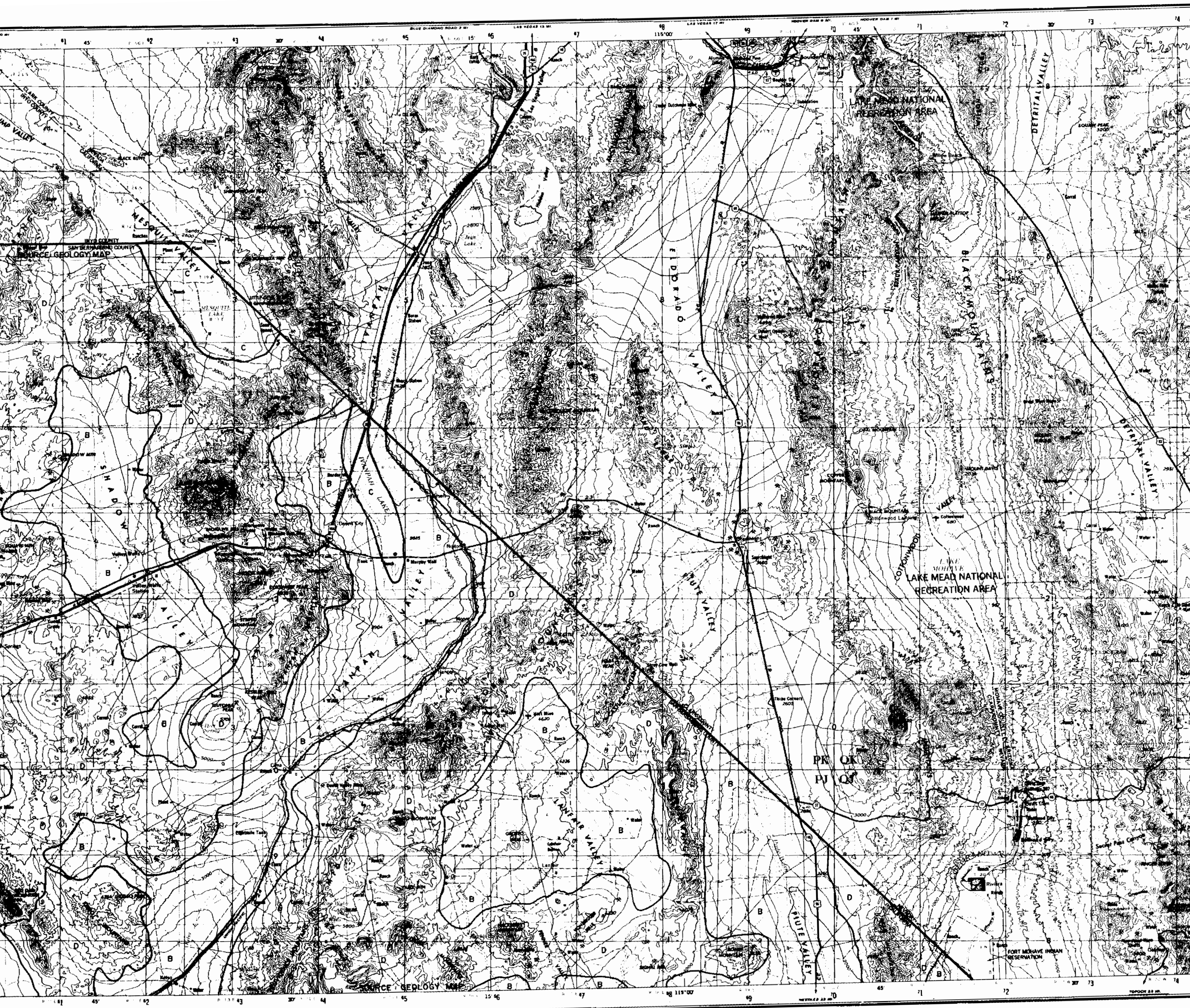

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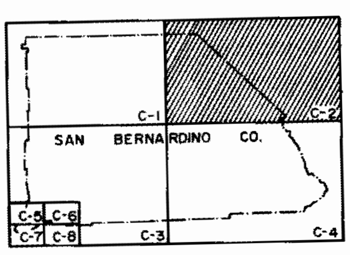


INDEX MAP

Scale 1:250,000

CONTOUR INTERVAL 200 FEET

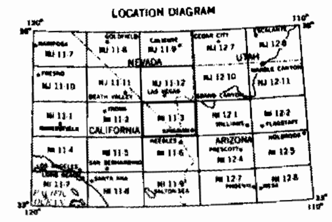
TRANSVERSE MERCATOR PROJECTION

BLACK NUMBERED LINES INDICATE THE 10,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 11

BASE MAP REPRODUCED FROM U.S.G.S. "KINGMAN" TOPOGRAPHIC MAP

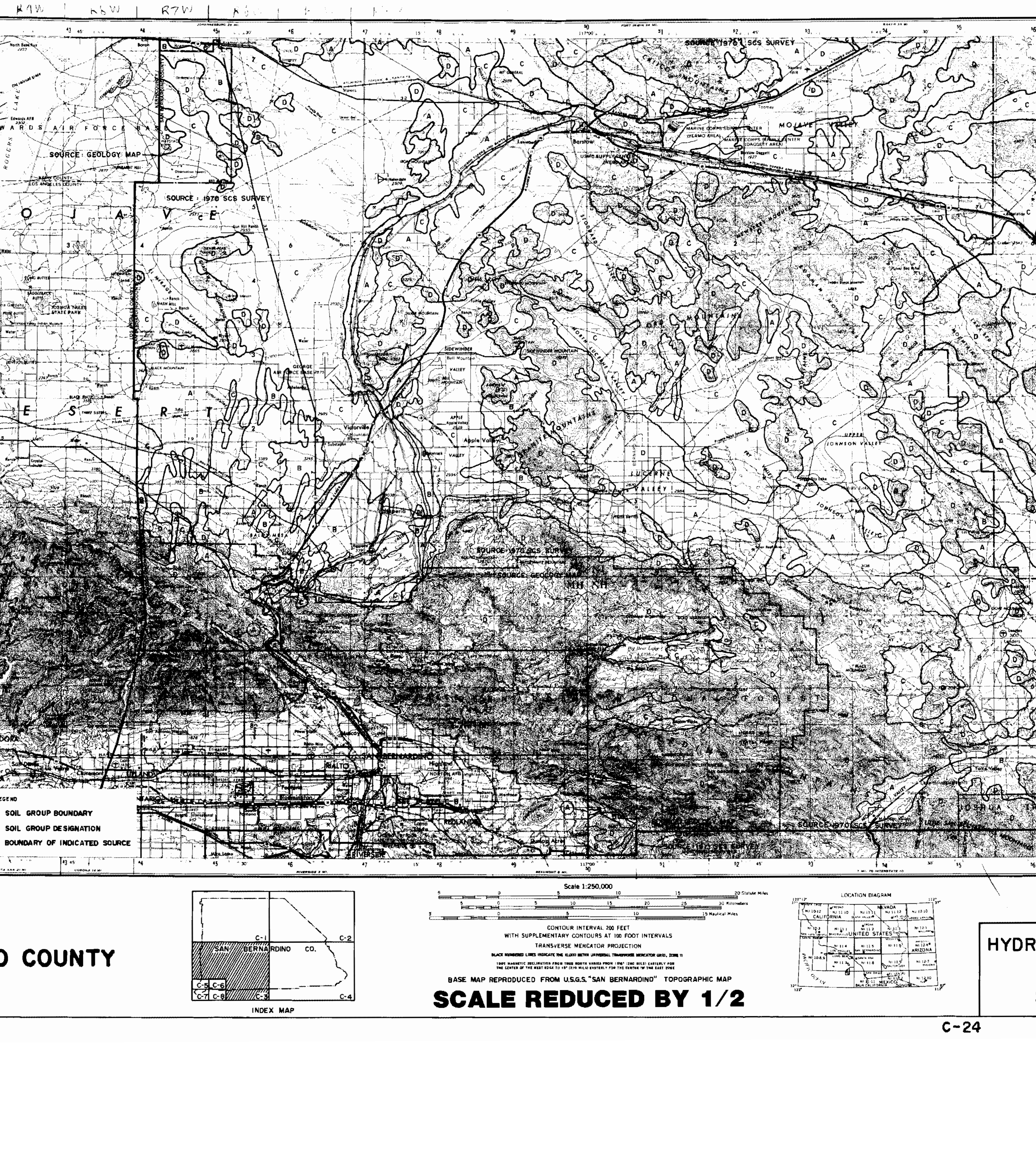
SCALE REDUCED BY 1/2

LOCATION DIAGRAM



HYDR

C-23



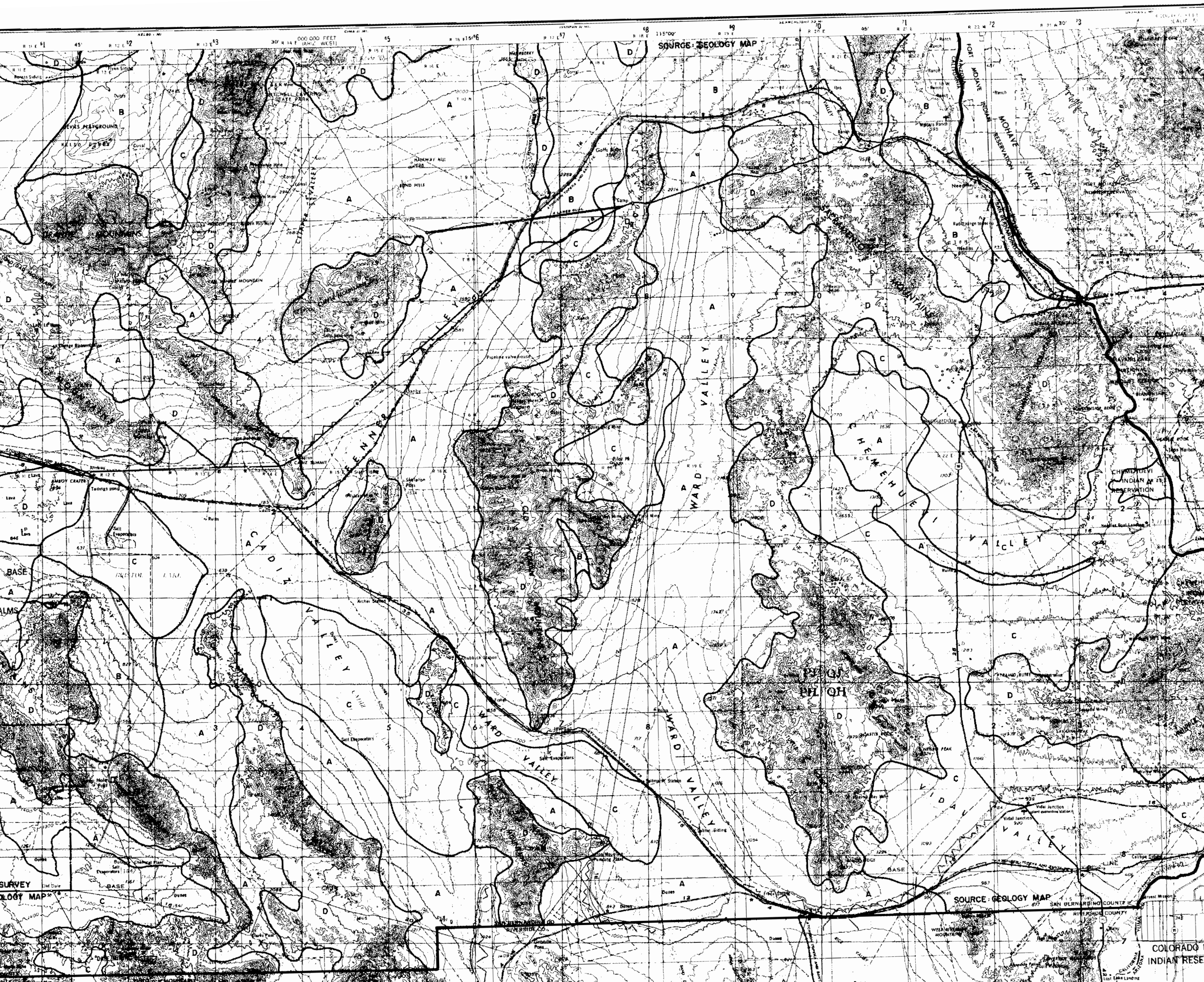
D COUNTY

BASE MAP REPRODUCED FROM U.S.G.S. "SAN BERNARDINO" TOPOGRAPHIC MAP

SCALE REDUCED BY 1/2

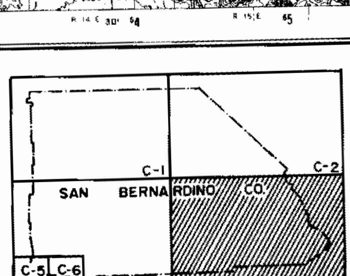
HYDRO

C-24



O COUNTY

L



INDEX MAP

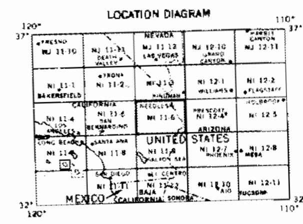
Scale 1:250,000

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

BASE MAP REPRODUCED FROM U.S.G.S. "NEEDLES" TOPOGRAPHIC MAP

SCALE REDUCED BY 1/2

LOCATION DIAGRAM



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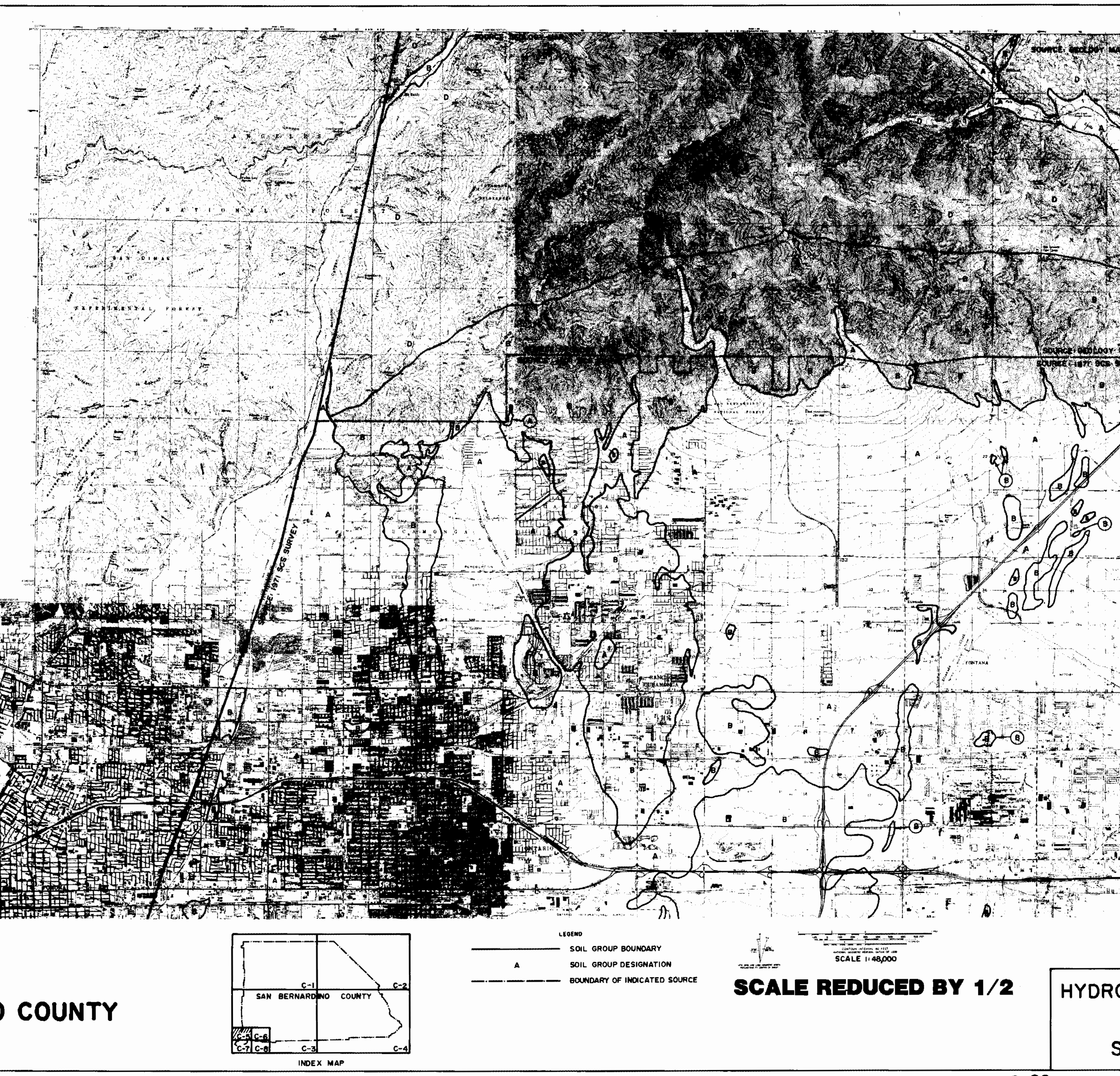
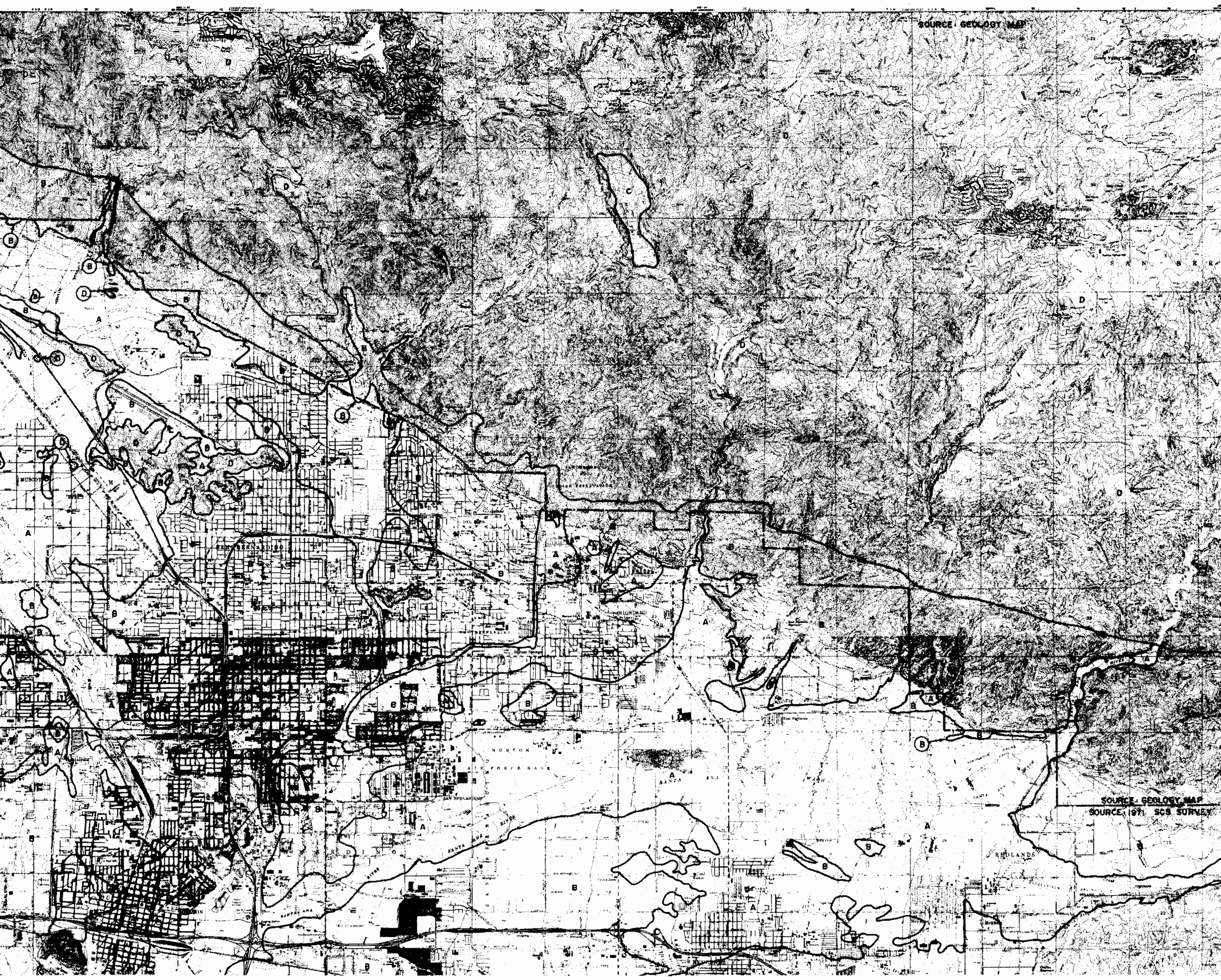
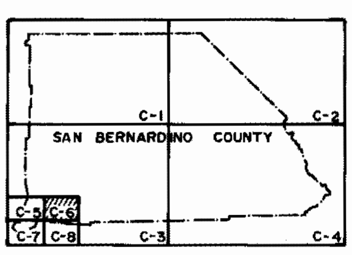
C-25


SOURCE: 1971 SCS SURVEY
LEGEND
SOIL GROUP BOUNDARY
A SOIL GROUP DESIGNATION
BOUNDARY OF INDICATED SOURCE
SCALE 1:48,000
SCALE REDUCED BY 1/2
SAN BERNARDINO COUNTY
C-1
C-2
C-3
C-4
C-6
C-7
C-8
INDEX MAP
O COUNTY
HYDRO
S

C-26





INDEX MAP

LEGEND

SOIL GROUP BOUNDARY

A SOIL GROUP DESIGNATION

BOUNDARY OF INDICATED SOURCE

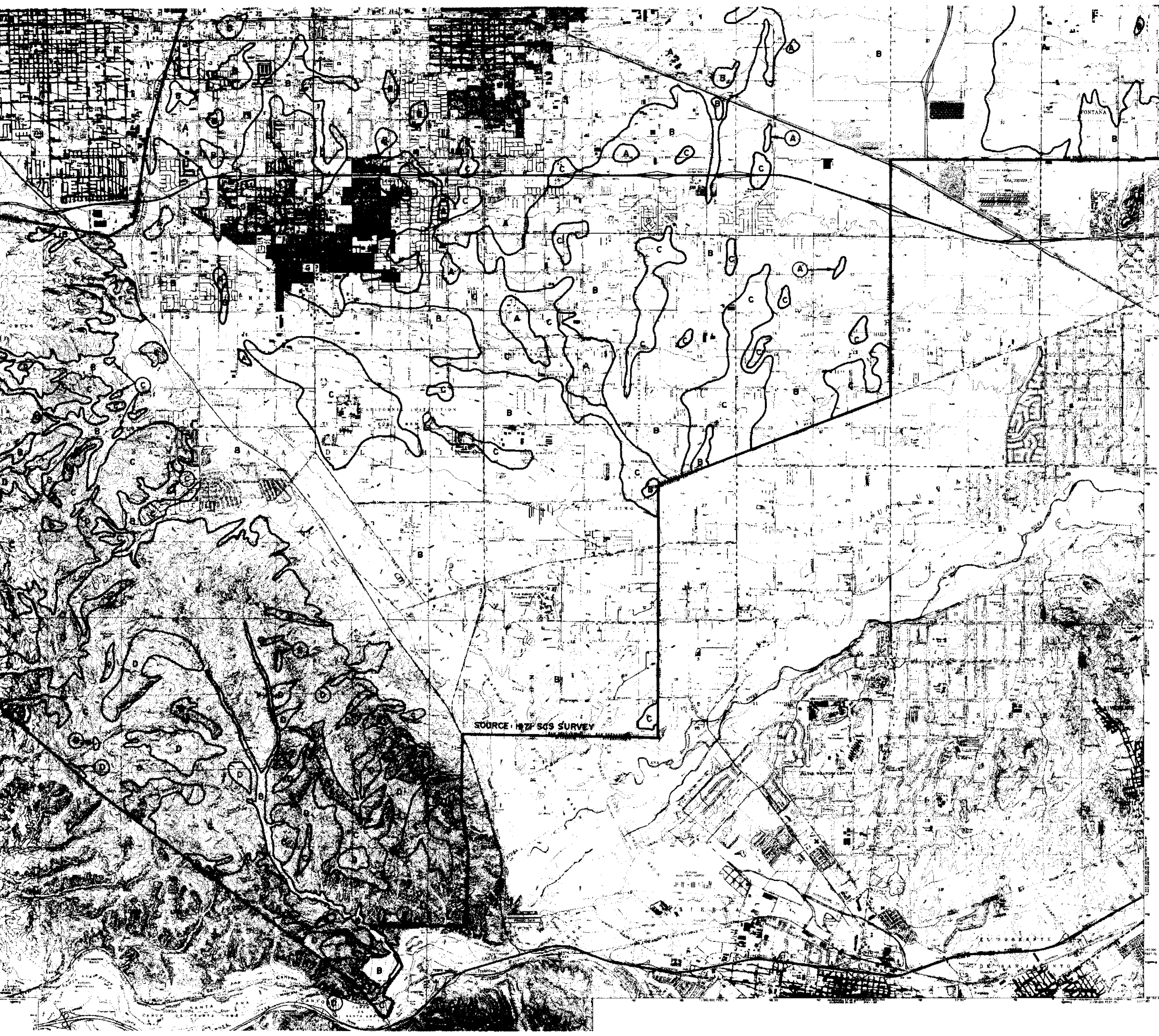
SCALE 1:48,000

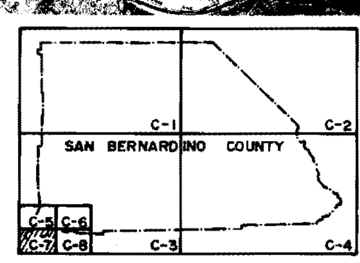
SCALE REDUCED BY 1/2

O COUNTY

HYDRO

S





INDEX MAP

O COUNTY

LEGEND

———	SOIL GROUP BOUNDARY
A	SOIL GROUP DESIGNATION
—·—·—	BOUNDARY OF INDICATED SOURCE

SCALE 1:48,000

SCALE REDUCED BY 1/2

HYDRO

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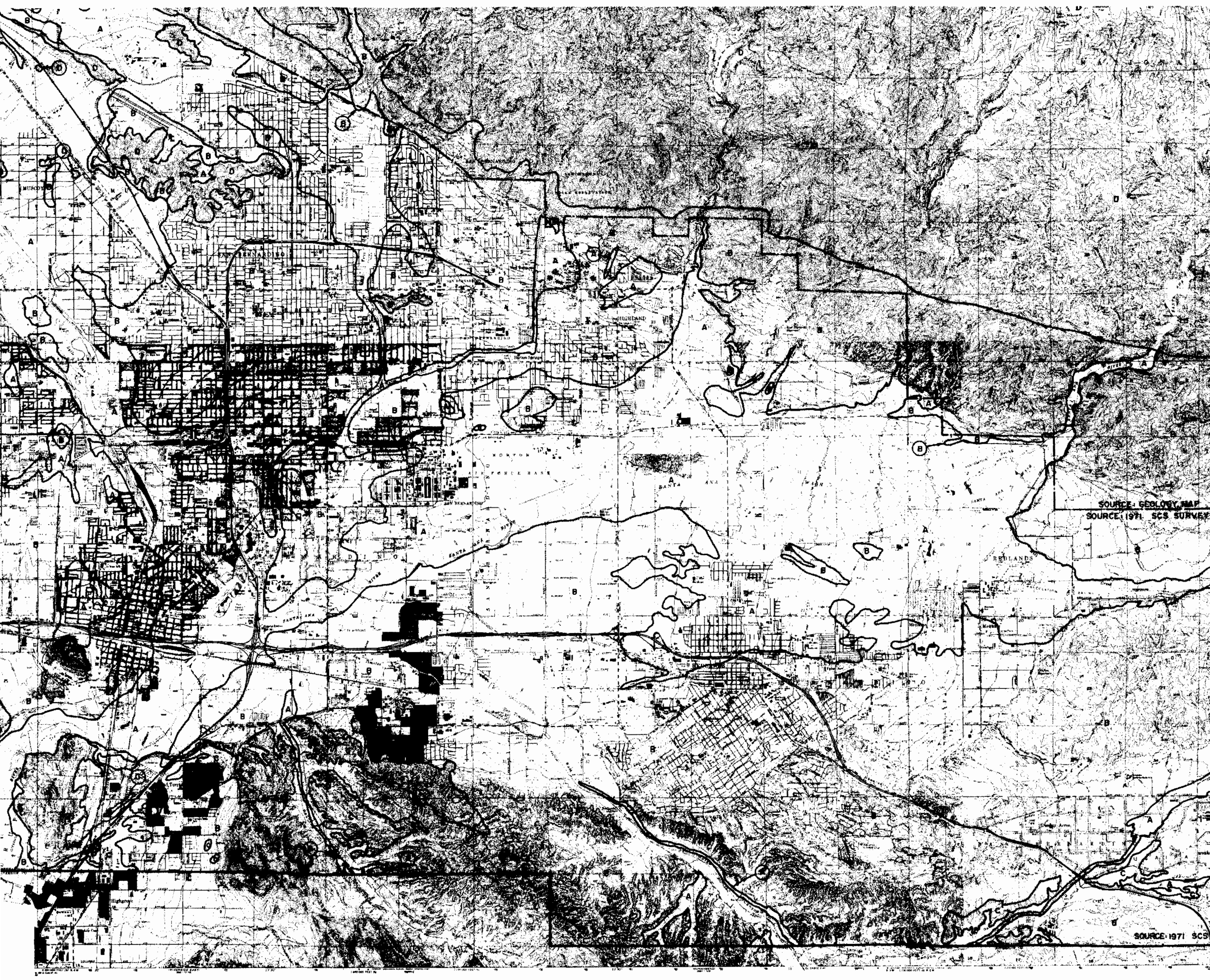

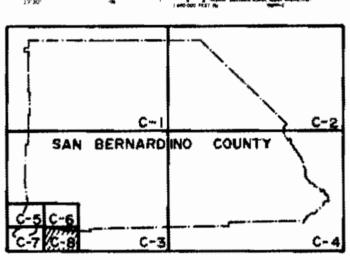

INDEX MAP

LEGEND

———	SOIL GROUP BOUNDARY
A	SOIL GROUP DESIGNATION
— - — - —	BOUNDARY OF INDICATED SOURCE

SCALE 1:48,000

SCALE REDUCED BY 1/2

D COUNTY

HYDRO

S

TABLE C.1

AABERG	C	AHL	C	ALMY	B	ANLAUF	C	AROOSTOOK	
AASTAD	B	AHLSTROM	C	ALOHA	C	ANNABELLA	B	AROSA	C
ABAC	D	AHMEEK	B	ALONSO	B	ANNANDALE	C	ARP	C
ABAJO	C	AHOLT	D	ALOVAR	C	ANNISTON	B	ARRINGTON	B
ABBOTT	D	AHTANUM	C	ALPENA	B	ANOKA	A	ARRITOLA	D
ABBOTTSTOWN	C	AHWAHNEE	C	ALPHA	C	ANONES	C	ARROLIME	C
ABCAL	D	AIBONITO	C	ALPON	B	ANSARI	D	ARRON	D
ABEGG	B	AIKEN	B/C	ALPOWA	B	ANSEL	B	ARROW	B
ABELA	B	AIKMAN	D	ALPS	C	ANSELMO	A	ARROWSMITH	B
ABELL	B	AILEY	B	ALSEA	B	ANSON	B	ARROYO SECO	B
ABERDEEN	D	AINAKEA	B	ALSPAUGH	C	ANTELOPE SPRINGS	C	ARTA	C
ABES	D	AIRMONT	C	ALSTAD	B	ANTERO	C	ARTOIS	C
ABILENE	C	AIROTSA	B	ALSTOWN	B	ANT FLAT	C	ARVADA	D
ABINGTON	B	AIRPORT	D	ALTAMONT	D	ANTHO	B	ARVANA	C
ABIQUA	C	AITS	B	ALTAVISTA	C	ANTHONY	B	ARVESON	D
ABO	B/C	AJO	C	ALTDORF	D	ANTIGO	B	ARVILLA	B
ABOR	D	AKAKA	A	ALTMAR	B	ANTILON	B	ARZELL	C
ABRA	C	AKASKA	B	ALTO	C	ANTIOCH	D	ASA	B
ABRAHAM	B	AKELA	C	ALTOGA	C	ANTLER	C	ASBURY	B
ABSAROKEE	C	ALADDIN	B	ALTON	B	ANTOINE	C	ASCALON	B
ABSCOTA	B	ALAE	A	ALTUS	B	ANTROBUS	B	ASCHOFF	B
ABSHER	D	ALAELOA	B	ALTVAN	B	ANTY	B	ASHBY	C
ABSTED	D	ALAGA	A	ALUM	B	ANVIK	B	ASHCROFT	B
ACACIO	C	ALAKAI	D	ALUSA	D	ANWAY	B	ASHDALE	B
ACADEMY	C	ALAMA	B	ALVIN	B	ANZA	B	ASHE	B
ACADIA	D	ALAMANCE	B	ALVIRA	C	ANZIANO	C	ASHKUM	C
ACANA	D	ALAMO	D	ALVISO	D	APACHE	D	ASHLAR	B
ACASCO	D	ALAMOSA	C	ALVOR	C	APAKUIE	A	ASHLEY	A
ACEITUNAS	B	ALAPAHA	D	AMADOR	D	APISHAPA	C	ASH SPRINGS	C
ACEL	D	ALAPAI	A	AMAGON	D	APISON	B	ASHTON	B
ACKER	B	ALBAN	B	AMALU	D	APOPKA	A	ASHUE	B
ACKMEN	B	ALBANO	D	AMANA	B	APPIAN	C	ASHUELOT	C
ACME	C	ALBANY	C	AMARGOSA	D	APPLEGATE	C	ASHWOOD	C
ACO	B	ALBATON	D	AMARILLO	B	APPLETON	C	ASKEW	C
ACOLITA	B	ALBEE	C	AMASA	B	APPLING	B	ASO	C
ACOMA	C	ALBEMARLE	B	AMBERSON		APRON	B	ASOTIN	C
ACOVE	C	ALBERTVILLE	C	AMBOY	C	APT	C	ASPEN	B
ACREE	C	ALBIA	C	AMBRAW	C	APTAKISIC	B	ASPERMONT	B
ACRELANE	C	ALBION	B	AMEDEE	A	ARABY		ASSINNIBOINE	B
ACTON	B	ALBRIGHTS	C	AMELIA	B	ARADA	C	ASSUMPTION	B
ACUFF	B	ALCALDE	C	AMENIA	B	ARANSAS	D	ASTATULA	A
ACWORTH	B	ALCESTER	B	AMERICUS	A	ARAPIEN	C	ASTOR	A/D
ACY	C	ALCOA	B	AMES	C	ARAVE	D	ASTORIA	B
ADA	B	ALCONA	B	AMESHA	B	ARAVETON	B	ATASCADERO	C
ADAIR	D	ALCOVA	B	AMHERST	C	ARBELA	C	ATASCOSA	D
ADAMS	A	ALDA	C	AMITY	C	ARBONE	B	ATCO	B
ADAMSON	B	ALDAX	D	AMMON	B	ARBOR	B	ATENCIO	B
ADAMSTOWN		ALDEN	D	AMOLE	C	ARBUCKLE	B	ATEPIC	D
ADAMSVILLE	C	ALDER	B	AMOR	B	ARCATA	B	ATHELWOLD	B
ADATON	D	ALDERDALE	C	AMOS	C	ARCH	B	ATHENA	B
ADAVEN	D	ALDERWOOD	C	AMSDEN	B	ARCHABAL	B	ATHENS	B
ADDIELOU	C	ALDINO	C	AMSTERDAM	B	ARCHER	C	ATHERLY	B
ADDISON	D	ALDWELL	C	AMTOFT	D	ARCHIN	C	ATHERTON	B/D
ADDY	C	ALEKNAGIK	B	AMY	D	ARCO	B	ATHMAR	C
ADE	A	ALEMEDA	C	ANACAPA	B	ARCOLA	C	ATHOL	B
ADEL	A	ALEX	B	ANAHUAC	D	ARD	C	ATKINSON	B
ADELAIDE	D	ALEXANDRIA	C	ANAMITE	D	ARDEN	B	ATLAS	D
ADELANTO	B	ALEXIS	B	ANAPRA	B	ARDENVOIR	B	ATLEE	C
ADELINO	B	ALFORD	B	ANASAZI	B	ARDILLA	C	ATMORE	B/D
ADELPHIA	C	ALGANSEE	B	ANATONE	D	AREDALE	B	ATOKA	C
ADENA	C	ALGERITA	B	ANAVERDE	B	ARENA	C	ATON	B
ADGER	D	ALGIERS	C/D	ANAWALT	D	ARENALES	A	ATRYPA	C
ADILIS	A	ALGOMA	B/D	ANCHO	B	ARENDTSVILLE	B	ATSION	C
ADIRONDACK		ALHAMBRA	B	ANCHORAGE	A	ARENOSA	A	ATTERBERRY	B
ADIV	B	ALICE	A	ANCHOR BAY	D	ARENZVILLE	B	ATTEWAN	A
ADJUNTAS	C	ALICEL	B	ANCHOR POINT	D	ARGONAUT	D	ATTICA	B
ADKINS	B	ALICIA	B	ANCLOTE	D	ARGUELLO	B	ATTLEBORO	
ADLER	C	ALIDA	B	ANCO	C	ARGYLE	B	ATWATER	B
ADOLPH	D	ALIKCHI	B	ANDERLY	C	ARIEL	C	ATWELL	C/D
ADRIAN	A/D	ALINE	A	ANDERS	C	ARIZO	A	ATWOOD	B
AENEAS	B	ALKO	D	ANDERSON	B	ARKABUTLA	C	AUBBEENAUBBEE	B
AETNA	B	ALLAGASH	B	ANDES	C	ARKPORT	B	AUBERRY	B
AFTON	D	ALLARD	B	ANDORINIA	C	ARLAND	B	AUBURN	C/D
AGAR	B	ALLEGHENY	B	ANDOVER	D	ARLE	B	AUBURNDALE	D
AGASSIZ	D	ALLEMANDS	D	ANDREEN	B	ARLING	D	AUDIAN	B
AGATE	D	ALLEN	B	ANDREESON	C	ARLINGTON	C	AU GRES	C
AGAWAM	B	ALLENDALE	C	ANDRES	B	ARLOVAL	C	AUGSBURG	B
AGENCY	C	ALLENS PARK	B	ANDREWS	C	ARMAGH	D	AUGUSTA	C
AGER	D	ALLENSVILLE	C	ANED	D	ARMIJO	D	AULD	D
AGNER	B	ALLENTINE	D	ANETH	A	ARMINGTON	D	AURA	B
AGNEW	B/C	ALLENWOOD	B	ANGELICA	D	ARMO	B	AURORA	C
AGNOS	B	ALLESSIO	B	ANGELINA	B/D	ARMOUR	B	AUSTIN	C
AGUA	B	ALLEY	C	ANGELO	C	ARMSTER	C	AUSTWELL	D
AGUADILLA	A	ALLIANCE	B	ANGIE	C	ARMSTRONG	D	AUXVASSE	D
AGUA DULCE	C	ALLIGATOR	D	ANGLE	A	ARMUCHEE	D	AUZQUI	B
AGUA FRIA	B	ALLIS	D	ANGLEN	B	ARNEGARD	B	AVA	C
AGUALT	B	ALLISON	C	ANGOLA	C	ARNHART	C	AVALANCHE	B
AGUEDA	B	ALLOUEZ	C	ANGOSTURA	B	ARNHEIM	C	AVALON	B
AGUILITA	B	ALLOWAY		ANHALT	D	ARNO	D	AVERY	B
AGUIRRE	D	ALMAC	B	ANIAK	D	ARNOLD	B	AVON	C
AGUSTIN	B	ALMENA	C	ANITA	D	ARNOT	C/D	AVONBURG	D
AHATONE	D	ALMONT	D	ANKENY	A	ARNY	A	AVONDALE	C

NOTES A BLANK HYDROLOGIC SOIL GROUP INDICATES THE SOIL GROUP HAS NOT BEEN DETERMINED
TWO SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION

AWBREY	D
AXTELL	D
AYAR	D
AYCOCK	B
AYON	B
AYR	B
AYRES	D
AYRSHIRE	C
AYSEES	B
AZAAR	C
AZARMAN	C
AZELTINE	B
AZFIELD	B
AZTALAN	B
AZTEC	B
AZULE	C
AZWELL	B
BABB	A
BABBINGTON	B
BABCOCK	C
BABYLON	A
BACA	C
BACH	D
BACHUS	C
BACKBONE	A
BACULAN	A
BADENAUGH	B
BADGER	C
BADGERTON	B
BADO	D
BADUS	C
BAGARD	C
BAGDAD	B
BAGGOTT	D
BAGLEY	B
BAHEM	B
BAILE	D
BAINVILLE	C
BAIRD HOLLOW	C
BAJURA	D
BAKEOVEN	D
BAKER	C
BAKER PASS	B
BALAAM	A
BALCH	D
BALCOM	B
BALD	C
BALDER	C
BALDOCK	B/C
BALDWIN	D
BALDY	B
BALE	C
BALLARD	B
BALLER	D
BALLINGER	C
BALM	B/C
BALMAN	B/C
BALON	B
BALTIC	D
BALTIMORE	B
BALTO	D
BAMBER	B
BAMFORTH	B
BANCAS	B
BANCROFT	B
BANDERA	B
BANGO	C
BANGOR	B
BANGSTON	A
BANKARD	A
BANKS	A
BANNER	C
BANNERVILLE	C/D
BANNOCK	B
BANQUETE	D
BARABOO	B
BARAGA	C
BARBARY	D
BARBOUR	B
BARBOURVILLE	B
BARCLAY	C
BARCO	B
BARCUS	B
BARD	D
BARDEN	C
BARDLEY	C
BARELA	C
BARFIELD	D
BARFUSS	B
BARGE	C
BARISHMAN	C
BARKER	C
BARKERVILLE	C
BARKLEY	B
BARLANE	D
BARLING	C
BARLOW	B
BARNARD	D
BARNES	B
BARNESTON	B
BARNEY	A
BARNHARDT	B
BARNSTEAD	
BARNUM	B
BARRADA	D
BARRETT	D
BARRINGTON	B
BARRON	B
BARRONETT	C
BARROWS	D
BARRY	D
BARSTOW	B
BARTH	C
BARTINE	C
BARTLE	D
BARTLEY	C
BARTON	B
BARTONFLAT	B
BARVON	C
BASCOM	B
BASEHOR	D
BASHAW	D
BASHER	B
BASILE	D
BASIN	C
BASINGER	C
BASKET	C
BASS	A
BASSEL	B
BASSETT	B
BASSFIELD	B
BASSLER	D
BASTIAN	D
BASTROP	B
BATA	A
BATAVIA	B
BATES	B
BATH	C
BATTERSON	D
BATTLE CREEK	C
BATZA	D
BAUDETTE	B
BAUER	C
BAUGH	B/C
BAXTER	B
BAXTERVILLE	B
BAYAMON	B
BAYARD	A
BAYBORO	D
BAYERTON	C
BAYLOR	D
BAYSHORE	B/C
BAYSIDE	C
BAYUCOS	D
BAYWOOD	A
BAZETTE	C
BAZILE	B
BEAD	C
BEADLE	C
BEALES	A
BEAR BASIN	B
BEAR CREEK	C
BEARDALL	C
BEARDEN	C
BEARDSTOWN	C
BEAR LAKE	D
BEARMOUTH	A
BEARPAW	B
BEAR PRAIRIE	B
BEARSKIN	D
BEASLEY	C
BEASON	C
BEATON	C
BEATTY	C
BEAUCOUP	B
BEAUFORD	D
BEAUMONT	D
BEAUREGARD	C
BEAUSITE	B
BEAUVAIS	B
BEAVERTON	A
BECK	C
BECKER	B
BECKET	C
BECKLEY	B
BECKTON	D
BECKWITH	C
BECKWOURTH	B
BECREEK	B
BEDFORD	C
BEDINGTON	B
BEDNER	C
BEEBE	A
BEECHER	C
BEECHY	
BEEHIVE	B
BEEK	C
BEENOM	D
BEEZAR	B
BEGAY	B
BEGOSHIAN	C
BEHANIN	B
BEHEMOTOSH	B
BEHRING	D
BEIRMAN	D
BEJUCOS	B
BELCHER	D
BELDEN	D
BELDING	B
BELEN	C
BELFAST	B
BELFIELD	B
BELFORE	B
BELGRADE	B
BELINDA	D
BELKNAP	C
BELLAMY	C
BELLAVISTA	D
BELLE	B
BELLEFONTAINE	
BELLICUM	B
BELLINGHAM	C
BELLPINE	C
BELMONT	B
BELMORE	B
BELT	D
BELTED	D
BELTON	C
BELTRAMI	B
BELTSVILLE	C
BELUGA	D
BELVOIR	C
BENCLARE	C
BENEVOLA	C
BENEWAH	C
BENFIELD	C
BENGE	B
BEN HUR	B
BENIN	D
BENITO	D
BENJAMIN	D
BEN LOMOND	B
BENMAN	A
BENNDALE	B
BENNETT	C
BENNINGTON	D
BENOIT	D
BENSON	C/D
BENTEEN	B
BENTONVILLE	C
BENZ	D
BEOTIA	B
BEOWAWE	D
BERCAIL	C
BERDA	B
BEREA	C
BERENICETON	B
BERENT	A
BERGLAND	D
BERGSTROM	B
BERINO	B
BERKELEY	
BERKS	C
BERKSHIRE	B
BERLIN	C
BERMESA	C
BERMUDIAN	B
BERNAL	D
BERNALDO	B
BERNARD	D
BERNARDINO	C
BERNARDSTON	C
BERNHILL	B
BERNICE	A
BERNING	C
BERRENDOS	D
BERRYLAND	D
BERTELSON	B
BERTHOUD	B
BERTIE	C
BERTOLOTTI	B
BERTRAND	B
BERVILLE	D
BERYL	B
BESSEMER	B
BETHANY	C
BETHEL	D
BETTERAVIA	C
BETTS	B
BEULAH	B
BEVENT	B
BEVERLY	B
BEW	D
BEWLEYVILLE	B
BEWLIN	D
BEXAR	C
BEZZANT	B
BIBB	B/D
BIBON	A
BICKELTON	B
BICKLETON	C
BICKMORE	C
BICONDOA	C
BIDDEFORD	D
BIDDLEMAN	C
BIDMAN	C
BIDWELL	B
BIEBER	D
BIENVILLE	A
BIG BLUE	D
BIGEL	A
BIGELOW	C
BIGETTY	C
BIGGS	A
BIGGSVILLE	B
BIG HORN	C
BIGNELL	B
BIG TIMBER	D
BIGWIN	D
BIJOU	A
BILLETT	A
BILLINGS	C
BINDLE	B
BINFORD	B
BINGHAM	B
BINNSVILLE	D
BINS	B
BINTON	C
BIPPUS	B
BIRCH	A
BIRCHWOOD	C
BIRDOW	B
BIRDS	C
BIRDSALL	D
BIRDSBORO	B
BIRDSLEY	D
BIRKBECK	B
BISBEE	A
BISCAY	C
BISHOP	B/C
BISPING	B
BISSELL	B
BISTI	C
BIT	D
BITTERON	A
BITTERROOT	C
BITTER SPRING	C
BITTON	B
BIXBY	B
BJORK	C
BLACHLY	C
BLACKBURN	B
BLACK BUTTE	C
BLACK CANYON	D
BLACKCAP	A
BLACKETT	B
BLACKFOOT	B/C
BLACKHALL	D
BLACKHAWK	D
BLACKLEAF	B
BLACKLEED	A
BLACKLOCK	D
BLACKMAN	C
BLACK MOUNTAIN	D
BLACKOAR	C
BLACKPIPE	C
BLACK RIDGE	D
BLACKROCK	B
BLACKSTON	B
BLACKTAIL	B
BLACKWATER	D
BLACKWELL	B/D
BLADEN	D
BLAGO	D
BLAINE	B
BLAIR	C
BLAIRTON	C
BLAKE	C
BLAKELAND	A
BLAKENEY	C
BLAKEPORT	B
BLALOCK	D
BLAMER	C
BLANCA	B
BLANCHARD	A
BLANCHESTER	B/D
BLAND	C
BLANDFORD	C
BLANDING	B
BLANEY	B
BLANKET	C
BLANTON	A
BLANYON	C
BLASDELL	A
BLASINGAME	C
BLAZON	D
BLENCOE	C
BLEND	D
BLENDON	B
BLETHEN	B
BLEVINS	B
BLEVINTON	B/D
BLICHTON	D
BLISS	D
BLOCKTON	C
BLODGETT	A
BLOMFORD	B
BLOOM	C
BLOOMFIELD	A
BLOOMING	B
BLOOR	D
BLOSSOM	C
BLOUNT	C
BLOUNTVILLE	C
BLUCHER	C
BLUEBELL	C
BLUE EARTH	D
BLUEJOINT	B
BLUE LAKE	A
BLUEPOINT	B
BLUE STAR	B
BLUEWING	B
BLUFFDALE	C
BLUFFTON	D
BLUFORD	D
BLY	B
BLYTHE	D
BOARDTREE	C
BOBS	D
BOBTAIL	B
BOCK	B
BODELL	D
BODENBURG	B
BODINE	B
BOEL	A
BOELUS	A
BOESEL	B
BOETTCHER	C
BOGAN	C
BOGART	B
BOGUE	D
BOHANNON	C
BOHEMIAN	B
BOISTFORT	C
BOLAR	C
BOLD	B
BOLES	C
BOLIVAR	B
BOLIVIA	B
BOLTON	B
BOMBAY	B
BON	B
BONACCORD	D
BONAPARTE	A
BOND	D
BONDRANCH	D
BONDURANT	B
BONE	D
BONG	B

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BONHAM	C	BRANDON	B	BROOKLYN	D	BUSTER	C	CAMPSPASS	C
BONIFAY	A	BRANDYWINE	C	BROOKSIDE	C	BUTANO	C	CAMPUS	B
BONILLA	B	BRANFORD	B	BROOKSTON	B/D	BUTLER	D	CAMRODEN	C
BONITA	D	BRANTFORD	B	BROOKSVILLE	D	BUTLERTOWN	C	CANA	C
BONN	D	BRANYON	D	BROOMFIELD	D	BUTTE	C	CANAAN	C/D
BONNER	B	BRASHEAR	C	BROSELEY	B	BUTTERFIELD	C	CANADIAN	B
BONNET	B	BRASSFIELD	B	BROSS	B	BUTTON	C	CANADICE	D
BONNEVILLE	B	BRATTON	B	BROUGHTON	D	BUXIN	D	CANANDAIGUA	D
BONNICK	A	BRAVANE	D	BROWARD	C	BUXTON	C	CANASERAGA	C
BONNIE	D	BRAXTON	C	BROWNELL	B	BYARS	D	CANAVERAL	C
BONO	D	BRAYMILL	B/D	BROWNFIELD	A	BYNUM	C	CANBURN	D
BONSALL	D	BRAYS	D	BROWNLEE	B	BYRON	A	CANDELERO	C
BONTA	C	BRAYTON	C	BROYLES	B			CANE	C
BONTI	C	BRAZITO	A	BRUCE	D	CABALLO	B	CANEADEA	D
BOOKER	D	BRAZOS	A	BRUFFY	C	CABARTON	D	CANEEK	B
BOOMER	B	BREA	B	BRUIN	C	CABBA	C	CANEL	B
BOONE	A	BRECKENRIDGE	D	BRUNEEL	B/C	CABBART	D	CANELO	D
BOONESBORO	B	BRECKNOCK	B	BRUNO	A	CABEZON	D	CANEY	C
BOONTON	C	BREECE	B	BRUNT	C	CABIN	C	CANEYVILLE	C
BOOTH	C	BREGAR	D	BRUSH		CABINET	C	CANEZ	B
BORACHO	C	BREMEN	B	BRUSSETT	B	CABLE	D	CANFIELD	C
BORAH	A/C	BREMER	B	BRYAN	A	CABO ROJO	C	CANISTED	C
BORDA	D	BREMO	C	BRYCAN	B	CABOT	D	CANNINGER	D
BORDEAUX	B	BREMS	A	BRYCE	D	CACAPON	B	CANNON	B
BORDEN	B	BRENDA	C	BUCAN	D	CACHE	D	CANOE	B
BORDER	B	BRENNAN	B	BUCHANAN	C	CACIQUE	C	CANONCITO	B
BORNSTEDT	C	BRENNER	C/D	BUCHENAU	C	CADDO	D	CANOVA	B/D
BORREGO	C	BRENT	C	BUCHER	C	CADEVILLE	D	CANTALA	B
BORUP	B	BRENTON	B	BUCKHOUSE	A	CADMUS	B	CANTON	B
BORVANT	D	BRENTWOOD	B	BUCKINGHAM		CADOMA	D	CANTRIL	B
BORZA	C	BRESSER	B	BUCKLAND	C	CADOR	C	CANTUA	B
BOSANKO	D	BREVARD	B	BUCKLEBAR	B	CAGEY	C	CANUTIO	B
BOSCO	B	BREVORT	B	BUCKLEY	B/C	CAGUABO	D	CANYON	D
BOSKET	B	BREWER	C	BUCKLON	D	CAGWIN	B	CAPAC	B
BOSLER	B	BREWSTER	D	BUCKNER	A	CAHABA	B	CAPAY	D
BOSQUE	B	BREWTON	C	BUCKNEY	A	CAHILL	B	CAPE	D
BOSS	D	BRICKEL	C	BUCKS	B	CAHONE	C	CAPE FEAR	D
BOSTON	C	BRICKTON	C	BUCKSKIN	C	CAHTO	C	CAPERS	D
BOSTWICK	B	BRIDGE	C	BUCODA	C	CAID	B	CAPILLO	C
BOSWELL	D	BRIDGEHAMPTON	B	BUDD	B	CAIRO	D	CAPLES	C
BOSWORTH	D	BRIDGEPORT	B	BUDE	C	CAJALCO	C	CAPPS	B
BOTELLA	B	BRIDGER	A	BUELL	B	CAJON	A	CAPSHAW	C
BOTHWELL	C	BRIDGESON	B/C	BUENA VISTA	B	CALABAR	D	CAPULIN	B
BOTTINEAU	C	BRIDGET	B	BUFFINGTON	B	CALABASAS	B	CAPUTA	C
BOTTLE	A	BRIDGEVILLE	B	BUFFMEYER	B	CALAIS	C	CARACO	C
BOULDER	B	BRIDGPORT	B	BUFF PEAK	C	CALAMINE	D	CARALAMPI	B
BOULDER LAKE	D	BRIEDWELL	B	BUICK	C	CALAPOOYA	C	CARBO	C
BOULDER POINT	B	BRIEF	B	BUIST	B	CALAWAH	B	CARBOL	D
BOULFLAT	D	BRIENSBURG		BUKREEK	B	CALCO	C	CARBONDALE	D
BOURNE	C	BRIGGS	A	BULLION	D	CALDER	D	CARBURY	B
BOW	C	BRIGGSDALE	C	BULLREY	B	CALDWELL	B	CARCITY	D
BOWBAC	C	BRIGGSVILLE	C	BULL RUN	B	CALEAST	C	CARDIFF	B
BOWBELLS	B	BRIGHTON	A/D	BULL TRAIL	B	CALEB	B	CARDINGTON	C
BOWDOIN	D	BRIGHTWOOD	C	BULLY	B	CALERA	C	CARDON	D
BOWDRE	C	BRILL	B	BUMGARD	B	CALHI	A	CAREY	B
BOWERS	C	BRIM	C	BUNCOMBE	A	CALHOUN	D	CAREY LAKE	B
BOWIE	B	BRIMFIELD	C/D	BUNDO	B	CALICO	D	CAREYTOWN	D
BOWMAN	B/D	BRIMLEY	B	BUNOYMAN	C	CALIFON	C	CARGILL	C
BOWMANSVILLE	C	BRINEGAR	B	BUNEJUG	C	CALIMUS	B	CARIBE	B
BOXELDER	C	BRINKERT	C	BUNKER	D	CALITA	B	CARIBEL	B
BOXWELL	C	BRINKERTON	D	BUNSELMEIER	C	CALIZA	B	CARIBOU	B
BOY	A	BRISCOT	B	BUNTINGVILLE	B/C	CALKINS	C	CARLIN	D
BOYCE	B/D	BRITE	C	BUNYAN	B	CALLABO	C	CARLINTON	B
BOYD	D	BRITTON	C	BURBANK	A	CALLAHAN	C	CARLISLE	A/D
BOYER	B	BRIZAM	A	BURCH	B	CALLEGUAS	D	CARLOTTA	B
BOYNTON		BROAD	C	BURCHARD	B	CALLINGS	C	CARLOW	D
BOYSAG	D	BROADALBIN	C	BURCHELL	B/C	CALLOWAY	C	CARLSBAD	C
BOYSEN	D	BROADAX	B	BURDETT	C	CALMAR	B	CARLSBORG	A
BOZARTH	C	BROADBROOK	C	BUREN	C	CALNEVA	C	CARLSON	C
BOZE	B	BROAD CANYON	B	BURGESS	C	CALOUSE	B	CARLTON	B
BOZEMAN	A	BROADHEAD	C	BURGI	B	CALPINE	B	CARMI	B
BRACEVILLE	C	BROADHURST	D	BURGIN	D	CALVERT	D	CARNASAW	C
BRACKEN	D	BROCK	D	BURKE	C	CALVERTON	C	CARNEGIE	C
BRACKETT	C	BROCKLISS	C	BURKHARDT	B	CALVIN	C	CARNERO	C
BRAD	D	BROCKMAN	C	BURLEIGH	D	CALVISTA	D	CARNEY	D
BRADDOCK	C	BROCKO	B	BURLESON	D	CAM	B	CAROLINE	C
BRADENTON	B/D	BROCKPORT	D	BURLINGTON	A	CAMAGUEY	D	CARR	B
BRADER	D	BROCKTON	D	BURMA		CAMARGO	B	CARRISALITOS	D
BRADFORD	B	BROCKWAY	B	BURMESTER	D	CAMARILLO	B/C	CARRIZO	A
BRADSHAW	B	BRODY	C	BURNAC	C	CAMAS	A	CARSITAS	A
BRADWAY	D	BROE	B	BURNETTE	B	CAMAS CREEK	B/D	CARSLEY	C
BRADY	B	BROGAN	B	BURNHAM	D	CAMBERN	C	CARSO	D
BRADYVILLE	C	BROGDON	B	BURNSIDE	B	CAMBRIDGE	C	CARSON	D
BRAHAM	B	BROLLIAR	D	BURNSVILLE	B	CAMDEN	B	CARSTAIRS	B
BRAINERD	B	BROMO	B	BURNT LAKE	B	CAMERON	D	CARSTUMP	C
BRALLIER	D	BRONAUGH	B	BURRIS	D	CAMILLUS	B	CART	B
BRAM	B	BRONCHO	B	BURT	D	CAMP	B	CARTAGENA	D
BRAMARD	B	BRONSON	B	BURTON	B	CAMPBELL	B/C	CARTECAY	C
BRAMBLE	C	BRONTE	C	BUSE	B	CAMPHORA	B	CARUSO	C
BRAMWELL	C	BROOKE	C	BUSH	B	CAMPIA	B	CARUTHERSVILLE	B
BRAND	D	BROOKFIELD	B	BUSHNELL	C	CAMPO	C	CARVER	A
BRANDENBURG	A	BROOKINGS	B	BUSHVALLEY	D	CAMPONE	B/C	CARWILE	D

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HYDROLOGY MANUAL

S.C.S. SOIL NAMES
FOR
HYDROLOGIC CLASSIFICATIONS

CARYVILLE	B	CENTRAL POINT	B	CHILGREN	C	CLARESON	C	COKEDALE	B/C
CASA GRANDE	C	CERESCO	A	CHILHOWIE	C	CLAREVILLE	C	COKEL	B
CASCADE	C	CERRILLOS	B	CHILI	B	CLARINDA	D	COKER	D
CASCAJO	B	CERRO	C	CHILKAT	C	CLARION	B	COKESBURY	D
CASCILLA	B	CHACRA	C	CHILLICOTHE	C	CLARITA	D	COKEVILLE	B
CASCO	B	CHAFFEE	C	CHILLISQUAQUE		CLARK	B	COLBATH	C/D
CASE	B	CHAGRIN	B	CHILLUM	B	CLARK FORK	A	COLBERT	D
CASEBIER	D	CHAIX	B	CHILMARK	B	CLARKSBURG	C	COLBURN	B
CASEY	C	CHALFONT	C	CHILO	B/D	CLARKSDALE	C	COLBY	B
CASHEL	C	CHALMERS	C	CHILOQUIN	B	CLARKSON	B	COLCHESTER	B
CASHION	D	CHAMA	B	CHILSON	D	CLARKSVILLE	B	COLDCREEK	B
CASHMERE	B	CHAMBER	C	CHILTON	B	CLARNO	B	COLDEN	D
CASHMONT	B	CHAMBERINO	C	CHIMAYO	D	CLARY	B	COLD SPRINGS	C
CASINO	A	CHAMISE	B	CHIMNEY	B	CLATO	B	COLE	B/C
CASITO	D	CHAMOKANE	B	CHINA CREEK	B	CLATSOP	D	COLEBROOK	B
CASPAR	B	CHAMPION	B	CHINCHALLO	B/D	CLAVERACK	C	COLEMAN	C
CASPIANA	B	CHANCE	B/D	CHINIAK	A	CLAWSON	C	COLEMANTOWN	D
CASS	A	CHANDLER	B	CHINO	B/C	CLAYBURN	B	COLETO	A
CASSADAGA		CHANEY	C	CHINOOK	B	CLAYSPRINGS	D	COLFAX	C
CASSIA	C	CHANNAHON	B	CHIPETA	D	CLAYTON	B	COLIBRO	B
CASSIRO	C	CHANNING	B	CHIPLEY	C	CLEARFIELD	C	COLINAS	B
CASSOLARY	B	CHANTA	B	CHIPMAN	D	CLEAR LAKE	D	COLLAMER	C
CASSVILLE		CHANTIER	D	CHIPPENY	D	CLEEK	C	COLLARD	B
CASTAIC	C	CHAPIN	C	CHIPPEWA	B/D	CLE ELUM	B	COLLBRAN	C
CASTALIA	C	CHAPMAN		CHIQUITO	C/D	CLEGG	B	COLLEEN	C
CASTANA	B	CHAPPELL	B	CHIRICAHUA	D	CLEMAN	B	COLLEGIATE	C
CASTELL	C	CHARD	B	CHISPA	B	CLEMS	B	COLLETT	C
CASTILE	B	CHARGO	D	CHITINA	B	CLEMVILLE	B	COLLIER	A
CASTINO	C	CHARITON	D	CHITTENDEN	C	CLEORA	B	COLLINGTON	B
CASTLE	D	CHARITY	D	CHITWOOD	C	CLERF	C	COLLINS	C
CASTLEVALE	D	CHARLEBOIS	C	CHIVATO	D	CLERMONT	D	COLLINSTON	C
CASTNER	C	CHARLESTON	C	CHIWAWA	B	CLEVERLY	B	COLLINSVILLE	C
CASTO	C	CHARLEVOIX	B	CHO	C	CLICK	A	COLMA	B
CASTRO	C	CHARLOS	A	CHOBEE	D	CLIFFDOWN	B	COLMOR	B
CASTROVILLE	B	CHARLOTTE	A/D	CHOCK	B/D	CLIFFHOUSE	C	COLO	B
CASUSE	D	CHARLTON	B	CHOCOLOCCO	B	CLIFFORD	B	COLOCKUM	B
CASWELL	D	CHASE	C	CHOPAKA	C	CLIFFWOOD	C	COLOMA	A
CATALINA	B	CHASEBURG	B	CHOPTANK	A	CLIFTERSON	B	COLOMBO	B
CATALPA	C	CHASEVILLE	A	CHOPTIE	D	CLIFTON	C	COLONA	C
CATANO	A	CHASKA	C	CHORALMONT	B	CLIFTY	B	COLONIE	A
CATARINA	D	CHASTAIN	D	CHOSKA	B	CLIMARA	D	COLORADO	B
CATAULA	C	CHATBURN	B	CHOTEAU	C	CLIMAX	D	COLOROCK	D
CATAWBA	B	CHATFIELD	C	CHRISTIAN	C	CLIME	C	COLOSO	D
CATH	D	CHATHAM	B	CHRISTIANA	B	CLINTON	B	COLOSSE	A
CATHCART	C	CHATSWORTH	D	CHRISTIANBURG	D	CLIPPER	B/C	COLP	D
CATHEDRAL	D	CHAUNCEY	C	CHRISTY	B	CLODINE	D	COLRAIN	B
CATHERINE	B/D	CHAVIES	B	CHROME	C	CLONTARF	B	COLTON	A
CATHRO	D	CHAWANAKEE	C	CHUALAR	B	CLOQUALLUM	C	COLTS NECK	B
CATLETT	C/D	CHEADLE	C	CHUBBS	C	CLOQUATO	B	COLUMBIA	B
CATLIN	B	CHECKETT	D	CHUCKAWALLA	B	CLOQUET	B	COLUMBINE	A
CATNIP	D	CHEDEHAP	B	CHUGTER	B	CLOUD	D	COLUSA	C
CATOCTIN	C	CHEEKTOWAGA	D	CHULITNA	B	CLOUDCROFT	D	COLVILLE	B/C
CATODSA	B	CHEESEMAN	C	CHUMMY	C/D	CLOUD PEAK	C	COLVIN	C
CATSKILL	A	CHEHALEM	C	CHUMSTICK	C	CLOUD RIM	B	COLWOOD	B/D
CATTARAUGUS	C	CHEHALIS	B	CHUPADERA	C	CLOUGH	D	COLY	B
CAUDLE	B	CHEHULPUM	D	CHURCH	D	CLOVERDALE	D	COLYER	C/D
CAVAL	B	CHELAN	B	CHURCHILL	D	CLOVER SPRINGS	B	COMER	B
CAVE	D	CHELSEA	A	CHURCHVILLE	D	CLOVIS	B	COMERIO	B
CAVELT	D	CHEMAWA	B	CHURN	B	CLUFF	C	COMETA	D
CAVE ROCK	A	CHEMUNG		CHURNDASHER	B	CLUNIE	D	COMFREY	C
CAVO	D	CHEN	D	CHUTE	A	CLURDE	C	COMITAS	A
CAVODE	C	CHENA	A	CIALES	D	CLURO	C	COMLY	C
CAVOUR	D	CHENANGO	A	CIBEQUE	B	CLYDE	D	COMMERCE	C
CAWKER	B	CHENEY	B	CIBO	D	CLYMER	B	COMO	A
CAYAGUA	C	CHENNEBY	C	CIBOLA	B	COACHELLA	B	COMODORE	B
CAYLOR	B	CHENOWETH	B	CICERO	D	COAD	B	COMORO	B
CAYUGA	C	CHEQUEST	C	CIDRAL	C	COAL CREEK	D	COMPTCHE	B
CAZADERO	C	CHEREETE	A	CIENEBA	C	COALMONT	C	COMPTON	C
CAZADOR	B	CHERIONI	D	CIMA	C	COAMO	C	COMSTOCK	C
CAZENOVIA	B	CHEROKEE	D	CIMARRON	C	COARSEGOLD	B/C	COMUS	B
CEBOLIA	C	CHERRY	C	CINCINNATI	C	COATICOOK	C	CONALB	B
CEBONE	C	CHERRYHILL	B	CINCO	A	COATSBURG	D	CONANT	C
CECIL	B	CHERRY SPRINGS	C	CINDERCONE	B	COBB	B	CONASAUGA	C
CEDA	B	CHESAW	A	CINEBAR	B	COBEN	D	CONATA	D
CEDARAN	D	CHESHIRE	B	CINTRONA	D	COBEY	B	CONBOY	D
CEDAR BUTTE	C	CHESHNINA	C	CIPRIANO	D	COBURG	C	CONCHAS	C
CEDAREDGE	B	CHESNIMNUS	B	CIRCLE	C	COCHETOPA	C	CONCHO	C
CEDAR MOUNTAIN	D	CHESTER	B	CIRCLEVILLE	C	COCOA	A	CONCONULLY	B
CEDARVILLE	B	CHESTERTON	C	CISNE	D	COCOLALLA	C	CONCORD	D
CEDONIA	B	CHETCO	D	CISPUS	A	COCOKUS	C	CONCREEK	B
CEDRON	C/D	CHETEK	B	CITICO	B	CODY	A	CONDA	C
CELAYA	B	CHEVELON	C	CLACKAMAS	C	COE	A	CONDIT	D
CELETON	D	CHEWACLA	C	CLAIBORNE	B	COEBURN	C	CONDON	C
CELINA	C	CHEWELAH	B	CLAIRE	A	COEROCK	D	CONE	A
CELIO	A/D	CHEYENNE	B	CLAIREMONT	B	COFF	D	CONEJO	C
CELLAR	D	CHIARA	D	CLALLAM	C	COFFEEN	B	CONESTOGA	B
CENCOVE	B	CHICKASHA	B	CLAM GULCH	D	COGGON	B	CONESUS	B
CENTER	C	CHICOPEE	B	CLAMO	C	COGSWELL	C	CONGAREE	B
CENTER CREEK	B	CHICOTE	D	CLANTON	C	COHASSET	B	CONGER	B
CENTERFIELD	B	CHIGLEY	C	CLAPPER	B	COHOCTAH	D	CONI	D
CENTERVILLE	D	CHILCOTT	C	CLAREMORE	D	COHOE	B	CONKLIN	B
CENTRALIA	B	CHILOS	B	CLARENCE	D	COIT	C	CONLEN	B

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HYDROLOGY MANUAL

S.C.S. SOIL NAMES FOR HYDROLOGIC CLASSIFICATIONS

CONLEY	C	COURT	B	CROWLEY	D	DANSKIN	B	DELLROSE	B
CONNEAUT	C	COURTHOUSE	D	CROWN	B	DANT	D	DELM	D
CONNECTICUT		COURTLAND	B	CROWSHAW	B	DANVERS	C	DELMAR	D
CONNERTON	B	COURTNEY	D	CROZIER	C	DANVILLE	C	DELMITA	C
CONOTTON	B	COURTROCK	B	CRUCES	D	DANZ	B	DELMONT	B
CONOVER	B	COUSE	C	CRUCKTON	B	DARCO	A	DELNORTE	C
CONOWINGO	C	COUSHATTA	B	CRUICKSHANK	C	DARGOL	D	DELPHI	B
CONRAD	B	COVE	D	CRUME	B	DARIEN	C	DELPHILL	C
CONROE	B	COVEILO	B	CRUMP	D	DARLING	B	DELPIEDRA	C
CONSER	C/D	COVELAND	C	CRUTCH	B	DARNELL	C	DELPINE	D
CONSTABLE	A	COVELLO	B/C	CRUTCHER	D	DARNEN	B	DELRAY	A/D
CONSTANCIA	D	COVENTRY	B	CRUZE	C	DARR	A	DEL REY	C
CONSUMO	B	COVEYTOWN	C	CRYSTAL LAKE	B	DARRET	C	DEL RIO	B
CONTEE	D	COVINGTON	D	CRYSTAL SPRINGS	D	DARROCH	C	DELSON	C
CONTINE	C	COWAN	A	CRYSTOLA	B	DARRDUZETT	C	DELTA	C
CONTINENTAL	C	COWARTS	C	CUBA	B	DART	A	DELTON	B
CONTRA COSTA	C	COWDEN	D	CUBERANT	B	DARVADA	D	DELWIN	A
CONVENT	C	COWDREY	C	CUCHILLAS	D	DARWIN	D	DELYNDIA	A
COOK	D	COWEEMAN	D	CUDAHY	D	DASSEL	D	DEMAST	B
COOKPORT	C	COWERS	B	CUERO	B	DAST	C	DE MASTERS	B
COOLBRITH	B	COWETA	C	CUEVA	D	DATEMAN	C	DE MAYA	C
COOLIDGE	B	COWICHE	B	CUEVITAS	D	DATINO	C	DEMERS	D
COOLVILLE	C	COWOOD	C	CULBERTSON	B	DATWYLER	C	DEMKY	D
COOMBS	B	COX	D	CULLEN	C	DAULTON	D	DEMONA	C
COONEY	B	COXVILLE	D	CULLEOKA	B	DAUPHIN		DEMOPOLIS	C
COOPER	C	COY	D	CULLO	C	DAVEY	A	DEMPSEY	B
COOTER	C	COYATA	C	CULPEPER	C	DAVIDSON	B	DEMPSTER	B
COPAKE	B	COZAD	B	CULVERS	C	DAVIS	B	DENAY	B
COPALIS	B	CRABTON	B	CUMBERLAND	B	DAVISON	B	DENHAWKEN	D
COPELAND	B/D	CRADDOCK	B	CUNLEY	C	DAVTONE	B	DENISON	C
COPITA	B	CRADLEBAUGH	D	CUMMINGS	B/D	DAWES	C	DENMARK	D
COPLAY		CRAFTON	C	CUNDIYO	B	DAWHOO	B/D	DENNIS	C
COPPER RIVER	D	CRAGO	B	CUNICO	C	DAWSON	D	DENNY	D
COPPERTON	B	CRAGOLA	D	CUPPER	B	DAXTY	C	DENROCK	D
COPPOCK	B	CRAIG	C	CURANT	B	DAY	D	DENTON	D
COPSEY	D	CRAIGMONT	C	CUROLI	C	DAYBELL	A	DENVER	C
COQUILLE	C/D	CRAIGSVILLE	A	CURECANTI	B	DAYTON	D	DEODAR	D
CORA	D	CRAMER	D	CURHOLLOW	D	DAYVILLE	B/C	DEPEW	C
CORAL	C	CRANE	B	CURLEW	C	DAZE	D	DEPOE	D
CORBETT	B	CRANSTON	B	CURRAN	C	DEACON	B	DEPORT	D
CORBIN	B	CRARY	C	CURTIS CREEK	D	DEADFALL	B	DERA	B
CORCEGA	C	CRATER LAKE	B	CURTIS SIDING	A	DEANA	C	DERINDA	C
CORD	C	CRAVEN	C	CUSHING	B	DEAN	C	DERR	C
CORDES	B	CRAWFORD	D	CUSHMAN	C	DEAN LAKE	C	DERRICK	B
CORDOVA	C	CREAL	D	CUSTER	C	DEARDURFF	B	DESAN	A
CORINTH	C	CREBBIN	C	CUTTER	D	DEARY	C	DESART	C
CORKINDALE	B	CREDO	C	CUTZ	D	DEARYTON	B	DESCALABRADO	D
CORLENA	A	CREEDMAN	D	CUYAMA	B	DEATMAN	C	DESCHUTES	C
CORLETT	B	CREEDMOOR	C	CUYON	A	DEAVER	C	DESERET	C
CORLEY	C	CREIGHTON	B	CYAN	D	DEBENGER	C	DESERTER	B
CORMANT	C	CRELDON	B	CYLINDER	B	DEBORAH	D	DESHA	D
CORNHILL	B	CRESBARD	C	CYNTHIANA	C/D	DECAN	D	DESHLER	C
CORNING	D	CRESCENT	B	CYPREMORT	C	DECATHON	D	DESOLATION	C
CORNISH	B	CRESCO	C	CYRIL	B	DECATUR	B	DESPAIN	B
CORNUTT	C	CRESPIN	C			DECCA	B	DETER	C
CORNVILLE	B	CREST	C	DABOB	B	DECKER	C	DETLOR	C
COROZAL	C	CRESTLINE	B	DACONO	C	DECKERVILLE	C	DETOUR	C
CORPENING	D	CRESTMORE		DACOSTA	D	DECLO	B	DETRA	B
CORRALITOS	A	CRESTON	A	DADE	A	DECORRA	B	DETROIT	C
CORRECO	C	CRESWELL	C	DAFTER	B	DECROSS	B	DEV	B
CORRERA	D	CRETE	D	DAGFLAT	C	DEE	C	DEVILS DIVE	D
CORSON	C	CREVA	D	DAGGETT	A	DEEPWATER	C	DEVOE	D
CORTADA	B	CREVASSE	A	DAGLUM	D	DEER CREEK	C	DEVOIGNES	C/D
CORTEZ	D	CREWS	D	DAGOR	B	DEERFIELD	B	DEVOL	B
CORTINA	A	CRIDER	B	DAGUAO	C	DEERFORD	D	DEVON	B
CORUNNA	D	CRIM	B	DAGUEY	C	DEERING	B	DEVORE	B
CORVALLIS	B	CRISFIELD	B	DAHLQUIST	B	DEERLODGE	D	DEVOY	D
CORWIN	B	CRITCHELL	B	DAIGLE	C	DEER PARK	A	DEWART	
CORY	C	CRIVITZ	A	DAILEY	A	DEERTON	B	DEWEY	B
CORYDON	C	CROCKER	A	DAKOTA	B	DEERTRAIL	C	DEWVILLE	B
COSAD	C	CROCKETT	D	DALBO	B	DEFIANCE	D	DEXTER	B
COSH	C	CROESUS	C	DALBY	D	DEFORD	D	DIA	C
COSHOCTON	C	CROFTON	B	DALCAN	C	DEGARMO	B/C	DIABLO	D
COSKI	B	CROGHAN	B	DALE	B	DEGNER	C	DIAMOND	D
COSSAYUNA	C	CROOKED	C	DALHART	B	DE GREY	D	DIAMOND SPRINGS	C
COSTILLA	A	CROOKED CREEK	D	DALIAN	B	DEJARNET	B	DIAMONDVILLE	C
COTACO	C	CROOKSTON	B	DALLAM	B	DEKALB	C	DIANEV	C
COTATI	C	CROOM	B	DALTON	C	DEKOVEN	D	DIANOLA	D
COTITO	C	CROPLEY	D	DALUPE	B	DELA	B	DIAZ	C
COTO	C	CROSBY	C	DAMASCUS	D	DELAKE	B	DIBBLE	C
COTOPAXI	A	CROSS	D	DAMON	D	DELANCO	C	DICK	A
COTT	B	CROSSVILLE	B	DANA	B	DELANEY	A	DICKEY	A
COTTER	B	CROSWELL	A	DANBURY	C	DELANO	B/C	DICKINSON	A
COTTERAL	B	CROT	D	DANBY		DELECO	D	DICKSON	C
COTTIER	B	CROTON	D	DANDREA	C	DELENA	D	DIGBY	C
COTTONWOOD	C	CROUCH	B	DANDRIDGE	D	DELFINA	B	DIGGER	C
COTTRELL	C	CROW	C	DANGBERG	D	DELHI	A	DIGHTON	B
COUCH	C	CROW CREEK	B	DANIC	C	DELICIAS	B	DILL	B
COUGAR	D	CROWFOOT	B	DANIELS	B	DELKS	B/D	DILLARD	C
COULSTONE	B	CROWHEART	D	DANKO	D	DELL	C	DILLDOWN	
COUNTS	C	CROW HEART	D	DANLEY	C	DELLEKER	B	DILLINGER	B
COUPEVILLE	'C	CROW HILL	C	DANNEMORA	D	DELLO	A/C	DILLON	D

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES
FOR
HYDROLOGIC CLASSIFICATIONS

DILLWYN	A
DILMAN	C
DILTS	D
DILWORTH	D
DIMAL	D
DIMYAW	C
DINGLE	B
DINGLISHNA	D
DINKELMAN	B
DINKEY	A
DINNEN	B
DINSDALE	B
DINUBA	B/C
DINZER	B
DIOXICE	B
DIPMAN	D
DIQUE	B
DISABEL	D
DISAUTEL	B
DISCO	B
DISHNER	D
DISTERHEFF	C
DITCHCAMP	C
DITHOD	C
DIVEAS	B
DIVIDE	B
DIX	A
DIXIE	C
DIXMONT	C
DIXMORE	B
DIXONVILLE	C
DIXVILLE	A
DOAK	B
DOBBS	C
DOBEL	D
DOBROW	D
DOBY	D
DOCAS	B
DOCKERY	C
DOCT	B
DODGE	B
DODGEVILLE	B
DODSON	C
DOGER	A
DOGUE	C
DOLAND	B
DOLE	C
DOLLAR	B
DOLLARD	C
DOLORES	B
DOLPH	C
DOMEZ	C
DOMINGO	C
DOMINGUEZ	C
DOMINIC	A
DOMINO	C
DOMINSON	A
DONA ANA	B
DONAHUE	C
DONALD	B
DONAVAN	B
DONEGAL	
DONERAIL	C
DONEY	C
DONICA	A
DONLONTON	C
DONNA	D
DONNAN	C
DONNARDO	B
DONNYBROOK	D
DONOVAN	B
DOOLEY	A
DOONE	B
DOOR	B
DORA	D
DORAN	C
DORCHESTER	B
DOROSHIN	D
DOROTHEA	C
DOROVAN	D
DORS	B
DORSET	B
DOS CABEZAS	C
DOSS	C
DOSSMAN	B
DOTEN	D
DOTHAN	B
DOTTA	B
DOTY	B
DOUBLETOP	B
DOUDS	B
DOUGHERTY	A
DOUGHTY	A
DOUGLAS	B
DOURO	B
DOVER	B
DOVRAY	D
DOW	B
DOWAGIAC	B
DOWDEN	C
DOWELLTON	D
DOWNER	B
DOWNEY	B
DOWNS	B
DOXIE	C
DOYCE	C
DOYLE	A
DOYLESTOWN	D
DOYN	C
DRA	C
DRACUT	C
DRAGE	B
DRAGOON	B
DRAGSTON	C
DRAHAT	D
DRAIN	D
DRAKE	B
DRANYON	B
DRAPER	C
DRESDEN	B
DRESSLER	C
DREWS	B
DREXEL	B
DRIFTON	C
DRIGGS	B
DRUM	C
DRUMMER	B
DRUMMOND	D
DRURY	B
DRYAD	C
DRYBURG	B
DRY CREEK	C
DRYDEN	B
DRY LAKE	C
DUANE	B
DUART	C
DUBAKELLA	C
DUBAY	D
DUBBS	B
DUBOIS	C
DUBUQUE	B
DUCEY	B
DUCHESNE	B
DUCKETT	C
DUCOR	D
DUDA	A
DUDLEY	D
DUEL	B
DUELM	C
DUFFAU	B
DUFFER	D
DUFFIELD	B
DUFFSON	B
DUFFY	B
DUFUR	B
DUGGINS	D
DUGOUT	D
DUGWAY	D
DUKES	A
DULAC	C
DUMAS	B
DUMECQ	C
DUMONT	B
DUNBAR	D
DUNBARTON	C
DUNBRIDGE	B
DUNCAN	D
DUNCANNON	B
DUNCOM	D
DUNDAS	C
DUNDAY	A
DUNDEE	C
DUNELLEN	B
DUNE SAND	A
DUNGENESS	B
DUN GLEN	C
DUNKINSVILLE	B
DUNKIRK	B
DUNLAP	B
DUNMORE	B
DUNNING	C
DUNPHY	D
DUNUL	A
DUNVILLE	B
DU PAGE	B
DUPEE	C
DUPLIN	C
DUPO	C
DUPONT	D
DUPREE	D
DURALDE	C
DURAND	B
DURANT	D
DURELLE	B
DURHAM	B
DURKEE	C
DUROC	B
DURRSTEIN	D
DUSTON	B
DUTCHESS	B
DUTSON	D
DUTTON	D
DUVAL	B
DUZEL	B
DWIGHT	D
DWYER	A
DYE	D
DYER	
DYKE	B
DYRENG	D
EACHUSTON	D
EAD	C
EAGAR	B
EAGLECONE	B
EAKIN	B
EAMES	B
EARLE	D
EARLMONT	B/C
EARP	B
EASLEY	D
EAST FORK	C
EAST LAKE	A
EASTLAND	C
EASTON	C
EASTONVILLE	A
EAST PARK	D
EASTPORT	A
EATONTOWN	
EAUGALLIE	B/D
EBA	C
EBBERT	D
EBBS	B
EBENEZER	C
ECCLES	B
ECHARD	C
ECHLER	B
ECKERT	D
ECKLEY	B
ECKMAN	B
ECKRANT	D
ECTOR	D
EDALGO	C
EDDS	B
EDDY	C
EDEN	C
EDENTON	C
EDENVALE	D
EDGAR	B
EDGECUMBE	B
EDGELEY	C
EDGEMONT	B
EDGEWATER	C
EDGEWICK	B
EDGEWOOD	A
EDGINGTON	C
EDINA	D
EDINBURG	C
EDISON	B
EDISTO	C
EDITH	A
EDLOE	B
EDMONDS	D
EDMORE	D
EDMUND	C
EDNA	D
EDNEYVILLE	B
EDOM	C
EDROY	D
EDSON	C
EDWARDS	B/D
EEL	C
EFFINGTON	D
EFWUN	A
EGAM	C
EGAN	B
EGBERT	B/C
EGELAND	B
EGGLESTON	B
EGNAR	C
EICKS	C
EIFORT	C
EKAH	C
EKALAKA	B
ELAM	A
ELBERT	D
ELBURN	B
ELCO	B
ELD	B
ELDER	B
ELDER HOLLOW	D
ELDERON	B
ELDON	B
ELDORADO	C
ELDRIDGE	C
ELEPHANT	D
ELEROY	B
ELFRIDA	B
ELIJAH	C
ELIOAK	C
ELK	B
ELKADER	B
ELKCREEK	C
ELK HOLLOW	B
ELKHORN	B
ELKINS	D
ELKINSVILLE	B
ELKMOUND	C
ELK MOUNTAIN	B
ELKOL	D
ELKTON	D
ELLABELLE	B/D
ELLEDGE	C
ELLERY	D
ELLETT	D
ELLIBER	A
ELLICOTT	A
ELLINGTON	B
ELLINOR	C
ELLIOTT	C
ELLIS	D
ELLISFORDE	C
ELLISON	B
ELLOAM	D
ELLSBERRY	C
ELLSWORTH	C
ELLUM	C
ELMA	B
ELMDALE	B
ELMENDORF	D
ELMIRA	A
ELMO	C
ELMONT	B
ELMORE	B
ELMWOOD	C
ELNORA	B
ELOIKA	B
ELPAN	D
EL PECO	C
EL RANCHO	B
ELRED	B/D
ELROSE	B
ELS	A
ELSAH	B
ELSINBORO	B
ELSINORE	A
ELSMERE	A
ELSO	D
EL SOLYO	C
ELSTON	B
ELTOPIA	B
ELTREE	B
ELTSAC	D
ELWHA	B
ELWOOD	C
ELY	B
ELYSIAN	B
ELZINGA	B
EMSDEN	B
EMBRY	B
EMBUDO	B
EMDENT	C
EMER	C
EMERALD	B
EMERSON	B
EMIDA	D
EMIGRANT	B
EMIGRATION	D
EMILY	B
EMLIN	B
EMMA	C
EMMERT	A
EMMET	B
EMMONS	C
EMORY	B
EMPEDRADO	C
EMPEY	B
EMPEYVILLE	C
EMPIRE	C
EMRICK	B
ENCE	B
ENCIERRO	D
ENCINA	B
ENDERS	C
ENDERSBY	B
ENDICOTT	C
ENET	B
ENFIELD	B
ENGLE	B
ENGLESIDE	B
ENGLEWOOD	C
ENGLUND	D
ENNIS	B
ENOCHVILLE	B/D
ENOLA	B
ENON	C
ENOREE	D
ENOS	B
ENOSBURG	D
ENSENADA	B
ENSIGN	D
ENSLEY	D
ENSTROM	B
ENTENTE	B
ENTERPRISE	B
ENTIAT	D
ENUMCLAW	C
EPHRAIM	C
EPHRATA	B
EPLEY	B
EPOUFETTE	D
EPPING	D
EPSIE	D
ERA	B
ERAM	C
ERBER	C
ERIC	B
ERIE	C
ERIN	B
ERNEST	C
ERNO	B
ERRAMOUSPE	C
ESCABOSA	C
ESCAL	B
ESCALANTE	B
ESCAMBIA	C
ESCONDIDO	C
ESMOND	B
ESPARTO	B
ESPIL	D
ESPINAL	A
ESPLIN	D
ESPY	C
ESQUATZEL	B
ESS	B
ESSEN	C
ESSEX	C
ESSEXVILLE	D
ESTACADO	B
ESTELLINE	B
ESTER	D
ESTERBROOK	B
ESTHERVILLE	B
ESTIVE	C
ESTO	B
ESTRELLA	B
ETHAN	B
ETHETE	B
ETHRIDGE	C
ETIL	A
ETNA	
ETOE	B
ETOWAH	B
ETOWN	B
ETSEL	D
ETTA	C
ETTER	B
ETTERSBURG	B
ETTRICK	D
EUBANKS	B

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES FOR HYDROLOGIC CLASSIFICATIONS

EUDORA	B	FE	D	FLOWELL	C	FRENCH	C	GARLOCK	C
EUFAULA	A	FEDORA	B	FLOWEREE	B	FRENCHTOWN	D	GARMON	C
EUREKA	D	FELAN	A	FLOYD	B	FRENEAU	C	GARMORE	B
EUSTIS	A	FELDA	B/D	FLUETSCH	C	FRESNO	C/D	GARNER	D
EUTAW	D	FELIDA	B	FLUSHING		FRIANA	D	GARO	D
EVANGELINE	C	FELKER	D	FLUVANNA	C	FRIANT	D	GARR	D
EVANS	B	FELLOWSHIP	D	FLYGARE	B	FRIOLO	C	GARRARD	B
EVANSTON	B	FELT	B	FLYNN	D	FRIEDMAN	B	GARRETSON	B
EVARO	A	FELTA	C	FOARD	D	FRIENDS	D	GARRETT	B
EVART	D	FELTHAM	A	FOGELSVILLE	B	FRIES	D	GARRISON	B
EVENDALE	C	FELTON	B	FOLA	B	FRINDLE	B	GARTON	C
EVERETT	B	FELTONIA	B	FOLEY	D	FRIO	B	GARWIN	C
EVERGLADES	A/D	FENCE	B	FONDA	D	FRIZZELL	C	GASCONADE	D
EVERLY	B	FENDALL	C	FONDIS	C	FROBERG	D	GAS CREEK	C
EVERMAN	C	FENWOOD	B	FONTAL	D	FROHMAN	C	GASKELL	C
EVERSON	D	FERA	C	FONTREEN	B	FRONDORF	C	GASS	D
EVESBORO	A	FERDELFORD	C	FOPIANO	D	FRONHOFER	C	GASSET	D
EWA	B	FERDIG	C	FORBES	B	FRONTON	D	GATESBURG	A
EWAIL	A	FERDINAND	C	FORD	D	FROST	D	GATESON	C
EWALL	A	FERGUS	B	FORDNEY	A	FRUITA	B	GATEVIEW	B
EWINGSVILLE	B	FERGUSON	B	FORDTRAN	C	FRUITLAND	B	GATEWAY	C
EXCELSIOR	B	FERNANDO	B	FORDVILLE	B	FRYE	C	GATEWOOD	D
EXCHEQUER	D	FERN CLIFF	B	FORE	D	FUEGO	C	GAULDY	B
EXETER	C/D	FERNDALE	B	FORELAND	D	FUERA	C	GAVINS	C
EXLINE	D	FERNLEY	C	FORELLE	B	FUGAWEE	B	GAVIOTA	D
EXRAY	D	FERNOW	B	FORESMAN	B	FULCHER	C	GAY	D
EXUM	C	FERNPOINT	C	FORESTDALE	D	FULDA	C	GAYLORD	B
EYERBOW	D	FERRELO	B	FORESTER	C	FULLERTON	B	GAYNOR	C
EYRE	B	FERRIS	D	FORESTON	C	FULMER	B/D	GAYVILLE	B
		FERRON	D	FORGAY	A	FULSHEAR	C	GAZELLE	D
FABIUS	B	FERTALINE	D	FORMAN	B	FULTON	D	GAZOS	B
FACEVILLE	B	FESTINA	B	FORNEY	D	FUQUAY	B	GEARHART	A
FAHEY	B	FETT	D	FORREST	C	FURNISS	B/D	GEARY	B
FAIM	C	FETTIC	D	FORSEY	C	FURY	B/D	GEE	B
FAINES	A	FIANDER	C	FORSGREN	C	FUSULINA	C	GEEBURG	C
FAIRBANKS	B	FIBEA	D	FORT COLLINS	B			GEER	C
FAIRDALE	B	FIDALGO	C	FORT DRUM	C	GAASTRA	C	GEFO	A
FAIRFAX	B	FIDDLETOWN	C	FORT LYON	B	GABALDON	B	GELKIE	B
FAIRFIELD	B	FIDDYMENT	C	FORT MEADE	A	GABBS	D	GEM	C
FAIRHAVEN	B	FIELDING	B	FORT MOTT	A	GABEL	C	GEMID	C
FAIRMOUNT	D	FIELDON	B	FORT PIERCE	C	GABICA	D	GEMSON	C
FAIRPORT	C	FIELDSON	A	FORT ROCK	C	GACEY	D	GENESEE	B
FAIRYDELL	C	FIFE	B	FORTUNA	D	GACHADO	D	GENEVA	C
FAJARDO	C	FIFER	D	FORTWINGATE	C	GADDES	C	GENOA	D
FALAYA	C	FILLMORE	D	FORWARD	C	GADES	C	GENOLA	B
FALCON	D	FINCASTLE	C	FOSHOME	B	GADSDEN	D	GEORGEVILLE	B
FALFA	C	FINGAL	C	FOSSUM	B	GAGE		GEORGIA	B
FALFURRIAS	A	FINLEY	B	FOSTER	B/C	GAGEBY	B	GERALD	D
FALK	B	FIRESTEEL	B	FOSTORIA	B	GAGETOWN	C	GERBER	D
FALKNER	C	FIRGRELL	B	FOUNTAIN	D	GAHEE	B	GERIG	B
FALL	B	FIRMAGE	B	FOURLOG	D	GAINES	C	GERING	B
FALLBROOK	B/C	FIRO	D	FOURMILE	B	GAINESVILLE	A	GERLAND	C
FALLON	C	FIRTH	B/C	FOUR STAR	B/C	GALATA	D	GERMANIA	
FALLSBURG	C	FISH CREEK	B	FOUTS	B	GALE	B	GERMANY	B
FALLSINGTON	D	FISHERS	B	FOX	B	GALEN	B	GERRARD	D
FANCHER	C	FISHHOOK	D	FOXCREEK	B/D	GALENA	C	GESTRIN	B
FANG	B	FISHKILL		FOXMOUNT	C	GALEPPI	C	GETTA	C
FANNIN	B	FITCH	A	FOXOL	D	GALESTOWN	A	GETTYS	C
FANNO	C	FITCHVILLE	C	FOXPARK	D	GALETON	D	GEYSEN	D
FANU	C	FITZGERALD	B	FOX PARK	D	GALEY	B	GHENT	C
FARADAY	B	FITZHUGH	B	FOXTON	C	GALISTEO	C	GIBBLER	C
FARALLONE	B	FIVE DOT	B	FRAILEY	B	GALLAGHER	B	GIBBON	B
FARAWAY	D	FIVEMILE	B	FRAM	B	GALLATIN	A	GIBBS	D
FARB	D	FIVES	B	FRANCIS	A	GALLEGOS	B	GIBBSTOWN	A
FARGO	D	FLAGG	B	FRANCITAS	D	GALLINA	C	GIFFIN	C
FARISITA	C	FLAGSTAFF	C	FRANK	D	GALLION	B	GIFFORD	C
FARLAND	B	FLAK	B	FRANKFORT	D	GALVA	B	GILA	B
FARMINGTON	C/D	FLAMING	B	FRANKIRK	C	GALVESTON	A	GILBY	B
FARNHAM	B	FLAMINGO	D	FRANKLIN	B	GALVEZ	C	GILCHRIST	B
FARNHAMTON	B/C	FLANAGAN	B	FRANKSTOWN	B	GALVIN	C	GILCREST	B
FARNUF	B	FLANDREAU	B	FRANKTOWN	D	GALWAY	B	GILEAD	C
FARNUM	B	FLASHER	A	FRANKVILLE	B	GAMBLER	A	GILES	B
FARRAGUT	C	FLATHEAD	A	FRATERNIDAD	D	GAMBOA	B	GILFORD	B/D
FARRAR	B	FLAT HORN	B	FRAZER	C	GANNETT	D	GILHOULY	B
FARRELL	B	FLATTOP	D	FRED	C	GANSNER	D	GILISPIE	C
FARRENBURG	B	FLATWILLOW	B	FREDENSBORG	C	GAPO	D	GILLIAM	C
FARROT	C	FLAXTON	A	FREDERICK	B	GAPPMAYER	B	GILLIGAN	B
FARSON	B	FLEAK	A	FREDON	C	GARA	B	GILLS	C
FARWELL	C	FLECHADO	B	FREDONIA	C	GARBER	A	GILLSBURG	C
FASKIN	B	FLEER	D	FREDRICKSON	C	GARBUTT	B	GILMAN	B
FATIMA	B	FLEETWOOD		FREEBURG	C	GARCENO	C	GILMORE	C
FATTIG	C	FLEISCHMANN	D	FREECE	D	GARDELLA	D	GILPIN	C
FAUNCE	A	FLEMING	C	FREEDOM	C	GARDENA	B	GILROY	C
FAUQUIER	C	FLETCHER	B	FREEHOLD	B	GARDINER	A	GILSON	B
FAUSSE	D	FLOKE	D	FREEL	B	GARDNER'S FORK	B	GILT EDGE	D
FAWCETT	C	FLOM	C	FREEMAN	C	GARDNERVILLE	D	GINAT	D
FAWN	B	FLOMATION	A	FREEMANVILLE	B	GARDONE	A	GINGER	C
FAXON	D	FLOMOT	B	FREEON	B	GAREY	C	GINI	B
FAYAL	C	FLORENCE	C	FREER	C	GARFIELD	C	GINSER	C
FAYETTE	B	FLORESVILLE	C	FREESTONE	C	GARITA	C	GIRARDOT	D
FAYETTEVILLE	B	FLORIDANA	B/D	FREEZENER	C	GARLAND	B	GIRD	A
FAYWOOD	C	FLORISSANT	C	FREMONT	C	GARLET	A	GIVEN	C

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES FOR HYDROLOGIC CLASSIFICATIONS

GLADDEN	A
GLADE PARK	C
GLADSTONE	B
GLADWIN	A
GLAMIS	C
GLANN	B/C
GLASGOW	C
GLEAN	B
GLEASON	C
GLEN	B
GLENBAR	B
GLENBERG	B
GLENBROOK	D
GLENCOE	D
GLENDALE	B
GLENDIVE	B
GLENDORA	D
GLENELG	B
GLENFIELD	D
GLENFORD	C
GLENHALL	B
GLENHAM	B
GLENMORA	C
GLENNALLEN	C
GLENOMA	B
GLENROSE	B
GLENSTED	D
GLENTON	B
GLENVIEW	B
GLENVILLE	C
GLIDE	B
GLIKON	B
GLORIA	C
GLOUCESTER	A
GLOVER	C/D
GLYNDON	B
GLYNN	C
GOBLE	C
GODDARD	B
GODDE	D
GODECKE	D
GODFREY	C
GODWIN	D
GOEGLEIN	C
GOESSEL	D
GOFF	C
GOGEBIC	B
GOLBIN	C
GOLCONDA	D
GOLD CREEK	D
GOLDENDALE	B
GOLDFIELD	B
GOLDHILL	B
GOLDMAN	C
GOLDRIDGE	B
GOLDRUN	A
GOLDSBORO	C
GOLDSTON	C
GOLDSTREAM	D
GOLDVALE	C
GOLDVEIN	C
GOLIAD	C
GOLLAHER	A
GOLTRY	A
GOMEZ	B
GOMM	D
GONVICK	B
GOOCH	D
GOODALE	C
GOODING	C
GOODINGTON	C
GOODLOW	B
GOODMAN	B
GOODRICH	B
GOODSPRINGS	D
GOOSE CREEK	B
GOOSE LAKE	D
GOOSMUS	B
GORDO	B
GORDON	D
GORE	D
GORGONIO	A
GORHAM	B
GORIN	C
GORING	C
GORMAN	B
GORUS	A
GORZELL	B
GOSHEN	B
GOSHUTE	D
GOSPORT	C
GOTHAM	A
GOTHARD	D
GOTHIC	C
GOTHO	C
GOULDING	D
GOVAN	C
GOVE	B
GOWEN	B
GRABE	B
GRABLE	B
GRACEMONT	B
GRACEVILLE	B
GRADY	D
GRAFEN	B
GRAFTON	B
GRAHAM	D
GRAIL	C
GRAMM	B
GRANATH	B
GRANBY	A/D
GRANDE RONDE	D
GRANDFIELD	B
GRANDVIEW	C
GRANER	C
GRANGER	C
GRANGEVILLE	B/C
GRANILE	B
GRANO	D
GRANT	B
GRANTSBURG	C
GRANTSDALE	A
GRANVILLE	B
GRAPEVINE	C
GRASMERE	B
GRASSNA	B
GRASSY BUTTE	A
GRATZ	C
GRAVDEN	C
GRAVE	B
GRAVITY	C
GRAYCALM	A
GRAYFORD	B
GRAYLING	A
GRAYLOCK	B
GRAYPOINT	B
GRAYS	B
GREAT BEND	B
GREELEY	B
GREEN BLUFF	B
GREENBRAE	C
GREEN CANYON	B
GREENCREEK	B
GREENDALE	B
GREENFIELD	B
GREENHORN	D
GREENLEAF	B
GREENOUGH	C
GREENPORT	
GREEN RIVER	B
GREENSBORO	
GREENSON	C
GREENTON	C
GREENVILLE	B
GREENWATER	A
GREENWICH	B
GREENWOOD	D
GREER	C
GREGORY	A
GREHALEM	B
GRELL	D
GRENADA	C
GRENVILLE	B
GRESHAM	C
GREWINGK	D
GREYBACK	B
GREYBULL	C
GREYCLIFF	C
GREYS	B
GRIFFY	B
GRIGSTON	B
GRIMSTAD	B
GRISWOLD	B
GRITNEY	C
GRIVER	C
GRIZZLY	C
GROGAN	B
GROSECLOSE	C
GROSS	C
GROTON	A
GROVE	A
GROVELAND	B
GROVER	B
GROVETON	B
GROWDEN	B
GROWLER	B
GRUBBS	D
GRULLA	D
GRUMMIT	D
GRUNDY	C
GRUVER	C
GRYGLA	C
GUADALUPE	B
GUAJE	A
GUALALA	D
GUAMANI	B
GUANABANO	B
GUANAJIBO	C
GUANICA	D
GUAYABO	B
GUAYABOTA	D
GUAYAMA	D
GUBEN	B
GUCKEEN	C
GUELPH	B
GUENOC	C
GUERNSEY	C
GUERRERO	C
GUEST	D
GUIN	A
GULER	B
GULKANA	B
GUMBOOT	C
GUNBARREL	A
GUNN	B
GUNNUK	C
GUNSIGHT	B
GUNTER	A
GURABO	D
GURNEY	C
GUSTAVUS	D
GUSTIN	C
GUTHRIE	D
GUYTON	D
GWIN	D
GWINNETT	B
GYMER	C
GYPSTRUM	B
HACCKE	C
HACIENDA	D
HACK	B
HACKERS	B
HACKETTSTOWN	B
HADAR	A
HADES	C
HADLEY	B
HADO	B
HAGEN	B
HAGENBARTH	B
HAGENER	A
HAGER	C
HAGERMAN	C
HAGERSTOWN	C
HAGGA	B
HAGGERTY	B
HAGSTADT	C
HAGUE	A
HAIG	C
HAIKU	B
HAILMAN	B
HAINES	B/C
HAIRE	C
HALAWA	B
HALDER	C
HALE	B
HALEDON	C
HALEIWA	B
HALEY	B
HALF MOON	B
HALFORD	A
HALFWAY	D
HALGAITOH	B
HALII	B
HALIIMAILE	B
HALIS	B
HALL	B
HALLECK	B
HALL RANCH	C
HALLVILLE	B
HALSEY	D
HAMACER	A
HAMAKUAPOKO	B
HAMAN	B
HAMAR	B
HAMBLEN	C
HAMBRIGHT	D
HAMBURG	B
HAMBY	C
HAMEL	C
HAMERLY	C
HAMILTON	A
HAMLET	B
HAMLIN	B
HAMMONTON	C
HAMPDEN	
HAMPSHIRE	C
HAMPTON	C
HAMTAH	C
HANA	A
HANALEI	C
HANAMAULU	A
HANCEVILLE	B
HANCO	D
HAND	B
HANORAN	C
HANDSBORO	D
HANDY	D
HANEY	B
HANFORD	B
HANGAARD	C
HANGER	B
HANIPOE	B
HANKINS	C
HANKS	B
HANLY	A
HANNA	B
HANNUM	D
HANOVER	C
HANS	C
HANSEL	C
HANSKA	C
HANSON	A
HANTHO	B
HANTZ	D
HAP	B
HAPGOOD	B
HAPNEY	C
HARBORD	B
HARBOURTON	
HARCO	B
HARDEMAN	B
HARDESTY	B
HARDING	D
HARDSCRABBLE	B
HARDY	D
HARGREAVE	B
HARKERS	C
HARKEY	B
HARLAN	B
HARLEM	C
HARLESTON	C
HARLINGEN	D
HARMEHL	C
HARMONY	C
HARNEY	C
HARPER	D
HARPETH	B
HARPS	B
HARPSTER	C
HARPT	B
HARQUA	C
HARRIET	D
HARRIMAN	B
HARRIS	D
HARRISBURG	D
HARRISON	C
HARRISVILLE	C
HARSTENE	B
HARSTINE	C
HART	D
HART CAMP	C
HARTFORD	A
HARTIG	B
HARTLAND	B
HARTLETON	B
HARTLINE	B
HARTSBURG	B
HARTSELLS	B
HARTSHORN	B
HARVARD	B
HARVEL	B
HARVEY	C
HARWOOD	C
HASKI	B
HASKILL	A
HASKINS	C
HASSELL	C
HASTINGS	B
HAT	D
HATBORO	D
HATCH	C
HATCHERY	C
HATFIELD	C
HATHAWAY	B
HATTIE	C
HATTON	C
HAUBSTADT	C
HAUGAN	B
HAUSER	D
HAVANA	B
HAVEN	B
HAVERLY	B
HAVERSON	B
HAVILLAH	C
HAVINGDON	D
HAVRE	B
HAVRELON	B
HAW	B
HAWES	A
HAWI	B
HAWKEYE	A
HAWKSELL	A
HAWKSPRINGS	B
HAXTUN	A
HAYBOURNE	B
HAYBRO	C
HAYDEN	B
HAYESTON	B
HAYESVILLE	B
HAYFIELD	B
HAYFORD	C
HAYMOND	B
HAYNESS	B
HAYNIE	B
HAYPRESS	A
HAYSPUR	B/D
HAYTER	B
HAYTI	D
HAYWOOD	B
HAZEL	C
HAZELAIR	D
HAZEN	B
HAZLEHURST	C
HAZLETON	B
HAZTON	D
HEADLEY	B
HEADQUARTERS	B
HEAKE	D
HEATH	C
HEATLY	A
HEBBRONVILLE	B
HEBER	B
HEBERT	C
HEBGEN	A
HEBO	D
HEBRON	C
HECHT	C
HECKI	C
HECLA	B
HECTOR	D
HEDDEN	C
HEDRICK	B
HEDVILLE	D
HEGNE	D
HEIDEN	D
HEIDTMAN	C
HEIL	D
HEIMDAL	B
HEISETON	B
HEISLER	B
HEIZER	D
HELDT	C
HELEMANO	C
HELENA	C
HELMER	C
HELVETIA	C
HELY	B
HEMBRE	B
HEMMI	C
HEMPFIELD	
HEMPSTEAD	C
HENCRATT	B
HENDERSON	B
HENDRICKS	B
HENEFER	C
HENKIN	B

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HYDROLOGY MANUAL

S.C.S. SOIL NAMES
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HYDROLOGIC CLASSIFICATIONS

HENLEY	C	HOBOG	D	HORD	B	HYAT	A	IZAGORA	C
HENLINE	C	HOBSON	C	HOREB	B	HYATTVILLE	C	IZEE	C
HENNEKE	D	HOCHHEIM	B	HORNE	D	HYDABURG	D		
HENNEPIN	B	HOCKING	B	HORNELL	D	HYDE	D	JABU	C
HENNINGSEN	C	HOCKINSON	C	HORNING	A	HYDRO	C	JACAGUAS	B
HENRY	D	HOCKLEY	C	HORNITOS	D	HYMAS	D	JACANA	D
HENSEL	B	HODGE	B	HORROCKS	B	HYRUM	B	JACINTO	B
HENSHAW	C	HODGINS	C	HORSESHOE	B	HYSHAM	D	JACK CREEK	A
HENSLEY	D	HODGSON	C	HORTON	B			JACKLIN	B
HEPLER	D	HOEBE	B	HORTONVILLE	B	IAD	C	JACKNIFE	C
HERBERT	B	HOELZLE	C	HOSKIN	C	IBERIA	D	JACKPORT	D
HEREFORD	B	HOFFMAN	C	HOSKINNINI	D	ICENE	C	JACKS	C
HERKIMER	B	HOFFMANVILLE	C	HOSLEY	D	IDA	B	JACKSON	B
HERLONG	D	HOGANSBURG	B	HOSMER	C	IDABEL	B	JACKSONVILLE	C
HERMISTON	B	HOGELAND	B	HOTAW	C	IDAK	B	JACOB	D
HERMON	A	HOGG	C	HOT LAKE	C	IDANA	C	JACOBSEN	D
HERNDON	B	HOGRIS	B	HOUDEK	B	IDEON	D	JACOBY	C
HERD	B	HOH	B	HOUGHTON	A/D	IDMON	B	JACQUES	C
HERRERA	A	HOHMANN	C	HOUK	C	IGNACIO	C	JACQUITH	C
HERRICK	C	HOKO	C	HOULKA	D	IGO	D	JADWIN	B
HERRON	B	HOLBROOK	B	HOULTON	C/D	IGUALDAD	D	JAFFREY	A
HERSH	A	HOLCOMB	D	HOUNDBY	D	IHLEN	D	JAGUEYES	B
HERSHAL	B/D	HOLDAWAY	D	HOURGLASS	B	IJAM	D	JAL	B
HESCH	B	HOLDEN	A	HOUSATONIC	D	ILDEFONSO	B	JALMAR	A
HESPER	C	HOLDER	B	HOUSE MOUNTAIN	D	ILKA	B	JAMES CANYON	B/C
HESPERIA	B	HOLDERMAN	C	HOUSEVILLE	C	ILLION	B/D	JAMESTOWN	C
HESPERUS	B	HOLDERNESS	C	HOUSTON	D	IMA	B	JAME	C
HESSE	C	HOLDREGE	B	HOUSTON BLACK	D	IMBLER	B	JANISE	C
HESSEL	D	HOLLAND	B	HOVDE	A/C	IMLAY	C	JANSEN	A
HESSELBERG	D	HOLLINGER	B	HOVEN	D	IMMOKALEE	B/D	JARAB	D
HESSELTINE	B	HOLLIS	C/D	HOVENWEEP	C	IMPERIAL	D	JARBOE	C
HESSLAN	C	HOLLISTER	D	HOVERT	D	INAVALE	A	JARITA	C
HESSON	C	HOLLOMAN	C	HOVEY	C	INDART	B	JARRE	B
HETTINGER	D	HOLLOWAY	A	HOWARD	B	INDIAHOMA	D	JARVIS	B
HEXT	B	HOLLY	D	HOWELL	C	INDIAN		JASPER	B
HEZEL	B	HOLLY SPRINGS	D	HOWLAND	C	INDIAN CREEK	D	JAUCAS	A
HIALEAH	D	HOLLYWOOD	D	HOYE	B	INDIANO	C	JAVA	B
HIAWATHA	A	HOLMDEL	C	HOYLETON	C	INDIANOLA	A	JAY	C
HIBBARD	D	HOLMES	B	HOYPUS	A	INDIO	B	JAYEM	B
HIBBING	C	HOLOKUA	B	HOYTVILLE	D	INGA	B	JAYSON	D
HIBERNIA	C	HOLOPAW	B/D	HUBBARD	A	INGALLS	B	JEAN	A
HICKORY	C	HOLROYD	B	HUBERLY	D	INGARD	B	JEANERETTE	D
HICKS	B	HOLSINE	B	HUBERT	B	INGENIO	C	JEAN LAKE	B
HIDALGO	B	HOLST	B	HUBLERSBURG	C	INGRAM	D	JEDD	C
HIDEAWAY	D	HOLSTON	B	HUCKLEBERRY	C	INKLER	B	JEDDO	D
HIDEWOOD	C	HOLT	B	HUDSON	C	INKS	D	JEFFERSON	B
HIERRO	C	HOLTLE	B	HUECO	C	INMACHUK	D	JEKLEY	C
HIGHAMS	D	HOLTVILLE	C	HUEL	A	INMAN	C	JELM	D
HIGHFIELD	B	HOLYOKE	C/D	HUENEME	B/C	INMO	A	JENA	B
HIGH GAP	C	HOMA	C	HUERHUERO	D	INNESVALE	D	JENKINS	B
HIGHLAND	B	HOME CAMP	C	HUEY	D	INSKIP	C	JENKINSON	D
HIGHMORE	B	HOMELAKE	B	HUFFINE	A	INVERNESS	D	JENNESS	B
HIGH PARK	B	HOMER	C	HUGGINS	C	INVILLE	B	JENNINGS	C
HIHIMANU	A	HOMESTAKE	D	HUGHES	B	INWOOD	C	JENNY	D
HIIBNER	C	HOMESTEAD	B	HUGHESVILLE	B	IO	B	JERAULD	D
HIKO PEAK	B	HONAUNAU	C	HUGO	B	IOLA	A	JERICHO	C
HIKO SPRINGS	D	HONCUT	B	HUICHICA	C/D	IOLEAU	C	JEROME	C
HILDRETH	D	HONDALE	D	HUIKAU	A	IONA	B	JERRY	C
HILEA	D	HONDO	C	HULETT	B	IONIA	B	JESBEL	D
HILES	B	HONDOHO	B	HULLS	C	IOSCO	B	JESSE CAMP	C
HILGER	B	HONEOYE	B	HULLT	B	IPAVA	B	JESSUP	C
HILGRAVE	B	HONEY	D	HULUA	D	IRA	C	JETT	B
HILLEMANN	C	HONEYGROVE	C	HUM	B	IREDELL	D	JIGGS	C
HILLERY	D	HONEYVILLE	C	HUMACAO	B	IRETEBA	C	JIM	C
HILLET	D	HONN	B	HUMATAS	C	IRIM	C	JIMENEZ	C
HILLFIELD	B	HONOKAA	A	HUMBARGER	B	IROCK	B	JIMTOWN	C
HILLGATE	D	HONOLUA	B	HUMBIRD	C	IRON BLOSSOM	D	JOB	C
HILLIARD	B	HONOMANU	B	HUMBOLDT	D	IRON MOUNTAIN	D	JOBOS	C
HILLON	B	HONOULIULI	D	HUMDUN	B	IRON RIVER	B	JOCITY	B
HILLSBORO	B	HONUAULU	A	HUME	C	IRONTON	C	JOCKO	A
HILLSDALE	B	HOOD	B	HUMESTON	C	IRRIGON	C	JODERO	B
HILMAR	C/D	HOODLE	B	HUMMINGTON	C	IRVINGTON	C	JOEL	B
HILO	A	HOODSPORT	C	HUMPHREYS	B	IRWIN	D	JOES	B
HILT	B	HOODVIEW	B	HUMPTULIPS	B	ISAAC	C	JOHNS	C
HILTON	B	HOOKTON	C	HUNSAKER	B/C	ISAAQUAH	B/C	JOHNSBURG	D
HINCKLEY	A	HOOLEHUA	B	HUNTERS	B	ISAN	D	JOHNSON	B
HINDES	C	HOOPAL	D	HUNTING	C	ISANTI	D	JOHNSTON	B/D
HINESBURG	C	HOOPER	D	HUNTINGTON	B	ISBELL	C	JOHNSWOOD	B
HINKLE	D	HOOPESTON	B	HUNTSVILLE	B	ISHAM	C	JOICE	D
HINMAN	C	HOOSIC	A	HUPP	B	ISHI PISHI	C	JOLAN	C
HINSDALE		HOOT	D	HURDS	B	ISLAND	B	JOLIET	C
HINTZE	D	HOOTEN	D	HURLEY	D	ISOM	B	JONESVILLE	A
HIPPLE	C	HOOVER	B	HURON	C	ISSAQUAH	B/C	JONUS	B
HISLE	D	HOPEKA	D	HURST	D	ISTOKPOGA	D	JOPLIN	B
HITT	B	HOPETON	C	HURWAL	B	ITCA	D	JOPPA	B
HI VISTA	C	HOPEWELL		HUSE	C	ITSWOOT	B	JORDAN	D
HIWASSEE	B	HOPGOOD	C	HUSSA	B/D	IUKA	C	JORGE	B
HIWOOD	A	HOPKINS	B	HUSSMAN	D	IVA	C	JORNADA	C
HIXTON	B	HOPLEY	B	HUTCHINSON	C	IVAN	B	JORY	C
HOBACKER	B	HOPPER	B	HUTSON	B	IVES	B	JOSE	C
HOBAN	C	HOQUIAM	B	HUXLEY	D	IVIE	A	JOSEPHINE	B
HOBBS	B	HORATIO	D	HYAM	D	IVINS	C	JOSIE	B

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HYDROLOGY MANUAL

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JOY	B	KARNAK	D	KEOWNS	D	KIPP	C	KOVICH	D
JUANA DIAZ	B	KARNES	B	KEPLER	C	KIPPEN	A	KOYEN	B
JUBILEE	C	KARRO	B	KERBY	B	KIPSON	C	KOYUKUK	B
JUDD	D	KARS	A	KERMEL	B	KIRK	B/D	KRADE	B
JUDITH	B	KARSHNER	D	KERMIT	A	KIRKHAM	C	KRANZBURG	B
JUDKINS	C	KARTA	C	KERMO	A	KIRKLAND	D	KRATKA	C
JUDSON	B	KARTAR	B	KERR	B	KIRKTON	B	KRAUSE	A
JUDY	C	KASCHMIT	D	KERRICK	B	KIRKVILLE	C	KREAMER	C
JUGET	D	KASHWITNA	B	KERRTOWN		KIRTLEY	C	KREMLIN	B
JUGHANDLE	B	KASILOF	A	KERSHAW	A	KIRVIN	C	KRENTZ	C
JULES	B	KASKI	B	KERSICK	D	KISRING	D	KRESSON	C
JULESBURG	A	KASOTA	C	KERSTON	A/D	KISSICK	D	KRUM	D
JULIAETTA	B	KASSLER	A	KEAT	C	KISTLER	C/D	KRUSE	B
JUMPE	B	KASSON	C	KERWIN	C	KITCHELL	B	KRUZOF	B
JUNCAL	C	KATANA	B	KESSLER	C	KITCHEN CREEK	B	KUBE	B
JUNCOS	D	KATEMCY	C	KESWICK	D	KITSAP	C	KUBLER	C
JUNCTION	B	KATO	C	KETCHLY	B	KITTANNING		KUBLI	C
JUNEAU	B	KATRINE	B	KETTLE	B	KITTITAS	D	KUCERA	B
JUNIATA		KATULA	B	KETTLEMAN	B	KITTREDGE	C	KUCK	C
JUNIPERO	B	KATY	C	KETTNER	C	KITTSON	C	KUGRUG	D
JUNIUS	C	KAUFMAN	D	KEVIN	C	KIUP	B	KUHL	D
JUNO	B	KAUPO	A	KEWAUNEE	C	KIVA	B	KUKAIAU	A
JUNQUITOS	C	KAVETT	D	KEWEENAW	A	KIWANIS	A	KULA	B
JURA	C	KAWAIHAE	C	KEYA	B	KIZHUYAK	B	KULAKALA	B/C
JUVA	B	KAWAIHAPAI	B	KEYES	D	KJAR	D	KULLIT	B
JUVAN	D	KAWBAWGAM	C	KEYNER	D	KLABER	C	KUMA	B
		KAWICH	A	KEYPORT	C	KLAMATH	B/D	KUNIA	B
KAALUALU	A	KAWKAWLIN	C	KEYSTONE	A	KLAUS	A	KUNUWEIA	C
KACHEMAK	B	KEAAU	D	KEYTESVILLE	D	KLAWASI	D	KUPREANOF	B
KADAKE	D	KEAHUA	B	KEZAR	B	KLEJ	B	KUREB	A
KADASHAN	B	KEALAKEKUA	C	KIAWAH	C	KLICKER	C	KURO	D
KADE	C	KEALIA	D	KIBBIE	B	KLICKITAT	C	KUSKOKWIM	D
KADIN	B	KEANSBURG	D	KICKERVILLE	B	KLINE	B	KUSLINA	D
KADOKA	B	KEARNS	B	KIDD	D	KLINESVILLE	C/D	KUTCH	D
KAENA	D	KEATING	C	KIDMAN	B	KLINGER	B	KUTZTOWN	B
KAHALUU	D	KEAUKAHA	D	KIEHL	A	KLONDIKE	D	KVICHAK	B
KAHANA	B	KEAWAKAPU	B	KIETZKE	D	KLONE	B	KWETHLUK	A
KAHANUI	B	KEBLER	B	KIEV	B	KLOOCHMAN	C	KYLE	D
KAHLER	B	KECH	D	KIKONI	B	KLOTEN	B	KYLER	D
KAHOLA	B	KECKO	B	KILARC	D	KLUTINA	B		
KAH SHEETS	D	KEDRON	C	KILAUEA	B	KNAPPA	B	LA BARGE	B
KAHUA	D	KEEFERS	C	KILBOURNE	A	KNEELAND	C	LABETTE	C
KAIKLI	D	KEEGAN		KILBURN	B	KNIFFIN	C	LABISH	D
KAILUA	A	KEEI	D	KILCHIS	D	KNIGHT	C	LABOU	D
KAIMU	A	KEEKEE	B	KILOOR	C	KNIK	B	LABOUNTY	C
KAINALIU	A	KEELDAR	B	KILGORE	B/D	KNIPPA	D	LA BOUNTY	C
KAIPOIOI	B	KEENE	C	KILKENNY	B	KNOB HILL	B	LA BRIER	C
KAIWIKI	A	KEENO	C	KILLBUCK	C/D	KNOWLES	B	LABSHAFT	D
KALAE	B	KEESE	D	KILLEY	D	KNOX	B	LACAMAS	C/D
KALALOCH	B	KEG	B	KILLINGWORTH		KNULL	C	LA CASA	C
KALAMA	C	KEHENA	C	KILLPACK	C	KNUTSEN	B	LACITA	B
KALAMAZOO	B	KEIGLEY	C	KILMERQUE	C	KOBAR	C	LACKAWANNA	C
KALAPA	B	KEISER	B	KILN	D	KOBEH	B	LACONA	C
KALAUPAPA	D	KEITH	B	KILOA	A	KOCH	C	LACOTA	D
KALIFONSKY	D	KEKAHA	B	KILOHANA	A	KODAK	C	LACY	D
KALIHI	D	KEKAKE	D	KILWINNING	C	KODIAK	B	LADD	B
KALISPELL	A	KELLER	C	KIM	B	KOEHLER	C	LADDER	D
KALKASKA	A	KELLY	D	KIMAMA	B	KOELE	B	LADELLE	B
KALMIA	B	KELN	C	KIMBALL	C	KOEPKE	B	LADOGA	C
KALOKO	D	KELSEY	D	KIMBERLY	B	KOERLING	B	LADUE	B
KALOLOCH	B	KELSO	C	KIMBROUGH	D	KOGISH	D	LADYSMITH	D
KALSIN	D	KELTNER	B	KIMMERLING	D	KOHALA	A	LA FARGE	B
KAMACK	B	KELVIN	C	KIMMONS	C	KOKEE	B	LAFE	D
KAMAKOA	A	KEMMERER	C	KIMO	C	KOKERNOT	C	LAFITTE	D
KAMAOA	B	KEMOO	B	KINA	D	KOKO	B	LA FONDA	B
KAMAOLE	B	KEMPSVILLE	B	KINCO	A	KOKOKAHI	D	LAFONT	B
KAMAY	D	KEMPTON	B	KINESAVA	C	KOKOMO	B/D	LAGLORIA	B
KAMIE	B	KENAI	C	KINGFISHER	B	KOLBERG	B	LAGONDA	C
KAMRAR	B	KENANSVILLE	A	KINGHURST	B	KOLEKOLE	C	LA GRANDE	C
KANABEC	B	KENDAIA	C	KINGMAN	D	KOLLS	D	LAGRANGE	D
KANAKA	B	KENDALL	B	KINGS	C/D	KOLLUTUK	D	LAHAINA	B
KANAPAHA	A/D	KENDALLVILLE	B	KINGSBURY	D	KOLOA	C	LA HOGUE	B
KANDIK	B	KENESAW	B	KINGSLEY	B	KOLOB	C	LAHONTAN	D
KANE	B	KENMOOR	B	KINGS RIVER	C	KOLOKOLO	B	LAHRITY	A
KANEOHE	B	KENNALLY	B	KINGSTON	B	KONA	D	LAIDIG	C
KANEPUU	B	KENNAN	B	KINGSVILLE	C	KONAHA	B	LAIDLAW	B
KANIMA	C	KENNEBEC	B	KINKEAD	C	KONNER	D	LAIL	C
KANLEE	B	KENNEDY	B/C	KINKEL	B	KONGKTI	C	LAIRDSVILLE	D
KANOSH	C	KENNER	D	KINKORA	D	KOOLAU	C	LAIREP	D
KANZA	D	KENNEWICK	B	KINMAN	C	KOOSKIA	C	LAJARA	D
KAPAA	A	KENNEY	A	KINNEAR	B	KOOTENAI	A	LAKE	A
KAPAPALA	B	KENNEY LAKE	C	KINNEY	B	KOPIAH	D	LAKE CHARLES	D
KAPOO	B	KENO	D	KINNICK	C	KOPP	B	LAKE CREEK	C
KAPOWSIN	C	KENOMA	D	KINREAD	D	KOPPES	B	LAKEHELEN	B
KAPUHIKANI	D	KENSAL	B	KINROSS	D	KORCHEA	B	LAKEHURST	A
KARAMIN	B	KENSPUR	A	KINSTON	D	KORNMAN	B	LAKE JANEE	B
KARDE	B	KENT	D	KINTA	D	KOSMOS	D	LAKELAND	A
KARHEEN	D	KENYON	C	KINTON	C	KOSSE	D	LAKEMONT	D
KARLAN	C	KEO	B	KINZEL	B	KUSTER	C	LAKEPORT	B
KARLIN	A	KEOLDAR	B	KIOMATIA	A	KOSZTA	B	LAKESHORE	D
KARLO	D	KEOMAH	C	KIONA	B	KOTEDO	D	LAKESOL	B
KARLUK	D	KEOTA	C	KIPLING	D	KOUTS	B	LAKETON	B

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LAKEVIEW	C	LATAH	C	LENAWEE	B/D	LINVILLE	B	LORADALE	C
LAKEWIN	B	LATAHCO	C	LENNEP	D	LINWOOD	A/D	LORAIN	C/D
LAKEWOOD	A	LATANG	B	LENOIR	D	LIPAN	D	LORDSTOWN	C
LAKI	B	LATANIER	D	LENOX	B	LIPPINCOTT	B/D	LOREAUVILLE	C
LAKIN	A	LATENE	B	LENZ	B	LIRIOS	B	LORELLA	D
LAKOMA	D	LATHAM	D	LEO	B	LIRRET	D	LORENZO	A
LALAAU	A	LATHROP	C	LEON	A/D	LISADE	B	LORETTO	B
LA LANDE	B	LATINA	D	LEONARD	C	LISAM	D	LORING	C
LALLIE	D	LATOM	D	LEONARDO	B	LISBON	B	LOS ALAMOS	B
LAM	B/D	LATONIA	B	LEONARDTOWN	D	LISMAS	D	LOS BANOS	C
LAMAR	B	LATTY	D	LEONIDAS	B	LISMORE	B	LOSEE	B
LAMARTINE	B	LAUDERDALE	B	LEOTA	C	LITCHFIELD	A	LOS GATOS	B/C
LAMBERT	B	LAUGENOUR	B/D	LEPLEY	D	LITHGOW	C	LOS GUINEOS	C
LAMBETH	C	LAUGHLIN	B	LERDAL	C	LITHIA	C	LOSHMAN	D
LAMBORN	D	LAUMAIA	B	LEROY	B	LITIMBER	C	LOS OSOS	C
LAMINGTON	D	LAUREL	C	LESAGE	B	LITLE	C	LOS ROBLES	B
LAMO	B	LAURELHURST	C	LESHARA	B	LITTLEBEAR	A	LOS TANOS	B
LAMONI	D	LAURELWOOD	B	LESHO	C	LITTLEFIELD	D	LOST CREEK	B
LAMONT	A	LAUREN	B	LESLIE	D	LITTLE HORN	C	LOST HILLS	C
LAMONTA	D	LAVALLEE	B	LESTER	B	LITTLE POLE	D	LOS TRANCOS	D
LAMOURE	C	LAVATE	B	LE SUEUR	B	LITTLETON	B	LOSTWELLS	B
LAMPHIER	B	LAVEEN	B	LETA	C	LITTLE WOOD	B	LOTHAIR	C
LAMPSHIRE	D	LAVELDO	D	LETCHER	D	LITZ	C	LOTUS	B
LAMSON	D	LAVERKIN	C	LETHA	D	LIV	C	LOUDON	C
LANARK	B	LA VERKIN	C	LETHENT	C	LIVERMORE	A	LOUDONVILLE	C
LANCASTER	B	LAVINA	C	LETORT	B	LIVIA	D	LOUIE	C
LANCE	C	LAWAI	B	LETTERBOX	B	LIVINGSTON	D	LOUISA	B
LAND	D	LAWET	C	LEVAN	A	LIVONA	A	LOUISBURG	B
LANDES	B	LAWLER	B	LEVASY	C	LIZE	C	LOUP	D
LANDISBURG	C	LAWRENCE	C	LEVERETT	C	LIZZANT	B	LOURDES	C
LANDLOW	C	LAWRENCEVILLE	C	LEVIATHAN	B	LLANOS	C	LOUVIERS	D
LANDUSKY	D	LAWSHE	C	LEVIS	C	LOBDELL	C	LOVEJOY	C
LANE	C	LAWSON	B	LEWIS	D	LOBELVILLE	C	LOVELAND	C
LANEY	C	LAWTHER	D	LEWISBERRY	B	LOBERG	B	LOVELL	C
LANG	B/D	LAWTON	C	LEWISBURG	C	LOBERT	B	LOVELOCK	C/D
LANGFORD	C	LAX	C	LEWISTON	C	LOBITOS	C	LOWELL	C
LANGHEI	B	LAXAL	B	LEWISVILLE	C	LOCANE	D	LOWRY	B
LANGLEY	C	LAYCOCK	B	LEX	B	LOCEY	C	LOWVILLE	B
LANGLOIS	D	LAYTON	A	LEXINGTON	B	LOCHSA	B	LOYAL	B
LANGOLA	B	LAZEAR	D	LHAZ	B	LOCKE	B	LOYALTON	D
LANGRELL	B	LEA	C	LIBBINGS	D	LOCKERBY	C	LOYSVILLE	D
LANGSTON	C	LEADER	B	LIBBY	B	LOCKHARD	B	LOZANO	B
LANIER	B	LEADPOINT	B	LIBEG	A	LOCKHART	B	LOZIER	D
LANIGER	B	LEADVALE	C	LIBERAL	D	LOCKPORT	D	LUALUALEI	D
LANKBUSH	B	LEADVILLE	B	LIBERTY	C	LOCKWOOD	B	LUBBOCK	C
LANKIN	C	LEAF	D	LIBORY	A	LOCUST	C	LUBRECHT	C
LANKTREE	C	LEAHY	C	LIBRARY	D	LODAR	D	LUCAS	C
LANOAK	B	LEAL	B	LIBUTTE	D	LODEMA	A	LUCE	C
LANSDALE	B	LEAPS	C	LICK	B	LODI	C	LUCEDALE	B
LANSDOWNE	C	LEATHAM	C	LICK CREEK	D	LODO	D	LUCERNE	B
LANSING	B	LEAVENWORTH	B	LICKDALE	D	LOFFTUS	C	LUCIEN	C
LANTIS	B	LEAVITT	B	LICKING	C	LOFTON	D	LUCILE	D
LANTON	D	LEAVITTVILLE	B	LICKSKILLET	D	LOGAN	D	LUCILETON	B
LANTONIA	B	LEBANON	C	LIDDELL	D	LOGDELL	D	LUCKENBACH	C
LANTZ	D	LEBAK	B	LIEBERMAN	C	LOGGERT	A	LUCKY	B
LAP	D	LE BAR	B	LIEN	D	LOGHOUSE	B	LUCKY STAR	B
LA PALMA	C	LEBEC	B	LIGGET	B	LOGY	B	LUCY	A
LAPEER	B	LEBO	C	LIGHTNING	D	LOHLER	C	LUDDEN	D
LAPINE	A	LEBSACK	C	LIGNUM	C	LOHMILLER	C	LUDLOW	C
LAPLATTA	C	LECK KILL	B	LIGON	D	LOHNES	A	LUEDERS	C
LAPON	D	LEDBEDER	B	LIHEN	A	LOIRE	B	LUFKIN	D
LAPORTE	C	LEDGEFORK	A	LIHUE	B	LOLAK	D	LUHON	B
LA POSTA	A	LEDGER	D	LIKES	A	LOLALITA	B	LUJANE	C
LA PRAIRIE	B	LEDRU	D	LILAH	A	LOLEKAA	B	LUKIN	C
LARABEE	B	LEDY		LILLIWAUP	A	LOLETA	C/D	LULA	B
LARAND	B	LEE	D	LIMA	B	LOLO	A	LULING	D
LARCHMOUNT	B	LEEDS	C	LIMANI	B	LOLON	A	LUMBEE	D
LARDELL	C	LEEFIELD	C	LIMBER	B	LOMA	C	LUMMI	B/C
LAREDO	B	LEELANAU	A	LIMERICK	C	LOMALTA	D	LUN	C
LARES	C	LEEPER	D	LIMON	C	LOMAX	B	LUNA	C
LARGENT	D	LEESVILLE	B/C	LIMONES	B	LOMIRA	B	LUNCH	C
LARGO	B	LEETON	C	LIMPIA	C	LOMITAS	D	LUNDIMO	C
LARIM	A	LEETONIA	C	LINCO	B	LONDO	C	LUNDY	D
LARIMER	B	LEFOR	B	LINCOLN	A	LONE	C	LUNT	C
LARKIN	B	LEGLER	B	LINCROFT	A	LONEPINE	C	LUPPINO	C
LARKSON	C	LEGORE	B	LINDLEY	C	LONERIDGE	B	LUPTON	D
LA ROSE	B	LEHEW	C	LINDSEY	D	LONE ROCK	A	LURA	D
LARRY	D	LEHIGH	C	LINDSIDE	C	LONETREE	A	LURAY	C/D
LARSON	D	LEHMANS	D	LINDSTROM	B	LONGFORD	C	LUTE	D
LARUE	A	LEHR	B	LINDY	C	LONGLOIS	B	LUTH	C
LARVIE	D	LEICESTER	C	LINEVILLE	C	LONGMARE	D	LUTHER	B
LAS	C	LEILEHUA	B	LINGANORE	B	LONGMONT	C	LUTIE	B
LAS ANIMAS	C	LELA	D	LINKER	B	LONGRIE	C	LUTON	D
LASAUSES	C	LELAND	D	LINKVILLE	B	LONGVAL	B	LUVERNE	C
LAS FLORES	D	LEMETA	D	LINNE	C	LONG VALLEY	B	LUXOR	D
LASHLEY		LEMING	C	LINNET	D	LONGVIEW	C	LUZENA	D
LASIL	D	LEMM	B	LINNEUS	B	LONOKE	B	LYCAN	B
LAS LUCAS	C	LEMONEX	D	LINO	C	LONTI	C	LYCOMING	C
LAS POSAS	C	LEMPSTER	C/D	LINOYER	B	LOOKOUT	C	LYDA	D
LASSEN	D	LEN	C	LINSLAW	D	LOON	B	LYDICK	B
LASTANCE	B	LENA	A	LINT	B	LOPER	B	LYFORD	C
LAS VEGAS	D	LENAPAH	D	LINTON	B	LOPEZ	D	LYLES	B

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LYMAN	C/D	MALIN	C/D	MARLETTE	B	MAY DAY	D	MCPHERSON	C
LYMANSON	C	MALJAMAR	B	MARLEY	C	MAYER	D	MCPHIE	B
LYNCH	D	MALLOT	A	MARLIN	D	MAYES	D	MCQUARRIE	D
LYNCHBURG	B/D	MALM	C	MARLOW	C	MAYFIELD	B	MCQUEEN	C
LYNDEN	A	MALO	B	MARLTON	C	MAYFLOWER	C	MCRAE	B
LYNNDYL	A	MALONE	B	MARMARTH	B	MAYHEW	D	MCTAGGART	B
LYNN HAVEN	B/D	MALOTERRE	D	MARNA	D	MAYLAND	C	MCVICKERS	C
LYNNVILLE	C	MALPAIS	C	MARPA	B	MAYMEN	D	MEAD	D
LYNX	B	MALPOSA	C	MARPLEEN	D	MAYNARD LAKE	B	MEADIN	A
LYONMAN	C	MALVERN	C	MARQUETTE	A	MAYO	B	MEADOWVILLE	B
LYONS	D	MAMALA	D	MARR	B	MAYODAN	B	MEADVILLE	C
LYONSVILLE	B	MAMOU	C	MARRIOTT	B	MAYOWORTH	C	MEANDER	D
LYSINE	D	MANAHAA	C	MARSDEN	C	MAYSDORF	B	MECAN	B
LYSTAIR	B	MANALAPAN		MARSELL	B	MAYSVILLE		MECCA	B
LYTELL	B	MANANA	C	MARSHALL	B	MAYTOWN	C	MECKESVILLE	C
		MANASSA	C	MARSHAN	D	MAYVILLE	B	MECKLENBURG	C
MABANK	D	MANASSAS	B	MARSHDALE	C	MAYWOOD	B	MEDA	B
MABEN	C	MANASTASH	C	MARSHFIELD	C	MAZEPPA	B	MEDANO	C
MABI	D	MANATEE	B/D	MARSING	B	MAZON	C	MEDARY	C
MABRAY	D	MANAWA	C	MART	C	MAZUMA	C	MEDFORD	B
MACAR	B	MANCELONA	A	MARTELLA	B	MCAFEE	C	MEDFRA	U
MACEDONIA	C	MANCHESTER	A	MARTIN	C	MCALLEN	B	MEDICINE LODGE	B
MACFARLANE	B	MANDAN	B	MARTINA	A	MCALLISTER	C	MEDINA	B
MACHETE	C	MANDERFIELD	B	MARTINECK	D	MCALPIN	C	MEDLEY	B
MACHIAS	B	MANDEVILLE	B	MARTINEZ	D	MCBEE	B	MEDWAY	B
MACHUELO	D	MANFRED	D	MARTINI	B	MCBETH	D	MEEKS	A
MACK	C	MANGUM	D	MARTINSBURG	B	MCBRIDE	B	MEETEETSE	D
MACKEN	D	MANHATTAN	A	MARTINSDALE	B	MCCABE	B	MEGGETT	D
MACKINAC	B	MANHEIM	C	MARTINSON	D	MCCAFFERY	A	MEGON	C
MACKSBURG	B	MANI	C	MARTINSVILLE	B	MCCAIN	C	MEHL	C
MACOMB	B	MANILA	C	MARTINTON	C	MCCALEB	B	MEHLHORN	C
MACOMBER	B	MANISTEE	B	MARTY	B	MCCALLY	D	MEIGS	
MACON	B	MANITOU	C	MARVAN	D	MCCAMMON	D	MEIKLE	D
MACY	B	MANLEY	B	MARVELL	B	MCCANN	C	MEISS	D
MADALIN	D	MANLIUS	C	MARVIN	C	MCCARRAN	D	MELBOURNE	B
MADAWASKA	B	MANLOVE	B	MARY	C	MCCARTHY	B	MELBY	C
MADDOCK	A	MANNING	B	MARYDEL	B	MCCLAVE	C	MELITA	B
MADDOX		MANOGUE	D	MARYSLAND	D	MCCLEARY	C	MELLENTHIN	D
MADELIA	C	MANOR	B	MASADA	C	MCCLELLAN	B	MELLOR	D
MADELINE	D	MANSFIELD	D	MASCAMP	D	MCCLOUD	C	MELLOTT	B
MADERA	D	MANSIC	B	MASCHETAH	B	MCCOIN	D	MELOLAND	C
MADISON	B	MANSKER	B	MASCOTTE	D	MCCOLL	D	MELROSE	C
MADONNA	C	MANTACHIE	C	MASHEL	C	MCCONNEL	B	MELSTONE	A
MADRAS	C	MANTEO	C/D	MASHULAVILLE	B/D	MCCOOK	B	MELTON	B
MADRID	B	MANTER	B	MASON	B	MCCORMICK	C	MELVILLE	B
MADRONE	C	MANTON	B	MASONVILLE	C	MCCOY	C	MELVIN	D
MADUREZ	B	MANTZ	B	MASSACK	B	MCCREE	B	MEMALOOSE	D
MAFURT	B	MANU	C	MASSENA	C	MCCRORY	D	MEMPHIS	B
MAGALLON	B	MANVEL	C	MASSILLON	B	MCCROSKIE	D	MENAHGA	A
MAGENS	B	MANWOOD	D	MASTERSON	B	MCCULLOUGH	C	MENAN	C
MAGGIE	D	MANZANITA	C	MATAGORDA	D	MCCULLY	C	MENARD	B
MAGINNIS	C	MANZANO	C	MATAMOROS	C	MCCUNE	D	MENCH	C
MAGNA	D	MANZANOLA	C	MATANUSKA	C	MCCUTCHEN	C	MENDEBOURE	C
MAGNOLIA	B	MAPES	C	MATANZAS	B	MCDOLE	B	MENDOCINO	B
MAGNUS	C	MAPLE MOUNTAIN	B	MATAPEAKE	B	MCDONALD	B	MENDON	B
MAGOTSU	D	MAPLETON	C/D	MATAWAN	C	MCDONALDSVILLE	C	MENDOTA	B
MAGUAYO	D	MARAGUEZ	B	MATCHER	A	MCEWEN	B	MENEFEE	D
MAHAFFEY	C/D	MARATHON	B	MATFIELD	C	MCFADDEN	B	MENFRO	B
MAHAFFY	C/D	MARBLE	A	MATHERS	B	MCFAIN	C	MENLO	D
MAHALA	C	MARBLEMOUNT	B	MATHERTON	B	MCFAUL	C	MENO	C
MAHALASVILLE	B/D	MARCELINAS	D	MATHESON	B	MCGAFFEY	B	MENOKEN	C
MAHANA	B	MARCETTA	A	MATHEWS		MCGARR	C	MENOMINES	B
MAHASKA	B	MARCIAL	D	MATHIS	A	MCGARY	C	MENTO	C
MAHER	C	MARCUM	B	MATHISTON	C	MCGEHEE	C	MENTOR	B
MAHONING	D	MARCUS	C	MATLOCK	D	MCGILVERY	D	MEQUON	C
MAHUKONA	B	MARCUSE	D	MATMON	D	MCGINTY	B	MERCED	C/D
MAIDEN	B	MARCY	D	MATTAPEX	C	MCGIRK	C	MERCEDES	D
MAILE	A	MARDEN	C	MATTOLE	C	MCGOWAN	B	MERCER	C
MAINSTAY	D	MARDIN	C	MAU	D	MCGRATH	B	MERCEY	C
MAJADA	B	MARENGO	C/D	MAUDE	B	MCGREW	A	MEREDITH	B
MAKAALAE	B	MARESUA	B	MAUGHAN	C	MCHENRY	B	MERETA	C
MAKALAPA	D	MARGERUM	B	MAUKEY	C	MCILWAINE	A	MERGEL	B
MAKAPILI	A	MARGUERITE	B	MAUMEE	A/D	MCINTOSH	B	MERIDIAN	B
MAKAWAO	B	MARIA	B/C	MAUNABO	D	MCINTYRE	B	MERINO	D
MAKAWELI	B	MARIANA	C	MAUPIN	C	MCKAMIE	D	MERKEL	B
MAKENA	B	MARIAS	D	MAUREPAS	D	MCKAY	D	MERLIN	D
MAKIKI	B	MARICAO	B	MAURICE	A	MCKENNA	C/D	MERMILL	B/D
MAKLAK	A	MARICOPA	B	MAURINE	D	MCKENZIE	D	MERNA	D
MAKOTI	C	MARIETTA	C	MAURY	B	MCKINLEY	B	MEROS	A
MAL	B	MARILLA	C	MAVERICK	C	MCKINNEY	D	MERRIFIELD	B
MALA	B	MARINA	A	MAVIE	D	MCLAIN	C	MERRILL	C
MALABAR	A/D	MARION	D	MAWAE	A	MCLAURIN	B	MERRILLAN	C
MALABON	C	MARIPOSA	C	MAX	B	MCLEAN	C	MERRIMAC	A
MALACHY	B	MARISSA	C	MAXEY	C	MCLEOD	B	MERRITT	B/C
MALAGA	B	MARKES	D	MAXFIELD	C	MCMAHON	C	MER ROUGE	B
MALAMA	A	MARKEY	D	MAXSON	A	MCMEEN	C	MERTON	B
MALAYA	D	MARKHAM	C	MAXTON	B	MCMULLIN	D	MERTZ	B
MALBIS	B	MARKLAND	C	MAXVILLE	A	MCMURDIE	C	MESA	B
MALCOLM	B	MARKSBORO	C	MAXWELL	D	MCMURPHY	B	MESCAL	B
MALETTI	C	MARLA	A	MAY	B	MCMURRAY	D	MESCALERO	C
MALEZA	B	MARLBORO	B	MAYBERRY	C	MCNARY	D	MESITA	C
MALIBU	D	MARLEAN	B	MAYBESO	D	MCPAUL	B	MESKILL	C

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES
FOR
HYDROLOGIC CLASSIFICATIONS

MESMAN	C	MINORA	C	MONTOYA	D	MURDOCK	C	NAVARRO	B
MESPUN	A	MINTO	C	MONTPELLIER	C	MUREN	B	NAVESINK	
MESSER	C	MINU	D	MONTROSE	B	MURRILL	B	NAYLOR	
MET	D	MINVALE	B	MONTVALE	D	MURVILLE	D	NAYPED	C
METALINE	B	MIRA	D	MONTVERDE	A/D	MUSCATINE	B	NAZ	B
METAMORA	B	MIRABAL	C	MONTWEL	C	MUSE	C	N-BAR	B
METEA	B	MIRACLE	B	MONUE	B	MUSELLA	B	NEAPOLIS	B/D
METHOW	B	MIRAMAR	B	MOODY	B	MUSICK	B	NEBEKER	C
METIGOSHE	A	MIRANDA	D	MOOHOO	B	MUSINIA	B	NEBGEN	D
METOLIUS	B	MIRES	B	MOOSE RIVER	D	MUSKINGUM	C	NEBISH	B
METRE	D	MIRROR	B	MORA	B	MUSKOGEE	C	NEBO	
METZ	A	MIRROR LAKE	A	MORADO	C	MUSQUIZ	C	NECHE	C
MEXICO	D	MISSION	B	MORALES	D	MUSSEL	B	NEDERLAND	B
MHOON	D	MITCH	B	MORD	C	MUSSELSHELL	B	NEEDHAM	D
MIAMI	B	MITCHELL	B	MOREAU	D	MUSSEY	D	NEEDLE PEAK	C
MIAMIAN	C	MITIWANGA	C	MOREHEAD	C	MUSTANG	A/D	NEEDMORE	C
MICCO	A/D	MITRE	C	MOREHOUSE	C	MUTNALA	B	NEELEY	B
MICHELSON	B	MIZEL	D	MORELAND	D	MUTUAL	B	NEESOPAH	C
MICHIGAMME	C	MIZPAH	C	MORELANDTON	A	MYAKKA	A/D	NEGITA	B
MICK	B	MOANO	D	MORET	D	MYATT	B/D	NEGLEY	B
MIDAS	D	MOAPA	D	MOREY	D	MYERS	D	NEHALEM	B
MIDDLE	C	MOAULA	A	MORFITT	B	MYERSVILLE	B	NEHAR	B
MIDDLEBURY	B	MOBEETIE	B	MORGANFIELD	B	MYLREA	B	NEILTON	A
MIDESSA	B	MOCA	D	MORGNEC		MYRICK	D	NEISSON	B
MIDLAND	D	MOCHO	B	MORIARTY	D	MYRTLE	B	NEKIA	C
MIDNIGHT	D	MODA	D	MORICAL	C	MYSTEN	A	NELLIS	B
MIDVALE	C	MODALE	C	MORLEY	C	MYSTIC	D	NELMAN	B
MIDWAY	D	MODEL	C	MORMON MESA	D	MYTON	B	NELSCOTT	B
MIFFLIN	B	MODENA	B	MOROCCO	A/C			NELSON	B
MIFFLINBURG	B	MODESTO	C	MORONI	D	NAALEHU	B	NEMAH	C
MIGUEL	D	MODOC	C	MOROP	C	NABESNA	D	NEMOTE	A
MIKE	D	MOENKOPIE	D	MORRILL	B	NACEVILLE	C	NENANA	B
MIKESELL	C	MOEPITZ	B	MORRIS	C	NACHES	B	NENNO	B
MILACA	B	MOFFAT	B	MORRISON	B	NACIMIENTO	C	NEOLA	D
MILAN	B	MOGOLLON	B	MORROW	C	NACOGDOCHES	B	NEOTOMA	B
MILES	B	MOGUL	B	MORSE	D	NADEAN	B	NEPALTO	A
MILFORD	C	MOHALL	B	MORTENSON	C	NADINA	D	NEPESTA	C
MILHAM	C	MOHAVE	B	MORTON	B	NAFF	B	NEPHI	B
MILHEIM	C	MOHAWK	B	MORVAL	B	NAGEESI	B	NEPPEL	B
MILL	B	MOIRA	C	MOSBY	C	NAGITSY	C	NEPTUNE	A
MILLARD	B	MOKELUMNE	D	MOSCA	A	NAGLE	B	NERESON	B
MILLBORO	D	MOKENA	C	MOSCOW	C	NAGOS	D	NESDA	A
MILLBROOK	B	MOKIAK	B	MOSEL	C	NAHATCHE	C	NESHAMINY	B
MILLBURNE	B	MOKULEIA	B	MOSHANNON	B	NAHMA	C	NESIKA	B
MILLCREEK	B	MOLAND	B	MOSHER	D	NAHUNTA	C	NESKAHI	B
MILLER	D	MOLCAL	B	MOSHERVILLE	C	NAIWA	B	NESKOWIN	C
MILLERLUX	D	MOLENA	A	MOSIDA	B	NAKAI	B	NESPELEM	B
MILLERTON	D	MOLINOS	B	MOSQUET	D	NAKNEK	D	NESS	D
MILLETT	B	MOLLVILLE	D	MOSSYROCK	B	NALDO	B	NESSEL	B
MILLGROVE	B/D	MOLLY	B	MOTA	B	NAMBE	B	NESSOPAH	B
MILL HOLLOW	B	MOLOKAI	B	MOTLEY	B	NAMON	C	NESTER	C
MILLICH	D	MOLSON	B	MOTOQUA	D	NANAMKIN	A	NESTUCCA	C
MILLIKEN	C	MOLYNEUX	B	MOTTSVILLE	A	NANCY	B	NETARTS	A
MILLINGTON	B	MONAD	A	MOULTON	B/D	NANNY	B	NETCONG	B
MILLIS	C	MONAHAN	D	MOUND	C	NANNYTON	B	NETO	B
MILLRACE	B	MONAHANS	B	MOUNTAINBURG	D	NANSENE	B	NETTLETON	C
MILLSAP	C	MONARDA	D	MOUNTAINVIEW	B/D	NANTUCKET	C	NEUBERT	B
MILLSDALE	B/D	MONCLOVA	B	MOUNTAINVILLE	B	NANUM	C	NEUNS	B
MILLSHOLM	C	MONDAMIN	C	MOUNT AIRY	A	NAPA	D	NEUSKE	B
MILLVILLE	B	MONDOVI	B	MOUNT CARROLL	B	NAPAISHAK	D	NEVADOR	C
MILLWOOD	D	MONEE	D	MOUNT HOME	B	NAPAVINE	B	NEVILLE	B
MILNER	C	MONICO	B	MOUNT HOOD	B	NAPIER	B	NEVIN	C
MILPITAS	C	MONIDA	B	MOUNT LUCAS	C	NAPLENE	B	NEVINE	B
MILROY	D	MONITEAU	D	MOUNT OLIVE	D	NAPLES	B	NEVKA	C
MILTON	C	MONMOUTH	C	MOUNTVIEW	B	NAPPANEE	D	NEVOYER	D
MIMBRES	C	MONO	D	MOVILLE	C	NAPTOWNE	B	NEVTAH	C
MIMOSA	C	MONOLITH	C	MOWATA	D	NARANJITO	C	NEVU	D
MINA	C	MONONA	B	MOWER	C	NARANJO	C	NEWARK	C
MINAM	B	MONONGAHELA	C	MOYERSON	D	NARCISSE	B	NEWART	B
MINATARE	D	MONROE	B	MOYINA	D	NARD	B	NEWAYGO	B
MINCHEY	B	MONROEVILLE	C/D	MUCARA	D	NARLON	C	NEWBERG	B
MINCO	B	MONSE	B	MUCET	C	NARON	B	NEWBERRY	C
MINDALE	B	MONSERATE	C	MUDRAY	D	NARRAGANSETT	B	NEWBY	B
MINDEGO	B	MONTAGUE	D	MUD SPRINGS	C	NARROWS	D	NEW CAMBRIA	C
MINDEMAN	B	MONTALTO	C	MUGHOUSE	C	NASER	B	NEWCASTLE	B
MINDEN	C	MONTARA	C	MUIR	B	NASH	B	NEWCOMB	A
MINE	B	MONTAUK	C	MUIRKIRK	B	NASHUA	A	NEWDALE	B
MINEOLA		MONTCALM	A	MUKILTEO	D	NASHVILLE	B	NEWELL	B
MINER	D	MONTE	B	MULDROW	D	NASON	C	NEWELLTON	D
MINERAL	A	MONTE CRISTO	D	MULKEY	C	NASSAU	C/D	NEWFANE	
MINERAL MOUNTAIN	C	MONTEGRANDE	D	MULLINS	D	NASSET	B	NEWFORK	D
MINERVA	B	MONTELL	D	MULLINVILLE	B	NATALIE	C	NEWKIRK	D
MINO	B	MONTELLO	C	MULT	C	NATCHEZ	B	NEWLANDS	B
MINGO	B	MONTEOLA	D	MULTORPOR	A	NATHROP	B	NEWLIN	B
MINIDOKA	C	MONTEROSA	D	MUMFORD	B	NATIONAL	B	NEWMARKET	B
MINNEISKA	C	MONTEVALLO	D	MUNDELEIN	B	NATRONA	B	NEWPORT	C
MINNEOSA	B	MONTGOMERY	D	MUNDOS	B	NATROY	D	NEWRUSS	B
MINNEQUA	B	MONTICELLO	B	MUNISING	B	NATURITA	B	NEWRY	B
MINNETONKA	D	MONTIETH	A	MUNK	C	NAUKATI	D	NEWSKAH	B
MINNEWAUKAN	B	MONTMORENCI	B	MUNSON	D	NAUMBURG	C	NEWSTEAD	D
MINNIECE	D	MONTOSO	B	MUNUSCONG	D	NAVAJO	D	NEWTON	A/D
MINUA	C	MONTOUR	D	MURDO	B	NAVAN	D	NEWTONIA	B

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HYDROLOGY MANUAL

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NEWTOWN	C	NORTON	C	OKAW	D	ORELLA	D	PACK	C
NEWVILLE	C	NORTONVILLE	C	OKAY	B	OREM	A	PACKARD	B
NEZ PERCE	C	NORTUNE	D	OKEECHOBEE	A/D	ORESTIMBA	C	PACKER	C
NIAGARA	C	NORWALK	B	OKEELANTA	A/D	ORFORD	C	PACKHAM	B
NIART	B	NORWAY FLAT	B	OKEMAH	C	ORIDIA	C	PACKSADDLE	B
NIBLEY	C	NORWELL	C	OKLARED	B	ORIF	A	PACKWOOD	D
NICHOLSON	C	NORWICH	D	OKLAWAHA	A/D	ORIO	C	PACOLET	B
NICHOLVILLE	C	NORWOOD	B	OKMOK	B	ORION	B	PACTOLUS	C
NICKEL	B	NOTI	D	OKO	D	ORITA	B	PADEN	C
NICODEMUS	B	NOTUS	A/C	OKOBOJI	C	ORLAND	B	PADRONI	B
NICOLAUS	C	NOUQUE	D	OKOLONA	D	ORLANDO	A	PADUCAH	B
NICOLLET	B	NUVARA	B	OKREEK	D	ORMAN	C	PAJUS	B
NIELSEN	D	NOVARY	B	OKTIBBEHA	D	ORMSBY	B/C	PAESL	B
NIGHTHAWK	B	NOWOOD	C	OLA	C	ORODELL	C	PAGET	B
NIHILL	B	NOYO	C	OLAA	A	ORO FINO	B	PAGODA	C
NIKABUNA	D	NOYSON	C	OLALLA	C	ORO GRANDE	C	PAHRANAGAT	C
NIKEY	B	NUBY	C/D	OLANTA	B	ORONO	C	PAHREAH	D
NIKISHKA	A	NUCKOLLS	C	OLATHE	C	OROVADA	C	PAHROC	D
NIKLASON	B	NUCLA	B	OLD CAMP	D	ORPHANT	D	PAIA	C
NIKOLAI	D	NUECES	C	OLDHAM	C	ORR	C	PAICE	C
NILAND	C	NUGENT	A	OLDS	D	ORRVILLE	C	PAINESVILLE	C
NILES	C	NUGGET	C	OLDSMAR	B/D	ORSA	A	PAINTROCK	C
NIMROD	C	NUMA	C	OLOWICK	B	ORSINO	A	PAIT	B
NINCH	C	NUNDA	C	OLELO	B	ORTELLO	A	PAJARITO	B
NINEMILE	D	NUNICA	C	OLENA	B	ORTIGALITA	C	PAJARO	C
NINEVEH	B	NUNN	C	OLEQUA	B	ORTING	C	PAKA	B
NINIGRET	B	NUSS	D	OLETE	C	ORTIZ	C	PAKALA	B
NININGER	B	NUTLEY	C	OLEX	B	ORTLEY	B	PAKINI	B
NINNESCAH	C	NUTRAS	C	OLGA	C	ORWET	A	PALA	B
NIOBELL	C	NUTRIOSO	B	OLI	B	ORWOOD	B	PALACIO	B
NIOTA	D	NUVALDE	C	OLIAGA	B/D	OSAGE	D	PALAPALAI	B
NIPE	B	NYALA	D	OLINDA	B	OSAKIS	B	PALATINE	B
NIPPERSINK	B	NYMORE	A	OLIPHANT	B	OSCAR	D	PALESTINE	B
NIPPT	A	NYSSA	C	OLIVENHAIN	D	OSCURA	C	PALISADE	B
NIPSUM	C	NYSSATON	B	OLIVER	B	OSGOOD	B	PALMA	B
NIRA	B	NYSTROM	C	OLIVIER	C	OSHA	B	PALMAREJO	C
NISHNA	C			OLJETO	A	OSHAWA	D	PALM BEACH	A
NISHON	D	OAHE	B	OLMITO	D	O'SHEA	C	PALMER	D
NISQUALLY	A	OAKDALE	B	OLMITZ	B	OSHKOSH	C	PALMER CANYON	B
NISSWA	B	OAKDEN	D	OLMOS	C	OSHTEMO	B	PALMICH	B
NIU	B	OAKFORD	B	OLMSTED	B/D	OSIER	B/D	PALMS	D
NIULII	C	OAK GLEN	B	OLNEY	B	OSKA	C	PALMYRA	B
NIVLOC	D	OAK GROVE	C	OLOKUI	D	OSMUND	B	PALO	B
NIWOT	C	OAK LAKE	B	OLPE	C	OSO	B	PALODURO	B
NIXA	C	OAKLAND	C	OLSON	D	OSOBB	D	PALOMAS	B
NIXON	B	OAKS RIDGE	C	OLTON	C	OSORIDGE	D	PALOMINO	D
NIXONTON	B	OAKVILLE	A	OLUSTEE	B/D	OSOTE	B	PALOS VERDES	B
NIZINA	A	OAKWOOD	D	OLYIC	B	OSSIAN	C	PALOUSE	B
NOBE	D	OANAPUKA	B	OLYMPIC	B	OST	B	PALSGROVE	B
NOBLE	B	OASIS	B	OMADI	B	OSTRANDER	B	PAMLICO	D
NOBSCOTT	A	OATMAN	B	OMAHA	B	OTERO	B	PAMOA	C
NOCKEN	C	OBAN	C	OMAK	C	OTHELLO	D	PAMSDEL	D
NODAWAY	B	OBARC	B	OMEGA	A	OTIS	C	PAMUNKEY	C
NOEL	D	OBEN	C	OMENA	B	OTISCO	A	PANA	B
NOHILI	D	OBRAST	D	OMNI	C	OTISVILLE	A	PANACA	D
NOKASIPPI	D	OBRAY	D	ONA	A/D	OTLEY	B	PANAEWA	D
NOKAY	C	OBURN	D	ONALASKA	B	OTSEGO	C	PANASOFFKEE	D
NOKOMIS	B	OCALA	D	ONAMIA	B	OTTER	B/D	PANCHERI	B
NOLAM	B	OCEANET	D	ONARGA	B	OTTERBEIN	C	PANCHUELA	C
NOLICHUCKY	B	OCEANO	A	ONAWA	D	OTTERHOLT	B	PANDO	B
NOLIN	B	OCHEYEDAN	B	ONAWAY	B	OTTOKEE	A	PANDOAH	C
NOLO	B	OCHLOCKONEE	B	ONDAWA	B	OTWAY	D	PANDORA	D
NOME	D	OCHO	D	ONEIDA	B	OTWELL	C	PANDURA	D
NONDALTON	B	OCHOCO	C	O'NEILL	B	OUACHITA	C	PANE	B
NONOPAHU	D	OCHOPEE	B/D	ONEONTA	B	OURAY	A	PANGUITCH	B
NOOKACHAMPS	C/D	OCILLA	C	ONITA	C	OUTLET	C	PANHILL	B
NOOKSACK	B	OCKLEY	B	ONITE	B	OVALL	C	PANIOGUE	B
NOONAN	D	OCOEE	A/D	ONOTA	C	OVERGAARD	C	PANKY	C
NORA	B	OCONEE	C	ONOVA	D	OVERLAND	C	PANOCHE	B
NORAD	B	OCONTO	B	ONRAY	C	OVERLY	C	PANOLA	D
NORBERT	D	OCOSTA	D	ONSLOW	B	OVERTON	D	PANSEY	D
NORBORNE	B	OCQUEOC	B	ONTARIO	B	OVID	C	PANTEGO	D
NORBY	B	OCTAGON	B	ONTKO	B/D	OVINA	B	PANTHER	D
NORD	B	ODEE	D	ONTONAGON	D	OWEGO	D	PANTON	D
NORDBY	B	ODELL	B	ONYX	B	OWEN CREEK	C	PAOLA	A
NORDEN	B	ODEM	A	OOKALA	A	OWENS	D	PAOLI	B
NORDNESS	B	ODERMOTT	C	OPAL	D	OWHI	B	PAONIA	C
NORFOLK	B	ODESSA	D	OPEQUON	C/D	OWOSSO	B	PAPAA	D
NORGE	B	ODIN	C	OPHIR	C	OWYHEE	B	PAPAI	A
NORKA	B	ODNE	C	OPIHIKAO	D	OXALIS	C	PAPAKATING	D
NORMA	B/C	O'FALLON	D	OPPIO	D	OXBOW	C	PAPOOSE	C
NORMANGEE	D	OGDEN	D	OQUAGA	C	OXERINE	C	PARADISE	C
NORREST	C	OGEECHEE	C	ORA	C	OXFORD	D	PARADOX	B
NORRIS	C	OGEMAW	C	ORAN	B	OZAMIS	B/D	PARALOMA	C
NORRISTON	B	OGILVIE	C	ORANGE	D	OZAN	D	PARAMORE	D
NORTE	B	OGLALA	B	ORANGEBURG	B	OZAUKEE	C	PARASOL	B
NORTHDALE	C	OGLE	B	ORCAS	D			PARCELAS	D
NORTHFIELD	B	OHAYSI	D	ORCHARD	B	PAAIKI	B	PARDEE	D
NORTHMORE	C	OHIA	A	ORD	A	PAALOA	B	PAREHAT	C
NORTHPORT		OJAI	B	ORDNANCE	C	PAAUHAU	A	PARENT	C
NORTH POWDER	C	OJATA	D	ORDWAY	D	PACHAPPA	B	PARISETTE	C
NORTHUMBERLAND	C/D	OKANOGAN	B	ORELIA	D	PACHECO	B/C	PARIS	

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PARISHVILLE	C	PELIC	D	PICAYUNE	B	PLEASANT VIEW	B	POST	D
PARKAY	B	PELLA	D	PICKAWAY	C	PLEDGER	D	POTAMO	D
PARKDALE	B	PELLEJAS	B	PICKENS	D	PLEEK	C	POTH	C
PARKE	B	PELONA	C	PICKETT	B	PLEINE	D	POTLATCH	C
PARKER	B	PELUK	D	PICKFORD	D	PLEVNA	D	POTRATZ	C
PARKFIELD	C	PEMBERTON	A	PICKRELL	D	PLOME	B	POTSDAM	B
PARKHILL	D	PEMBINA	C	PICKWICK	B	PLOVER	B	POTTER	C
PARKHURST		PEMBROKE	B	PICO	B	PLUMAS	B	POTTS	B
PARKINSON	B	PENA	B	PICOSA	C	PLUMMER	B/D	POUDRE	B
PARKVIEW	B	PENCE	A	PICTOU	B	PLUSH	B	POULTNEY	B
PARKVILLE	C	PENDEN	B	PIE CREEK	D	PLUTH	B	POUNCEY	D
PARKWOOD	A/D	PEND OREILLE	B	PIERIAN	A	PLUTOS	C	POVERTY	A
PARLEYS	B	PENDROY	D	PIERPONT	C	PLYMOUTH	A	POWDER	B
PARLIN	C	PENELAS	D	PIERRE	D	POALL	C	POWDERHORN	C
PARLO	B	PENINSULA	C	PIERSONTE	B	POARCH	B	POWELL	C
PARMA	C	PENISTAJA	B	PIIHONUA	A	POCALLA	A	POWER	B
PARNELL	D	PENITENTE	B	PIKE	B	POCATELLO	B	POWHITE	C
PARR	B	PENLAW	C	PILCHUCK	A	POCKER	D	POWLEY	D
PARRAN	D	PENN	C	PILGRIM	B	POCOMOKE	D	POWWATKA	C
PARRISH	C	PENNEL	C	PILOT	B	POOD	D	POY	D
PARSHALL	B	PENNINGTON	B	PILOT ROCK	C	PODUNK	B	POYGAN	D
PARSIPPANY	D	PENO	C	PIMA	B	POE	B/C	POZO	C/D
PARSONS	D	PENOYER	C	PIMER	B	POEVILLE	D	POZO BLANCO	B
PARTRI	C	PENROSE	D	PINAL	D	POGAL	B	PRAG	C
PASAGSHAK	D	PENSORE	D	PINALENO	B	POGANEAB	D	PRATHER	B
PASCO	B/C	PENTHOUSE	D	PINAMT	B	POGUE	B	PRATLEY	C
PASO SECO	D	PENTZ	D	PINATA	C	POHAKUPU	A	PRATT	A
PASQUETTI	C/D	PENWELL	A	PINAVETES	A	POINDEXTER	C	PR[illegible]HER	B
PASQUOTANK	B/D	PENWOOD	A	PINCHER	C	POINSETT	B	PREAKNESS	D
PASSAR	C	PEOGA	C	PINCKNEY	C	POINT	B	PREBISH	D
PASS CANYON	D	PEOH	C	PINCONNING	D	POINT ISABEL	C	PREDUE	C
PASSCREEK	C	PEONE	B/C	PINCUSHION	B	POJOAQUE	B	PRENTISS	C
PASTURA	D	PEORIA	D	PINEDA	B/D	POKEGEMA	B	PRESQUE ISLE	B
PATAHS	B	PEOTONE	C	PINEDALE	B	POKEMAN	B	PRESTO	A
PATENT	C	PEPOON	B	PINEGUEST	B	POKER	C	PRESTON	A
PATILLAS	B	PEQUEA	C	PINELLOS	A/D	POLAND	H	PREWITT	B
PATILO	C	PERCHAS	D	PINETOP	C	POLAR	B	PREY	D
PATIT CREEK	B	PERCIVAL	C	PINEVILLE	B	POLATIS	C	PRICE	C
PATNA	B	PERELLA	C	PINEY	C	POLE	A	PRIDA	D
PATOUTVILLE	C	PERHAM	C	PINICON	B	POLEBAR	C	PRIDHAM	D
PATRICIA	B	PERICO	B	PINKEL	C	POLELINE	B	PRIETA	D
PATRICK	B	PERITSA	C	PINKHAM	B	POLEO	B	PRIMEAUX	C
PATROLE	C	PERKINS	C	PINKSTON	B	POLEY	C	PRIMGHAR	B
PATTANI	D	PERKS	A	PINNACLES	C	POLICH	B	PRINCETON	B
PATTENBURG	B	PERLA	C	PINO	C	POLLARD	C	PRINEVILLE	C
PATTER	C	PERMA	A	PINOLA	C	POLLASKY	C	PRING	B
PATTERSON	C	PERMANENTE	C	PINOLE	B	POLLY	B	PRINS	C
PATTON	B/D	PERRIN	B	PINON	C	POLO	B	PRITCHETT	C
PATWAY	C	PERRINE	D	PIMONES	D	POLSON	C	PROCTOR	B
PAUL	B	PERROT	D	PINTAS	D	POLVADERA	B	PROGRESSO	C
PAULDING	D	PERRY	D	PINTLAR	A	POMAT	C	PROMISE	D
PAULINA	D	PERRYPARK	B	PINTO	C	POMELLO	C	PROMO	D
PAULSELL	D	PERRYVILLE	B	PINTURA	A	POMPANO	A/D	PROMONTORY	B
PAULSON	B	PERSANTI	C	PINTWATER	D	POMPONIO	C/D	PRONG	C
PAULVILLE	B	PERSAYO	D	PIOCHE	D	POMPTON	B	PROSPECT	B
PAUMALU	B	PERSHING	C	PIOPOLIS	D	POMROY	B	PROSPER	B
PAUNSAUGUNT	D	PERSIS	B	PIPER	B/C	PONCA	B	PROSSER	C
PAUSANT	B	PERT	D	PIROUETTE	D	PONCENA	D	PROTIVIN	C
PAUWELA	B	PERU	C	PIRUM	B	PONCHA	A	PROUT	C
PAVANT	D	PESCADERO	C/D	PISGAH	C	POND	B/C	PROVIDENCE	C
PAVILLION	B	PESET	C	PISHKUN	B	POND CREEK	B	PROVO	D
PAVOHROO	B	PESHASTIN	B	PISTAKEE	B	PONDILLA	A	PROVO BAY	D
PAWCATUCK	D	PESO	C	PIT	D	PONIL	D	PROWERS	B
PAWLET	B	PETEETNEET	D	PITTMAN	D	PONTOTOC	B	PTARMIGAN	B
PAWNEE	D	PETERBORO	B	PITTSFIELD	B	PONZER	D	PUAULU	A
PAXTON	C	PETERS	D	PITTSTOWN	C	POOKU	A	PUCHYAN	A
PAXVILLE	D	PETOSKEY		PITTWOOD	B	POOLE	B/D	PUDDLE	D
PAYETTE	B	PETRIE	D	PITZER	C	POOLER	D	PUERCO	D
PAYMASTER	B	PETROLIA	D	PIUTE	D	POORMA	B	PUERTA	D
PAYNE	C	PETTONS	C	PLACEDO	D	POPE	B	PUETT	D
PAYSON	D	PEWAMO	B/D	PLACENTIA	D	POPPLETON	A	PUGET	B/C
PEACHAM	D	PEYTON	B	PLACERITOS	C	POQUONOCK	C	PUGSLEY	B
PEARL HARBOR	D	PFEIFFER	B	PLACID	A/D	PORRETT	B/D	PUHI	A
PEARMAN		PHAGE	B	PLACK	D	PORT	B	PUHIMAU	D
PEARSOLL	D	PHANTOM	C	PLAINFIELD	A	PORTAGEVILLE	D	PULASKI	B
PEAVINE	C	PHARO	B	PLAINVIEW	C	PORTALES	B	PULEHU	B
PECATONICA	B	PHAROLIO	D	PLAISTED	C	PORTALTO	B	PULLMAN	D
PECOS	D	PHEBA	C	PLAND	B	PORT BYRON	B	PULS	D
PEDEE	C	PHEENEY	B	PLASKETT	D	PORTERS	B	PULSIPHER	D
PEDERNALES	C	PHELAN	B	PLATA	B	PORTERVILLE	D	PULTNEY	C
PEDIGO	B/C	PHELPS	B	PLATEA	C	PORTHILL	C	PUMEL	C
PEDLAR	D	PHIFERSON	B	PLATEAU	B	PORTINO	C	PUMPER	C
PEDOLI	C	PHILBON	B/D	PLATNER	C	PORTLAND	D	PUNA	A
PEDRICK	B	PHILIPSBURG	B	PLATO	C	PORTNEUF	B	PUNALUU	D
PEEBLES	C	PHILLIPS	C	PLATORO	B	PORTOLA	C	PUNOHU	A
PEEL	C	PHILO	B	PLATTE	D	PORTSMOUTH	D	PUPDAM	C
PEELER	B	PHILOMATH	D	PLATTVILLE	B	PORUM	C	PURDY	D
PEEVER	C	PHIPPS	C	PLAZA	B/C	POSANT	C	PURGATORY	D
PEGLER	D	PHOEBE	B	PLEASANT	C	POSEY	B	PURNER	D
PEGRAM	B	PHOENIX	D	PLEASANT GROVE	B	POSITAS	D	PURSLEY	B
PEKIN	C	PIASA	D	PLEASANTON	B	POSKIN	C	PURVES	D
PELHAM	B/D	PICACHO	C	PLEASANT VALE	B	POSOS	C	PUSTOI	A

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PUTNAM	D	RANDMAN	D	REELFOOT	C	RIFFE	B	ROLETTE	C
PUUKALA	D	RANDOLPH	D	REESER	C	RIFLE	A/D	ROLFE	C
PUUONE	C	RANDS	C	REESVILLE	C	RIGA	D	ROLISS	D
PUU OO	A	RANGER	D	REEVES	C	RIGGINS	A	ROLLA	C
PUU OPAE	B	RANIER	C	REFUGE	C	RIGLEY	B	ROLLIN	D
PUU PA	B	RANKIN	C	REGAN	B	RILEY	C	ROLOFF	C
PUYALLUP	B	RANTOUL	D	REGENT	C	RILLA	B	ROMBERG	B
PYLE	A	RANYHAN	B	REHM	C	RILLITO	B	ROMBO	C
PYLON	D	RAPELJE	C	REICHEL	B	RIMER	C	ROMEO	C
PYOTE	A	RAPHO	B	REIFF	B	RIMINI	A	ROMNEY	C
PYRAMID	D	RAPIDAN	B	REILLY	A	RIMROCK	D	ROMULUS	D
PYRMONT	D	RAPLEE	C	REINACH	B	RIN	B	ROND	C
		RARDEN	C	REKOP	D	RINCON	C	RONNEBY	B
QUACKENBUSH	C	RARICK	B	RELAN	A	RINCONADA	C	RONSON	B
QUAKER	C	RARITAN	C	RELAY	B	RINDGE	D	ROOSET	B
QUAKERTOWN	B	RASBAND	B	RELIANCE	C	RINGLING	C	ROOTEL	D
QUAMBA	D	RASSET	B	RELIZ	D	RINGO	D	ROSACHI	C
QUAMON	A	RATAKE	C	RELSE	B	RINGOLD	B	ROSAMOND	B
QUANAH	B	RATHBUN	C	REMBERT	D	RINGWOOD	B	ROSANE	C
QUANDAHL	B	RATLIFF	B	REMMIT	A	RIO	D	ROSANKY	C
QUARLES	D	RATON	D	REMSEN	D	RIO ARRIBA	D	ROSARIO	C
QUARTZBURG	C	RATTLER	B	REMUDAR	B	RIOCONCHO	C	ROSCOE	D
QUATAMA	C	RATTO	D	REMUNDA	C	RIO GRANDE	B	ROSCOMMON	D
QUAY	B	RAUB	B	RENBAC	D	RIO KING	C	ROSEBERRY	B/D
QUAZO	D	RAUVILLE	D	RENCALSON	C	RIO LAJAS	A	ROSEBLOOM	D
QUEALY	D	RAUZI	B	RENCOT	A	RIO PIEDRAS	B	ROSEBUD	B
QUEBRADA	C	RAVALLI	C	RENFROW	D	RIPLEY	B	ROSEBURG	B
QUEENY	D	RAVENDALE	D	RENICK	D	RIPON	B	ROSE CREEK	C
QUEETS	B	RAVENNA	C	RENNIE	C/D	RIRIE	B	ROSEGLEN	B
QUEMADO	C	RAVOLA	B	RENO	D	RISBECK	B	ROSEHILL	D
QUENZER	D	RAWAH	B	RENOHILL	C	RISLEY	D	ROSELAND	D
QUICKSELL	D	RAWHIDE	D	RENOVA	B	RISTA	C	ROSELLA	D
QUIETUS	C	RAWSON	B	RENOX	B	RISUE	D	ROSELMS	D
QUIGLEY	B	RAY	B	RENSHAW	B	RITCHEY	B	ROSEMOUNT	B
QUILCENE	C	RAYADO	C	RENSLOW	B	RITNER	C	ROSENDALE	B
QUILLAYUTE	B	RAYENOUF	B	RENSSELAER	C	RITO	B	ROSE VALLEY	C
QUIMBY	B	RAYMONDVILLE	D	RENTIDE	C	RITTER	B	ROSEVILLE	B
QUINCY	A	RAYNE	B	RENTON	B/C	RITTMAN	C	ROSEWORTH	C
QUINLAN	C	RAYNESFORD	B	RENTSAC	C	RITZ	B/D	ROSHE SPRINGS	D
QUINN	D	RAYNHAM	C	REPARADA	D	RITZCAL	B	ROSITAS	A
QUINNEY	C	RAYNOR	D	REPP	A	RITZVILLE	B	ROSLYN	B
QUINTON		RAZOR	C	REPPART	B	RIVERHEAD	B	ROSMAN	B
QUITMAN	C	RAZORT	B	REPUBLIC	B	RIVERSIDE	A	ROSNEY	C
QUONSET	A	READING	C	RESCUE	C	RIVERTON	C	ROSS	B
		READINGTON	C	RESERVE	B	RIVERVIEW	B	ROSS FORK	C
RABER	C	READLYN	B	RESNER	B	RIVRA	A	ROSSI	C
RAREY	A	REAGAN	B	RET	B/C	RIXIE	C	ROSSMOYNE	C
RABIDEUX	B	REAKOR	B	RETRIEVER	D	RIXON	C	ROSS VALLEY	C
RABUN	B	REAL	C	RETSOF	C	RIZ	D	ROTAN	C
RACE	D	REAP	D	RETSOK	B	ROANOKE	D	ROTHIEMAY	B
RACHERT	D	REARDAN	C	REXBURG	B	ROBANA	B	ROTHSAY	B
RACINE	B	REAVILLE	C	REXFORD	C	ROBBINS	B	ROTTULEE	B
RACOON	D	REBA	C	REXOR	A	ROBBS	D	ROUBIDEAU	C
RAD	C	REBEL	B	REYES	C/D	ROBERTS	D	ROUEN	C
RADERSBURG	B	REBUCK		REYNOLDS		ROBERTSDALE	C	ROUND BUTTE	D
RADFORD	B	RECAL	D	REYNOSA	B	ROBERTSVILLE	D	ROUNDLEY	C
RADLEY	C	RECLUSE	C	REYWAT	D	ROBIN	B	ROUNDTOP	C
RADNOR	D	REDBANK	B	RHAME	B	ROBINSON	D	ROUNDUP	C
RAFAEL	D	RED BAY	B	RHEA	B	ROBINSONVILLE	B	ROUNDY	C
RAGER	B	RED BLUFF	C	RHINEBECK	D	ROBLEDO	D	ROUSSEAU	A
RAGLAN	C	RED BUTTE	B	RHOADES	D	ROB ROY	C	ROUTON	D
RAGNAR	B	REDBY	C	RHOAME	C	ROBY	C	ROUTT	C
RAGO	C	REDCHIEF	C	RIB	C	ROCA	D	ROVAL	D
RAGSDALE	B/D	REDCLOUD	B	RICCO	D	ROCHE	C	ROWE	D
RAGTOWN	D	REDDICK	C	RICETON	B	ROCHELLE	C	ROWENA	C
RAHAL	C	REDDING	D	RICEVILLE	C	ROCHEPORT	C	ROWLAND	C
RAHM	C	REDFIELD	B	RICHARDSON	B	ROCKAWAY	C	ROWLEY	B
RAIL	C/D	RED HILL	C	RICHEAU	C	ROCKCASTLE	D	ROXAL	D
RAINBOW	C	RED HOOK	C	RICHEY	C	ROCK CREEK	D	ROXBURY	B
RAINEY	B	REDLAKE	D	RICHFIELD	C	ROCKFORD	B	ROY	B
RAINS	B/D	REDLANDS	B	RICHFORD	A	ROCKHOUSE	A	ROYAL	B
RAINSBORO	C	REDLODGE	D	RICHLIE	A	ROCKINGHAM	C/D	ROYALTON	C
RAKE	D	REDMANSON	B	RICHMOND	D	ROCKLIN	C/D	ROYCE	B
RALSEN	B/C	REDMOND	C	RICHTER	B	ROCKLY	D	ROYSTONE	B
RAMADA	C	REDNUN	C	RICHVALE	B	ROCKPORT	C	ROZA	D
RAMADERO	B	REDOLA	B	RICHVIEW	C	ROCK RIVER	B	ROZELLVILLE	B
RAMBLER	B	REDONA	B	RICHWOOD	B	ROCKTON	B	ROZETTA	B
RAMELLI	C	REDRIDGE	B	RICKMORE	C	ROCKWELL	B	ROZLEE	C
RAMIRES	D	REDROB	D	RICKS	A	ROCKWOOD	B	RUARK	C
RAMMEL	C	RED ROCK	B	RICO	C	ROCKY FORD	B	RUBICON	A
RAMO	C	RED SPUR	B	RICREST	B	RODDY		RUBIO	C
RAMONA	B	REDSTOE	B	RIDD	C	RODMAN	A	RUBY	B
RAMPART	B	REDTHAYNE	B	RIDGEBURY	C	ROE	B	RUBYHILL	C
RAMPARTAR	A	REDTOM	C	RIDGECREST	C	ROEBUCK	D	RUCH	B
RAMPARTER	A	REDVALE	C	RIDGEDALE	B	ROELLEN	D	RUCKLES	D
RAMSEY	D	REDVIEW	C	RIDGELAND	D	ROEMER	C	RUCLICK	C
RAMSHORN	B	REE	B	RIDGELAWN	A	ROESIGER	B	RUDD	D
RANCE	C	REEBEX	C	RIDGELY	B	ROGERT	D	RUDEEN	B
RANCHERIA	B	REED	D	RIDGEVILLE	B	ROHNERVILLE	B	RUDOLPH	C
RAND	B	REEDER	B	RIDGEWAY	D	ROHRERSVILLE	C	RUDYARD	D
RANDADO	C	REEDPOINT	C	RIDIT	C	ROIC	D	RUELLA	B
RANDALL	D	REEDY	D	RIETBROCK	C	ROKEBY	D	RUGGLES	B

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RUIDOSO	C	SALVISA	C	SAUK	B	SEDAN		SHELBY	B
RUKO	D	SALZER	D	SAULICH	D	SEDILLO	B	SHELBYVILLE	B
RULE	B	SAMBA	D	SAUM	C	SEDWELL	C	SHELDON	
RULICK	C	SAMISH	C/D	SAUNDERS	C	SEEDSKADEE	D	SHELIKOF	D
RUMBO	C	SAMMAMISH	C	SAUVIE	C/D	SEES	C	SHELLABARGER	B
RUMFORD	B	SAMPSEL	D	SAUVOLA	C	SEEWEE	B	SHELLDRAKE	A
RUMNEY	C	SAMPSON	B	SAVAGE	C	SEGAL	D	SHELLROCK	A
RUMPLE	C	SAMSIL	D	SAVANNAH	C	SEGNO	C	SHELMADINE	D
RUM RIVER	C	SAN ANDREAS	C	SAVENAC	C	SEHORN	D	SHELOCTA	B
RUNE	C	SAN ANTON	B	SAVO	C	SEITZ	C	SHELTON	C
RUNGE	B	SAN ANTONIO	C	SAVOIA	B	SEJITA	D	SHENA	C
RUNNELLS	C	SAN ARCACIO	B	SAWABE	D	SEKIL	C	SHENANDOAH	C
RUNNYMEDE	B	SAN BENITO	B	SAWATCH	C	SEKIU	D	SHEP	B
RUPERT	A	SANCHEZ	D	SAWCREEK	B	SELAH	C	SHEPPARD	A
RUSCO	C	SANDALL	C	SAWMILL	C	SELDEN	C	SHERANDO	A
RUSE	D	SANDERSON	B	SAWYER	C	SELEGNA	D	SHERAR	C
RUSH	C	SANDLAKE	C	SAXBY	D	SELFRIDGE	C	SHERBURNE	B
RUSHTOWN	A	SANDLEE	A	SAXON	B	SELKIRK	D	SHERIDAN	B
RUSHVILLE	D	SANELI	D	SAYBROOK	B	SELLE	B	SHERLOCK	B
RUSS	B	SAN EMIGDIO	B	SAYLESVILLE	C	SELLERS	A/D	SHERM	D
RUSSELL	B	SANFORD	A	SAYLOR	A	SELMA	B	SHERRYL	B
RUSSELLVILLE	C	SANGER	B	SCALA	B	SEMIAHMOO	D	SHERWOOD	B
RUSSLER	C	SAN GERMAN	D	SCAMMAN	C	SEMIHMOO	D	SHIBLE	B
RUSTON	B	SANGO	C	SCANDIA	B	SEMINARIO	D	SHIELDS	C
RUTLAND	C	SANGREY	A	SCANTIC	C	SEMIX	C	SHIFFER	B
RUTLEGE	D	SANILAC	C	SCAR	A	SEN	B	SHILOH	C
RYAN	D	SAN ISABEL	B	SCARBORO	D	SENECAVILLE	C	SHINAKU	D
RYAN PARK	B	SAN JOAQUIN	D	SCAVE	C	SEQUATCHIE	B	SHINGLE	D
RYDE	B/D	SAN JON	C	SCHAFFENAKER	A	SEQUIM	A	SHINGLETOWN	C
RYDER	C	SAN JOSE	B	SCHAMBER	A	SEQUIN	B	SHINN	B
RYEGATE	B	SAN JUAN	A	SCHAMP	C	SEQUOIA	C	SHINROCK	C
RYELL	A	SAN LUIS	B	SCHAPVILLE	C	SERENE	D	SHIOCTON	B
RYEPATCH	D	SAN MATEO	B	SCHEBLY	D	SERNA	D	SHIPLEY	C
RYER	C	SAN MIGUEL	C	SCHERRARD	D	SEROCO	A	SHIPROCK	B
RYORP	C	SANPETE	B	SCHLEY	B	SERPA	C/D	SHIRAT	B
RYUS	C	SANPITCH	C	SCHMUTZ	B	SERVOSS.	D	SHIRK	C
		SAN POIL	B	SCHNEBLY	D	SESAME	C	SHOALS	C
SABANA	D	SAN SABA	D	SCHNEIDER	C	SESPE	C	SHOEBAR	B
SABANA SECA	D	SAN SEBASTIAN	B	SCHNOORSON	B/D	SESSIONS	C	SHOEFFLER	B
SABENYO	B	SANTA	C	SCHNORBUSH	C	SESSUM	D	SHONKIN	D
SABINA	C	SANTA CLARA	C	SCHODACK		SETTERS	C	SHOOFLIN	C
SABINE	A	SANTA FE	D	SCHOOSON	C	SETTLEMEYER	D	SHOOK	A
SABLE	D	SANTA ISABEL	D	SCHOFIELD	B	SEVAL	D	SHOREWOOD	C
SAC	B	SANTA LUCIA	C	SCHOHARIE	C	SEVERN	B	SHOREY	B
SACO	D	SANTA MARTA	C	SCHOLLE	B	SEVILLE	D	SHORN	B
SACRAMENTO	C/D	SANTANA	C	SCHOOLEY	C/D	SEVY	C	SHORT CREEK	D
SACUL	D	SANTAQUIN	A	SCHOONER	D	SEWARD	B	SHOSHONE	D
SADDLE	B	SANTA YNEZ	C	SCHRADER	D	SEWELL	B	SHOTWELL	D
SADDLEBACK	B	SANTEE	D	SCHRAP	D	SEXTON	D	SHOUNS	B
SADER	D	SANTIAGO	B	SCHRIER	B	SEYMOUR	C	SHOWALTER	C
SADIE	B	SANTIAM	C	SCHROCK	B	SHAAK	D	SHOWLOW	C
SADLER	C	SAN TIMOTEO	C	SCHUMACHER	B	SHADELAND	C	SHREWSBURY	D
SAFFELL	B	SANTONI	D	SCHUYLKILL	B	SHAFFER	A	SHRINE	B
SAGANING	D	SANTOS	C	SCIO	B	SHAKAN	B	SHROE	D
SAGE	D	SANTO TOMAS	B	SCIOTOVILLE	C	SHAKESPEARE	C	SHROUTS	D
SAGEHILL	B	SAN YSIDRO	D	SCISM	B	SHAKOPEE	C	SHUBUTA	C
SAGEMOOR	C	SAPINERO	B	SCITUATE	C	SHALCAR	D	SHULE	B
SAGERTON	C	SAPP	D	SCOBEY	C	SHALET	D	SHULLSBURG	C
SAGINAW		SAPPHIRE	B	SCOOTENEY	B	SHAN	D	SHUMWAY	D
SAGO	D	SAPPHO	B	SCORUP	C	SHAMBO	B	SHUPERT	C
SAGOUSPE	C	SAPPINGTON	B	SCOTT	D	SHAMEL	B	SHUWAH	B
SAGUACHE	A	SARA	C	SCOTT LAKE	B	SHANAHAN	B	SI	B
SAHALIE	B	SARALEGUI	B	SCOUT	B	SHANDON		SIBLEYVILLE	B
SAINT HELENS	A	SARANAC	D	SCOWLALE	C	SHANE	D	SIBYLEE	D
SAINT MARTIN	C	SARAPH	D	SCRANTON	B/D	SHANO	B	SICILY	B
SALADO	B	SARATOGA	B	SCRAVO	A	SHANTA	B	SICKLESTEETS	C
SALADON	D	SARATON	B	SCRIBA	C	SHAPLEIGH	C/D	SIDELL	B
SALAL	B	SARBEN	A	SCRIVER	B	SHARATIN	B	SIEANCIA	B
SALAMATOF	D	SARCO	B	SCROGGIN	C	SHARKEY	D	SIEBER	A
SALAS	C	SARDINIA	C	SCULLIN	C	SHARON	B	SIELO	C
SALCHAKET	B	SARDO	E	SEABROOK	C	SHARPSBURG	B	SIEROCLIFF	D
SALEM	B	SARGEANT	D	SEAMAN	C	SHARROTT	D	SIERRA	B
SALEMSBURG	B	SARITA	A	SEAQUEST	C	SHARVANA	C	SIERRAVILLE	B
SALGA	C	SARKAR	D	SEARCHLIGHT	C	SHASKIT	B/C	SIESTA	D
SALIDA	A	SARPY	A	SEARING	B	SHASTA	A	SIFTON	B
SALINAS	C	SARTELL	A	SEARLA	B	SHAVANO	B	SIGNAL	C
SALISBURY	D	SASKA	B	SEARLES	C	SHAVER	B	SIGURD	B
SALIX	B	SASPAMCO	B	SEATON	B	SHAWA	B	SIKESTON	D
SALKUM	C	SASSAFRAS	B	SEATTLE	D	SHAWANO	A	SILCOX	B
SALLISAW	B	SASSER	B	SEAWILLOW	B	SHAWMUT	B	SILENT	D
SALLYANN	C	SATANKA	C	SEBAGO	D	SHAY	D	SILER	B
SALMON	B	SATANTA	B	SEBASTIAN	D	SHEAR	C	SILERTON	B
SALOL	D	SATELLITE	C	SEBASTOPOL	C	SHECKLER	C	SILI	D
SALONIE	D	SATT	D	SEBEKA	D	SHEDADO	B	SILSTID	A
SALREE	C/D	SATTLEY	B	SEBEWA	B/D	SHEDD	C	SILVER	C
SALTAIR	D	SATTRE	B	SEBREE	D	SHEEGE	D	SILVERADO	C
SALT CHUCK	A	SATURN	B	SEBRING	D	SHEEP CREEK	C	SILVERBOW	D
SALTER	B	SATUS	B	SEBUD	B	SHEEPHEAD	C	SILVER CREEK	D
SALTERY	D	SAUCIER	E	SECATA	C/D	SHEEPROCK	A	SILVERTON	C
SALT LAKE	D	SAUDE	B	SECCA	C	SHEETIRON	B	SILVIES	D
SALUDA	C	SAUGATUCK	C	SECRET	C	SHEFFIELD	D	SIMAS	C
SALUVIA		SAUGUS	B	SECRET CREEK	B	SHELBURNE	C	SIMCOE	C

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES
FOR
HYDROLOGIC CLASSIFICATIONS

SIMEON	A	SNOW	B	SQUALICUM	B	STISSING	C	SURGH	B
SIMMLER	D	SNOWDEN	C	SQUAW	B	STIVERSVILLE	B	SURPRISE	B
SIMMONT	C	SNOWLIN	B	SQUILLCHUCK	B	STOCKBRIDGE	B	SURRENCY	B/D
SIMNER	A	SNOWVILLE	D	SQUIMER	B	STOCKLAND	B	SURVYA	C
SIMON	C	SNOWY	A	SQUIRES	B	STOCKPEN	D	SUSIE CREEK	D
SIMONA	D	SOAKPAK	B	ST. ALBANS	B	STOCKTON	D	SUSITNA	B
SIMOTE	C	SOAP LAKE	B	ST. CHARLES	B	STODICK	D	SUSQUEHANNA	D
SIMPERS	B	SOBOBA	A	ST. CLAIR	D	STOKES	D	SUTHER	C
SIMPSON	C	SOBRANTE	C	ST. ELMO	A	STOMAR	C	SUTHERLIN	C
SIMS	D	SODA LAKE	B	ST. GEORGE	C	STONER	B	SUTLEW	B/C
SINAI	C	SODHOUSE	D	ST. HELENS	A	STONEWALL	A	SUTPHEN	D
SINCLAIR	C	SODUS	C	ST. IGNACE	C	STONO	B/D	SUTTLER	B
SINE	C	SOELBERG	B	ST. JOE	B/D	STONYFORD	D	SUTTON	B
SINGLETREE	C	SOFIA	B	ST. JOHNS	B/D	STOOKEY	B	SVEA	B
SINGSAAS	B	SOGN	D	ST. LUCIE	A	STORDEN	B	SVERDRUP	B
SINNIGAM	C	SOGZIE	B	ST. MARTIN	C	STORLA	B	SVOLD	C
SINOMAX	B	SOKOLOF	B	ST. MARYS	B	STORMITT	B	SWAGER	C
SINTON	B	SOLANO	D	ST. NICHOLAS	D	STORM KING	D	SWAKANE	C
SINUK	D	SOLDATNA	B	ST. PAUL	B	STORY	C	SWAN	C
SION	B	SOLDIER	C	ST. THOMAS	D	STOSSEL	C	SWANBOY	D
SIOUX	A	SOL DUC	B	STAATSBURG		STOUGH	C	SWANNER	D
SIPPLE	A	SOLDUC	B	STABLER	B	STOWELL	D	SWANSON	B
SIRI	B	SOLLEKS	C	STACY	B	STOY	D	SWANTON	B/D
SISKIYOU	B	SOLLER	D	STADY	B	STRAIGHT	C	SWANTOWN	C
SISSETON	B	SOLOMON	D	STAFFORD	C	STRAIN	B	SWAPPS	C
SISSON	B	SOLONA	B	STAGECOACH	B	STRASBURG	C	SWARTSWOOD	C
SITES	C	SOMBRERO	D	STAHL	C	STRATFORD	B	SWARTZ	D
SITKA	B	SOMERS	B	STALEY	C	STRAUSS	C	SWASEY	D
SIXMILE	B	SOMERSET	D	STAMBAUGH	B	STRAW	B	SWASTIKA	C
SIZEMORE	B	SOMERVELL	B	STAMFORD	D	STRAWN	B	SWATARA	A
SIZER	B	SOMSEN	C	STAMPEDE	D	STREATOR	C	SWAUK	C
SKAGGS	B	SONOITA	B	STAN	B	STROLE	B	SWAWILLIA	A
SKAGIT	B/C	SONOMA	D	STANDISH	C/D	STRONGHURST	B	SWEATMAN	C
SKAHA	A	SONTAG	D	STANEY	D	STRONTIA	B	SWEDE	B
SKALAN	C	SOPER	B/C	STANFIELD	C	STROUPE	C	SWEDEN	B
SKAMANIA	B	SOQUEL	B	STANLEY	C	STRYKER	B	SWEEN	C
SKAMOKAWA	B	SORDO	C	STANSBURY	D	STUBBS	C	SWEENEY	B
SKANEE	C	SORF	C	STANTON	D	STUCKCREEK	B	SWEET	C
SKELLOCK	B	SORRENTO	B	STAPLETON	B	STUKEL	D	SWEETGRASS	B
SKERRY	C	SORTER	B/D	STARBUCK	D	STUKEY	B	SWEETWATER	D
SKIDMORE	B	SOSA	C	STARGO	B	STUMBLE	A	SWENODA	B
SKIPLET	C	SOTELLA	C	STARICHKOF	D	STUMPP	D	SWIFTCREEK	B
SKINNER	C	SOTIM	B	STARKS	C	STUMP SPRINGS	B	SWIFTON	A
SKIYOU	C	SOUTHFORK	D	STARLEY	D	STUNNER	B	SWIMS	A
SKOKOMISH	B/C	SOUTHGATE	D	STARR	B	STUTTGART	D	SWINGLER	C
SKOOKUMCHUCK	B	SOUTHWICK	C	STASER	B	STUTZMAN	C	SWINK	D
SKOWHEGAN	B	SPAA	D	STATE	B	STUTZVILLE	B/C	SWISBOB	D
SKULL CREEK	D	SPACE CITY	A	STATEN	D	SUBLETTE	B	SWITCHBACK	C
SKUMPAH	D	SPADE	B	STATLER	B	SUDBURY	B	SWITZERLAND	B
SKUTUM	C	SPALDING	D	STAVE	D	SUDDUTH	C	SWOPE	C
SKYBERG	C	SPAN	D	STAYTON	D	SUFFIELD	C	SWYGERT	C
SKYHAVEN	D	SPANAWAY	B	STEAMBOAT	D	SUGARLOAF	B	SYCAMORE	B/C
SKYKOMISH	B	SPANEL	D	STEARNS	D	SUISUN	D	SYCAN	A
SKYLICK	C	SPARTA	A	STECUM	A	SULA	B	SYLACAUGA	B/D
SKYLINE	D	SPEARFISH	B	STEED	A	SULLY	B	SYLVAN	B
SKYWAY	B	SPEARMAN	C	STEEDMAN	D	SULPHURA	D	SYMERTON	B
SLAB	D	SPEARVILLE	C	STEEKEE	C	SULTAN	B	SYNAREP	B
SLATE CREEK	C	SPECK	D	STEELE	B	SUMAS	B/C	SYRACUSE	B
SLAUGHTER	C	SPECTER	D	STEESE	C	SUMDUM	D	SYRENE	D
SLAVEN	D	SPEELYAI	C	STEFF	C	SUMMA	B	SYRETT	C
SLAWSON	B	SPEIGLE	B	STEGALL	C	SUMMERFIELD	C		
SLAYTON	D	SPENARD	D	STEIGER	A	SUMMERS	B	TABERNASH	B
SLEETH	C	SPENCER	B	STEINAUER	B	SUMMERVILLE	C	TABIONA	B
SLETTEN	D	SPENLO	B	STEINBECK	B	SUMMIT	C	TABLE MOUNTAIN	B
SLICKROCK	B	SPERRY	C	STEINMETZ	D	SUMMITVILLE	B	TABLER	D
SLIGHTS	D	SPICER	C	STEINSBURG	C	SUMTER	C	TABOR	D
SLIGO	B	SPILLVILLE	B	STEIWER	C	SUN	D	TACAN	B
SLIKOK	D	SPINKS	A	STELLAR	C	SUNBURST	C	TACOMA	D
SLIP	B	SPIRES	D	STEMILT	C	SUNBURY	B	TACOOSH	D
SLIPMAN	B/C	SPIRIT	B	STENDAL	C	SUNCOOK	A	TAFT	C
SLOAN	D	SPIRO	B	STEPHEN	C	SUND	C	TAGGERT	C
SLOCUM	B	SPLENDORA	C	STEPHENSBURG	B	SUNDELL	C	TAHOMA	B
SLODUC	C	SPLITRO	D	STEPHENVILLE	B	SUNDERLAND	C/D	TAHQUAMENON	D
SLOSS	C	SPOFFORD	C	STERLING	B	SUNDOWN	B	TAHQUATS	C
SLUICE	B	SPOKANE	B	STERLINGTON	B	SUNFIELD	B	TAINTOR	C
SMARTS	B	SPONSELLER	B	STETSON	B	SUNNILAND	C	TAJO	C
SMITH CREEK	A	SPOON BUTTE	D	STETTER	D	SUNNYHAY	D	TAKEUCHI	C
SMITHDALE	B	SPOONER	C	STEUBEN	B	SUNNYSIDE	B	TAKILMA	B
SMITHNECK	B	SPOTTSWOOD	B	STEVENS	B	SUNNYVALE	C	TAKOTNA	B
SMITHTON	D	SPRAGUE	B/C	STEVENSON	B	SUNRAY	B	TALAG	D
SMOLAN	C	SPRECKELS	C	STEWART	D	SUNRISE	D	TALANTE	C
SMOOT	D	SPRING	C/D	STICKNEY	C	SUNSET	B	TALAPUS	B
SNAG	B	SPRING CREEK	C	STIDHAM	A	SUNSHINE	C	TALBOTT	C
SNAHOPISH	B	SPRINGDALE	B	STIGLER	C	SUNSWEET	C	TALCOT	C
SNAKE	C	SPRINGER	B	STILLMAN	A	SUNUP	D	TALIHINA	D
SNAKE HOLLOW	B	SPRINGERVILLE	D	STILLWATER	D	SUPAN	B	TALKEETNA	C
SNAKELUM	B	SPRINGFIELD	D	STILSON	B	SUPERIOR	C	TALLAC	B
SNEAD	D	SPRINGMEYER	C	STIMSON	B/C	SUPERSTITION	A	TALLADEGA	C
SNELL	C	SPRINGTOWN	C	STINGAL	B	SUPERVISOR	C	TALLAPOOSA	C
SNELLING	B	SPROUL	D	STINSON	C	SUPPLEE	B	TALLEYVILLE	B
SNOHOMISH	D	SPUR	B	STIRK	D	SUR	B	TALLS	B
SNOQUALMIE	B	SPURLOCK	B	STIRUM	B	SURGEM	C	TALLULA	B

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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES FOR HYDROLOGIC CLASSIFICATIONS

TALLY	B	TENINO	B	TIGERON	A	TOMERA	D	TRENTON	D
TALMAGE	A	TENNO	D	TIGIWON	B	TOMICHI	A	TREP	B
TALMO	B	TENORIO	B	TIGRETI		TOMOKA	A/D	TRES HERMANOS	B
TALOKA	D	TENOT	C	TIGUA	D	TONASKET	B	TRETTEN	C
TALPA	D	TENRAG	B	TIJERAS	B	TONATA	C	TREVINO	D
TAMA	B	TENSAS	D	TILFORD	B	TONAWANDA	C	TREXLER	C
TAMAHA	C	TENSED	C	TILLEDA	B	TONEY	D	TRIAMI	C
TAMALCO	D	TENSLEEP	B	TILLICUM	B	TONGUE RIVER	C	TRIASSIC	
TAMBA	C/D	TEOCULLI	B	TILLMAN	C	TONINI	B	TRICON	C
TAMELY	[illegible]	TEPEE	D	TILMA	C	TONKA	C	TRIDELL	B
TAMMANY CREEK	B	TEPETE	B/D	TILSIT	C	TONKEY	D	TRIDENT	D
TAMMANY RIDGE	B	TERBIES	C	TILTON	B	TONKIN	C	TRIGO	C
TAMMS	C	TERESA	C	TIMBERG	C	TONKS	B/D	TRIMBLE	B
TAMPICO	B	TERINO	D	TIMBERLY	B	TONOPAH	B	TRIMMER	B
TANAMA	D	TERMINAL	D	TIMBLIN	D	TONOR	C	TRINCHERA	C
TANANA	D	TERMO	C	TIMENTWA	B	TONOWEK	B	TRINITY	D
TANBERG	D	TEROUGE	D	TIMKEN	D	TONRA	A	TRIOMAS	B
TANDY	C	TERRA CEIA	A/D	TIMMERMAN	B	TONSINA	B	TRIPIT	C
TANEUM	C	TERRAD	D	TIMMONS	B	TONUCO	C	TRIPLEN	B
TANEY	C	TERRERA	C	TIMPAHUTE	D	TOOLE	D	TRIPOLI	C
TANGAIR	C	TERRETON	C	TIMPANOGOS	B	TOOMES	D	TRIPP	B
TANNA	C	TERRIL	B	TIMPER	D	TOP	C	TRITON	C
TANNER	C	TERRY	B	TIMPOONEKE	B	TOPIA	D	TRIX	B
TANSEM	B	TERWILLIGER	C	TIMULA	B	TOPPENISH	B/C	TROJAN	B
TANTALUS	A	TESAJO	A	TINA	C	TOPTON		TRONMALD	D
TANWAX	D	TESCOTT	C	TINDAHAY	A	TOQUERVILLE	C	TROMP	C
TAOPI	C	TESUQUE	B	TINE	A	TOQUOP	A	TRONSEN	C
TAOS	D	TETON	A	TINGEY	B	TORBOY	B	TROOK	B
TAPIA	C	TETONIA	B	TINSLEY	A	TORCHLIGHT	C	TROPAL	D
TAPPEN	D	TETONKA	C	TINTON	A	TORDIA	D	TROSI	D
TARA	B	TETOTUM	C	TINYTOWN	B	TORHUNTA	C	TROUP	A
TARKIO	D	TEW	B/D	TIOCANO	D	TORNING	B	TROUT CREEK	C
TARKLIN	C	TEX	B	TIOGA	B	TORODA	B	TROUTDALE	B
TARPO	C	TEXLINE	B	TIPPAH	C	TORONTO	C	TROUT LAKE	C
TARRANT	D	TEZUMA	C	TIPPECANOE	B	TORPEDO LAKE	D	TROUT RIVER	A
TARRETE	D	THACKERY	B	TIPPER	A	TORREON	C	TROUTVILLE	B
TARRYALL	B	THADER	C	TIPPERARY	A	TORRES	B	TROXEL	B
TASCOSA	B	THAGE	C	TIPPIPAH	D	TORRINGTON	B	TROY	C
TASSEL	D	THANTON	A	TIPPO	C	TORRO	C	TRUCE	C
TATE	B	THATCHER	B	TIPTON	B	TORSIDO	D	TRUCKEE	C
TATIYEE	C	THATUNA	C	TIPTONVILLE	B	TORTUGAS	D	TRUCKTON	B
TATU	C	THAYNE	B	TIRO	C	TOSTON	D	TRUEFISSURE	A
TATUM	C	THEBES	B	TISBURY	B	TOTELAKE	A	TRUESDALE	C
TAUNTON	C	THEBO	D	TISCH	C	TOTEM	B	TRULL	C
TAVARES	A	THEDALUND	C	TISH TANG	B	TOTTEN	B	TRULON	B
TAWAS	A/D	THENAS	C	TITUSVILLE	C	TOUCHET	B	TRUMAN	B
TAWCAW	C	THEO	C	TIVERTON	A	TOUHEY	B	TRUMBULL	D
TAYLOR	C	THERESA	B	TIVOLI	A	TOULON	B	TRUMP	D
TAYLOR CREEK	D	THERIOT	D	TIVY	C	TOURN	C	TRYON	D
TAYLORSFLAT	D	THERMAL	C	TOA	C	TOURNQUIST	B	TSCHICOMA	B
TAYLORSVILLE	C	THERMOPOLIS	D	TOBICO	D	TOURS	B	TUB	C
TAYSOM	B	THESS	B	TOBIN	B	TOUTLE	A	TUBAC	C
TAZLINA	A	THETFORD	A	TOBISH	C	TOWER	D	TUCANNON	C
TEAL	D	THIEL	A	TOBLER	B	TOWHEE	D	TUCKERMAN	D
TEALSON	C	THIOKOL	C	TOBOSA	D	TOWNER	B	TUCSON	B
TEALWHIT	C	THOENY	D	TOBY	B	TOWNLEY	C	TUCUMCARI	B
TEANAWAY	C	THOMAS	D	TOCCOA	B	TOWNSBURY	B	TUFFIT	D
TEAPO	B	THORNDALE	D	TODD	B	TOWNSEND	C	TUGHILL	D
TEAS	C	THORNDIKE	C/D	TODDLER	B	TOWSON	B	TUJUNGA	A
TEASDALE	B	THORNOCK	D	TODDVILLE	B	TOXAWAY	D	TUKEY	C
TEBO	B	THORNTON	D	TOEHEAD	C	TOY	D	TUKWILA	D
TECHICK	B	THORNWOOD	B	TOEJA	C	TOYAH	B	TULA	C
TECOLOTE	B	THOROUGHFARE	B	TOEM	C	TOZE	B	TULANA	C/D
TECUMSAH	B	THORP	C	TOGO	B	TRABUCO	C	TULARE	C/D
TEDROW	B	THORR	B	TOGUS	D	TRACK	B/C	TULAROSA	B
TEEL	B	THORREL	B	TOHONA	C	TRACY	B	TULIA	B
TEHACHAPI	D	THOW	B	TOINE	C	TRAER	C	TULLAHASSEE	C
TEHAMA	C	THREE MILE	D	TOISNOT	D	TRAIL	A	TULLER	D
TEJA	I	THROCK	C	TOIYABE	C	TRAIL CREEK	B	TULLOCK	B
TEJON	B	THUNDERBIRD	D	TOKEEN	B	TRAM	B	TULLY	C
TEKOA	C	THURBER	C	TOKUL	C	TRANSYLVANIA	B	TULUKSAK	D
TELA	B	THURLONI	C	TOLBY	A	TRAPPER	A	TUMBEZ	D
TELEFONO	C	THURLOW	C	TOLEDO	D	TRAPPIST	C	TUMEY	D
TELEPHONE	D	THURMAN	A	TOLICHA	D	TRAPPS	B	TUMITAS	B
TELFER	A	THURMONT	B	TOLKE	B	TRASK	C	TUMWATER	A
TELFERNER	D	THURSTON	B	TOLL	A	TRAVELERS	D	TUNEHEAN	D
TELIDA	D	TIAGOS	B	TOLLGATE	B	TRAVER	B/C	TUNICA	D
TELL	B	TIAK	C	TOLLHOUSE	D	TRAVESSILLA	D	TUNIS	D
TELLER	B	TIBAN	B	TOLMAN	D	TRAVIS	C	TUNITAS	B
TELLICO	B	TIBBITTS	B	TOLNA	B	TRAWICK	B	TUNKHANNOCK	A
TELLMAN	B	TICA	D	TOLO	B	TRAY	C	TUNNEL	B
TELSTAD	B	TICE	C	TOLSONA	D	TREADWAY	D	TUPELO	D
TEMESCAL	D	TICHIGAN	C	TOLSTOI	D	TREASURE	B	TUPUKNUK	D
TEMPLE	B/C	TICHNOR	D	TOLT	D	TREBLOC	D	TUQUE	B
TEMVIK	B	TICKAPOO	D	TOLTEC	C	TREGO	C	TURBEVILLE	C
TENABO	D	TICKASON	B	TOLUCA	B	TRELONA	D	TURBOTVILLE	C
TENAHA	B	TIDWELL	D	TOLVAR	B	TREMANT	B	TURBYFILL	B
TENAS	C	TIERRA	D	TOMAH	C	TREMBLES	B	TURIN	B
TENCEE	D	TIETON	B	TOMAS	B	TREMPE	A	TURK	D
TENERIFFE	C	TIFFANY	C	TOMAST	C	TREMPEALEAU	B	TURKEYSPRINGS	C
TENEX	A	TIFTON	B	TOME	B	TRENARY	B	TURLEY	C
TENIBAC	B	TIGER CREEK	B	TOMEL	D	TRENT	B	TURLIN	B

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TURNBOW	C	USINE	B	VERDUN	D	WADDELL	B	WARDEN	B
TURNER	B	USKA	D	VERGENNES	D	WADDUPS	B	WARDWELL	C
TURNERVILLE	B	UTALINE	B	VERHALEN	D	WADELL	B	WARE	B
TURNEY	B	UTE	C	VERMEJO	D	WADENA	B	WAREHAM	C
TURRAH	D	UTICA	A	VERNAL	B	WADESBORO	B	WARMAN	D
TURRET	B	UTLEY	B	VERNALIS	B	WADLEIGH	D	WARM SPRINGS	C
TURRIA	C	UTUADO	B	VERNIA	A	WADMALAW	D	WARNERS	A/D
TURSON	B/C	UVADA	D	VERNON	D	WADSWORTH	C	WARREN	
TUSCAN	D	UVALDE	C	VERONA	C	WAGES	B	WARRENTON	B/D
TUSCARAWAS	C	UWALA	B	VESSER	C	WAGNER	D	WARRIOR	
TUSCARORA	C			VESTON	D	WAGRAM	A	WARSAW	B
TUSCOLA	B	VACHERIE	C	VETAL	A	WAHA	C	WARSING	B
TUSCUMBIA	D	VADER	B	VETERAN	B	WAHEE	D	WARWICK	A
TUSEL	C	VADO	B	VEYO	D	WAHIAWA	B	WASATCH	A
TUSKEEGO	C	VAIDEN	D	VIA	B	WAHIKULI	B	WASEPI	B
TUSLER	B	VAILTON	B	VIAN	B	WAHKEENA	B	WASHBURN	
TUSQUITEE	B	VALBY	C	VIBORAS	D	WAHKIACUS	B	WASHINGTON	B
TUSTIN	B	VALCO	C	VIBORG	B	WAHLUKE	B	WASHOE	C
TUSTUMENA	B	VALDEZ	B/C	VICKERY	C	WAHMONIE	D	WASHOUGAL	B
TUTHILL	B	VALE	B	VICKSBURG	B	WAHPETON	C	WASHTENAW	C/D
TUTNI	B	VALENCIA	B	VICTOR	A	WAHTIGUP	B	WASILLA	D
TUTWILER	B	VALENT	A	VICTORIA	D	WAHTUM	D	WASIOJA	B
TUXEDO		VALENTINE	A	VICTORY	B	WAIAHA	D	WASSAIC	B
TUXEKAN	B	VALERA	C	VICU	D	WAIAKOA	C	WATAB	C
TWIN CREEK	B	VALKARIA	B/D	VIDA	B	WAIALEALE	D	WATAUGA	B
TWINING	C	VALLAN	D	VIDRINE	C	WAIALUA	B	WATCHAUG	B
TWISP	B	VALLECITOS	C/D	VIEJA	D	WAIAWA	D	WATCHUNG	D
TWO DOT	C	VALLEONO	B	VIENNA	B	WAIHUNA	D	WATERBORO	
TYBO	D	VALLERS	C	VIEQUES	B	WAIKALOA	B	WATERBURY	D
TYEE	D	VALMONT	C	VIEW	C	WAIKANE	B	WATERINO	C
TYGART	D	VALMY	B	VIGAR	C	WAIKAPU	B	WATERS	C
TYLER	D	VALOIS	B	VIGO	D	WAIKOMO	D	WATKINS	B
TYNDALL	B/C	VAMER	D	VIGUS	C	WAILUKU	B	WATKINS RIDGE	B
TYNER	A	VANAJO	D	VIKING	D	WAIMEA	B	WATO	B
TYRONE	C	VANANDA	D	VIL	D	WAINEE	B	WATOPA	B
TYSON	C	VAN BUREN		VILAS	A	WAINGLA	A	WATROUS	B
		VANCE	C	VILLA GROVE	B	WAIPAHU	C	WATSEKA	C
UANA	D	VANDA	D	VILLARS	B	WAISKA	B	WATSON	C
UBAR	C	VANDALIA	C	VILLY	D	WAITS	B	WATSONIA	D
UBLY	B	VANDERDASSON	D	VINA	B	WAKE	D	WATSONVILLE	D
UCOLA	D	VANDERGRIFT	C	VINCENNES	C	WAKEEN	B	WATT	D
UCOLO	C	VANDERHOFF	D	VINCENT	C	WAKEFIELD	B	WATTON	C
UCOPIA	B	VANDERLIP	A	VINEYARD	C	WAKELAND	B/D	WAUBAY	B
UDEL	D	VAN DUSEN	B	VINGO	B	WAKONDA	C	WAUBEEK	B
UDOLPHO	C	VANET	D	VINING	C	WAKULLA	A	WAUBONSIE	B
UFFENS	D	VANG	B	VINITA	C	WALCOTT	B	WAUCHULA	B/D
UGAK	D	VANHORN	B	VINLAND	C	WALDECK	C	WAUCOMA	B
UHLAND	B	VAN NOSTERN	B	VINSAD	C	WALDO	D	WAUCONDA	B
UHLIG	B	VANNOY	B	VINT	B	WALDRON	D	WAUKEE	B
UINTA	B	VANOSS	B	VINTON	B	WALDROUP	D	WAUKEGAN	B
UKIAH	C	VANTAGE	C	VIRA	C	WALES	B	WAUKENA	D
ULEN	B	VAN WAGONER	D	VIRATON	C	WALFORD	C	WAUKON	B
ULLOA	B	VARCO	C	VIRDEN	C	WALKE	C	WAUMBEK	B
ULM	B	VARELUM	C	VIRGIL	B	WALL	B	WAURIKA	D
ULRICHER	B	VARICK	D	VIRGIN PEAK	D	WALLACE	B	WAUSEON	B/D
ULUPALAKUA	B	VARINA	C	VIRGIN RIVER	D	WALLA WALLA	B	WAVERLY	B/D
ULY	B	VARNA	C	VIRTUE	C	WALLER	B/D	WAWAKA	C
ULYSSES	B	VARRO	B	VISALIA	B	WALLINGTON	C	WAYCUP	B
UMA	A	VARYSBURG	B	VISTA	C	WALLIS	B	WAYDEN	D
UMAPINE	B/C	VASHTI	C	VIVES	B	WALLKILL	C/D	WAYLAND	C/D
UMIAT	D	VASQUEZ	B	VIVI	B	WALLMAN	C	WAYNE	B
UMIKOA	B	VASSALBORO	D	VLASATY	C	WALLOWA	C	WAYNESBORO	B
UMIL	D	VASSAR	B	VOCA	C	WALLPACK	C	WAYSIDE	
UMNAK	B	VASTINE	C	VODERMAIER	B	WALLROCK	B/C	WEA	B
UMPA	B	VAUCLUSE	C	VOLADORA	B	WALLSBURG	D	WEAVER	C
UMPQUA	B	VAUGHNSVILLE	C	VOLCO	D	WALLSON	B	WEBB	C
UNA	D	VAYAS	D	VOLENTE	C	WALPOLE	C	WEBER	B
UNADILLA	B	VEAL	B	VOLGA	D	WALSH	B	WEBSTER	C
UNAWEEP	B	VEAZIE	B	VOLIN	B	WALSHVILLE	D	WEDEKIND	D
UNCOM	B	VEBAR	B	VOLINIA	B	WALTERS	A	WEDERTZ	C
UNCOMPAHGRE	D	VECONT	D	VOLKE	C	WALTON	C	WEDGE	A
UNEEDA	B	VEGA	C	VOLKMAR	B	WALUM	B	WEDOWEE	D
UNGERS	B	VEGA ALTA	C	VOLMER	D	WALVAN	B	WEED	B
UNION	C	VEGA BAJA	C	VOLNEY	B	WAMBA	B/C	WEEDING	A/C
UNIONTOWN	B	VEKOL	D	VOLPERIE	C	WAMIC	B	WEEDMARK	B
UNIONVILLE	C	VELDA	B	VOLTAIRE	D	WAMPSVILLE	B	WEEKSVILLE	B/D
UNISON	C	VELMA	B	VOLUSIA	C	WANATAH	B	WEEPON	D
UPDIKE	D	VELVA	B	VONA	B	WANBLEE	D	WEHADKEE	D
UPSAL	C	VENA	C	VORE	B	WANDO	A	WEIKERT	C/D
UPSATA	A	VENANGO	C	VROOMAN	B	WANETTA	A	WEIMER	D
UPSHUR	C	VENATOR	D	VULCAN	C	WANILLA	C	WEINBACH	C
UPTON	C	VENETA	C	VYLACH	D	WANN	A	WEIR	D
URACCA	B	VENEZIA	D			WAPAL	B	WEIRMAN	B
URBANA	C	VENICE	D	WABANICA	D	WAPATO	C/D	WEISER	C
URBO	D	VENLO	D	WABASH	D	WAPELLO	B	WEISHAUPT	D
URICH	D	VENUS	B	WABASHA	D	WAPINITIA	B	WEISS	A
URNE	B	VERBOORT	D	WABASSA	B/D	WAPPING	B	WEITCHPEC	B
URSINE	D	VERDE	C	WABEK	B	WAPSIE	B	WELAKA	A
URTAH	C	VERDEL	D	WACA	C	WARBA	B	WELBY	B
URWIL	D	VERDELLA	D	WACOTA	B	WARD	D	WELCH	C
USAL	B	VERDICO	D	WACOUSTA	C	WARDBORO	A	WELD	C
USHAR	B	VERDIGRIS	B	WADAMS	B	WARDELL	D	WELDA	C

NOTES A BLANK HYDROLOGIC SOIL GROUP INDICATES THE SOIL GROUP HAS NOT BEEN DETERMINED
TWO SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION

Soil Name	Group
WELDON	D
WELDONA	B
WELLER	C
WELLINGTON	D
WELLMAN	B
WELLNER	B
WELLSBORO	C
WELLSTON	B
WELLSVILLE	B
WELRING	D
WEMPLE	B
WENAS	B/C
WENATCHEE	C
WENDEL	B/C
WENHAM	
WENONA	C
WENTWORTH	B
WERLOW	C
WERNER	B
WESO	C
WESSEL	B
WESTBROOK	D
WESTBURY	C
WESTCREEK	B
WESTERVILLE	C
WESTFALL	C
WESTFIELD	
WESTFORD	
WESTLAND	B/D
WESTMINSTER	C/D
WESTMORE	B
WESTMORELAND	B
WESTON	D
WESTPHALIA	B
WESTPLAIN	C
WESTPORT	A
WESTVILLE	B
WETHERSFIELD	C
WETHEY	B/C
WETTERHORN	C
WETZEL	D
WEYMOUTH	B
WHAKANA	B
WHALAN	B
WHARTON	C
WHATCOM	C
WHATELY	D
WHEATLEY	D
WHEATRIDGE	C
WHEATVILLE	B
WHEELER	B
WHEELING	B
WHEELON	D
WHELCHEL	B
WHETSTONE	B
WHIDBEY	C
WHIPPANY	C
WHIPSTOCK	C
WHIRLO	B
WHIT	B
WHITAKER	C
WHITCOMB	C
WHITE BIRD	C
WHITECAP	D
WHITEFISH	B
WHITEFORD	B
WHITEHORSE	B
WHITE HOUSE	C
WHITELAKE	B
WHITELAW	B
WHITEMAN	D
WHITEROCK	D
WHITESBURG	C
WHITE STORE	D
WHITE SWAN	C
WHITEWATER	B
WHITEWOOD	C
WHITLEY	B
WHITLOCK	B
WHITMAN	D
WHITNEY	B
WHITORE	A
WHITSOL	B
WHITSON	D
WHITWELL	C
WHOLAN	C
WIBAUX	C
WICHITA	C
WICHUP	D
WICKERSHAM	B
WICKETT	C
WICKHAM	B
WICKIUP	C
WICKLIFFE	D
WICKSBURG	B
WIDTSOE	C
WIEHL	C
WIEN	D
WIGGLETON	B
WIGTON	A
WILBRAHAM	C
WILBUR	C
WILCO	C
WILCOX	D
WILCOXSON	C
WILDCAT	D
WILDER	B
WILDERNESS	C
WILDROSE	D
WILDWOOD	D
WILEY	C
WILKES	C
WILKESON	C
WILKINS	D
WILL	D
WILLACY	B
WILLAKENZIE	C
WILLAMAR	D
WILLAMETTE	B
WILLAPA	C
WILLARD	B
WILLETTE	A/D
WILLHAND	B
WILLIAMS	B
WILLIAMSBURG	B
WILLIAMSON	C
WILLIS	C
WILLITS	B
WILLOUGHBY	B
WILLOW CREEK	B
WILLOWDALE	B
WILLOWS	D
WILLWOOD	A
WILMER	C
WILPAR	D
WILSON	D
WILTSHIRE	C
WINANS	B/C
WINBERRY	D
WINCHESTER	A
WINCHUCK	C
WINDER	B/D
WINDHAM	B
WINDMILL	B
WINDOM	B
WIND RIVER	B
WINDSOR	A
WINDTHORST	C
WINDY	C
WINEG	C
WINEMA	C
WINETTI	B
WINFIELD	C
WING	D
WINGATE	B
WINGER	C
WINGVILLE	B/D
WINIFRED	C
WINK	B
WINKEL	D
WINKLEMAN	C
WINKLER	A
WINLO	D
WINLOCK	C
WINN	C
WINNEBAGO	B
WINNEMUCCA	B
WINNESHIEK	B
WINNETT	D
WINONA	D
WINOOSKI	B
WINSTON	A
WINTERS	C
WINTERSBURG	C
WINTERSET	C
WINTHROP	A
WINTONER	C
WINU	C
WINZ	C
WIOTA	B
WISHARD	A
WISHEYLU	C
WISHKAH	C
WISKAH	C
WISNER	D
WITBECK	D
WITCH	D
WITHAM	D
WITHEE	C
WITT	B
WITZEL	D
WODEN	B
WODSKOW	B/C
WOLCOTTSBURG	
WOLDALE	C/D
WOLF	B
WOLFESEN	C
WOLFESON	C
WOLFORD	B
WOLF POINT	D
WOLFTEVER	C
WOLVERINE	A
WOODBINE	B
WOODBRIDGE	C
WOODBURN	C
WOODBURY	D
WOODCOCK	B
WOODENVILLE	C
WOODGLEN	D
WOODHALL	B
WOODHURST	A
WOODINVILLE	C/D
WOODLY	B
WOODLYN	C/D
WOODMANSIE	B
WOODMERE	B
WOOD RIVER	D
WOODROCK	C
WOODROW	C
WOODS CROSS	D
WOODSFIELD	C
WOODSIDE	A
WOODSON	D
WOODSTOCK	C/D
WOODSTOWN	C
WOODWARD	B
WOOLMAN	B
WOOLPER	C
WOOLSEY	C
WOOSLEY	C
WOOSTER	C
WOOSTERN	B
WOOTEN	A
WORCESTER	B
WORF	D
WORK	C
WORLAND	B
WORLEY	C
WORMSER	C
WOROCK	B
WORSHAM	D
WORTH	C
WORTHEN	B
WORTHING	D
WORTHINGTON	C
WORTMAN	C
WRENTHAM	C
WRIGHT	C
WRIGHTMAN	C
WRIGHTSVILLE	D
WUNJEY	B
WURTSBORO	C
WYALUSING	D
WYARD	B
WYARNO	B
WYATT	C
WYEAST	C
WYEVILLE	C
WYGANT	C
WYKOFF	B
WYMAN	B
WYMORE	C
WYNN	B
WYNOOSE	D
WYO	B
WYOCENA	B
XAVIER	B
YACOLT	B
YAHARA	B
YAHOLA	B
YAKI	D
YAKIMA	B
YAKUS	D
YALLANI	B
YALMER	B
YAMAC	B
YAMHILL	C
YAMPA	C
YAMSAY	D
YANA	B
YANCY	C
YARDLEY	C
YATES	D
YAUCO	C
YAWDIM	D
YAWKEY	C
YAXON	B
YEARY	C
YEATES HOLLOW	C
YEGEN	B
YELM	B
YENRAB	A
YEOMAN	B
YESUM	B
YSTULL	A
YOOER	B
YOKOHL	D
YOLLABOLLY	D
YOLO	B
YOLOGO	D
YOMBA	C
YOMONT	B
YONCALLA	C
YONGES	D
YONNA	B/D
YORDY	B
YORK	C
YORKVILLE	D
YOST	C
YOUGA	B
YOUMAN	C
YOUNGSTON	B
YOURAME	A
YOVIMPA	D
YSIDORA	D
YTURBIDE	A
YUBA	D
YUKO	C
YUKON	D
YUNES	D
YUNQUE	C
ZAAR	D
ZACA	D
ZACHARIAS	B
ZACHARY	D
ZAFRA	B
ZAHILL	B
ZAHL	B
ZALESKI	C
ZALLA	A
ZAMORA	B
ZANE	C
ZANEIS	B
ZANESVILLE	C
ZANONE	C
ZAPATA	C
ZAVALA	B
ZAVCO	C
ZEB	B
ZEESIX	C
ZELL	B
ZEN	C
ZENDA	C
ZENIA	B
ZENIFF	B
ZEONA	A
ZIEGLER	C
ZIGWEID	B
ZILLAH	B/C
ZIM	D
ZIMMERMAN	A
ZING	C
ZINZER	B
ZION	C
ZIPP	C/D
ZITA	B
ZOAR	C
ZOATE	D
ZOHNER	B/D
ZOOK	C
ZORRAVISTA	A
ZUFELT	B/D
ZUKAN	D
ZUMBRO	B
ZUMWALT	C
ZUNDELL	B/C
ZUNHALL	B/C
ZUNI	D
ZURICH	B
ZWINGLE	D

NOTES A BLANK HYDROLOGIC SOIL GROUP INDICATES THE SOIL GROUP HAS NOT BEEN DETERMINED
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SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

S.C.S. SOIL NAMES FOR HYDROLOGIC CLASSIFICATIONS

SECTION D

RATIONAL METHOD

D.1. RATIONAL METHOD EQUATION

The rational method was originally developed to estimate peak discharges from small (less then one square mile) urban and developed areas and its use should normally be limited to those conditions. The rational method equation relates rainfall intensity, a runoff coefficient, and drainage area size to the peak runoff from the drainage area. This relationship is expressed by the equation:

$$Q = CIA \qquad \text{(D.1)}$$

where

Q = the peak discharge in cubic feet per second (cfs)

C = a runoff coefficient representing the ratio of runoff depth to rainfall depth (dimensionless)

I = the time-averaged rainfall intensity for a storm duration equal to the time of concentration (inches/hr)

A = drainage area (acres)

The values of the runoff coefficient (C) and the rainfall intensity (I) are based on a study of drainage area characteristics such as type and condition of the runoff surfaces and the time of concentration. These factors and the limitations of the rational method equation are discussed in the following sections. Drainage area (A) may be determined by planimetering a suitable topographic map of the project area.

Data required for the computation of peak discharge by the rational method are: (i) rainfall intensity (I) for a storm of specified duration and selected design frequency; (ii) drainage area characteristics of size (A), shape, slope; and (iii) a runoff coefficient (C).

D.2. LIMITATIONS OF THE RATIONAL METHOD

The validity of the relationship expressed by the rational method equation holds true only if certain assumptions are reasonably correct and limitations of the method are observed. Two basic assumptions are that (i) the frequency of a storm runoff is the same as the frequency of the rainfall producing this runoff; i.e., a 25-year recurrence interval rainfall will provide a 25-year recurrence interval storm runoff, and (ii) that the peak runoff occurs when all parts of the drainage area are contributing to the runoff.

The rational method equation is only applicable where the rainfall intensity (I) can be assumed to be uniformly distributed over the drainage area at a uniform rate throughout the duration of the storm. This condition is generally assumed to reasonably apply to small areas of less than 640 acres. Beyond this limit, the rainfall distribution may vary considerably from the point values given in rainfall isohyetal maps and the rational method equation may be inappropriate.

The selection of the runoff coefficient (C) is another major limitation for the rational method equation. For small urban and developed areas the runoff coefficient can be reasonably well estimated from field and aerial photo studies. For larger areas where the determination of the runoff coefficient is to be based on vegetation type, cover density, the infiltration capacity of the ground surface, and the slope of the drainage area, an estimate of the runoff coefficient may be subject to a much greater error due to the variability of the drainage area characteristics. Rainfall losses due to evaporation, transpiration, depression and channel storage are inadequately evaluated, and may appreciably affect the estimate of the watershed peak rate of runoff, especially in natural cover and desert catchment areas. The effects of depth-area-duration (or depth-area) factors are not accounted for in the simple intensity-duration curve used for rational method studies. For large drainage areas, the absence of depth-area adjustments can result in significant differences in the estimate of the average depth of catchment point rainfalls.

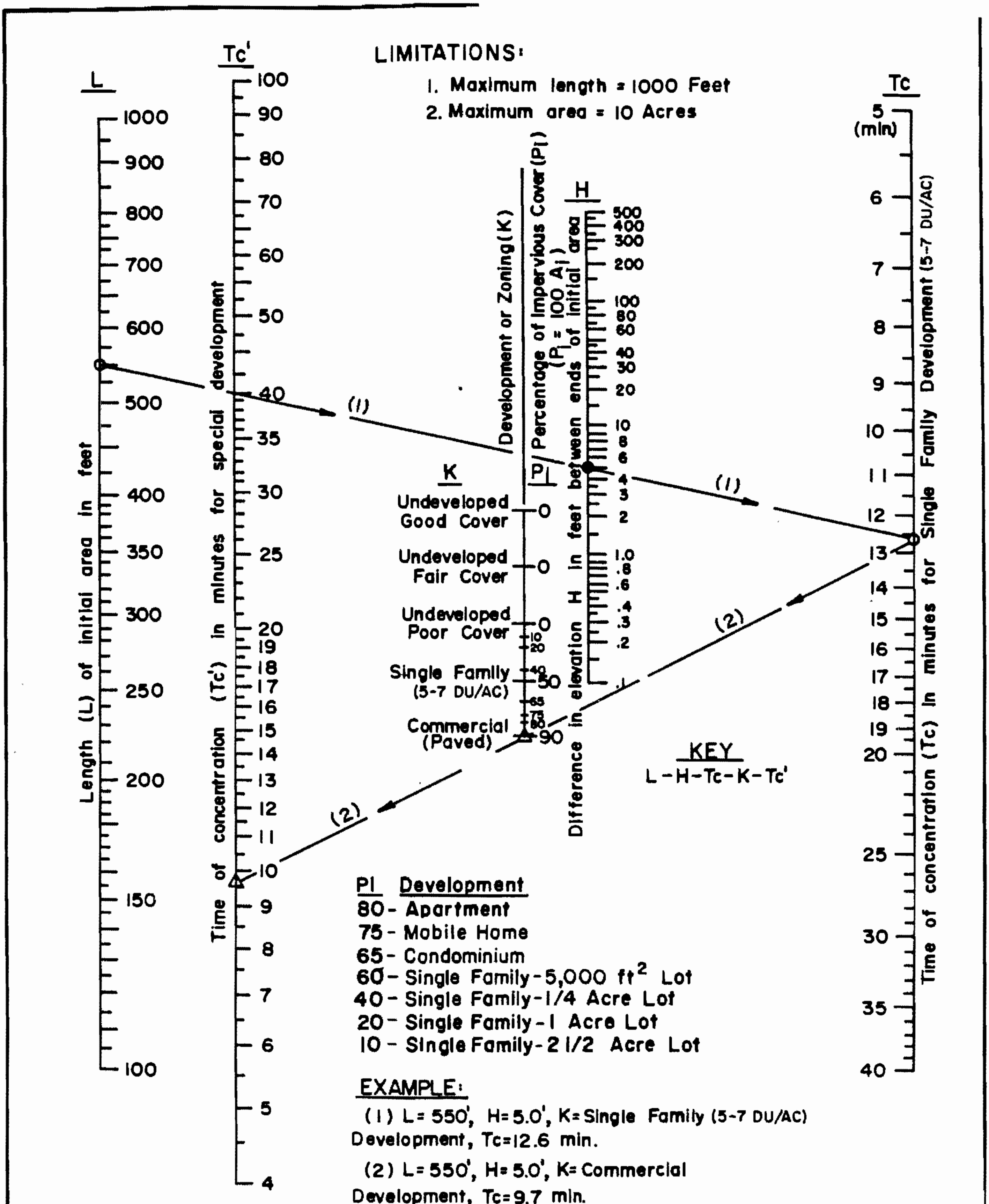
The above limitations indicate that an estimate of the peak rate of runoff becomes less reliable as the drainage area becomes larger and the rational method equation should generally not be used for drainage areas larger than 640 acres.

D.3. CRITICAL DURATION (TIME OF CONCENTRATION)

The critical duration of the storm rainfall required in the rational method equation is based on the time of concentration of the drainage area.

The time of concentration (Tc) is defined as the interval of time (in minutes) required for the flow at a given point to become a maximum under a uniform rainfall intensity. Often this occurs when all parts of the drainage area are contributing to the flow. Generally, the time of concentration is the interval of time from the beginning of rainfall for water from the hydraulically most remote portion of the drainage area to reach the point of concentration; e.g., the inlet of the drainage structure. The time of concentration is a function of many variables including the length of the flow path from the most remote point of an area to the concentration point, the slope and other characteristics of natural and improved channels in the area, the loss rate characteristics of the soil, and the extent and type of development.

For rational method studies based on this manual, the time of concentration for an initial subarea may be estimated from the nomograph of Figure D-1. The time of concentration for the next downstream subarea is computed by adding to the initial Tc, the time required for the computed peak flow to travel to the next concentration point. Time of concentration is computed for each subsequent subarea by computing the runoff peak flow rate travel time between subareas and adding to the cumulative sum.



SAN BERNARDINO COUNTY

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TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

When the flow is concentrated in curb and gutters, drainage channels or conduits, the flow velocity may be estimated by the well-known Manning's equation

$$V = \frac{1.49}{n} R^{2/3} S^{1/2} \qquad \text{(D.2)}$$

where

V	=	mean velocity (fps)
n	=	Manning coefficient of roughness
R	=	hydraulic radius (feet)
S	=	energy slope which equals the conduit invert slope for uniform flow

The travel time will then be the flow distance divided by the velocity of flow.

Computations of travel time through subareas which continually add runoff to the peak flow (e.g., streetflow) should be based on the average peak flow through the subarea. This average peak flow is generally a simple average of the peak flow rates estimated at the upstream and downstream points of the subarea.

The initial subarea Tc estimation often is the most significant factor leading to the Tc computation of a watershed. Small development studies typically utilize only initial subarea estimations due to the small subarea sizes. Larger study areas generally show high sensitivity to the initial subarea Tc. Consequently, judgment is needed when developing initial subarea Tc estimates. The nomograph of Figure D-1 is based on the Kirpich formula and relates an initial subarea Tc to subarea slope and development type. It is assumed in the nomograph that overland flow effects dominate the travel time hydraulics.

It is noted that the Tc computation procedure is based upon the summation of an initial subarea time of concentration with the several travel times estimated by normal depth flow-velocities of the peak flow rates through subsequent subareas.

D.4. INTENSITY-DURATION CURVES

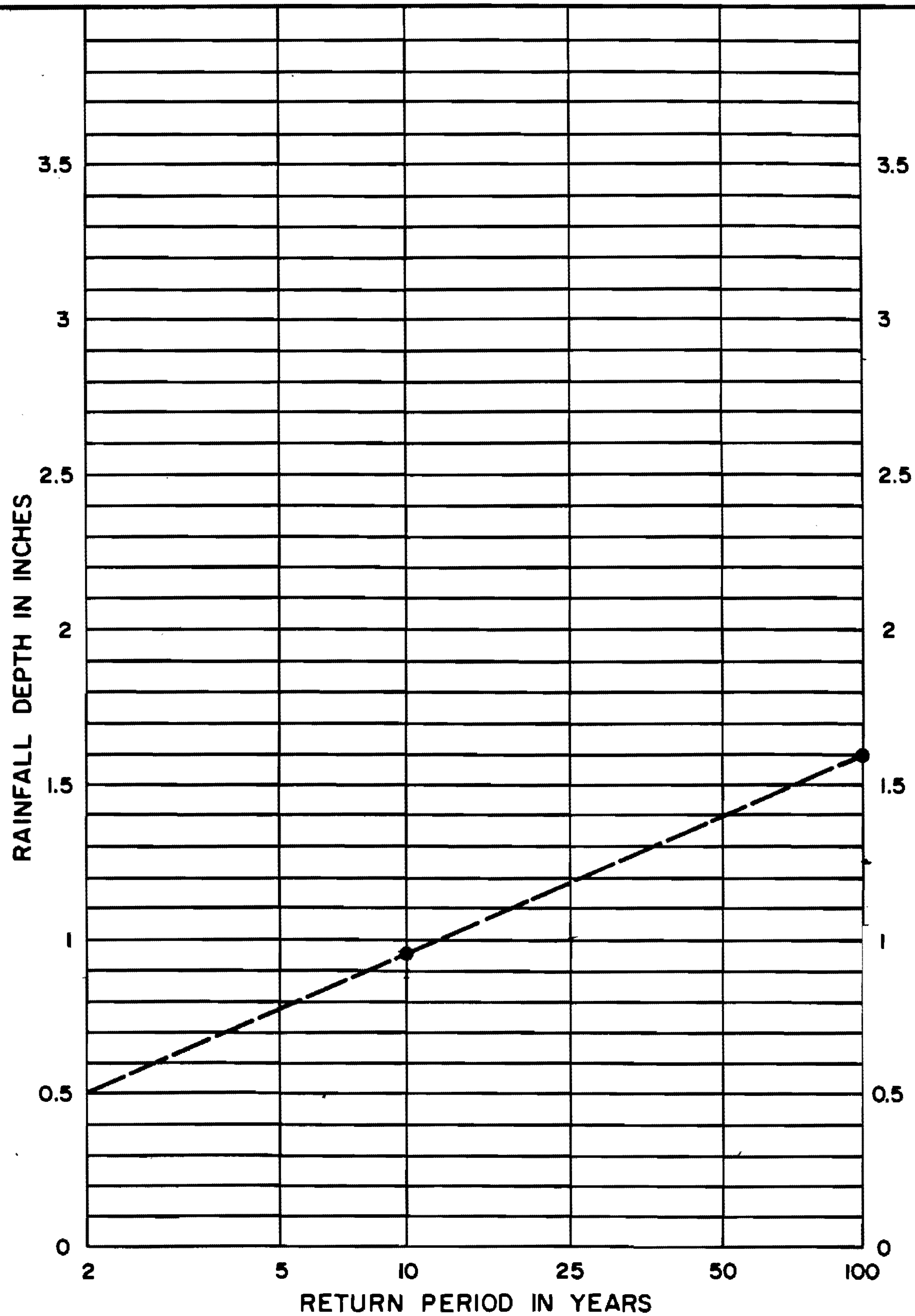
Rainfall intensity (I) is determined using intensity-duration curves which are appropriate for the study watershed.

San Bernardino County has prepared isohyetal maps corresponding to 10-year 1-hour and 100-year 1-hour return frequency precipitation. Point rainfall for intermediate return periods can be determined from Figure D-2. Intensity duration curves for a particular area can be developed using the log-log paper of Figure D-3, plotting the 1-hour point rainfall value for the desired return period, and drawing a straight line through the 1-hour value parallel to the required slope. The slope of the intensity duration curve is assumed to be 0.6 for watersheds in the southwest portion of the County. For desert and mountain watersheds, the slope of the intensity duration curves is assumed to be 0.7. These slope values may be modified if rainfall data record analysis indicates that such modifications are appropriate. Any modifications of the slope values must be approved by the County prior to submittal of a study for County review.

D.5. RUNOFF COEFFICIENT

The runoff coefficient (C) is the ratio of rate of runoff to the rate of rainfall at an average intensity (I) when the total drainage area is contributing. The selection of the runoff coefficient depends on rainfall intensity, drainage area slope, type and amount of vegetative cover, infiltration capacity of the ground surface, and various other factors.

Since one acre-inch/hour is equal to 1.008 cfs, the rational formula is used to estimate a peak flowrate in cfs. The runoff coefficient is assumed to be a function of the impervious and pervious area fractions, an infiltration rate,



NOTE:

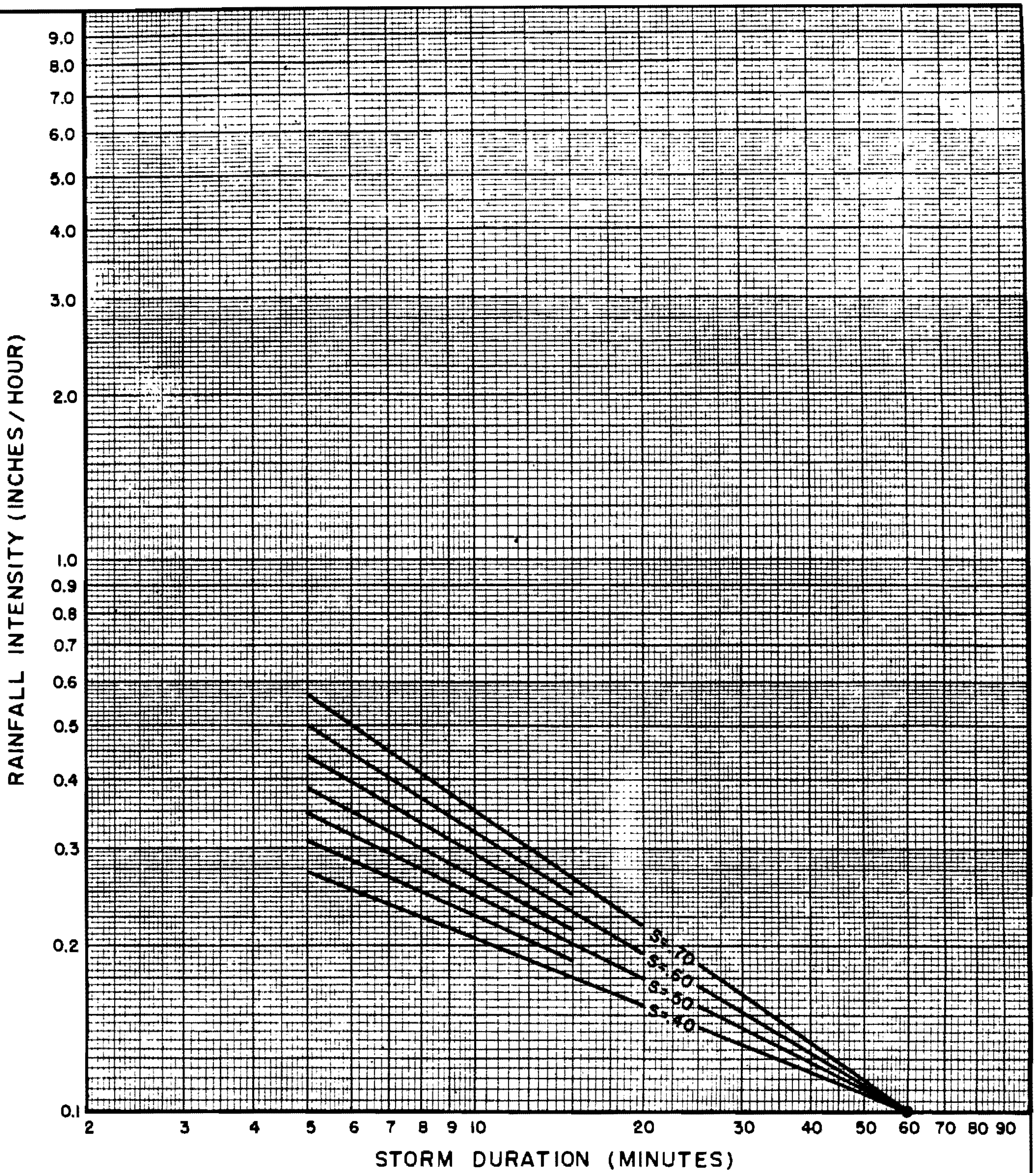
1. FOR INTERMEDIATE RETURN PERIODS PLOT 10-YEAR AND 100-YEAR ONE HOUR VALUES FROM MAPS, THEN CONNECT POINTS AND READ VALUE FOR DESIRED RETURN PERIOD. FOR EXAMPLE GIVEN 10-YEAR ONE HOUR = 0.95" AND 100-YEAR ONE HOUR = 1.60", 25-YEAR ONE HOUR = 1.18".

REFERENCE: NOAA ATLAS 2, VOLUME XI - CAL., 1973

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

RAINFALL DEPTH VERSUS RETURN PERIOD FOR PARTIAL DURATION SERIES

FIGURE D-2



DESIGN STORM FREQUENCY = ______ YEARS

ONE HOUR POINT RAINFALL = ______ INCHES

LOG-LOG SLOPE = ______

PROJECT LOCATION = ____________________

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION
CURVES
CALCULATION SHEET

FIGURE D-3

F_p, for the pervious area, and the effects of watershed detention. Runoff coefficient curves are developed using the relationship:

$$C = \begin{cases} 0.90\left(a_i + \frac{(I - F_p)a_p}{I}\right), & \text{for I greater than } F_p; \\ 0.90\, a_i, & \text{for I less than or equal to } F_p \end{cases} \quad \text{(D.3)}$$

where the proportion factor of 0.90 is a calibration constant determined by an average fit between the rational method and design storm unit hydrograph (see Section E) peak flow rate estimates, and where

C	=	runoff coefficient
I	=	rainfall intensity (inches/hour)
F_p	=	infiltration rate for pervious areas (inches/hour) (see section C.6.4)
a_i	=	ratio of impervious area to total area (decimal fraction)
a_p	=	ratio of pervious area to total area (decimal fraction), ($a_p = 1 - a_i$)

D.6. PEAK FLOW RATE FORMULA

Combining Equations (D.1) and (D.3), the peak flow estimate for Q is written in simpler terms by

$$Q = .90\,(I - F_m)A \quad \text{(D.4)}$$

where $F_m = a_p F_p$ (see section C.6.5), and where in (D.4) it is understood that I is greater than F_p (otherwise $Q = .90\, a_i IA$).

In (D.4), F_m represents the loss rate for the total watershed tributary to the point of concentration. Should the tributary area contain several runoff surfaces, an area-averaged F_m is calculated. Table D.1 illustrates such an area-averaged F_m computation.

TABLE D.1. AREA - AVERAGED F_m COMPUTATION

Subarea Number (1)	a_p (2)	F_p (inch/hour) (3)	Area (acres) (4)	Area Weighting (5)
1	0.60	0.40	8	1.92
2	0.80	0.30	12	2.88
3	0.75	0.25	11	2.06
4	0.10	0.20	15	0.30
5	0.50	0.25	16	2.00
			62	9.16

From Table D.1, the area-averaged maximum loss rate, F_m, is given by F_m = (9.16)/(62) = 0.147 inch/hour, say 0.15.

D.7. DRAINAGE AREA

The contributing drainage area may be determined from topographic contour maps, aerial photos, and field surveys. Watershed divides are then drawn on a suitable topographic map and the enclosed drainage area is determined by planimeter or other methods. In areas where lateral and transverse slopes on the watershed are very mild, the nominal watershed area (or drainage subdivision) runoff may "cascade" under severe rainfall. That is, when the divide between one watershed and another is defined by a low relief feature such as the crown of a road, the runoff from such a watershed may "spill over" into the adjacent watershed or watershed subdivision. This may occur, for example, when gutter capacity is exceeded thereby increasing runoff contributions at downstream or adjacent concentration points above those anticipated by analysis of the nominal or "low flow" drainage boundaries. The possibility of such cascading shall be considered and accounted for by the hydrologist.

D.8. RATIONAL METHOD CONFLUENCE ANALYSIS

In most studies, the calculation of peak flow rates along a main channel or stream involves only the direct application of (D.4). Such studies typically involve the inclusion of subarea runoff to the stream where the effect on the stream peak flow rate is relatively minor and, consequently, only (D.4) is needed for the analysis.

At the junction of two or more streams, however, the estimation of the peak flow rate involves a confluence analysis of the associated runoff hydrographs (see Appendix I).

For the confluence of two streams, let T_1, I_1, Fm_1, A_1, and Q_1, be the time of concentration, rainfall intensity, area-averaged loss rate, catchment area, and peak flow rate for stream #1 while T_2, I_2, Fm_2, A_2 and Q_2 correspond to stream #2. Also, let Q_1 be less than Q_2. Finally, let T_p, A_p, and Q_p be the resulting confluence estimates for Tc, area, and peak flow rate, respectively. Then two cases are possible:

*Case 1: $T_1 = T_2$. The runoff hydrographs must both peak at $T_p = T_1 = T_2$. And $Q_p = Q_1+Q_2$ for a total contributing area of $A_p = A_1+A_2$.

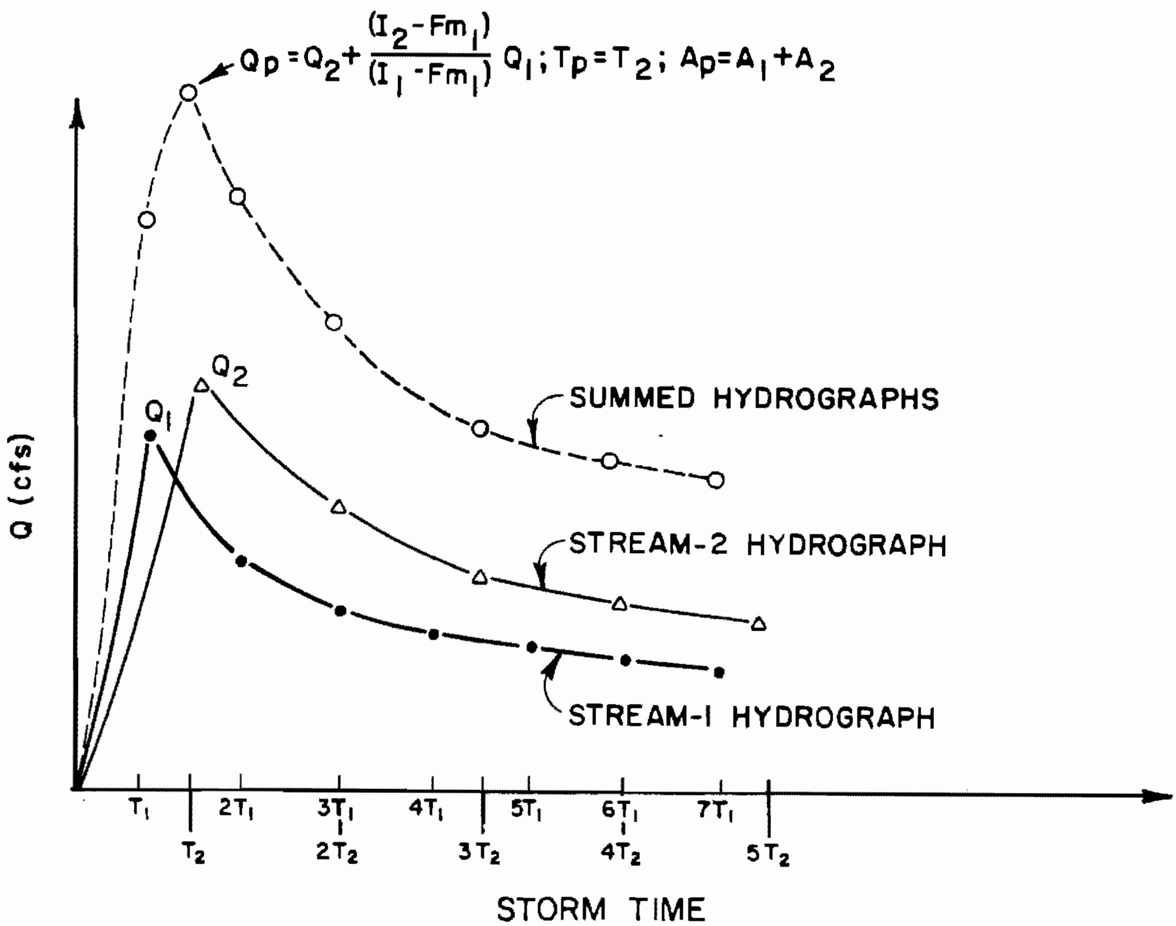
*Case 2: $T_1 \neq T_2$. In this case, the sum of the two runoff hydrographs must be considered. Except in very unusual conditions, flow rates of the summed runoff hydrograph typically achieve a maximum at either T_1 or T_2, and the peak flow rate estimates are calculated as follows:

Case 2a: T_1 is less than T_2. In this case, the stream with the largest Q has the longest Tc. The flow rate of the summed runoff hydrograph at time T_2 is estimated by

$$Q_p = Q_2 + \frac{(I_2-Fm_1)}{(I_1-Fm_1)} Q_1 \tag{D.5}$$

and $T_p = T_2$ (see Figure D-4). It is noted that the confluence peak Q of (D.5) equals the peak flow rate estimated from direct use of (D.4). Additionally, the total contributing area is $A_p=A_1+A_2$.

Case 2b: T_1 is greater than T_2. In this case, the stream with the largest Q has the shortest Tc. The flow rate of the summed runoff hydrograph at time T_1 is estimated using a ratio of



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

RATIONAL METHOD
CONFLUENCE ANALYSIS
(Summation of Runoff Hydrographs)

Figure D-4

stream 1 effective rainfall intensities and Tc values corresponding to times T_2 and T_1 giving

$$Q_p = Q_2 + \frac{(I_2 - Fm_1)}{(I_1 - Fm_1)} \frac{(T_2)}{(T_1)} Q_1 \qquad \text{(D.6)}$$

and $T_p = T_2$. Equation (D.6) indicates that the peak flow rate at time T_2 is the result of the high peak discharge from stream 2 and the runoff contribution from a fraction of the stream 1 catchment area.

That is, a portion of the catchment tributary to stream 1 is not contributing at time T_2 and, in the general case, only $(T_2/T_1)A_1$ of the stream 1 catchment area is contributing to the peak flow rate (at time T_2). Consequently for downstream study purposes, the "effective" catchment area corresponding to the subject peak flow rate is

$$A_p = A_2 + (T_2/T_1)A_1 \qquad \text{(D.7)}$$

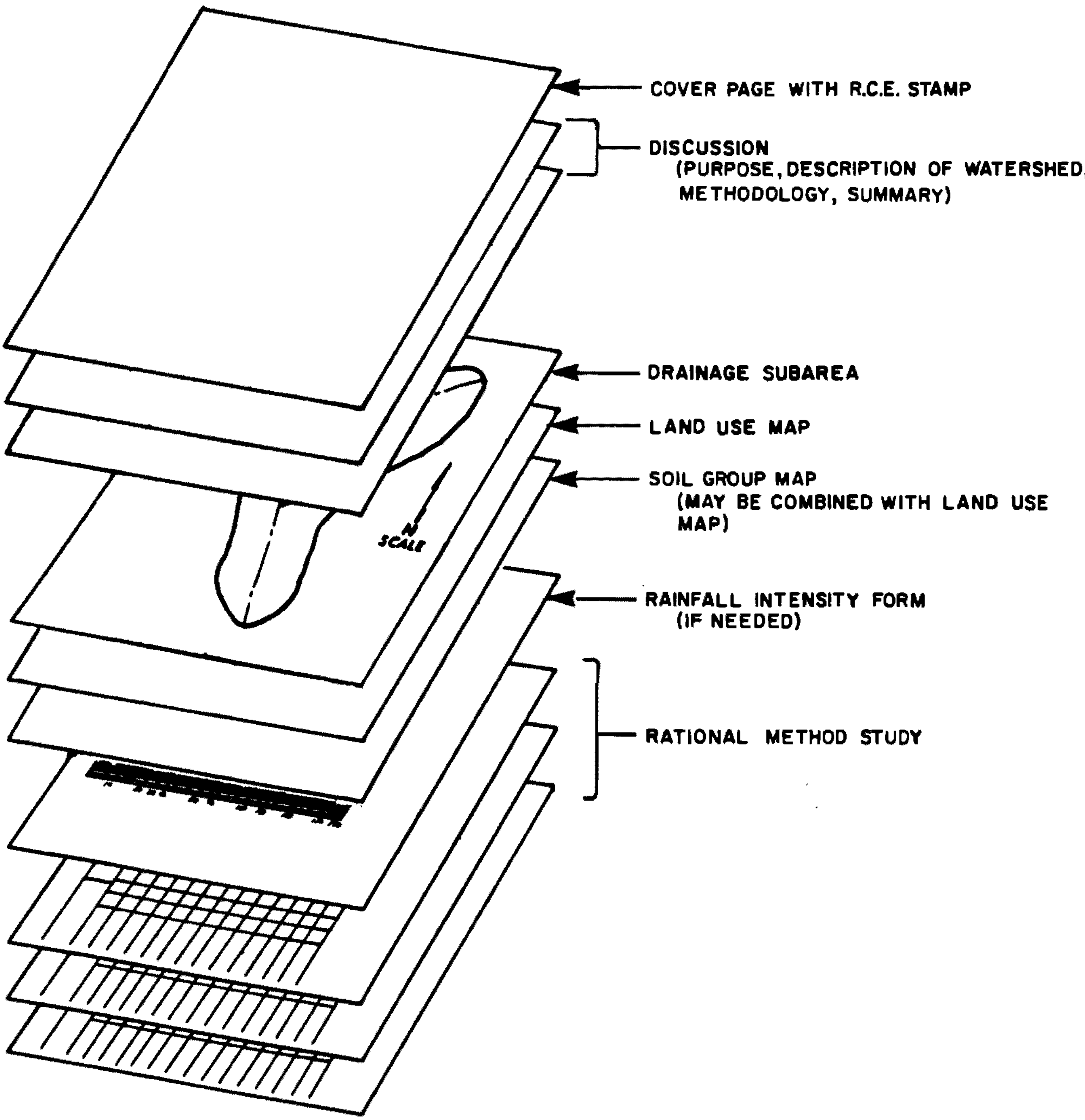
It is noted that in the confluence peak flow rate estimate of (D.6), the critical duration is $T_p = T_2$ which corresponds to the effective catchment area of (D.7). Consequently, the peak flow rate contribution from the effective catchment area of stream 1 must reflect the higher rainfall intensity corresponding to time T_2 rather than time T_1. Use of (D.6) results in a peak flow which equals the governing rational method peak flow rate estimate from (D.4) applied to the effective catchment area computed by (D.7). It is noted that the estimation of the effective catchment area is only an approximation, and shall be verified by the hydrologist.

D.9. RATIONAL METHOD T_C CALCULATIONS FOR UNIT HYDROGRAPH STUDIES

Although the peak flow rate formula should generally not be used for catchments larger than 1 square mile, the rational method can be used to estimate T_C values for larger areas. That is, the rational method estimate for T_C in large areas is adequate for use in the unit hydrograph studies of Section E. T-year storm estimates for T_C are determined by use of the associated T-year intensity-duration curves (Figures D-2 and D-3). For example, a 2-year design storm T_C is estimated using 2-year rainfalls in the rational method whereas a 100-year T_C estimate is based on 100-year rainfalls.

D.10. REQUIRED FORMAT

Figure D-5 illustrates the required format for the submittal of rational method hydrology studies. All rational method calculations must be summarized on the form shown in Figure D-6.



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TYPICAL REPORT FORMAT FOR RATIONAL METHOD STUDY

Figure D-5

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL	STUDY NAME: ______-YEAR STORM 1-HOUR RAINFALL (INCH)=______; SLOPE =______	Calculated by ______ Date ______ Checked by ______ Date ______ Page ______ of ______

Concentration Point	Area (Acres)		Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total	Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
	Subarea	Total												

Figure D-6

D.11. INSTRUCTIONS FOR RATIONAL METHOD HYDROLOGY CALCULATIONS

1. On a topographic map of the drainage area, draw the study drainage system and designate subareas tributary to the various points of concentration (see example problem).

2. Determine the initial time of concentration, (Tc), using Figure D-1. The initial subarea should be less than 10 acres, have a flow path of less than 1,000 feet, and generally should be the most upstream subarea of the watershed drainage system.

3. Using the time of concentration, determine (I) (intensity of rainfall in inches per hour) from the appropriate intensity-duration curve for the particular area under study using Figure D-3.

4. Calculate the area-averaged maximum loss rate, F_m, which corresponds to the soil group, cover complex, and imperviousness of the drainage subarea. Loss rates for the pervious area, F_p, follow from section C.6.4.

5. Determine the area (A, acres) of the total watershed tributary to the point of concentration. Because the rational method computational results are sensitive to the subarea size definitions (especially in the most upstream reaches of the watershed), limit the size of subareas to allow for a gradual increase in subarea size as the study progresses downstream. The method is sensitive to large differences in successive subarea shapes, and lengths of reaches where travel times are estimated. Points of concentration should be selected downstream of the initial subarea such that subarea travel times are less than 3-minutes and 5-minutes for Tc values of 30-minutes and 60-minutes, respectively. After a Tc of 1-hour, subarea travel times should be limited to less than 10-minutes.

6a. Compute $Q = .90\ (I - F_m)A$ for the point of concentration.

6b. Should the computed Q be less than the previous upstream point of concentration Q, use the upstream Q value.

7. Measure the length that the peak runoff must travel to the point of concentration of the next downstream subarea. Determine the average velocity of flow in this reach using the peak Q in the appropriate type of conveyance being considered (natural channel, street, pipe, or open channel) using Manning's formula. Where necessary, the mean flow in the conveyance (e.g., streetflow) should be used to compute mean flow velocity.

Using the reach length and average flow velocity, compute the travel time and add to the time of concentration from the upstream subarea to determine a new time of concentration.

8. Calculate Q for the new point of concentration using steps 3 through 6 and the new time of concentration. Determine the time of concentration for the next downstream subarea using Step 7. Continue the above computation procedure downstream until a junction with a lateral drain is reached.

9. Start at the upstream end of the lateral and compute its Q down to the junction with the main line, using the methods outlined in the previous steps.

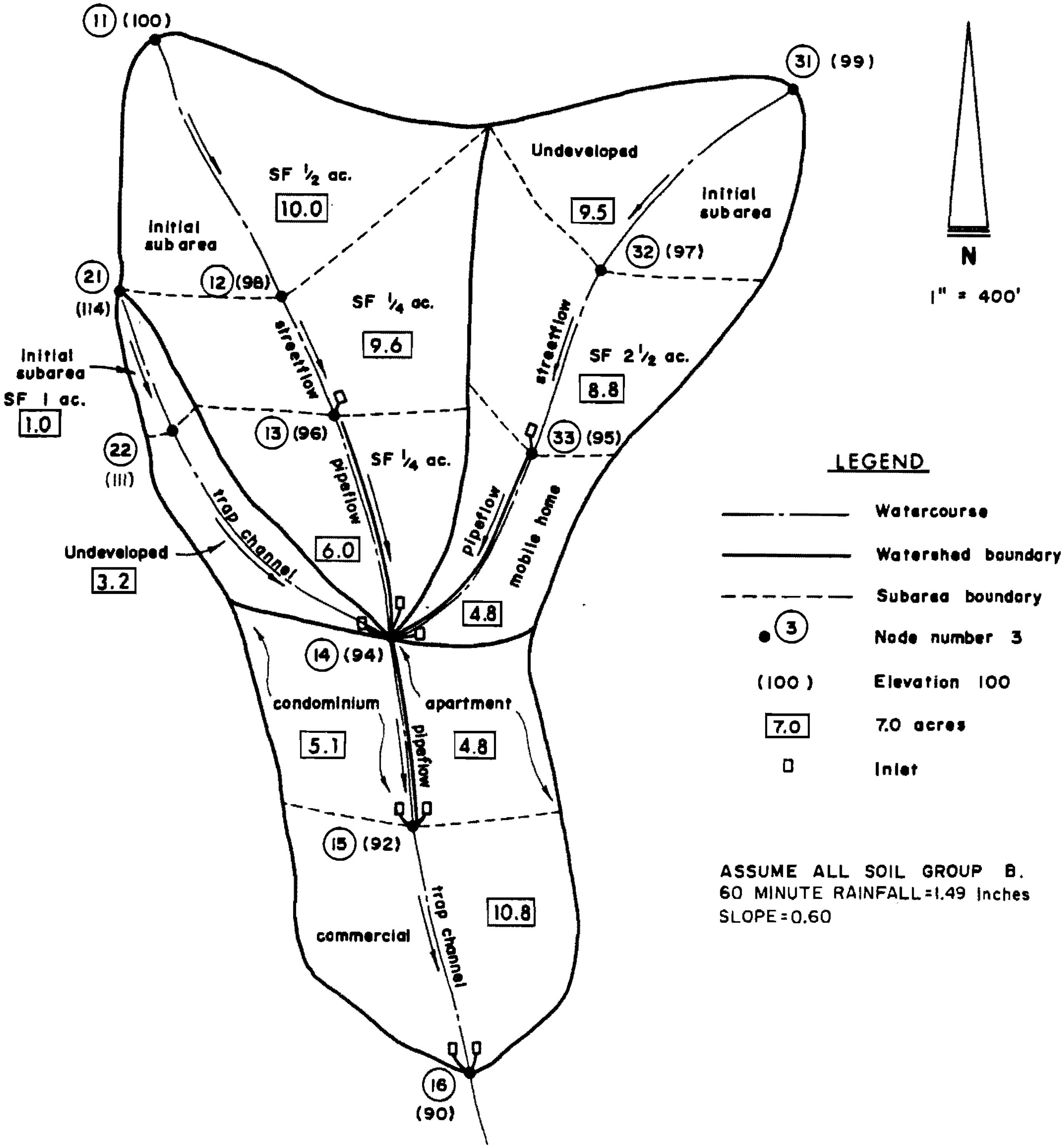
10. Compute the peak Q at the junction (confluence analysis--see Section D.8) and evaluate the sensitivity of the computed results to using the other Q and Tc values determined. That is, the downstream estimated peak Q values may be higher had a lower Q and lower Tc value been used at an upstream confluence point. The largest Q is, therefore, estimated along the entire watershed main channel.

D.12. EXAMPLE PROBLEM

The following example problem illustrates the format required for rational method hydrology studies. In the following, an example watershed is analyzed using the rational method approach. The example problem presentation contains the following information:

Description

- o Example Problem Drainage System Map
- o Example problem Intensity - Duration Precipitation Form
- o Example Problem Rational Method Calculation Sheets

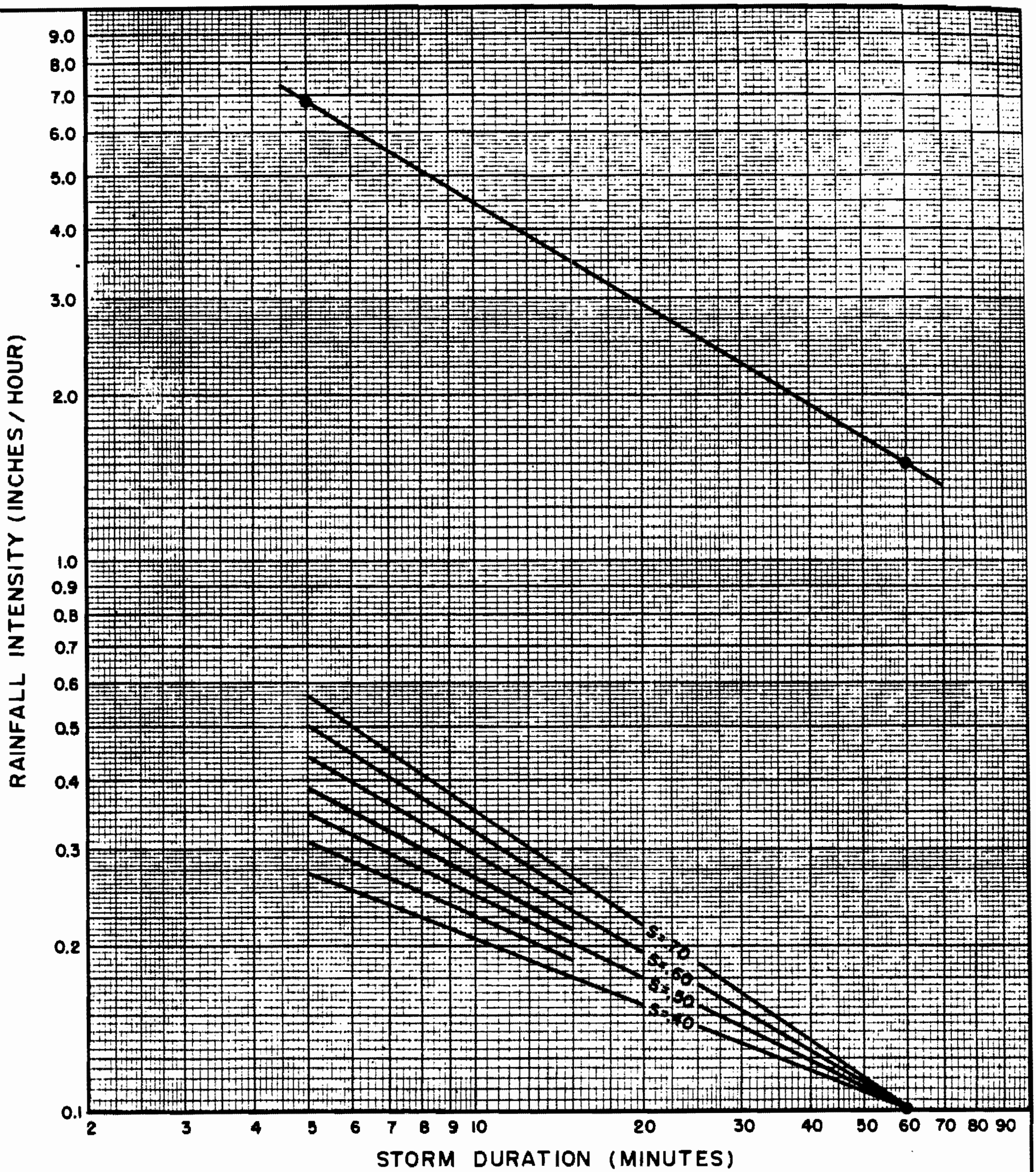


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM

DRAINAGE SYSTEM



DESIGN STORM FREQUENCY = 10 YEARS

ONE HOUR POINT RAINFALL = 1.49 INCHES

LOG-LOG SLOPE = 0.60

PROJECT LOCATION = EXAMPLE PROBLEM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL	INTENSITY - DURATION CURVES CALCULATION SHEET

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL	STUDY NAME: *EXAMPLE PROBLEM* *10* -YEAR STORM I-HOUR RAINFALL (INCH)= *1.49* ; SLOPE = *0.60*	Calculated by *MHS* Date *9-28-86* Checked by ______ Date *9-28-86* Page *1* of *2*

Concentration Point	Area (Acres) Subarea	Total	Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total	Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
12.00	10.0	10.0	B	SF(½)	—	21.0	2.85	0.53	0.53	20.9	800	0.0025		INITIAL SUBAREA
13.00	9.6	19.6	B	SF(¼)	1.9	22.9	2.70	0.45	0.49	39.0	350	0.0057	3.0	44 ft. STREET Dn=0.61 ft.
14.00	6.0	25.6	B	SF(¼)	1.7	24.6	2.57	0.45	0.48	48.2	650	0.0031	6.2	39" RCP n=0.013 Dn=2.3
14.00		25.6				24.6				48.2				STREAM SUMMARY
22.00	1.0	1.0	B	SF(1)	—	13.70	3.70	0.60	0.60	2.8	400	0.0075	—	INITIAL SUBAREA
14.00	3.2	4.2	B	UNDEV (GRASS)	2.7	16.4	3.30	0.56	0.57	10.3	850	0.020	5.3	B=0.5' Z=2.0 n=0.015 Dn=0.4
14.00		4.2				16.4				10.3				STREAM SUMMARY
32.00	9.5	9.5	B	UNDEV (GRASS)		42.0	1.87	0.56	0.56	11.2	750	0.0027	—	INITIAL SUBAREA
33.00	8.8	18.3	B	SF(2½)	4.8	46.8	1.75	0.68	0.62	18.6	550	0.0036	1.9	44 ft. STREET Dn=0.54 ft.
14.00	4.8	23.1	B	MH	3.0	49.8	1.68	0.19	0.53	23.9	700	0.0014	3.9	36" RCP n=0.013 Dn=1.93
14.00		23.1				49.8				23.9				STREAM SUMMARY

Confluence analysis for Pt #14.00:

$$14.00 \quad \bar{Q}_1 = 48.2 + (10.3)\left(\frac{2.57-0.57}{3.30-0.57}\right) + (23.9)\left(\frac{24.6}{49.8}\right)\left(\frac{2.57-0.53}{1.68-0.53}\right) = 76.7$$

$$\bar{Q}_2 = (48.2)\left(\frac{16.4}{24.6}\right)\left(\frac{3.30-0.48}{2.57-0.48}\right) + 10.3 + (23.9)\left(\frac{16.4}{49.8}\right)\left(\frac{3.30-0.53}{1.68-0.53}\right) = 72.6$$

$$\bar{Q}_3 = (48.2)\left(\frac{1.68-0.48}{2.57-0.48}\right) + (10.3)\left(\frac{1.68-0.57}{3.30-0.57}\right) + 23.9 = 55.8$$

$$\bar{A} = 25.6 + 4.2 + \frac{24.6}{49.8}(23.1) = 41.2 \qquad 24.6 \qquad 76.7$$

CONFLUENCE ANALYSIS FOR PT #14.00

CONFLUENCE RESULTS

RATIONAL METHOD STUDY FORM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL	STUDY NAME: *EXAMPLE PROBLEM*	Calculated by *MHS* Date *9-28-86*
	10 -YEAR STORM 1-HOUR RAINFALL (INCH)= *1.49* ; SLOPE = *0.60*	Checked by ____ Date *9-28-86*
		Page *2* of *2*

Concentration Point	Area (Acres) Subarea	Area (Acres) Total	Soil Type	Dev. Type	T_t min.	T_c min.	I in/hr	Fm in/hr	Fm avg.	Q Total	Flow Path Length ft.	Slope ft./ft.	V ft./sec.	Hydraulics and Notes
15.00	5.1	46.3	B	CONDO	1.2	25.8	2.50	0.26	0.49	83.8	550	0.0036	7.8	48" RCP Dn=2.9 n=0.013
15.00	4.8	51.1	B	APT	—	25.8	2.50	0.15	0.46	93.8				ADDITION OF SUBAREA
					1.9						700	0.0029	6.2	n=0.015 Dn=2.3 Z=2.0 B=2.0
16.00	10.8	61.9	B	COM		27.7	2.40	0.08	0.41	110.9				
16.00		61.9				27.7				110.9				

SECTION E

THE UNIT HYDROGRAPH METHOD FOR CATCHMENT RUNOFF HYDROGRAPHS

E.1. BACKGROUND

The unit hydrograph method assumes that watershed discharge is related to the total volume of runoff, and that the time factors which affect the unit hydrograph shape are invariant, and that watershed storm rainfall-runoff relationships are characterized by watershed area, slope, and shape factors. The UH method is used to estimate the time distribution of watershed runoff in drainage basins where stream gauge information is either unavailable or inadequate to justify statistical interpretation (refs. 4-10). The unit hydrograph method for determining the time distribution of runoff is used for hydrology studies of all San Bernardino County watersheds in excess of approximately 1 square mile in area.

E.2. TERMINOLOGY

The following definitions are used in the discussion of unit hydrograph and runoff hydrograph synthesis:

Effective rainfall is that part of rainfall that runs off in a relatively brief time period. (Here, the brief time period is selected sufficiently small such that the significant hydrologic effects are adequately represented by the time-period's average values.) Effective rainfall is the total rainfall less infiltration, evaporation, transpiration, absorption, and detention.

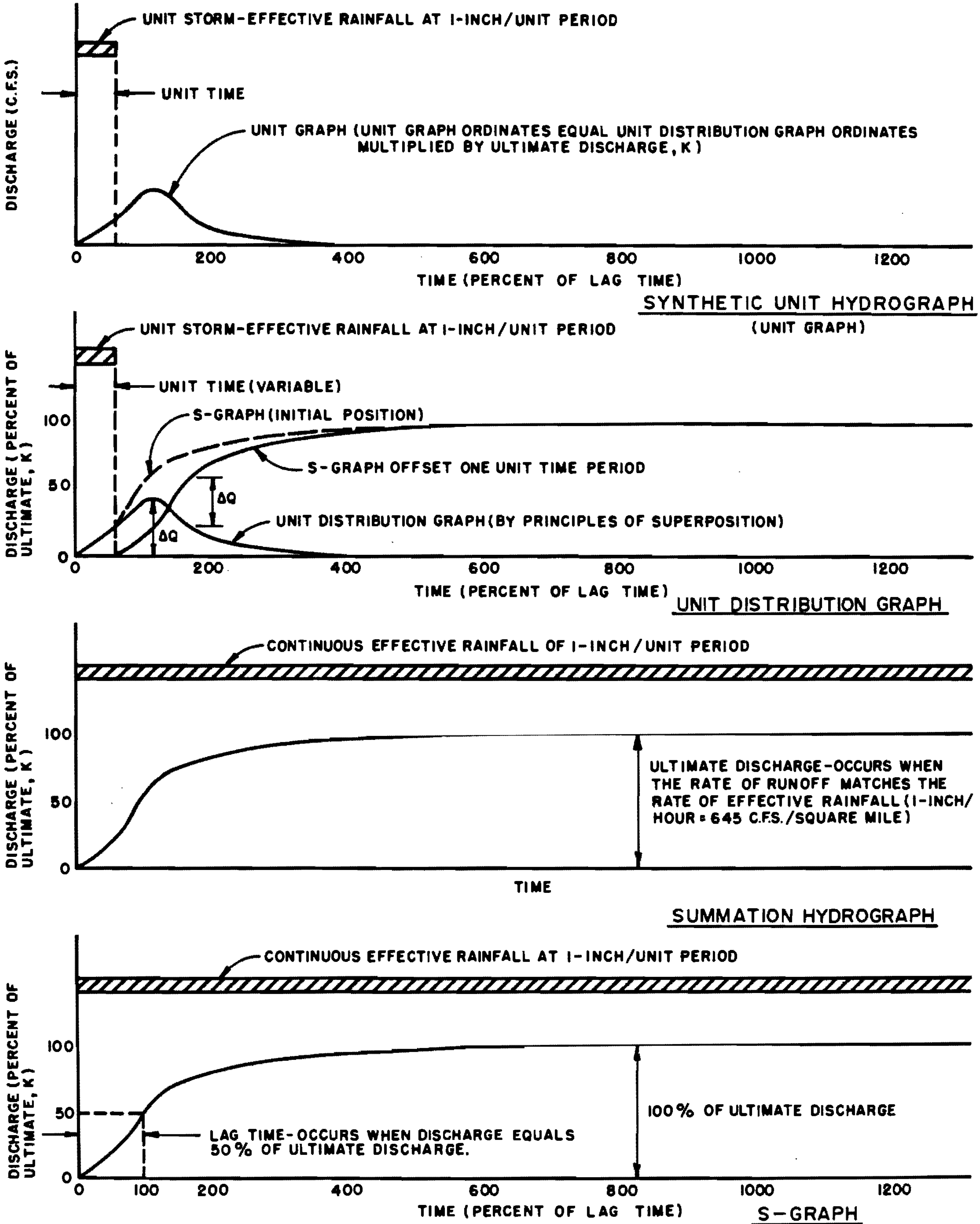
Unit hydrograph (or unit graph) for a point of concentration on a watershed (catchment) stream is a curve (hydrograph) showing the time distribution of rates of runoff which results from one inch of effective rainfall during a unit period of time over the tributary watershed upstream of the point of concentration. The unit effective rainfall is generally assumed to occur as an equivalent constant rainfall intensity during a specified unit period of time (such as 5, 10, 15 or 30-minutes). Figure E-1 illustrates the general formulation of the unit hydrograph.

Distribution graph is a unit hydrograph whose ordinates are expressed in terms of percent of ultimate discharge. A distribution graph is generally developed as a block graph with each block representing its associated percent of unit runoff which occurs during the specified unit time. The unit time used in the distribution graph is identical to the unit time specified for the unit hydrograph.

Summation hydrograph for a point of concentration on a given stream is a curve (hydrograph) showing the time distribution of the rates of runoff that would result from a continuous series of unit period effective rainfalls over the tributary watershed upstream of the subject point of concentration. The ordinates of the summation hydrograph are expressed in percent of the ultimate discharge.

Lag for a watershed is the time (hours) from the beginning of a continuous series of unit period effective rainfalls over the watershed area (tributary to a point of concentration) to the instant when the rate of resulting tributary watershed runoff (at the point of concentration) equals 50 percent of the ultimate rate of the resulting runoff.

Ultimate discharge is the maximum rate of watershed runoff which can result from a specified effective rainfall intensity. Ultimate discharge from a watershed occurs when the rate of runoff on the summation hydrograph is equivalent to the rate of effective rainfall. For an effective rainfall rate of one inch occurring in a unit period of one hour, the ultimate discharge is 645 cfs for every square mile of watershed. Ultimate discharge for different unit periods is given by



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DERIVATION OF A SYNTHETIC UNIT HYDROGRAPH

FIGURE E-1

dividing 645 by the unit period in hours, and multiplying by the watershed area in square miles.

S-Graph is a summation hydrograph developed by plotting watershed discharge expressed in percent of ultimate discharge as a function of time expressed in percent of lag.

E.3. DETERMINATION OF SYNTHETIC DISTRIBUTION GRAPHS

Adequate storm rainfall and watershed runoff information are available for the determination of distribution graphs for several streams in Southern California. The distribution graphs for each of the gauged streams can be determined by trial-and-error attempts to duplicate the runoff hydrographs produced by major storm events (i.e., reconstitution studies). The derived distribution graphs are then verified by using them to reproduce runoff hydrographs from other major storm events.

The method of determining synthetic distribution graphs is used to estimate the time distribution of watershed runoff in drainage basins where stream gauge data is inadequate. The procedure develops a time distribution of runoff based on the properties of distribution graphs from several gauged watersheds (refs. 4-10).

It is assumed that the drainage areas within a given region are physiographically and hydrologically similar. Because no two drainage areas have identical hydrologic characteristics, the runoff patterns from these areas are generally dissimilar and the distribution graphs of these areas may differ considerably. Therefore, direct transposition of distribution graphs from one watershed to another is usually precluded. However, most distribution graphs exhibit certain similarities which the introduction of a factor called "lag" will bring the arrangement of ordinates along the bases of distribution graphs into a generally consistent relationship. Lag, which was initially defined in the literature as the time difference in phase between salient features of the rainfall and runoff rate curves, is an empirical expression of the hydrologic characteristics of a watershed in terms of time. Details of the determination of lag for watersheds where the time distributions of runoff are known and of the use of lag in developing synthetic distribution graphs are discussed in the following:

1. Summation Hydrograph - The first step in determining lag for a watershed is the determination of the summation hydrograph, which is the hydrograph of runoff that would result from the continuous generation of unit effective rainfall over the watershed. The ordinates of summation hydrographs are expressed in percent of ultimate discharge and a summation hydrograph for a point of concentration is determined by adding a continuous series of identical distribution graphs out of phase one unit period. On such a hydrograph, the time required to reach maximum (ultimate) discharge is equal to the length of the base of one distribution graph less one unit period.

2. Lag - Lag for a watershed can be defined as the elapsed time (in hours) from the beginning of unit effective rainfall to the instant that the summation hydrograph for the point of concentration reaches 50 percent of ultimate discharge. When the lags determined from summation hydrographs for several gauged watersheds are correlated to the hydrologic characteristics of the watersheds, an empirical relationship is usually apparent. This relationship can then be used to determine the lags for comparable drainage areas for which the hydrologic characteristics can be determined, but for which the distribution graphs for concentration points cannot be determined because of inadequate hydrologic data. By comparing lag values (obtained from the analysis of rainfall-runoff data) to catchment time of concentration Tc values estimated from a detailed rational method analysis (section D.9), a relationship is readily determined,

$$\text{lag} = 0.8Tc \qquad (E.1)$$

9

It it noted that the rational method time of concentration, used for the estimation of basin lag time, is a critical parameter in the unit hydrograph method. Extreme care must be taken in the evaluation of the catchment Tc in order to reduce uncertainty, and enable "reproducibility" of this parameter. Section D provides the procedure for estimating Tc using the rational method.

(E.1) is used in all unit hydrograph studies where sufficient topographic information is available to compute the time of concentration, Tc. It is noted that due to Tc being the sum of the rational method's initial subarea Tc and the subsequent downstream reach hydraulic traveltimes, Tc values will vary depending on the return frequency of rainfall used in the analysis. That is, a 2-year storm estimated Tc value typically is longer in duration than a 100-year storm estimated Tc value. Consequently, when computing the lag corresponding to a T-year design storm event, the Tc is estimated using the T-year intensity-duration rainfalls in the rational method. For certain large scale natural condition catchment studies, the Agency may consider the use of the lag relationship given by the empirical formula:

$$\text{lag (hours)} = C_t \left((L \cdot L_{ca})/S^{0.5}\right)^m \qquad \text{(E.2)}$$

where

- C_t = a constant (determined by regional flood reconstitution studies)
- L = length of longest watercourse (miles)
- L_{ca} = length along longest watercourse, measured upstream to a point opposite center of area (miles)
- S = overall slope of drainage area between the headwaters and the collection point (feet per mile)
- m = a constant determined by regional flood reconstitution studies

It is then assumed that there exists a relationship between watershed lag and the quotient $((L \cdot L_{ca})/(S^{0.5}))^m$. This relationship is given by the above empirical formula for lag when

C_t = 24 $\bar{n}$; ($\bar{n}$ is the visually estimated basin factor of all collection streams and watershed channels, see Figure E-2)

m = 0.38

3. S-graph - After lag factors are determined for several gauged watersheds the next step in determining synthetic distribution graphs is the development of S-graphs, which are summation hydrographs modified so that the percent of ultimate discharge is related to time expressed in percent of lag. The derivation of an S-graph is identical to the derivation of a summation hydrograph, except that the factor of lag has been introduced. Time in percent of lag has been used to determine S-graphs for five major groupings of watersheds.

Five S-graphs are used for unit hydrograph development in San Bernardino County. These S-graphs are entitled Valley:Developed, Valley:Undeveloped, Foothill, Mountain, and Desert (Figures E-3a, b, c, d and e). In conformity with the definition of lag, each S-graph reaches 50 percent of ultimate discharge at 100 percent of lag. The average of the several S-graphs determined for mountain watersheds is assumed to be applicable to the mountain drainage basins with unknown runoff characteristics. Similarly the average of the S-graphs determined for valley watersheds is assumed to be applicable to the valley drainage basins, and so forth. Use of the Foothill S-graph is only for watersheds characterized by natural channels that are sharply incised in canyon bottoms; i.e., overbank flows are confined near the defined channel. Use of the Mountain S-graph is only for watersheds characterized by natural channels with numerous plunging flow reaches and lodged boulders/debris. Use of the Valley:Undeveloped S-graph is for natural watersheds whose channels are not sharply incised, i.e., where overbank flows may spread widely from the defined channel. Use of the Valley:Developed S-

$\bar{n}$ = **0.015**

1. Drainage area has fairly uniform, gentle slopes
2. Most watercourses either improved or along paved streets
3. Groundcover consists of some grasses - large % of area impervious
4. Main water course improved channel or conduit

$\bar{n}$ = **0.020**

1. Drainage area has some graded and non-uniform, gentle slopes
2. Over half of the area watercourses are improved or paved streets
3. Groundcover consists of equal amount of grasses and impervious area
4. Main watercourse is partly improved channel or conduit and partly greenbelt (see n = 0.025)

$\bar{n}$ = **0.025**

1. Drainage area is generally rolling with gentle side slopes
2. Some drainage improvements in the area - streets and canals
3. Groundcover consists mostly of scattered brush and grass and small % impervious
4. Main watercourse is straight channels which are turfed or with stony beds and weeds on earth bank (greenbelt type)

$\bar{n}$ = **0.030**

1. Drainage area is generally rolling with rounded ridges and moderate side slopes
2. No drainage improvements exist in the area
3. Groundcover includes scattered brush and grasses
4. Watercourses meander in fairly straight, unimproved channels with some boulders and lodged debris

$\bar{n}$ = **0.040**

1. Drainage area is composed of steep upper canyons with moderate slopes in lower canyons
2. No drainage improvements exist in the area
3. Groundcover is mixed brush and trees with grasses in lower canyons
4. Watercourses have moderate bends and are moderately impeded by boulders and debris with meandering courses

$\bar{n}$ = **0.050**

1. Drainage area is quite rugged with sharp ridges and steep canyons
2. No drainage improvements exist in the area
3. Groundcover, excluding small areas of rock outcrops, includes many trees and considerable underbrush
4. Watercourses meander around sharp bends, over large boulders and considerable debris obstruction

$\bar{n}$ = **0.200**

1. Drainage area has comparatively uniform slopes
2. No drainage improvements exist in the area
3. Groundcover consists of cultivated crops or substantial growths of grass and fairly dense small shrubs, cacti, or similar vegetation
4. Surface characteristics are such that channelization does not occur

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

BASIN FACTOR DESCRIPTIONS

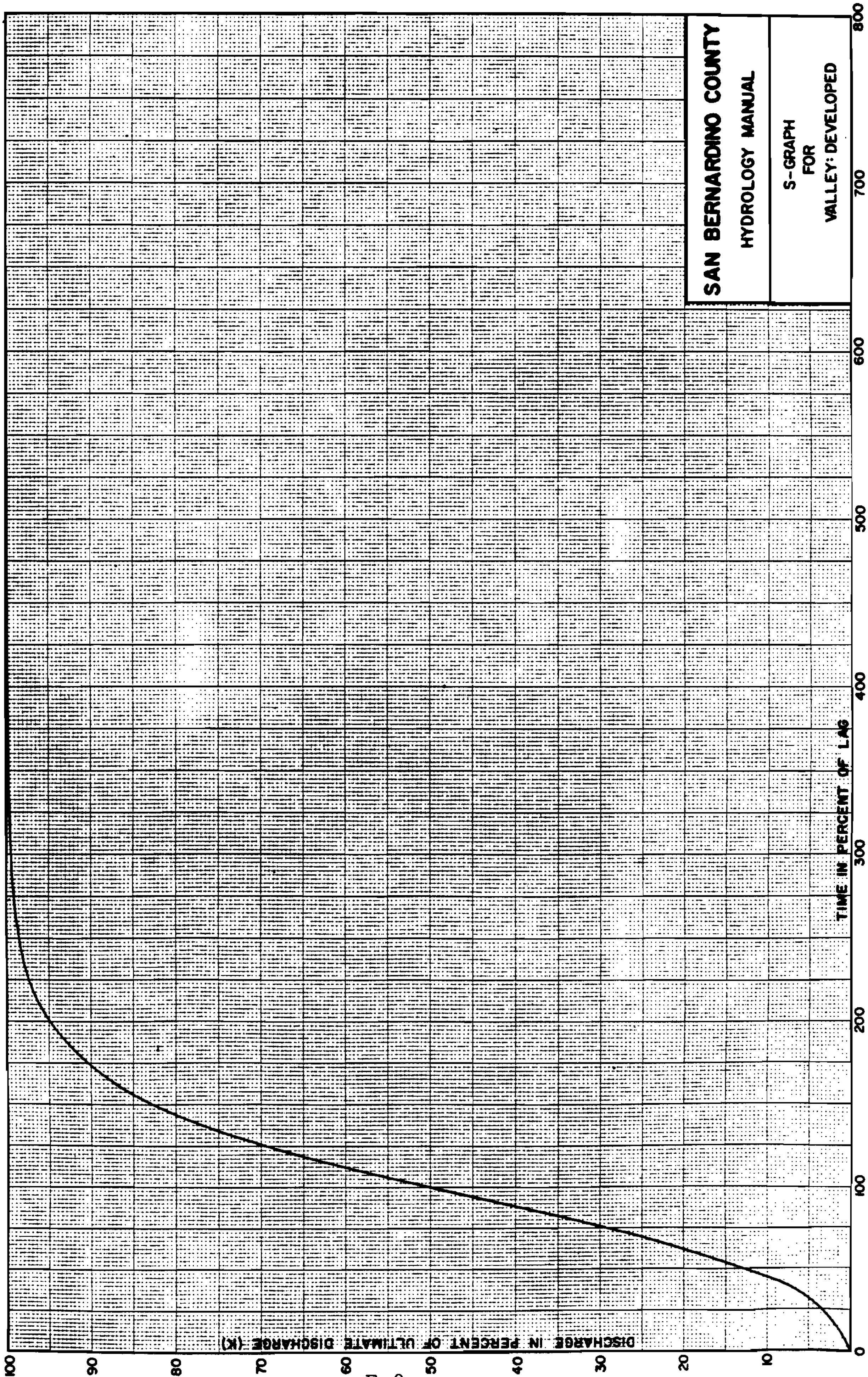
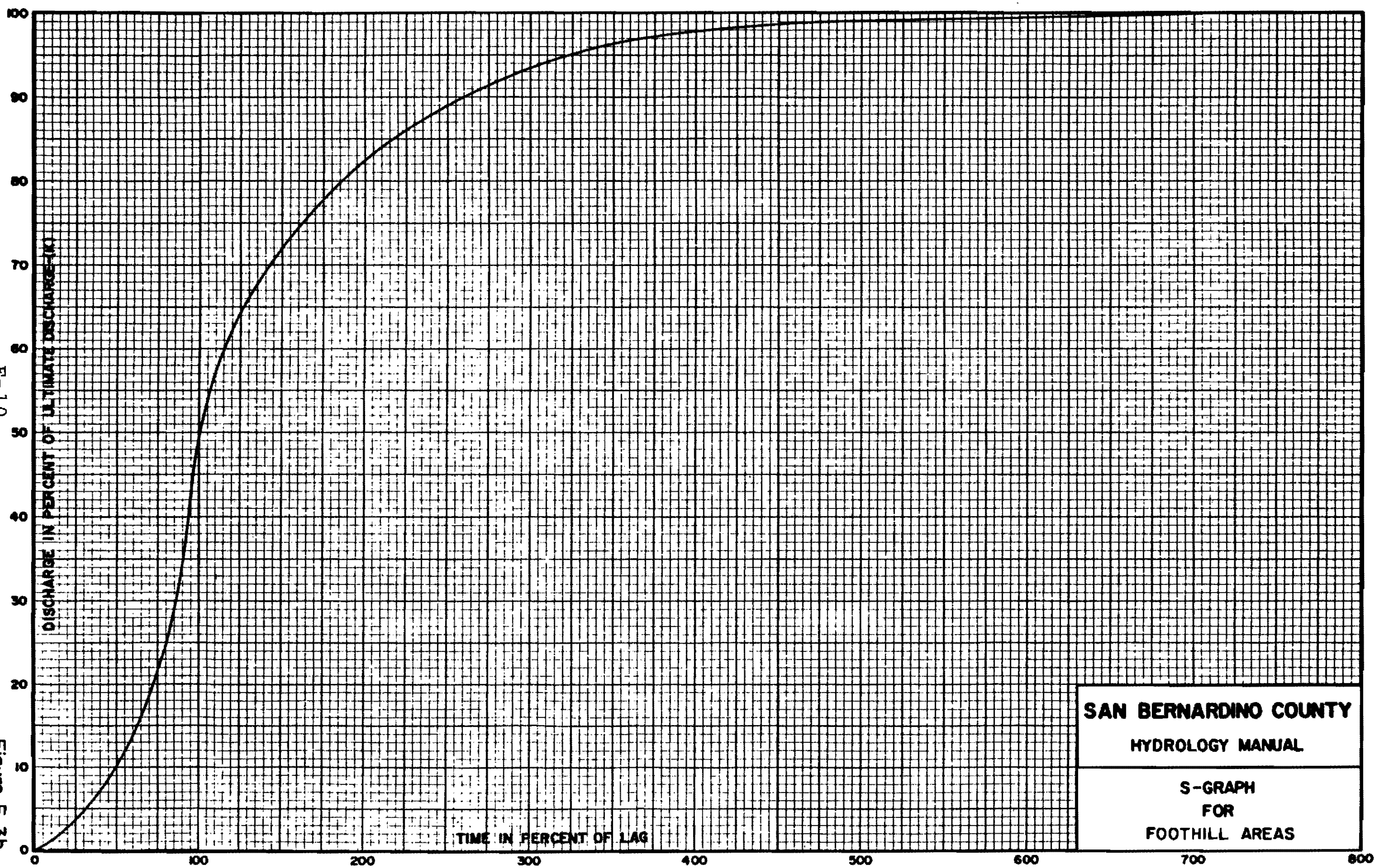
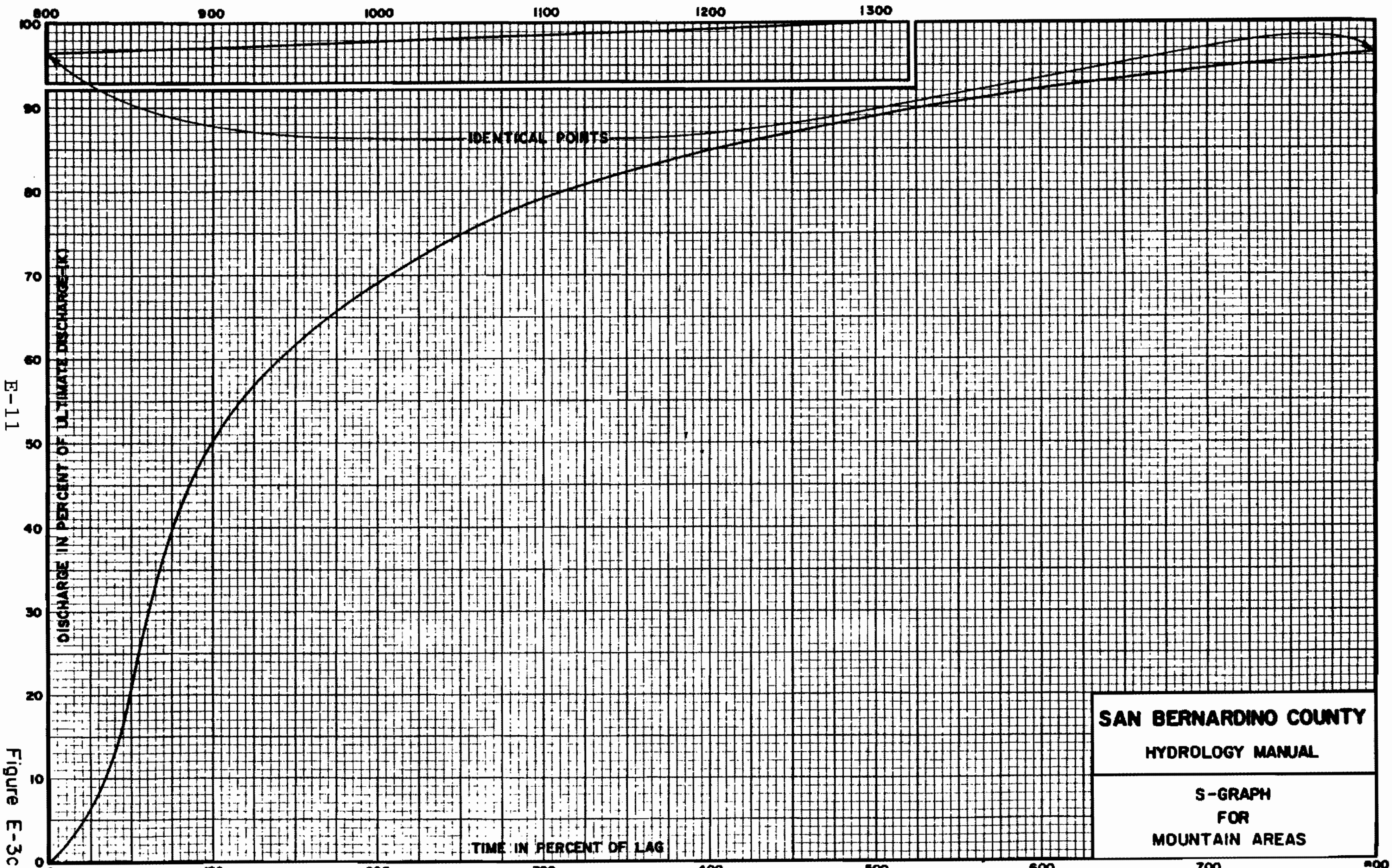

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
S-GRAPH
FOR
VALLEY: DEVELOPED
TIME IN PERCENT OF LAG
0
100
200
300
400
500
600
700
800
DISCHARGE IN PERCENT OF ULTIMATE DISCHARGE (K)
10
20
30
40
50
60
70
80
90
100

Figure E-3a



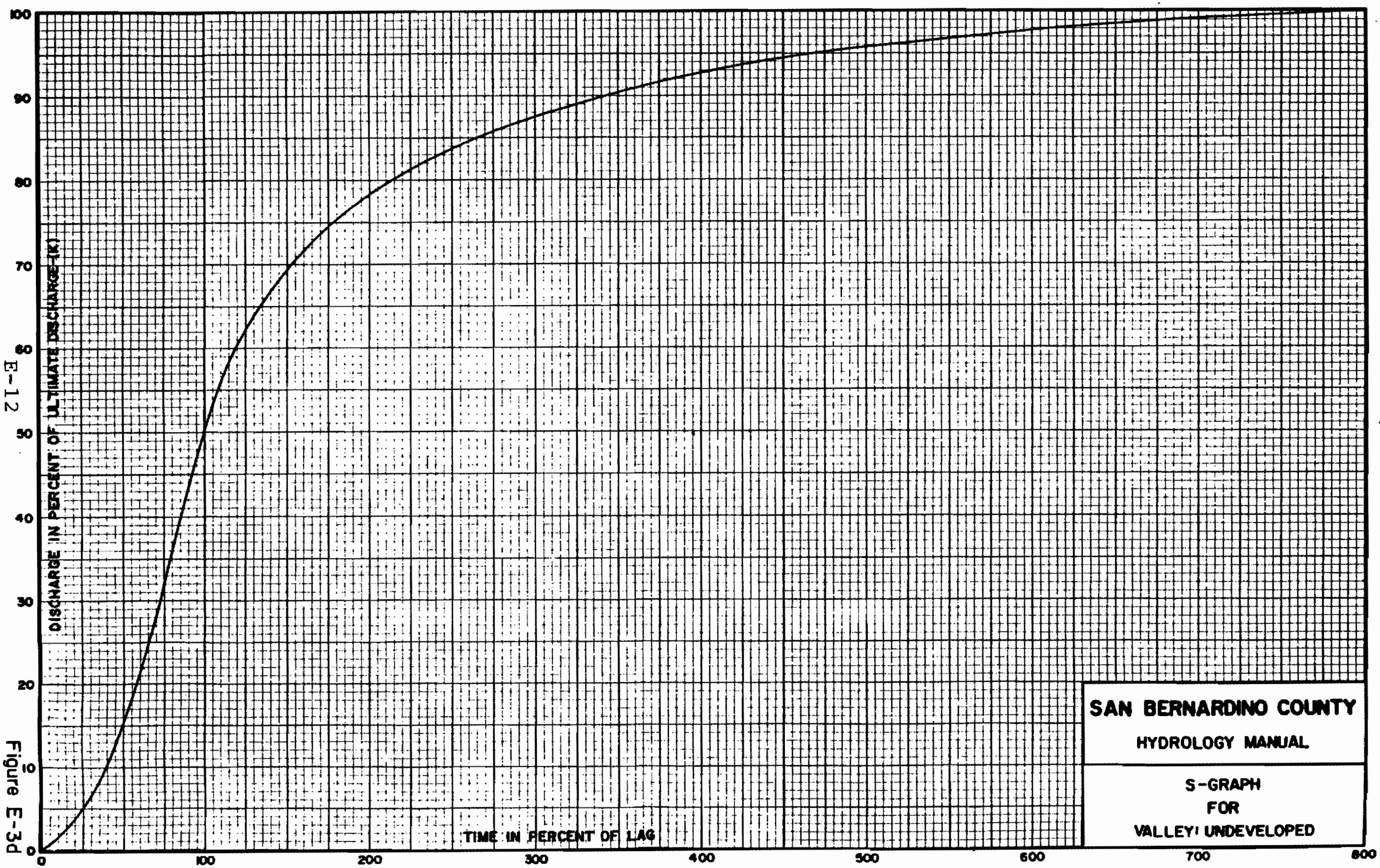
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
S-GRAPH
FOR
FOOTHILL AREAS
DISCHARGE IN PERCENT OF ULTIMATE DISCHARGE-(K)
TIME IN PERCENT OF LAG
0
10
20
30
40
50
60
70
80
90
100
100
200
300
400
500
600
700
800

Figure E-3b



800
900
1000
1100
1200
1300
IDENTICAL POINTS
DISCHARGE IN PERCENT OF ULTIMATE DISCHARGE (K)
TIME IN PERCENT OF LAG
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
S-GRAPH
FOR
MOUNTAIN AREAS

Figure E-3c



DISCHARGE IN PERCENT OF ULTIMATE DISCHARGE-(K)
100
90
80
70
60
50
40
30
20
10
0
TIME IN PERCENT OF LAG
0
100
200
300
400
500
600
700
800
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
S-GRAPH
FOR
VALLEY/ UNDEVELOPED

Figure E-3d

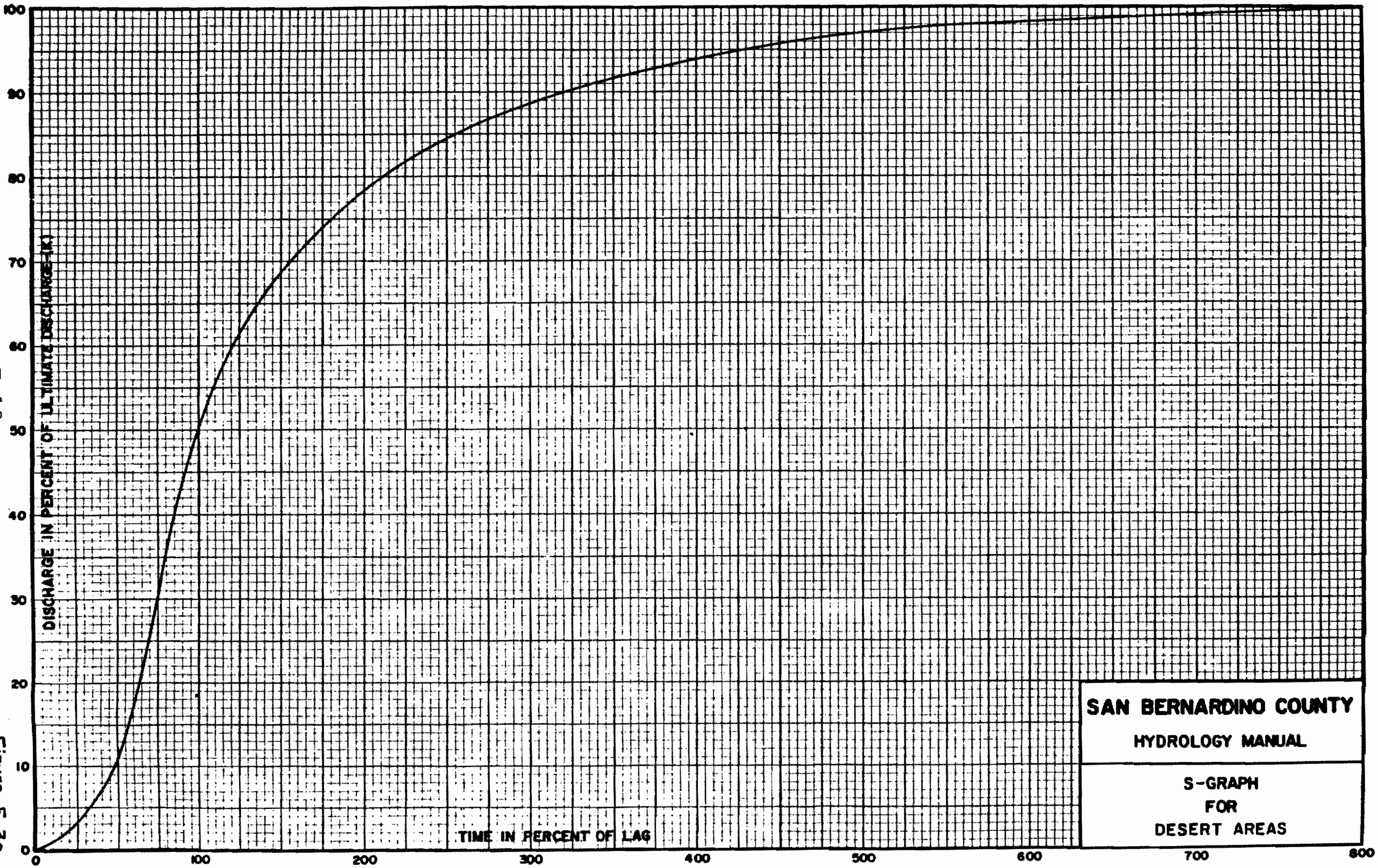

DISCHARGE IN PERCENT OF ULTIMATE DISCHARGE-(K)
TIME IN PERCENT OF LAG
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
S-GRAPH
FOR
DESERT AREAS

Figure E-3e

graph is for all watershed conditions where prismatic channels exist or are to be provided for conveyance of T-year peak flows. This S-graph is representative of fully urbanized catchments where the ultimately planned, free-draining (no detention facilities) storm drains and major flood control channels are operative. In comparison, should the catchment be fully developed but the storm drain system is generally deficient, with significant ponding and storage effects occuring interior of the catchment, the Valley:Undeveloped S-graph may be more appropriate than the Valley:Developed S-graph.

E.3.1. Application of Lag and S-graphs

Using the rational method, the watershed time of concentration (Section D) is computed and lag is determined using (E.1). A unit time is selected (generally 15 to 25 percent of the lag) and accumulated unit time periods are expressed as accumulated percentages of the watershed lag. These percentages of lag are used in superimposing a "block" graph on the appropriate average S-graph for the watershed and the resulting pattern is used in determining the accumulated mean percentage of ultimate discharge for each accumulated unit time (see example problem). Because these accumulated mean percentages represent the accumulated mean percentages for the synthetic distribution graph for the watershed, the mean percentage for successive unit periods are determined by a series of subtractions.

E.4. DEVELOPMENT OF THE SYNTHETIC UNIT HYDROGRAPH

For watersheds where stream gauge data is inadequate, it may generally be assumed that a synthetic unit hydrograph adequately approximates the time distribution of runoff at the subject watershed point of concentration. From the above discussion, a method to develop a synthetic unit hydrograph is described in the following steps:

1. Estimate the watershed lag using topographic information and a rational method Tc calculation based on the appropriate T-year rainfall.

2. Select a unit period to be used for the hydrograph analysis. This unit period will be used for development of design critical storm unit rainfalls and the runoff hydrograph. The unit period is generally chosen to be within 15 and 25 percent of the watershed lag in order to provide sufficient definition of the unit hydrograph.

3. An S-graph is chosen which is appropriate for the catchment being studied.

4. The appropriate watershed S-graph can be approximated by a block graph where the base of each block is the selected unit period percentage of lag (Step 2) and the ordinate of each block is the time-averaged percentage of ultimate discharge (from the S-graph) for that unit period. The area of each block equals the area under the S-graph for each respective unit period. Consequently, at the end of each unit period the total area under the S-graph equals the sum of the areas of the equivalent unit period blocks.

5. The unit distribution block graph is developed by computing the difference between the ordinates (percentage of ultimate discharge) assigned to the unit period blocks used to approximate the S-graph of Step 4. This is equivalent to computing the difference between the ordinates of two S-graphs which have been offset by one unit period.

6. The final step to develop the synthetic unit hydrograph (or unit graph) is to multiply the ordinates of the distribution block graph (Step 5) by the factor K, the ultimate discharge. The ultimate discharge is defined by

$$K \text{ (cfs)} = 645\ A/T \qquad \text{(E.3)}$$

where

A = drainage area (square miles)
T = unit time period (hours)

E.5. DESIGN STORM POINT PRECIPITATION

The Agency's prescribed level of flood protection is obtained by using T-year rainfalls for the development of the T-year runoff hydrograph. Based on the NOAA Atlas 2, the Agency has prepared rainfall isohyetal maps to be used to analyze point precipitation patterns within a watershed, (see Section B.5). Because additional rainfall information may alter the statistical patterns assumed for point rainfall, the rainfall data obtained from the NOAA Atlas 2 (and the San Bernardino County isohyetal maps) should be checked against current frequency analysis for all rain gauges within the study watershed and adjustments made as necessary and as approved by the Agency. (For example, it is noted that, based on an analysis of the rainfall data, the valley area of the County has been in a dry spell for the last 40 years).

It may generally be assumed that the peak 3-hour point precipitation value within a watershed is related to the peak 1-hour and 6-hour point precipitation values by straightline interpolation on log-log paper. This approach is an approximation, and also should be checked against current rain gauge data within the watershed.

The shorter duration (less than 3 hours) rainfall intensity - duration data used in rational method studies plot as a straight line on standard log-log paper. Using the appropriate 1-hour point precipitation value, an estimate of the peak 5 and 30-minute point rainfalls can be computed using the procedures outlined in Section D (see Figure D-3).

The peak 5-minute, 30-minute, 1-hour, 3-hour, 6-hour, and 24-hour area-averaged point precipitation values are required in order to develop the design storm pattern to be used to compute the watershed runoff hydrograph for the subject rainfall return frequency. Unit-hydrograph studies to be submitted for review should contain the following point precipitation information:

1. Three separate maps showing the watershed 1-hour, 6-hour and 24-hour isohyetals for the appropriate storm return frequency.

2. Calculate an area averaged point precipitation value within the watershed for the peak 1-hour, 6-hour and 24-hour durations.

3. Using standard log-log paper (Figure E-8), plot the area averaged point precipitation values for the peak 1-hour and 6-hours of rainfall. Assuming a straight line relationship, estimate the area-averaged 3-hours point precipitation value for the watershed. If available, verify this value against record rainfall data.

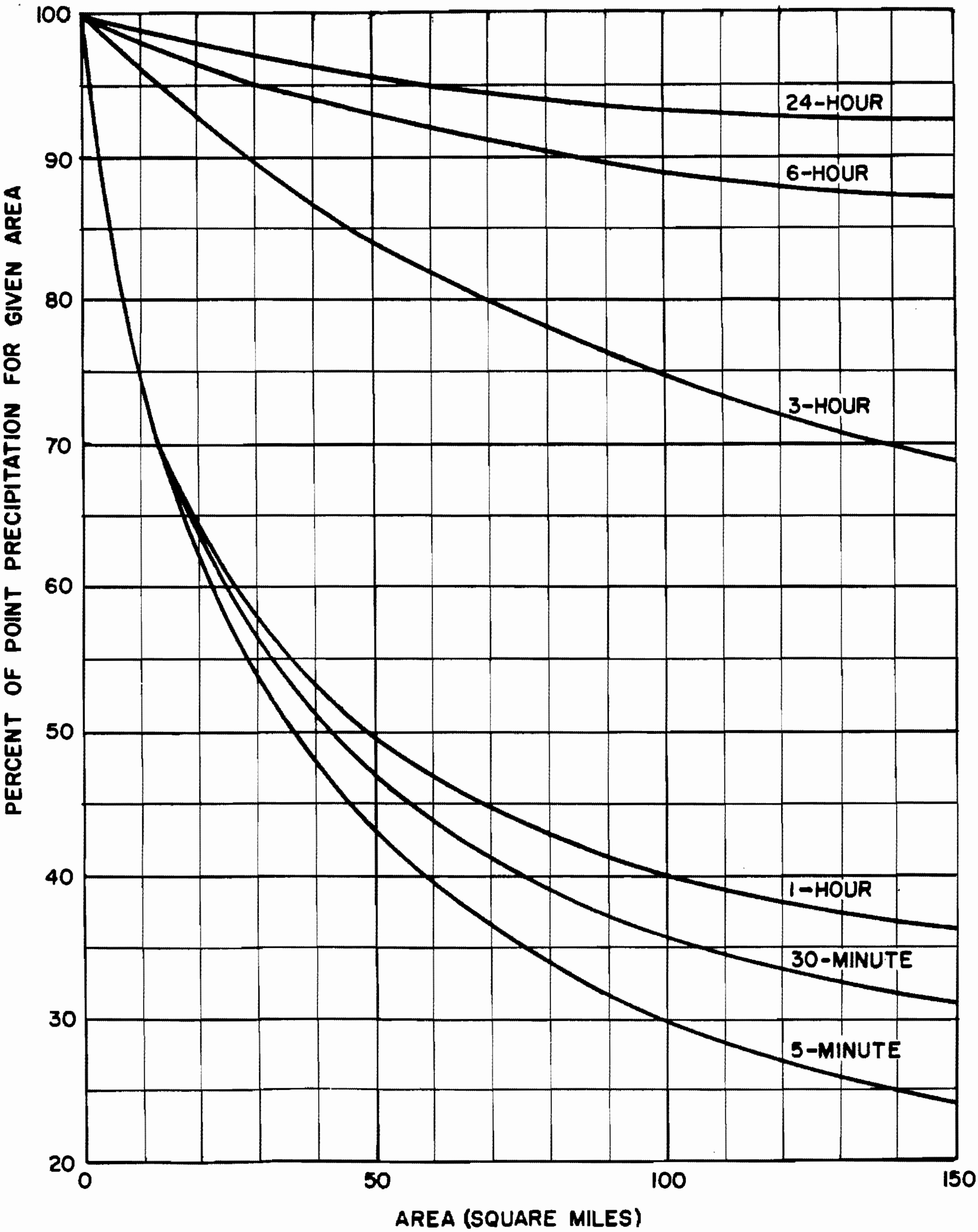
4. Using the rainfall intensity log-log paper (Figure D-3), estimate the area-averaged 5-minute and 30-minute point precipitation values for the watershed. If available, verify these values against record rainfall data.

E.5.1. Point Precipitation Adjustment for Watershed Area

In the unit hydrograph approach, the volume of watershed runoff is related to the watershed average depth of precipitation rather than the depth at specific points within the watershed. Depth-area curves approximately relate the average of all point precipitation values for a specific duration and frequency to the average depth of precipitation within the subject watershed for the same duration and frequency (Figure E-4).

E.6. DESIGN STORM PATTERN

The design storm pattern is based upon a single synthetic 24-hour critical storm pattern which includes the peak rainfall intensities estimated for the 5-minute, 30-minute, 1-hour, 3-hour, 6-hour, and 24-hour durations. The storm pattern is developed from the watershed area-averaged point precipitation values, and modified incrementally according to the depth-area curves of Figure E-4. The assignment of peak rainfall values within the synthetic critical storm pattern is shown in Figure E-5(a,b,c) (refs. 2, 4, 10).

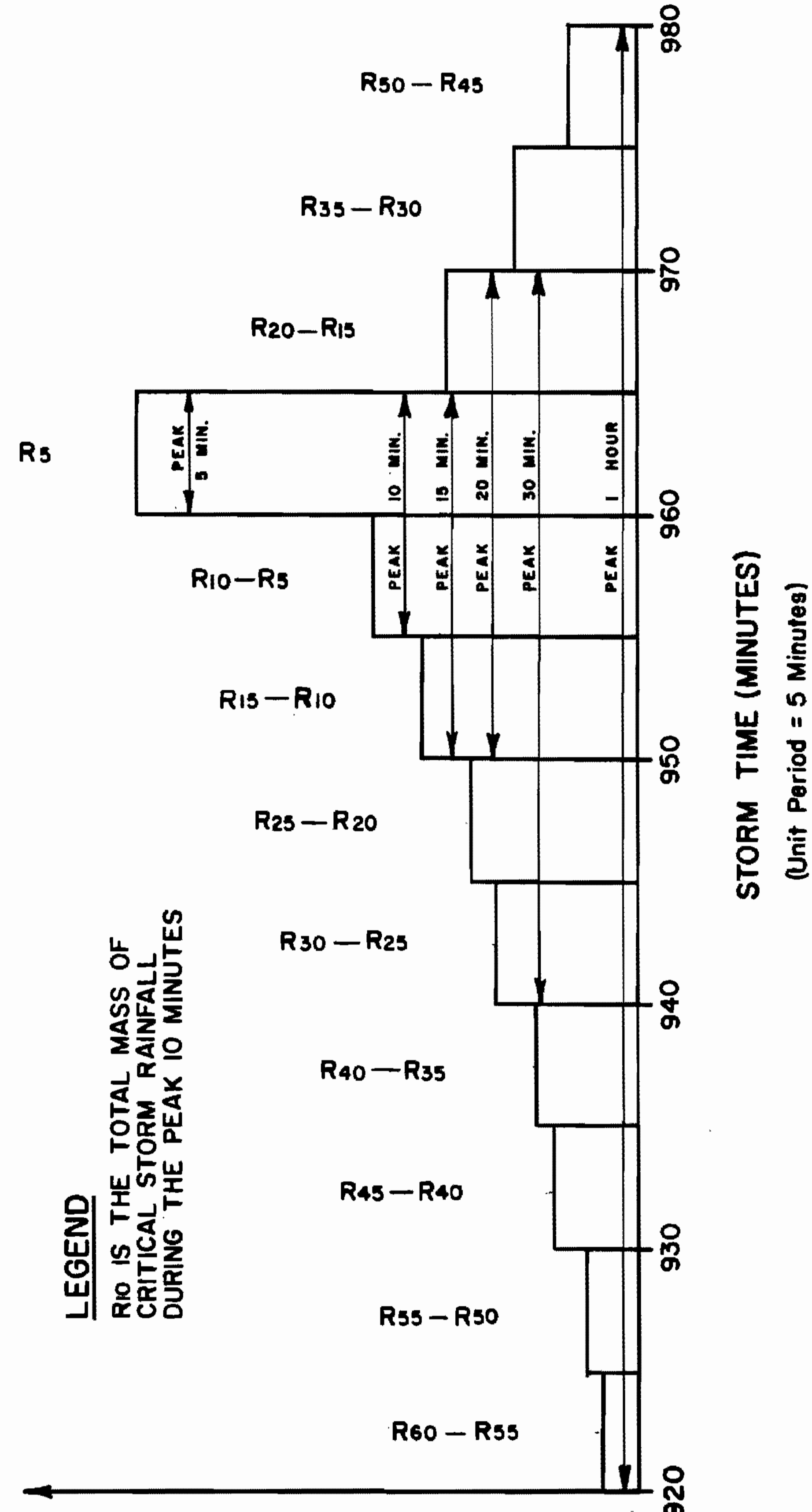


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DESIGN STORM
DEPTH AREA
CURVES

Figure E-4

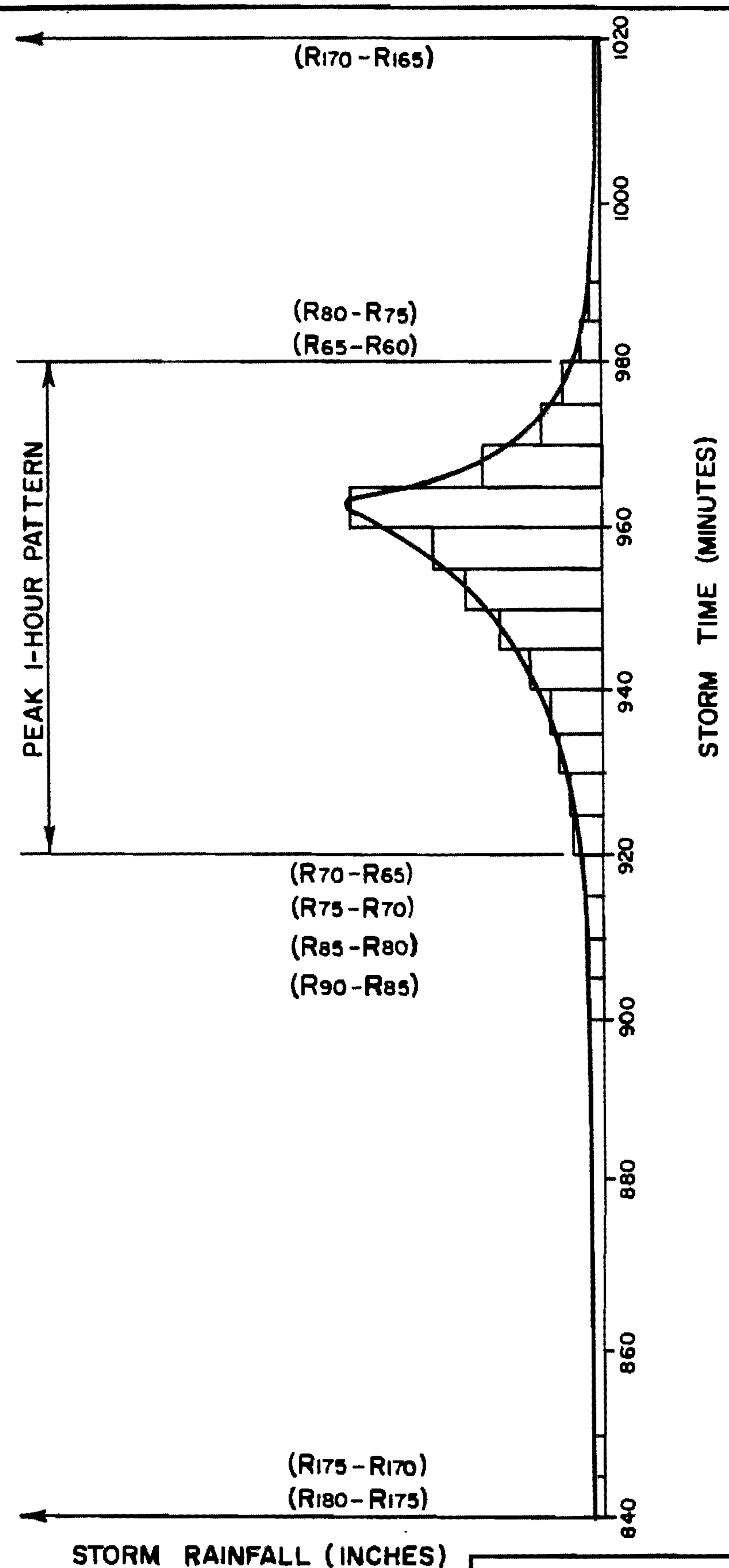


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DESIGN CRITICAL STORM PEAK 1-HOUR PATTERN

Figure E-5a

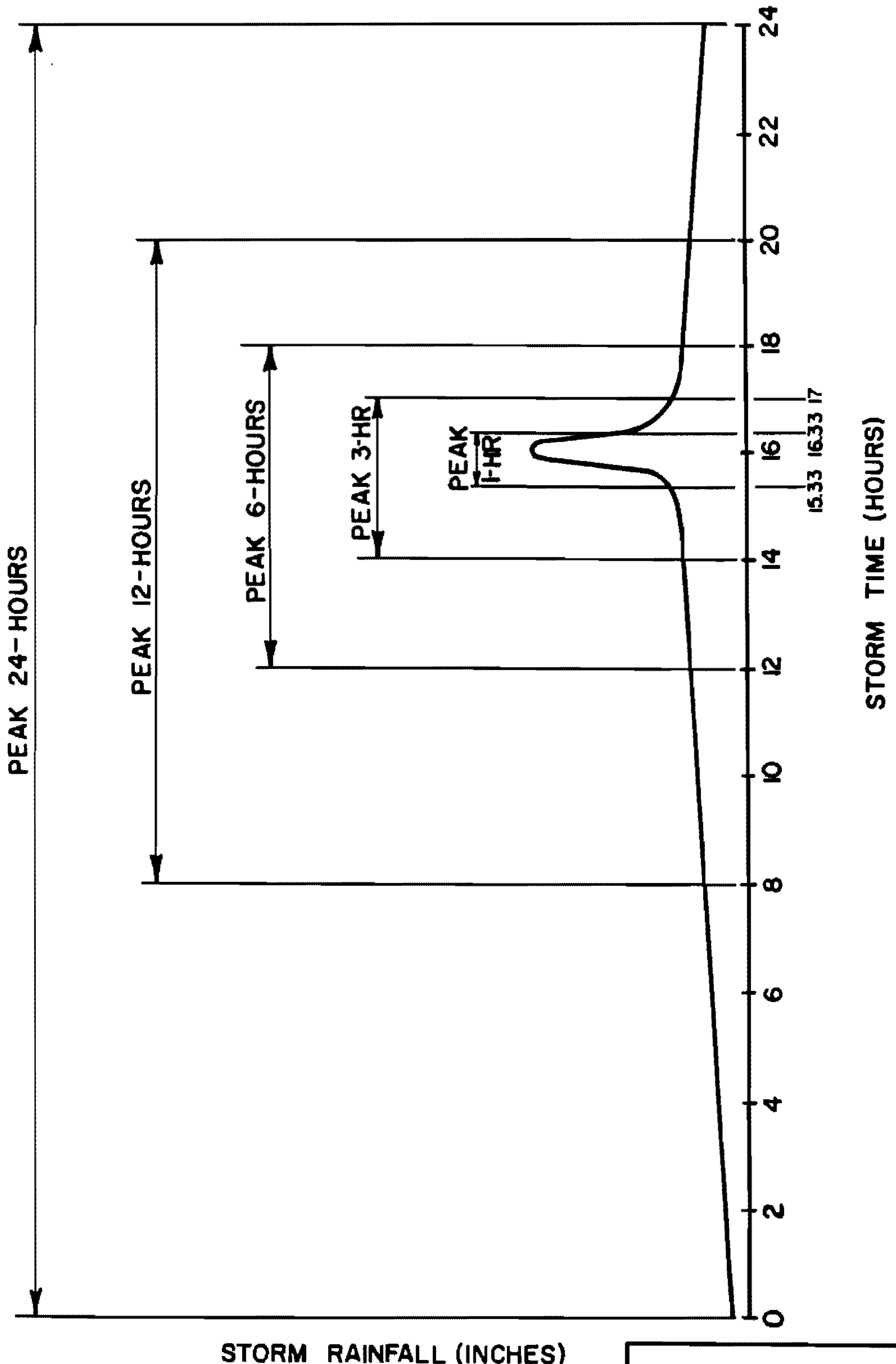


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DESIGN CRITICAL
STORM PEAK
3-HOUR PATTERN

Figure E-5b



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

DESIGN CRITICAL STORM PEAK 24-HOUR PATTERN

For large watersheds (e.g., 5 square miles or larger) or for detention basin studies, the entire 24-hour synthetic storm pattern may be required for hydrologic study purposes. For small watersheds (less than 5 square miles) where only peak runoff rates are required, the peak 3-hours of the 24-hour synthetic storm pattern generally can be used for study purposes, ignoring the remaining 21-hours of lower intensity rainfall.

E.7. DESIGN STORM LOSS RATES

Where sufficient stream gauge information is of adequate quantity and quality as determined by the Agency, loss rates for unit hydrograph hydrology may be estimated from a study of rainfall-runoff relationships of major storms. Where such data is not available, loss rates for pervious areas shall be estimated using the methods of section C.6.

E.7.1. Maximum Loss Rate, F_m

The maximum loss rate, F_m, for a catchment is computed by

$$F_m = a_p F_p \qquad \text{(E.4)}$$

where

F_m = maximum loss rate (inches/hour)
a_p = pervious area fraction (see Figure C-4)
F_p = maximum loss rate for pervious areas (inches/hour); (see section C.6.5)

Maximum loss rates, F_m, for runoff hydrograph studies are usually within the range of 0.10 to 0.40 inches per hour in urbanized areas.

E.7.2. Low Loss Rate, F*

During the peak rainfall intensities of the synthetic design storm pattern, the loss rate used to estimate effective rainfall is typically the maximum loss rate, F_m. At lower rainfall intensities, however, a low loss rate, F*, is used for the estimation of effective rainfall. The low loss rate F* is based upon the low loss fraction, $\bar{Y}$, defined by (see section C.6.3)

$$\bar{Y} = 1 - Y \qquad \text{(E.5)}$$

where

$\bar{Y}$ = catchment low loss fraction

Y = catchment 24-hour storm runoff yield (fraction) computed from (C.4)

The corresponding low loss rate based on the $\bar{Y}$ value is

$$F^* = \bar{Y} \cdot I \qquad \text{(E.6)}$$

where

F^* = low loss rate (inches/hour)

$\bar{Y}$ = low loss fraction

I = rainfall intensity (inches/hour)

Using both the low loss rate (F*) and the maximum loss rate (F_m) in the determination of effective rainfall will result in 24-hour storm watershed yields (ratio of total runoff to total rainfall) that approximate the values predicted by the curve number approach (see Figures C-5 and C-7).

The low loss fraction should be used to estimate effective rainfall whenever the maximum loss rate, F_m, exceeds F*. In all cases, however, the maximum loss rate is the constant value, F_m. Use of these two loss rate parameters enables the 24-hour design storm runoff hydrograph model to develop peak runoff rates based upon a maximum watershed loss rate (phi index), and also develop 24-hour storm runoff yields which approximate the values obtained from the SCS curve number approach.

E.8. RUNOFF VOLUME ESTIMATION

The catchment yield fraction, Y, can be used to approximate the total runoff volume produced from a 24-hour duration precipitation event without developing the 24-hour storm runoff hydrograph. The basis of this determination is the curve number approach which provides a rainfall-runoff relationship (Figure C-5).

E.8.1. Example Runoff Volume Estimation Problem

The runoff volume from a 24-hour duration precipitation event with a 25-year return frequency is estimated using the low loss fraction. Assume a 1,000-acre watershed with the following land uses (AMC II assumed), cover complexes, and soil groups (See Figures C-3 and C-4):

TABLE E.1. EXAMPLE PROBLEM ASSUMPTIONS

Subarea Number	Area Fraction	Land Use and Condition	Soil Group	Pervious CN
1	0.10	meadow: good condition	D	78
2	0.05	woodland: poor cover	C	77
3	0.05	annual grass: good condition	D	80
4	0.80	residential (1/8 acre lots) impervious area fraction $a_i = 0.60$	C	69

The yield is computed for each subarea using (C.3) where, for the 25-year design storm, $P_{24} = 4.49$ inches (example) as follows:

TABLE E.2. EXAMPLE PROBLEM YIELD CALCULATIONS

Subarea Numbers	CN	S	Ia	Y	Area Fraction
1	78	2.82	0.56	0.51	0.10
2	77	2.99	0.60	0.49	0.05
3	80	2.50	0.50	0.55	0.05
4a	69	4.49	0.90	0.36	0.32
4b	98	0.20	0.04	0.95	0.48

In Table E.2, subarea 4 is further subdivided into pervious and impervious area fractions as subareas 4a and 4b. Normally, the entire catchment impervious area fraction is lumped together for simplicity.

Using Table E.2, the catchment runoff yield (fraction), Y, is calculated from (C.4) as

$$Y = (0.51)(0.10) + (0.49)(0.05) + (0.55)(0.05) + (0.36)(0.32) + (0.95)(0.48) = 0.67$$

Thus, the 24-hour 25-year design storm runoff volume is estimated to be

$$\text{VOLUME} = (0.67)(4.49\text{-inches})(1000\text{-acres})(1\text{-ft}/12\text{-inches})$$
$$= \underline{250.7 \text{ acre-feet}}$$

It is noted that the above volume estimate is typically slightly less than the runoff volume developed from a 24-hour 25-year design storm runoff hydrograph analysis because the effects of the maximum loss rate, F_m, were neglected in the calculations.

E.9. BASEFLOWS

Baseflow is usually a minor factor in developing flood hydrographs for relatively rare flood events in San Bernardino County. Generally, 10 cfs per watershed square mile is adequate for unlined channels that intercept mountainous regions where many geologic strata are crossed by the stream bed. Baseflow can be included in the watershed runoff by adding to the ordinates of the computed runoff hydrograph. In fully urbanized areas, baseflow can be entirely neglected.

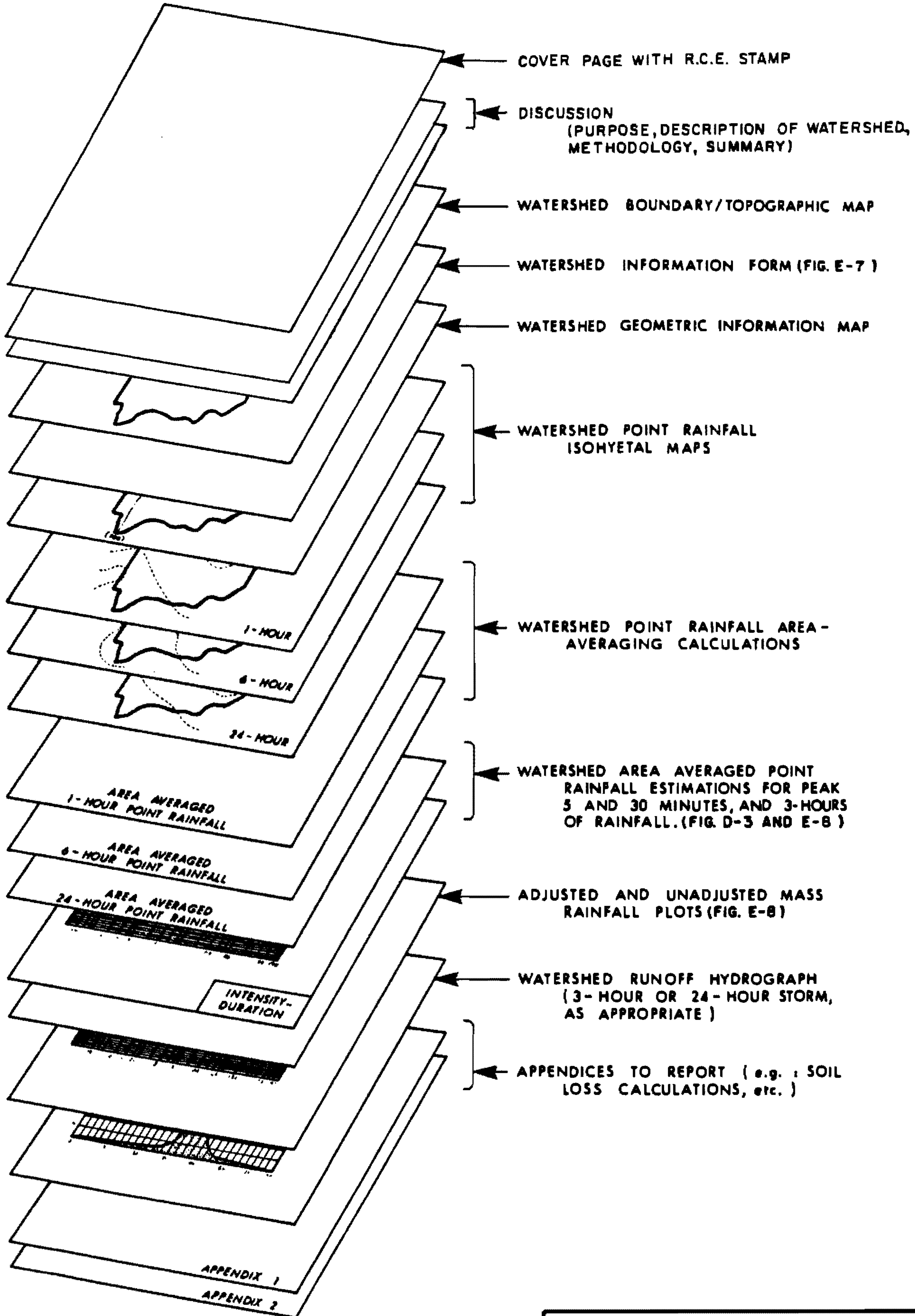
E.10. ALTERNATIVE RUNOFF HYDROGRAPH METHODS

The San Bernardino County Hydrology Manual has been calibrated to local watershed conditions (without the use of channel routing parameters) in order that the unit hydrograph hydrologic methods achieve the desired level of protection in estimating the return frequency of floodflows. The introduction of additional parameters, in particular the routing of subarea flows, may alter the calibration, resulting in a failure to achieve the flood control protection level objectives. Because model sensitivity analysis and model calibration is essentially precluded for studies involving ungauged watersheds, any hydrologic study not prepared in accordance with this hydrology manual may be rejected (see Section K).

E.11. REQUIRED FORMAT

Figure E-6 illustrates the required format for submitting unit hydrograph study results for review.

Figure E-7 is to be used to supply the necessary hydrology information to determine the runoff hydrograph. Figure E-8 is used to plot both the unadjusted and adjusted mass rainfall curves. Figure E-10 is the Flood Computation Form.



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

REQUIRED REPORT FORMAT FOR UNIT HYDROGRAPH STUDY

Figure E-6

PROJECT: ______________________ DATE:

____

ENGINEER: ______________________

1. Enter the design storm return frequency **(years)** ________
2. Enter catchment lag **(hours)** ________
3. Enter the catchment area **(acres)** ________
4. Enter baseflow **(cfs/square mile)** ________
5. Enter S-Graph proportions **(decimal)**

    Valley: Developed ________
    Foothill ________
    Mountain ________
    Valley: Undeveloped ________
    Desert ________

6. Enter maximum loss rate, F_m **(inch/hour)** ________
7. Enter low loss fraction, $\bar{Y}$ **(decimal)** ________
8. Enter watershed area-averaged 5-minute point rainfall **(inches)*** ________

    Enter watershed area-averaged 30-minute point rainfall **(inches)*** ________

    Enter watershed area-averaged 1-hour point rainfall **(inches)*** ________

    Enter watershed area-averaged 3-hour point rainfall **(inches)*** ________

    Enter watershed area-averaged 6-hour point rainfall **(inches)*** ________

    Enter watershed area-averaged 24-hour point rainfall **(inches)*** ________

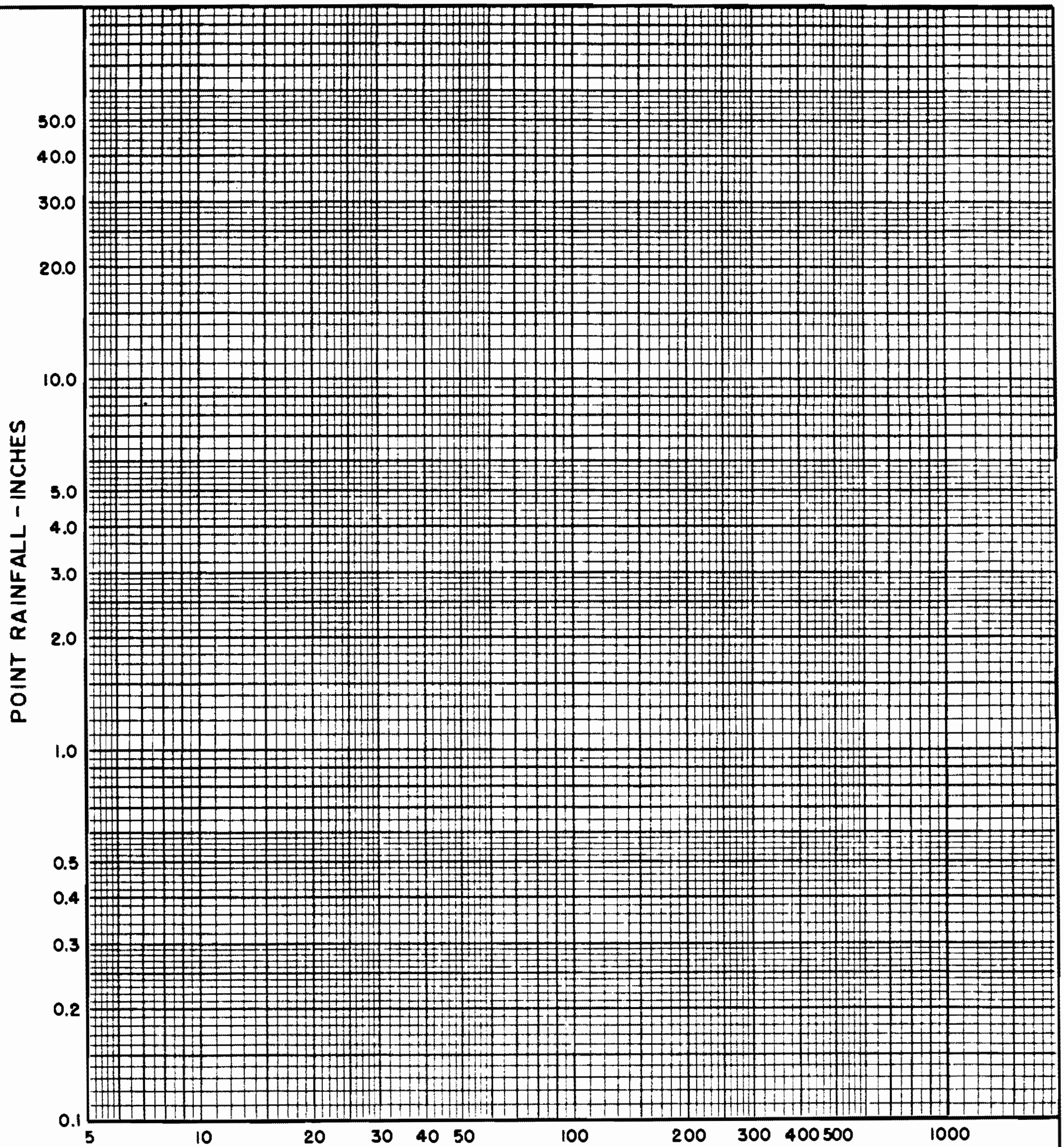
9. Enter 24-hour storm unit interval **(minutes)** ________

*Note: enter values unadjusted by depth-area factors

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

WATERSHED INFORMATION FORM

Figure E-7



PROJECT LOCATION ____________________

NOTES ____________________

____

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET

FIGURE E-8

E.12. INSTRUCTIONS FOR SYNTHETIC UNIT HYDROGRAPH METHOD HYDROLOGY CALCULATIONS

I. Synthetic Unit Hydrograph Development

A. On a USGS topographic quadrangle sheet or other topographic map of suitable scale, outline the watershed boundary.

B. Calculate the catchment time of concentration (Tc) by using a rational method analysis for the T-year storm.

1. Catchment lag is computed by

$$lag = 0.8Tc$$

2. For certain large scale natural condition catchment studies, the Agency may use the lag relationship given by

$$lag\ (hours) = 24\bar{n}(L \cdot L_{ca}/S^{0.50})^{0.38}$$

where

A	=	drainage area (square miles)
L	=	length of longest watercourse (miles)
L_{ca}	=	length along the longest watercourse, measured upstream to a point opposite the centroid of the area (miles)
H	=	difference in elevation between the concentration point and the most remote point of the basin (feet)
S	=	overall slope of longest watercourse between headwaters and concentration point (S = H/L, feet per mile)
$\bar{n}$	=	visually estimated average basin factor from Figure E-2.

C. Select a unit time period. To adequately define the unit hydrograph the unit time period should be about 20 percent of lag time, and never more than 25 percent of lag time. If possible, use the unit time of the synthetic critical storm pattern of 5-minutes.

D. Select the S-graph applicable to the drainage basin (Figures E-3a,b,c,d,e). Determine the average percentage of the ultimate discharge for each unit period. In reading the percentage of ultimate discharge from the S-graph, the average ordinate over the time increment should be determined rather than the mean of the ordinates at the beginning and end of the time increment (see example problem).

E. Compute the unit distribution graph by subtracting from the percentage of ultimate discharge for each unit time period, the percentage of ultimate discharge for the previous time period.

F. Compute the ordinates of the synthetic unit hydrograph (unit graph) by multiplying the distribution graph values by the ultimate discharge K, using:

$$K\ (cfs) = 645A/T$$

where

A = drainage area (square miles)
T = unit time period (hours)

II. T-Year Design Storm Pattern Development

A. Using the appropriate T-year point precipitation values from the rainfall isohyetal maps and figures D-3 and E-8, compute the area-averaged precipitation values for the 5-minute, 30-minute, 1-hour, 3-hour, 6-hour, and 24-hour durations.

B. Adjust all point precipitation values for areal effect by using Figure E-4.

C. Develop a synthetic critical storm peak rainfall mass plot using Figure E-8 (see example problem for demonstration).

D. Using the unit interval duration for the unit hydrograph development, calculate the synthetic storm unit interval rainfall quantities by successive subtraction of mass peak rainfall values, each offset in time by one unit period.

E. Arrange the unit rainfall quantities determined in step D into the critical storm pattern shown in Figures E-5a,b,c. For most hydrology studies, only the peak 3-hours of the synthetic critical storm may need consideration.

III. Runoff Hydrograph Development

A. Find the pervious area loss rates for subareas within the drainage area using Figures C-3 and C-4. Adjust these rates to account for impervious area using the relationship below, and then compute an area-averaged maximum loss rate for the catchment.

$$F_m = a_p F_p$$

where

F_m = maximum loss rate (inches/hour)

a_p = pervious area fraction (decimal percent of total area). See Figure C-4.

F_p = maximum loss rate for pervious areas fraction. See section C.6.4.

B. Compute the low loss fraction, $\bar{Y}$. Use F* in each unit time period where the maximum loss rate F_m exceeds the low loss rate F*, ($F^* = \bar{Y} \cdot I$, see section C.6.3).

C. Compute the unit effective rainfall for each unit time period by subtracting the unit loss from the unit rainfall.

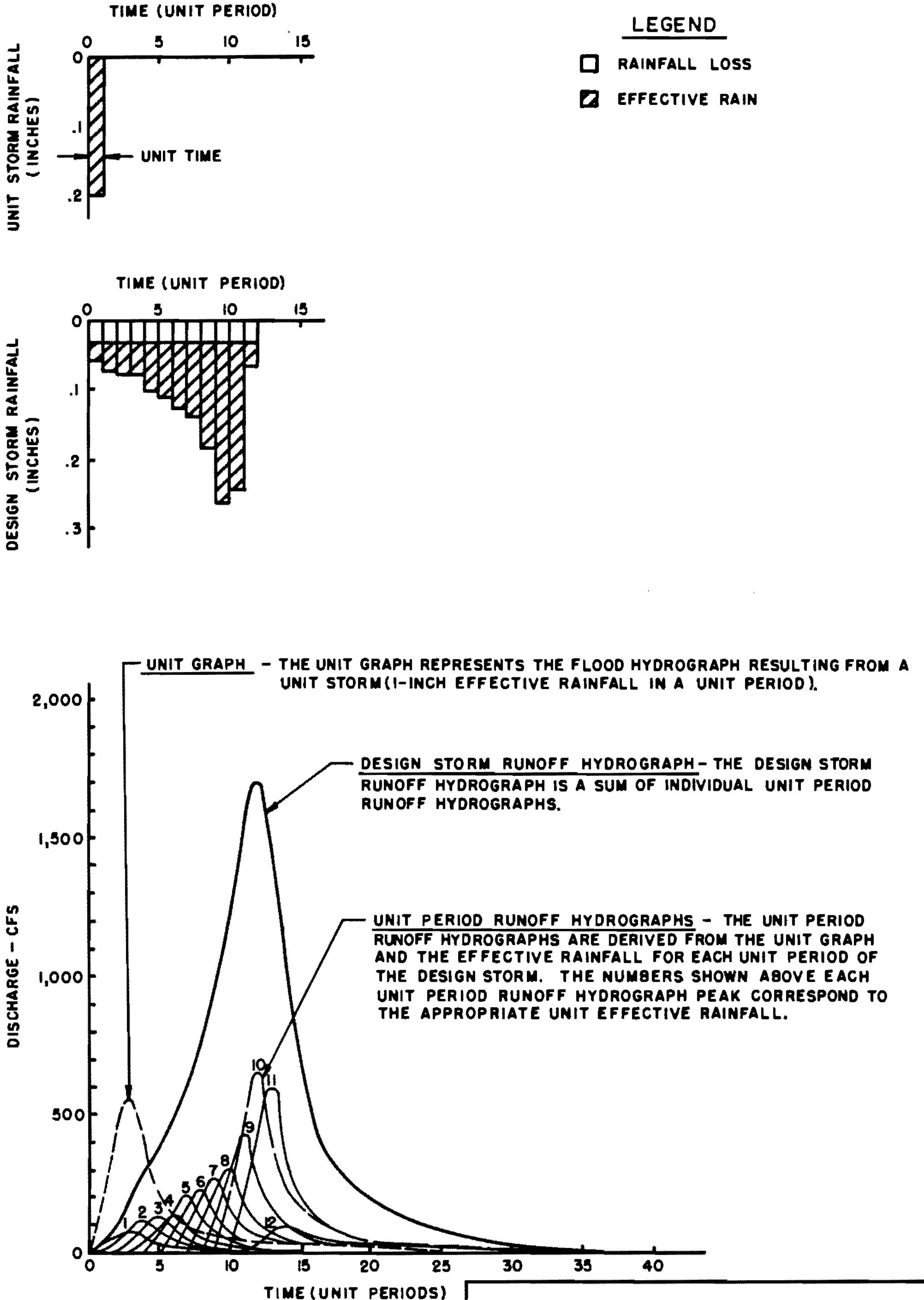
D. Compute the flood hydrograph.

1. Multiply the effective unit rainfall for the first unit time period by each synthetic unit hydrograph value to determine the flood hydrograph which would result from that rainfall increment.

2. Repeat the above process for each succeeding effective rainfall value, advancing the resultant flood hydrographs one unit time period for each computation cycle. See Figure E-9.

3. Sum the flow ordinates found in the steps above to determine the average flow ordinate per unit time period for the design storm flood hydrograph.

E. Add the appropriate base flow to the flood hydrograph ordinates determined in Step D.



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DERIVATION OF A RUNOFF HYDROGRAPH

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

SYNTHETIC UNIT HYDROGRAPH METHOD

Flood Hydrograph Calculation Form

Project ______________________

By__________ Date________

Checked__________ Date________

Sheet

	EFFEC RAIN		FLOOD HYDRO-GRAPH
UNIT GRAPH	UNIT PER.		

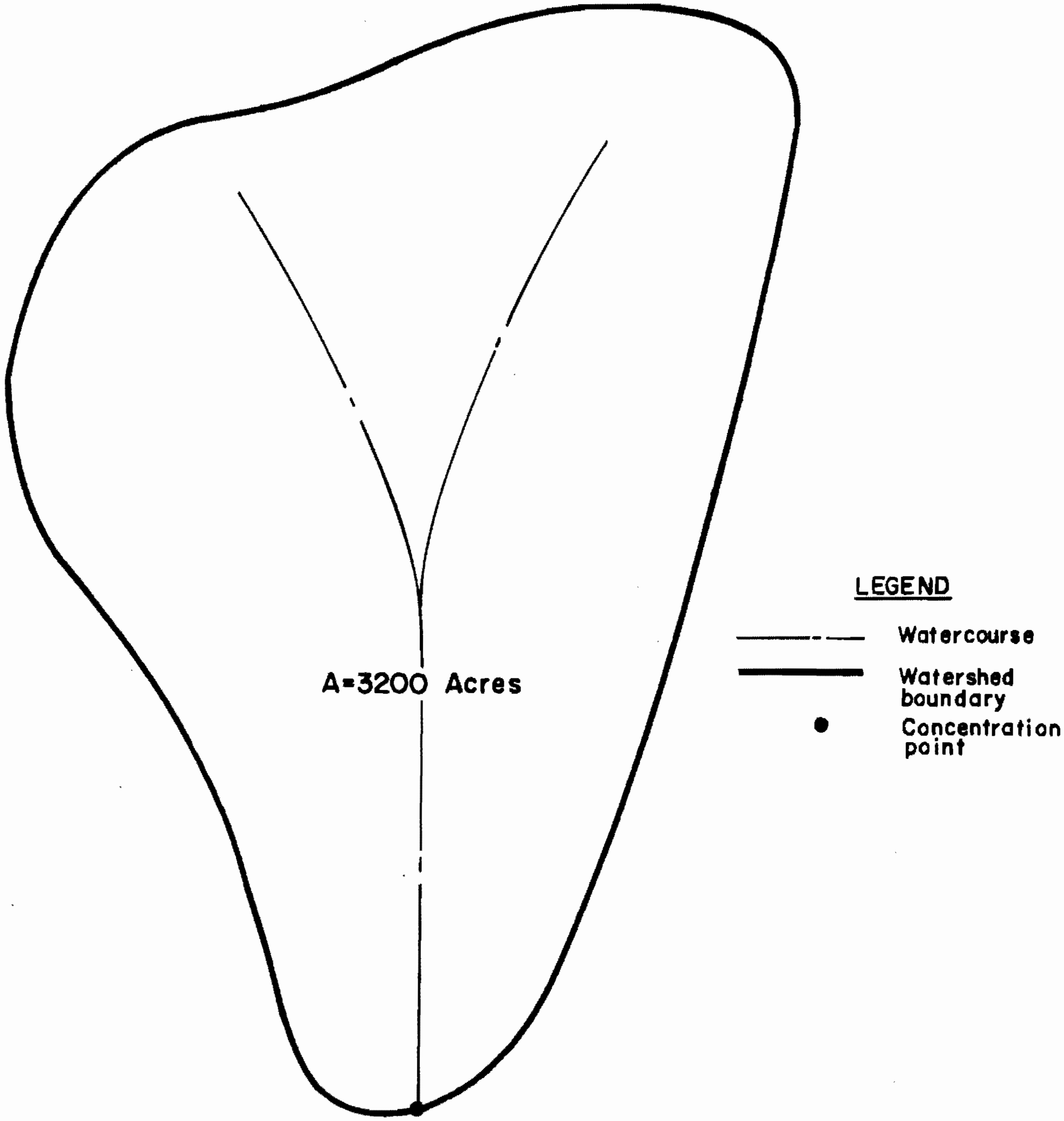
Figure E-10

E.13. EXAMPLE PROBLEM

The following example problem illustrates the format suggested for synthetic unit hydrograph hydrology studies to be submitted for review. In the following, an example watershed is analyzed using the Agency unit hydrograph approach. The example problem presentation contains the following information:

<u>Description</u>

- Watershed Map including Boundary and Geometric Information
- Watershed Information Form
- 1-Hour Rainfall Isohyetals
- 6-Hour Rainfall Isohyetals
- 24-Hour Rainfall Isohyetals
- Area-Averaged Rainfall Determination
- 3-Hour Area-Averaged Rainfall Estimation
- 5-Minute and 30-Minute Area-Averaged Rainfall Estimation
- Adjusted and Unadjusted Mass Rainfall Plots (Depth-Area Effects)
- 3-Hour Storm Unit Rainfall Determination (5-Minute Unit Interval)
- Watershed-Loss Information Map
- Area-Averaged Maximum Loss Rate (F_m) Determination
- Area-Averaged Low Loss Fraction ($\bar{Y}$) Determination
- Effective Rainfall Determination
- 3-Hour Critical Storm
- S-Curve Approximation
- Unit Hydrograph Determination
- Runoff Hydrograph Determination
- Runoff Hydrograph



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM
WATERSHED BOUNDARY

PROJECT: *EXAMPLE PROBLEM* DATE:

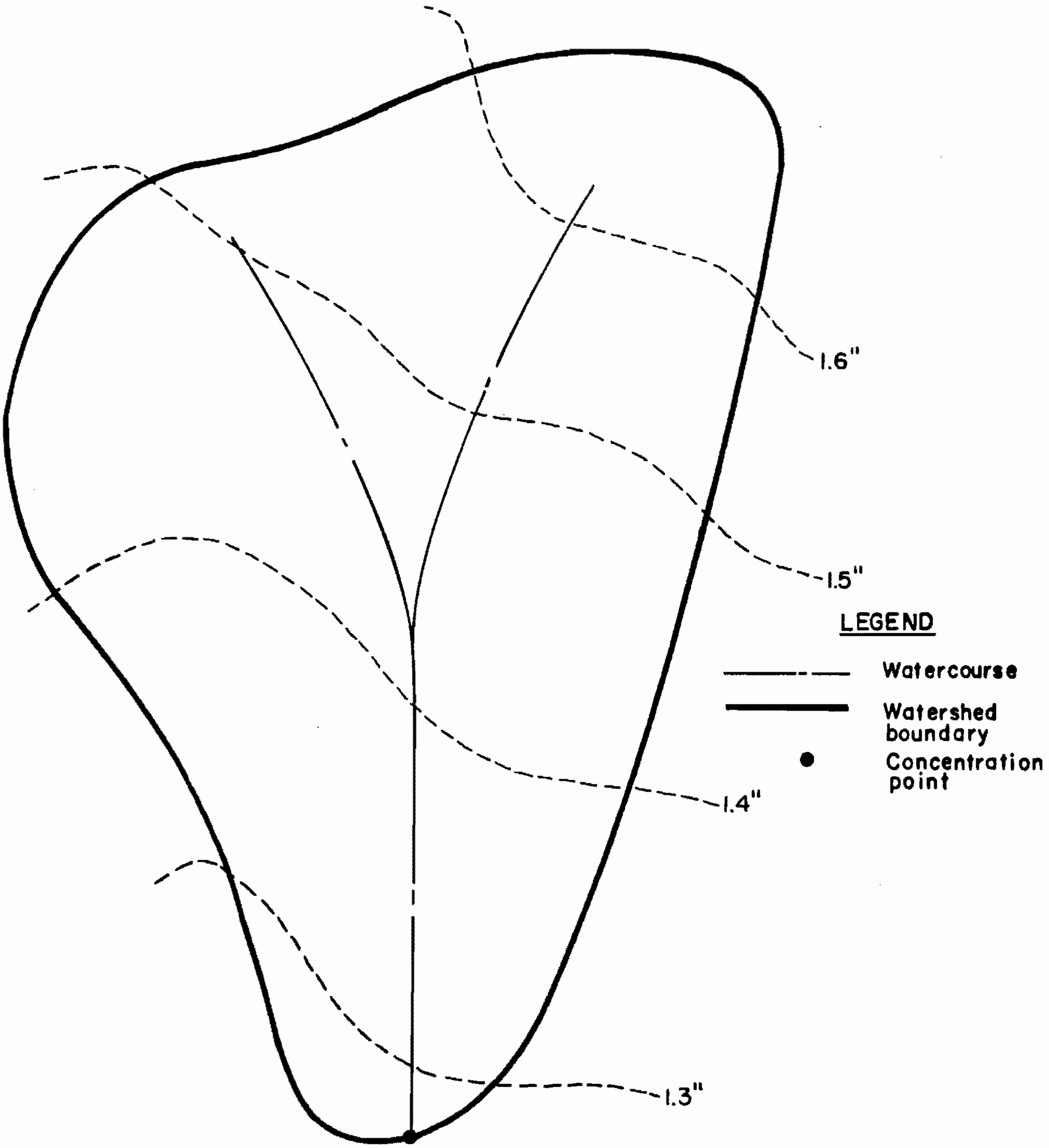
ENGINEER:

1.	Enter the design storm return frequency **(years)**	*100*
2.	Enter catchment lag **(hours)**	*0.75*
3.	Enter the catchment area **(acres)**	*3200*
4.	Enter baseflow **(cfs/square mile)**	*0*
5.	Enter S-Graph proportions **(decimal)**	
	Valley: Developed	*1.0*
	Foothill	*0.0*
	Mountain	*0.0*
	Valley: Undeveloped	*0.0*
	Desert	
6.	Enter maximum loss rate, F_m **(inch/hour)**	*0.28*
7.	Enter low loss fraction, $\bar{Y}$ **(decimal)**	*0.30*
8.	Enter watershed area-averaged 5-minute point rainfall **(inches)***	*0.52*
	Enter watershed area-averaged 30-minute point rainfall **(inches)***	*1.09*
	Enter watershed area-averaged 1-hour point rainfall **(inches)***	*1.45*
	Enter watershed area-averaged 3-hour point rainfall **(inches)***	*2.43*
	Enter watershed area-averaged 6-hour point rainfall **(inches)***	*3.36*
	Enter watershed area-averaged 24-hour point rainfall **(inches)***	*5.63*
9.	Enter 24-hour storm unit interval **(minutes)**	*5.0*

*Note: enter values unadjusted by depth-area factors

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

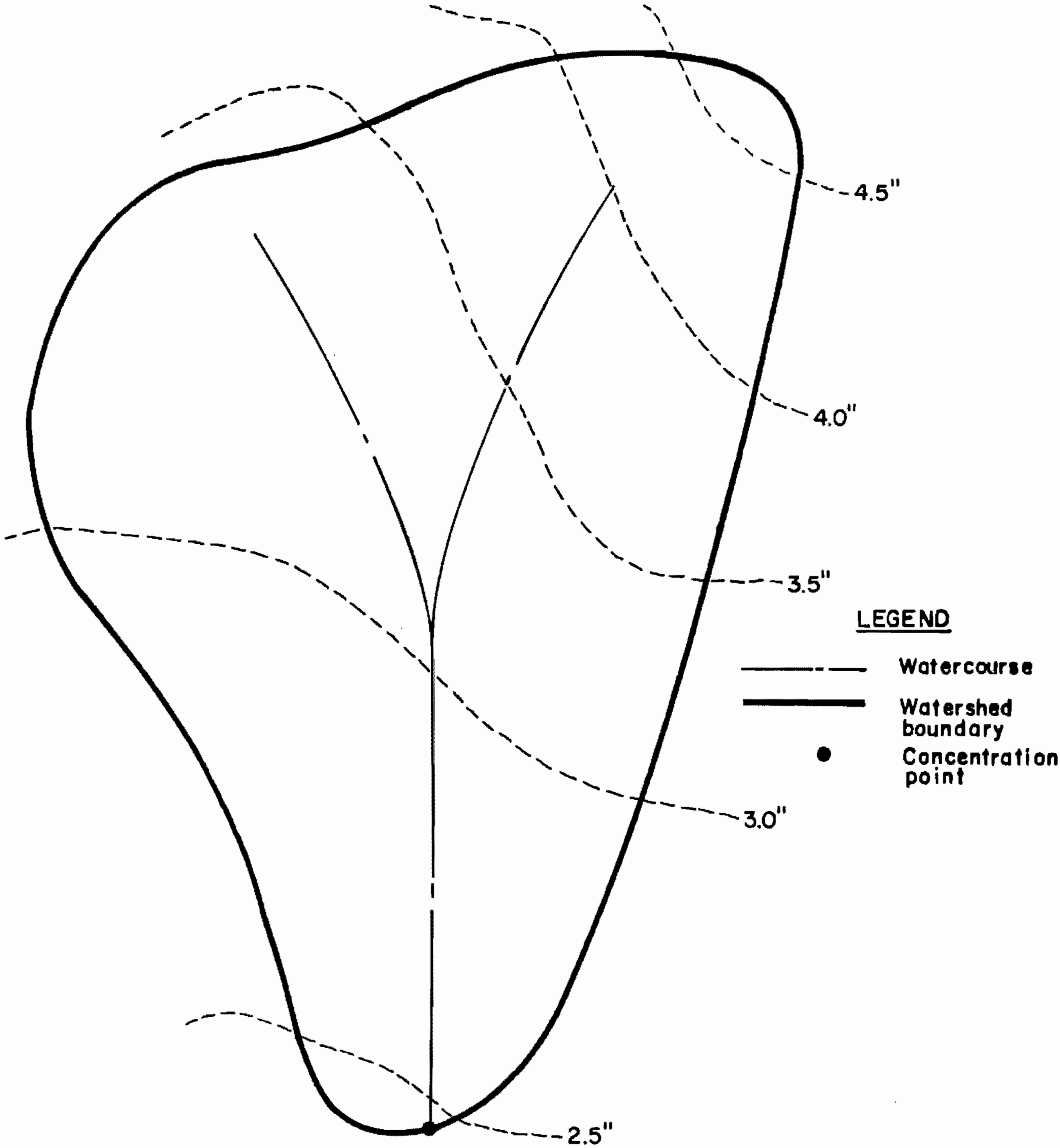
WATERSHED INFORMATION FORM



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

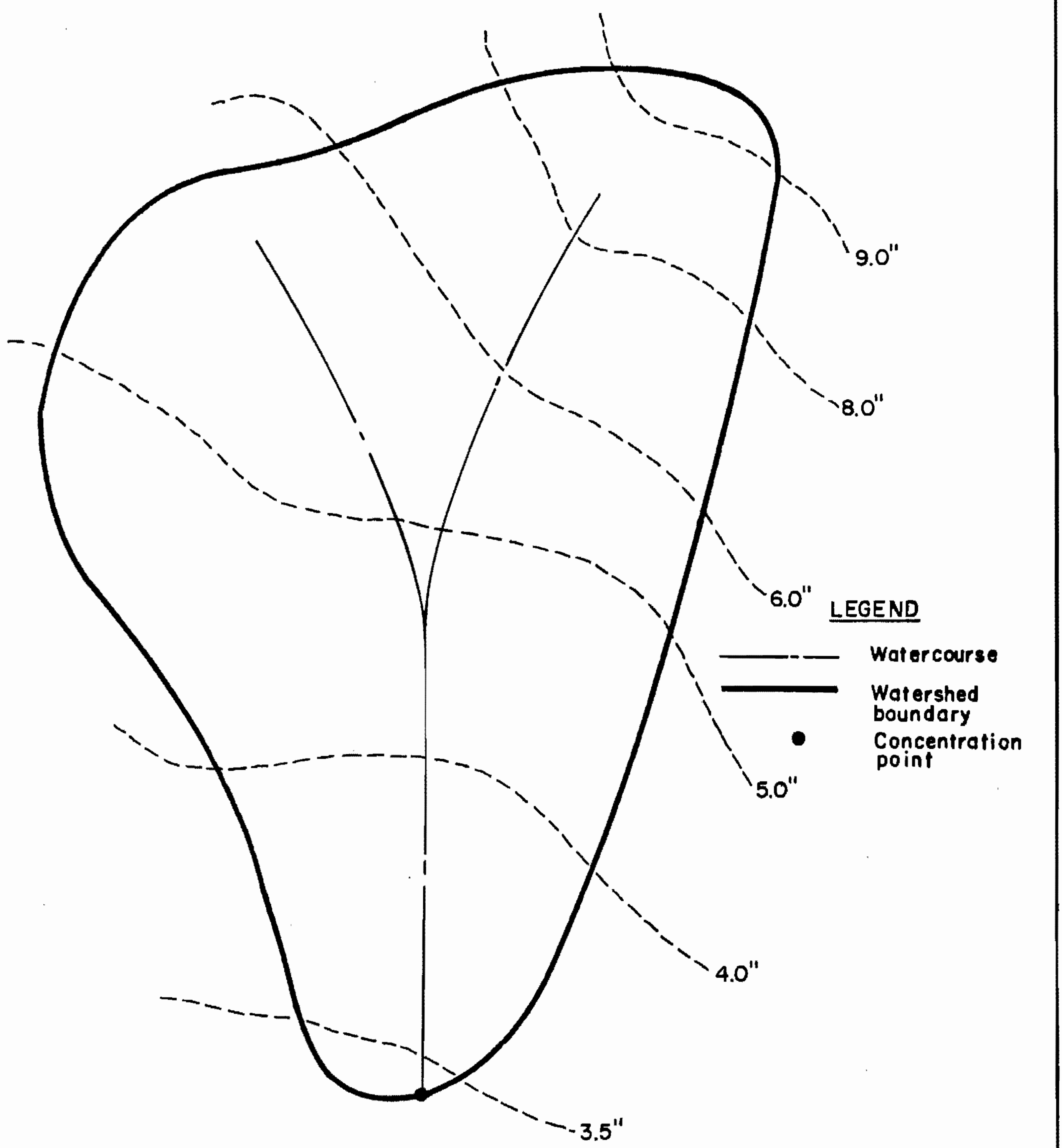
EXAMPLE PROBLEM
100-YEAR, 1-HOUR RAINFALL
ISOHYETALS



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM
100-YEAR, 6-HOUR RAINFALL
ISOHYETALS



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM

100-YEAR, 24-HOUR RAINFALL ISOHYETALS

SAN BERNARDINO COUNTY
UNIT HYDROGRAPH STUDY:
EXAMPLE PROBLEM AREA-AVERAGED POINT PRECIPITATION DETERMINATION

(1) Isohyetal (inches)	(2) Area (acres)	Weighting (1) · (2)

1-Hour Isohyetal Area-Averaging

Isohyetal (inches)	Area (acres)	Weighting
1.6	640	1024.0
1.5	928	1392.0
1.4	1152	1612.8
1.3	480	624.0
	Total Map Area = 3200	Total Weighting = 4652.8

Area-Averaged Value = 4652.8 / 3200 = 1.45

6-Hour Isohyetal Area-Averaging

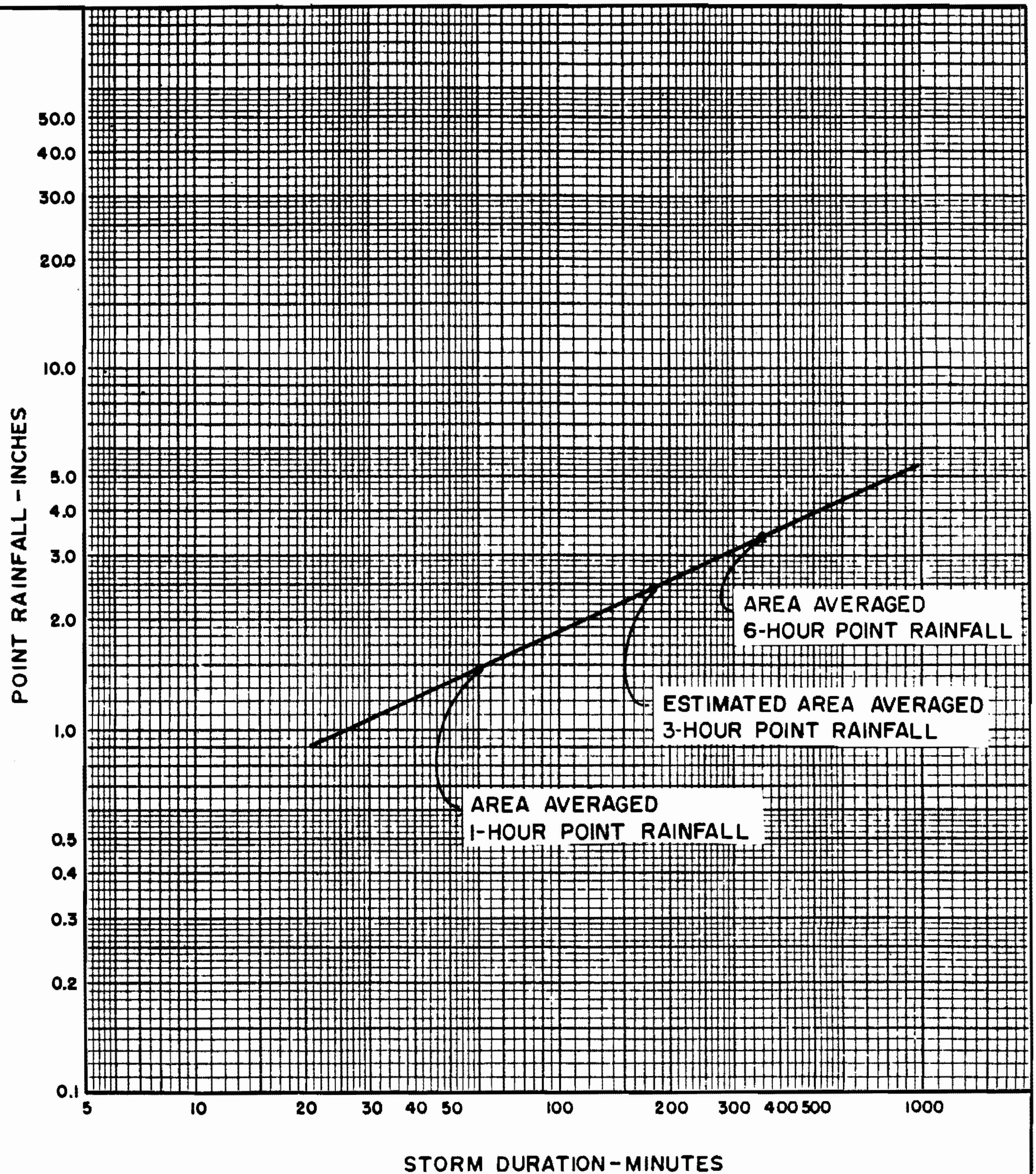
Isohyetal (inches)	Area (acres)	Weighting
4.5	224	1008.0
4.0	448	1792.0
3.5	1024	3584.0
3.0	1216	3648.0
2.5	288	720.0
	Total Map Area = 3200	Total Weighting = 10752.0

Area-Averaged Value = 10,752 / 3200 = 3.36

24-Hour Isohyetal Area-Averaging

Isohyetal (inches)	Area (acres)	Weighting
9.0	160	1440.0
8.0	480	3840.0
6.0	800	4800.0
5.0	960	4800.0
4.0	640	2560.0
3.5	160	560.0
	Total Map Area = 3200	Total Weighting = 18000.0

Area-Averaged Value = 18,000 / 3200 = 5.63



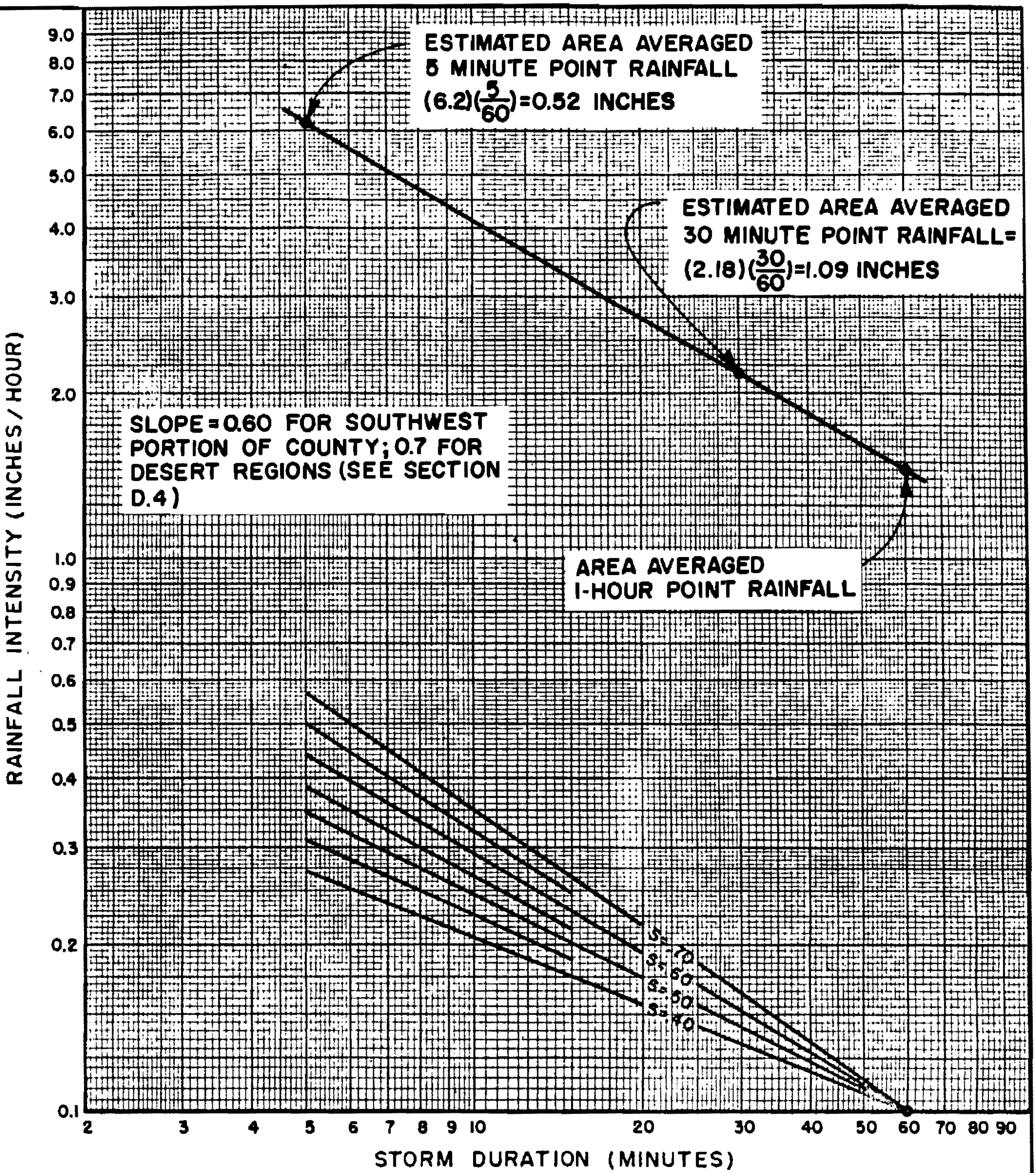
PROJECT LOCATION *EXAMPLE PROBLEM*

NOTES *100-YR: 1 HOUR = 1.45, 6-HOUR = 3.96*

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET



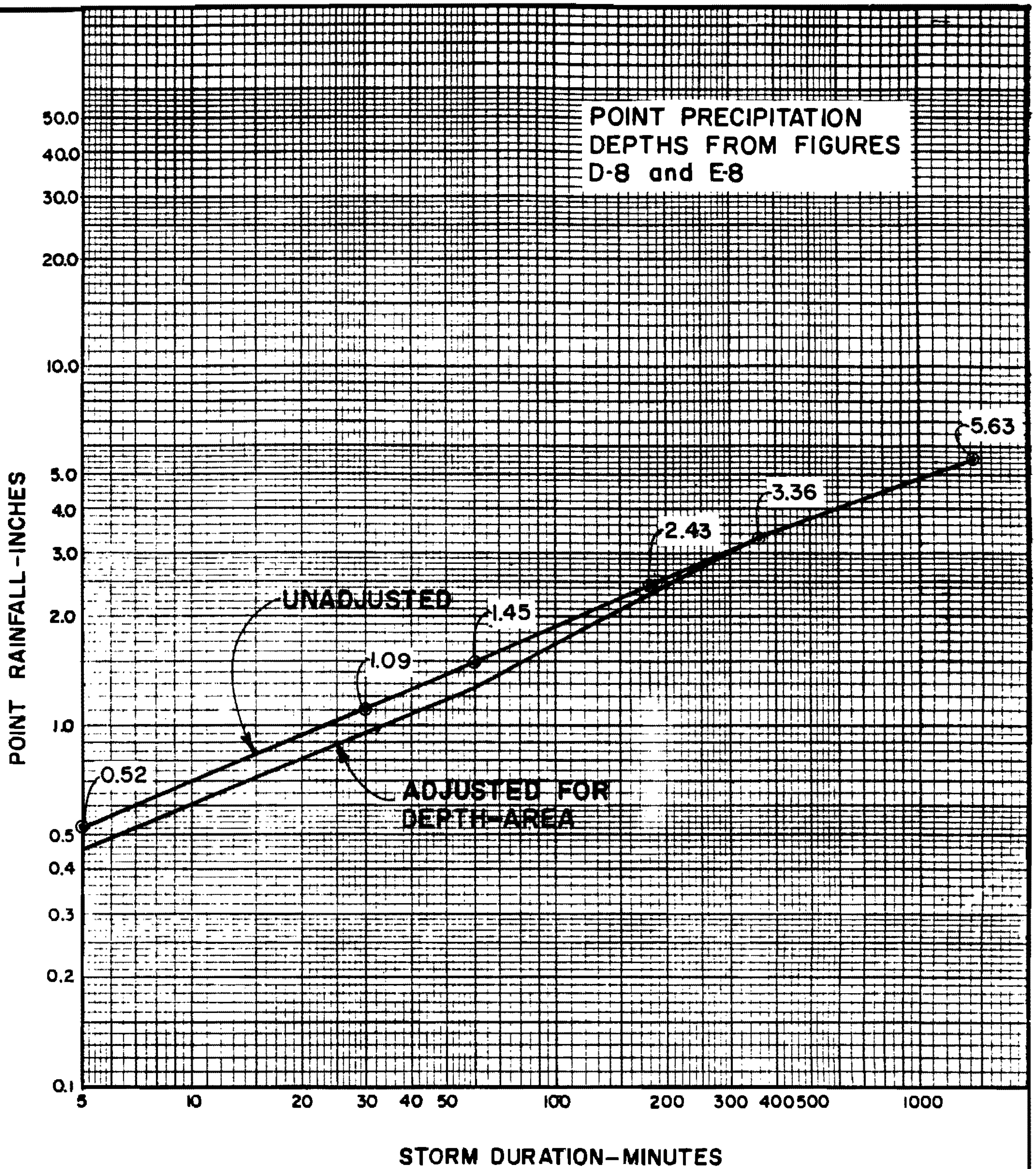
DESIGN STORM FREQUENCY = 100 YEARS

ONE HOUR POINT RAINFALL = 1.45 INCHES

LOG-LOG SLOPE = 0.60

PROJECT LOCATION = EXAMPLE PROBLEM

SAN BERNARDINO COUNTY HYDROLOGY MANUAL	INTENSITY - DURATION CURVES CALCULATION SHEET



PROJECT LOCATION *EXAMPLE PROBLEM*

NOTES *100-YEAR STORM*

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

AREA - AVERAGED MASS RAINFALL PLOTTING SHEET

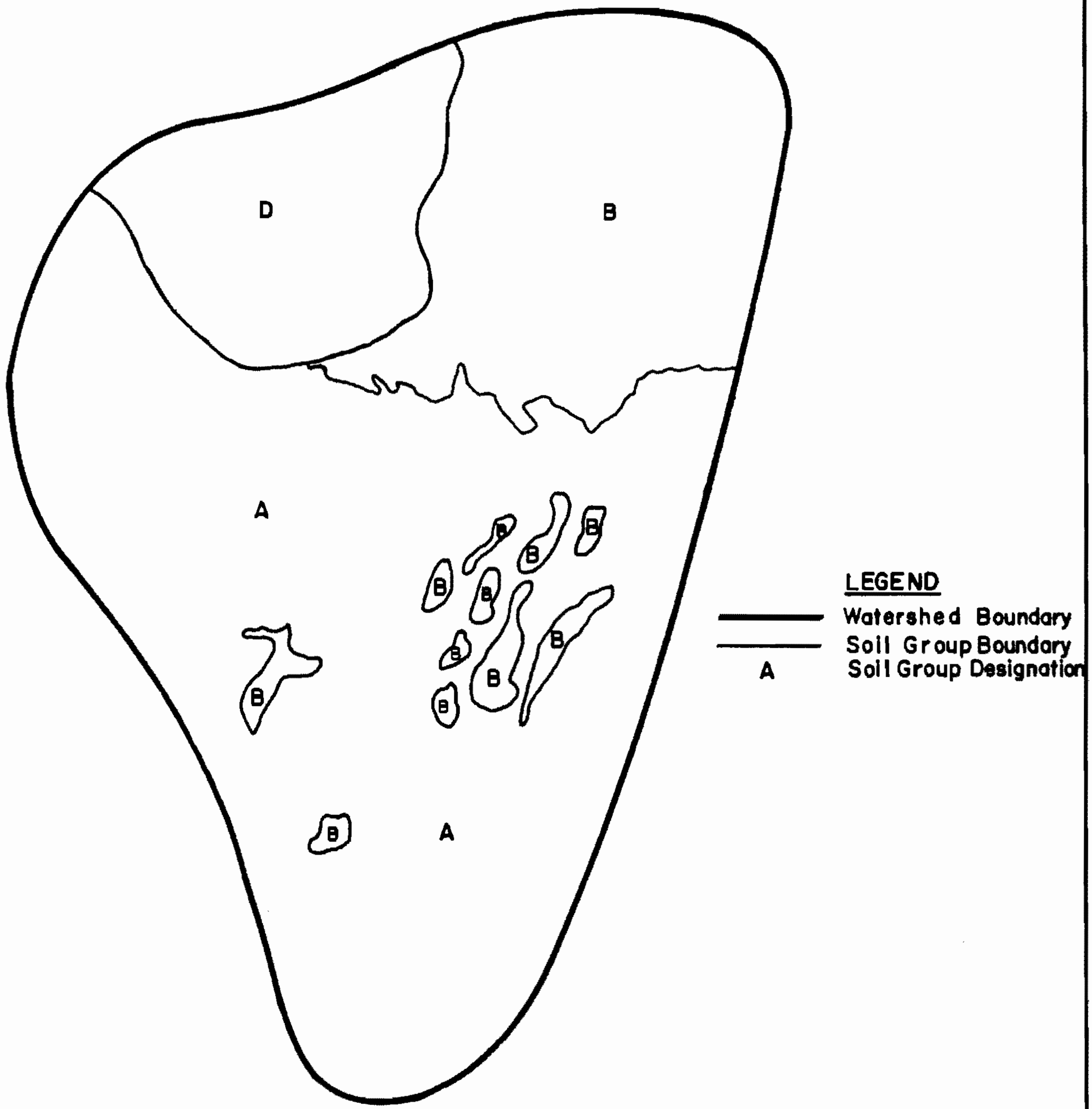
UNIT HYDROGRAPH STUDY:
EXAMPLE PROBLEM UNIT RAINFALL DETERMINATION

(Example Unit Period = 5 minutes)

Peak Rainfall Unit Number	Adjusted Mass Rainfall (inches)	Unit Rainfall (inches)
1	0.45	0.45
2	0.60	0.15
3	0.71	0.11
4	0.80	0.09
5	0.88	0.08
6	0.95	0.07
7	1.02	0.07
8	1.08	0.06
9	1.13	0.05
10	1.19	0.06
11	1.24	0.05
12	1.28	0.04
13	1.33	0.05
14	1.39	0.05
15	1.45	0.06
16	1.50	0.05
17	1.55	0.05
18	1.60	0.05
19	1.65	0.05
20	1.70	0.05
21	1.74	0.04
22	1.79	0.05
23	1.84	0.05
24	1.89	0.05
25	1.93	0.04
26	1.97	0.04
27	2.01	0.04
28	2.05	0.04
29	2.09	0.04
30	2.13	0.04
31	2.17	0.04
32	2.21	0.04
33	2.25	0.04
34	2.29	0.04
35	2.33	0.04
36	2.38	0.04

TIME = 3 HOURS

TOTAL = 2.38 INCHES



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM
WATERSHED-LOSS DETERMINATION
INFORMATION MAP

UNIT HYDROGRAPH STUDY:
EXAMPLE PROBLEM WATERSHED LOSS DETERMINATIONS

Area-Averaged Maximum Loss Rate, F_m

1. Using the watershed soil and development characteristics, estimate the area-averaged maximum loss rate:

Land Use and Condition	Area Fraction	Soil Group	F_p (inch/hour) (Fig. C-6)	a_p (Fig. C-4)	F_m (inch/hour)
Annual grass; fair cover (100% pervious)	.10	D	0.31	1.0	0.31
Residential: S.F. (1/4 acre) Lots (50% pervious)	.60	B	0.75	0.50	0.38
Commercial: (10% pervious)	.30	B	0.75	0.10	.075

Area-Averaged Adjusted Loss Rate (inch/hour) = <u>0.28</u>

UNIT HYDROGRAPH STUDY:
EXAMPLE PROBLEM WATERSHED LOSS DETERMINATIONS

Area-Averaged Low Loss Fraction, $\bar{Y}$

1. Using the watershed soil and development characteristics, estimate the area-averaged low loss fraction:

Land Use and Condition	Area Fraction	Soil Group	Curve Number (CN) (Fig. C-3)	$S^{(2)}$	Pervious Area Yield Fraction, $Y^{(3)}$
Annual grass; fair cover (100% pervious)	.10	D	84	1.90	0.68
Residential: S.F. (1/4 acre) Lots (50% pervious)	.30	B	56	7.86	0.25
	.30	B	98	0.20	0.96
Commercial: (10% pervious)	.03	B	56	7.86	0.25
	.27	B	98	0.20	0.96

Area-Averaged Catchment Yield Fraction (Y) = .698

Area Averaged Low Loss Fraction ($\bar{Y}$) = .302, Say 0.30

NOTES:

(2): $S = (1000/CN)-10$

(3): $Y = (P24-0.2S)^2/((P24+0.8S)P24$

(4): $\bar{Y} = 1-Y$

UNIT HYDROGRAPH STUDY:
EXAMPLE PROBLEM 3-HOUR STORM
EFFECTIVE RAINFALL DETERMINATION

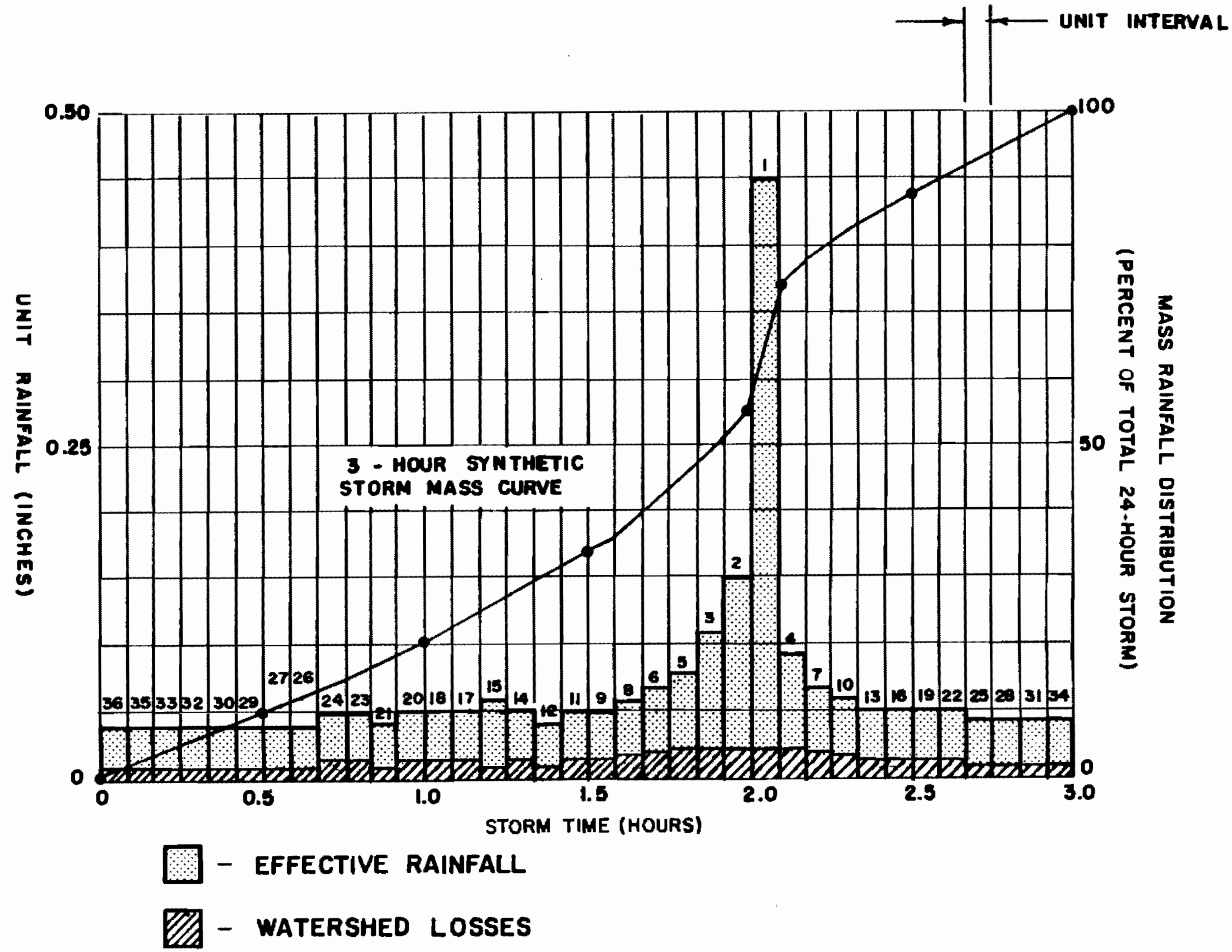
(Unit Period = 5 minutes)

Unit Period Number	Unit Rainfall (inches)	Unit Loss (inches)	Effective Rainfall (inches)
1	.04	.012	.028
2	.04	.012	.028
3	.04	.012	.028
4	.04	.012	.028
5	.04	.012	.028
6	.04	.012	.028
7	.04	.012	.028
8	.04	.012	.028
9	.05	.015	.035
10	.05	.015	.035
11	.04	.012	.028
12	.05	.015	.035
13	.05	.015	.035
14	.05	.015	.035
15	.06	.018	.042
16	.05	.015	.035
17	.04	.012	.028
18	.05	.015	.035
19	.05	.015	.035
20	.06	.018	.042
21	.07	.021	.049
22	.08	.023 *	.057
23	.11	.023 *	.087
24	.15	.023 *	.127
25	.45	.023 *	.427
26	.09	.023 *	.067
27	.07	.021	.049
28	.06	.018	.042
29	.05	.015	.035
30	.05	.015	.035
31	.05	.015	.035
32	.05	.015	.035
33	.04	.012	.028
34	.04	.012	.028
35	.04	.012	.028
36	.04	.012	.028
	2.36	0.56	1.80

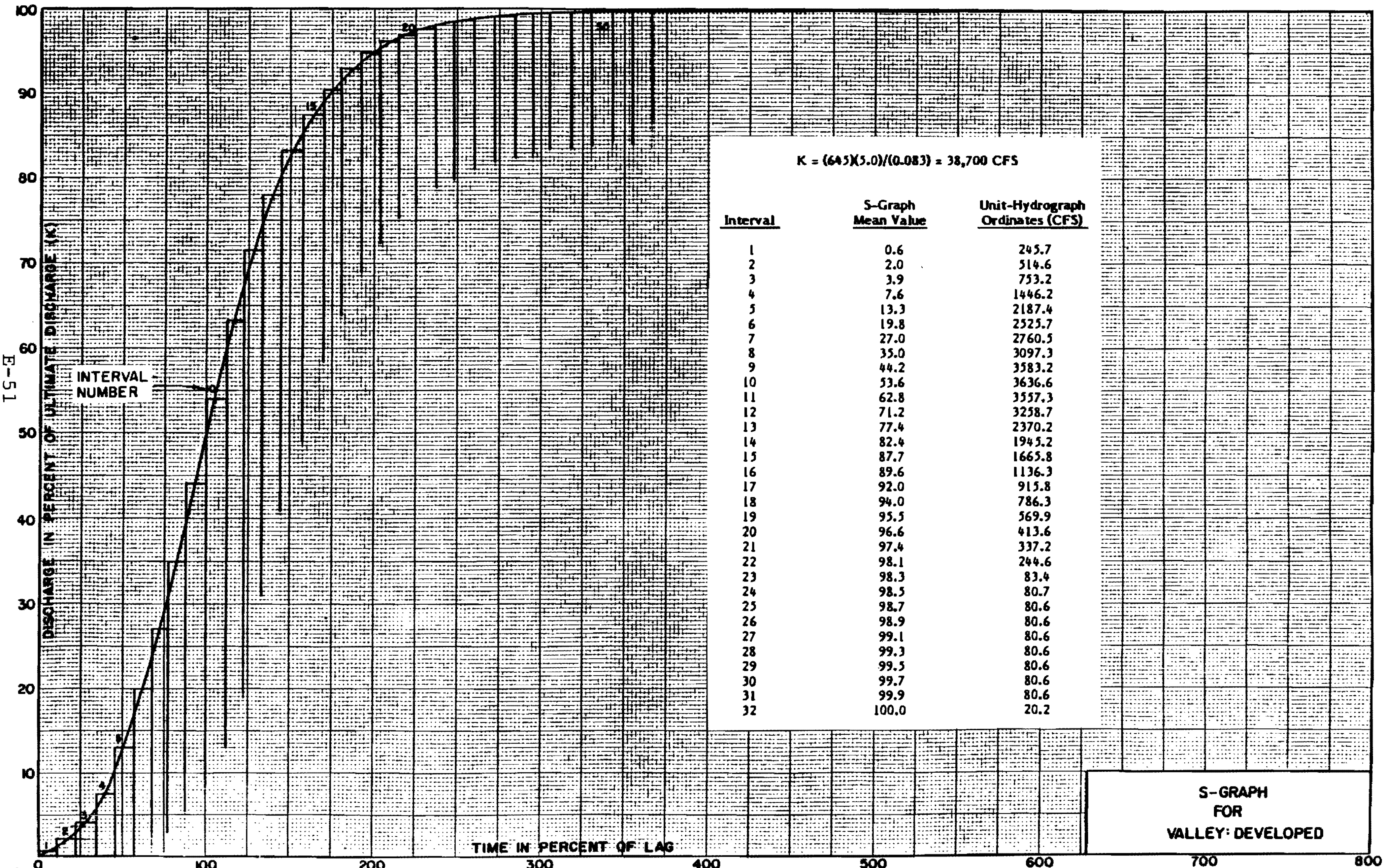
*unit low loss exceeds maximum loss rate, F_m

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

NOTE: THE EXAMPLE UNIT INTERVAL = 5 MINUTES.
NUMBERS ABOVE UNIT RAINFALLS CORRESPOND
TO UNIT NUMBERS IN UNIT RAINFALL DETERMINATION.



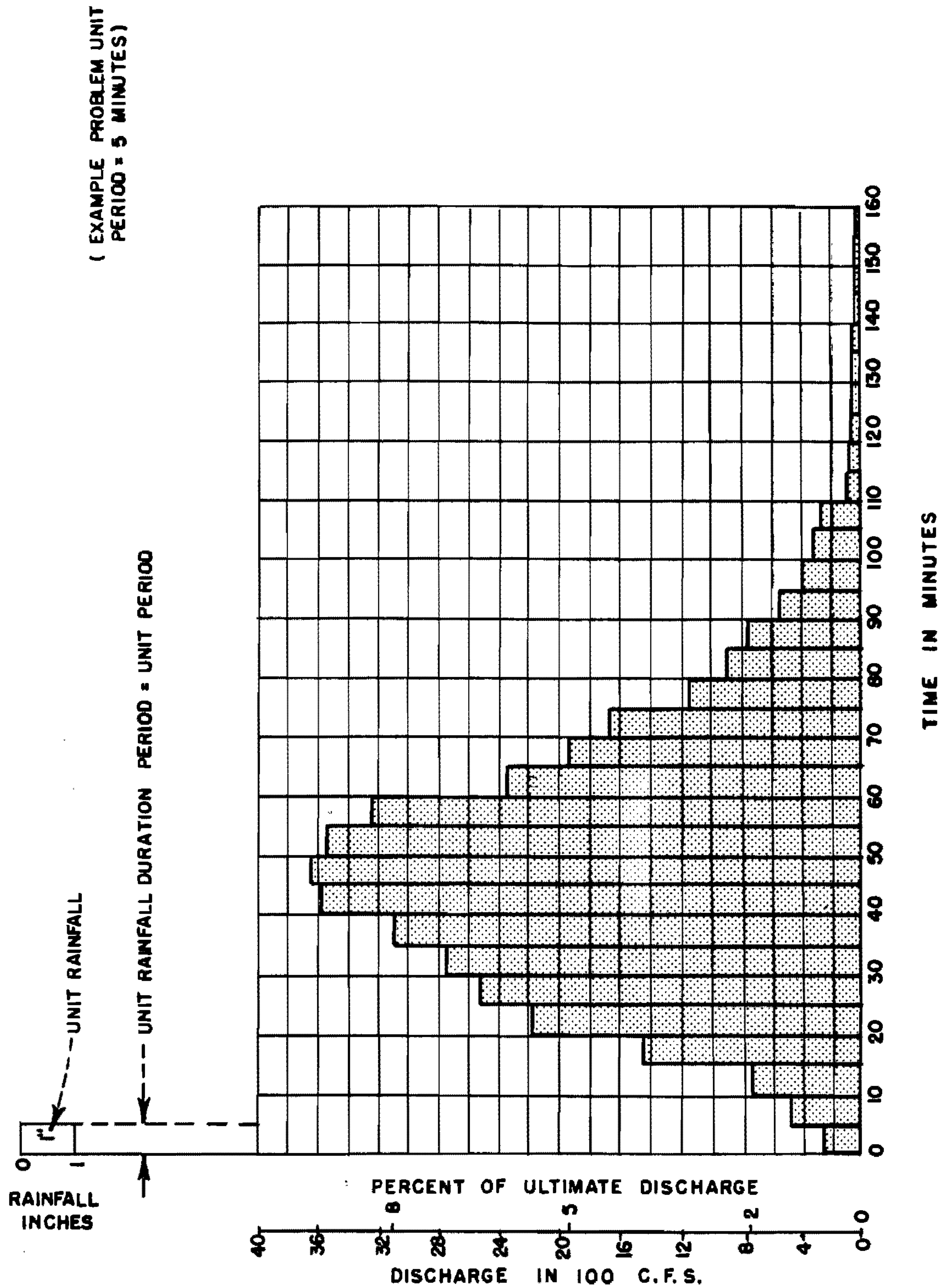
EXAMPLE
SYNTHETIC 3-HOUR
CRITICAL STORM



K = (645)(5.0)/(0.083) = 38,700 CFS

Interval	S-Graph Mean Value	Unit-Hydrograph Ordinates (CFS)
1	0.6	245.7
2	2.0	514.6
3	3.9	753.2
4	7.6	1446.2
5	13.3	2187.4
6	19.8	2525.7
7	27.0	2760.5
8	35.0	3097.3
9	44.2	3583.2
10	53.6	3636.6
11	62.8	3557.3
12	71.2	3258.7
13	77.4	2370.2
14	82.4	1945.2
15	87.7	1665.8
16	89.6	1136.3
17	92.0	915.8
18	94.0	786.3
19	95.5	569.9
20	96.6	413.6
21	97.4	337.2
22	98.1	244.6
23	98.3	83.4
24	98.5	80.7
25	98.7	80.6
26	98.9	80.6
27	99.1	80.6
28	99.3	80.6
29	99.5	80.6
30	99.7	80.6
31	99.9	80.6
32	100.0	20.2

S-GRAPH
FOR
VALLEY: DEVELOPED



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM

UNIT DISTRIBUTION GRAPH

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

SYNTHETIC UNIT HYDROGRAPH METHOD

Flood Hydrograph Calculation Form

Project: EXAMPLE PROBLEM
By: W.V.B. Date: 7-31-86
Checked: M.H.S. Date: 8-1-86
Sheet 1/2

UNIT GRAPH	EFFEC RAIN / UNIT PER.	.028	.028	.028	.028	.028	.028	.028	.028	.035	.035	.028	.035	.035	.035	.042	.035	.028	.035	.035	.042	.049	.057	.087	.127	FLOOD HYDRO-GRAPH
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
246	1	7																								7
515	2	14	7																							21
753	3	21	14	7																						42
1446	4	40	21	14	7																					82
2187	5	61	40	21	14	7																				143
2526	6	71	61	40	21	14	7																			214
2761	7	77	71	61	40	21	14	7																		291
3097	8	87	77	71	61	40	21	14	7																	378
3583	9	100	87	77	71	61	40	21	14	9																480
3637	10	102	100	87	77	71	61	40	21	18	9															586
3557	11	100	102	100	87	77	71	61	40	26	18	7														689
3259	12	91	100	102	100	87	77	71	61	51	26	14	9													789
2370	13	66	91	100	102	100	87	77	71	77	51	21	18	9												870
1945	14	54	66	91	100	102	100	87	77	88	77	40	26	18	9											935
1666	15	47	54	66	91	100	102	100	87	97	88	61	51	26	18	10										998
1136	16	32	47	54	66	91	100	102	100	108	97	71	77	51	26	22	9									1053
916	17	26	32	47	54	66	91	100	102	125	108	77	88	77	51	32	18	7								1101
786	18	22	26	32	47	54	66	91	100	127	125	87	97	88	77	61	26	14	9							1149
570	19	16	22	26	32	47	54	66	91	124	127	100	108	97	88	92	51	21	18	9						1189
414	20	12	16	22	26	32	47	54	66	114	124	102	125	108	97	106	77	40	26	18	10					1222
337	21	9	12	16	22	26	32	47	54	83	114	100	127	125	108	116	88	61	51	26	22	12				1251
245	22	7	9	12	16	22	26	32	47	68	83	91	124	127	125	130	97	71	77	51	32	25	14			1286
83	23	2	7	9	12	16	22	26	32	58	68	66	114	124	127	150	108	77	88	77	61	37	29	21		1331
81	24	2	2	7	9	12	16	22	26	40	58	54	83	114	124	153	125	87	97	88	92	71	43	45	31	1401
81	25	2	2	2	7	9	12	16	22	32	40	47	68	83	114	149	127	100	108	97	106	107	82	66	65	
81	26	2	2	2	2	7	9	12	16	28	32	32	58	68	83	137	124	102	125	108	116	124	125	126	96	
81	27	2	2	2	2	2	7	9	12	20	28	26	40	58	68	100	114	100	127	125	130	135	144	190	184	
81	28	2	2	2	2	2	2	7	9	14	20	22	32	40	58	82	83	91	124	127	150	152	157	220	278	
81	29	2	2	2	2	2	2	2	7	12	14	16	28	32	40	70	68	66	114	124	153	176	177	240	321	
81	30	2	2	2	2	2	2	2	2	9	12	12	20	28	32	48	58	54	83	114	149	178	204	269	351	
81	31	2	2	2	2	2	2	2	2	3	9	9	14	20	28	38	40	47	68	83	137	174	207	312	393	
20	32	1	2	2	2	2	2	2	2	3	3	7	12	14	20	33	32	32	58	68	100	160	203	316	455	
			1	2	2	2	2	2	2	3	3	2	9	12	14	24	28	26	40	58	82	116	186	309	462	
				1	2	2	2	2	2	3	3	2	3	9	12	17	20	22	32	40	70	95	135	284	452	
					1	2	2	2	2	3	3	2	3	3	9	14	14	16	28	32	48	82	111	206	414	
						1	2	2	2	3	3	2	3	3	3	10	12	12	20	28	38	56	95	169	301	
							1	2	2	3	3	2	3	3	3	3	9	9	14	20	33	45	65	145	247	
								1	2	3	3	2	3	3	3	3	3	7	12	14	24	39	52	99	212	
									1	3	3	2	3	3	3	3	3	2	9	12	17	28	45	80	144	
										1	3	2	3	3	3	3	3	2	3	9	14	20	32	68	116	
											1	2	3	3	3	3	3	2	3	3	10	17	24	50	100	
												1	3	3	3	3	3	2	3	3	3	12	19	36	72	
													1	3	3	3	3	2	3	3	3	4	14	29	53	
														1	3	3	3	2	3	3	3	4	5	21	43	
															1	3	3	2	3	3	3	4	5	7	31	
																1	3	2	3	3	3	4	5	7	11	
																	1	2	3	3	3	4	5	7	10	
																		1	3	3	3	4	5	7	10	
																			1	3	3	4	5	7	10	
																				1	3	4	5	7	10	
																					1	4	5	7	10	
																						1	5	7	10	
																							1	7	10	
																								2	10	
																									3	

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

SYNTHETIC UNIT HYDROGRAPH METHOD

Flood Hydrograph Calculation Form

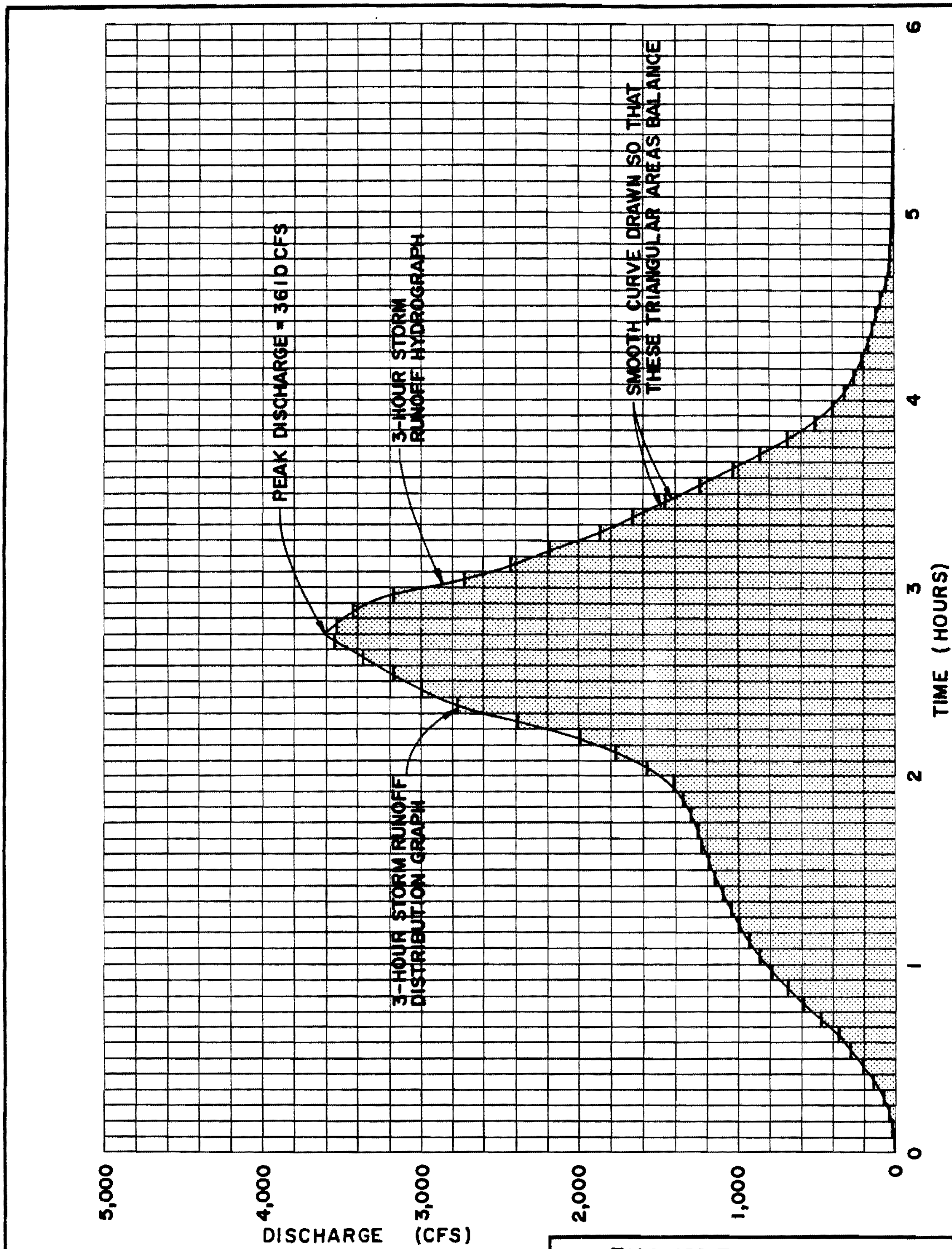
Project: EXAMPLE PROBLEM

By: W.V.B. Date: 7-31-86

Checked: M.H.S. Date: 8-1-86

Sheet 2 / 2

	EFFEC RAIN	.427	.067	.049	.042	.035	.035	.035	.035	.028	.028	.028	.028	
UNIT GRAPH	UNIT PER.	25	26	27	28	29	30	31	32	33	34	35	36	FLOOD HYDRO-GRAPH
246	1	105												1568
515	2	220	16											1772
753	3	322	35	12										1996
1446	4	617	50	25	10									2380
2187	5	934	97	37	22	9								2771
2526	6	1079	147	71	32	18	9							2993
2761	7	1179	169	107	61	26	18	9						3167
3097	8	1322	185	124	92	51	26	18	9					3358
3583	9	1530	207	135	106	77	51	26	18	7				3544
3637	10	1553	240	152	116	88	77	51	26	14	7			3534
3557	11	1519	244	176	130	97	88	77	51	21	14	7		3421
3259	12	1392	238	178	150	108	97	88	77	40	21	14	7	3175
2370	13	1012	218	174	153	125	108	97	88	61	40	21	14	2723
1945	14	831	159	160	149	127	125	108	97	71	61	40	21	2434
1666	15	711	130	116	137	124	127	125	108	77	71	61	40	2188
1136	16	485	112	95	100	114	124	127	125	87	77	71	61	1863
916	17	391	76	82	82	83	114	124	127	100	87	77	71	1641
786	18	336	61	56	70	68	83	114	124	102	100	87	77	1444
570	19	243	53	45	48	58	68	83	114	100	102	100	87	1225
414	20	177	38	39	38	40	58	68	83	91	100	102	100	1028
337	21	144	28	28	33	32	40	58	68	66	91	100	102	855
245	22	105	23	20	24	28	32	40	58	54	66	91	100	683
83	23	35	16	17	17	20	28	32	40	47	54	66	91	501
81	24	35	6	12	14	14	20	28	32	32	47	54	66	396
81	25	35	5	4	10	12	14	20	28	26	32	47	54	320
81	26	35	5	4	3	9	12	14	20	22	26	32	47	259
81	27	35	5	4	3	3	9	12	14	16	22	26	32	208
81	28	35	5	4	3	3	3	9	12	12	16	22	26	173
81	29	35	5	4	3	3	3	3	9	9	12	16	22	142
81	30	35	5	4	3	3	3	3	3	7	9	12	16	115
81	31	35	5	4	3	3	3	3	3	2	7	9	12	92
20	32	9	5	4	3	3	3	3	3	2	2	7	9	53
			1	4	3	3	3	3	3	2	2	2	7	33
				1	3	3	3	3	3	2	2	2	2	24
					1	3	3	3	3	2	2	2	2	21
						1	3	3	3	2	2	2	2	18
							1	3	3	2	2	2	2	15
								1	3	2	2	2	2	12
									1	2	2	2	2	9
										1	2	2	2	7
											1	2	2	5
												1	2	3
													1	1



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM

3-HOUR STORM

RUNOFF HYDROGRAPH

SECTION F

FLOW-THROUGH BASIN ANALYSIS

F.1. INTRODUCTION

There are two types of routing that are important in watershed planning; reservoir routing and streamflow routing. Both processes operate upon an inflow hydrograph to produce an outflow hydrograph. In this section, reservoir routing will be presented based on the modified Pul's method. Section H will present the convex method for streamflow routing. It is noted that the Agency has hydraulic design criteria which must be considered in addition to the hydrologic criteria established in this manual.

Section E of this hydrology manual includes a detailed discussion of the unit hydrograph approach to be used for hydrologic studies of watersheds. The approach develops a 24-hour duration synthetic critical storm pattern which is composed of peak rainfall intensities for a specified return frequency (e.g., peak 5-minutes, 30-minutes, 1-hour, 3-hour, 6-hour and 24-hour) nested together with the storm peak 5-minutes of rainfall defined to occur at storm time of hour 16.

Use of this synthetic storm pattern subjects a study watershed to all durations of storm events (of a given rainfall return frequency) up to 24-hours. That is, the 24-hour critical storm pattern for floodwater detention basin studies will include all durations of critical storm events up to 24-hours. Therefore, in many cases only one design storm is necessary for analysis of the detention basin flood routing.

For a discussion of environmental considerations in using detention basins, see Appendix II.

F.2. DETENTION BASIN ANALYSIS

F.2.1. Detention Basin Routing Procedure

The modified Pul's (refs. 2, 3, 5) method may be used for detention basin routing studies. The basin routing relationships are based upon the formula

$$I - O = \frac{\Delta S}{\Delta t} \tag{F.1}$$

where

I	=	basin inflow rate (cfs)
O	=	basin outflow rate (cfs)
ΔS	=	change in basin storage during the time step (cubic feet)
Δt	=	time step (sec)

Equation (F.1) is approximated by replacing the variables I and O by an average value during the timestep using

$$I = \frac{I_1 + I_2}{2} \tag{F.2}$$

$$O = \frac{O_1 + O_2}{2} \tag{F.3}$$

where the subscript 1 indicates the beginning of a time period and subscript 2 indicates the end of the subject time period. Substituting (F.2) and (F.3) into the basin routing equation of (F.1) and rearranging terms gives

$$(S_2 + O_2\ \Delta t/2) = (S_1 - O_1\,\Delta t/2) + (I_1 + I_2)\,\Delta t/2 \tag{F.4}$$

In (F.4), the right side is known from the previously computed values of storage, S_1, outflow, O_1, and the average basin inflow $(I_1+I_2)/2$ for time step Δt.

The solution of the basin routing problem requires the following information:

1. Known initial conditions for basin storage and outflow
2. A routing timestep, Δt
3. The basin inflow hydrograph
4. Basin volume vs. depth and outflow vs. depth relationships

To solve (F.4), a storage indication curve should be developed. Such a curve may be derived from the known storage-discharge relationship by selecting various values of depth and computing $(S+O\,\Delta t/2)$ from the associated values for storage and outflow. This quantity is plotted versus outflow such as shown in Figure F-4.

The solution procedure then proceeds with the following steps:

1. Determine the average inflow volume from the inflow hydrograph during the timestep Δt; i.e., calculate $(I_1 + I_2)\,\Delta t/2$.

2. Compute $S_1 - O_1\,\Delta t/2$ from the assumed initial condition of the basin flowdepth or the last computed values of S and O.

3. Use (F.4) to compute $(S_2 + O_2\,\Delta t/2)$.

4. Use the estimate from step 3 and the storage indication curve (see Figure F-4) to compute O_2.

5. Use O_2 and the known storage vs. depth and outflow vs. depth relationships to compute S_2.

These five steps are repeated for the next timestep using I_2, O_2, and S_2 as the new values of I_1, O_1, and S_1, respectively. This procedure is repeated until the basin inflow hydrograph has been completely analyzed and basin outflow becomes negligible.

The example problem illustrates the basin routing procedure.

F.2.2. Example Problem: Detention Basin Hydrograph Routing

The assumed detention basin depth vs. outflow and depth vs. storage relationships are shown in Figures F-1 and F-2, respectively. The detention basin information sheet (Figure F-8) is completed in Figure F-3. Using a timestep of 60 minutes (3600 seconds), the associated storage-indication curve is developed in the following table and plotted in Figure F-4.

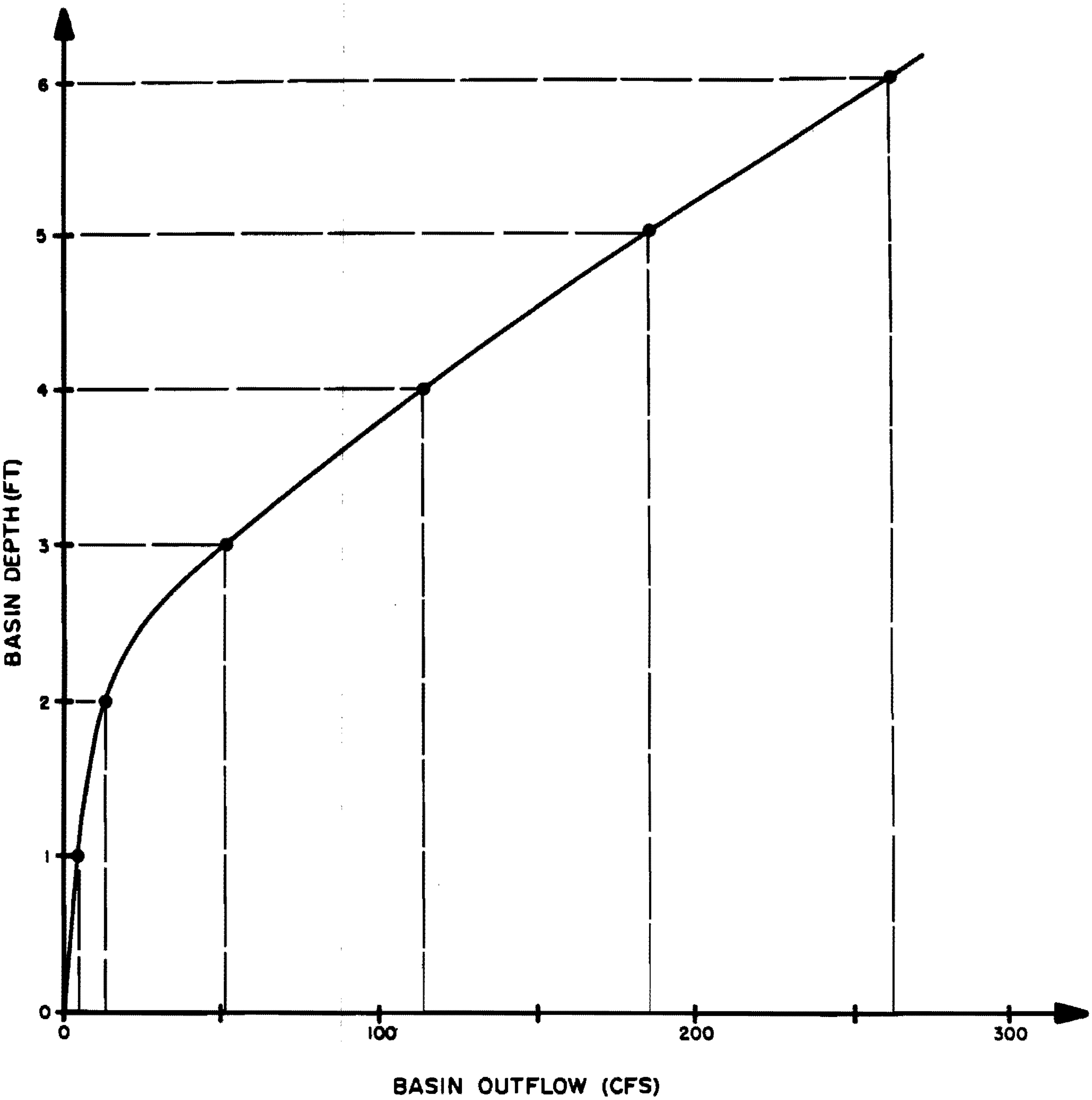
TABLE F.1.
EXAMPLE PROBLEM STORAGE-INDICATION CURVE DEVELOPMENT

Depth (ft)	O (cfs)	S (AF)	S-O $\Delta t/2$ (AF)	S+O $\Delta t/2$ (AF)
0	0.0	0.0	0.00	0.00
1	4.2	14.4	14.22	14.57
2	12.0	28.8	28.30	29.30
3	51.7	43.2	41.06	45.34
4	114.7	57.6	52.86	62.34
5	186.8	72.0	64.28	79.72
6	263.2	86.4	75.52	97.28

Assuming an initial condition of zero basin outflow and storage, an example basin inflow hydrograph (unit period of 60 minutes) is routed using the modified Pul's method in the tabulation of Table F.2. The 60-minute timestep is used for demonstration purposes only. Typically, a 5-minute timestep is needed in order to adequately describe the runoff hydrograph peak flow rates. Important features of a routed detention basin hydrograph are shown in Figure F-5.

F.3. EXTENDED DESIGN STORM CRITERIA

Due to the interaction of watershed size, Tc, percentage of peak discharge reduction, and basin volume, the critical storm duration is

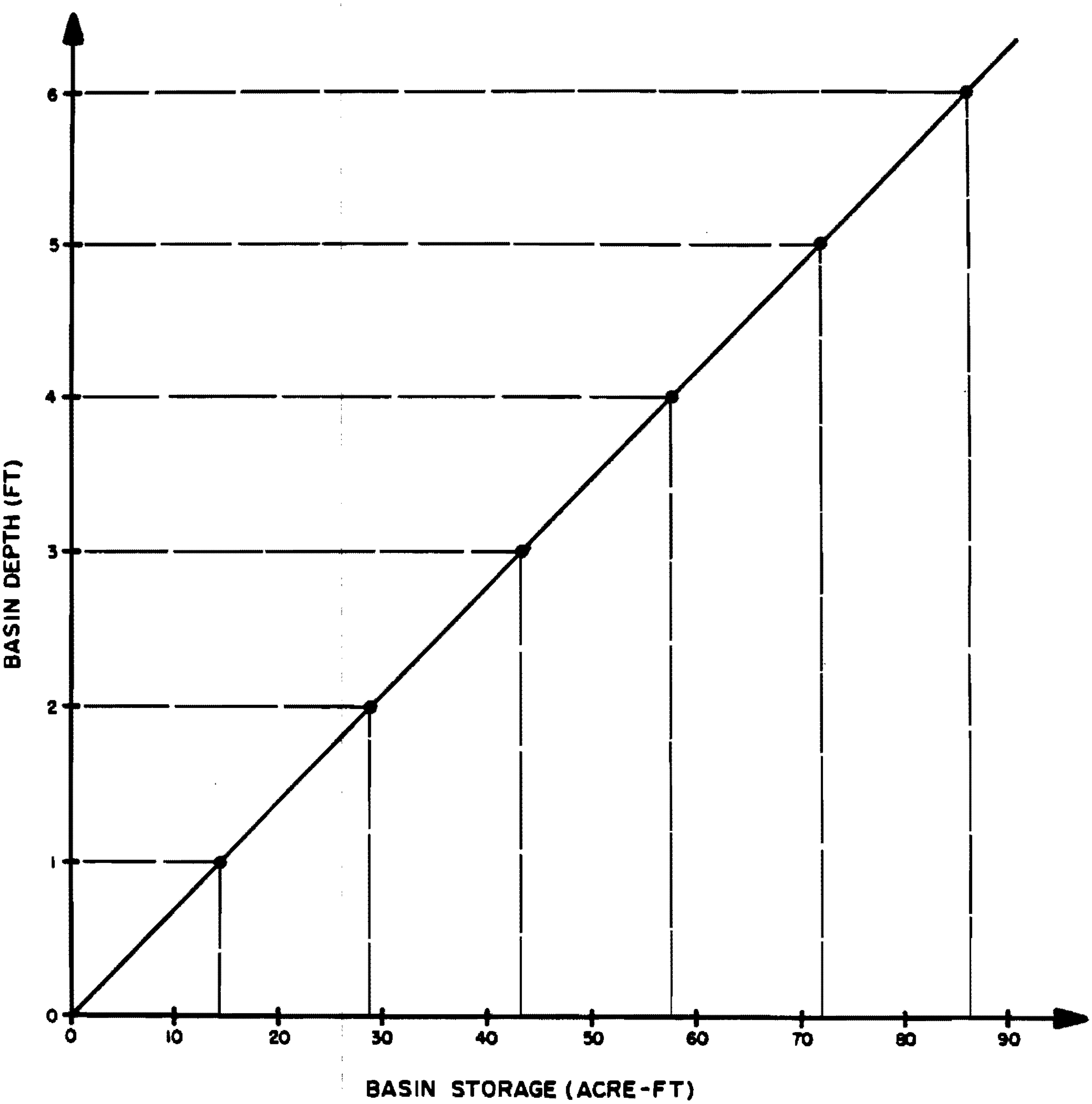


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM
DETENTION BASIN OUTFLOW (CFS) AS A FUNCTION OF DEPTH (FT)

Figure F-1



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM
DETENTION BASIN STORAGE (AF)
AS A FUNCTION OF DEPTH (FT)

Figure F-2

PROJECT: EXAMPLE PROBLEM DATE:

ENGINEER: A.E.S.

1. Enter the hydrograph unit interval duration (minutes) 60

2. Enter total number of basin depth-versus-outflow values (maximum of 20) 7

3. Enter basin outflow (cfs) and storage volume (AF) for each basin depth value in the following table. Enter values in order of increasing outflow basin depth:

Entry No.	Water Surface Elevation (FT)	Basin Depth (FT)	Basin Storage (AF)	Basin Outflow (CFS)
1	100	0.0 (defined)	0	0.0 (defined)
2	101	1	14.4	4.2
3	102	2	28.8	12.0
4	103	3	43.2	51.7
5	104	4	57.6	114.7
6	105	5	72.0	186.8
7	106	6	86.4	263.2
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

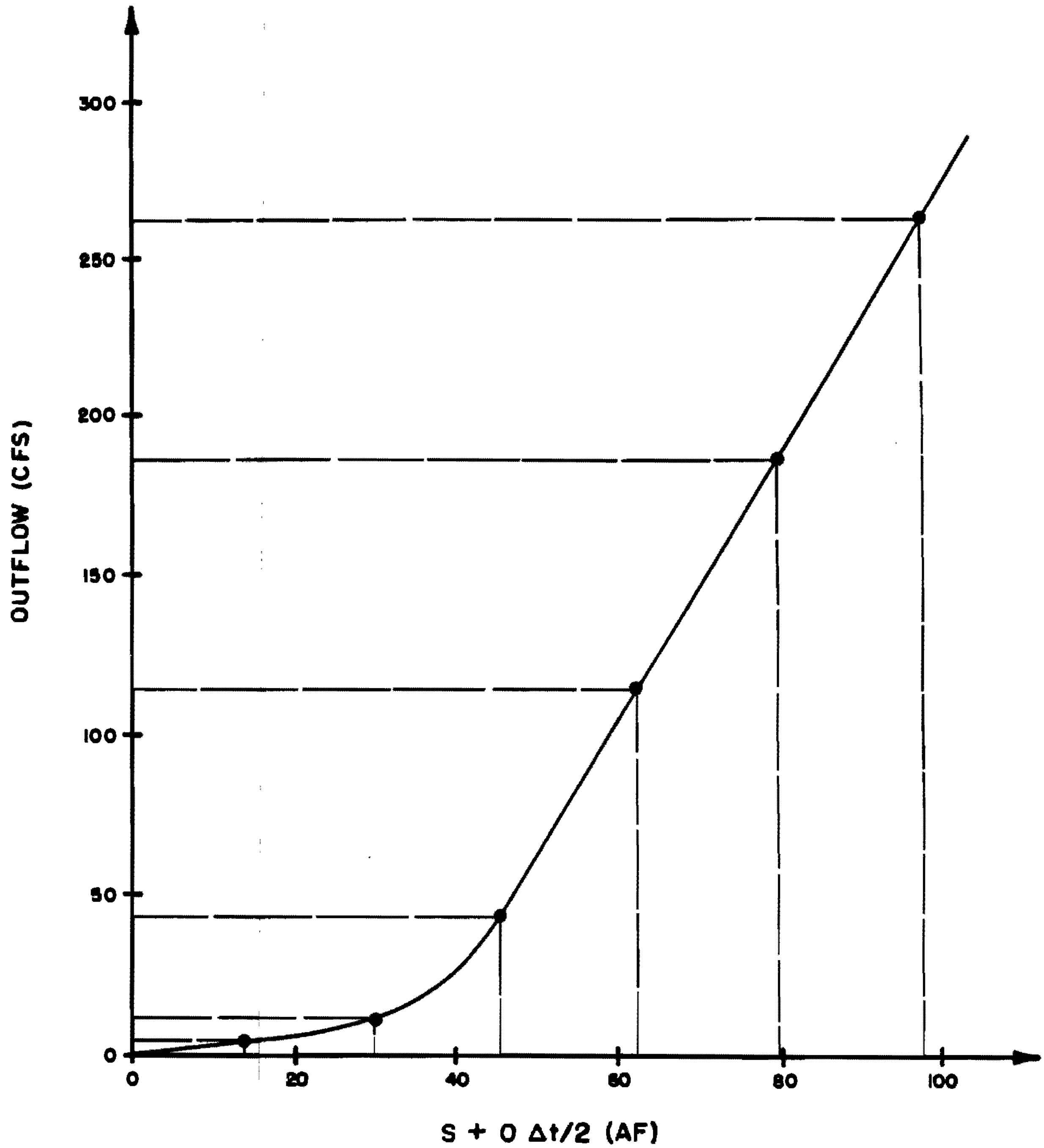
4. Enter assumed initial depth (feet) of water in detention basin 0

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DETENTION BASIN

INFORMATION FORM



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM

STORAGE-INDICATION CURVE

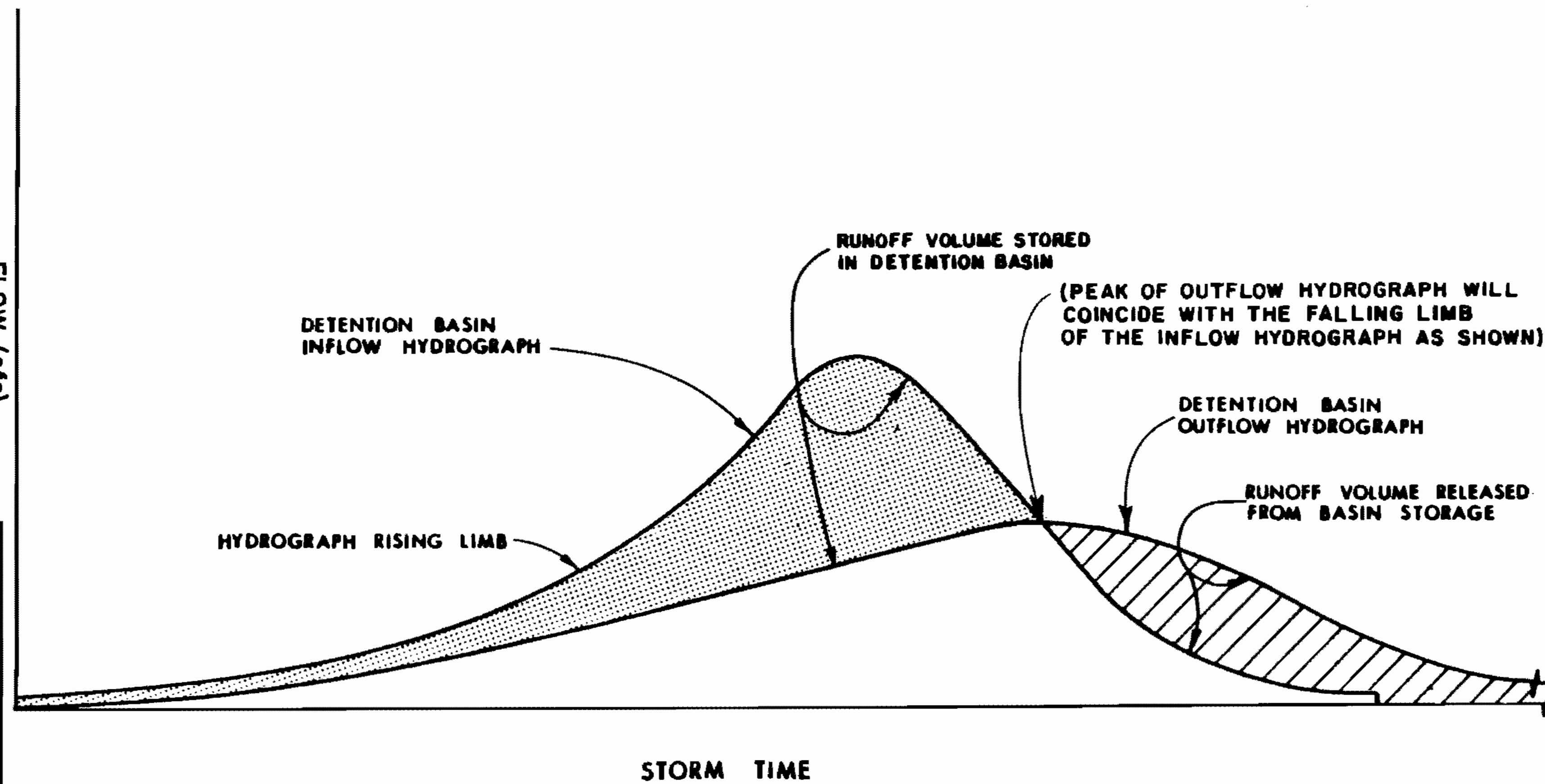
Figure F-4

TABLE F.2.
EXAMPLE PROBLEM BASIN ROUTING TABULATION

Time (min.)	Inflow (cfs)	Average Inflow (cfs)	$(I_1+I_2)\Delta t/2$ (AF)	$S_1-O_1\Delta t/2$ (AF)	$S_2+O_2\Delta t/2$ (AF)	Outflow (cfs)	Storage (AF)
0	0					0	0
		30	2.48	0	2.48		
60	60					.7	2.45
		90	7.44	2.42	9.86		
120	120					2.8	9.74
		200	16.53	9.62	26.16		
180	280					10.3	25.73
		265	21.90	25.31	47.21		
240	250					58.6	44.79
		235	19.42	42.37	61.79		
300	220					112.7	57.14
		170	14.05	52.48	66.53		
360	120					132.1	61.07
		110	9.09	55.61	64.70		
420	100					124.5	59.56
		80	6.61	54.41	61.02		
480	60					109.8	56.48
		30	2.48	51.94	54.42		
540	0					85.4	50.89
		0	0	47.36	47.36		
600	0					59.20	44.91
		0	0	42.46	42.46		

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

DETENTION BASIN INFLOW AND OUTFLOW HYDROGRAPHS



Figgre F-5

generally not known (in advance) for a watershed flood control system which includes one or several detention basins. Hence, the use of the 24-hour design storm may not be the "critical" storm for flow-through detention basin design purposes, and a longer duration design storm may be needed. Figure F-6 illustrates the extended design storm (multiday) for a two day duration. Longer duration design storms are developed in a similar fashion.

The multiday design storm utilizes the structure of Figure F-6 for all flow-through detention basin systems. Successive day storms are developed and added in the front of the previously developed design storm patterns until the detention basin system demonstrates no increase in the required basin volume due to the further extension of the design storm pattern. By increasing the basin outlet capacity, the critical duration can be reduced.

From Figure F-6 it is seen that the extended design storm is constructed from an arrangement of rainfalls of identical T-year return frequency. That is, even though a two day or longer duration multiday storm is being used to test the detention basin's level of flood protection, the extended design storm still contains no more than T-year rainfall depths for the extended duration. Each of the 24-hour storm patterns are constructed by a simple scaling of the peak 24-hour design pattern according to a ratio of the respective 24-hour precipitation values.

F.4. REQUIRED FORMAT

Figure F-7 illustrates the required format for submitting detention basin study results for review.

Figure F-8 is to be used to supply the necessary detention basin information to determine the routing results.

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

EXTENDED DESIGN STORM:
FLOW-THROUGH BASIN

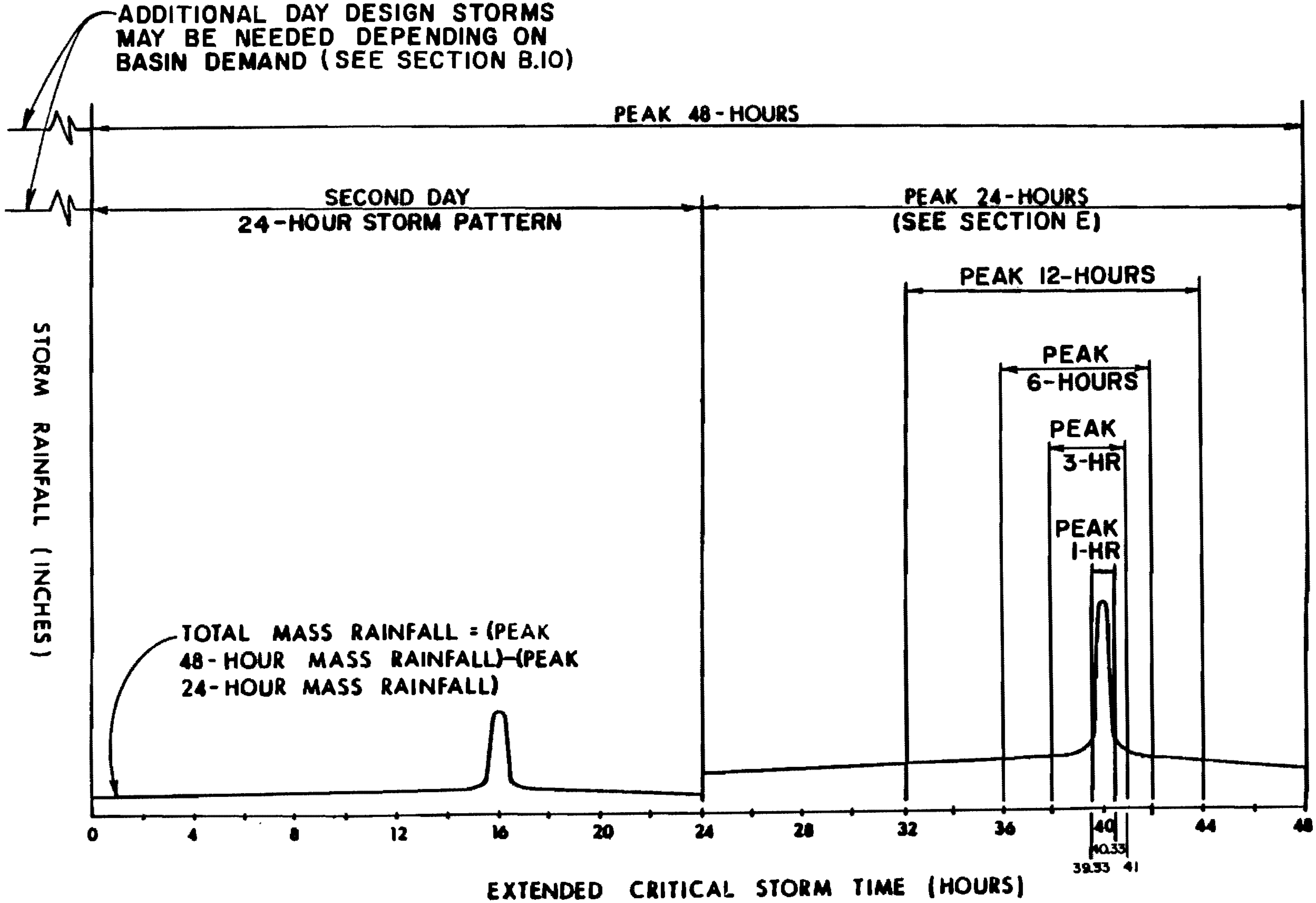
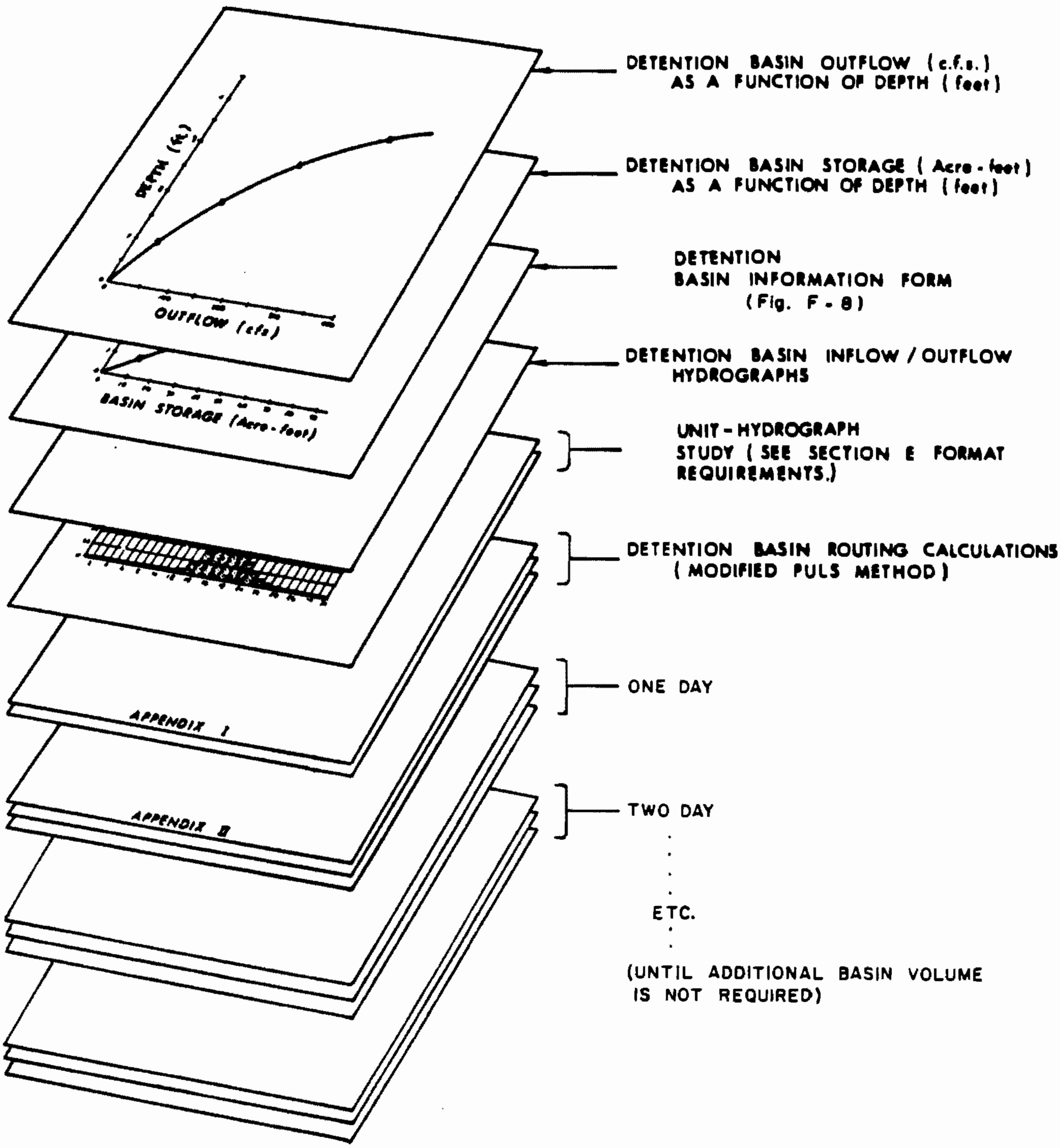


Figure F-6



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REQUIRED REPORT FORMAT FOR DETENTION BASIN STUDY

Figure F-7

PROJECT: ______________________ DATE:

____

ENGINEER: ______________________

1. Enter the hydrograph unit interval duration **(minutes)** ________

2. Enter total number of basin depth-versus-outflow values **(maximum of 20)** ________

3. Enter basin outflow (cfs) and storage volume (AF) for each basin depth value in the following table. Enter values in order of increasing outflow basin depth:

Entry No.	Water Surface Elevation (FT)	Basin Depth (FT)	Basin Storage (AF)	Basin Outflow (CFS)
1		0.0 (defined)		0.0 (defined)
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

4. Enter assumed initial depth (feet) of water in detention basin ________

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

DETENTION BASIN INFORMATION FORM

SECTION G

FLOW-BY BASIN ANALYSIS
(HYDROGRAPH SEPARATION)

G.1. INTRODUCTION

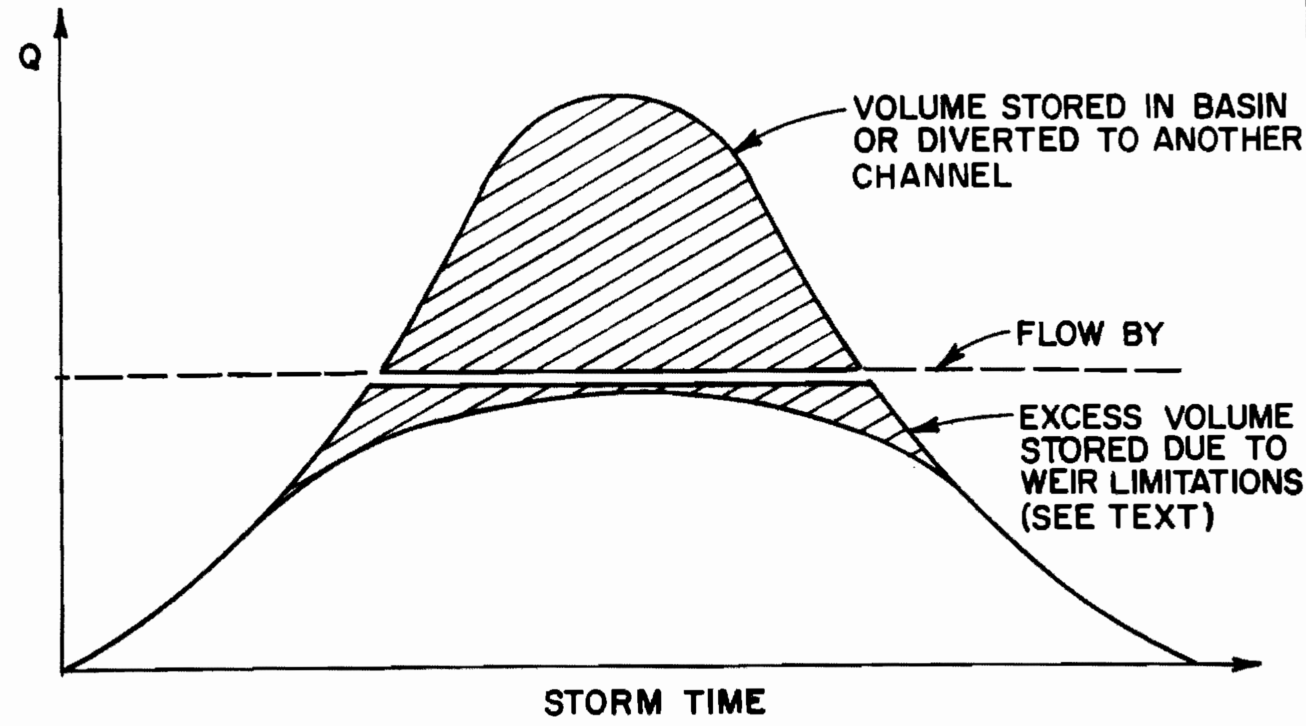
This process models the effect of a channel flowing by a detention basin or structure which intercepts and diverts away from the channel all runoff flows in excess of some specified flowrate. Although simple in concept, use of a flow-by basin in a flood control system can provide a useful reduction in the runoff hydrograph peak flowrate. Figure G-1 shows the main elements of a typical flow-by basin. For a discussion on the considerations in using detention basins, see Appendix II.

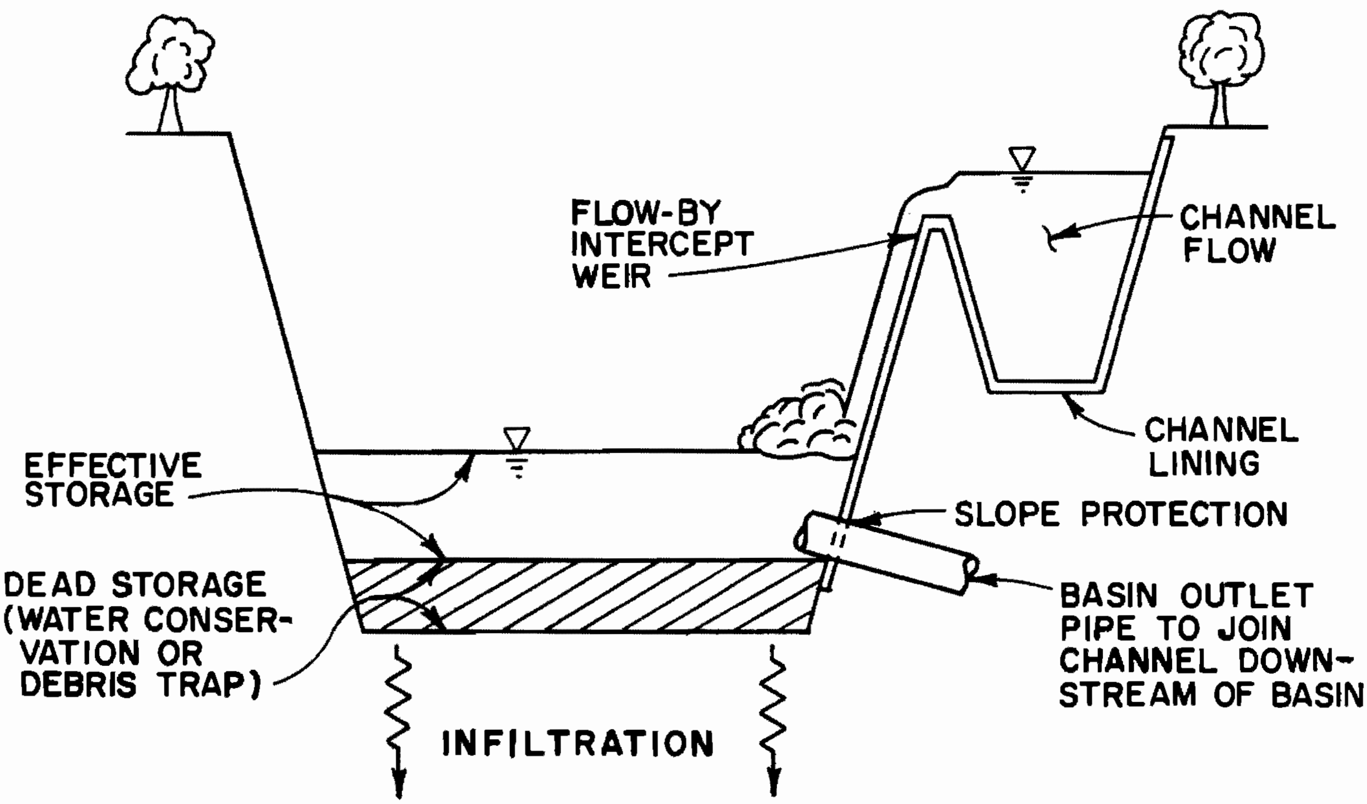
G.2. EXTENDED DESIGN STORM CRITERIA

A multiple day storm may be required to guarantee that the basin has an adequate storage capacity remaining when a peak 24-hour storm event occurs. For a multiple day storm condition involving a flow-by basin system, the peak rainfall intensities of the selected T-year return frequency should be incorporated within each 24 hour duration (up to the appropriate mass rainfall volume with the desired return frequency) such as is shown in Figure G-2.

G.3. FLOW-BY BASIN VOLUME ANALYSIS: WEIR STRUCTURE EFFICIENCY

Figure G-1 illustrates a typical weir structure flow-by basin design. Due to the finite weir length, the actual flow-by discharge (i.e., no overflow into the basin) is less than the desired flow-by discharge and, consequently, the actual basin storage requirements are higher than idealized by a simple separation of the hydrograph. Generally, this volume excess ranges between 20 and 50 percent depending on the weir length used for the overflow.



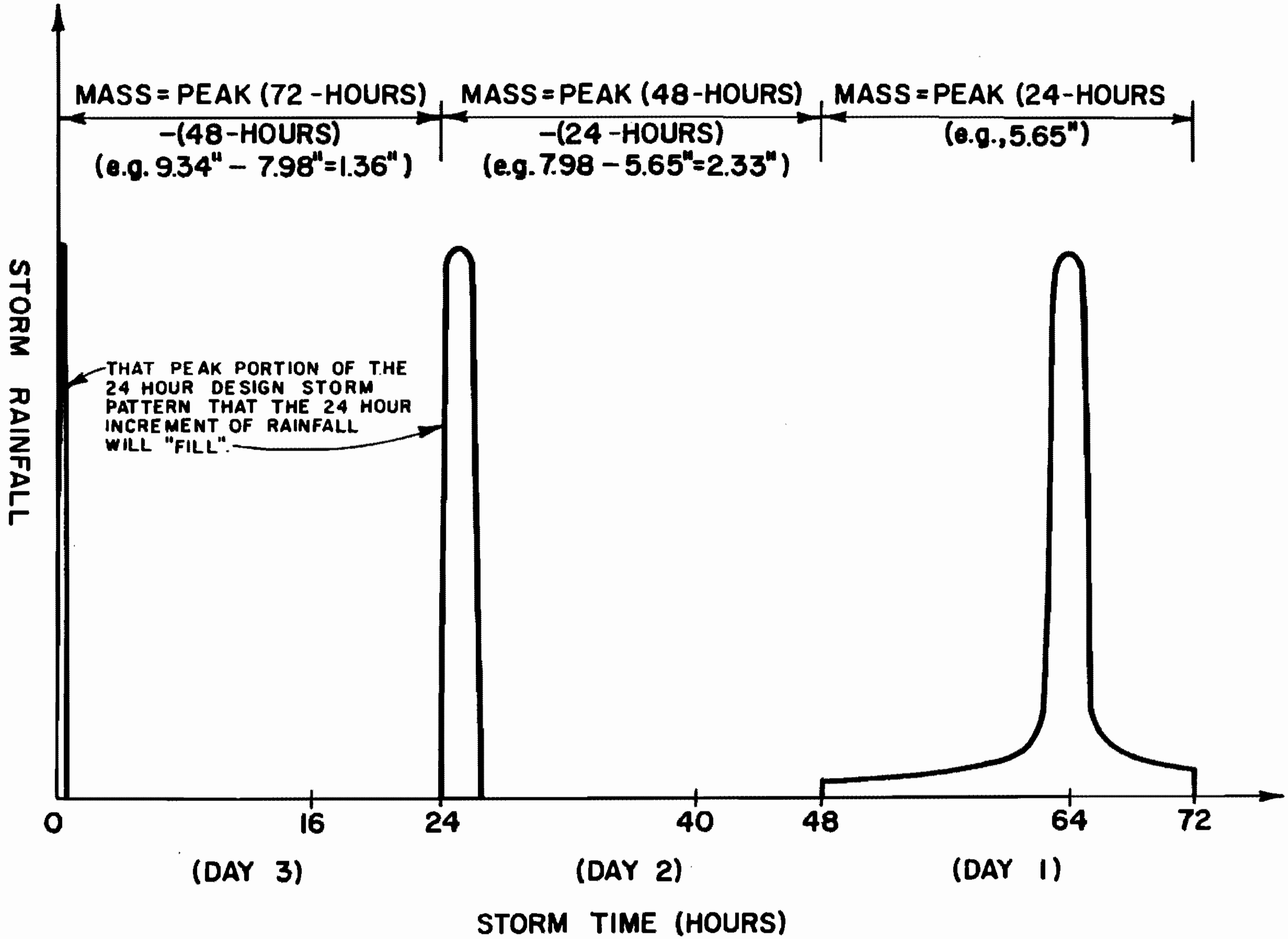


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

FLOW-BY BASIN
CONCEPT AND ELEMENTS

Figure G-1

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL



DWR STATION No. YOI 7723 OO (SAN BERNARDINO), IOO-YEAR I-DAY DEPTH = 5.65", 2-DAY = 7.98", 3-DAY = 9.34"
(USE LOCAL STATION DATA AS APPROVED BY SBCFCD. SEE SECTION B.IO)

FLOW-BY BASIN CRITICAL STORM PATTERN (3-DAY EXAMPLE)

Figure G-2

SECTION H

STREAMFLOW ROUTING

H.1. INTRODUCTION

The convex streamflow routing technique is described for use in design storm hydrology studies for watershed flood control systems (refs. 2, 3).

H.2. CONVEX ROUTING METHOD FOR UNSTEADY OPEN CHANNEL FLOW

The governing relationship used in the convex routing approach is:

$$O_{T+dT} = (1-C)O_T + CI_T \tag{H.1}$$

where

I_T	=	hydrograph inflow at time T
O_T	=	channel outflow at time T
O_{T+dT}	=	channel outflow at time T + dT
C	=	a routing coefficient (where C is between 0 and 1)

Rearranging (H.1) gives the explicit statement

$$O_{T+dT} = O_T + C(I_T - O_T) \tag{H.2}$$

and

$$C = (O_{T+dT} - O_T)/(I_T - O_T) \tag{H.3}$$

The routing coefficient may be estimated by the empirical relationship (ref. 3),

$$C = V/(V + 1.7) \tag{H.4}$$

where V is a mean flow velocity assumed for the inflow hydrograph. One method of computing V is to calculate the normal depth corresponding to the average flowrate of all unit flows greater than 50 percent of the inflow hydrograph peak flowrate. From this normal depth calculation, V is defined to be the corresponding flow velocity. Thus V represents an average velocity which is used to translate the inflow hydrograph along the total length of the channel. Obviously, other values for V can result depending on the choice of which average flowrate value to be used from the inflow hydrograph, and care must be taken to avoid offsetting the hydrograph peak flowrates at channel confluences by the selection of the channel V parameter.

The routing timestep, dT, is given by

$$dT = \frac{CL}{3600\ V} \tag{H.5}$$

where C is given by (H.4), L is the channel length in feet, and dT is in units of hours.

Because the unit hydrograph analysis base unit period (defined in this section as dT*) is usually different than the dT time period of (H.1) a modification of C is required. Typically, a 5-minute unit period is used in runoff hydrograph studies. For a unit period of 5 minutes, dT* = 0.0833 hours and the modified routing coefficient is

$$C^* = 1 - (1-C)^E \tag{H.6}$$

where $E = (dT^* + 0.5dT)/(1.5dT)$.

To determine the dT which corresponds to (H.1), it is assumed that

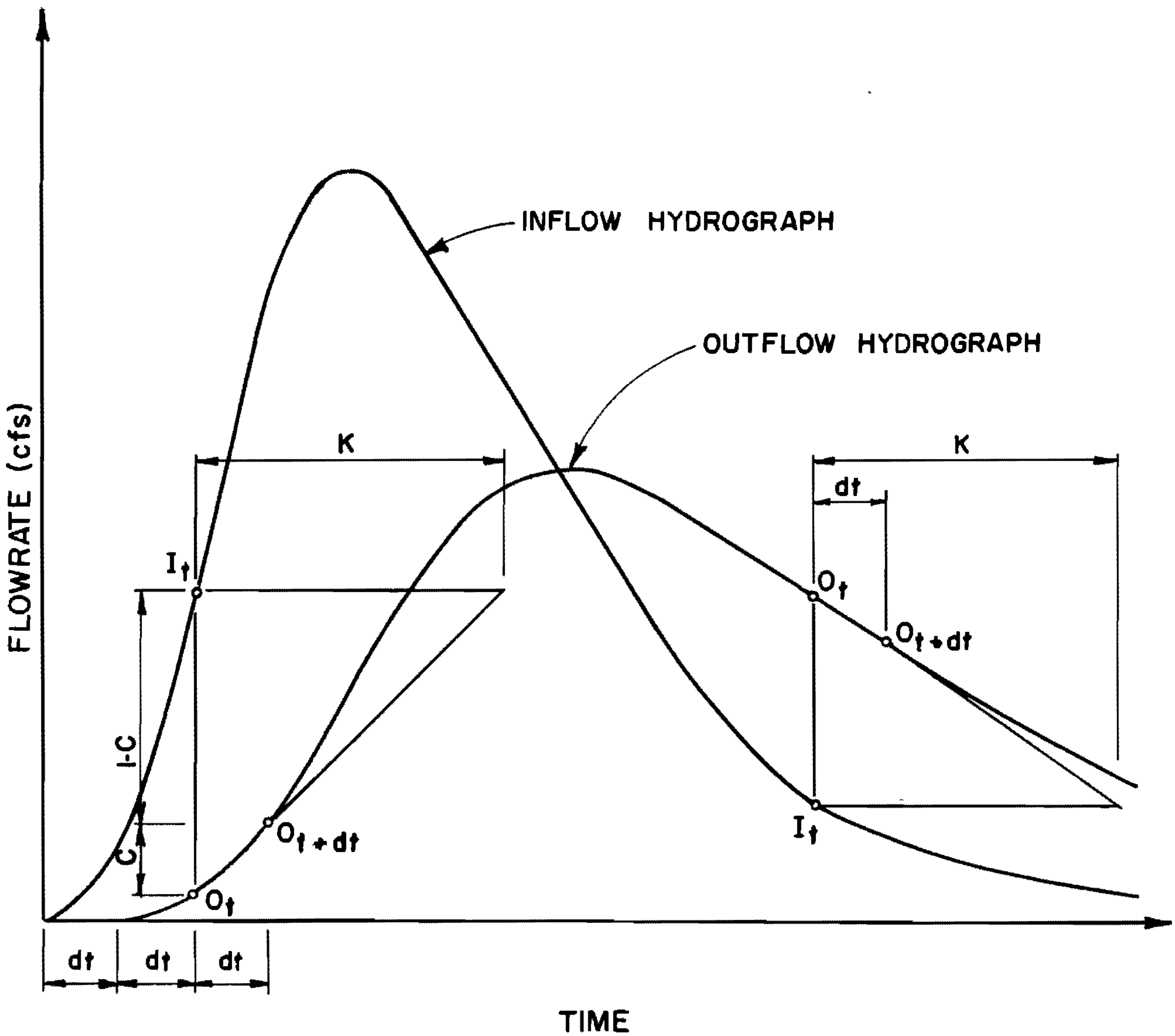
$$(O_{T+dT} - O_T)/(I_T - O_T) = dT/K \quad (H.7)$$

where K is the channel reach travel time as estimated from the selection of the inflow hydrograph mean V value and the channel length, L. Figure H-1 illustrates the geometric interpretation of the relationship given by (H.7). Thus,

$$dT = CK \quad (H.8)$$

A 5-minute unit period is used for all convex routing applications.

An examination of the convex routing method reveals that the entire routing approach is a function of the routing coefficient, C. Consequently, a watershed link-node model composed of m such channel links necessarily includes m channel routing parameters, each with an associated unknown uncertainty function. Additionally, the uncertainty involved in combining the m channel links is further aggravated by the fact that each channel-routed hydrograph is also a function of the number and channel reach lengths used for each channel link. That is, the routed hydrograph through a channel with a length of 20,000 feet will differ from the results of routing a hydrograph through two successive reaches with a length of 10,000 feet, and so forth. Channel routing processes usually involve relatively short reaches of improved channel where storage effects are minor, or where confluences from other channels (or pipes) enter the main channel and a summation of hydrographs occurs.



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

ASSUMED ROUTING COEFFICIENT GEOMETRIC RELATIONSHIPS

Figure H-1

H.2.1. Example Problem: Convex Channel Routing

The example problem channel is a rectangular concrete section with a base of 10 feet, a Manning friction factor of 0.015, length of 3000 feet, and a mean slope of 0.005 foot/foot. The problem inflow hydrograph is tabulated in Table H.1. From the table, the average flowrate in excess of the 50-percent peak flowrate value is 767.4 cfs.

Using Manning's equation, the normal depth flow velocity is calculated as

$$V = (1.486 R_h^{0.67} S_0^{0.50})/n \tag{H.9}$$

where R_h is the hydraulic radius, and S_0 is the channel slope. For the example problem, V is 13.5 fps (feet per second) and the default routing coefficient from (H.4) is C = 0.89. From (H.8),

$$K = (3000\text{ ft})/(13.5\text{ fps})(3600\text{ sec/hr}) = 0.062\text{ hour}$$

$$dT = (0.89)(0.062) = 0.055\text{ hour}$$

From (H.5), C* is estimated for a timestep of dT* equal to 5 minutes by

$$C^* = 1 - (1-0.89)^E = 0.948$$

where E = (0.0833 + (0.5)(0.055))/((1.5)(0.055)) = 1.343. Thus the appropriate convex method routing approximation statement is

$$O_{T+dT} = (1-C^*)O_{T+dT-dT^*} + C^* I_T \tag{H.10}$$

where for the example problem

$$O_{T+dT} = (0.052)O_{T+dT-dT^*} + (0.948)I_T$$

TABLE H.1.

CONVEX ROUTING EXAMPLE PROBLEM SOLUTION

Storm Time (minutes)	Inflow (cfs)	Outflow[1] (cfs)
0	0.0	0.0
5	0.8	0.3
10	0.9	0.8
15	40.5	7.7
20	202.7	91.1
25	445.1	274.6
30	602.9	486.8
35	653.7	613.1
40	600.9	634.7
45	608.0	605.0
50	917.1	706.9
55	1186.7	992.5
60	1001.2	1117.1
65	763.6	931.1
70	714.9	756.7

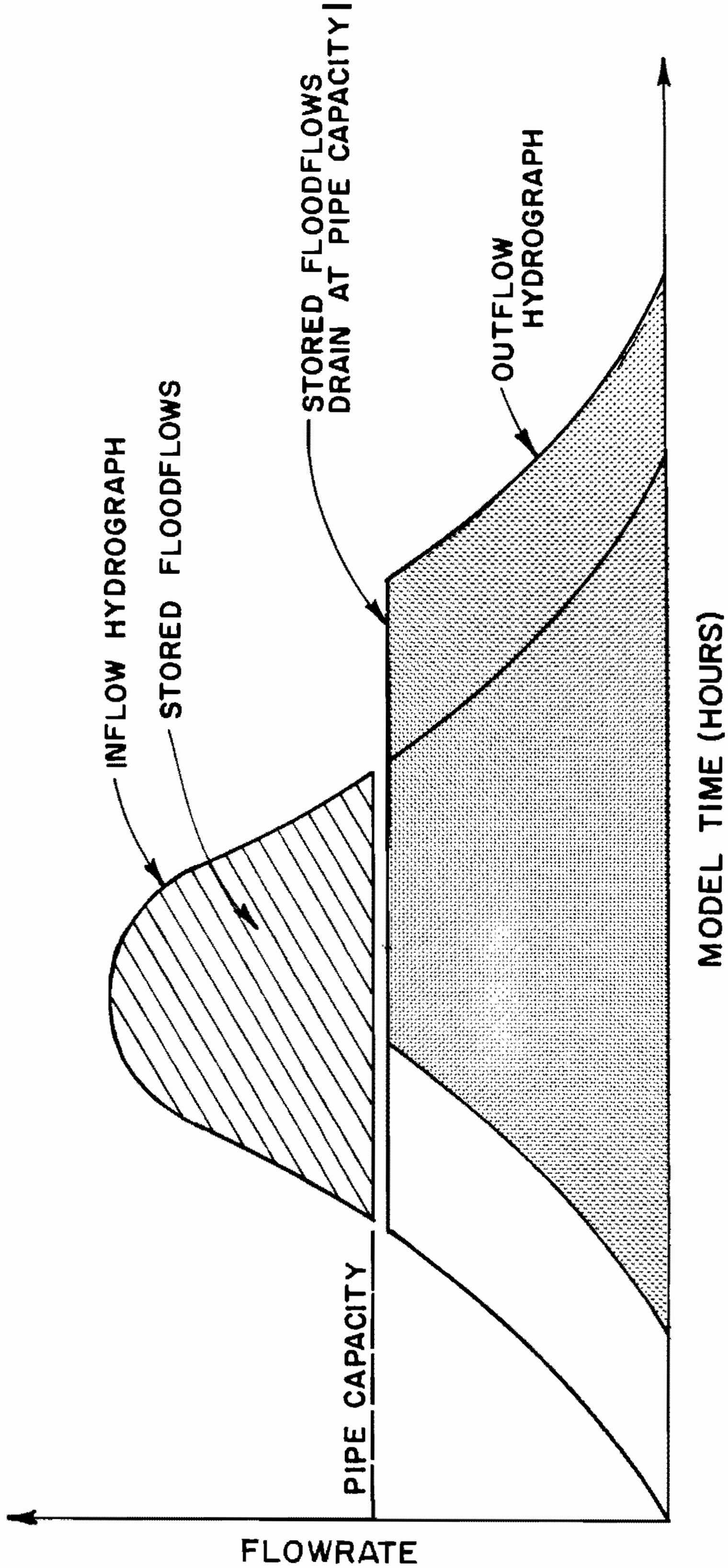
Note 1: outflow is to be offset by 3.7 minutes of travel time due to a computed mean flow velocity of 13.5 fps.

SECTION I

A PIPEFLOW ROUTING MODEL

Similar to the convex routing approximation procedure, the pipeflow routing model develops an outflow hydrograph from a reach of pipe given an inflow hydrograph and appropriate pipe section data. In the considered pipeflow model, however, a limiting value of outflow is assumed whereby all inflows greater than this pipe capacity are temporarily stored at the upstream endpoint of the pipe. The stored floodwaters subsequently drain into the pipe at a rate equal to the pipe capacity. Where this assumption is not valid, an alternative approach should be used. This modeling approach approximates the ponding of floodwaters where a significant volume of storage is available with a small change in flooding depths. Similar to the convex channel routing method, backwater effects are not included in the modeling approach.

The pipeflow routing process is modeled by calculating a normal depth flow velocity for each unit period (e.g., 5-minute) runoff value from the inflow hydrograph, and translating the unit runoff forward in storm time by the appropriate time increment. Generally, flowdepths in excess of 0.82 of the pipe diameter are assumed to be sealed and the unit interval flow velocities are computed based on a full flow condition. Figure I-1 shows the salient features of the pipeflow modeling approach.



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

PIPEFLOW
MODELING ELEMENTS

Figure I-1

SECTION J

SMALL AREA RUNOFF HYDROGRAPH DEVELOPMENT

J.1. INTRODUCTION

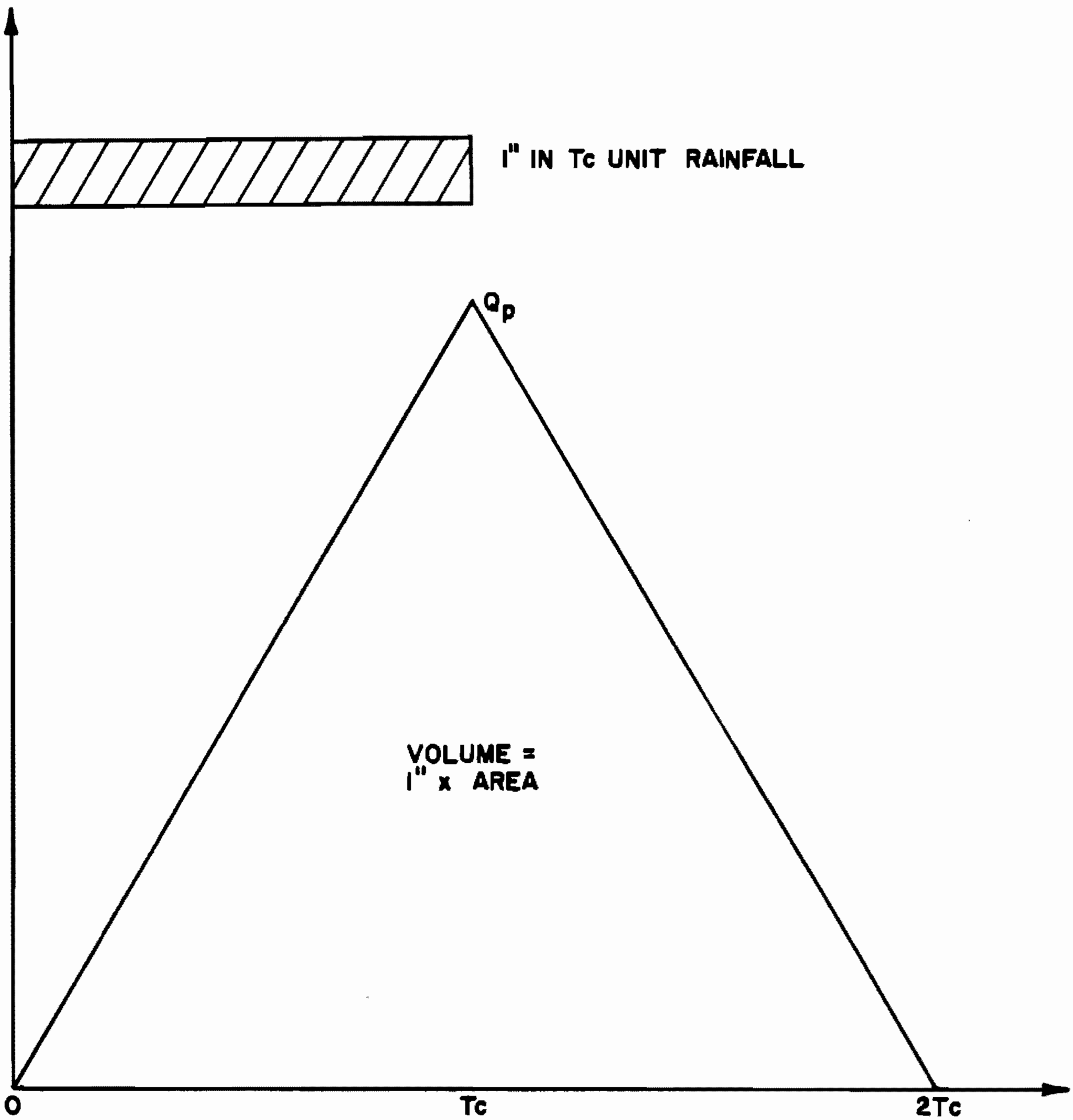
For watersheds whose time of concentration (see Section D) is less than 25 minutes, a simpler procedure can be used to develop the design storm runoff hydrograph. Additionally, the 25-minute limitation corresponds to a 25-percent unit interval (of watershed lag) when using 5-minute unit rainfalls in the unit hydrograph technique. Consequently, in order to avoid the unit hydrograph being too coarse an approximation, a small-area unit hydrograph method is needed. This technique is analogous to the design storm approach of Section E but has the following simplifications:

i. Depth-area Adjustment - Generally, watersheds whose time of concentration is less than 30 minutes have a drainage area small enough that depth-area adjustment is not required; i.e., the regionalized point rainfall depths are used without depth-area adjustment.

ii. Design Storm Pattern Development - Using a unit interval equal to the time of concentration (Tc), unit rainfalls are determined by successive subtractions along the mass rainfall plot (see Example).

iii. Loss Rates - Conforms to Section E.

iv. Unit Hydrograph - The unit hydrograph is defined to be a triangle with a base of 2Tc, and a peak at time of Tc (see Figure J-1). The volume of the unit hydrograph is (1-inch)(area). The example problem illustrates the triangle unit hydrograph. Note that in this case, lag is defined to equal the Tc estimate; (i.e., 50-percent volume occurs at time of Tc). Also note that lag is not computed, but the rational method Tc is used directly.



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

SMALL AREA

UNIT HYDROGRAPH

Figure J-1

v. Convolution - The convolution of the unit hydrograph with the unit effective rainfalls (storm rainfall less losses) is simply the addition of peak runoff values at each of the Tc unit intervals (see Example), where peak flow estimates follow from the rational method of section D.

It is noted that in the small area runoff hydrograph method, the total catchment area shall be used in the calculations; i.e., although the effective area may be used for rational method estimates for peak flow rates, the total catchment area is needed for runoff hydrograph volume study purposes. Any deviation from the use of the total catchment area must be approved by the Agency.

J.1.1. Example Problem: Small Area Runoff Hydrograph Development

1. Assume given from a rational method study (see section D):
   watershed area = 8 acres
   time of concentration = 10 minutes = unit interval
   maximum loss rate (F_m) = 0.12 inches/hour
   low loss fraction ($\bar{Y}$) = 0.35

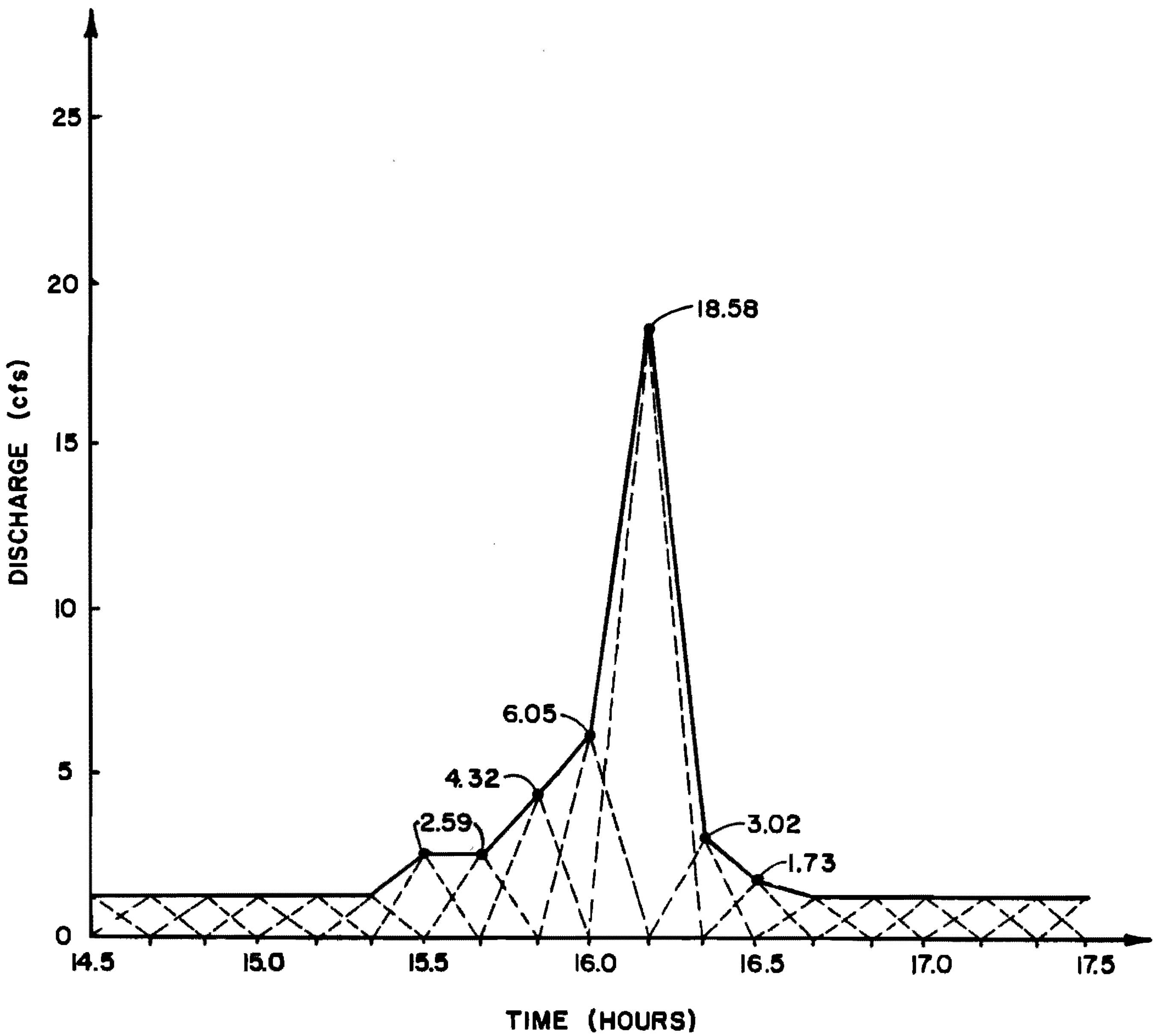
2. D_{10} follows from Figure D-3,
   where
   D_{10} = 10-year frequency depth (inches)
   T = duration (minutes)

3. $Q = 0.9\,(I-F_m)A$

TABLE J.1. EXAMPLE PROBLEM RESULTS

Peak Rainfall Unit Number	Mass Rainfall (Inches)	Unit Rainfall (Inches)	Unit Loss (Inches)	Net Rainfall (Inches)	Effective Rainfall (Inch/Hr.)	Discharge (Q) (cfs)
1	0.45	0.45	.02*	0.43	2.58	18.58
2	0.61	0.16	.02*	0.14	.84	6.05
3	0.73	0.12	.02*	0.10	.60	4.32
4	0.82	0.09	.02*	0.07	.42	3.02
5	0.90	0.08	.02*	0.06	.36	2.59
6	0.98	0.08	.02*	0.06	.36	2.59
7	1.04	0.06	.02*	0.04	.24	1.73
8	1.10	0.06	.02*	0.04	.24	1.73
9	1.16	0.06	.02*	0.04	.24	1.73
10	1.21	0.05	.02*	0.03	.18	1.30
11	1.27	0.06	.02*	0.04	.24	1.73
12	1.31	0.04	.01	0.03	.18	1.30
13	1.36	0.05	.02*	0.03	.18	1.30
14	1.40	0.04	.01	0.03	.18	1.30
15	1.44	0.04	.01	0.03	.18	1.30
16	1.48	0.04	.01	0.03	.18	1.30
17	1.52	0.04	.01	0.03	.18	1.30
18	1.56	0.04	.01	0.03	.18	1.30
19	1.60	0.04	.01	0.03	.18	1.30
20	1.63	0.03	.01	0.02	.12	0.86

*Unit low loss exceeds unit adjusted loss
Discharge to 24 hours is calculated by the above method



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

EXAMPLE PROBLEM
SMALL AREA
RUNOFF HYDROGRAPH

Figure J-2

SECTION K

WATERSHED MODELING GUIDELINES

K.1. INTRODUCTION

The previous sections provide the several elements used in developing a link-node watershed model for hydrologic planning purposes. In this section, guidelines are presented for development of complex hydrologic models for the analysis of the design storm condition. The combination of the several submodels described in Sections E-J provides the hydrologist with the modeling capability to analyze complex watershed conditions including variations in runoff production caused by flood control measures and alternative watershed development plans. It is frequently required that the difference in runoff production between existing and the ultimate development conditions be mitigated. For example, in large watersheds, the location of greenbelt channels or detention basins can significantly effect the total watershed peak flowrate estimate. Similarly, the planned location of high density development may mitigate the effects of watershed urbanization.

K.2. SINGLE AREA RUNOFF HYDROGRAPH DEVELOPMENT

In many cases, watershed studies involve a free flowing drainage system where storm runoff is collected by major storm drains or street systems and is carried from the watershed by means of a major flood control channel. These watersheds typically have minor storage or detention effects due to detention basins, channel constrictions, or channel capacity (i.e., overbank flow) problems. Additionally, these watersheds have a time of concentration which approximately equals the watershed critical duration and are comparable to the watersheds from which the S-graphs were derived.

Generally, a single basin unit hydrograph study such as illustrated in the example problem of Section E will be appropriate for the development of a design storm runoff hydrograph and peak flow rate (see Sections E and J).

K.3. COMPLEX WATERSHED RUNOFF HYDROGRAPH DEVELOPMENT

For complex watershed modeling conditions, the watershed is divided into subareas which are "linked" together by routing processes. Such watersheds are characterized by significant detention or storage effects and large areas of different development or soil loss conditions.

The procedures to be used for the various routing processes are given in the preceding sections. Subarea unit hydrograph and subsequent runoff hydrograph development follows directly from Section E.

i. Watershed Division into Subareas - All watershed modeling results differ based on the number and selection of subareas linked together to represent the total watershed. A guideline for the watershed division is to limit subareas such that the largest subarea is no greater than four times the area of the smallest subarea. Generally, subareas are defined which are tributary to detention basins or major channels whose storage routing effects are considered significant. Additionally, subareas should be determined such that the corresponding lag values are between 20 minutes and 2.5 hours; preferably, between 25 minutes and 1.5 hours (the range of lag values used in the calibration effort). Arbitrary subdivision of the watershed into subareas should generally be avoided. It must be remembered that an increase in the watershed subdivision does not necessarily increase the modeling "accuracy" but rather transfers the model's reliability from the calibrated unit hydrograph and lag relationships to the unknown reliability of the several flow routing submodels used to link together the several subareas.

ii. Subarea Design Storm Analysis - Each subarea is subject to the design storm condition. Therefore, all flood control facilities shall be analyzed based on the design storm impacting each subarea independently (see Section E).

iii. Depth-area Adjustment - As the watershed area increases, depth-area adjustment is needed based upon the entire tributary area. For example, should a point of concentration have three tributary subareas with a combined area of 6 square miles, then each of the subareas must be reanalyzed for the design storm condition with the depth-area factors based upon the total area of 6 square miles. All routing procedures are also reevaluated based upon the new subarea runoff hydrographs. In this fashion, each point of concentration has the appropriate depth-area adjustment applied to the design storm.

K.4. USE OF WATERSHED MODEL COMPUTER PROGRAMS

Several single event unit hydrograph computer models are currently available. For example, the unit hydrograph option of the HEC-1 and TR-20 programs have been used for both small and large watershed master planning. As discussed in Section E, unmodified use of these models are precluded. In the following, guidelines are presented which provide the parameter and design storm restrictions needed to conform the various available watershed models to the design storm conditions described in this manual:

i. Effective Rainfall Computation - All watershed loss rates are to conform to the specifications of Section C (i.e., watershed 24-hour storm runoff yields, maximum loss rates (Fm), and low loss fraction ($\bar{Y}$)).

ii. Single Event Design Storm Pattern - The watershed model is to be based upon the design storm patterns shown in Sections E, F and G. Depth-area adjustment and rainfall depths are to conform to the requirements of Sections B and E.

iii. Routing Processes - Basin and channel routing modeling techniques are to be based upon the modified Pul's and convex methods described in the previous sections. (Full details of these techniques are contained in refs. 2, 3, 5.)

iv. Complex Watershed Modeling - The division of the watershed into subareas and the application of depth-area adjustment to tributary area must conform to the guidelines of this section of the manual.

v. Unit Hydrograph Development - The development of unit hydrographs must conform to the S-graphs and lag computation procedures described in Section E. Calculation of watershed time of concentration must conform to the rational method procedures of Section D.

vi. Preproject Meeting - All complex watershed modeling proposals are to be discussed with the Agency prior to study submittals for review. This preproject meeting will aid in familiarizing the project with the Agency, and also aid in checking whether the modeling approach conforms to the hydrology manual.

K.5. SINGLE AREA RUNOFF HYDROGRAPH COMPARISON CRITERIA

When a complex watershed model (e.g. a "link-node" schematic involving subareas linked by channel routing) is to be used, a single area runoff hydrograph model is also to be developed for comparison purposes. Should detention basins be planned, the complex model without the basins (i.e. "free-draining") is to be compared to a single subarea model.

Should the peak Q from the free-draining complex model be greater than the single area runoff hydrograph model, then the complex model peak Q is to be used as the design Q. The use of a higher Q for design purposes aids in accommodating for the increased uncertainty in the complex model.

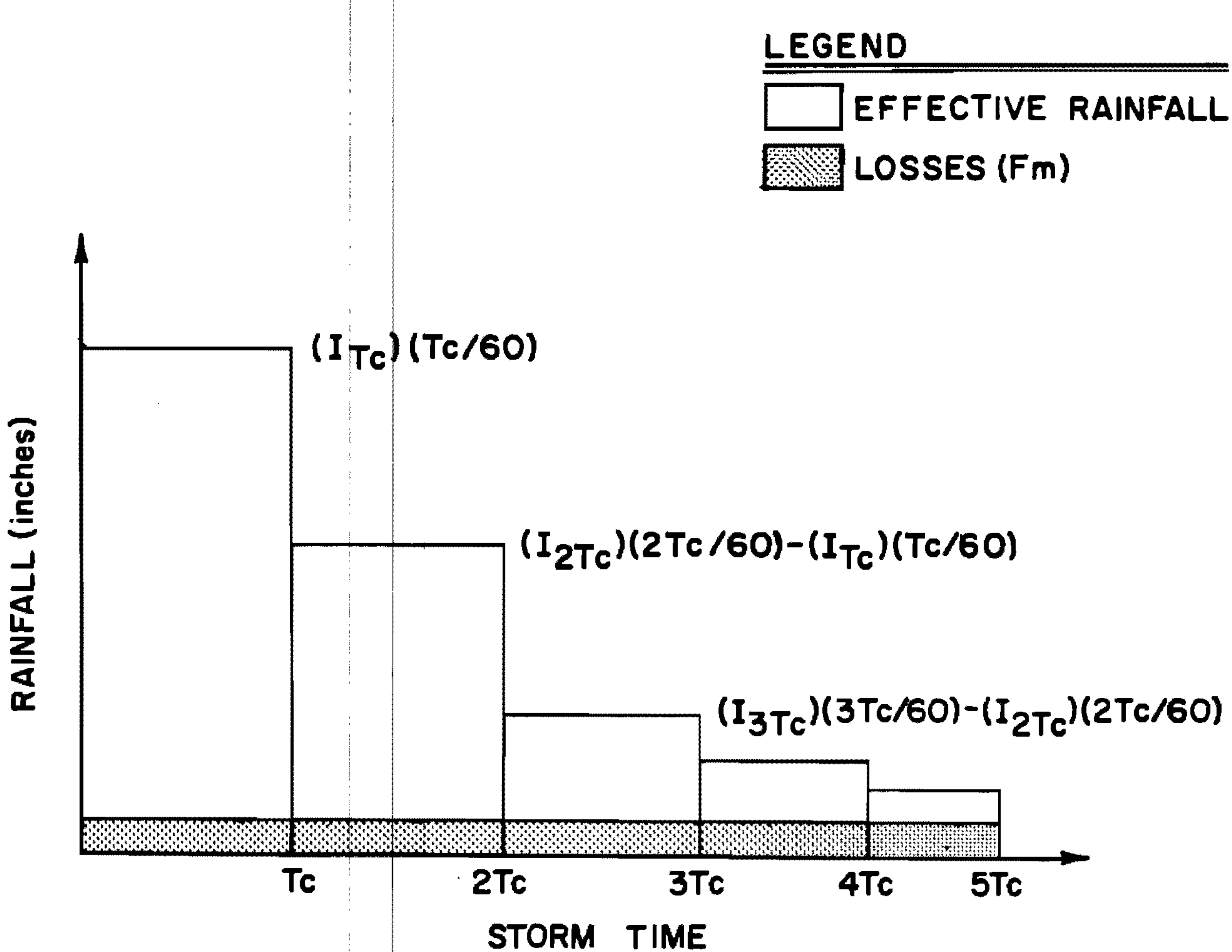
APPENDIX I

THE RATIONAL METHOD AS A DESIGN STORM UNIT HYDROGRAPH METHOD

The rational method can be interpreted as a design storm unit hydrograph method. The design storm pattern is developed by using a selected return frequency rainfall intensity - duration curve. At a point of concentration with time of concentration, Tc, the rational method design storm pattern is constructed from an intensity-duration curve by first determining the total amount of rainfall (i.e., unit rainfalls) which falls in several successive unit periods, each of duration Tc. The next step is to arrange these several unit rainfalls into the rational method design storm pattern (see Figure I-1) by placing the largest unit rainfall as the first unit, followed by the second largest unit rainfall, and so forth until a sufficiently long design storm pattern is developed (usually about 1-hour in total length, but may be longer depending on the various stream confluence Tc values).

Using the area-averaged loss rate F_m (e.g., see Section C.6.5), the design storm unit effective rainfalls are calculated by subtracting the appropriate proportion of F_m from each unit rainfall. It is noted that the design storm unit rainfalls are given in units of inches of precipitation whereas F_m is given as a rate (inch/hour).

The unit hydrograph corresponding to the rational method is a triangle with base 2Tc, and a peak occurring at time Tc (see Figure I-2). For a unit period of duration equal to Tc and a unit effective rainfall of 1 inch, the associated unit period runoff hydrograph must have a peak flow rate of (60/Tc) cfs per acre where Tc is given in minutes. Similarly, a unit period effective rainfall of only 1/2-inch must have an associated unit period runoff hydrograph with a base of 2Tc and a peak flow rate of (1/2)(60/Tc) cfs per acre. The runoff hydrographs associated to each unit effective rainfall are determined similarly, and then arranged as shown in Figure I-3 so that the resulting unit period runoff hydrographs correspond in timing to the proper unit period effective rainfalls. The runoff hydrograph is developed by adding the flow contributions from the several unit period runoff hydrographs.



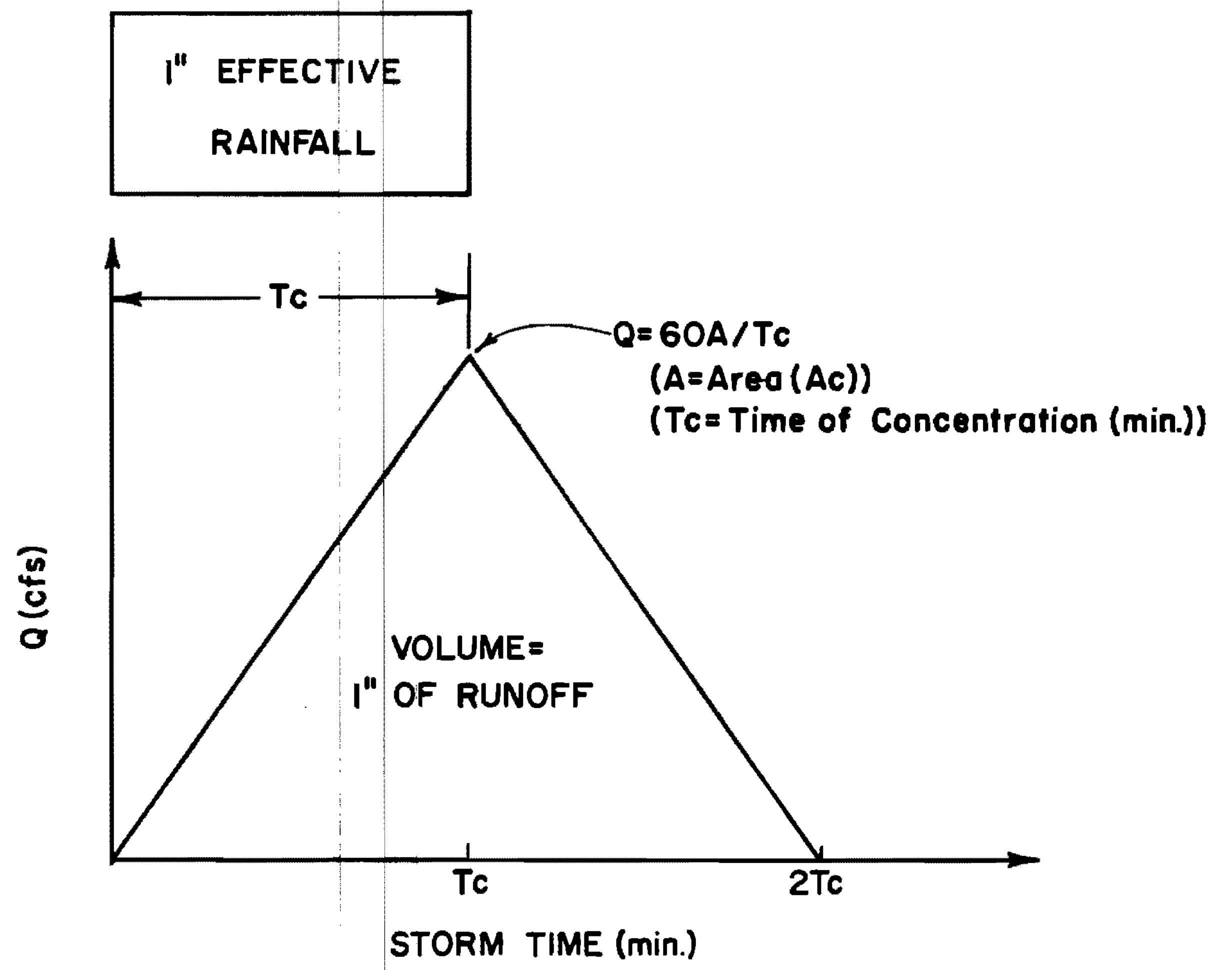
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

RATIONAL METHOD

DESIGN STORM PATTERN

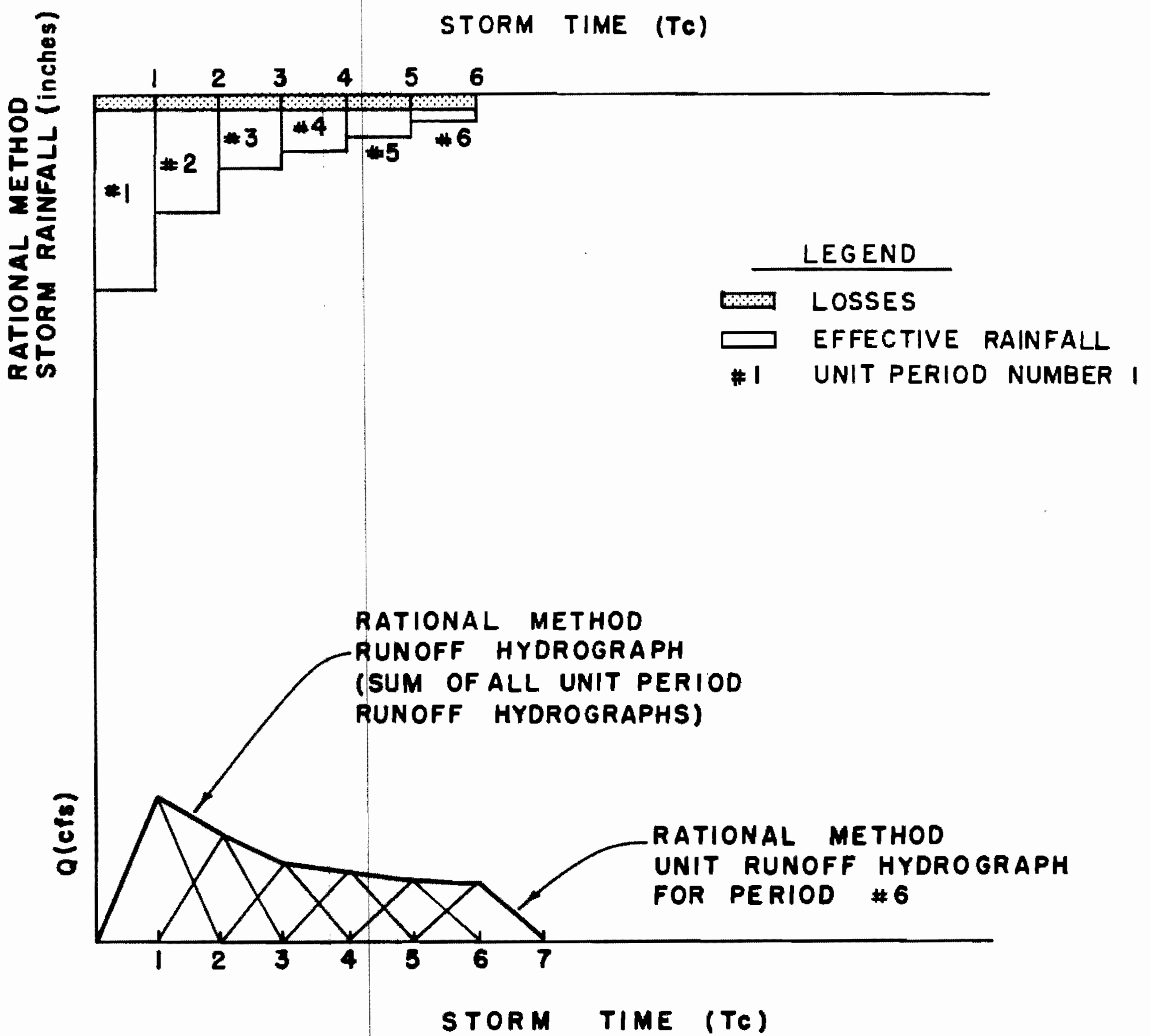
Figure I-1



SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

RATIONAL METHOD
UNIT HYDROGRAPH

Figure I-2



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

RATIONAL METHOD

RUNOFF HYDROGRAPH DEVELOPMENT

Figure I-3

APPENDIX II

DETENTION BASIN CONSIDERATIONS

Generally, the main purpose for inclusion of a stormwater detention basin in a flood control system is to reduce peak rates of runoff generated from an upstream watershed and to control peak flows into downstream areas. Some of the advantages and disadvantages of use of detention basins are listed in the following:

BENEFITS

- o Reduce peak rates of runoff to downstream areas.
- o Basin reduces transport of sediments carried in floodwaters.
- o Reduces size of downstream flood control facilities.
- o Provides location for groundwater recharge if aquifer contact exists.
- o Provides location to concentrate floodwaters for contaminant treatments.

POTENTIAL CONCERNS

- o Detention basins do not reduce total storm runoff volume (unless the groundwater recharge potential is large).
- o Maintenance of storage capacity, inflow and outflow facilities is critical.
- o Basins increase the duration of flows which may increase erosion effects downstream from the basin. Downstream erosion may be further increased due to sediment extraction in the basin.
- o Improperly sized and placed basins may aggravate rather than reduce downstream flooding potential (especially in large complex systems).
- o Accumulated debris from runoff decreases flood control storage volume in a detention basin.
- o Cost of debris removal.
- o Detention basins in urban areas may become unsightly and/or vermin infested without intensive maintenance.

The consideration of a detention basin system needs to address the various hydrologic, hydraulic, environmental and flood control concerns listed above, as well as any other concern which may arise during the course of the project study, and determine the necessary mitigative measures which are acceptable to the Agency. Of special concern is the interplay between the several components of the total system network. Unplanned placement of detention basins without consideration of other watershed detention basins and tributary watersheds can increase the downstream peak flow rate above the anticipated runoff peak flow rate attained without any detention basins in the watershed.

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