UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Regional Technical Service Center
Engineering and Watershed Planning Unit
Portland, Oregon

October 21, 1975

TSC TECHNICAL NOTE - HYDROLOGY - PO-6 (Rev. 2)

Re: Use of National Weather Service Revised Precipitation-Frequency Maps and Estimation of 10-Day Precipitation Values

The National Weather Service has revised the precipitation-frequency maps in Technical Paper No. 40, "Rainfall Frequency Atlas for the United States," for individual states in the WRTSC area. This revision, NOAA Atlas 2 "Precipitation-Frequency Atlas of Western United States," makes the precipitation-frequency maps in the National Weather Service Technical Paper No. 49 outdated for the states where the revised maps have been prepared.

This technical note has two parts. The first part, or Appendix A, explains how the revised maps for an individual state should be used to obtain consistency in developing a frequency curve of precipitation. The second part, or Appendix B, explains how to develop 10-day precipitation values using the revised maps and how to obtain consistency in developing the frequency curve of precipitation. A revised procedure for estimating the 1-hr. precipitation values has been incorporated into Appendix B.

All the information included in previous memorandums to all hydrologists from R. E. Rallison dated December 22, 1969; July 18, 1969; and January 7, 1969 is included in this technical note. The previous memorandums may be discarded.

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Head, Engineering and
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Attachments

cc:
State Conservationists - West (4)
RTSC - Lincoln, Fort Worth, Broomall (2)
Kenneth L Williams, Director, RTSC
Neil F. Bogner, Washington, D.C. (1)
R. E. Rallison, Washington, D. C. (1)

APPENDIX A

Use of Revised Precipitation-Frequency Maps

The partial duration series rather than the annual series was used to develop the individual climatological station precipitation-duration-frequency curves. The partial duration series uses all values above a base within a selected time period to develop a frequency curve of the data. The annual series uses the largest annual event to develop the frequency curve.

Normally, all design and evaluation analyses are made using the annual series rather than the partial duration series. The following procedure should be used to convert the partial duration series map values to an annual series frequency curve.

1. Using the basic 6- or 24-hour maps, read the data from the 2-, 5-, 10-, 25-, 50-, and 100-year return periods using linear interpolation between the isopluvial lines. List the values in tabular form similar to the attached example. These values are for the partial duration series.

2. Convert the values from step 1 to the annual series values using the values in Table A-1.

3. Plot the converted values from step 2 on log-normal probability paper. After plotting the data, fit a straight line to the plotted values. See page A-5 of the example.

4. Values for selected events should be read from the frequency curve as shown in the right-hand column, page A-4 of the example.

Figure A-1 can be used to obtain areal correction factors for various size watersheds. The areal correction curves in Chapter 21, NEH-4 are to be used only with the emergency spillway design hydrographs. The following equation can be used to determine the precipitation values for a 12-hour storm: 12 hr = 24 hr - .51(24 hr - 6 hr).

TABLE A-1

Empirical Factors for Converting
Partial-Duration Series to Annual Series

Return Period	Factors
2 year	0.88
5 year	0.96
10 year	0.99
25 year	1.00
50 year	1.00
100 year	1.00

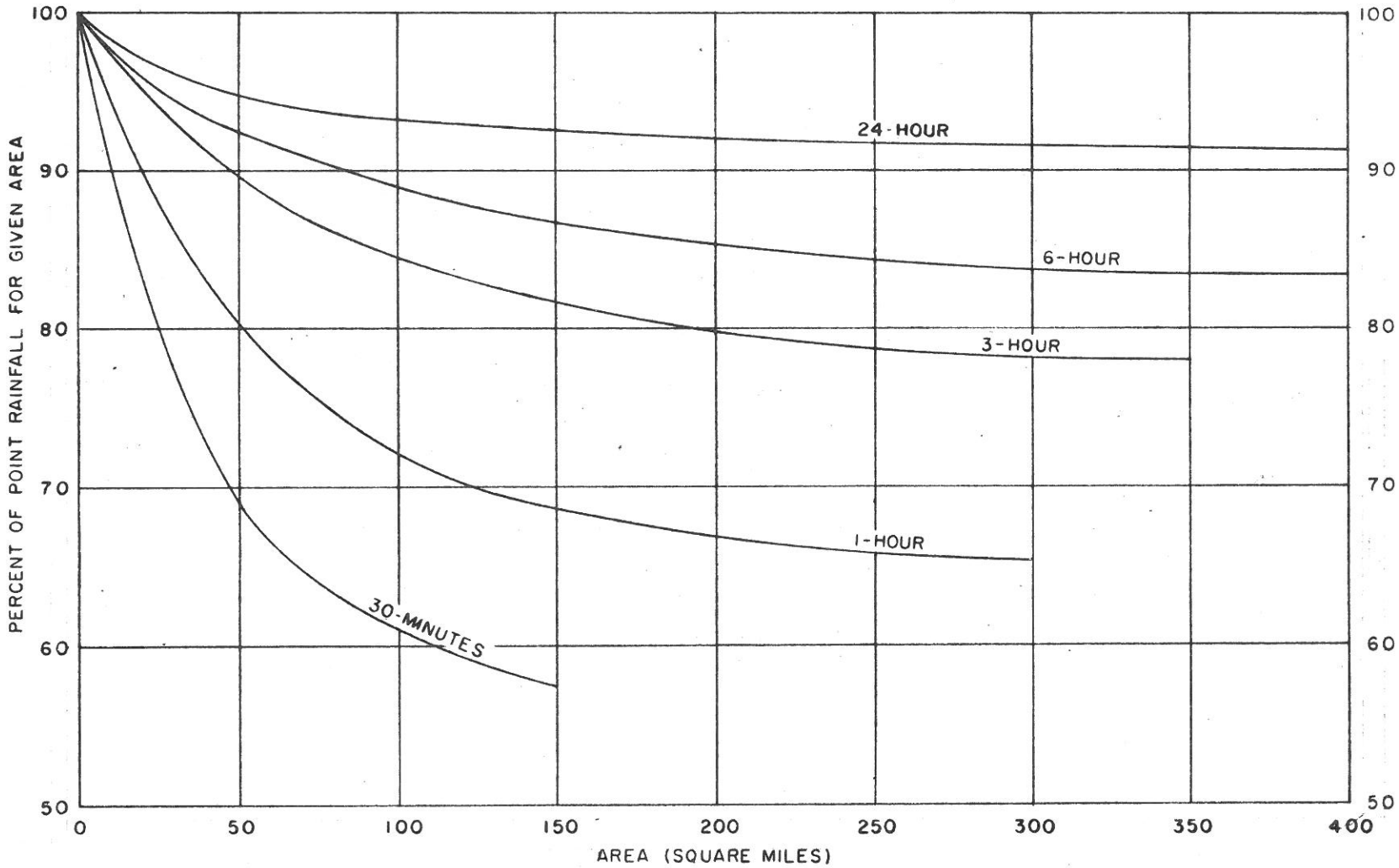


FIGURE A-1 — AREA-DEPTH CURVES

COMPUTATION SHEET
SCS-523 REV 5-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GPO 1958 O—470867

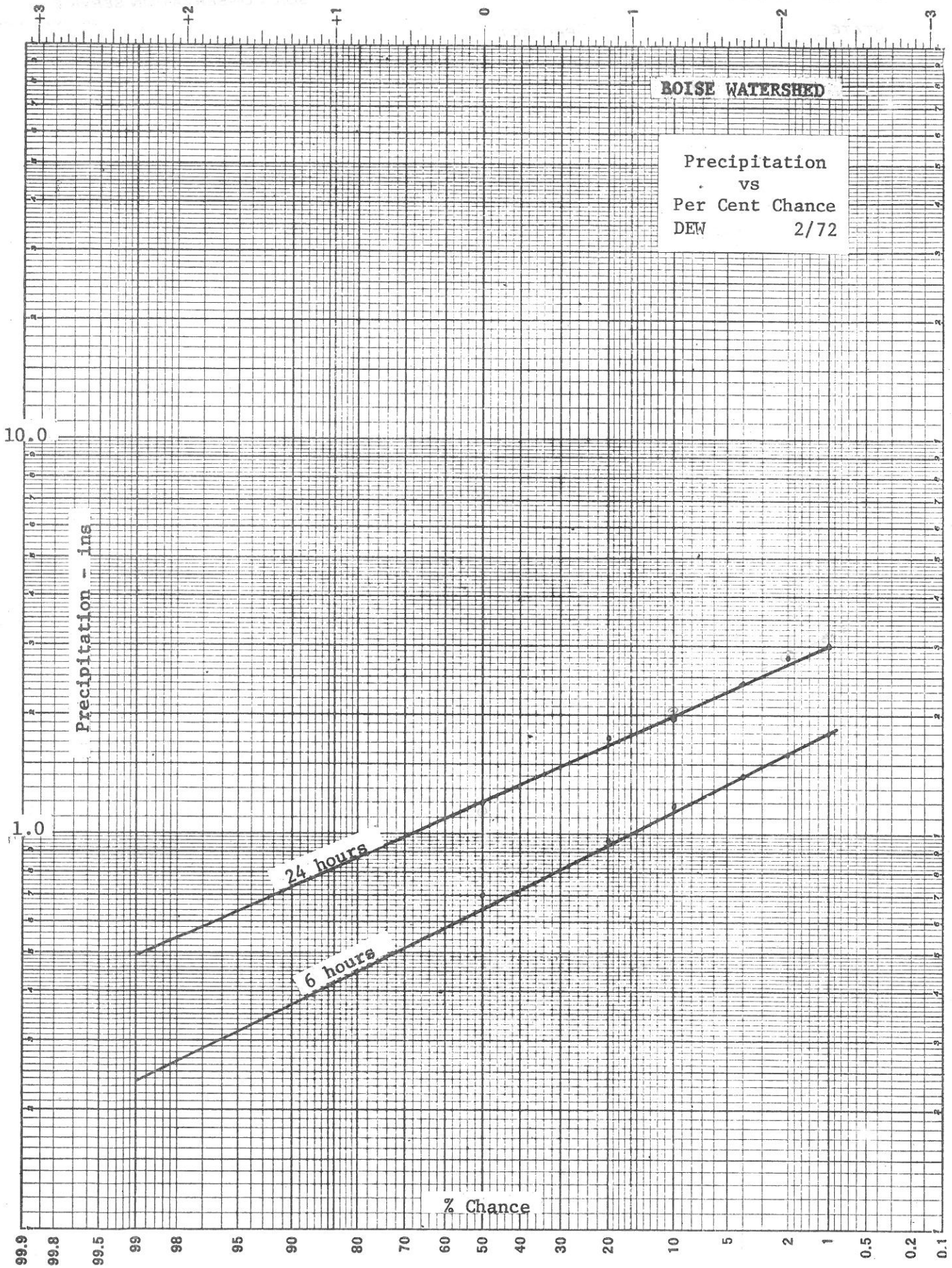
STATE Idaho		PROJECT Boise W/S		
BY DEW	DATE 2/72	CHECKED BY WAS	DATE 3/72	JOB NO.
SUBJECT Estimation of Precipitation Freq. Data				SHEET ____ OF ____

24-Hour Precipitation

Frequency -yrs-	Map Value -ins-	Factor	Plotted Value -ins-	Value used -ins-
100	3.0	1.00	3.00	3.00
50	2.8	1.00	2.80	2.80
25	2.4	1.00	2.40	2.50
10	2.0	0.99	1.98	2.00
5	1.8	0.96	1.75	1.70
2	1.4	0.88	1.20	1.20

6-Hour Precipitation

Frequency -yrs-	Map Value -ins-	Factor	Plotted Value -ins-	Value used -ins-
100	1.8	1.00	1.80	1.80
50	1.6	1.00	1.60	1.60
25	1.4	1.00	1.40	1.40
10	1.2	0.99	1.18	1.15
5	1.0	0.96	0.96	0.95
2	0.8	0.88	0.70	0.65


BOISE WATERSHED
Precipitation
vs
Per Cent Chance
DEW 2/72
10.0
1.0
Precipitation - ins
24 hours
6 hours
% Chance
+3
+2
+1
0
-1
-2
-3
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1

APPENDIX B

Estimation of 10-Day Precipitation Values

The precipitation-frequency maps in National Weather Service Technical Paper No. 49, "Two- to Ten-Day Precipitation for Return Periods from 2 to 100 Years," should not be used to estimate the 10-day precipitation in those states included in the new "Precipitation-Frequency Atlas of Western United States." The following procedure should be used to estimate the 10-day precipitation for various frequencies or return periods. An example is shown on page B-6.

1. Select the 2-year, 6- and 24-hour precipitation amounts from the new Atlas maps. Use linear interpolation between the isopluvial lines.

2. Select the appropriate region from Figure B-1.

3. Estimate the 2-year, 1-hour precipitation using the equations in Table B-1 and the 6-hour and 24-hour amounts selected in step 1 above.

4. Estimate the 2-year, 10-day precipitation amounts from Figure B-2.

5. Estimate the 100-year/2-year 10-day precipitation ratio from Figure B-3.

6. Multiply the 2-year, 10-day precipitation amount by the ratio obtained from step 4 to obtain the 100-year, 10-day rainfall amount.

7. Multiply the 2-year, 10-day precipitation amount by 0.88 to convert from partial duration series to the annual series normally used.

8. Plot the 2-year and 100-year precipitation amounts on log-normal probability paper to obtain precipitation amounts for other return periods.

Figure B-4 can be used to obtain precipitation amounts for durations between 2-day and 10-day.

Table 21.1 in Chapter 21, NEH-4, can be used to obtain areal correction factors for 10-day precipitation amounts for various size watersheds when developing the principal spillway mass curve or hydrograph. Figure B-5 can be used to obtain areal correction factors for 1- through 10-day duration storms for other purposes.

TABLE B-1

List of Equations for Determining
2-year 1-hour Precipitation Values

Region

1. $$\text{2-yr 1-hr} = 0.028 + 0.890 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

2. $$\text{2-yr 1-hr} = 0.019 + 0.711 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

3. $$\text{2-yr 1-hr} = 0.077 + 0.715 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

4. $$\text{2-yr 1-hr} = 0.160 + 0.520 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

5. $$\text{2-yr 1-hr} = 0.157 + 0.513 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

6. $$\text{2-yr 1-hr} = 0.218 + 0.709 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

7. $$\text{2-yr 1-hr} = -0.011 + 0.942 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

8. $$\text{2-yr 1-hr} = 0.005 + 0.852 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

9. $$\text{2-yr 1-hr} = 0.126 + 0.561 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

10. $$\text{2-yr 1-hr} = 0.111 + 0.545 \frac{(\text{2-yr 6-hr})^2}{\text{2-yr 24-hr}}$$

11. $$\text{2-yr 1-hr} = 0.107 + 0.315\ (\text{2-yr 6-hr})$$

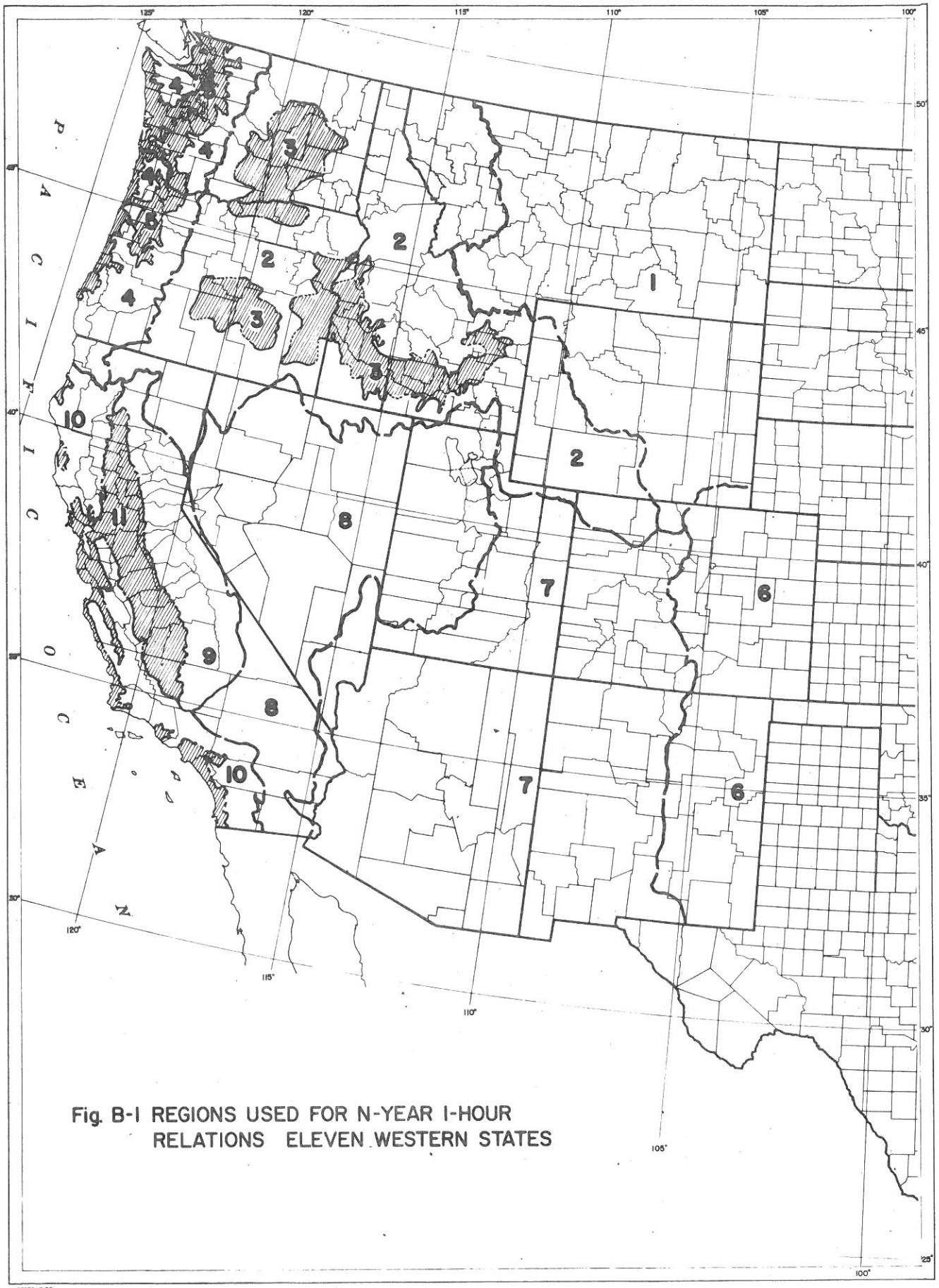


Fig. B-1 REGIONS USED FOR N-YEAR 1-HOUR RELATIONS ELEVEN WESTERN STATES

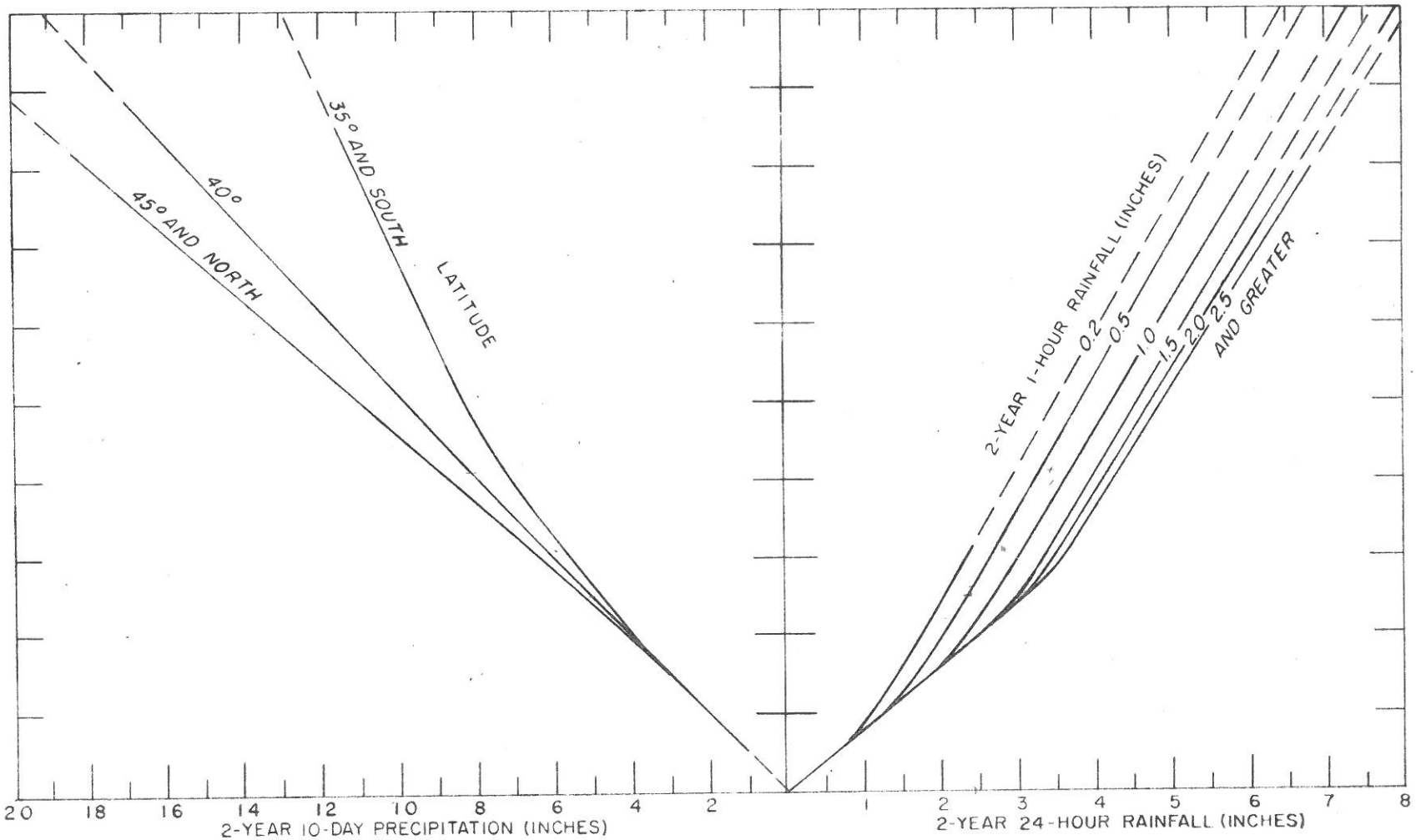


FIGURE B-2 — Relation for estimating 2-year 10-day precipitation from 2-year 1- and 24-hour rainfall and latitude

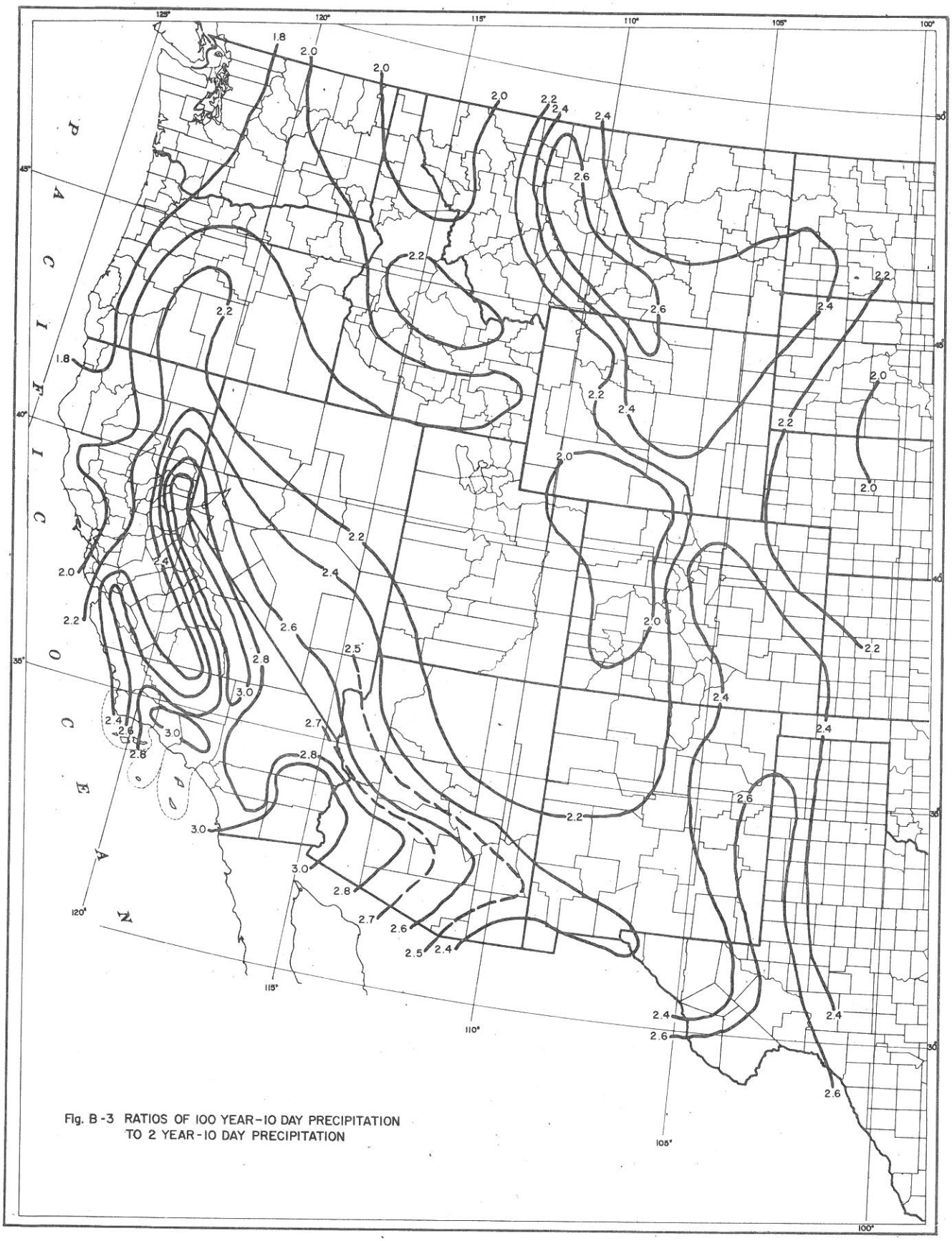


Fig. B-3 RATIOS OF 100 YEAR-10 DAY PRECIPITATION TO 2 YEAR-10 DAY PRECIPITATION

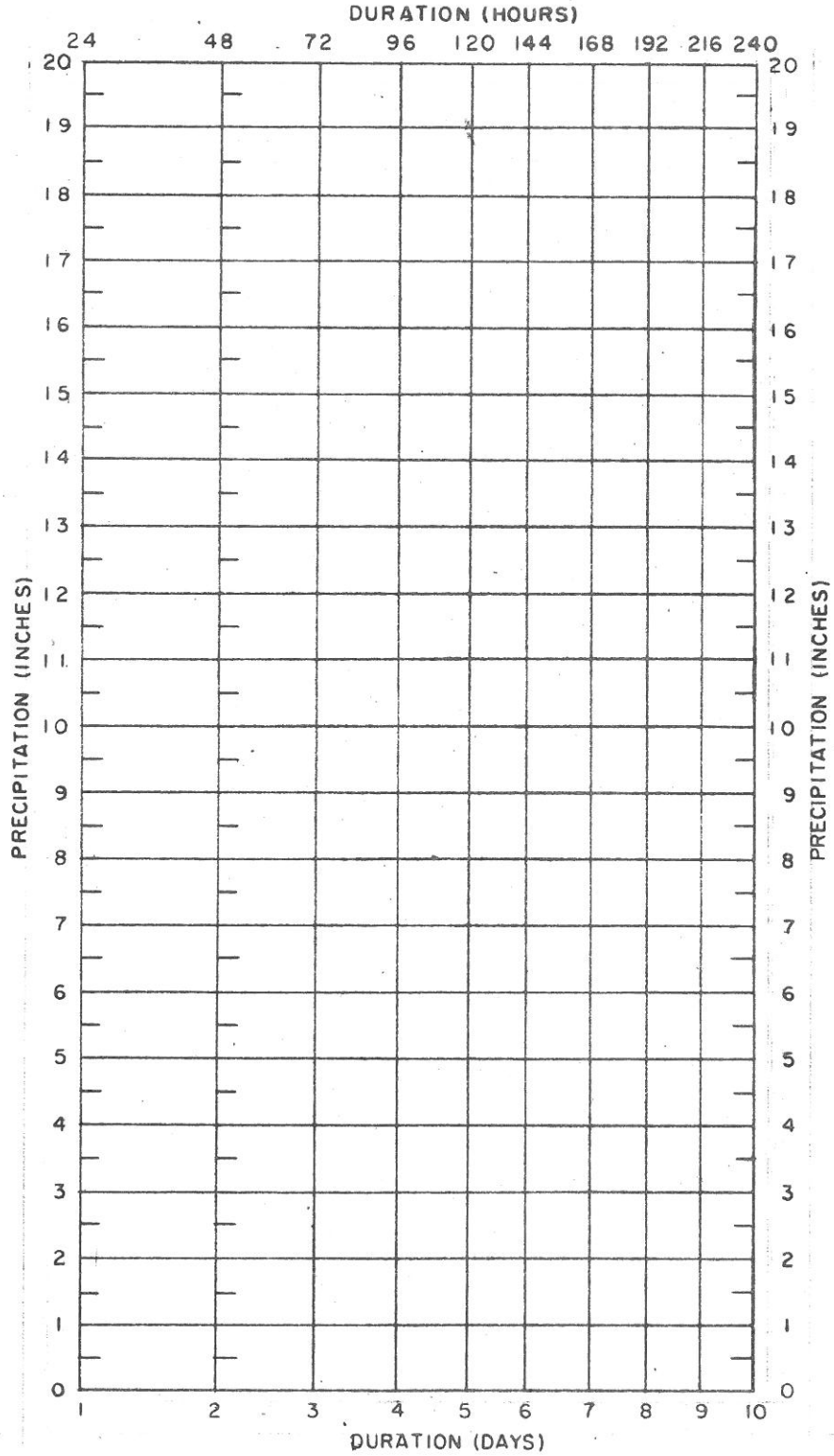


FIGURE B-4—Duration-interpolation diagram

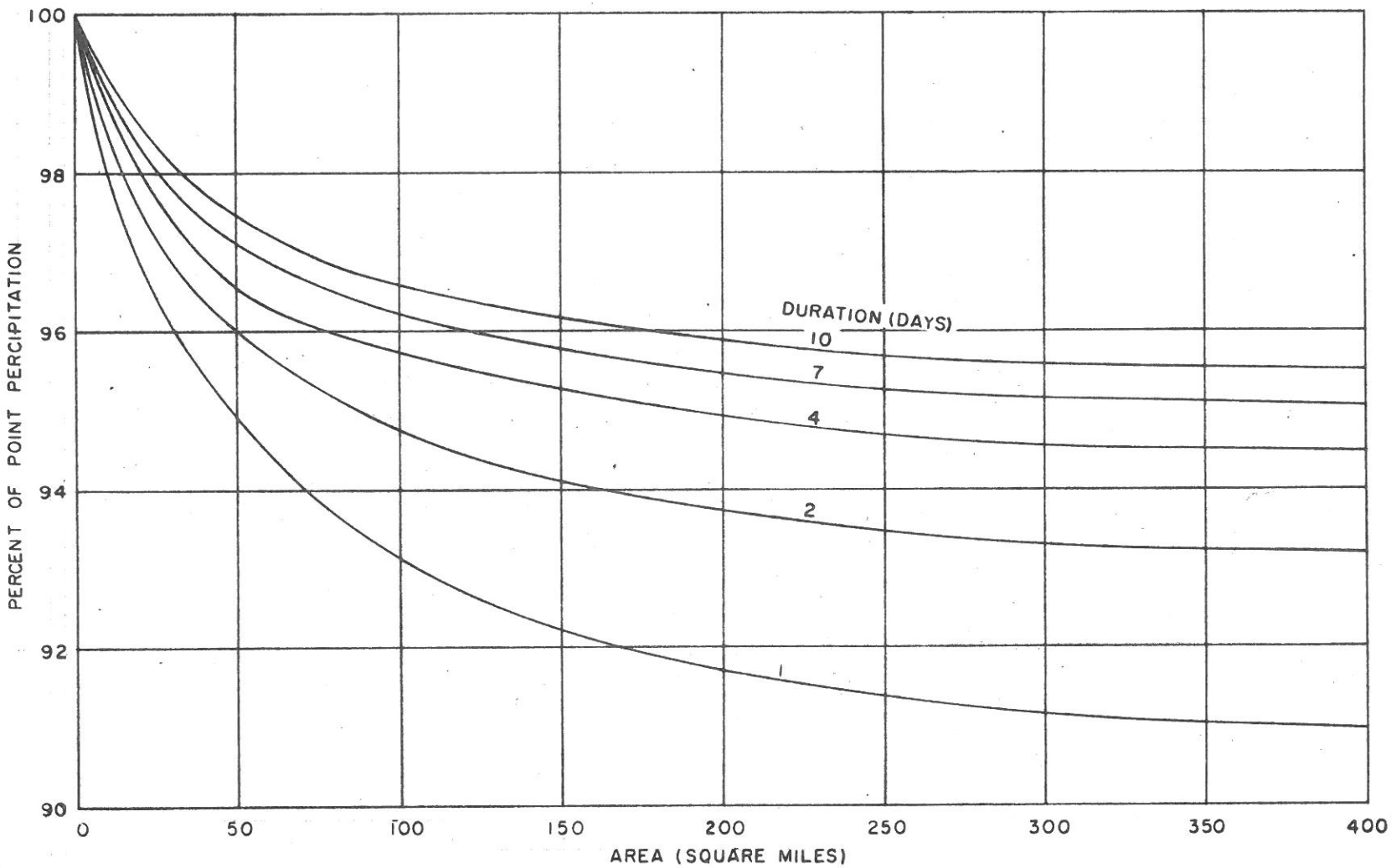


FIGURE B-5 — AREA-DEPTH CURVES

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
☆ GPO: 1969—O-367-545

STATE Oregon		PROJECT Boise W/S		
BY DEW	DATE 12/72	CHECKED BY WAS	DATE 12/72	JOB NO.
SUBJECT Estimation of 10-day precipitation				SHEET ____ OF ____

10 - DAY PRECIPITATION

1. Select 2year 6hr & 24hr precipitation values using Precipitation-Frequency Atlas

   2yr 6hr = 0.8ins
   2yr 24hr = 1.6 ins

2. Select appropriate region - 3

3. Determine 2yr - 1hr amount using appropriate equation in Table B-1

4. $$2yr\text{-}1hr = 0.077 + 0.715\frac{(2yr\text{-}6hr)^2}{2yr\text{-}24hr}$$

   $$= 0.077 + 0.715\frac{(.8)^2}{1.6}$$

   $$= .363 \text{ or } 0.36 \text{ ins}$$

5. Estimate 2yr-10day amount using Fig B-2

   2yr 10day = 3.1 ins

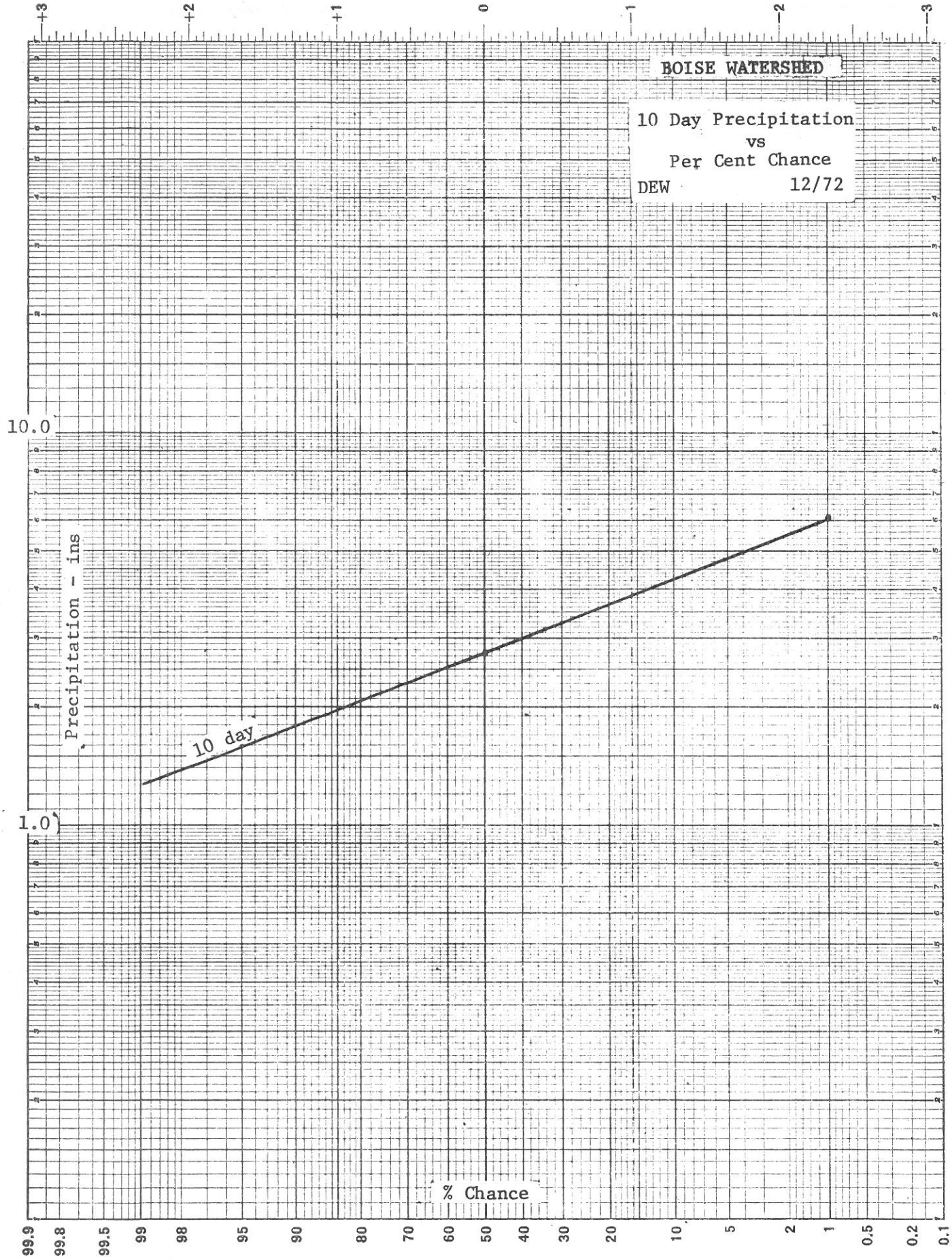
6. Estimate 100yr/2yr ratio using Fig B-3 = 2.0

7. Estimate 100yr-10day amount

   100yr-10day = (3.1)(2.0) = 6.2 ins

8. Estimate 2yr-10day amount

   2yr-10day = (3.1)(.88) = 2.7ins


BOISE WATERSHED
10 Day Precipitation
vs
Per Cent Chance
DEW 12/72
10.0
1.0
Precipitation - ins
10 day
% Chance
+3
+2
+1
0
-1
-2
-3
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1