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WATER RESOURCES ANALYSIS
AND INFORMATION SECTION

Office Report No. 46

NATURAL MONTHLY STREAMFLOW
IN THE METHOW BASIN

by

Don Richardson

(For Use by the Water Resources Management Division)

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NATURAL MONTHLY STREAMFLOW IN THE METHOW BASIN

I N T R O D U C T I O N

A task of the Water Resources Analysis and Information Section is to determine the average monthly streamflow under natural conditions in tributary streams of the Okanogan and Methow Basins. Such information will be useful in developing a sound water resource management program in these basins. For the Okanogan, natural monthly flows at the mouth of 15 streams were previously estimated, and are listed in Office Report No. 38 (January 1976). For the Methow Basin, similar information is presented in this report for 15 tributaries of the Methow River and for Frazer Creek, a tributary of Beaver Creek. In addition, estimated monthly flows are listed for the upper Methow River (above Winthrop) and Chewack River.

M E A N A N N U A L R U N O F F

The method used here for estimating mean monthly flows of ungaged streams is first to estimate the mean annual flow on the basis of drainage area and a regional map of average runoff, and then to distribute the annual runoff by monthly ratios that are based on selected streamflow records. The runoff map of Figure 1 was derived from a regional study by the Geological Survey, published in Water Supply Paper 1687, but it has been modified for this study

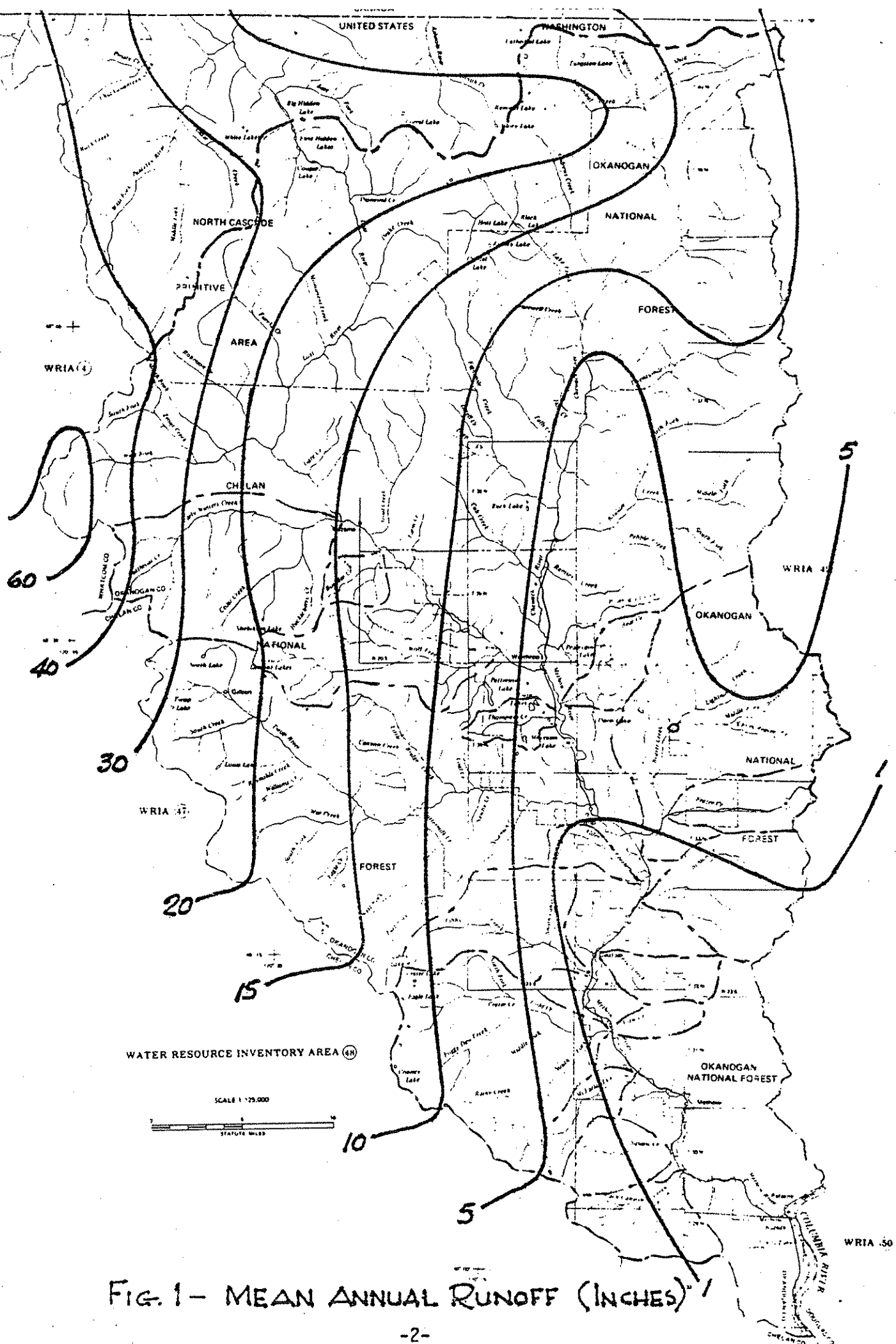


FIG. 1 - MEAN ANNUAL RUNOFF (INCHES)

on the basis of more recent records of Andrews and Beaver Creeks in the Methow Basin, and three small streams in the Chelan Basin. Although the lines of mean annual runoff are highly generalized, they are probably as well defined as isohyets on a precipitation map and have the added advantage of being derived directly from streamflow records.

As shown on Figure 1, mean annual runoff in the Methow Basin has a strong east-west gradient, decreasing from about 60 inches near Washington Pass to about one inch near Pateros. For the tributary streams where monthly flows are needed, estimated values of mean annual runoff (based on Figure 1) are listed in Table 1.

ESTIMATED MEAN MONTHLY FLOWS

The monthly distribution of annual runoff varies with altitude because of the pronounced effect of temperature where snowmelt is the main source of streamflow. At higher altitudes (above 5,000 feet) where spring snowpacks are deeper and temperatures are cooler, streamflows in the Okanogan and Methow Basins are generally greatest in the month of June. At lower altitudes snowmelt begins sooner in the spring, and streamflow in smaller basins generally peaks in April or May. This is reflected in the curves of Figure 2, which show the assumed monthly distribution of annual runoff for four altitude zones in the Methow Basin. These curves are slightly different from those that were used in the Okanogan study (Report No. 38), but in both the Okanogan and Methow Basins the predominance of snowmelt over rainfall runoff is apparent.

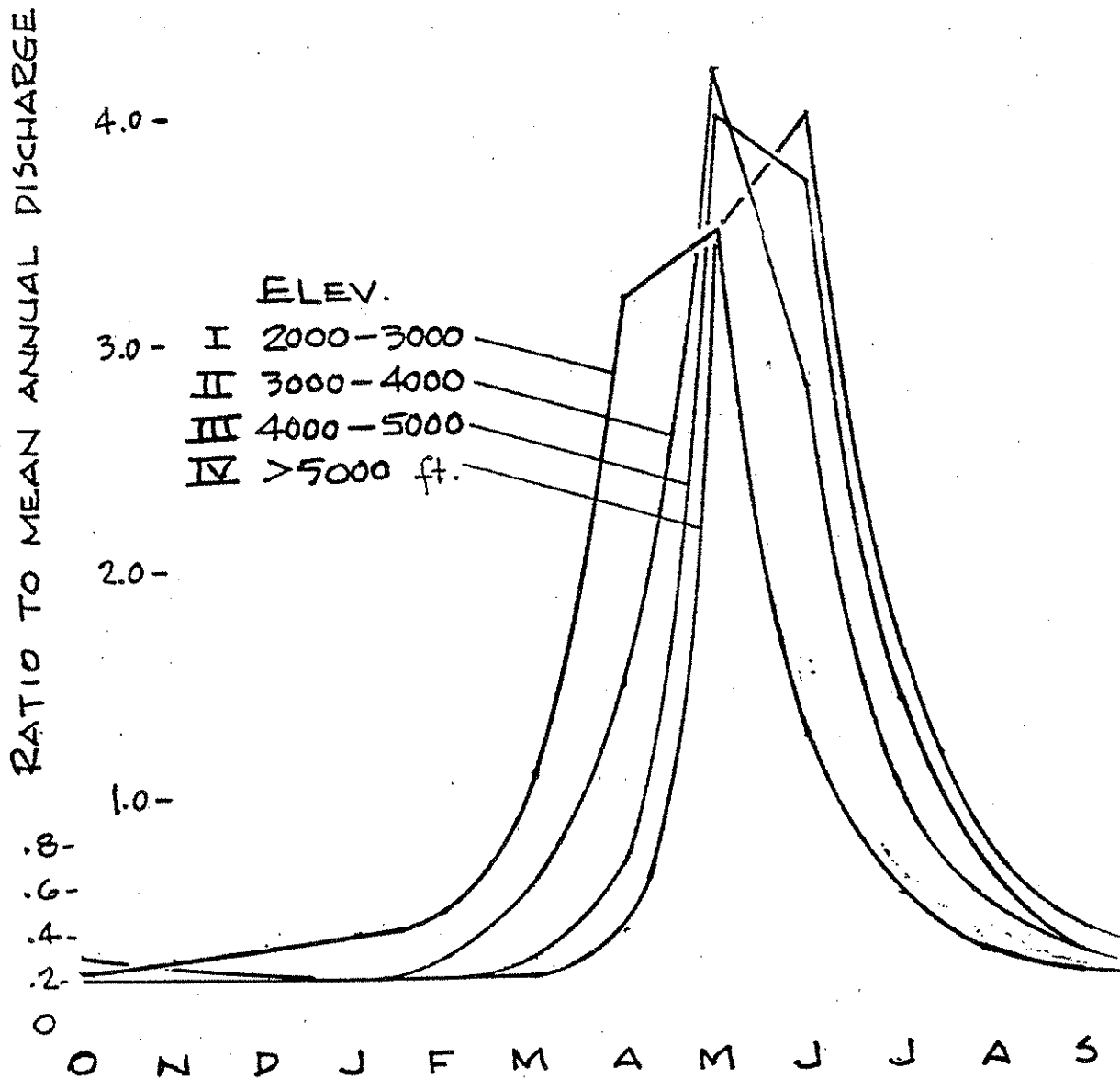
TABLE 1. ESTIMATED MEAN ANNUAL RUNOFF OF 16 STREAMS.

CREEK	D.A. (square miles)	BASIN ELEVATION (feet)	ANNUAL RUNOFF (inches)	MEAN DISCHARGE (cfs)
Early Winters	79.2	>5,000	25	146
Little Boulder	8.3	4,500	14	8.6
Wolf	38.4	4,500	14	39.7
Bear	18.4	<4,000	3	4.1
Thompson	14.5*	2,500	5	5.4
Frazer	21.1	3,500	2.5	3.9
Beaver at gage	62.0	4,800	4.6	20.8**
Beaver below gage	49	<3,000	3	10.8
Alder	12	<3,000	1	0.9
Benson	38.8	<3,000	0.9	2.6
Texas	10.9	<3,000	0.8	0.6
Libby	40.1	3,500	5	14.8
Cow	6.0	<3,000	0.8	0.4
Gold	88.6	>4,000	5	32.7
McFarland	13.1	3,000	1	1.0
Squaw	15.8	3,000	1	1.2
Black Canyon	24.6	3,000	1	1.8

* From USBR report, 1961. All other drainage areas are from USGS open-file report, 1964.

**1960-74.

FIGURE 2 -
MONTHLY DISTRIBUTION OF ANNUAL RUNOFF,
METHOW BASIN



Monthly Ratios -

I	.25	.3	.35	.4	.5	1.1	3.2	3.5	1.3	.6	.3	.2
II	.2	.2	.2	.2	.3	.6	1.5	4.2	2.8	1.0	.5	.3
III	.2	.2	.2	.2	.2	.3	.7	4.0	3.7	1.4	.6	.3
IV	.3	.25	.25	.2	.2	.2	.4	3.5	4.0	1.6	.7	.4

When the monthly ratios of Figure 2 are applied to the estimated values of mean annual discharge in Table 1, the estimated monthly discharges of Table 2 are obtained. It should be recognized that these are estimated natural average flows, which would be expected only if there were no effect of diversions or artificial storage. Also, under unusual conditions of surface- and ground-water interchange, actual flows during low flow months may vary considerably from estimated average values.

NATURAL FLOWS IN THE UPPER METHOW BASIN

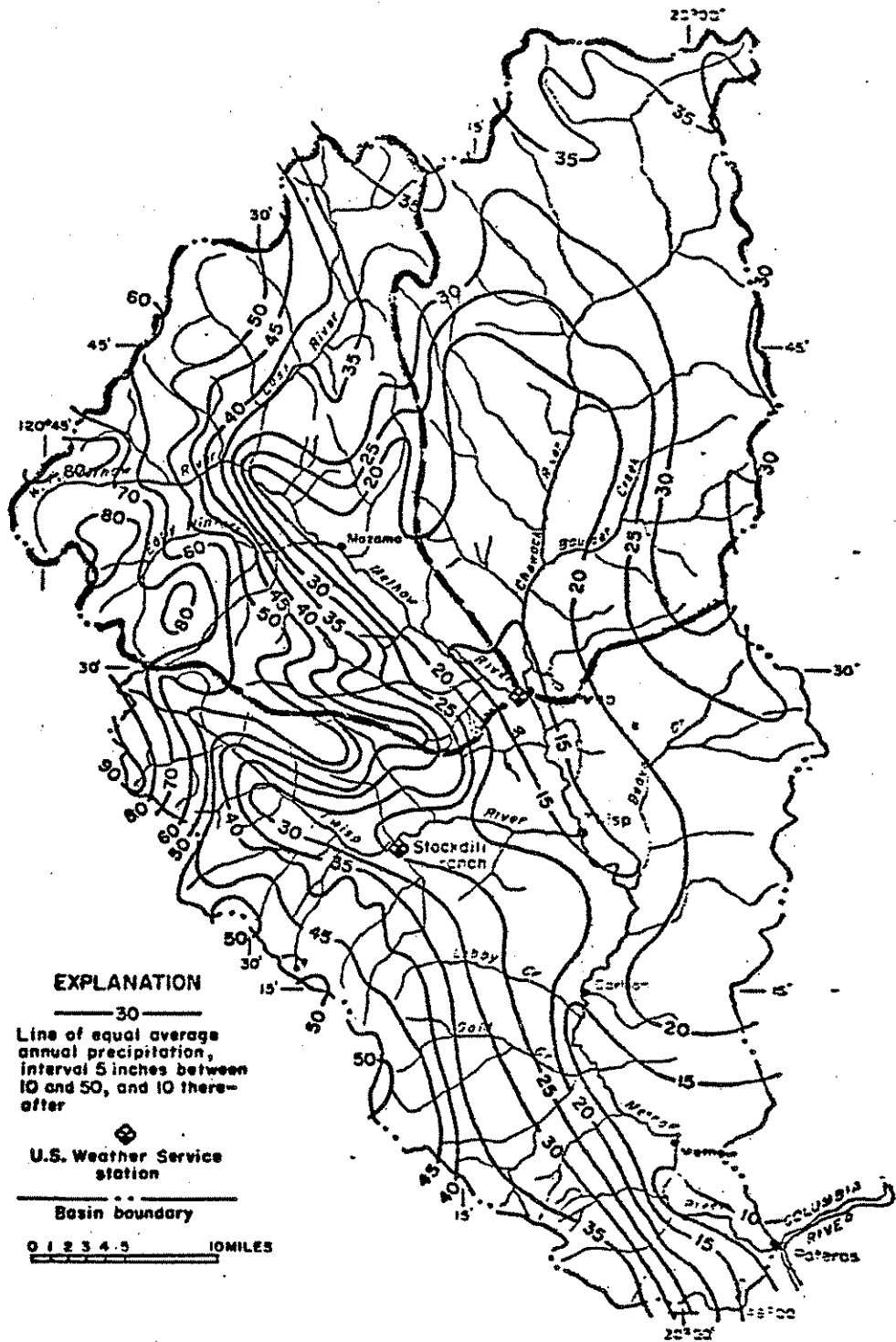
Above Winthrop, the Methow Basin is divided into drainages of nearly equal size, the Methow River draining 480 square miles and the Chewack 525 square miles.* Runoff from the Methow is much greater than it is from the Chewack, however, because of the precipitation pattern. As indicated on the map of Figure 3, average annual precipitation is about 40 inches in the upper Methow and about 25 inches in the Chewack subbasin. Annual evapotranspiration is about 15 inches in these areas, which means that average annual runoff is about 25 inches for the Methow and 10 inches for the Chewack. (Note that these figures agree with the runoff map of Figure 1.) Estimates of natural monthly flows at the confluence of these two rivers may best be made on the basis of available gaging station records.

* The Methow drainage area may be about 20 square miles larger, as the USGS figure for Lost River appears to be in error by that amount.

ESTIMATED NATURAL MONTHLY FLOW IN CFS, METHOW DAM

CREEK	O	N	D	J	F	M	A	M	J	J	A
✓ EARLY WINTERS	44	36	36	29	29	29	58	511	584	234	102
7 LITTLE BOULDER	1.7	1.7	1.7	1.7	1.7	2.6	6.0	34	32	12	5.2
✓ WOLF	7.9	7.9	7.9	7.9	7.9	12	28	159	147	56	24
✓ BEAR	0.8	0.8	0.8	0.8	1.2	2.5	6.2	17	11	4.1	2.0
✓ THOMPSON	1.4	1.6	1.9	2.2	2.7	5.9	17	19	7.0	3.2	1.6
? FRAZER (Beaver Blw. S.F.)	0.8 (8.0)	0.8 (7.5)	0.8 (6.6)	0.8 (6.6)	1.2 (6.9)	2.3 (7.9)	5.8 (17.2)	16 (81.7)	11 (69.5)	3.9 (20.7)	2.0 (9.4)
✓ BEAVER	10.7	10.7	10.4	10.9	12.3	19.8	51.8	120	83.5	27.2	12.6
✓ ALDER	0.2	0.3	0.3	0.4	0.4	1.0	2.9	3.2	1.2	0.5	0.3
✓ BENSON	0.6	.8	.9	1.0	1.3	2.9	8.3	9.1	3.4	1.6	0.8
✓ TEXAS	0.2	.2	.2	.2	.3	0.7	1.9	2.1	0.8	0.4	.2
✓ LIBBY	3.0	3.0	3.0	3.0	4.4	8.9	22	62	41	15	7.4
✓ COW	0.1	0.1	0.1	0.2	0.2	0.4	1.3	1.4	0.5	0.2	0.1
✓ GOLD	6.5	6.5	6.5	6.5	6.5	9.8	22.9	131	121	46	20
✓ MCFARLAND	0.2	0.3	0.4	0.4	0.5	1.1	3.2	3.5	1.3	0.6	0.3
✓ SQUAW	0.3	0.4	.4	.5	.6	1.3	3.8	4.2	1.6	.7	0.4
✓ BLACK CANYON	.4	.5	.6	.7	.9	2.0	5.8	6.3	2.3	1.1	.5

DESCRIPTION OF THE BASIN



3.
 FIGURE *AZ*. Areal distribution of average annual precipitation in the Methow River basin. Data from U.S. Weather Bureau (1965).

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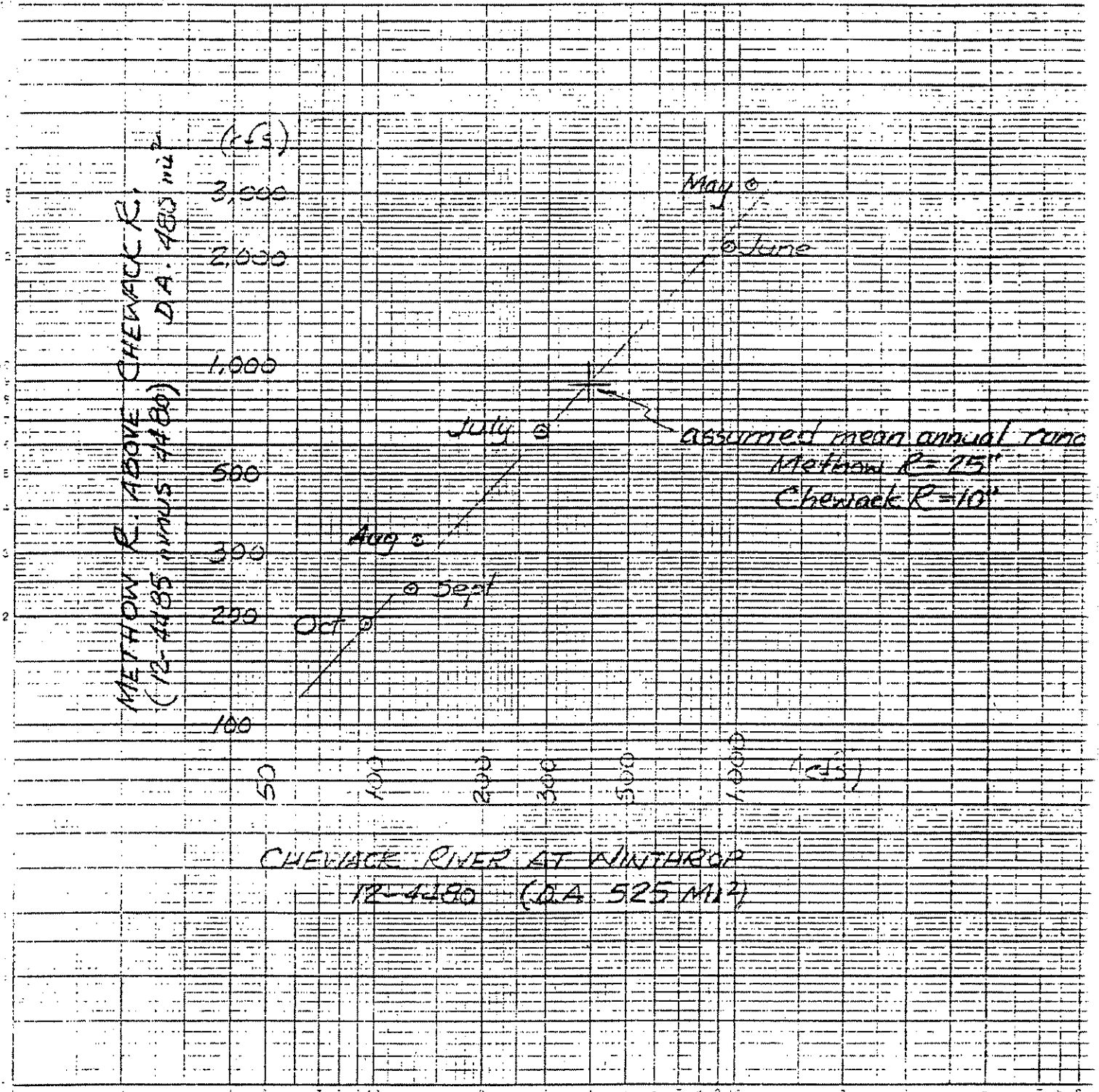


FIG. 4 - REGRESSION OF METHOW AND CHEWACK R. MONTHLY FLOWS, 1912.

Streamflow records were collected at Winthrop for only a few months in 1912-13. A regression of concurrent monthly mean flows from May to October 1912 (Figure 4) is a fair check on the estimated mean annual runoff of about 25 inches for the Methow and 10 inches for the Chewack. Another check is provided by the 1920-21 record of Chewack River "below Boulder Creek," a few miles upstream from Winthrop and above major diversions.

The 1921 water year was a period of higher-than-average runoff at Twisp, however, so the Chewack record for that year needs to be adjusted to a long-term mean. Adjusting each month by comparison with concurrent records at Twisp, long-term average flows of the Chewack are estimated as follows:

MONTHLY DISCHARGE OF CHEWACK RIVER IN CFS -

	O	N	D	J	F	M	A	M	J	J	A	S	YEAR
Below Boulder Creek	118	123	106	60	50	69	247	1620	1530	338	102	64	370
At Winthrop	123	129	111	63	52	72	258	1690	1600	354	107	67	387

For the Methow River above the Chewack, long-term monthly means are estimated on basis of the 1912 record at Winthrop, adjusted by comparison with records at Pateros and by subtracting the estimated Chewack flows. Estimated long-term average flows of the Methow are as follows:

MONTHLY DISCHARGE OF METHOW RIVER IN CFS

	O	N	D	J	F	M	A	M	J	J	A	S	YEAR
Below Winthrop	361	424	365	272	251	328	1397	4570	4537	1344	483	308	1208
Above Winthrop	238	295	254	209	199	256	1139	2880	2757	990	376	241	821

The estimate of 821 cfs for mean annual discharge is equivalent to 23 inches of annual runoff, slightly less than our first estimate of 25 inches.

Possibly the difference resulted from irrigation diversion and/or subsurface flow bypassing the gaging station near Winthrop in 1912, but further adjustment of the above "natural" flows are not warranted, considering the paucity of available data.