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FLOODS IN WESTERN WASHINGTON

FREQUENCY AND MAGNITUDE IN RELATION TO DRAINAGE BASIN CHARACTERISTICS

By G. L. Bodhaine and W. H. Robinson

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ABSTRACT

This report presents a method of determining the magnitude and frequency of expected floods applicable for any area in western Washington (fig. 1). A composite frequency curve was developed that expresses the relation to mean annual floods of floods having recurrence intervals from 1.03 to 50 yr. This composite frequency curve was based on the combined frequency curves for all gaging stations in the region with 5 or more years of record. Records for 131 stations, with drainage areas ranging from 1 to 2,700 sq mi, and recorded flood peaks ranging from 30 to 210,000 cfs were combined to obtain the composite curve. An equation was derived expressing the relationship between mean annual floods and basin characteristics. Those basin characteristics that may easily be determined from topographic maps and that significantly affect the peak discharge were compiled for all streams in the region on which 5 or more years of stream-flow records are available. These basin characteristics were correlated with mean annual flood of the streams, and as a result of this correlation a formula for the computation of the mean annual flood for any basin was derived. The limitations of the formula and its probable accuracy are discussed in the report.

Included in the report are curves of magnitude and frequency of floods at all gaging stations in the region with 15 or more years of record. Also included is an enveloping curve of the maximum recorded discharges in the region.

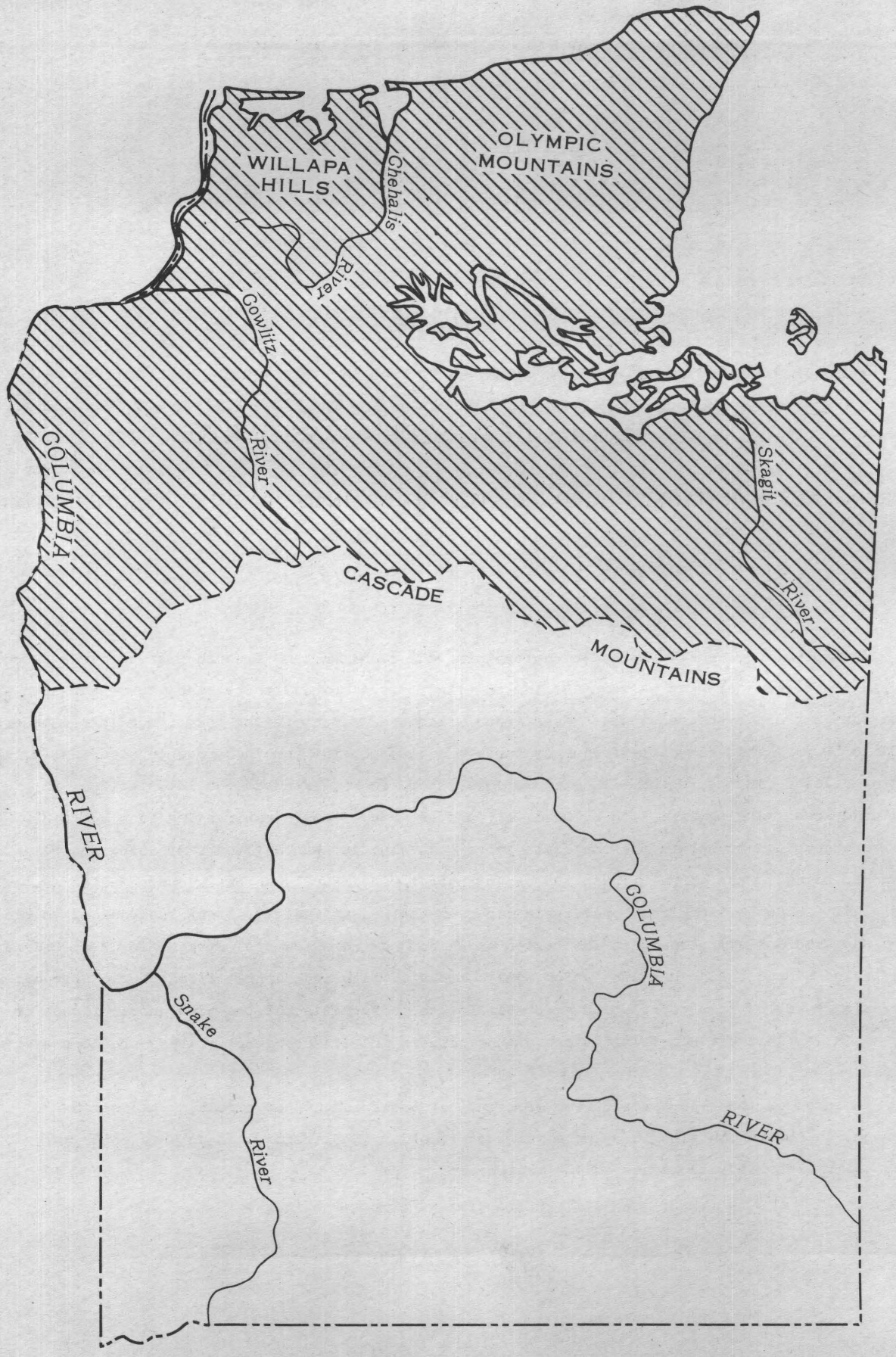

Figure 1.--Map showing western Washington.

INTRODUCTION

Purpose and scope

The objective of this report is to relate physical characteristics of a drainage basin to the frequency and magnitude of past floods and to develop methods of applying these data to any basin in an area for the determination of the flood expectancy.

The determination of the magnitude and frequency of future floods always has been a major problem of the engineering profession and has been the subject of intensive study. Interest in floods is being renewed constantly because so many valuable structures are on or near streams and therefore subject to flood damage. Where loss of life may be involved if the structure is overtopped or destroyed, the design flood perhaps should be of such magnitude that it probably will not be exceeded. However, in most places it will prove more economical to design the structure for a flood that may be expected to occur on the average of once in 10, 20, 50, or some other period of years, and to balance the expected damage against the additional cost of the structure if designed to prevent such damage. It should be noted that the recurrence interval of a flood does not imply any regularity of such occurrence. It represents the average period in which a flood of such magnitude would recur over a long period of years. Two 50-yr floods could occur in consecutive years.

Using the available stream-flow data, the technique was first developed of determining the magnitude and frequency of expected floods at the point of collection of the data, that is, at the gaging stations. This technique is very seldom applied directly, because, in the first place, structures subject to flood damage are seldom located at gaging stations. The continuing program of stream gaging could not possibly be sufficiently comprehensive to include records at all possible points where information on the magnitude and frequency of floods might be desired, or to have the record at each point of sufficient length so that the magnitude and frequency at the point could be based on those records alone. This is especially true of drainage areas of less than 50 sq mi for which records now available are most inadequate for such a procedure. Great care also must be exercised in the use of any single record because of the many variable factors such as drought and excessive precipitation, which may cause the records to be unrepresentative of the average. Therefore, it is important to develop a method by which the records of flood frequency at the gaging stations can be "consolidated" and made applicable to any point.

Many formulas have been developed as a means of determining the magnitude of expected floods in ungaged areas. Such formulas in the past have been largely empirical and have been applied over an area and a range that greatly exceed those of their derivation.

The flood formulas of Kinnison and Colby (1945)[1] are perhaps the first to correlate the physical characteristics of a basin to the magnitude and frequency of past floods and to present these data in such a manner that they are applicable for any basin within the area of derivation. The authors have carefully limited the area of application of their formulas to the area for which the formulas were derived (drainage basins in and adjacent to the State of Massachusetts)

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[1] See page 124 for list of references cited.

and also have limited the range of application to the range of physical characteristics used in their derivation. Their time base, however, was very much extended.

Many of the principles set forth by other authors were considered in this report of floods in western Washington. Every effort has been made to use known basin characteristics and to determine their effect on flood peaks. All stream-flow records in the region have been carefully reviewed and used in the study. The results of this report have been consolidated and presented in such a manner that the procedure can be readily followed, and it is believed that reliable results can be obtained without an undue amount of detailed effort.

This report was derived from stream-flow and drainage-basin data for all that part of the State of Washington lying west of the divide of the Cascade Range and, in addition, the White Salmon River and Klickitat River basins, which are technically east of the Cascade Range but are more homogeneous with western Washington. A total area of about 26,000 sq mi is included.

Acknowledgments

This report has been prepared under the direction of F. M. Veatch, district engineer, Tacoma district, Surface Water Branch, Water Resources Division, U. S. Geological Survey. Financial cooperation was furnished by the Washington State Highway Department, W. A. Bugge, director, George Stevens, bridge engineer. The procedures used were outlined by the office of the Geological Survey at Washington, D. C. Technical guidance on analytical procedure was furnished by Tate Dalrymple, hydraulic engineer, U. S. Geological Survey, Washington, D. C. Acknowledgment is made for the helpful advice and criticism of C. C. McDonald, staff engineer, Technical Coordination Branch, U. S. Geological Survey, Tacoma, Washington.

PHYSICAL FEATURES OF THE AREA

Gaging-station records show the integrated result of the effect of all physical features of a drainage basin on the magnitude of a flood. The two broad classifications of physical features influencing floods are topography and climate.

Topographical features

Mountain ranges are the dominating topographical features of the region and, through their influence on the climatic elements, profoundly affect the runoff of the area.

The Cascade Range, extending north and south across the State, is a formidable barrier to the prevailing westerly winds and forms a natural line of division across the State. Its altitude ranges from 6,000 to 8,000 ft. Many extinct volcanoes protrude from the western slope into the zone of perpetual snow, the highest of which is Mt. Rainier (altitude 14,408 ft).

Two other smaller ranges complicate the topography of the region. The Olympic Mountains, extending from the Chehalis River north up the Olympic Peninsula to the Strait of Juan de Fuca, is comparable to the Cascade Range in its higher peaks. The other range is the Willapa Hills,

which lies in the southwestern part of the State just northeast of the mouth of the Columbia River. The maximum altitudes of this range are much lower than those of the Cascade Range or of the Olympic Mountains. The higher peaks have an altitude of about 2,000 ft.

Puget Sound and the adjacent lowland lying between the Olympic Mountains and Cascade Range separate these two ranges with a trough about 50 miles wide that is at or near sea level. The Chehalis River basin and lower Cowlitz River basin form a comparable low-elevation area between the Willapa Hills and the Cascade Range.

The rivers in the region have, in general, relatively steep slopes and flow from the mountain ranges directly into the Pacific Ocean or Puget Sound. The principle exceptions to this are the Chehalis and Cowlitz Rivers in the south and the Skagit River in the north, which have comparatively large flood plains in their lower reaches. This characteristic of short length and steep gradient of the streams results in comparatively short time of concentration of the flood waters.

Climatological features

Western Washington is subject to the moderating effects of prevailing winds from the Pacific Ocean. The Cascades on the east and the mountains of British Columbia on the north act as barriers that protect the region from the climatic extremes characteristice of the interior.

The principle source of precipitation in the region is the water vapor from the Pacific Ocean carried inland by prevailing southwesterly and westerly winds. Moisture-laden air enters the interior either through gaps occupied by the Columbia and Chehalis Rivers and the Strait of Juan de Fuca or over the Olympic Mountains and Willapa Hills. As this air is forced upwards over the mountains, it is cooled by adiabatic expansion (without loss or gain of heat) and produces precipitation in an irregular belt along the Pacific Coast. After passing over the mountains to the lower levels of Puget Sound or the basins of the Chehalis and Cowlitz Rivers, these air masses are warmed by compression and higher land temperatures at those levels. Hence the tendency is for them to yield only a relatively small amount of precipitation at these lower altitudes. The process of expanding and cooling is repeated as the air mass ascends to cross the Cascade Range.

The combined effect of topography and prevailing winds results in a wide variation of precipitation. For example, the upper Wynoochee River basin with a mean annual runoff of 160 in. (actual precipitation not known) is believed to be the wettest drainage basin in continental United States, while 50 miles northeast of the Wynoochee River basin, across the Olympic Mountains at Sequim, the mean annual precipitation is less than 20 in.

The heavy winter precipitation in the mountainous areas occurs as rain at the lower altitudes and as snow in the higher ones. Snow packs as deep as 22½ ft with an equivalent water content of 11½ ft have been measured in the Cascade Range. The deep snow pack and heavy winter precipitation have a decided effect on flood-runoff characteristics.

The generally mild and humid climate has a substantial effect on the types and rate of growth of vegetation. The forest cover is very heavy, especially on the western slopes. The

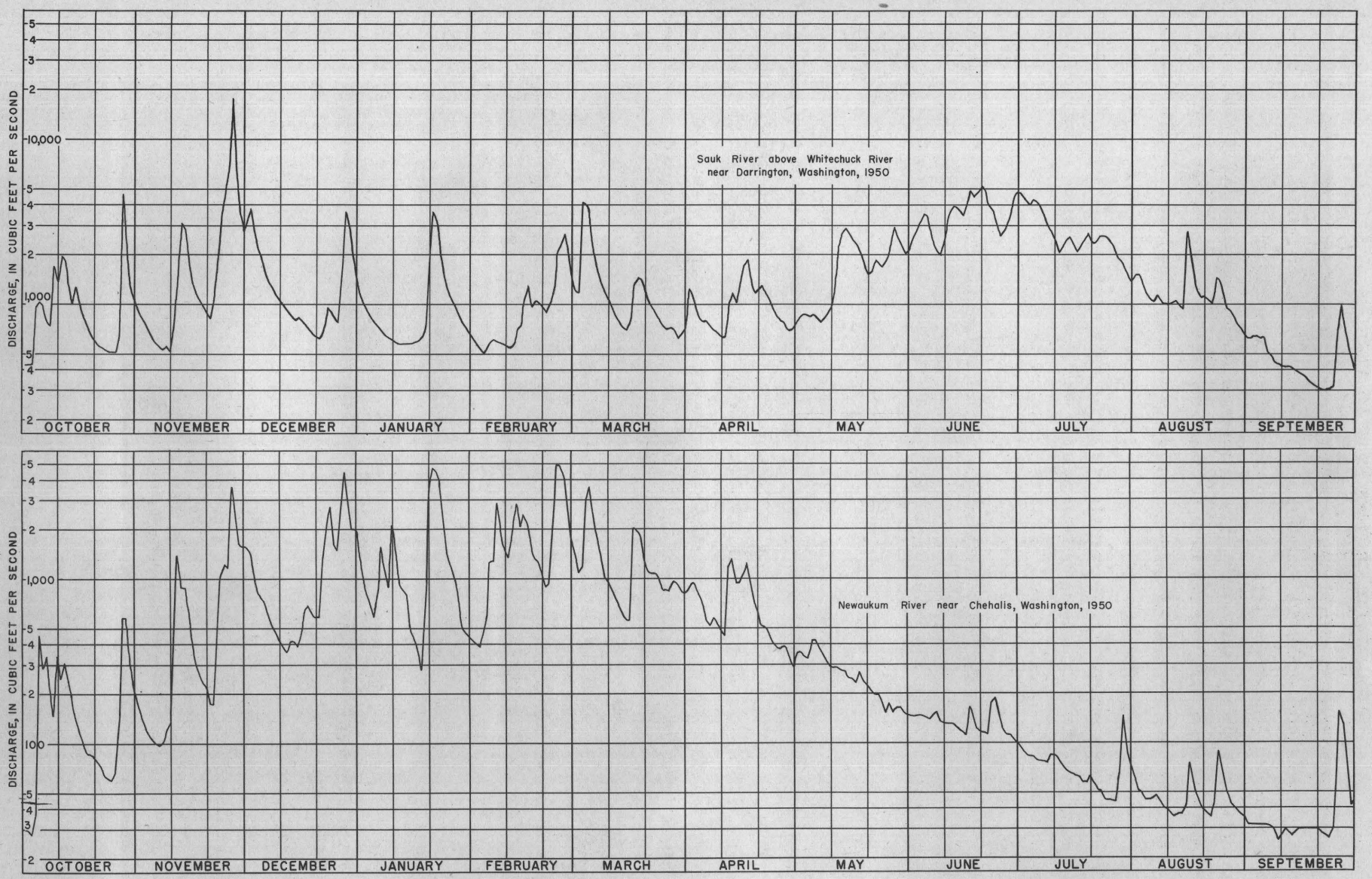

Figure 2.--Graph of mean daily discharge for Sauk River above Whitechuck River near Darrington and for Newaukum River near Chehalis, 1950.

generally dense vegetal cover undoubtedly affects the flood characteristics of the region.

CHARACTERISTICS OF FLOOD RUNOFF

Streams rising in the mountainous areas are characterized by two high-water periods each year: the first period, October through March, is referred to as the winter high-water period; and the second, April through June, is referred to as the spring high-water period. An example of such a stream is Sauk River above Whitechuck River near Darrington, Wash. (fig. 2).

Winter peaks occur during the period when precipitation is heavy. They are usually caused by warm southwest storms with rainfall making up the bulk of the flood water--sometimes augmented by snow melt, especially if the snow mantle extends to a low elevation at the beginning of the storm. These floods are characterized by peaks of relatively high magnitude and short duration. Almost without exception, the destructive floods in this region are floods of this type.

Spring peaks occur when the warmer temperatures begin melting the accumulated snow pack of the higher altitudes. Flood waters are largely snow melt, sometimes augmented by spring rains. The hydrographs of this period are characterized by rounded peaks of long duration.

Streams rising at lower altitudes have only one high-water period, October through March. The peaks of these streams are similar in cause and characteristics to the winter peaks described previously. Little or no winter accumulation of snow is present in the spring to cause an appreciable spring high-water period. However, some temporary storage in the form of snow sometimes adds to the magnitude of the winter peaks. The 1950 hydrograph for Newaukum River near Chehalis, Wash., (fig. 2) illustrates a stream of this type.

METHODS OF ANALYSIS

The method of computing flood frequency presented in this report reflects the latest developments based on a continuing study by engineers of the Water Resources Division of the Geological Survey and others. These analyses serve two purposes: first, the computation of flood frequency at gaging stations; and second, the transferring of these point data to other places or adapting them to apply over the region.

Frequency at gaging station

Many techniques have been developed for the determination of the frequency of expected floods at gaging stations from the past experience of recorded floods at the stations. These techniques have been discussed in length by Jarvis (1936), Cross (1946), Rantz and Riggs (1949), and others. No further discussion in this report is believed necessary except to indicate the method of analysis used in this study.

Method of analysis.--The flood data in this report are analyzed by the annual-flood method in preference to the partial-duration series method. In the annual-flood series the recurrence interval is the average interval in which a flood of a given size, or greater, will recur as an

annual maximum. In the partial-duration series, the recurrence interval is the average interval between floods of a given size, regardless of their relationship to the year or any other period of time. One similarity between the two, however, is the fact that for large floods the recurrence intervals are practically the same on both scales. The two methods give essentially the same results for intervals greater than 10 yr. As most designs are for intervals greater than 10 yr, it was concluded that either method is satisfactory. The annual-flood method has been used in this report because of its relative simplicity.

Basic data.--All stream-flow records in the region with 5 or more years of length have been used as the basic data for this report. The locations of the gaging stations used are shown in figure 3. A bar diagram (fig. 4) shows in a concise pictorial manner the length of record of the stations used. Records of all peak discharges were carefully reviewed for possible need of revision resulting from later information and improved techniques that became available before the data was tabulated.

A common period, 1912 to 1951, was used for all stations in order to place the records on a comparable basis as to time. Recurrence intervals were assigned to individual floods on basis of this period. Index stations, for which records extend through the base periods, were used as a basis for computing the order of magnitude of peaks for stations with shorter records.

Overlapping records for comparable gaging stations on the same stream were combined to form one record of greater length. When two stations on the same stream had less than 25 percent difference in drainage area they usually were combined, because they were not considered to be independent samples.

Tabulations of all annual peaks used in this study along with frequency curves adjusted to the base period for all stations with 15 or more years of record are listed under gaging-station records. These are the supporting data on which the analyses are based.

Regional distribution

A frequency graph based on the combined flood experience at several stations has much firmer support than one developed for a single station. A composite flood-frequency curve was drawn combining the flood-frequency data for all of the stations in the region. The floods used in developing this curve are expressed in terms of ratio of each individual flood to the mean annual flood, placing the curve on a dimensionless basis and applicable anywhere in the region, both for ungaged areas and as an aid in interpreting flood data for streams with a short period of record.

Regional sampling.--There are two aspects of sampling for an analysis of flood frequency in a region, time sampling and areal sampling. Time sampling requires a record of the floods at a few stations over a long period of time. Areal sampling requires a large number of stations to sample widely diverse terrain, and the length of record is not so important. To combine the records of all the stations, it was necessary to place all the floods on a comparable basis both as to time and as to the physical characteristics of the basins. It has been explained previously how all records were placed on a comparable time basis. There remains a need for expressing the

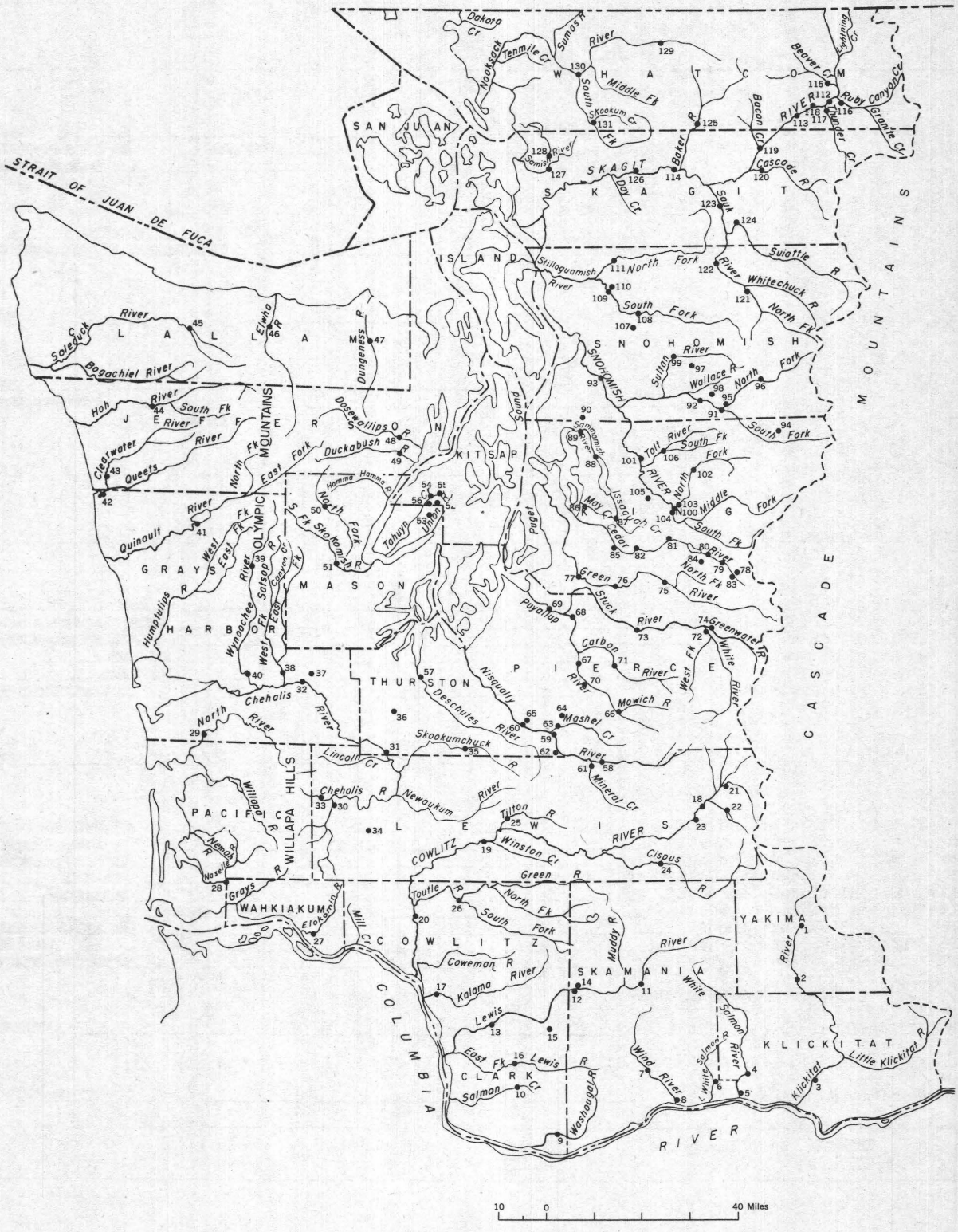

Figure 3.--Location of gaging stations in western Washington.

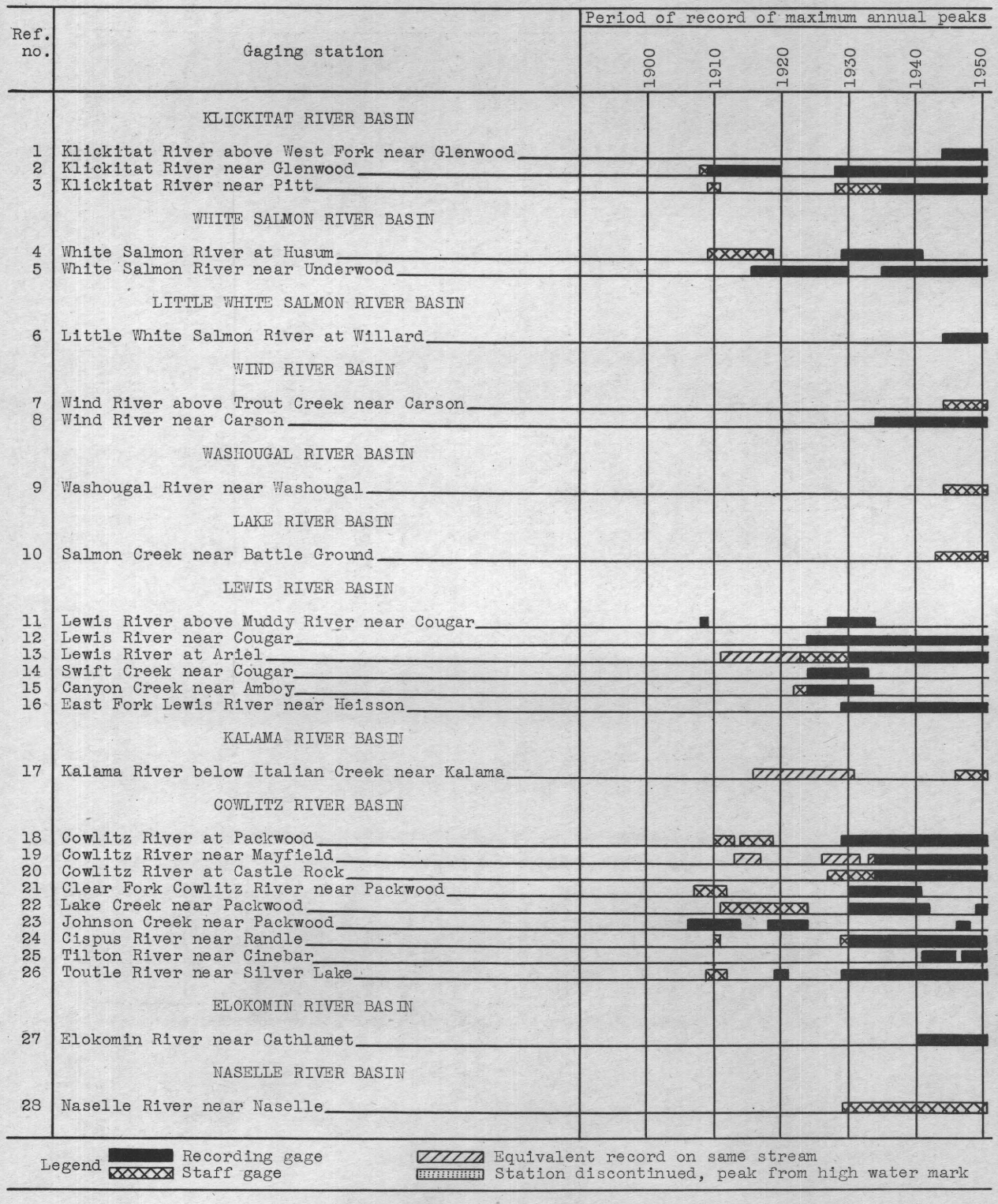

Figure 4.--Period of record of maximum annual peaks at gaging stations

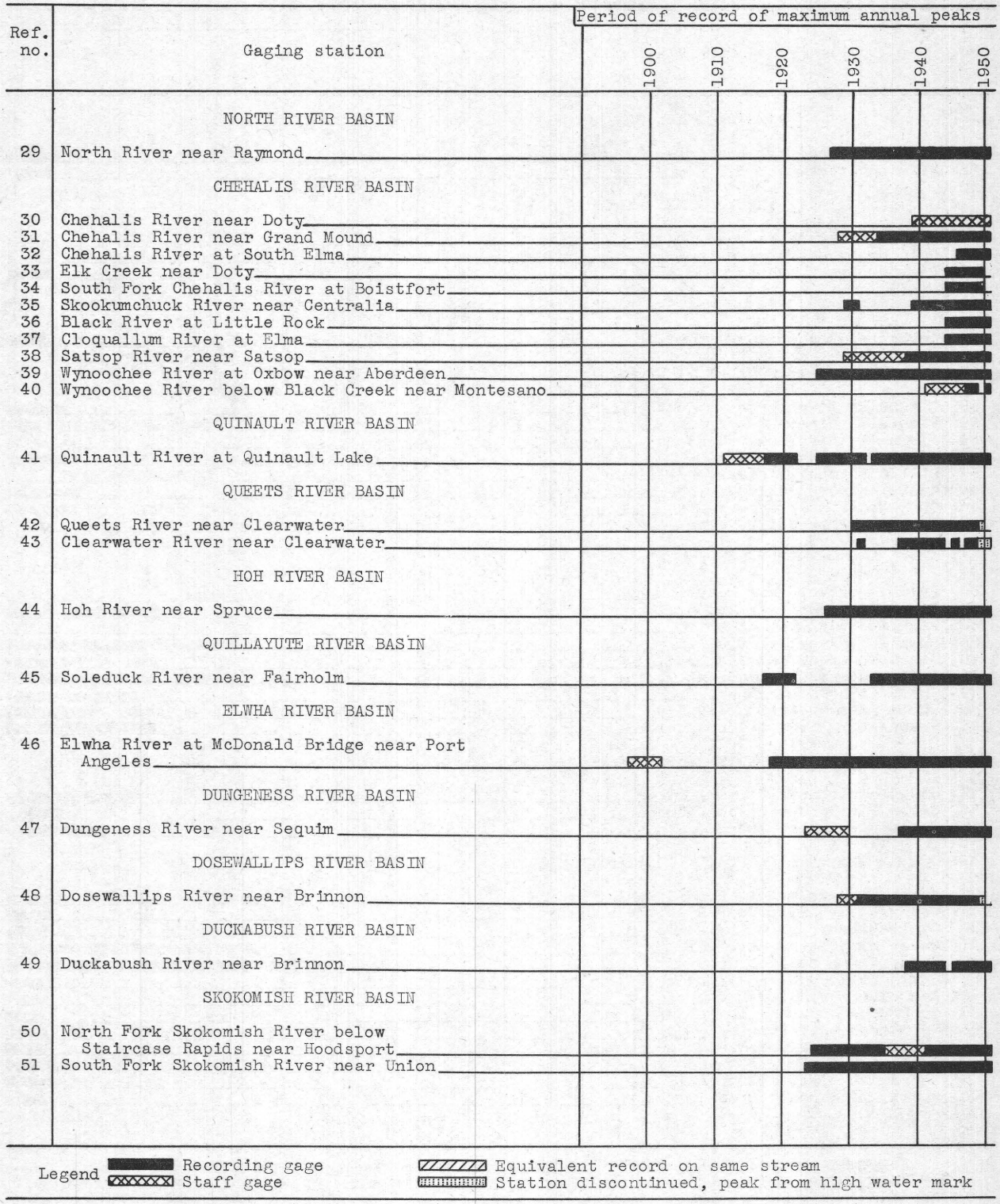

Figure 4.--Period of record of maximum annual peaks at gaging stations--Continued

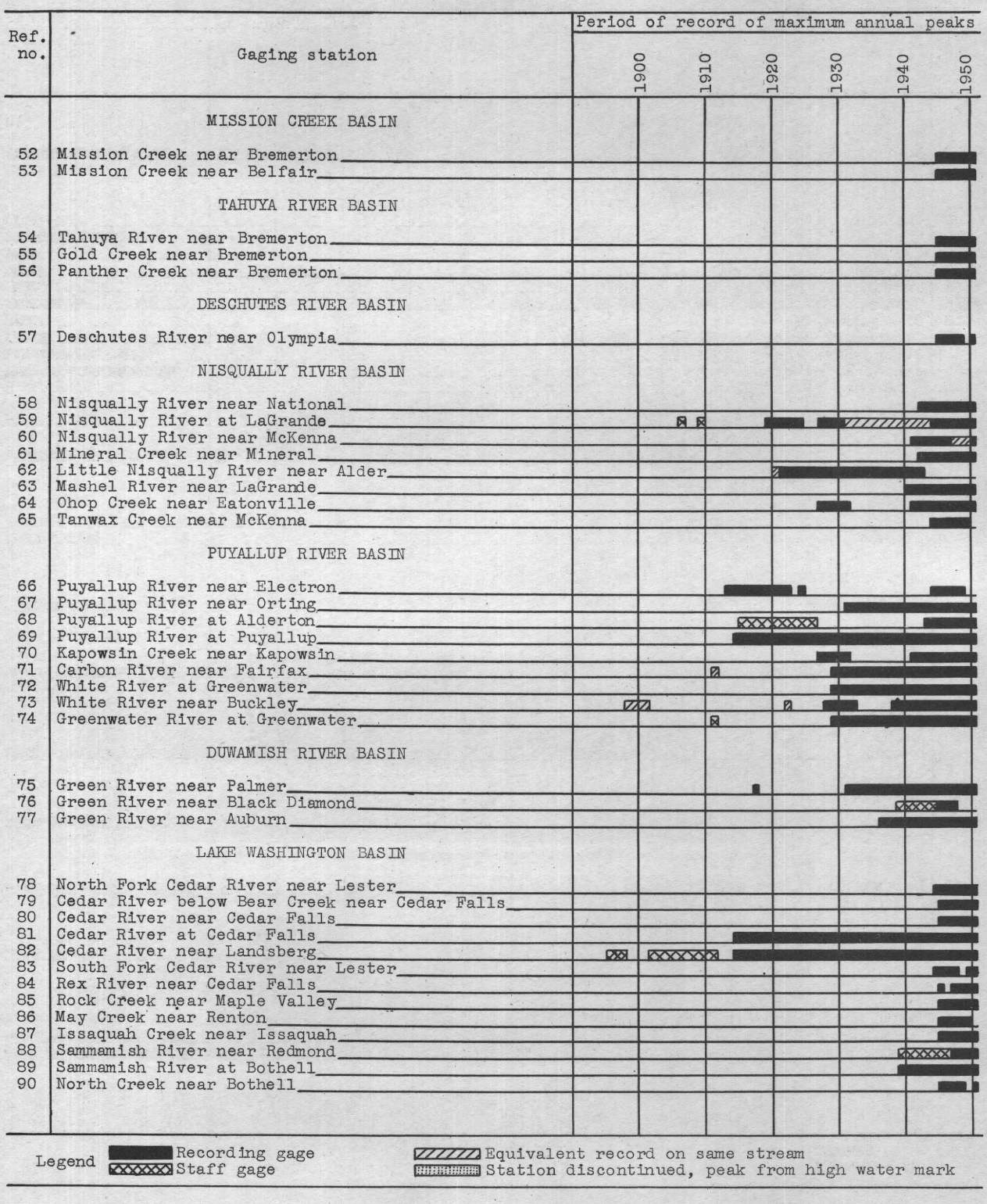

Figure 4.--Period of record of maximum annual peaks at gaging stations--Continued

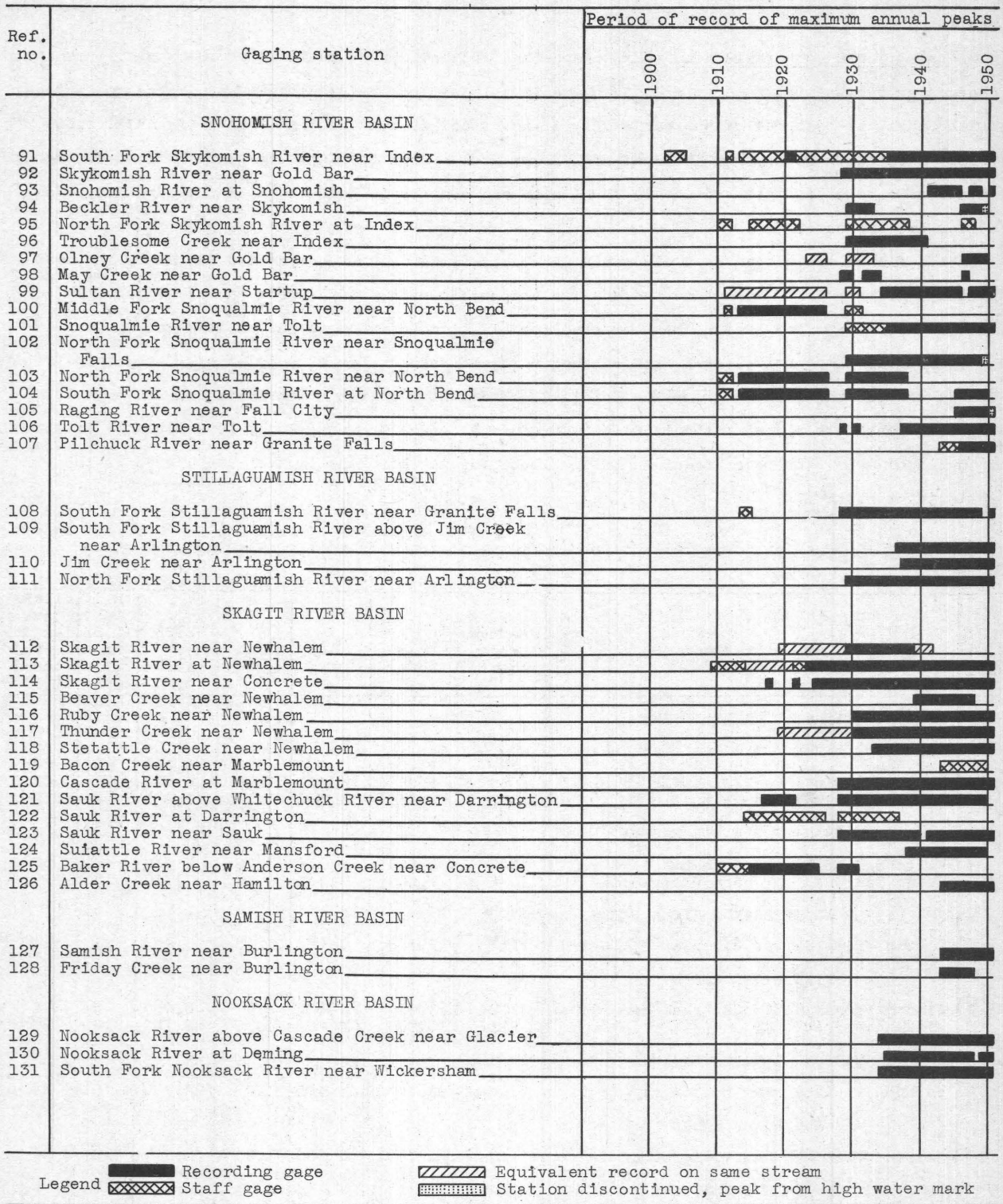

Figure 4.--Period of record of maximum annual peaks at gaging stations--Continued

effect of the physical characteristics of the basins, thus placing all floods on a comparable basis.

Selecting a comparable mean.--Experience has indicated that the mean of the annual peak discharges is representative of the flood characteristics of a drainage basin and therefore an index of the physical features of the basin that affect flood flow. The graphical mean annual flood, $Q_{2.33}$--flood with recurrence interval of 2.33 yr--taken from the adjusted station flood-frequency curves is easily obtained and should furnish a good comparable mean since the base period of all curves are the same.

All floods are placed on a dimensionless basis by dividing the recorded floods by the mean annual flood for that stream and thereby are comparable with other floods in the region. This ratio, called the flood ratio, was computed for all floods listed in the basic data.

Test for homogeneity.--A test for homogeneity of records for a group of stations is desirable before the records for the group are combined. The test involves a determination as to whether the differences in slope of the individual frequency curves are no greater than might be expected from random errors or vagaries of sampling. Data for the homogeneity test are listed in the following table.

Data for homogeneity test for gaging stations in western Washington

No.	Gaging station	Drainage area (sq mi)	$Q_{2.33}$ (cfs)	Q_{10} (cfs)	$\frac{Q_{10}}{Q_{2.33}}$	$Q_{2.33}$ x ratio (cfs)	R.I. for $Q_{2.33}$ x ratio (yr)	Effective length of record (yr)
	KLICKITAT RIVER BASIN							
1	Klickitat River above West Fork near Glenwood	151	1,800	3,070	1.70	2,990	9	24
2	Klickitat River near Glenwood	360	3,050	4,550	1.49	5,060	17	36
3	Klickitat River near Pitt	1,170	8,330	14,500	1.74	13,800	9	32
	WHITE SALMON RIVER BASIN							
4	White Salmon River at Husum	300	3,500	6,110	1.75	5,810	9	30
5	White Salmon River near Underwood	384	4,660	7,340	1.57	7,740	13	36
	LITTLE WHITE SALMON RIVER BASIN							
6	Little White Salmon River at Willard	117	2,380	3,460	1.45	3,950	21	24
	WIND RIVER BASIN							
7	Wind River above Trout Creek near Carson	108	3,900	7,800	2.00	6,480	6	24
8	Wind River near Carson	225	10,900	16,400	1.50	18,100	16	28
	WASHOUGAL RIVER BASIN							
9	Washougal River near Washougal	108	13,700	24,400	1.78	22,700	8	24
	LAKE RIVER BASIN							
10	Salmon Creek near Battle Ground	18.3	792	1,250	1.58	1,310	12	24
	LEWIS RIVER BASIN							
11	Lewis River above Muddy River near Cougar	227	11,800	19,900	1.69	19,600	10	24
12	Lewis River near Cougar	481	20,100	32,900	1.64	33,400	11	24
13	Lewis River at Ariel	731	39,200	61,500	1.57	65,100	13	40
14	Swift Creek near Cougar	26	1,520	2,500	1.64	2,520	10	24
15	Canyon Creek near Amboy	62	5,800	8,850	1.53	9,630	15	26
16	East Fork Lewis River near Heisson	125	9,100	12,200	1.34	15,100	44	31

Data for homogeneity test for gaging stations in western Washington--Continued

No.	Gaging station	Drainage area (sq mi)	$Q_{2.33}$ (cfs)	Q_{10} (cfs)	$\frac{Q_{10}}{Q_{2.33}}$	$Q_{2.33}$ x ratio (cfs)	R.I. for $Q_{2.33}$ x ratio (yr)	Effective length of record (yr)
	KALAMA RIVER BASIN							
17	Kalama River below Italian Creek near Kalama	201	10,000	14,900	1.49	16,600	18	30
	COWLITZ RIVER BASIN							
18	Cowlitz River at Packwood	287	14,300	22,200	1.55	23,700	14	34
19	Cowlitz River near Mayfield	1,400	30,500	44,300	1.45	50,600	21	34
20	Cowlitz River at Castle Rock	2,240	50,500	71,000	1.41	83,800	27	32
21	Clear Fork Cowlitz River near Packwood	56	2,420	4,150	1.71	4,020	9	26
22	Lake Creek near Packwood	18.8	460	760	1.65	764	10	34
23	Johnson Creek near Packwood	50	1,800	4,080	2.27	2,990	5	24
24	Cispus River near Randle	323	7,000	11,400	1.63	11,600	11	31
25	Tilton River near Cinebar	158	7,850	10,600	1.35	13,000	39	24
26	Toutle River near Silver Lake	474	15,700	22,000	1.40	26,100	30	32
	ELOKOMIN RIVER BASIN							
27	Elokomin River near Cathlamet	66	3,740	5,580	1.49	6,210	17	26
	NASELLE RIVER BASIN							
28	Naselle River near Naselle	55	5,220	7,340	1.41	8,660	27	31
	NORTH RIVER BASIN							
29	North River near Raymond	219	8,400	13,700	1.56	13,900	11	32
	CHEHALIS RIVER BASIN							
30	Chehalis River near Doty	113	9,150	16,100	1.76	15,200	8	26
31	Chehalis River near Grand Mound	897	24,500	37,800	1.54	40,700	14	32
32	Chehalis River at South Elma	1,420	28,600	41,500	1.45	47,500	21	22
33	Elk Creek near Doty	46.7	1,500	2,620	1.75	2,490	8	23
34	South Fork Chehalis River at Boistfort	49.2	2,400	4,710	1.96	3,980	6	23
35	Skookumchuck River near Centralia	60	3,670	5,850	1.59	6,090	12	26
36	Black River at Little Rock	64	895	1,370	1.53	1,490	15	23
37	Cloquallum River at Elma	66	2,600	3,710	1.43	4,320	24	24
38	Satsop River near Satsop	315	21,400	32,700	1.53	35,500	15	31
39	Wynoochee River at Oxbow near Aberdeen	65	10,900	15,100	1.39	18,100	31	33
40	Wynoochee River below Black Creek near Montesano	179	15,200	21,000	1.38	25,200	32	24
	QUINAULT RIVER BASIN							
41	Quinault River at Quinault Lake	264	21,600	33,600	1.56	35,800	13	38
	QUEETS RIVER BASIN							
42	Queets River near Clearwater	454	54,700	78,600	1.44	90,800	22	30
43	Clearwater River near Clearwater	140	16,300	24,700	1.52	27,000	15	26
	HOH RIVER BASIN							
44	Hoh River near Spruce	193	19,100	29,900	1.57	31,700	13	32
	QUILLAYUTE RIVER BASIN							
45	Soleduck River near Fairholm	84	8,650	13,600	1.57	14,400	12	34
	ELWHA RIVER BASIN							
46	Elwha River at McDonald Bridge near Port Angeles	262	12,400	21,700	1.75	20,600	8	36
	DUNGENESS RIVER BASIN							
47	Dungeness River near Sequim	156	2,880	5,320	1.85	4,780	7	30

Data for homogeneity test for gaging stations in western Washington--Continued

No.	Gaging station	Drainage area (sq mi)	$Q_{2.33}$ (cfs)	Q_{10} (cfs)	$\frac{Q_{10}}{Q_{2.33}}$	$Q_{2.33}$ x ratio (cfs)	R.I. for $Q_{2.33}$ x ratio (yr)	Effective length of record (yr)
	DOSEWALLIPS RIVER BASIN							
48	Dosewallips River near Brinnon	94	4,100	7,400	1.80	6,810	8	36
	DUCKABUSH RIVER BASIN							
49	Duckabush River near Brinnon	66	4,870	6,890	1.42	8,080	26	26
	SKOKOMISH RIVER BASIN							
50	North Fork Skokomish River below Staircase Rapids near Hoodsport	60	7,000	12,400	1.77	11,600	8	34
51	South Fork Skokomish River near Union	81	10,600	18,000	1.70	17,600	9	34
	MISSION CREEK BASIN							
52	Mission Creek near Bremerton	1.9	51	80	1.57	85	14	23
53	Mission Creek near Belfair	4.4	145	251	1.73	241	9	23
	TAHUYA RIVER BASIN							
54	Tahuya River near Bremerton	6.1	285	422	1.48	473	18	23
55	Gold Creek near Bremerton	1.5	105	146	1.39	174	30	23
56	Panther Creek near Bremerton	1.0	65	134	2.06	108	6	23
	DESCHUTES RIVER BASIN							
57	Deschutes River near Olympia	164	3,180	5,270	1.66	5,280	10	22
	NISQUALLY RIVER BASIN							
58	Nisqually River near National	133	6,080	10,700	1.76	10,100	8	24
59	Nisqually River at LaGrande	296	11,300	18,000	1.59	18,800	12	34
60	Nisqually River near McKenna	445	15,200	26,200	1.72	25,200	9	25
61	Mineral Creek near Mineral	75	4,440	7,200	1.62	7,370	11	24
62	Little Nisqually River near Alder	27.2	1,780	2,460	1.38	2,960	33	32
63	Mashel River near LaGrande	79	3,200	5,400	1.69	5,310	9	26
64	Ohop Creek near Eatonville	35	600	1,050	1.75	996	8	28
65	Tanwax Creek near McKenna	27.2	243	344	1.42	403	26	23
	PUYALLUP RIVER BASIN							
66	Puyallup River near Electron	93	4,000	7,350	1.84	6,640	7	28
67	Puyallup River near Orting	170	5,500	9,350	1.70	9,130	9	30
68	Puyallup River at Alderton	438	11,600	20,100	1.73	19,300	8	30
69	Puyallup River at Puyallup	948	22,400	37,300	1.66	37,200	10	38
70	Kapowsin Creek near Kapowsin	23	367	616	1.68	609	10	28
71	Carbon River near Fairfax	81	3,660	5,700	1.56	6,070	13	32
72	White River at Greenwater	216	3,950	7,200	1.82	6,560	7	36
73	White River near Buckley	403	9,750	17,000	1.74	16,200	8	30
74	Greenwater River at Greenwater	74	1,300	2,330	1.79	2,160	8	32
	DUWAMISH RIVER BASIN							
75	Green River near Palmer	231	11,000	17,800	1.62	18,300	11	30
76	Green River near Black Diamond	286	11,000	17,400	1.58	18,300	13	24
77	Green River near Auburn	386	11,600	18,400	1.59	19,300	13	28
	LAKE WASHINGTON BASIN							
78	North Fork Cedar River near Lester	8.8	870	1,360	1.56	1,440	13	24
79	Cedar River below Bear Creek near Cedar Falls	25.4	1,390	2,060	1.48	2,310	18	23
80	Cedar River near Cedar Falls	41.8	2,490	4,070	1.63	4,130	10	23
81	Cedar River at Cedar Falls	86	1,760	4,100	2.33	2,920	5	38
82	Cedar River near Landsberg	138	2,450	6,300	2.57	4,070	4	39
83	South Fork Cedar River near Lester	6.0	450	816	1.81	747	7	23
84	Rex River near Cedar Falls	13	835	1,460	1.75	1,390	8	23
85	Rock Creek near Maple Valley	12.6	116	225	1.94	193	6	23

Data for homogeneity test for gaging stations in western Washington--Continued

No.	Gaging station	Drainage area (sq mi)	$Q_{2.33}$ (cfs)	Q_{10} (cfs)	$\frac{Q_{10}}{Q_{2.33}}$	$Q_{2.33}$ x ratio (cfs)	R.I. for $Q_{2.33}$ x ratio (yr)	Effective length of record (yr)
	LAKE WASHINGTON BASIN--Continued							
86	May Creek near Renton	13	214	456	2.13	355	5	22
87	Issaquah Creek near Issaquah	26.2	525	830	1.58	871	13	23
88	Sammamish River near Redmond	140	780	1,300	1.67	1,290	10	26
89	Sammamish River at Bothell	199	995	1,540	1.55	1,650	14	26
90	North Creek near Bothell	18.7	244	484	1.98	398	6	22
	SNOHOMISH RIVER BASIN							
91	South Fork Skykomish River near Index	355	24,600	45,000	1.83	40,800	7	40
92	Skykomish River near Gold Bar	535	40,300	69,800	1.73	67,000	9	32
93	Snohomish River at Snohomish	1,700	61,000	104,000	1.71	101,000	9	24
94	Beckler River near Skykomish	95	6,050	10,400	1.72	10,000	9	24
95	North Fork Skykomish River at Index	149	11,100	17,500	1.58	18,400	12	30
96	Troublesome Creek near Index	10.4	940	1,480	1.58	1,560	12	26
97	Olney Creek near Gold Bar	7.9	1,190	1,850	1.55	1,980	14	26
98	May Creek near Gold Bar	4.3	240	408	1.70	398	9	23
99	Sultan River near Startup	75	14,500	24,700	1.70	24,100	9	36
100	Middle Fork Snoqualmie River near North Bend	173	12,500	19,700	1.58	20,700	13	28
101	Snoqualmie River near Tolt	605	30,100	49,500	1.64	50,000	11	31
102	North Fork Snoqualmie River near Snoqualmie Falls	65	5,780	8,270	1.43	9,600	24	30
103	North Fork Snoqualmie River near North Bend	105	7,200	11,300	1.57	12,000	13	32
104	South Fork Snoqualmie River at North Bend	83	4,840	8,140	1.68	8,030	9	32
105	Raging River near Fall City	31.2	1,740	2,550	1.47	2,890	19	23
106	Tolt River near Tolt	80	7,400	11,600	1.57	12,300	13	28
107	Pilchuck River near Granite Falls	53	4,080	7,400	1.81	6,770	7	24
	STILLAGUAMISH RIVER BASIN							
108	South Fork Stillaguamish River near Granite Falls	119	15,100	23,500	1.56	25,000	13	32
109	South Fork Stillaguamish River above Jim Creek near Arlington	199	21,900	35,500	1.62	36,400	11	32
110	Jim Creek near Arlington	48.9	2,610	4,260	1.63	4,330	11	27
111	North Fork Stillaguamish River near Arlington	269	18,800	29,000	1.54	31,200	14	32
	SKAGIT RIVER BASIN							
112	Skagit River near Newhalem	765	14,400	22,800	1.58	23,900	12	32
113	Skagit River at Newhalem	1,160	25,000	37,800	1.51	41,500	16	40
114	Skagit River near Concrete	2,700	87,000	142,000	1.63	144,000	10	34
115	Beaver Creek near Newhalem	63	2,850	4,400	1.54	4,730	14	24
116	Ruby Creek near Newhalem	203	4,730	6,600	1.39	7,860	30	30
117	Thunder Creek near Newhalem	98	4,580	7,350	1.60	7,600	12	36
118	Stetattle Creek near Newhalem	21.4	2,710	4,410	1.63	4,500	11	31
119	Bacon Creek near Marblemount	50	5,400	10,800	2.00	8,960	6	24
120	Cascade River at Marblemount	180	8,500	13,600	1.60	14,100	10	32
121	Sauk River above Whitechuck River near Darrington	152	10,200	19,400	1.90	16,900	7	34
122	Sauk River at Darrington	293	15,900	28,400	1.79	26,400	8	32
123	Sauk River near Sauk	714	32,100	65,000	2.02	53,300	6	31
124	Suiattle River near Mansford	335	14,300	25,500	1.78	23,700	8	28
125	Baker River below Anderson Creek near Concrete	184	17,500	31,200	1.78	29,000	8	28
126	Alder Creek near Hamilton	8.8	390	682	1.75	648	8	24
	SAMISH RIVER BASIN							
127	Samish River near Burlington	88	3,200	6,380	1.99	5,310	6	24
128	Friday Creek near Burlington	37.1	880	1,580	1.80	1,460	8	22
	NOOKSACK RIVER BASIN							
129	Nooksack River above Cascade Creek near Glacier	105	6,700	11,000	1.64	11,100	10	28
130	Nooksack River at Deming	580	30,000	53,200	1.77	49,800	8	28
131	South Fork Nooksack River near Wickersham	103	9,000	16,900	1.88	14,900	7	28

Note.--Arithmetic mean of all stations is 1.66

The test requires a study of the 10-yr flood as estimated at each station on the station frequency curve. These 10-yr floods expressed in ratio to mean annual floods are averaged to obtain the mean 10-yr ratio (Q_{10}) for the area. The recurrence interval (R.I.) corresponding to the mean annual flood times the average 10-yr ratio is determined for each station and plotted against the number of years of record on the test graph shown in figure 5. If the points for all the stations lie between the two curves, they are then considered homogeneous. Points outside the band indicate where the area should be further subdivided. This test was used before the records were combined to form a composite frequency curve. All points were found to plot within these bands except 12. Four of the 12 points plotted reasonably close to the upper limit, and when an investigation of the basic records of these stations showed no apparent cause for rejection, the stations were included in the analyses. The basic records of the other 11 stations were of short length, were affected by storage, or had poorly defined ratings; therefore the records for these stations were eliminated from the remainder of the analyses.

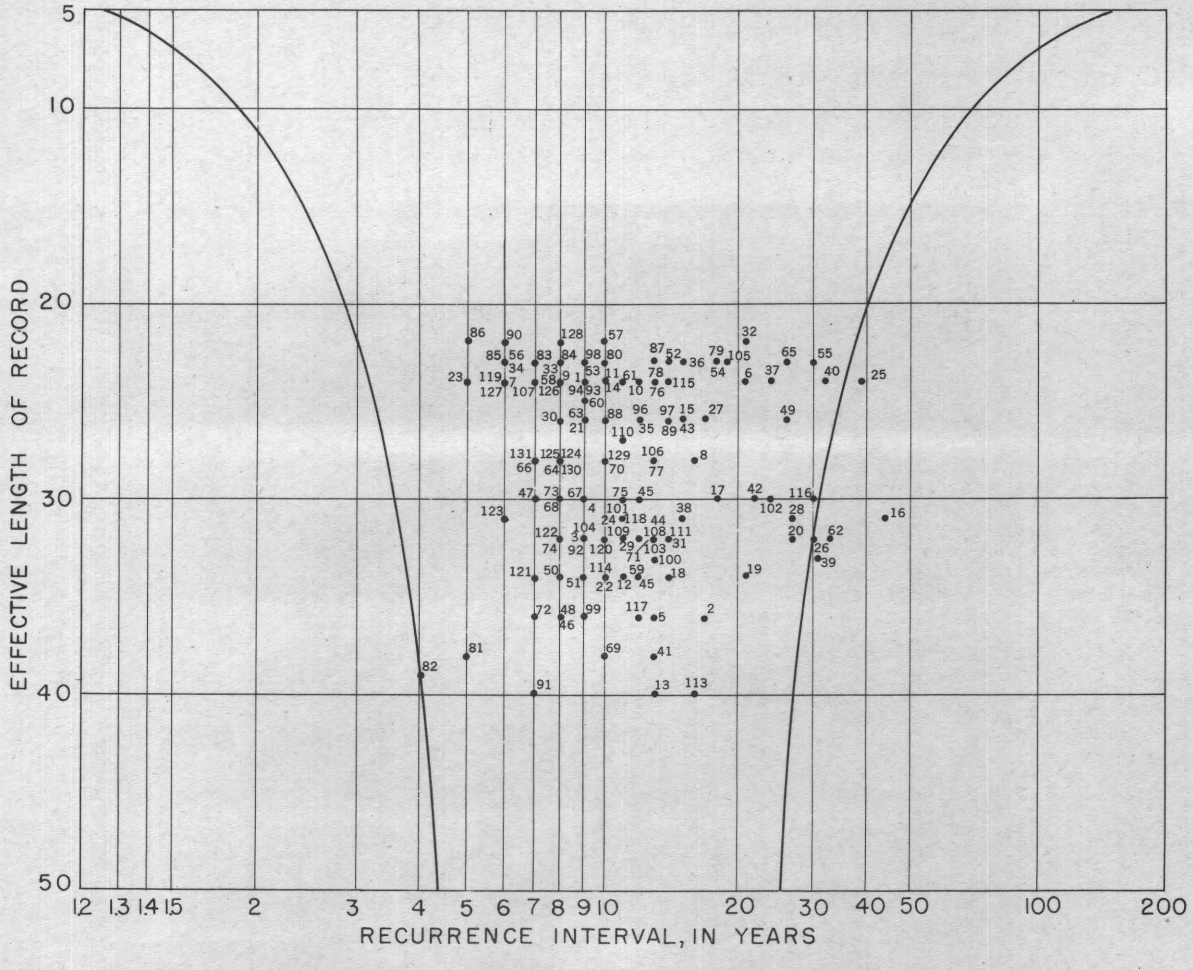

Figure 5.--Homogeneity test graph.

Composite frequency curve.--All stations satisfying the requirements for homogeneity may be grouped together for the purpose of computing average flood ratios for each recurrence interval applicable for the entire region. The flood ratios for all recorded floods for each recurrence interval were listed and the median flood ratios were selected from this tabulation. Each median flood ratio was then plotted to its corresponding recurrence interval on a frequency chart and an average or composite frequency curve drawn (fig. 6). This curve, showing flood discharge in ratio to mean annual flood, is based on all significant discharge records available and may be considered as representing the most likely flood-frequency values for all parts of the region. This curve was not extended beyond 50 yr because of the dangers involved in extrapolating too far beyond the basic data.

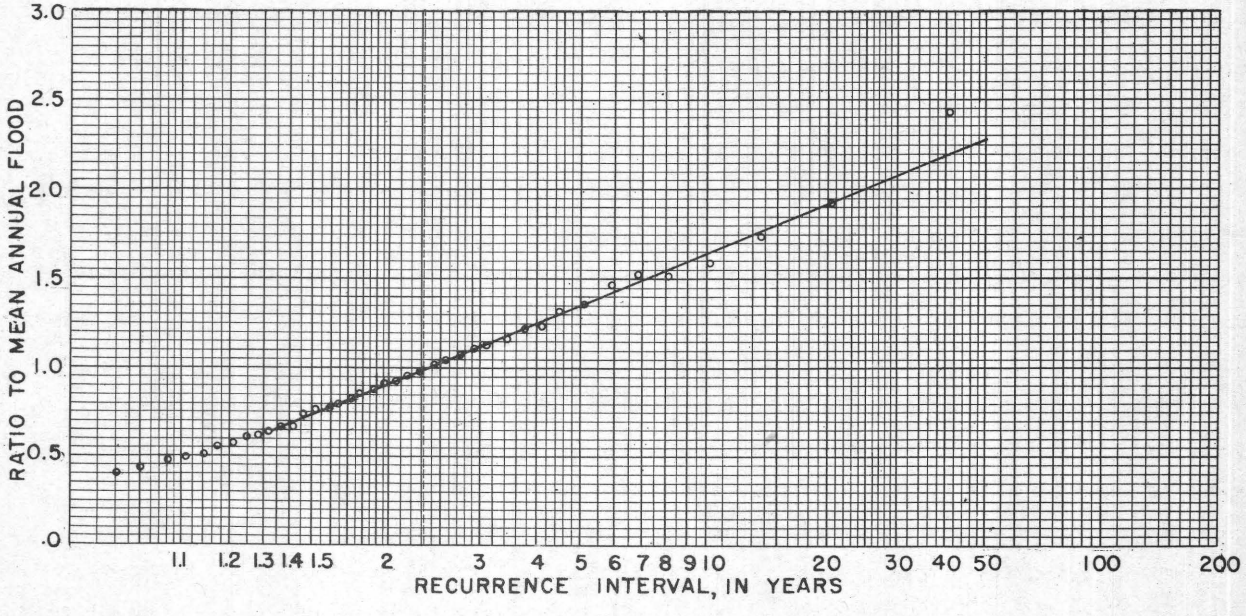

Figure 6.--Composite frequency curve for annual floods.

Derivation of the mean annual flood

The next step is to provide a means of determining the mean annual flood for any drainage basin in the region. A study was made of the relationship between the mean annual floods at the gaging stations and various basin characteristics that could conceivably affect flood flow. A formula was derived from this study by which it is possible to compute the mean annual flood for any drainage basin in the region using only its basin characteristics.

Drainage basin characteristics.--Drainage basin characteristics are numerous and often complex. Some are difficult if not impossible to determine, while others are difficult to express in mathematical terms. Some of the more obvious basin characteristics are drainage area, precipitation, vegetation, geology, prevailing winds, alinement, physical shape, slope, altitude, and storage.

The drainage area is the most easily determined basin characteristic and undoubtedly one of the most significant. The physical size of the catchment area is a positive factor that is readily computable. However, there are other factors concerning the drainage area that complicate its relation to the flood runoff, such as the relation of area to basin-wide rainfall intensities or to time of concentration of flood waters.

Precipitation might be a good characteristic to utilize as an element for correlation if it could be properly evaluated, but precipitation data are not adequate. Most precipitation stations are located at lower altitudes and cannot be used as indices for those few at higher ones. Also, the concentration of stations at low altitudes is so meager that it is not adequate to measure the sharp changes brought about by topography. This shortage of precipitation stations results in very poor coverage at medium altitudes and practically none for high areas. Isohyetal maps of the region are available, but they are a product of the combination of precipitation records and runoff records, the runoff being used to estimate the precipitation at higher altitudes. The influence of precipitation is probably reflected by other characteristics and because it cannot be evaluated properly, it was not used in this study.

The amount and type of vegetal cover have an effect on the magnitude of a flood. A forest in a humid region will retain large volumes of water while a steep sparsely covered escarpment will shed practically all of the rainfall. Because it would be very difficult, if not impossible, to measure these conditions in any but the smallest drainage basins, this factor was not used.

The geology of a basin has an effect on the size of floods and also may affect their frequency. A thorough and intensive geologic study of the entire area would be necessary in order to evaluate this factor. Because this is not practical and its influence is probably reflected by other elements, it has not been considered usable.

The relationship of flood runoff to rain barriers and prevailing winds is an index or orographic effect. The irregularity of the topography and its location preclude the possibility of using any one point or line as a reference to measure distance from any one barrier. The prevailing winds, however, are from the west and southwest; so practically all of the major

storms travel eastward. With this fact in mind, the general alinement of the basin with respect to west was considered as a basin characteristic.

The shape of the basin is an important element because it determines the coincidence of floods on major and minor tributaries. In a long, narrow basin the time and volume of concentration is radically different from that in a shorter, wider basin.

The slope of the basin affects the flood peak in a similar manner to the shape. The lag time, or speed of collection, is dependent on the slope, as well as on the size and shape of the basin.

The mean altitude of a basin reflects the precipitation to a great extent. The influence of vegetation and geology also may correlate quite closely with altitude. This characteristic is easily obtainable as compared to some others.

The area of lakes and ponds has a definite effect on the magnitude of a flood peak. It tends to reduce the sharpness of the peak because of the temporary storage action. Channel storage also may be a factor to consider here, but it cannot be determined in a satisfactory manner to supplement the storage effect of the measured area of lakes and ponds.

Basin characteristics correlated.--Basin characteristics may have a slightly different effect on the magnitude of each individual flood in a drainage basin, but on the average it may be assumed that they have the same relative effect on each flood. Because the mean annual flood is an average flood, it may also be assumed to be affected in like manner by the various basin characteristics.

The mean annual flood was correlated with the basin characteristics that were easily obtained from a topographic map. The average value of each element had to be used, which introduces errors, but it is thought that they may be compensating to some extent. The following list indicates the basin characteristics used and their ranges:

1. Drainage area in square miles ranging in size from 1 to 2,700 sq mi.
2. Mean altitude with a range of 390 to 5,800 ft.
3. Slope in feet per mile (mean altitude minus altitude of gage, divided by length of basin measured along the principle stream). Ranges from 8 to 555 ft per mile.
4. Shape factor (maximum straight line width divided by maximum straight line length). Ranges from 0.16 to 1.56.
5. Alinement in degrees from west ranging from 0^{o} to 175^{o}.
6. Area of lakes and ponds in percent of drainage area. Ranges from 0.01 to 20 percent.

Drainage area, mean altitude, and area of lakes and ponds were the only elements that were found to correlate significantly with the mean annual flood. Some rather large residuals still remained after the effects of these factors were removed. The probable causes of these residuals were inadequate sampling, geologic conditions and vegetal cover not being adequately represented, orographic and geographic effect not being sufficiently accounted for, and other factors not considered such as possible errors in basic data. There is also some scattering to be expected because of the chance elements inherent in relatively small samples such as are treated here. The basic data were checked for all "wild" points in an effort to ascertain the reason for such wide plotting.

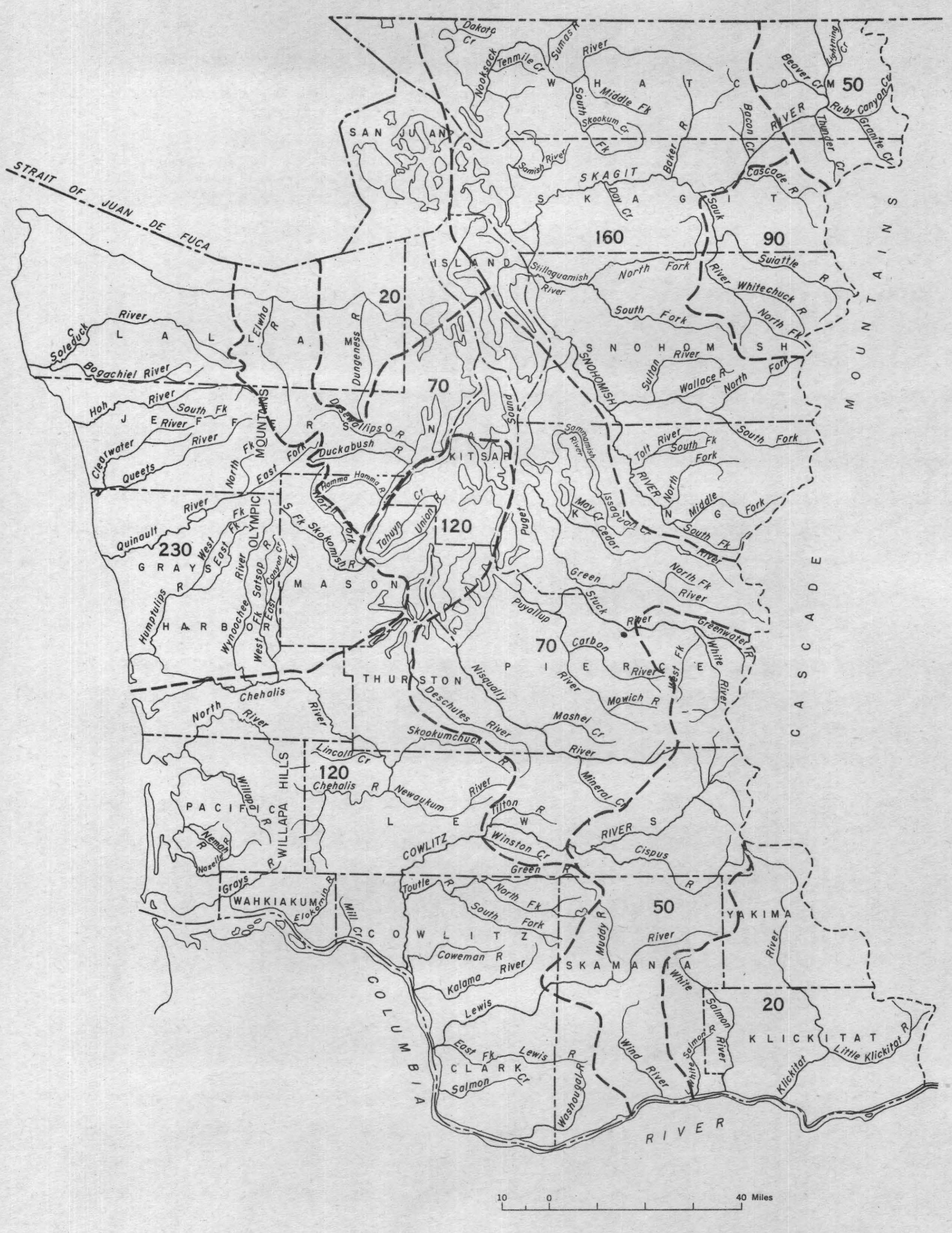

Figure 7.--Areas to which geographical factors apply in western Washington.

Geographical factor.--The residuals from the previous correlation had a tendency to plot in groups according to geographical location, indicating that the geographical location is a large contributing factor to the size of the residuals. In order to remove some of the geographical effect, a factor, called the geographical factor, was applied to the mean annual floods.

The entire region of western Washington was divided into seven geographical subregions. Isohyetal maps, topography, and the general grouping of the points were used as guides in determining the boundaries of the subregions in an effort to obtain better homogeneity. In general the boundaries of the subareas followed the divides between drainage basins.

A geographical factor was assigned to each subregion shown on figure 7, computed on the basis of the median of the residuals from the previous correlation of all streams lying within the boundaries of the subarea.

The final multiple correlation was made with mean annual flood as the dependent variable, with drainage area, altitude, percent area of lakes and ponds, and geographical factor as the independent variables. (See following table.) Drainage area was found to be the most significant, with altitude less important, and the percent area of lakes and ponds being the least effective factor. The geographical factor was a significant variable; but owing to the method by which it was derived, it is not considered directly comparable to the other variables in effectiveness.

Factors used in the multiple correlation of mean annual flood to basin characteristics

No.	Gaging station	Adjusted mean annual flood (cfs)	Drainage area (sq mi)	Mean altitude (ft)	Area of lakes (percent)	Geographical factor
	KLICKITAT RIVER BASIN					
1	Klickitat River above West Fork near Glenwood	1,800	151	4,700	0.01	20
2	Klickitat River near Glenwood	3,050	360	4,500	.14	20
3	Klickitat River near Pitt	8,330	1,170	3,500	.07	20
	WHITE SALMON RIVER BASIN					
4	White Salmon River at Husum	3,500	300	3,380	.07	20
5	White Salmon River near Underwood	4,660	384	3,070	.08	20
	LITTLE WHITE SALMON RIVER BASIN					
6	Little White Salmon River at Willard	2,380	117	2,460	.01	20
	WIND RIVER BASIN					
7	Wind River above Trout Creek near Carson	3,900	108	2,660	.09	50
8	Wind River near Carson	10,900	225	2,380	.04	50
	WASHOUGAL RIVER BASIN					
9	Washougal River near Washougal	13,700	108	1,730	.01	120
	LAKE RIVER BASIN					
10	Salmon Creek near Battle Ground	792	18.3	1,000	.01	120

Factors used in the multiple correlation of mean annual flood to basin characteristics--Continued

No.	Gaging station	Adjusted mean annual flood (cfs)	Drainage area (sq mi)	Mean altitude (ft)	Area of lakes (percent)	Geographical factor
	LEWIS RIVER BASIN					
11	Lewis River above Big Muddy River near Cougar	11,800	227	3,520	0.04	50
12	Lewis River near Cougar	20,100	481	3,120	.02	50
13	Lewis River at Ariel	39,200	731	2,730	.88	70
14	Swift Creek near Cougar	1,520	26	3,190	.01	50
15	Canyon Creek near Amboy	5,800	62	2,410	.01	120
16	East Fork Lewis River near Heisson	9,100	125	1,940	.01	120
	KALAMA RIVER BASIN					
17	Kalama River below Italian Creek near Kalama	10,000	201	1,880	.01	120
	COWLITZ RIVER BASIN					
18	Cowlitz River at Packwood	14,300	287	4,230	.07	50
19	Cowlitz River near Mayfield	30,500	1,400	3,170	.11	50
20	Cowlitz River at Castle Rock	50,500	2,240	2,540	.26	80
21	Clear Fork Cowlitz River near Packwood	2,420	56	4,330	.01	50
22	Lake Creek near Packwood	460	18.8	4,700	4.25	50
23	Johnson Creek near Packwood	1,800	50	4,010	.01	50
24	Cispus River near Randle	7,000	323	4,130	.15	50
25	Tilton River near Cinebar	7,850	158	1,990	.01	50
26	Toutle River near Silver Lake	15,700	474	2,310	.93	120
	ELOKOMIN RIVER BASIN					
27	Elokomin River near Cathlamet	3,740	66	1,190	.01	120
	NASELLE RIVER BASIN					
28	Naselle River near Naselle	5,220	55	910	.01	120
	NORTH RIVER BASIN					
29	North River near Raymond	8,400	219	700	.01	120
	CHEHALIS RIVER BASIN					
30	Chehalis River near Doty	9,150	113	1,000	.01	120
31	Chehalis River near Grand Mound	24,500	897	800	.03	120
32	Chehalis River at South Elma	28,600	1,420	700	.14	120
33	Elk Creek near Doty	1,500	46.7	810	.01	120
34	South Fork Chehalis River at Boistfort	2,400	49.2	830	.01	120
35	Skookumchuck River near Centralia	3,670	60	1,700	.01	120
36	Black River at Little Rock	895	64	420	1.56	120
37	Cloquallum River at Elma	2,600	66	410	.61	230
38	Satsop River near Satsop	21,400	315	500	.25	230
39	Wynoochee River at Oxbow near Aberdeen	10,900	65	2,000	.01	230
40	Wynoochee River below Black Creek near Montesano	15,200	179	900	.01	230
	QUINAULT RIVER BASIN					
41	Quinault River at Quinault Lake	21,600	264	2,700	2.08	230
	QUEETS RIVER BASIN					
42	Queets River near Clearwater	54,700	454	1,700	.01	230
43	Clearwater River near Clearwater	16,300	140	1,500	.01	230
	HOH RIVER BASIN					
44	Hoh River near Spruce	19,100	193	3,000	.10	230
	QUILLAYUTE RIVER BASIN					
45	Soleduck River near Fairholm	8,650	84	2,900	.48	230

Factors used in the multiple correlation of mean annual flood to basin characteristics--Continued

No.	Gaging station	Adjusted mean annual flood (cfs)	Drainage area (sq mi)	Mean altitude (ft)	Area of lakes (percent)	Geographical factor
	ELWHA RIVER BASIN					
46	Elwha River at McDonald Bridge near Port Angeles	12,400	262	3,700	0.23	70
	DUNGENESS RIVER BASIN					
47	Dungeness River near Sequim	2,880	156	4,500	.06	20
	DOSEWALLIPS RIVER BASIN					
48	Dosewallips River near Brinnon	4,100	94	4,700	.11	70
	DUCKABUSH RIVER BASIN					
49	Duckabush River near Brinnon	4,870	66	4,100	.30	70
	SKOKOMISH RIVER BASIN					
50	North Fork Skokomish River below Staircase Rapids near Hoodsport	7,000	60	3,700	.17	230
51	South Fork Skokomish River near Union	10,600	81	2,100	.25	230
	MISSION CREEK BASIN					
52	Mission Creek near Bremerton	51	1.9	810	5.27	120
53	Mission Creek near Belfair	145	4.4	650	4.55	120
	TAHUYA RIVER BASIN					
54	Tahuya Creek near Bremerton	285	6.1	930	1.64	120
55	Gold Creek near Bremerton	105	1.5	1,120	.01	120
56	Panther Creek near Bremerton	55	1	520	20.00	120
	DESCHUTES RIVER BASIN					
57	Deschutes River near Olympia	3,180	164	950	.67	70
	NISQUALLY RIVER BASIN					
58	Nisqually River near National	6,080	133	4,020	.38	70
59	Nisqually River at La Grande	11,300	296	3,200	1.79	70
60	Nisqually River near McKenna	15,200	445	2,740	1.48	70
61	Mineral Creek near Mineral	4,440	75	2,740	.01	70
62	Little Nisqually River near Alder	1,780	27.2	2,600	.37	70
63	Mashel River near La Grande	3,200	79	2,300	.01	70
64	Ohop Creek near Eatonville	600	35	1,600	1.72	70
65	Tanwax Creek near McKenna	243	27.2	640	1.84	70
	PUYALLUP RIVER BASIN					
66	Puyallup River near Electron	4,000	93	4,100	.54	70
67	Puyallup River near Orting	5,500	170	3,000	.82	70
68	Puyallup River at Alderton	11,600	438	2,000	.39	70
69	Puyallup River at Puyallup	22,400	948	2,500	.31	70
70	Kapowsin Creek at Kapowsin	367	23	1,500	3.04	70
71	Carbon River near Fairfax	3,660	81	4,000	.25	70
72	White River near Greenwater	3,950	216	4,700	.46	50
73	White River near Buckley	9,750	403	3,800	.30	50
74	Greenwater River at Greenwater	1,300	74	4,200	.27	50
	DUWAMISH RIVER BASIN					
75	Green River near Palmer	11,000	231	3,100	.09	70
76	Green River near Black Diamond	11,000	286	2,900	.07	70
77	Green River near Auburn	11,600	386	2,400	.60	70

Factors used in the multiple correlation of mean annual flood to basin characteristics--Continued

No.	Gaging station	Adjusted mean annual flood (cfs)	Drainage area (sq mi)	Mean altitude (ft)	Area of lakes (percent)	Geographical factor
	LAKE WASHINGTON BASIN					
78	North Fork Cedar River near Lester	870	8.8	3,830	5.68	70
79	Cedar River below Bear Creek near Cedar Falls	1,390	25.4	3,460	1.97	70
80	Cedar River near Cedar Falls	2,490	41.8	3,230	1.43	70
81	Cedar River at Cedar Falls	1,760	86	2,800	3.26	70
82	Cedar River near Landsberg	2,450	138	2,400	2.17	70
83	South Fork Cedar River near Lester	450	6	3,500	.01	70
84	Rex River near Cedar Falls	835	13	3,360	.01	70
85	Rock Creek near Maple Valley	116	12.6	690	.01	70
86	May Creek near Renton	214	13	540	.77	70
87	Issaquah Creek near Issaquah	525	26.2	940	.38	70
88	Sammamish River near Redmond	780	140	600	5.93	70
89	Sammamish River at Bothell	995	199	500	4.37	70
90	North Creek near Bothell	244	18.7	390	2.14	70
	SNOHOMISH RIVER BASIN					
91	South Fork Skykomish River near Index	24,600	355	3,800	.90	160
92	Skykomish River near Gold Bar	40,300	535	3,700	.73	160
93	Snohomish River at Snohomish	61,000	1,700	2,300	.64	160
94	Beckler River near Skykomish	6,050	95	3,600	.53	160
95	North Fork Skykomish River near Index	11,100	149	3,800	.40	160
96	Troublesome Creek near Index	940	10.4	3,500	3.85	160
97	Olney Creek near Gold Bar	1,190	7.9	1,800	.01	160
98	May Creek near Gold Bar	240	4.3	3,380	9.30	160
99	Sultan River near Startup	14,500	75	3,120	.40	160
100	Middle Fork Snoqualmie River near North Bend	12,500	173	3,500	1.27	160
101	Snoqualmie River near Tolt	30,100	605	2,400	.69	160
102	North Fork Snoqualmie River near Snoqualmie Falls	5,780	65	3,200	.77	160
103	North Fork Snoqualmie River near North Bend	7,200	105	3,100	1.52	160
104	South Fork Snoqualmie River at North Bend	4,840	83	2,900	.36	160
105	Raging River near Fall City	1,740	31.2	1,460	.01	160
106	Tolt River near Tolt	7,400	80	2,300	.12	160
107	Pilchuck River near Granite Falls	4,080	53	1,500	.19	160
	STILLAGUAMISH RIVER BASIN					
108	South Fork Stillaguamish River near Granite Falls	15,100	119	2,600	.08	160
109	South Fork Stillaguamish River above Jim Creek near Arlington	21,900	199	2,300	.05	160
110	Jim Creek near Arlington	2,610	48.9	1,400	.82	160
111	North Fork Stillaguamish River near Arlington	18,800	269	2,300	.01	160
	SKAGIT RIVER BASIN					
112	Skagit River near Newhalem	14,400	765	4,800	.20	50
113	Skagit River at Newhalem	25,000	1,160	5,000	2.21	50
114	Skagit River near Concrete	87,000	2,700	4,100	1.23	90
115	Beaver Creek near Newhalem	2,850	63	4,400	.01	50
116	Ruby Creek near Newhalem	4,730	203	5,700	.05	50
117	Thunder Creek near Newhalem	4,580	98	5,800	.10	50
118	Stetattle Creek near Newhalem	2,710	21.4	5,000	.47	160
119	Bacon Creek near Marblemount	5,400	50	4,500	.60	160
120	Cascade River at Marblemount	8,500	180	4,400	.17	90
121	Sauk River above Whitechuck River near Darrington	10,200	152	3,700	.13	90
122	Sauk River at Darrington	15,900	293	3,800	.07	90
123	Sauk River near Sauk	32,100	714	3,900	.10	90
124	Suiattle River near Mansford	14,300	335	4,500	.15	90
125	Baker River below Anderson Creek near Concrete	17,500	184	3,900	.71	160
126	Alder Creek near Hamilton	390	8.8	1,280	.01	160
	SAMISH RIVER BASIN					
127	Samish River near Burlington	3,200	88	580	1.82	160
128	Friday Creek near Burlington	880	37.1	710	4.04	160
	NOOKSACK RIVER BASIN					
129	Nooksack River above Cascade Creek near Glacier	6,700	105	4,300	.19	160
130	Nooksack River at Deming	30,000	580	3,000	.24	160
131	South Fork Nooksack River near Wickersham	9,000	103	3,000	.29	160

Formula.--The formula derived from the multiple correlation was:

$$\text{Mean annual flood} = .00284\ A^{.91}\ E^{.68}\ G\ L^{-.12}$$

where A = Area of drainage basin in square miles

E = Mean altitude of drainage basin

G = Geographical factor

L = Area of lakes and ponds in percent of drainage area

The standard error of estimate of the multiple correlation was computed to be 45 percent of the mean; that is, two-thirds of the plotted points fell within 45 percent of the computed curve. A part of this rather large standard error can be due to error in the individual station frequency curves themselves, and the plotted values do not necessarily represent the true mean annual flood for that station. In fact it is probable that the computed values, which represent the combined data of all the streams in the region, are more nearly correct than the values taken from the individual frequency curves.

The coefficient of determination for the formula was 0.94, meaning that 94 percent of the variation of the mean annual flood is accounted for by the formula. This high degree of correlation results from the fact that a great range of values has been considered in the analyses; therefore the computed figures of flood discharge should be as near to the correct magnitude as the accuracy of the basic data will permit. The 6 percent variance that remains unaccounted for may be due to factors not considered and to errors in sampling.

The formula has also been presented in nomograph form for ease of application. Two nomographs have been prepared to cover a range in drainage area of 5 to 500 sq mi: figure 8, 5 to 50 sq mi; and figure 9, 50 to 500 sq mi. For areas greater than 500 sq mi the formula must be applied.

Limitations.--The use of the formula is limited by the ranges of the basic data used to define it. The formula should not be applied to any area outside its region of derivation, western Washington. Although a small number of the drainage areas used in this report are in the range of 1 to 5 sq mi, it is thought unsafe to consider the formula applicable to these small areas when based on such meager data. Further studies on small areas are being made. With this reservation the formula is considered applicable to all areas from 5 to 2,700 sq mi.

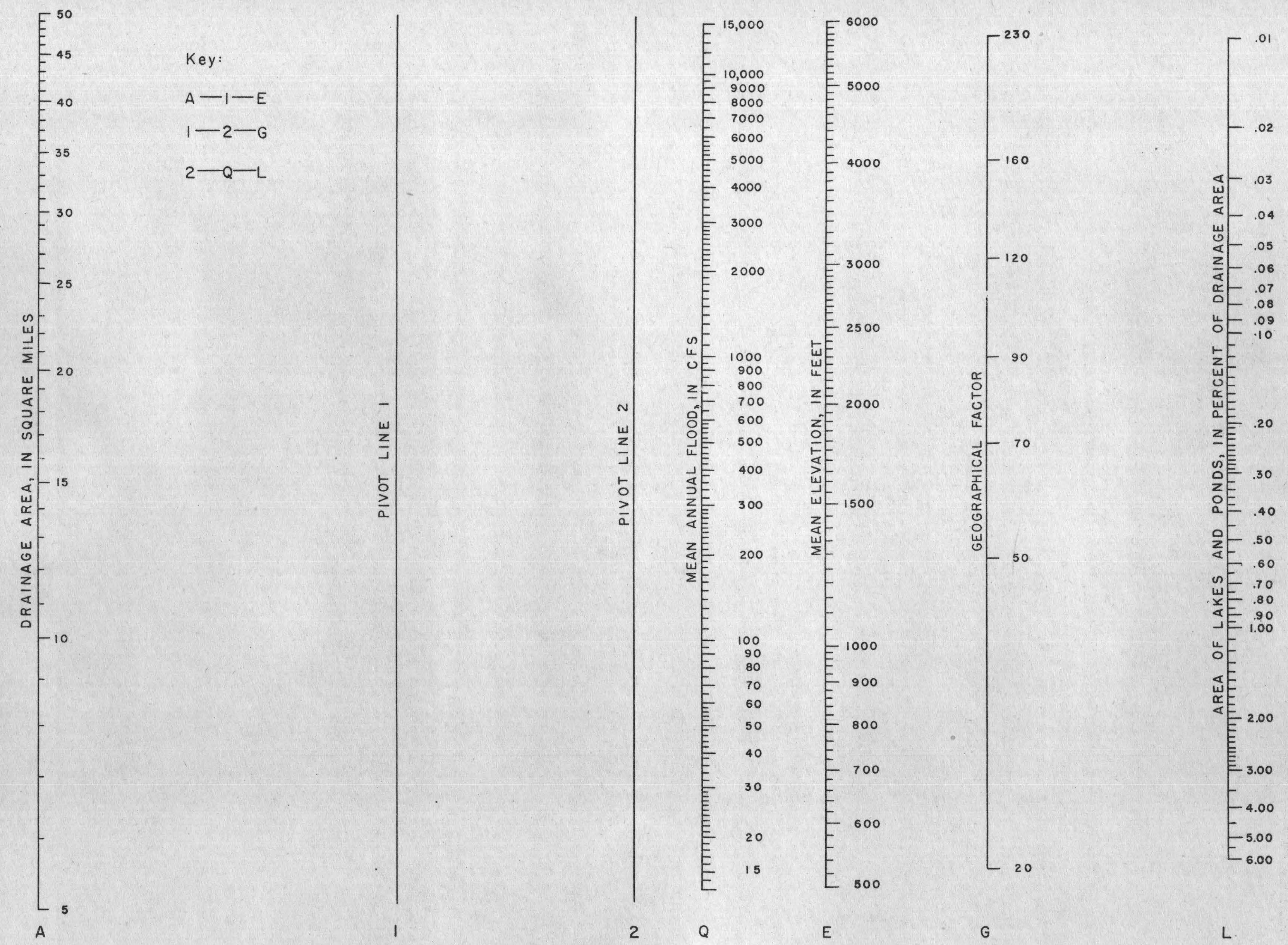

Figure 8.--Nomograph for computing mean annual flood for drainage areas of 5 to 50 sq mi.

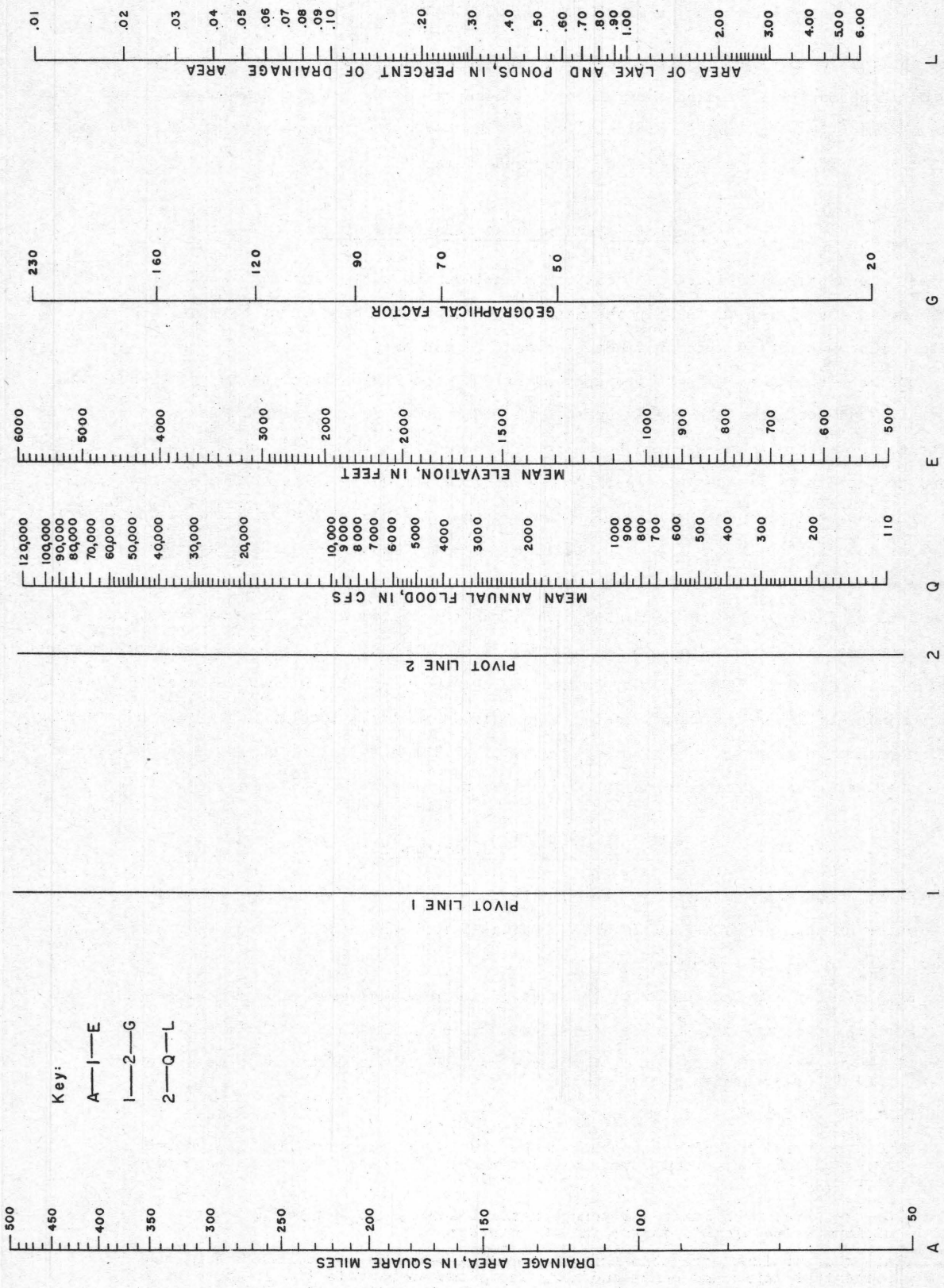

Figure 9.--Nomograph for computing mean annual flood for drainage areas of 50 to 500 sq mi.

APPLICATION OF FLOOD FORMULA

The application of the formula to a given area is accomplished by obtaining values for the various basin characteristics and then employing these values to get the mean annual flood. The mean annual flood is then used in conjunction with the composite frequency curve to solve for the magnitude of the flood at the desired recurrence interval.

Method of obtaining basin characteristics

Select the topographic sheet or sheets that include the entire drainage basin under consideration. Outline the area on the map and measure it by any method such as by the use of a planimeter or a transparent grid that has been made to map scale.

Measure mean altitude, using a transparent grid. Grid lines should be in accordance with the map scale and not more than 1 mile apart. On small areas the grid lines must necessarily be closer together to obtain the desired accuracy. The grid is then superimposed over the outlined area, and the altitudes at the intersections of the grid lines are listed. The arithmetical average of these altitudes is then taken as the average altitude of the drainage basin. There are other methods for obtaining the mean altitudes, but the added work in computation is not considered warranted for the little accuracy gained.

The area of lakes and ponds is measured in a manner similar to the drainage area, and that factor is recorded as a percentage of the drainage area. Because all streams have a small amount of storage in the form of lakes, ponds, swamps, or channels, a value of 0.01 percent (0.0001) is used as a minimum. The geographical factor is obtained by simply locating the area under consideration on the geographical factor map (fig. 7). If the area falls in more than one of the factor subregions, the approximate weighted average on an areal basis is computed.

Use of formula and nomograph

The formula for mean annual flood is readily solvable by the use of logarithms.

The value of mean annual flood is also obtainable with the nomograph and a straight edge. Apply nomograph in the following manner:

1. Select the nomograph that fits the size of the drainage area under consideration.
2. Plot the drainage area on the A scale and the mean altitude on the E scale.
3. Place the straight edge connecting these two points and mark the point where this line intersects with pivot line 1.
4. Plot the geographical factor on the G scale.
5. Place the straight edge connecting the marked point on pivot line 1 with the geographical factor and mark the point where this line intersects with pivot line 2.
6. Plot the percent of lakes and ponds on the L scale, keeping in mind that the minimum value of this factor is 0.01 percent.
7. Place the straight edge connecting the marked point on pivot line 2 with the percent of lakes and ponds and mark the point where this line intersects the Q scale. Read the value of the mean annual flood direct in cubic feet per second.

Use of composite frequency curve

After the mean annual flood has been computed, the magnitude of the flood for a selected recurrence is calculated.

From figure 6 (composite frequency curve) select the flood ratio that corresponds to the desired recurrence interval. Multiply this ratio by the mean annual flood, and the result is the magnitude of the flood that can be expected to be equalled or exceeded on the average of once in the number of years of the selected recurrence interval.

A complete frequency curve, if desired for any given area, may be defined by plotting, on any type of graph paper, flood discharges determined for several different recurrence intervals.

ENVELOPING CURVE

An enveloping curve of maximum discharges per square mile of many floods for different areas in western Washington (fig. 10) has been included as an additional guide to the possible maximum discharges of a stream in any area. Its use is very limited, and it should not be construed as a maximum expected flood-discharge curve. The enveloping curve presents the maximum recorded floods in a clear, concise manner where they can be compared for magnitude, area, and general location.

The enveloping curve for different areas in western Washington is based mainly on data used in this report, which may be found in the tabulation of peak discharges accompanying each station description listed under gaging-station records. The data used for some areas were determined by indirect methods while other data are historical flood information. The data for peak-discharge determinations at miscellaneous points are listed in the table on page 123.

CONCLUSION

The methods for computing flood magnitudes for a given recurrence interval as outlined in this report are not the final answer to the problem. As more gaging stations are installed in different areas where varying basin characteristics will be sampled, and as the period of record at existing gaging stations grows longer, more information will be available that will more firmly establish the present study and undoubtedly lead to further improvement. When the data become available for extending the curves used in this study from areas of 5 sq mi down to 1 sq mi or less, some very enlightening results may be forthcoming. It is anticipated that this report will be revised at such time as enough additional data are collected to complete such a study.

Eastern Washington presents an interesting field for this same type of study, and a similar report probably should be written covering this area when time and money are available.

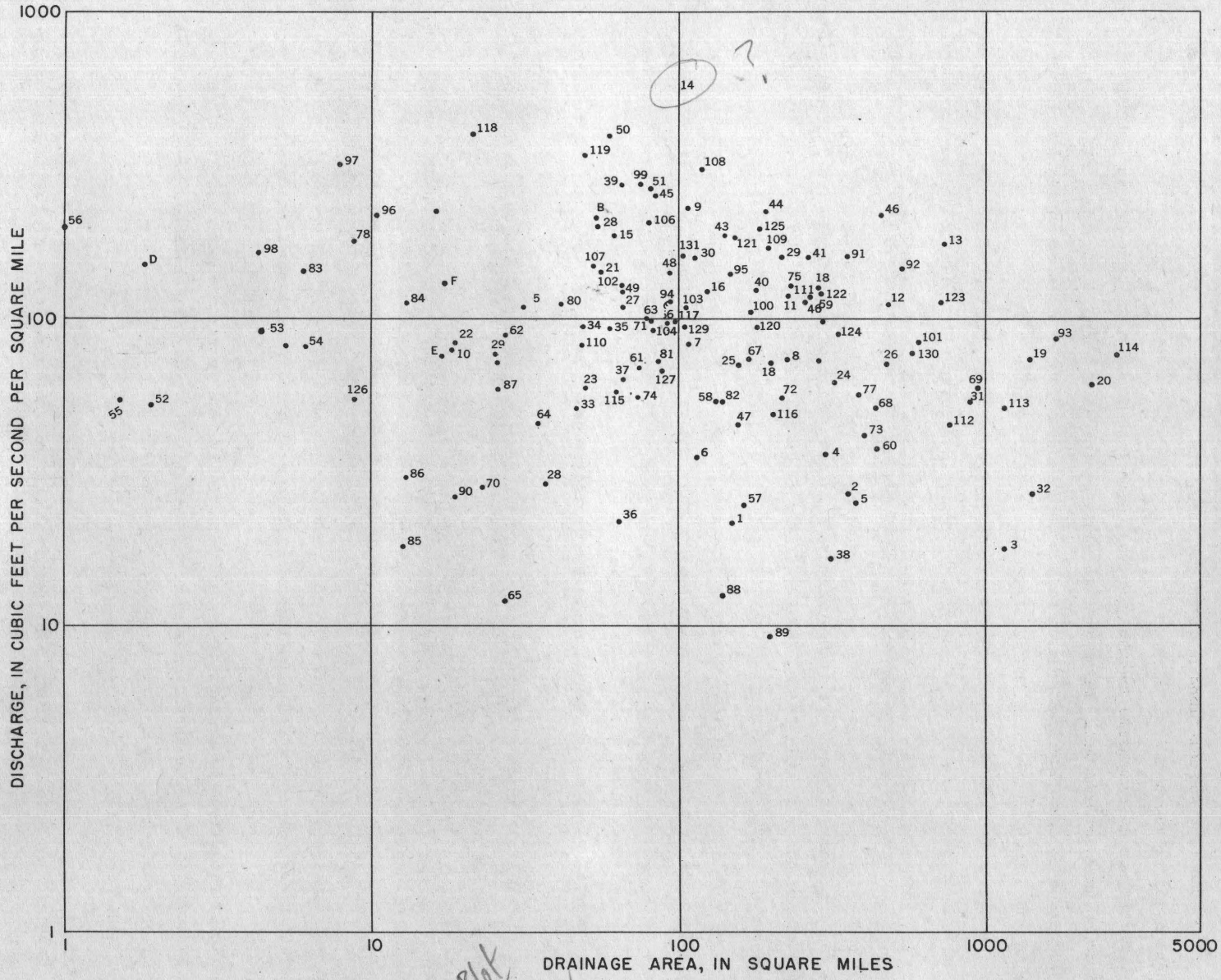

Figure 10.--Enveloping curve of maximum discharges in western Washington.

GAGING-STATION RECORDS

Stations from which homogeneous records were obtained

This section contains a brief description of each gaging station used in the report for the definition of the composite frequency curve along with a tabulation of all annual flood peaks both within and outside the base period, 1912-51. Where the magnitude of a flood peak in this report differs from that published in a water-supply paper, the revision was made solely to obtain consistency among the flood discharges being studied, except for the years 1949-51 for which records have not been published and the peaks are provisional.

For a few gaging stations that have 15 or more years of record, a plotting of the frequency of annual floods adjusted to the base period have been included. (See figs. 11-31.) Also, a plotting of the composite frequency curve is shown for comparative purposes. Curves for stations with less than 15 yr of record have not been shown because they have been considered as not having firm enough support for general use. If the data fit a smooth curve, the plotted points as shown could be used for defining the magnitude and frequency of floods at that point, but this practice is not recommended. It is considered more desirable to use the composite curve because it is based on the combined records of several stations. It should be noted that the discharge of the highest flood of record seldom plots on the curve because its recurrence interval is, in general, considerably greater than that to which it is plotted.

KLICKITAT RIVER BASIN

(1) Klickitat River above West Fork, near Glenwood, Wash.

Location.--Lat 46°15'40", long. 121°14'30", in S½ sec. 18, T. 9 N., R. 13 E., 1½ mi upstream from West Fork and 17 mi north of Glenwood.

Drainage area.--151 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,600 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	May 4, 1945	2.93	1,300
1946	May 17, 1946	3.28	1,710
1947	Dec. 15, 1946	3.21	1,600
1948	May 27, 1948	4.28	3,280
1949	May 15, 1949	4.00	2,800
1950	June 5, 1950	3.44	1,960
1951	May 11, 1951	3.75	2,420

(2) Klickitat River near Glenwood, Wash.

Location.--Lat 46°05'30", long. 121°15'30", in SE¼ sec. 14, T. 7 N., R. 12 E., half a mile downstream from Dairy Creek, 5 mi north of Glenwood, and 7 mi upstream from Trout Creek.

Drainage area.--360 sq mi.

Gage.--Nonrecording gage read once daily prior to July 19, 1910; recording gage thereafter. Datum of gage is 1,703 ft above mean sea level, datum of 1929 (since July 1934).

Stage-discharge relation.--Defined by current-meter measurements below 4,300 cfs and extended on basis of velocity-area studies.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1910	Nov. 24, 1909	5.20	6,250
1911	June 1, 1911	2.68	2,910
1912	May 15, 1912	2.87	2,790
1913	June 3, 1913	3.33	3,310
1914	Jan. 7, 1914	2.93	2,890
1915	Apr. 3, 1915	2.62	2,200
1916	June 18, 1916	3.47	4,620
1917	June 9, 1917	2.9	3,300
1918	Dec. 29, 1917	4.2	6,200
1919	Jan. 23, 1919	4.26	4,600
1920	May 17, 1920	2.58	1,810
1926	Apr. 18, 1926	2.99	1,750
1929	May 24, 1929	3.80	2,560
1930	Apr. 23, 1930	2.92	1,520
1931	May 2, 1931	3.77	2,200
1932	May - 1932	4.09	2,700
1933	June 15, 1933	4.76	3,950
1934	Dec. 22, 1933	6.9	9,870
	Change in datum		
1935	Nov. 6, 1934	3.62	2,680
1936	May 14, 1936	4.08	3,070
1937	June 21, 1937	3.96	2,390
1938	May 27, 1938	5.43	3,960
1939	May 16, 1939	4.26	2,140
1940	May 10, 1940	4.65	2,040
1941	Apr. 1, 1941	4.19	1,540
1942	Dec. 3, 1941	4.98	2,070
1943	May 25, 1943	5.96	3,280
1944	May 8, 1944	4.23	1,220
1945	May 4, 1945	5.41	2,380
1946	May 19, 1946	6.05	3,210
1947	Dec. 14, 1946	6.33	3,970
1948	May 26, 1948	7.01	4,710
1949	May 15, 1949	6.58	3,970
1950	June 5, 1950	6.26	3,410
1951	May 11, 1951	6.44	3,690

KLICKITAT RIVER BASIN

(3) Klickitat River near Pitt, Wash.

Location.--Lat 45°45', long. 120°12', in SW¼ sec. 8, T. 3 N., R. 13 E., 3½ mi south of Pitt, 5 mi upstream from Silvias Creek and 7 mi upstream from mouth at Lyle.

Drainage area.--1,170 sq mi.

Gage.--Nonrecording gage read twice daily prior to August 1935; recording gage thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 11,200 cfs and extended on basis of velocity-area studies.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1910	Mar. 2, 1910	8.7	10,600
1911	June 2, 1911	4.0	3,610
	Change in datum		
1929	May 24, 1929	3.68	3,010
1930	Feb. 20, 1930	5.15	5,100
1931	Mar. 31, 1931	10.3	13,600
1932	Feb. 26, 1932	6.06	7,390
1933	June 9, 1933	4.66	5,220
1934	Dec. 22, 1933	12.50	21,000
1935	Dec. 21, 1934	5.85	5,830
	Change in datum		
1936	Jan. 12, 1936	7.05	4,650
1937	Apr. 15, 1937	7.55	5,630
1938	Dec. 30, 1937	10.80	14,600
1939	Feb. 15, 1939	5.86	3,080
1940	Feb. 28, 1940	8.07	7,330
1941	Jan. 18, 1941	5.70	2,870
1942	Feb. 4, 1942	6.84	4,630
1943	Mar. 31, 1943	10.10	12,900
1944	Feb. 6, 1944	5.08	2,150
1945	Feb. 8, 1945	5.93	2,940
1946	Dec. 28, 1945	9.15	10,600
1947	Dec. 14, 1946	8.04	7,660
1948	Jan. 7, 1948	10.34	13,900
1949	Feb. 17, 1949	10.90	15,300
1950	Feb. 27, 1950	8.81	9,620
1951	Feb. 11, 1951	9.53	12,500

WHITE SALMON RIVER BASIN

(4) White Salmon River at Husum, Wash.

Location.--Lat 45°47'50", long. 121°29'15", in SW¼ sec. 30, T. 4 N., R. 11 E., at Husum, 500 ft upstream from Rattlesnake Creek.

Drainage area.--300 sq mi.

Gage.--Nonrecording gage read once daily prior to November 1, 1919 supplemented by recording gage for short periods. Recording gage after 1919.

Stage-discharge relation.--Defined by current-meter measurements below 4,500 cfs and extended or basis of velocity-area studies.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1910	Nov. 24, 1909	7.65	4,340
1911	Nov. 22, 1910	5.95	2,840
1912	Feb. 17, 1912	5.85	2,760
1913	June 2, 1913	5.60	2,070
1914	Jan. 6, 1914	6.32	2,370
1915	Apr. 3, 1915	5.60	2,260
1916	June 18, 1916	6.60	3,200
1917	May 29, 1917	5.55	2,180
1918	Dec. 29, 1917	10.0	7,500
1919	Jan. 23, 1919	6.90	5,000
	Change in datum		
1930	Feb. 20, 1930	4.91	2,410
1931	Apr. 1, 1931	7.10	4,720
1932	Mar. 19, 1932	4.90	2,330
1933	June 9, 1933	6.23	3,660
1934	Dec. 22, 1933	11.0	10,800
1935	Dec. 21, 1934	5.17	2,770
1936	May 5, 1936	4.61	2,180
1937	Apr. 15, 1937	5.51	3,070
1938	Dec. 30, 1937	7.36	5,370
1939	Feb. 15, 1939	3.30	1,240
1940	Mar. 1, 1940	4.71	2,180
1941	May 18, 1941	3.49	1,280

WHITE SALMON RIVER BASIN

(5) White Salmon River near Underwood, Wash.

Location.--Lat 45°45'00", long. 121°31'30", in NW¼ sec. 14, T. 3 N., R. 10 E., 1,000 ft downstream from Northwestern Electric Company's Condit power plant and 2 mi north of Underwood and mouth.

Drainage area.--384 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 5,800 cfs and extended by logarithmic plotting.

Remarks.--On basis of records for station at Husum the peak of December 1933 may have been 12,000 to 15,000 cfs near Underwood. Negligible diversions at flood stage. Regulation by power plant possibly effects lower peaks.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1916	Mar. 21, 1916	5.0	4,100	20	2.05
1917	June 9, 1917	3.0	2,130	38	1.08
1918	Dec. 29, 1917	9.5	9,700	2	20.50
1919	Jan. 23, 1919	7.45	5,800	11	3.73
1920	Jan. 26, 1920	5.83	3,820	23	1.78
1921	Mar. 18, 1921	5.98	4,300	18	2.28
1922	Dec. 1, 1921	5.67	3,930	21	1.95
1923	Jan. 7, 1923	8.0	6,800	6	6.83
1924	Feb. 1, 1924	5.10	3,060	33	1.24
1925	Feb. 3, 1925	6.8	5,190	15	2.73
1926	Feb. 6, 1926	4.75	2,780	35	1.17
1927	Feb. 22, 1927	6.25	4,410	17	2.41
1928	Nov. 25, 1927	6.90	5,320	12	3.42
1929	May 3, 1929	4.77	2,720	36	1.14
1930	Feb. 20, 1930	5.15	3,220	30	1.37
1934	Dec. 22, 1933	-	12,000	1	41.00
		Change in datum			
1936	May 18, 1936	6.90	3,490	27	1.52
1937	Apr. 15, 1937	7.47	4,210	19	2.16
1938	Dec. 29, 1937	9.05	7,300	3	13.67
1939	Feb. 15, 1939	5.65	2,260	37	1.11
1940	Feb. 28, 1940	6.91	3,920	22	1.86
1941	Jan. 19, 1941	5.09	1,750	39	1.05
1942	Dec. 19, 1941	6.81	3,790	24	1.71
1943	Mar. 31, 1943	8.31	6,000	9	4.56
1944	Dec. 3, 1943	5.10	1,720	40	1.02
1945	Feb. 8, 1945	6.49	3,440	28	1.46
1946	Dec. 29, 1945	7.73	5,280	13	3.15
1947	Dec. 13, 1946	8.68	6,910	5	8.20
1948	Jan. 7, 1948	8.40	6,430	7	5.86
1949	Feb. 17, 1949	8.84	7,200	4	10.25
1950	Feb. 24, 1950	7.69	5,260	14	2.93
1951	Feb. 11, 1951	8.26	6,190	8	5.12

WHITE SALMON RIVER BASIN

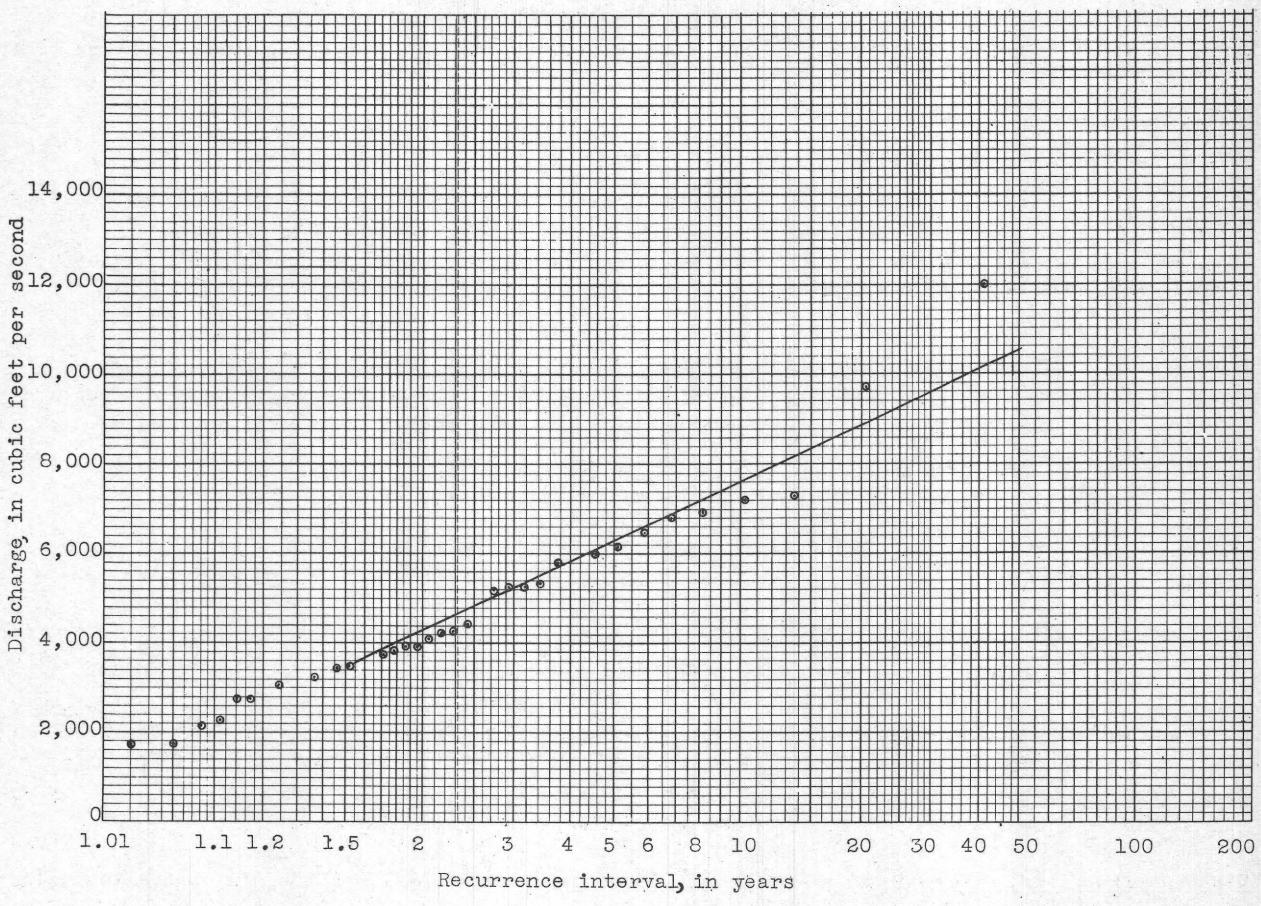

Figure 11.--Frequency of annual floods, White Salmon River near Underwood, Wash.

LITTLE WHITE SALMON RIVER BASIN

(6) Little White Salmon River at Willard, Wash.

Location.--Lat 45°47'00", long. 121°37'30", in NW¼ sec. 1, T. 3 N., R. 9 E., a quarter of a mile downstream from Lava Creek, at Willard.

Drainage area.--117 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,630 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 8, 1945	9.46	2,010
1946	Dec. 28, 1945	8.80	3,200
1947	Dec. 15, 1946	9.50	4,140
1948	Jan. 7, 1948	8.68	3,070
1949	Feb. 17, 1949	8.55	2,820
1950	Feb. 24, 1950	8.32	2,580
1951	Feb. 11, 1951	8.34	2,670

WIND RIVER BASIN

(7) Wind River above Trout Creek, near Carson, Wash.

Location.--Lat 45°48'30", long. 121°54'30", in NE¼ sec. 26, T. 4 N., R. 7 E., three-quarters of a mile upstream from mouth of Trout Creek and 7 mi northwest of Carson.

Drainage area.--108 sq mi.

Gage.--Nonrecording gage read twice daily.

Stage-discharge relation.--Defined by current-meter measurements below 5,800 cfs and extended by logarithmic plotting.

Remarks.--No diversion above station which is not returned to stream. Negligible regulation by fish hatchery dam above station.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 8, 1945	15.5	8,880
1946	Dec. 28, 1945	12.8	5,900
1947	Dec. 13, 1946	13.7	6,870
1948	Jan. 7, 1948	12.20	5,300
1949	May 2, 1949	9.66	3,020
1950	Nov. 27, 1949	11.8	4,770
1951	Feb. 11, 1951	11.0	4,050

(8) Wind River near Carson, Wash.

Location.--Lat 45°44'10", long. 121°48'10", in SW¼NE¼ sec. 21, T. 3 N., R. 8 E., three-quarters of a mile upstream from Little Wind River, 1 mi northeast of Carson, and 2½ mi upstream from mouth. Discharge measurements made just downstream from mouth of Little Wind River.

Drainage area.--225 sq mi, including that of Little Wind River.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 9,300 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Negligible regulation from Forest Service power plant on Trout Creek.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1935	Dec. 21, 1934	14.6	8,190
1936	Jan. 12, 1936	13.96	7,590
1937	Apr. 14, 1937	15.72	9,360
1938	Dec. 29, 1937	17.30	16,700
1939	Feb. 15, 1939	11.90	7,300
1940	Feb. 6, 1940	13.7	10,100
1941	Nov. 29, 1940	10.94	5,860
1942	Dec. 19, 1941	15.99	14,200
1943	Nov. 23, 1942	16.58	15,300
1944	Feb. 6, 1944	10.18	4,910
1945	Feb. 8, 1945	16.62	15,300
1946	Dec. 28, 1945	16.02	14,200
1947	Dec. 13, 1946	15.92	15,000
1948	Jan. 7, 1948	15.26	13,500
1949	Feb. 17, 1949	13.43	9,460
1950	Nov. 27, 1949	14.07	10,800
1951	Feb. 11, 1951	13.32	9,300

WASHOUGAL RIVER BASIN

(9) Washougal River near Washougal, Wash.

Location.--Lat 45°37'20", long. 122°18'00", in SE¼ sec. 27, T. 2 N., R. 4 E., half a mile upstream from Cougar Creek and 5½ mi northeast of Washougal.

Drainage area.--108 sq mi.

Gage.--Nonrecording read twice daily.

Stage-discharge relation.--Defined by current-meter measurements below 5,400 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 7, 1945	14.40	22,100
1946	Dec. 28, 1945	13.10	18,200
1947	Dec. 11, 1946	14.20	21,500
1948	Feb. 22, 1948	9.80	9,720
1949	Feb. 17, 1949	15.5	27,100
1950	Feb. 24, 1950	15.5	27,100
1951	Dec. 23, 1950	10.2	10,100

LAKE RIVER BASIN

(10) Salmon Creek near Battle Ground, Wash.

Location.--Lat 45°46'25", long. 122°26'35", in NE¼ SW¼ sec. 4, T. 3 N., R. 3 E., 100 ft upstream from county highway bridge, 150 ft downstream from Rock Creek, and 4 mi east of Battle Ground.

Drainage area.--18.3 sq mi.

Gage.--Nonrecording gage read once daily.

Stage-discharge relation.--Defined by current-meter measurements below 520 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Feb. 6, 1944	1.66	330
1945	Feb. 7, 1945	1.80	395
1946	Nov. 27, 1945	2.54	910
1947	Dec. 11, 1946	2.80	1,200
1948	Jan. 7, 1948	2.17	728
1949	Feb. 17, 1949	3.10	1,440
1950	Jan. 21, 1950	2.20	709
1951	Dec. 23, 1950	3.10	1,340

LEWIS RIVER BASIN

(11) Lewis River above Muddy River, near Cougar, Wash.

Location.--Lat 46°03'30", long. 121°59'00", in SW¼ sec. 30, T. 7 N., R. 7 E., 2 mi above mouth of Muddy River and 15 mi east of Cougar.

Drainage area.--227 sq mi (revised).

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 4,000 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1928	Nov. 25, 1927	8.97	14,500
1929	May 22, 1929	4.42	3,630
1930	Feb. 20, 1930	5.72	6,120
1931	Mar. 31, 1931	7.87	11,600
1932	Feb. 26, 1932	6.10	7,100
1933	June 9, 1933	7.42	10,300
1934	Dec. 21, 1933	13.2	27,000

(12) Lewis River near Cougar, Wash.

Location.--Lat 46°03'30", long. 122°12'50", in SE¼ sec. 29, T. 7 N., R. 5 E., 1 mi downstream from Swift Creek and 4 mi east of Cougar.

Drainage area.--481 sq mi.

Gage.--Recording. Datum of gage is 576.4 ft above mean sea level (from river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 17,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1925	Feb. 3, 1925	10.3	23,100	14	2.93
1926	Feb. 7, 1926	6.25	11,100	35	1.17
1927	Oct. 16, 1926	7.50	14,800	27	1.52
1928	Nov. 25, 1927	11.3	27,900	8	5.12
1929	Dec. 10, 1928	5.1	8,200	39	1.05
1930	Feb. 7, 1930	6.15	11,100	34	1.21
1931	Mar. 31, 1931	9.50	20,400	19	2.16
1932	Feb. 26, 1932	7.84	15,000	25	1.64
1933	June 9, 1933	8.44	16,700	23	1.78
1934	Dec. 21, 1933	15.7	54,400	1	41.00
1935	Nov. 5, 1934	9.33	21,800	16	2.56
	Change in datum				
1936	Jan. 12, 1936	9.24	12,300	31	1.32
1937	Apr. 14, 1937	12.08	24,400	12	3.42
1938	Dec. 29, 1937	12.96	30,200	5	8.20
1939	Jan. 2, 1939	7.90	9,440	37	1.11
1940	Dec. 15, 1939	10.78	20,200	20	2.05
1941	Nov. 29, 1940	9.00	11,800	33	1.24
1942	Dec. 19, 1941	11.35	22,700	15	2.73
1943	Nov. 23, 1942	12.56	30,300	4	10.25
1944	Dec. 3, 1943	7.61	8,690	38	1.08
1945	Feb. 7, 1945	11.42	24,300	13	3.15
1946	Dec. 28, 1945	-	30,000	6	6.83
1947	Dec. 13, 1946	12.98	32,300	2	20.50
1948	Oct. 17, 1947	9.30	15,000	26	1.58
1949	May 2, 1949	8.57	12,200	32	1.28
1950	Nov. 27, 1949	11.88	26,800	9	4.56
1951	Feb. 11, 1951	11.42	24,500	11	3.73

LEWIS RIVER BASIN

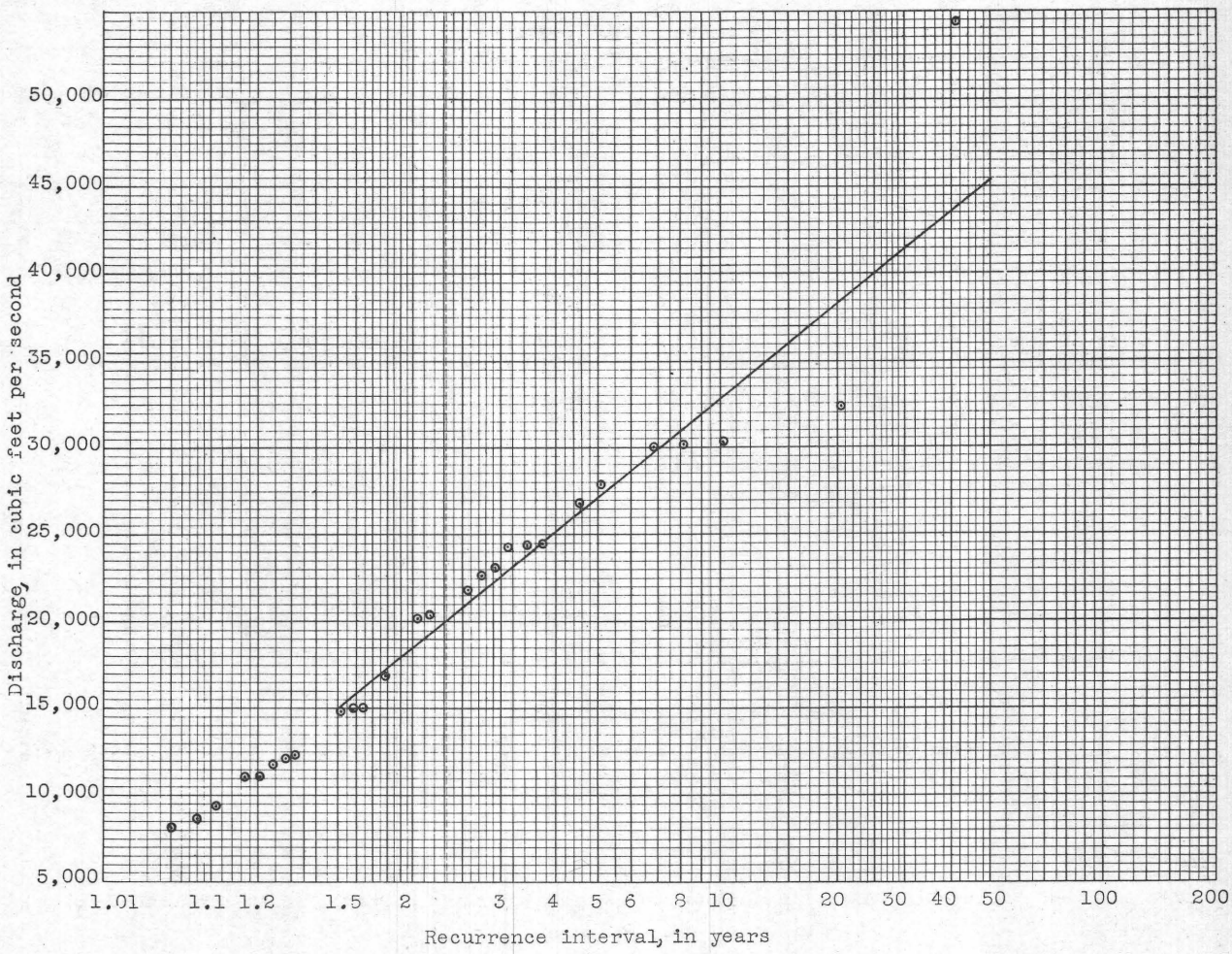

Figure 12.--Frequency of annual floods, Lewis River near Cougar, Wash.

(13) Lewis River at Ariel, Wash.

Location.--Lat 45°57'10", long. 122°33'45", in NW¼NE¼ sec. 4, T. 5 N., R. 2 E., at Ariel, half a mile downstream from Ariel Dam and power plant and 3 mi upstream from Cedar Creek.

Drainage area.--731 sq mi.

Gage.--Nonrecording gage read once or twice daily prior to April 21, 1930; recording gage thereafter. Datum of gage is 44 ft above mean sea level, unadjusted.

Stage-discharge relation.--Defined by current-meter measurements below 56,000 cfs and extended by computation of flow over dam.

Remarks.--No diversions. Lower peaks possibly regulated by Lake Merwin Reservoir on Lewis River (usable capacity 246,000 acre-ft) completed in 1931. Records for 1912-23 computed on basis of records for Lewis River near Amboy, Wash. Peak flow of December 22, 1933, partially caused by failure of natural dam above Dry Creek.

LEWIS RIVER BASIN

(13) Lewis River at Ariel, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1912	Jan. 13, 1912	-	34,200
1913	Nov. 13, 1912	-	25,700
1914	Jan. 5, 1914	-	40,000
1915	Apr. 2, 1915	-	19,500
1916	Dec. 21, 1915	-	43,700
1917	Apr. 8, 1917	-	12,800
1918	Dec. 18, 1917	-	63,500
1919	Jan. 23, 1919	-	44,100
1920	Dec. 24, 1919	-	26,100
1921	Dec. 30, 1920	-	46,600
1922	Dec. 12, 1921	-	39,400
1923	Jan. 7, 1923	-	57,700
1924	Dec. 6, 1923	10.7	29,100
1925	Feb. 3, 1925	14.85	42,600
1926	Feb. 6, 1926	9.79	26,200
1927	Nov. 29, 1926	10.3	27,800
1928	Nov. 25, 1927	19.5	59,000
1929	Nov. 10, 1928	6.06	14,100
1930	Feb. 14, 1930	8.6	20,600
	Change in datum		
1931	Apr. 1, 1931	14.20	30,600
1932	Feb. 26, 1932	16.92	41,700
1933	Jan. 8, 1933	15.25	34,700
1934	Dec. 22, 1933	35.0	129,000
1935	Nov. 6, 1934	16.13	38,000
1936	Jan. 12, 1936	15.65	34,100
1937	Apr. 14, 1937	18.56	49,100
1938	Dec. 30, 1937	21.3	61,500
1939	Feb. 15, 1939	12.7	24,600
1940	Feb. 6, 1940	15.80	36,900
1941	Nov. 29, 1940	13.90	29,200
1942	Dec. 19, 1941	17.40	40,600
1943	Nov. 23, 1942	21.66	57,600
1944	Feb. 6, 1944	10.93	18,700
1945	Feb. 7, 1945	18.08	42,800
1946	Dec. 28, 1945	17.23	39,500
1947	Dec. 13, 1946	24.04	67,300
1948	Jan. 7, 1948	14.75	30,800
1949	Feb. 23, 1949	13.35	26,200
1950	Nov. 27, 1949	19.5	49,000
1951	Dec. 23, 1950	17.3	40,200

(14) Swift Creek near Cougar, Wash.

Location.--Lat 46°03'50", long. 122°11'30", in NW¼ sec. 28, T. 7 N., R. 5 E., an eighth of a mile above mouth, 1½ mi east of Peterson's ranch, and 5 mi east of Cougar.

Drainage area.--26 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 510 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1925	Feb. 3, 1925	2.98	1,470
1926	Dec. 23, 1925	2.46	1,060
1927	Oct. 16, 1926	3.10	1,380
1928	Nov. 24, 1927	3.7	1,900
1929	Dec. 10, 1928	1.97	537
1930	Dec. 14, 1929	2.1	620
1931	Mar. 31, 1931	3.10	1,450
1932	Feb. 26, 1932	2.54	965
1933	Nov. 13, 1932	2.68	1,130

LEWIS RIVER BASIN

(15) Canyon Creek near Amboy, Wash.

Location.--Lat 45°56', long. 122°20', in SW¼ sec. 4, T. 5 N., R. 4 E., at bridge, 2 mi above mouth, and 6 mi northwest of Amboy.

Drainage area.--62 sq mi.

Gage.--Nonrecording gage read once daily prior to September 1924; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 7,000 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1923	Dec. 24, 1922	11.3	9,500
1924	Dec. 6, 1923	7.6	4,790
1925	Feb. 3, 1925	8.3	5,560
1926	Feb. 6, 1926	7.93	5,120
1927	Feb. 1, 1927	8.55	5,890
1928	Nov. 25, 1927	11.6	10,000
1929	Apr. 14, 1929	6.10	3,140
1930	Feb. 7, 1930	7.16	4,350
1931	Mar. 31, 1931	11.18	9,370
1932	Feb. 26, 1932	8.06	5,340
1933	Jan. 8, 1933	-	4,600
1934	Dec. 21, 1933	12.6	11,700

(16) East Fork Lewis River near Heisson, Wash.

Location.--Lat 45°50', long. 122°128', in N½ sec. 17, T. 4 N., R. 3 E., just upstream from Basket Creek, 1½ mi northeast of Heisson and 20 mi upstream from mouth.

Drainage area.--125 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 12,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Dec. 14, 1929	7.96	6,000
1931	Mar. 31, 1931	12.2	15,500
1932	Mar. 5, 1932	9.3	8,740
1933	Jan. 8, 1933	8.9	7,860
1934	Dec. 22, 1933	12.3	15,600
1935	Dec. 21, 1934	10.18	10,500
1936	Jan. 12, 1936	8.85	7,670
1937	Dec. 23, 1936	9.56	9,260
1938	Dec. 29, 1937	10.60	11,400
1939	Feb. 14, 1939	9.22	8,450
1940	Dec. 15, 1939	8.80	7,670

Water year	Date	Gage height (ft)	Discharge (cfs)
1941	Nov. 29, 1940	8.81	7,670
1942	Dec. 19, 1941	9.89	9,920
1943	Nov. 23, 1942	11.17	12,800
1944	Feb. 6, 1944	7.09	4,730
1945	Feb. 7, 1945	9.76	9,710
1946	Nov. 27, 1945	9.7	9,500
1947	Dec. 11, 1946	10.84	11,900
1948	Jan. 7, 1948	8.65	7,320
1949	Feb. 17, 1949	11.72	14,000
1950	Feb. 24, 1950	9.53	8,990
1951	Feb. 11, 1951	7.66	5,660

KALAMA RIVER BASIN

(17) Kalama River below Italian Creek, near Kalama, Wash.

Location.--Lat 46°02'30", long. 122°49'00", in NE¼SW¼ sec. 33, T. 7 N., R. 1 W., 2½ mi northeast of Kalama, 4 mi upstream from mouth, and 5 mi downstream from Italian Creek.

Drainage area.--201 sq mi.

Gage.--Nonrecording gage read twice daily.

Stage-discharge relation.--Defined by current-meter measurements below 6,700 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Records for 1917-31 computed on basis of records for Kalama River near Kalama, Wash.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1917	Jan. 5, 1917	-	4,800
1918	Dec. 18, 1917	-	12,800
1919	Jan. 23, 1919	-	11,700
1920	Dec. 24, 1919	-	6,290
1921	Mar. 17, 1921	-	11,400
1922	Nov. 21, 1921	-	7,100
1923	Jan. 6, 1923	-	13,400
1924	Jan. 31, 1924	-	7,590
1925	Feb. 3, 1925	-	10,000
1926	Dec. 21, 1925	-	6,680
1927	Feb. 1, 1927	-	7,170
1928	Nov. 25, 1927	-	14,400
1929	Dec. 10, 1928	-	5,680
1930	Dec. 14, 1929	-	7,260
1931	Mar. 31, 1931	-	11,900
1947	Dec. 13, 1946	13.40	14,400
1948	Jan. 7, 1948	9.10	7,160
1949	Feb. 17, 1949	10.42	9,140
1950	Feb. 24, 1950	11.90	11,600
1951	Feb. 11, 1951	10.10	8,660

COWLITZ RIVER BASIN

(18) Cowlitz River at Packwood, Wash.

Location.--Lat 46°36'40", long. 121°40'45", in SE¼ sec. 16, T. 13 N., R. 9 E., half a mile upstream from Skate Creek and half a mile northwest of Packwood.

Drainage area.--287 sq mi.

Gage.--Nonrecording gage usually read once daily prior to January 1920; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 13,200 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

COWLITZ RIVER BASIN

(18) Cowlitz River at Packwood, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1908	Mar. 15, 1908	7.0	13,600	-	-
1911	Nov. - 1910	8.5	17,600	-	-
1912	Nov. 19, 1911	7.35	13,200	21	1.95
1913	June 3, 1913	4.8	6,520	39	1.05
1915	Nov. 3, 1914	7.08	13,400	20	2.05
1916	July 2, 1916	7.10	11,600	24	1.71
1917	June 18, 1917	5.85	8,440	36	1.14
1918	Dec. 29, 1917	10.1	22,700	3	13.67
1919	Jan. 23, 1919	-	16,000	13	3.15
	Change in datum				
1930	Feb. 20, 1930	6.07	5,070	40	1.02
1931	Jan. 28, 1931	6.88	7,440	38	1.08
1932	Feb. 26, 1932	9.88	16,100	12	3.42
1933	Nov. 13, 1932	9.87	20,500	5	8.20
1934	Dec. 21, 1933	13.0	36,600	1	41.00
1935	Nov. 5, 1934	11.08	26,500	2	20.50
1936	June 7, 1936	8.45	9,560	31	1.32
1937	Apr. 14, 1937	-	9,220	33	1.24
1938	Apr. 18, 1938	10.49	15,700	15	2.73
1939	May 29, 1939	9.03	11,700	23	1.78
1940	Dec. 15, 1939	8.72	9,420	32	1.28
1941	Nov. 29, 1940	8.58	9,150	34	1.21
1942	Dec. 2, 1941	8.87	10,100	28	1.46
1943	Nov. 23, 1942	11.26	20,300	6	6.83
1944	Dec. 3, 1943	10.04	14,100	18	2.28
1945	Jan. 7, 1945	10.31	14,100	19	2.16
1946	Dec. 28, 1945	10.04	14,900	16	2.56
1947	Dec. 11, 1946	10.77	19,000	9	4.56
1948	Oct. 19, 1947	11.19	18,800	10	4.10
1949	May 13, 1949	8.48	9,850	29	1.41
1950	Nov. 27, 1949	11.98	21,400	4	10.25
1951	Feb. 9, 1951	9.98	13,100	22	1.86

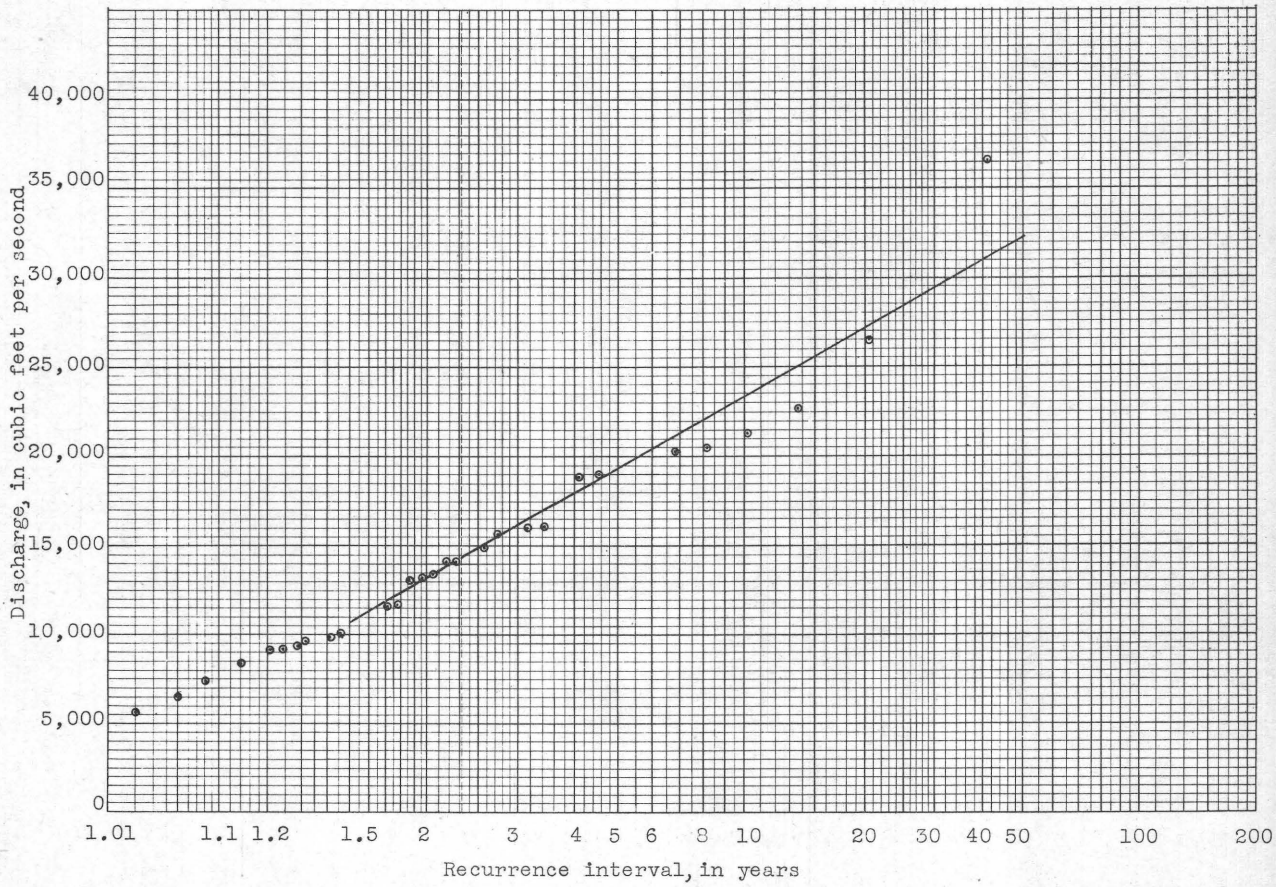

Figure 13.--Frequency of annual floods, Cowlitz River at Packwood, Wash.

COWLITZ RIVER BASIN

(19) Cowlitz River near Mayfield, Wash.

Location.--Lat 46°30'40", long. 122°36'50", in NE¼ sec. 24, T. 12 N., R. 1 E., 1 mi upstream from Mill Creek, 2 mi downstream from Winston Creek, and 2¼ mi west of Mayfield.

Drainage area.--1,400 sq mi.

Gage.--Recording. Datum of gage is 226.6 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 12,400 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Records for 1914-17, 1927-32, and 1934 computed on basis of records for Cowlitz River near Mossyrock, Wash.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1914	Jan. 7, 1914	-	35,700
1915	Apr. 3, 1915	-	18,500
1916	June 18, 1916	-	25,400
1917	June 19, 1917	-	18,100
1927	Dec. 2, 1926	-	23,500
1928	Nov. 26, 1927	-	35,500
1929	May 24, 1929	-	17,700
1930	Feb. 20, 1930	-	19,900
1931	Apr. 1, 1931	-	32,500
1932	Feb. 27, 1932	-	35,500
1934	Dec. 22, 1933	-	105,000
1935	Nov. 6, 1934	20.1	36,900
1936	June 8, 1936	16.57	23,400
1937	Apr. 15, 1937	18.32	29,900
1938	Dec. 30, 1937	19.91	36,100
1939	Feb. 15, 1939	15.45	19,400
1940	Dec. 17, 1939	17.26	25,900
1941	Nov. 29, 1940	14.96	17,700
1942	Dec. 20, 1941	19.26	33,600
1943	Nov. 24, 1942	21.50	42,600
1944	Dec. 4, 1943	16.42	22,500
1945	Feb. 8, 1945	18.22	29,200
1946	Dec. 29, 1945	20.33	37,600
1947	Dec. 13, 1946	24.75	58,000
1948	Oct. 20, 1947	17.70	27,100
1949	May 13, 1949	16.97	24,400
1950	Nov. 28, 1949	19.52	35,000
1951	Feb. 12, 1951	22.47	49,000

(20) Cowlitz River at Castle Rock, Wash.

Location.--Lat 46°16'30", long. 122°55'00", in SE¼ sec. 10, T. 9 N., R. 2 W., at highway bridge in Castle Rock, 2½ mi downstream from Toutle River and 14 mi upstream from mouth.

Drainage area.--2,240 sq mi.

Gage.--Nonrecording gage read twice daily prior to June 1934; recording gage thereafter. Datum of recording gage is 19.73 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 79,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1928	Nov. 25, 1927	13.95	74,000
1929	May 25, 1929	7.31	21,800
1930	Feb. 8, 1930	8.80	30,900
1931	Apr. 1, 1931	13.15	66,800
1932	Mar. 6, 1932	11.63	52,800
1933	Nov. 14, 1932	11.70	53,600
1934	Dec. 23, 1933	26.6	139,000
	Change in datum		
1935	Nov. 6, 1934	20.39	61,800
1936	Jan. 12, 1936	18.12	48,200
1937	Apr. 15, 1937	18.24	48,800
1938	Dec. 30, 1937	20.38	62,900
1939	Feb. 15, 1939	17.31	43,600
1940	Dec. 16, 1939	17.00	41,900
1941	Nov. 29, 1940	14.07	26,400
1942	Dec. 20, 1941	19.74	58,100
1943	Nov. 24, 1942	20.10	60,500
1944	Dec. 4, 1943	16.24	37,100
1945	Feb. 8, 1945	17.67	45,300
1946	Dec. 29, 1945	19.91	54,700
1947	Dec. 13, 1946	24.47	85,100
1948	Oct. 20, 1947	17.18	38,500
1949	Feb. 17, 1949	19.39	51,500
1950	Nov. 28, 1949	19.94	54,600
1951	Feb. 12, 1951	21.90	67,400

COWLITZ RIVER BASIN

(21) Clear Fork Cowlitz River near Packwood, Wash.

Location.--Lat 46°40'50", long. 121°34'30", in NE¼ sec. 29, T. 14 N., R. 10 E., three-quarters of a mile above mouth and 7 mi northeast of Packwood.

Drainage area.--56 sq mi.

Gage.--Nonrecording gage prior to 1912; recording gage thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 1,300 cfs and extended by velocity-area studies.

Remarks.--No regulation. Negligible diversion at flood stages.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1908	Mar. 15, 1908	-	2,040
1909	June 2, 1909	-	1,190
1910	Nov. 23, 1909	-	3,500
1911	Nov. 22, 1910	-	1,860
1912	Nov. 19, 1911	-	2,350
1931	Mar. 31, 1931	5.38	1,050
1932	Feb. 26, 1932	6.8	2,270
1933	Nov. 13, 1932	7.44	2,830
1934	Dec. 22, 1933	11.7	8,030
1935	Oct. 25, 1934	7.53	2,900
1936	June 7, 1936	6.0	1,150
1937	Apr. 14, 1937	5.96	1,410
1938	Apr. 18, 1938	7.11	2,600
1939	May 29, 1939	5.43	1,160
1940	Dec. 15, 1939	5.80	1,410
1941	Nov. 29, 1940	6.02	1,610

(22) Lake Creek near Packwood, Wash.

Location.--Lat 46°35'55", long. 121°34'15", in sec. 21, T. 13 N., R. 10 E., 500 ft downstream from outlet of Packwood Lake and 6 mi east of Packwood.

Drainage area.--18.8 sq mi.

Gage.--Nonrecording gage prior to August 1918; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 380 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Natural regulation by Packwood Lake. Discharge of flood of December 18, 1917, was estimated.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1912	Nov. 19, 1911	-	580	7	5.86
1913	June 3, 1913	-	480	19	2.16
1914	Jan. 7, 1914	-	242	33	1.24
1915	Nov. 11, 1914	-	262	32	1.28
1916	June 18, 1916	-	595	6	6.83
1917	June 17, 1917	-	510	18	2.28
1918	Dec. 18, 1917	6.0	1,570	1	41.00
1919	Jan. 23, 1919	3.2	419	22	1.86
1920	July 5, 1920	2.5	272	31	1.32
1921	June 7, 1921	3.1	452	20	2.05
1922	Dec. 12, 1921	3.88	631	5	8.20
1923	Jan. 9, 1923	3.55	521	15	2.73
1924	May 14, 1924	2.42	278	30	1.37
1931	May 14, 1931	3.23	241	34	1.21
1932	June 15, 1932	3.44	366	27	1.52
1933	Nov. 17, 1932	4.62	815	3	13.67
1934	Dec. 22, 1933	5.9	1,400	2	20.50
1935	Nov. 5, 1934	3.87	517	16	2.56
1936	June 8, 1936	3.94	512	17	2.41
1937	June 21, 1937	3.81	529	13	3.15
1938	Apr. 19, 1938	3.60	423	21	1.95
1939	May 29, 1939	3.81	365	28	1.46
1940	Dec. 17, 1939	2.94	234	36	1.14
1941	May 25, 1941	2.67	157	40	1.02
1942	Dec. 20, 1941	3.22	308	29	1.41
1950	Nov. 27, 1949	4.14	548	9	4.56
1951	Feb. 11, 1951	4.16	548	10	4.10

COWLITZ RIVER BASIN

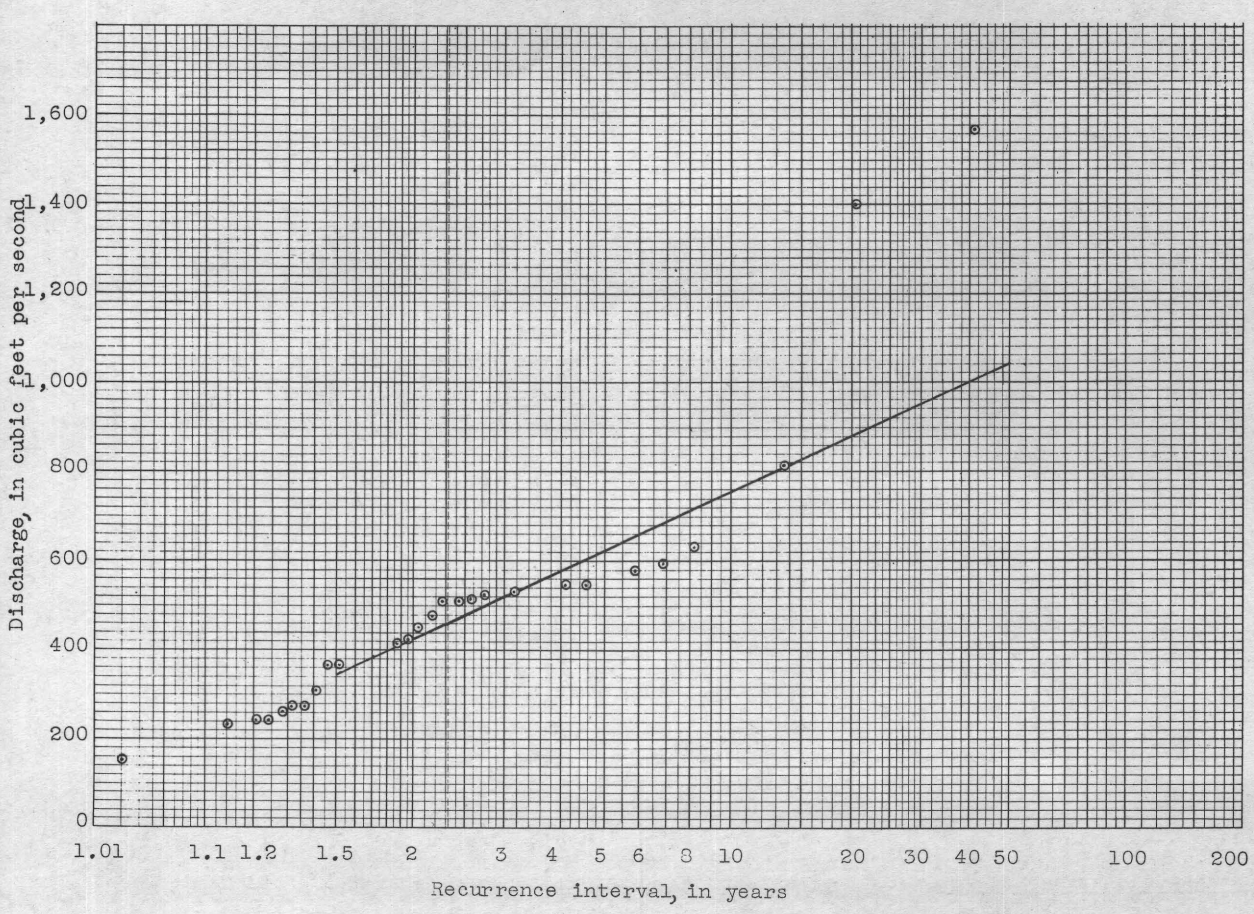

Figure 14.--Frequency of annual floods, Lake Creek near Packwood, Wash.

(23) Johnson Creek near Packwood, Wash.

Location.--Lat 46°34'30", long. 121°42'00", in NE¼ sec. 32, T. 13 N., R. 9 E., 400 ft upstream from mouth and 3 mi southwest of Packwood.

Drainage area.--49.6 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 710 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1919	Jan. 23, 1919	3.75	2,500
1920	Dec. 24, 1919	2.22	760
1921	Dec. 23, 1920	3.25	1,560
1923	Jan. 6, 1923	4.07	2,610
1924	Jan. 31, 1924	2.68	969
	Change in datum		
1947	Dec. 11, 1946	7.69	2,990
1948	May 24, 1948	5.98	1,270

COWLITZ RIVER BASIN

(24) Cispus River near Randle, Wash.

Location.--Lat 46°26'50", long. 121°51'35", in NW¼ sec. 18, T. 11 N., R. 8 E. (unsurveyed), 500 ft upstream from bridge to Tower Rock Ranger Station, 4 mi downstream from North Fork, and 8 mi southeast of Randle.

Drainage area.--323 sq mi.

Gage.--Nonrecording prior to November 1, 1930; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 8,500 cfs.

Remarks.--No diversions or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1911	Nov. 10, 1910	6.0	6,400	-	-
1930	Feb. 20, 1930	5.75	4,820	29	1.41
1931	Mar. 31, 1931	6.58	6,610	23	1.78
1932	Feb. 26, 1932	6.11	5,260	28	1.46
1933	June 9, 1933	7.64	8,080	12	3.42
1934	Dec. 22, 1933	12.7	20,000	1	41.00
1935	Nov. 5, 1934	9.30	11,900	3	13.67
1936	June 7, 1936	7.36	6,190	25	1.64
1937	Apr. 14, 1937	9.29	11,400	6	6.83
1938	Dec. 29, 1937	9.36	10,900	7	5.86
1939	May 15, 1939	6.1	3,640	33	1.24
1940	Dec. 16, 1939	7.88	7,120	17	2.41
1941	Nov. 29, 1940	5.82	3,110	35	1.17
1942	Dec. 20, 1941	-	7,500	15	2.73
1943	Nov. 23, 1942	10.20	13,200	2	20.50
1944	Dec. 3, 1943	5.29	2,460	37	1.11
1945	Feb. 8, 1945	8.26	8,240	11	3.73
1946	Dec. 29, 1945	7.69	6,870	20	2.05
1947	Dec. 14, 1946	9.65	11,500	4	10.25
1948	May 27, 1948	7.91	6,650	22	1.86
1949	May 13, 1949	8.13	7,790	14	2.93
1950	Nov. 27, 1949	7.95	6,850	21	1.95
1951	Feb. 11, 1951	8.90	8,800	9	4.56

COWLITZ RIVER BASIN

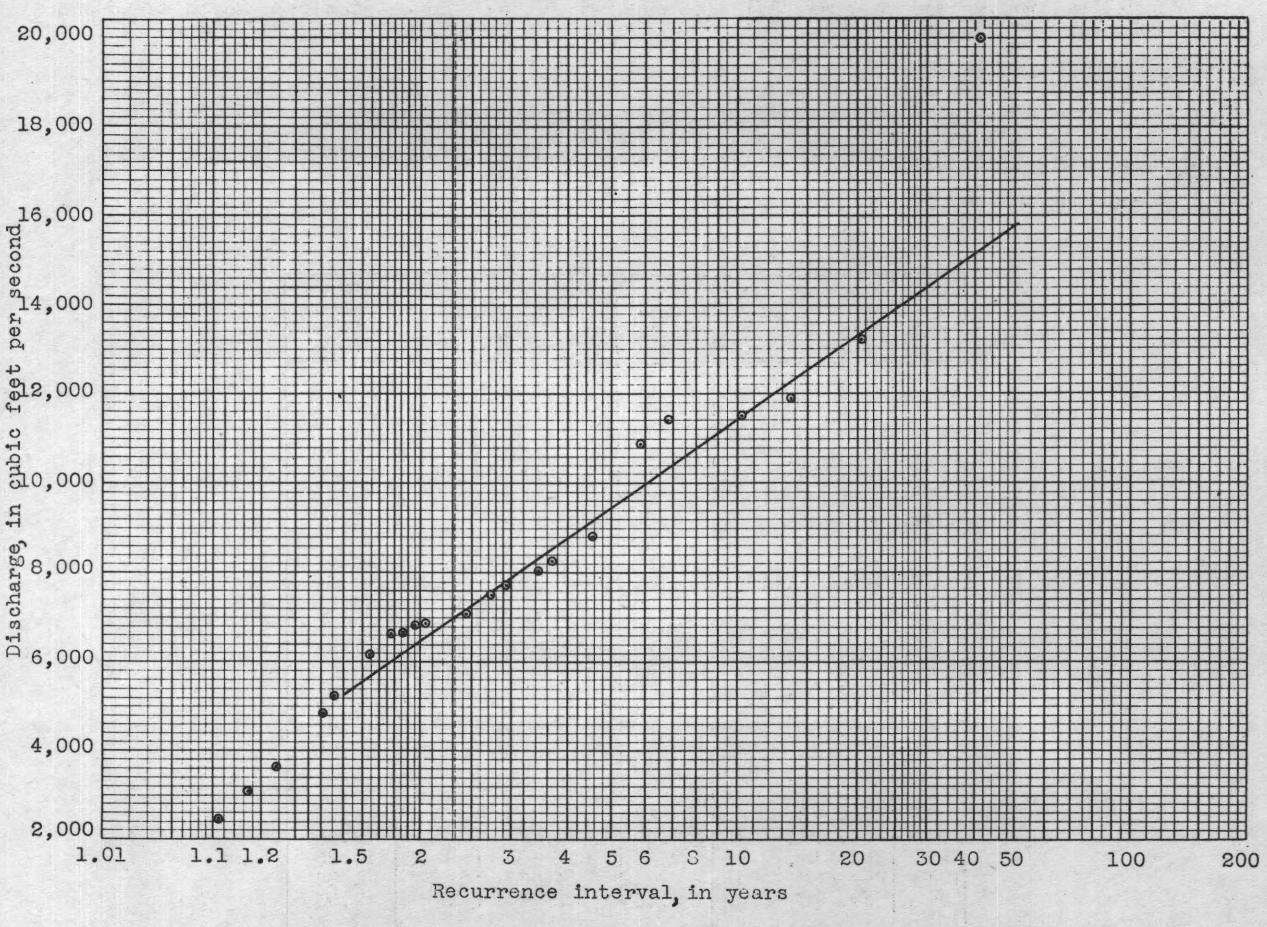

Figure 15.--Frequency of annual floods, Cispus River near Randle, Wash.

(25) Tilton River near Cinebar, Wash.

Location.--Lat 46°34'35", long. 122°31'15", in SW½ sec. 26, T. 13 N., R. 2 E., 1,000 ft downstream from Cinnabar Creek, 2 mi southeast of Cinebar, and 2½ mi upstream from mouth.

Drainage area.--158 sq mi.

Gage.--Recording. Datum of gage is 397.6 ft above mean sea level (from river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 3,900 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1942	Dec. 19, 1941	11.32	8,090
1943	Nov. 23, 1942	12.21	9,850
1944	Dec. 3, 1943	11.78	9,050
1945	Jan. 7, 1945	11.55	8,660
1946	Dec. 28, 1945	11.89	9,250
1947	Dec. -, 1946	-	14,500
1948	Nov. 7, 1947	10.56	6,800
1949	Feb. 17, 1949	10.60	7,210
1950	Feb. 24, 1950	12.63	11,200
1951	Feb. 9, 1951	12.60	11,200

COWLITZ RIVER BASIN

(26) Toutle River near Silver Lake, Wash.

Location.--Lat 46°20'10", long. 122°43'30", in SE¼ sec. 19, T. 10 N., R. 1 E., at highway bridge half a mile downstream from confluence of North and South Forks and 5 mi northeast of Silver Lake.

Drainage area.--474 sq mi.

Gage.--Nonrecording gage prior to August 1912; recording thereafter. Datum of gage since 1929 is 407.3 ft above mean sea level (from river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 17,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1910	Mar. 2, 1910	11.0	35,600
1911	Nov. - 1910	-	20,600
1912	Jan. 14, 1912	7.0	13,400
	Change in datum		
1920	Jan. 26, 1920	13.0	9,700
1921	Dec. 30, 1920	17.6	14,700
1922	Dec. - 1921	16.85	13,800
1923	Jan. - 1923	18.9	16,500
1930	Dec. 14, 1929	9.3	10,800
1931	Mar. 31, 1931	14.73	20,000
1932	Mar. 5, 1932	12.12	15,600
1933	Dec. 2, 1932	10.77	13,300
1934	Dec. 23, 1933	22.7	34,300
1935	Nov. 5, 1934	14.38	19,500
1936	Jan. 12, 1936	12.15	15,700
1937	Dec. 22, 1936	13.18	17,400
1938	Dec. 28, 1937	14.87	20,300
1939	Feb. 15, 1939	11.3	15,400
1940	Dec. 15, 1939	9.86	12,800
1941	Nov. 29, 1940	7.90	9,410
1942	Dec. 19, 1941	14.26	21,400
1943	Nov. 23, 1942	13.94	20,500
1944	Dec. 3, 1943	9.80	12,300
1945	Feb. 7, 1945	11.28	14,900
1946	Dec. 29, 1945	-	16,000
1947	Dec. 11, 1946	17.56	29,800
1948	Nov. 8, 1947	9.92	14,100
1949	Feb. 17, 1949	11.56	17,300
1950	Feb. 24, 1950	11.53	17,200
1951	Feb. 11, 1951	11.32	16,800

ELOKOMIN RIVER BASIN

(27) Elokomin River near Cathlamet, Wash.

Location.--Lat 46°13'10", long. 123°20'30", in SE¼ sec. 31, T. 9 N., R. 5 W., 2 mi northeast of Cathlamet and 4 mi upstream from mouth.

Drainage area.--66 sq mi.

Gage.--Recording. Datum of gage is 29.60 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 2,300 cfs and extended by slope-area method.

Remarks.--Negligible diversions at flood stage, no regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1941	Jan. 17, 1941	8.0	2,800
1942	Dec. 19, 1941	9.13	3,720
1943	Nov. 23, 1942	9.81	4,350
1944	Dec. 3, 1943	9.82	4,350
1945	Feb. 7, 1945	10.6	5,020
1946	Dec. 28, 1945	10.56	5,120
1947	Jan. 25, 1947	10.76	5,320
1948	Jan. 1, 1948	9.34	3,900
1949	Feb. 17, 1949	12.66	7,300
1950	Feb. 24, 1950	12.50	6,970
1951	Feb. - 1951	11.2	5,900

NASELLE RIVER BASIN

(28) Naselle River near Naselle, Wash.

Location.--Lat 46°22'25", long. 123°44'45", in SW¼ sec. 1, T. 10 N., R. 9 W., 1½ mi upstream from Salmon Creek and 3½ mi east of Naselle.

Drainage area.--55 sq mi.

Gage.--Nonrecording gage read twice daily.

Stage-discharge relation.--Defined by current-meter measurements below 3,800 cfs and extended by slope-area method.

Remarks.--Maximum stages are from graphs based on gage readings. No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Dec. 23, 1929	7.3	2,460
1931	Jan. 23, 1931	7.8	2,860
1932	Feb. 26, 1932	10.6	5,030
1933	Nov. 13, 1932	11.5	6,090
1934	Dec. 9, 1933	13.0	7,440
1935	Jan. 22, 1935	15.9	11,100
1936	Feb. 27, 1936	11.9	6,210
1937	Feb. 22, 1937	8.7	3,560
1938	Nov. 25, 1937	11.4	5,760
1939	Feb. 12, 1939	10.8	5,230
1940	Dec. 16, 1939	11.5	5,850
1941	Jan. 17, 1941	9.75	4,360
1942	Dec. 18, 1941	9.77	4,520
1943	Oct. 31, 1942	11.24	5,800
1944	Dec. 3, 1943	12.4	7,030
1945	Mar. 19, 1945	11.9	6,410
1946	Dec. 28, 1945	10.4	5,060
1947	Dec. 11, 1946	11.25	5,800
1948	Jan. 1, 1948	9.90	4,620
1949	Feb. 22, 1949	15.2	10,300
1950	Feb. 24, 1950	10.8	5,600
1951	Feb. 9, 1951	11.8	6,500

NORTH RIVER BASIN

(29) North River near Raymond, Wash.

Location.--Lat 46°49', long. 123°51', in sec. 6, T. 15 N., R. 9 W., 1¼ mi upstream from Salmon Creek and 10 mi northwest of Raymond.

Drainage area.--219 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 10,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. 35,000 cfs, December 10, 1933, caused by failure of crib dam. Natural discharge estimated at about 25,000 cfs.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1928	Nov. 24, 1927	7.80	8,610
1929	Mar. 27, 1929	6.40	5,660
1930	Dec. 23, 1929	6.05	4,900
1931	Apr. 13, 1931	7.2	7,320
1932	Feb. 27, 1932	8.11	11,000
1933	Jan. 9, 1933	-	7,240
1934	Dec. 10, 1933	15.8	35,000
1935	Jan. - 1935	12.5	24,000
1936	Feb. 28, 1936	7.43	7,890
1937	Apr. 15, 1937	6.92	6,600
1938	Dec. 29, 1937	-	23,000
1939	Feb. 13, 1939	7.10	7,100
1940	Dec. 16, 1939	7.20	7,360
1941	Jan. 18, 1941	6.39	5,440
1942	Dec. 20, 1941	7.37	7,890
1943	Apr. 2, 1943	6.41	5,410
1944	Dec. 4, 1943	7.32	7,230
1945	Feb. 8, 1945	6.99	6,600
1946	Dec. 30, 1945	7.32	7,230
1947	Jan. 27, 1947	7.46	7,660
1948	Mar. 23, 1948	6.58	5,800
1949	Feb. 23, 1949	8.42	8,660
1950	Dec. 29, 1949	9.30	10,400
1951	Feb. 11, 1951	11.0	13,800

CHEHALIS RIVER BASIN

(30) Chehalis River near Doty, Wash.

Location.--Lat 46°37'00", long. 123°16'40", in NW¼ sec. 14, T. 13 N., R. 5 W., 1½ mi upstream from Elk Creek, 1½ mi south of Doty, and 3½ mi north of Pe Ell.

Drainage area.--113 sq mi.

Gage.--Nonrecording gage read twice daily.

Stage-discharge relation.--Defined by current-meter measurements below 8,300 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1940	Dec. 15, 1939	15.76	15,100
1941	Jan. 17, 1941	11.70	9,140
1942	Dec. 19, 1941	11.50	8,780
1943	Feb. 6, 1943	9.46	6,400
1944	Dec. 3, 1943	9.07	5,670
1945	Feb. 7, 1945	17.80	18,100
1946	Nov. 26, 1945	10.76	7,910
1947	Feb. 2, 1947	12.28	9,980
1948	Jan. 2, 1948	11.35	8,720
1949	Feb. 22, 1949	14.30	12,800
1950	Nov. 27, 1949	13.9	12,200
1951	Feb. 9, 1951	15.9	15,200

(31) Chehalis River near Grand Mound, Wash.

Location.--Lat 46°46'35, long. 123°02'05", in NE¼ sec. 22, T. 15 N., R. 3 W., at Meadow, 1½ mi southwest of Grand Mound and 6 mi downstream from Skookumchuck River.

Drainage area.--897 sq mi.

Gage.--Nonrecording gage read once daily prior to October 1934; recording thereafter. Datum of recording gage is 123.27 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 37,000 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1929	Mar. 27, 1929	8.00	13,700	35	1.17
1930	Feb. 8, 1930	7.26	12,200	37	1.11
1931	Apr. 1, 1931	10.39	19,400	27	1.52
1932	Feb. 27, 1932	11.29	21,800	23	1.78
1933	1933 3, 1932	11.55	22,600	22	1.86
1934	Dec. 21, 1933	15.00	45,700	3	13.67
	Change in datum				
1935	Jan. 23, 1935	17.10	38,000	4	10.25
1936	Jan. 13, 1936	16.77	36,300	7	5.86
1937	Apr. 15, 1937	14.33	24,300	17	2.41
1938	Dec. 29, 1937	18.39	48,400	1	41.00
1939	Feb. 16, 1939	14.39	24,800	15	2.73
1940	Dec. 17, 1939	13.90	22,700	21	1.95
1941	Jan. 19, 1941	12.69	18,800	29	1.41
1942	Dec. 20, 1941	15.30	26,900	12	3.42
1943	Feb. 7, 1943	13.23	20,200	25	1.64
1944	Dec. 4, 1943	12.30	16,400	31	1.32
1945	Feb. 9, 1945	15.29	27,000	11	3.73
1946	Dec. 30, 1945	14.33	23,100	20	2.05
1947	Jan. 26, 1947	14.57	24,200	18	2.28
1948	Jan. 3, 1948	13.57	20,000	26	1.58
1949	Feb. 18, 1949	16.70	36,500	6	6.83
1950	Feb. 26, 1950	15.40	26,300	13	3.15
1951	Feb. 10, 1951	16.96	32,700	8	5.12

CHEHALIS RIVER BASIN

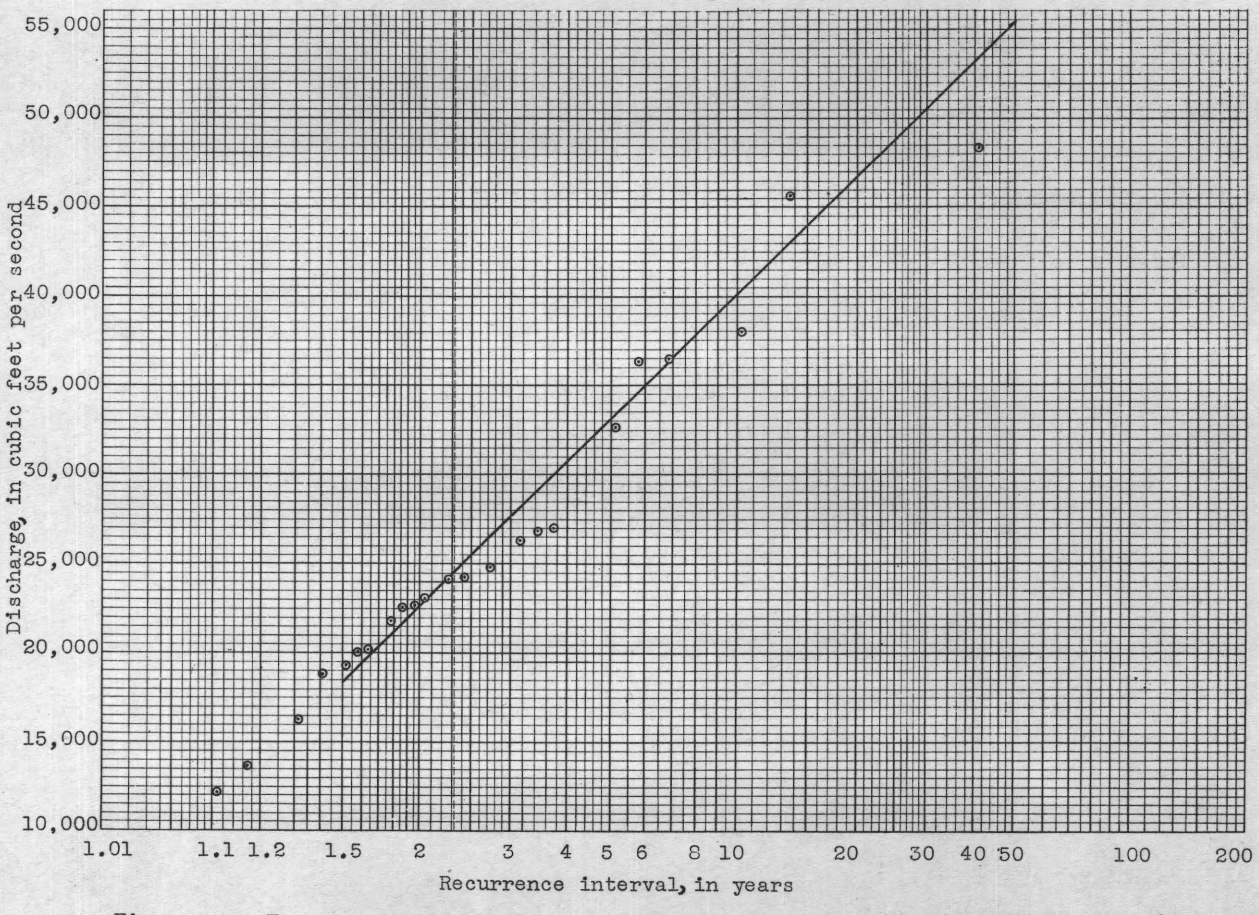

Figure 16.--Frequency of annual floods, Chehalis River near Grand Mound, Wash.

(32) Chehalis River at South Elma, Wash.

Location.--Lat 46°49'00", long. 123°24'40", in NE¼NE¼ sec. 10, T. 17 N., R. 6 W., at county bridge at South Elma, 1.1 mi downstream from Cloquallum Creek. Prior to April 1, 1947, at site 200 ft downstream at same datum.

Drainage area.--1,420 sq mi.

Gage.--Nonrecording read twice daily prior to April 1, 1947; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 35,000 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1947	Jan. 26, 1947	74.62	28,000
1948	Jan. 5, 1948	72.40	24,400
1949	Feb. 24, 1949	76.23	35,600
1950	Feb. 27, 1950	75.90	34,500
1951	Feb. 11, 1951	76.95	38,800

CHEHALIS RIVER BASIN

(33) Elk Creek near Doty, Wash.

Location.--Lat 46°37'40", long. 123°19'50", in NW¼ sec. 8, T. 13 N., R. 5 W., half a mile upstream from Nine Creek, 1 mi upstream from Deer Creek, and 2½ mi west of Doty.

Drainage area.--46.7 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,600 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 7, 1945	6.16	1,370
1946	Dec. 28, 1945	6.88	1,720
1947	Dec. 11, 1946	7.06	1,820
1948	Mar. 21, 1948	6.12	1,320
1949	Feb. 22, 1949	8.21	2,380
1950	Dec. 28, 1949	7.03	1,770

(34) South Fork Chehalis River at Boistfort, Wash.

Location.--Lat 46°32'45", long. 123°07'55", in NW¼NW¼ sec. 12, T. 12 N., R. 4 W., a quarter of a mile south of Boistfort and 6 mi upstream from mouth.

Drainage area.--49.2 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,500 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 7, 1945	11.57	4,680
1946	Dec. 29, 1945	8.06	2,560
1947	Feb. 2, 1947	8.39	2,720
1948	Jan. 2, 1948	8.20	2,630
1949	Feb. 17, 1949	10.78	4,190
1950	Nov. 27, 1949	9.77	3,590

CHEHALIS RIVER BASIN

(35) Skookumchuck River near Centralia, Wash.

Location.--Lat 46°47'15", long. 122°42'45", in SW¼NW¼ sec. 17, T. 15 N., R. 1 E., half a mile upstream from Bloody Run Creek, 4½ mi upstream from Thompson Creek, and 12 mi northeast of Centralia.

Drainage area.--60 sq mi.

Gage.--Recording. Datum of gage is 300.0 ft above mean sea level (river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 3,300 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Mar. 22, 1930	6.04	1,840
1931	Mar. 31, 1931	7.50	3,240
	Change in datum		
1940	Dec. 15, 1939	44.72	2,740
1941	Jan. 18, 1941	43.63	1,880
1942	Dec. 19, 1941	46.18	3,800
1943	Nov. 23, 1942	45.19	2,930
1944	Dec. 3, 1943	44.97	2,780
1945	Feb. 7, 1945	45.31	3,080
1946	Dec. 28, 1945	45.33	3,080
1947	Dec. 11, 1946	46.27	3,880
1948	Mar. 22, 1948	46.27	3,880
1949	Feb. 17, 1949	48.39	5,770
1950	Dec. 28, 1949	47.30	4,780
1951	Feb. 9, 1951	46.06	3,720

(36) Black River at Little Rock, Wash.

Location.--Lat 46°54'10", long. 123°01'20", in NE¼SW¼ sec. 2, T. 16 N., R. 3 W., at bridge crossing in Little Rock 0.4 mi upstream from Beaver Creek.

Drainage area.--64 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 720 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 8, 1945	5.11	840
1946	Jan. 4, 1946	5.23	840
1947	Jan. 25, 1947	6.44	1,220
1948	Jan. 4, 1948	4.96	695
1949	Feb. 23, 1949	6.50	1,350
1950	Dec. 28, 1949	7.39	1,720

CHEHALIS RIVER BASIN

(37) Cloquallum River at Elma, Wash.

Location.--Lat 47°00'20", long. 123°23'10", in S½NW¼ sec. 36, T. 18 N., R. 6 W., half a mile east of Elma and 1.8 mi downstream from Wildcat Creek.

Drainage area.--66 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,750 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions and regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 7, 1945	8.70	3,050
1946	Dec. 28, 1945	7.80	2,440
1947	Jan. 25, 1947	9.53	3,290
1948	Mar. 22, 1948	6.95	1,810
1949	Feb. 22, 1949	9.24	3,110
1950	Dec. 28, 1949	10.07	3,720
1951	Feb. 9, 1951	11.06	4,510

(38) Satsop River near Satsop, Wash.

Location.--Lat 47°00'05", long. 123°29'40", in sec. 36, T. 18 N., R. 7 W., 1 mi west of Satsop and 1½ mi upstream from mouth.

Drainage area.--315 sq mi.

Gage.--Nonrecording gage read once daily prior to March 1938; recording thereafter. Datum of recording gage is at mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 35,000 cfs and extended by logarithmic plotting.

Remarks.--Maximum stages for period of nonrecording gage are from graphs based on gage readings. No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Dec. 23, 1929	10.0	11,300
1931	Jan. 23, 1931	13.2	19,200
1932	Feb. 26, 1932	15.8	27,000
1933	Jan. 8, 1933	11.5	15,300
1934	Dec. 21, 1933	14.4	24,500
1935	Jan. 22, 1935	18.0	52,500
1936	Jan. 4, 1936	11.0	16,600
1937	Apr. 14, 1937	10.5	15,200
1938	Dec. 28, 1937	14.3	30,100
	Change in datum		
1939	Jan. 1, 1939	33.91	25,600
1940	Dec. 15, 1939	32.14	18,700
1941	Jan. 18, 1941	33.81	25,200
1942	Dec. 19, 1941	30.23	13,200
1943	Apr. 1, 1943	29.96	13,100
1944	Dec. 3, 1943	32.64	19,900
1945	Feb. 7, 1945	35.30	28,000
1946	Apr. 11, 1946	31.73	17,200
1947	Jan. 25, 1947	34.00	24,000
1948	Oct. 19, 1947	32.06	17,300
1949	Feb. 22, 1949	34.90	27,000
1950	Dec. 28, 1949	34.80	26,600
1951	Feb. 9, 1951	36.90	36,500

CHEHALIS RIVER BASIN

(39) Wynoochee River at Oxbow, near Aberdeen, Wash.

Location.--Lat 47°19'30", long. 123°38'20", in sec. 12, T. 21 N., R. 8 W., 1 mi downstream from Oxbow and 24 mi northeast of Aberdeen.

Drainage area.--About 65 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 4,800 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1926	Dec. 11, 1925	20.0	8,350
1927	Oct. 26, 1926	19.3	7,790
1928	Jan. 12, 1928	21.9	9,910
1929	Mar. 28, 1929	16.3	5,560
1930	Dec. 23, 1929	19.4	7,870
1931	Jan. 22, 1931	23.1	11,000
1932	Feb. 26, 1932	25.2	12,900
1933	Nov. 12, 1932	21.1	9,230
1934	Dec. 21, 1933	26.3	14,000
1935	Jan. 22, 1935	30.3	18,000
1936	Jan. 1, 1936	18.13	6,830
1937	Dec. 22, 1936	20.55	8,830
1938	Oct. 28, 1937	23.2	11,100
1939	Jan. 1, 1939	25.55	13,300
1940	Dec. 15, 1939	24.6	11,400
1941	Jan. 17, 1941	23.47	10,600
1942	Dec. 2, 1941	21.90	9,270
1943	Apr. - 1943	-	7,000
1944	Dec. 3, 1943	22.25	9,510
1945	Feb. 7, 1945	26.2	12,800
1946	Feb. 24, 1946	18.60	6,820
1947	Feb. 13, 1947	22.50	9,750
	Change in datum		
1948	Oct. 18, 1947	15.32	10,700
1949	Feb. 22, 1949	11.94	8,630
1950	Nov. 26, 1949	25.46	16,400
1951	Feb. 10, 1951	21.15	14,200

(40) Wynoochee River below Black Creek, near Montesano, Wash.

Location.--Lat 47°00'35", long. 123°39'00", in NW¼NW¼ sec. 35, T. 18 N., R. 8 W., at county road bridge 500 ft downstream from Black Creek and 2½ mi northwest of Montesano.

Drainage area.--179 sq mi.

Gage.--Nonrecording gage read once daily prior to July 9, 1947; recording to November 13, 1949.

Stage-discharge relation.--Defined by current-meter measurements below 14,500 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversion at flood stage. No regulation. Peak for 1951 obtained from high-water mark.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1942	Dec. 3, 1941	-	16,100
1943	Apr. 2, 1943	77.90	10,000
1944	Dec. 3, 1943	81.52	15,100
1945	Feb. 8, 1945	82.65	16,600
1946	Apr. 11, 1946	78.15	11,000
1947	Feb. 14, 1947	81.19	15,800
1948	Oct. 19, 1947	79.78	13,400
1949	Feb. 22, 1949	80.74	16,200
1951	Feb. 9, 1951	85.4	22,600

QUINAULT RIVER BASIN

(41) Quinault River at Quinault Lake, Wash.

Location.--Lat 47°27'30", long. 123°53'30", in sec. 25, T. 23 N., R. 10 W., at outlet of Quinault Lake and 4 mi southwest of Quinault.

Drainage area.--264 sq mi.

Gage.--Nonrecording gage read twice daily prior to October 1916; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 37,500 cfs and extended by logarithmic plotting. Relation for early floods was poorly defined.

Remarks.--For period of nonrecording gage, the maximum stages are from graphs based on gage readings. No diversion. Natural regulation by Quinault Lake.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1912	Nov. 18, 1911	12.2	21,800	16	2.56
1913	Nov. 19, 1912	8.2	12,000	36	1.14
1914	Jan. 6, 1914	16.3	32,500	6	6.83
1915	Oct. 19, 1914	10.0	16,200	27	1.52
1916	Dec. 8, 1915	11.2	19,200	22	1.86
		Change in datum			
1917	Nov. 4, 1916	5.76	6,750	40	1.02
1918	Dec. 18, 1917	14.83	32,300	7	5.86
1919	Dec. 14, 1918	12.08	23,800	13	3.15
1920	Nov. 15, 1919	11.66	22,600	15	2.73
1921	Feb. 11, 1921	10.95	20,400	19	2.16
1922	Dec. 12, 1921	16.30	37,000	3	13.67
1926	Dec. 23, 1925	9.14	14,800	32	1.28
1927	Oct. 16, 1926	9.10	14,800	33	1.24
1928	Jan. 12, 1928	9.87	17,100	25	1.64
1929	Nov. 13, 1928	7.44	10,300	39	1.05
1930	Feb. 5, 1930	7.95	11,800	37	1.11
1931	Jan. 23, 1931	11.2	21,000	18	2.28
1932	Feb. 27, 1932	13.5	28,100	8	5.12
1934	Dec. 21, 1933	-	35,000	5	8.20
1935	Jan. 24, 1935	16.0	36,100	4	10.25
		Change in datum			
1936	Jan. 4, 1936	9.17	11,800	38	1.08
1937	Dec. 22, 1936	10.79	16,100	28	1.46
1938	Dec. 29, 1937	12.86	23,400	14	2.93
1939	Jan. 1, 1939	14.06	27,600	9	4.56
1940	Dec. 15, 1939	12.91	21,500	17	2.41
1941	Oct. 19, 1940	11.12	16,000	29	1.41
1942	Dec. - 1941	-	15,500	30	1.37
1943	Apr. 2, 1943	9.97	13,100	35	1.17
1944	Dec. 3, 1943	12.32	19,600	21	1.95
1945	Feb. 8, 1945	14.69	27,500	10	4.10
1946	Nov. 15, 1945	10.37	14,100	34	1.21
1947	Feb. 14, 1947	14.63	27,100	11	3.73
1948	Oct. 19, 1947	11.54	17,100	26	1.58
1949	Feb. 23, 1949	10.78	15,200	31	1.32
1950	Nov. 27, 1949	18.60	42,300	1	41.00
1951	Feb. 10, 1951	17.29	37,100	2	20.50

QUINAULT RIVER BASIN

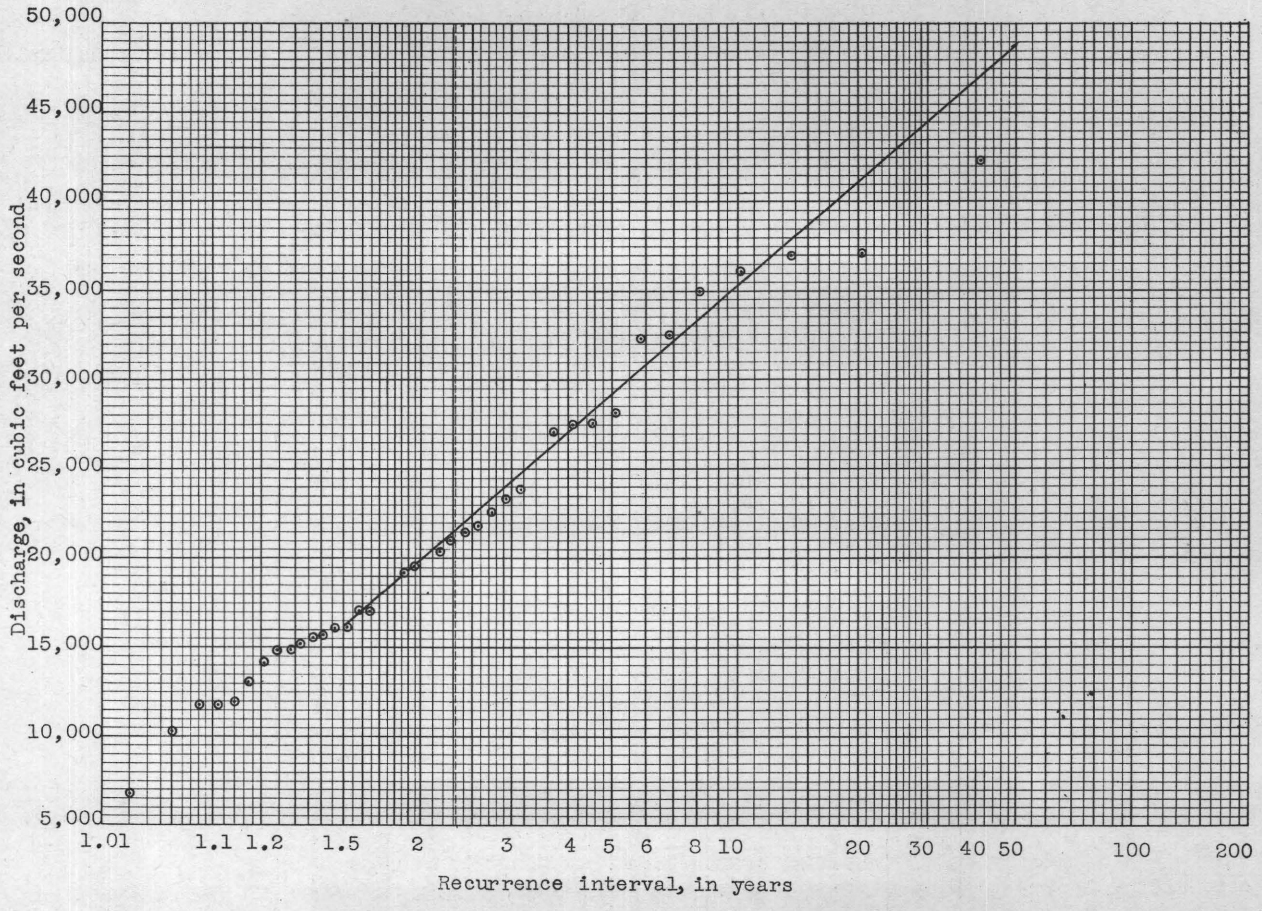

Figure 17.--Frequency of annual floods, Quinault River at Quinault Lake, Wash.

QUEETS RIVER BASIN

(42) Queets River near Clearwater, Wash.

Location.--Lat 47°32', long. 124°19', in SW¼ sec. 36, T. 24 N., R. 13 W., on Quinault Indian Reservation, 2 mi downstream from Clearwater River and 4 mi southwest of Clearwater.

Drainage area.--454 sq mi.

Gage.--Recording. Datum of gage is 14.5 ft above mean sea level (river-profile survey).

Stage discharge relation.--Defined by current-meter measurements below 25,000 cfs and extended by slope-area method.

Remarks.--No diversion or regulation. Peak for 1950 obtained from high-water mark.

QUEETS RIVER BASIN

(42) Queets River near Clearwater, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1931	Jan. 23, 1931	14.07	46,000
1932	Feb. 26, 1932	18.3	70,100
1933	Nov. 12, 1932	14.3	47,200
1934	Dec. 21, 1933	15.2	52,100
1935	Jan. 22, 1935	23.0	100,000
	Change in datum		
1936	Jan. 4, 1936	16.81	33,700
1937	Dec. 22, 1936	17.80	37,900
1938	Dec. 28, 1937	20.5	57,500
1939	Jan. 1, 1939	20.29	57,600
1940	Dec. 15, 1939	19.19	50,800
1941	Jan. 17, 1941	19.56	53,200
1942	Dec. 22, 1941	18.70	47,800
1943	Apr. 2, 1943	16.77	36,900
1944	Dec. 3, 1943	19.65	53,200
1945	Feb. 7, 1945	22.08	70,000
1946	Nov. 14, 1945	17.60	41,400
1947	Jan. 25, 1947	20.00	55,700
1948	Oct. 18, 1947	20.42	58,300
1949	Feb. 17, 1949	20.15	57,000
1950	Nov. 25, 1949	23.57	92,500

(43) Clearwater River near Clearwater, Wash.

Location.--Lat 47°35', long. 124°18', in lot 4, sec. 18, T. 24 N., R. 12 W., 1½ mi north of Clearwater and 3 mi upstream from mouth. Prior to September 1932 at site a quarter of a mile upstream.

Drainage area.--140 sq mi.

Gage.--Recording. Datum of gage is 60.0 ft above mean sea level, unadjusted.

Stage-discharge relation.--Defined by current-meter measurements below 7,000 cfs and extended by slope-area method.

Remarks.--No diversion or regulation. Peaks for 1950-51 obtained from high-water marks.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1932	Feb. 26, 1932	15.50	21,000
	Change in datum		
1938	Oct. 28, 1937	14.90	17,000
1939	Jan. 1, 1939	14.44	16,000
1940	Dec. 14, 1939	13.88	15,000
1941	Jan. 17, 1941	14.51	16,100
1942	Dec. 2, 1941	12.83	12,200
1943	Oct. 30, 1942	12.24	11,100
1944	Dec. 2, 1943	14.87	16,200
1946	Nov. 14, 1945	13.27	13,400
1948	Jan. 1, 1948	14.38	15,800
1949	Feb. 16, 1949	17.38	21,500
1950	Nov. 25, 1949	19.2	26,500
1951	Feb. - 1951	17.75	23,400

HOH RIVER BASIN

(44) Hoh River near Spruce, Wash.

Location.--Lat 47°48'20", long. 124°07'20", in sec. 34, T. 27 N., R. 11 W., 2½ mi downstream from Spruce and 5 mi downstream from South Fork.

Drainage area.--193 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 13,000 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1927	Oct. 16, 1926	12.6	15,600
1928	Jan. 12, 1928	13.13	16,800
1929	Oct. 8, 1928	11.04	11,900
1930	Feb. 18, 1930	10.96	11,900
1931	Jan. 22, 1931	14.12	19,400
1932	Feb. 26, 1932	15.4	22,800
1933	Nov. 12, 1932	13.36	17,600
1934	Dec. 21, 1933	17.3	28,600
1935	Nov. 5, 1934	21.2	40,000
1936	Jan. 4, 1936	9.85	9,840
1937	Dec. 22, 1936	12.23	15,000
1938	Oct. 28, 1937	15.36	21,500
1939	Jan. 1, 1939	14.92	20,200
1940	Dec. 15, 1939	15.08	20,700
1941	Jan. 17, 1941	13.24	16,000
1942	Dec. 2, 1941	15.48	21,800
1943	Oct. 31, 1942	10.68	11,000
1944	Dec. 3, 1943	13.85	17,400
1945	Feb. 7, 1945	13.79	17,400
1946	Nov. 15, 1945	9.79	9,580
1947	Feb. 13, 1947	12.79	15,700
1948	Oct. 18, 1947	14.39	19,400
1949	Feb. 22, 1949	10.86	12,200
1950	Nov. 25, 1949	22.2	38,700
1951	Feb. 10, 1951	15.20	21,500

QUILLAYUTE RIVER BASIN

(45) Soleduck River near Fairholm, Wash.

Location.--Lat 48°02'30", long. 123°57'30", in lot 4, sec. 35, T. 30 N., R. 10 W., 300 ft downstream from South Fork, 2½ mi southwest of Fairholm, and 17 mi west of Beaver.

Drainage area.--84 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 5,200 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1918	Dec. 18, 1917	11.7	14,700
1919	Dec. 4, 1918	10.4	12,300
1920	Nov. 15, 1919	8.8	9,500
1921	Feb. 11, 1921	9.5	10,700
1922	Oct. 28, 1921	12.5	16,200
1934	Dec. 21, 1933	14.9	18,400
1935	Nov. 5, 1934	14.4	17,600
1936	Jan. 4, 1936	6.48	4,000
1937	Dec. 22, 1936	9.26	8,030
1938	Dec. 28, 1937	11.06	11,400
1939	Jan. 1, 1939	9.73	9,100
1940	Dec. 15, 1939	9.74	9,150
1941	Jan. 17, 1941	8.97	7,800
1942	Dec. 2, 1941	9.48	8,700
1943	Nov. 23, 1942	7.04	4,800
1944	Dec. 3, 1943	8.17	6,400
1945	Feb. 7, 1945	12.34	13,700
1946	Nov. 14, 1945	8.00	5,200
1947	Feb. 13, 1947	8.60	7,200
1948	Oct. 18, 1947	8.89	7,700
1949	Dec. 1, 1948	7.02	4,800
1950	Nov. 25, 1949	16.42	21,400
1951	Feb. 9, 1951	10.40	10,300

ELWHA RIVER BASIN

(46) Elwha River at McDonald Bridge near Port Angeles, Wash.

Location.--Lat 48°03'20", long. 123°34'55", in NE¼NW¼ sec. 33, T. 30 N., R. 7 W., at site of McDonald Bridge (now removed), half a mile upstream from Little River, 7 mi upstream from mouth, and 8 mi southwest of Port Angeles.

Drainage area.--262 sq mi.

Gage.--Recording. Datum of gage since 1936 is 200.00 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 12,000 cfs and extended by computation of flow over dam.

Remarks.--No diversions. Partial regulation by Glines Canyon Reservoir on Elwha River since 1927 (usable capacity 38,650 acre-ft).

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1920	Nov. 15, 1919	6.7	6,500
1921	Feb. 11, 1921	6.9	10,100
1922	Dec. 12, 1921	9.4	16,200
1923	Dec. 24, 1922	6.3	8,900
1924	Jan. 31, 1924	7.7	13,000
1925	Nov. 19, 1924	6.1	8,680
1926	Dec. 11. 1925	5.15	6,070
1927	Dec. 2, 1926	5.7	6,500
1928	Jan. 12, 1928	6.9	8,600
1929	Oct. 9, 1928	6.65	8,200
1930	Feb. 18, 1930	5.7	6,440
1931	Jan. 23, 1931	7.3	9,640
1932	Feb. 26, 1932	8.37	12,200
1933	Nov. 12, 1932	7.3	9,640
1934	Dec. 21, 1933	10.5	26,700
1935	Nov. 5, 1934	10.17	25,200
1936	Jan. 4, 1936	5.47	4,680
	Change in datum		
1937	Dec. 22, 1936	16.10	8,870
1938	Dec. 28, 1937	19.6	18,600
1939	Jan. 1, 1939	19.0	17,100
1940	Dec. 15, 1939	18.44	15,600
1941	Jan. 17, 1941	16.29	10,800
1942	Dec. 2, 1941	19.05	17,100
1943	Apr. 2, 1943	14.20	6,770
1944	Dec. 3, 1943	15.93	10,000
1945	Feb. 7, 1945	17.70	14,000
1946	Dec. 28, 1945	13.68	5,910
1947	Feb. 13, 1947	17.48	13,000
1948	Oct. 18, 1947	19.31	18,000
1949	Nov. 28, 1948	13.40	5,370
1950	Nov. 26, 1949	24.2	30,000
1951	Feb. 9, 1951	17.90	14,300

DUNGENESS RIVER BASIN

(47) Dungeness River near Sequim, Wash.

Location.--Lat 48°00'40", long. 123°07'50", in SW¼SE¼ sec. 12, T. 29 N., R. 4 W., three-quarters of a mile upstream from Canyon Creek, 4½ mi southwest of Sequim, and 11½ mi upstream from mouth.

Drainage area.--156 sq mi.

Gage.--Nonrecording gage read once daily prior to August 1937; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 1,900 cfs and extended by slope-area method.

Remarks.--Maximum stages for period of nonrecording gage are from graphs based on gage readings. No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1924	Feb. 11, 1924	7.0	6,340
1925	Nov. 19, 1924	4.6	3,120
1926	Dec. 23, 1925	3.0	740
1927	Dec. 1, 1926	4.3	2,860
1928	Jan. 12, 1928	3.1	1,400
1929	June 15, 1929	2.9	1,000
1930	Feb. 20, 1930	3.2	920
	Change in datum		
1938	Dec. 28, 1937	6.85	5,380
1939	Jan. 1, 1939	6.17	3,850
1940	Dec. 15, 1939	6.27	4,010
1941	Jan. 17, 1941	5.47	2,400
1942	Dec. 2, 1941	6.28	4,120
1943	May 26, 1943	4.39	1,010
1944	Dec. 3, 1943	4.84	1,520
1945	Feb. 7, 1945	5.96	3,380
1946	June 14, 1946	4.57	1,200
1947	Feb. 12, 1947	5.48	2,530
1948	Oct. 19, 1947	5.65	2,790
1949	Dec. 1, 1948	5.73	2,820
1950	Nov. 27, 1949	7.3	6,820
1951	Feb. 9, 1951	6.53	4,830

DOSEWALLIPS RIVER BASIN

(48) Dosewallips River near Brinnon, Wash.

Location.--Lat 47°43', long. 123°00', in SW¼ sec. 24, T. 26 N., R. 3 W., half a mile upstream from Corrigenda ranger station, 5½ mi northwest of Brinnon, and 7½ mi upstream from mouth.

Drainage area.--94 sq mi.

Gage.--Nonrecording gage read once daily prior to October 1931; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 4,500 cfs and extended by slope-area method.

Remarks.--Records for 1929-30 were obtained at site 5 mi downstream. No diversion or regulation. Peak for 1950 obtained from high-water mark.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	Nov. 12, 1928	3.8	2,200
1930	Feb. 20, 1930	3.9	2,350
	Change in datum		
1931	Jan. 23, 1931	6.7	4,790
1932	Feb. 26, 1932	6.74	4,790
1933	Nov. 13, 1932	6.30	4,050
1934	Dec. 21, 1933	7.42	5,980
1935	Nov. 5, 1934	9.57	10,600
1936	June 16, 1936	5.35	2,460
1937	Dec. 22, 1936	4.96	1,980
1938	Dec. 28, 1937	6.30	3,870
1939	Jan. 1, 1939	6.50	4,220
1940	Dec. 8, 1939	6.56	4,310
1941	Oct. 20, 1940	6.06	3,400
1942	Dec. 2, 1941	7.64	6,370
1943	Apr. 2, 1943	4.62	1,580
1944	Dec. 3, 1943	5.99	3,410
1945	Feb. 7, 1945	6.91	4,950
1946	June 14, 1946	4.76	1,780
1947	Feb. 12, 1947	6.14	3,650
1948	Oct. 18, 1947	7.27	5,740
1949	May 12, 1949	4.81	1,830
1950	Nov. 26, 1949	9.92	13,200

DUCKABUSH RIVER BASIN

(49) Duckabush River near Brinnon, Wash.

Location.--Lat 47°41'00", long. 123°00'40", in SW¼SW¼ sec. 1, T. 25 N., R. 3 W., 4½ mi upstream from mouth and 5 mi west of Brinnon.

Drainage area.--66 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,700 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1939	Jan. 1, 1939	7.39	4,960
1940	Dec. 15, 1939	8.07	6,080
1941	Oct. 23, 1940	7.22	4,750
1942	Dec. 2, 1941	8.07	6,080
1943	Apr. 2, 1943	5.50	2,700
1944	Dec. 3, 1943	6.42	3,790
1946	Dec. 3, 1945	5.47	2,530
1947	Feb. 12, 1947	7.54	5,370
1948	Oct. 18, 1947	7.90	5,970
1949	Mar. 19, 1949	5.37	2,410
1950	Nov. 26, 1949	10.06	8,960
1951	Feb. 9, 1951	7.20	4,280

SKOKOMISH RIVER BASIN

(50) North Fork Skokomish River below Staircase Rapids, near Hoodsport, Wash.

Location.--Lat 47°30'55", long. 123°19'45", in NW¼ sec. 4, T. 23 N., R. 5 W., three-quarters of a mile upstream from Lake Cushman, 2 mi upstream from Dry Creek, and 11½ mi northwest of Hoodsport.

Drainage area.--60 sq mi.

Gage.--Recording except for period October 1935 to November 1941, when nonrecording gage was read once daily.

Stage-discharge relation.--Defined by current-meter measurements below 1,500 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1925	Feb. 2, 1925	6.88	4,400
1926	Dec. 11, 1925	6.80	4,250
1927	Dec. 1, 1926	7.50	5,350
1928	Jan. 3, 1928	6.70	4,100
1929	Nov. 9, 1928	5.49	2,540
1930	Dec. 14, 1929	6.62	4,050
1931	Jan. 22, 1931	8.67	8,830
1932	Dec. 19, 1931	7.38	5,950
1933	Nov. 12, 1932	6.90	4,940
1934	Dec. 21, 1933	10.0	11,300
1935	Nov. 5, 1934	14.4	23,300
1936	June 17, 1936	5.32	2,410
1937	Dec. 22, 1936	6.85	4,840
1938	Oct. 28, 1937	9.3	10,200
1939	Jan. 1, 1939	8.60	8,580
1940	Dec. 15, 1939	-	9,000
1941	Jan. 17, 1941	7.77	6,830
1942	Dec. 2, 1941	9.18	8,300
1943	Apr. 2, 1943	7.02	4,400
1944	Dec. 3, 1943	7.66	5,540
1945	Feb. 7, 1945	10.10	10,100
1946	Nov. 14, 1945	6.20	3,140
1947	Feb. 12, 1947	8.02	5,580
1948	Oct. 18, 1947	9.30	7,810
1949	Feb. 22, 1949	5.69	2,530
1950	Nov. 26, 1949	12.20	24,200
1951	Feb. 10, 1951	7.70	7,030

SKOKOMISH RIVER BASIN

(51) South Fork Skokomish River near Union, Wash.

Location.--Lat 47°20'30", long. 123°16'30", in NE¼ sec. 2, T. 21 N., R. 5 W., 2½ mi upstream from North Fork, 5 mi upstream from Vance Creek, and 8 mi west of Union.

Drainage area.--81 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 5,500 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Records for 1924-31 computed on basis of records for South Fork Skokomish River near Potlatch, Wash.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1924	Jan. 31, 1924	-	11,800	14	2.93
1925	Feb. 1, 1925	-	9,160	20	2.05
1926	Dec. 11, 1925	-	5,300	34	1.21
1927	Dec. 1, 1926	-	5,800	33	1.24
1928	Jan. 12, 1928	-	5,900	31	1.32
1929	Mar. 28, 1929	-	3,500	39	1.05
1930	Dec. 22, 1929	-	5,300	35	1.17
1931	Jan. 22, 1931	-	10,600	15	2.73
1932	Feb. 26, 1932	9.27	13,000	11	3.73
1933	Nov. 13, 1932	8.16	6,740	28	1.46
1934	Dec. 21, 1933	10.9	16,500	7	5.86
1935	Jan. 22, 1935	11.0	21,600	1	41.00
1936	Feb. 27, 1936	8.21	5,830	32	1.28
1937	Dec. 22, 1936	9.46	10,000	17	2.41
1938	Dec. 28, 1937	10.31	13,800	10	4.10
1939	Jan. 1, 1939	9.86	13,900	9	4.56
1940	Dec. 15, 1939	10.3	17,200	6	6.83
1941	Jan. 17, 1941	9.73	12,500	13	3.15
1942	Dec. 2, 1941	10.43	17,600	5	8.20
1943	Mar. 27, 1943	8.74	8,540	22	1.86
1944	Dec. 3, 1943	8.79	8,470	23	1.78
1945	Feb. 7, 1945	10.70	19,400	2	20.50
1946	Feb. 24, 1946	7.65	4,920	36	1.14
1947	Feb. 13, 1947	8.47	8,160	25	1.64
1948	Oct. 18, 1947	8.95	9,730	19	2.16
1949	Feb. 22, 1949	8.00	6,290	29	1.41
1950	Nov. 26, 1949	11.00	13,000	12	3.42
1951	Feb. 9, 1951	9.00	8,400	24	1.71

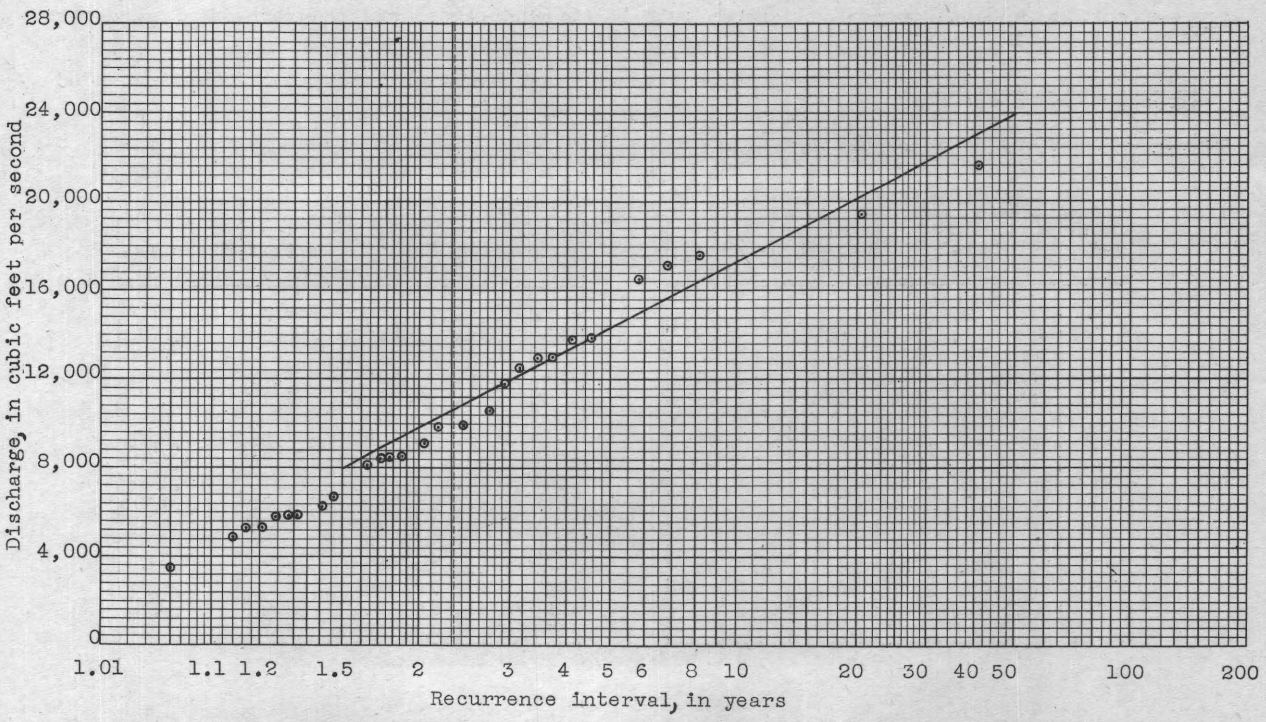

Figure 18.--Frequency of annual floods, South Fork Skokomish River near Union, Wash.

MISSION CREEK BASIN

(52) Mission Creek near Bremerton, Wash.

Location.--Lat 47°32', long. 122°50', in NE¼NW¼ sec. 32, T. 24 N., R. 1 W., on Mission Lake, 300 ft upstream from lake outlet and 9½ mi west of Bremerton.

Drainage area.--1.9 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 86 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Jan. 5, 1946	4.72	38
1947	Feb. 14, 1947	5.11	51
1948	Jan. 2, 1948	4.71	38
1949	Feb. 22, 1949	6.36	96
1950	Nov. 27, 1949	4.54	90
1951	Feb. 9, 1951	4.62	100

(53) Mission Creek near Belfair, Wash.

Location.--Lat 47°29'20", long. 122°51'40", in NW¼ sec. 18, T. 23 N., R. 1 W., 3 mi northwest of Belfair and 5 mi upstream from mouth.

Drainage area.--4.4 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 130 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Jan. 4, 1946	3.71	93
1947	Feb. 14, 1947	4.30	140
1948	Jan. 2, 1948	3.71	96
1949	Feb. 22, 1949	6.10	403
1950	Nov. 27, 1949	4.80	212
1951	Feb. 9, 1951	5.20	264

TAHUYA RIVER BASIN

(54) Tahuya River near Bremerton, Wash.

Location.--Lat 47°33'00", long. 122°50'30", in SE¼SE¼ sec. 19, T. 24 N., R. 1 W., 1¼ mi downstream from Tahuya Lake and 10 mi west of Bremerton.

Drainage area.--6.1 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 360 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Apr. 11, 1946	3.26	161
1947	Feb. 14, 1947	4.04	314
1948	Oct. 19, 1947	3.94	248
1949	Feb. 22, 1949	5.28	424
1950	Nov. 27, 1949	5.58	450
1951	Feb. 9, 1951	5.45	500

(55) Gold Creek near Bremerton, Wash.

Location.--Lat 47°33'20", long. 122°48'30", in NE¼SW¼ sec. 21, T. 24 N., R. 1 W., about 1 mi upstream from mouth and 7 mi west of Bremerton.

Drainage area.--1.5 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 54 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Apr. 11, 1946	2.28	65
1947	Feb. 2, 1947	2.74	106
1948	Oct. 18, 1947	2.95	123
1949	Feb. 22, 1949	3.27	164
1950	Nov. 26, 1949	3.17	190
1951	Feb. 9, 1951	2.80	140

TAHUYA RIVER BASIN

(56) Panther Creek near Bremerton, Wash.

Location.--Lat 47°31'40", long. 122°52'00", in NW¼ sec. 31, T. 24 N., R. 1 W., half a mile downstream from Panther Lake and 11 mi west of Bremerton.

Drainage area.--1 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 35 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Apr. 11, 1946	1.94	30
1947	Feb. 14, 1947	2.14	43
1948	Oct. 18, 1947	1.98	43
1949	Feb. 22, 1949	3.02	203
1950	Nov. 26, 1949	2.50	110
1951	Feb. 9, 1951	2.78	80

DESCHUTES RIVER BASIN

(57) Deschutes River near Olympia, Wash.

Location.--Lat 47°00'40", long. 122°53'40", in NW¼SE¼ sec. 35, T. 18 N., R. 2 W., 1⅔ mi upstream from mouth and 2½ mi south of Olympia.

Drainage area.--164 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 3,350 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 29, 1945	7.32	2,800
1947	Jan. 26, 1947	7.95	3,560
1948	Mar. 22, 1948	7.12	2,950
1949	Feb. 18, 1949	8.00	3,860
1951	Feb. 10, 1951	7.98	4,100

NISQUALLY RIVER BASIN

(58) Nisqually River near National, Wash.

Location.--Lat 46°45'50", long. 122°05'00", in SW¼SW¼ sec. 29, T. 15 N., R. 6 E., 100 ft downstream from railroad bridge, 1 mi west of National, 2½ mi west of Ashford, and 3 mi upstream from Mineral Creek.

Drainage area.--133 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 4,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Negligible regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1943	Nov. 23, 1942	9.96	6,870
1944	Dec. 3, 1943	8.74	4,830
1945	Jan. 7, 1945	9.00	5,280
1946	Dec. 28, 1945	8.76	5,000
1947	Dec. 11, 1946	10.34	7,230
1948	Nov. 8, 1947	8.46	5,560
1949	May 13, 1949	6.78	3,010
1950	Nov. 27, 1949	9.60	6,910
1951	Feb. 11, 1951	8.77	7,170

(59) Nisqually River at La Grande, Wash.

Location.--Lat 46°50'30", long. 122°19'40", in SE¼ sec. 29, T. 16 N., R. 4 E., half a mile downstream from city of Tacoma power plant, and three-quarters of a mile upstream from Mashel River.

Drainage area.--296 sq mi.

Gage.--Nonrecording gage used on 1907 and 1910; recording gage thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 13,000 cfs and extended by logarithmic plotting.

Remarks.--No diversions. Flood stages regulated by Alder Reservoir since November 1944 (usable capacity 158,700 acre-ft). Records for 1907, 1910, 1920-25, 1928-31 at site 3 mi upstream published as Nisqually River near La Grande. Records for 1932-44 computed on basis of records of Nisqually River near Alder.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1907	Nov. 15, 1906	19.1	16,600	-	-
1910	Mar. 2, 1910	14.2	10,600	-	-
	Change in datum				
1920	Dec. 24, 1919	-	11,000	20	2.05
1921	Dec. 30, 1920	12.8	11,800	13	3.15
1922	Dec. 12, 1921	15.6	19,500	2	20.50
1923	Jan. 7, 1923	14.2	16,100	8	5.12
1924	Feb. 12, 1924	12.7	12,400	11	3.73
1925	Feb. 3, 1925	11.0	8,610	27	1.52
1928	Nov. 25, 1927	-	11,300	16	2.56
1929	Dec. 10, 1928	-	4,590	39	1.05
1930	Dec. 14, 1929	-	6,070	35	1.17
1931	Mar. 31, 1931	-	10,700	21	1.95
1932	Feb. 26, 1932	-	17,200	5	8.20
1933	Nov. 13, 1932	-	14,800	10	4.10
1934	Dec. 22, 1933	-	29,400	1	41.00
1935	Oct. 25, 1934	-	16,900	6	6.83
1936	Jan. 12, 1936	-	7,320	33	11.24
1937	Apr. 14, 1937	-	9,520	25	1.64
1938	Apr. 18, 1938	-	11,300	17	2.41
1939	Jan. 2, 1939	-	7,820	30	1.37
1940	Dec. 15, 1939	-	11,600	15	2.73
1941	Jan. 18, 1941	-	5,880	37	1.11
1942	Dec. 19, 1941	-	11,200	19	2.16
1943	Nov. 23, 1942	-	15,200	9	4.56
1944	Dec. 3, 1943	-	9,980	24	1.71
1945	Feb. 8, 1945	7.4	12,000	12	3.42
1946	Dec. 31, 1945	7.15	10,600	22	1.86
1947	Dec. 14, 1946	7.97	11,600	14	2.93
1948	Jan. 2, 1948	6.66	8,360	28	1.46
1949	May 13, 1949	6.19	6,690	34	1.21
1950	Nov. 27, 1949	7.07	10,300	23	1.78
1951	Feb. 10, 1951	8.50	16,900	7	5.86

NISQUALLY RIVER BASIN

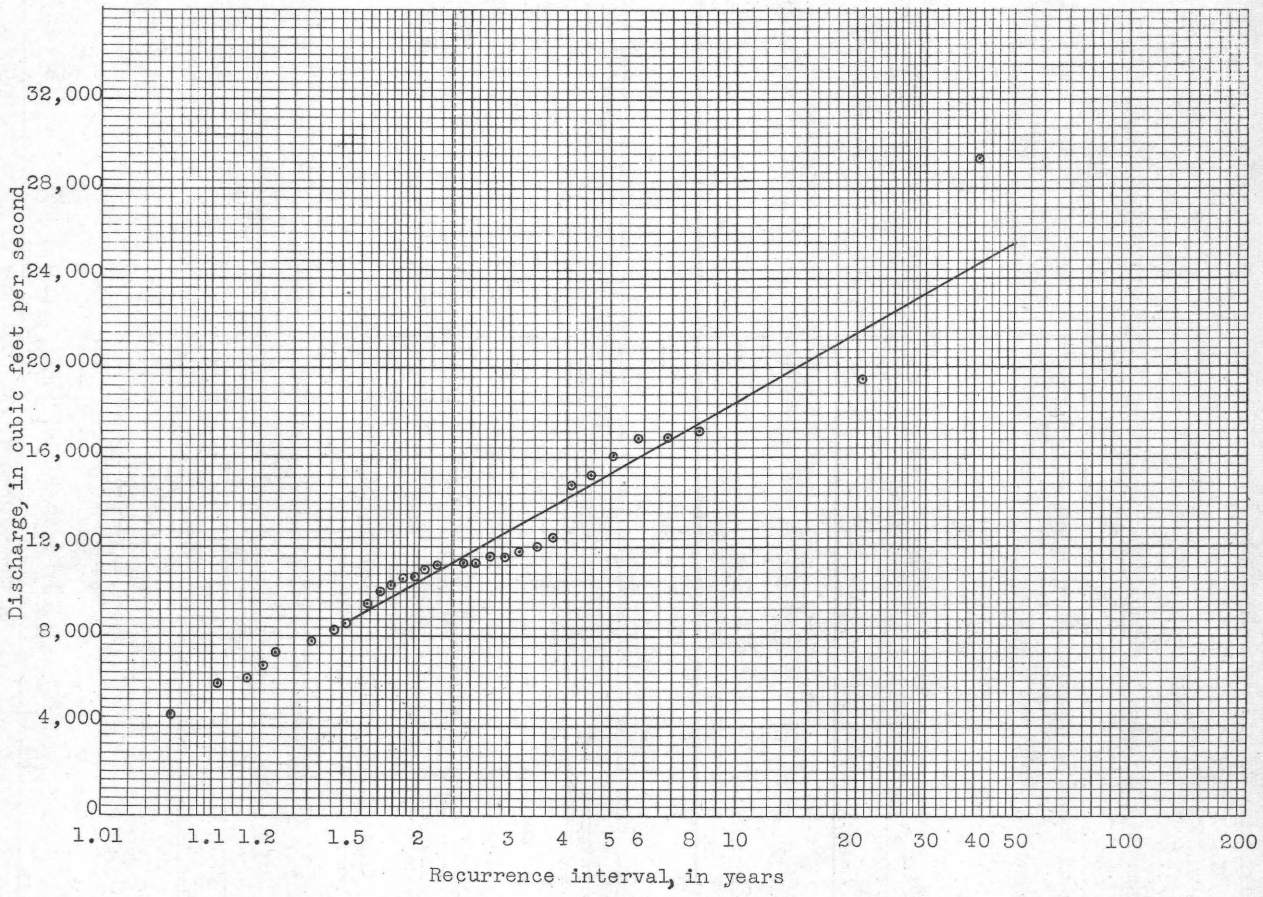

Figure 19.--Frequency of annual floods, Nisqually River at La Grande, Wash.

(60) Nisqually River near McKenna, Wash.

Location.--Lat 46°51'15", long. 122°27'10", in SE¼ sec. 20, T. 16 N., R. 3 E., 800 ft downstream from Elbow Creek, three-quarters of a mile upstream from Tanwax Creek, and 7.4 mi southeast of McKenna.

Drainage area.--445 sq mi.

Gage.--Recording. Datum of gage is 373.6 ft above mean sea level (from stadia traverse).

Stage-discharge relation.--Defined by current-meter measurements below 16,000 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversion at flood stage. Flood flows regulated by Alder Reservoir since November 1944 (usable capacity 158,700 acre-ft).

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1942	Dec. 19, 1941	10.60	16,000
1943	Nov. 23, 1942	10.67	16,400
1944	Dec. 3, 1943	9.30	10,800
1945	Feb. 8, 1945	10.22	14,400
1946	Dec. 31, 1946	9.13	10,500
1947	Dec. 11, 1946	11.45	17,000
1948	Jan. 2, 1948	9.31	10,300
1949	Dec. 9, 1948	8.69	8,460
1950	Nov. 27, 1949	9.56	11,100
1951	Feb. 11, 1951	11.37	17,700

NISQUALLY RIVER BASIN

(61) Mineral Creek near Mineral, Wash.

Location.--Lat 46°44'20", long. 122°08'20", in SW¼ sec. 35, T. 15 N., R. 5 E., three-eighths of a mile downstream from railroad bridge, 1 mi upstream from mouth, and 2⅔ mi northeast of Mineral.

Drainage area.--75 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 3,400 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1943	Nov. 23, 1942	7.52	4,750
1944	Dec. 3, 1943	6.06	2,860
1945	Feb. 7, 1945	7.43	4,610
1946	Dec. 28, 1945	6.76	4,130
1947	Dec. 11, 1946	8.25	5,240
1948	Jan. 1, 1948	5.91	2,640
1949	Feb. 17, 1949	6.49	3,270
1950	Nov. 27, 1949	7.38	4,790
1951	Feb. 9, 1951	7.65	4,790

(62) Little Nisqually River near Alder, Wash.

Location.--Lat 46°47'20", long. 122°18'45", in NW¼ sec. 16, T. 15 N., R. 4 E., 1,500 ft above mouth and 1½ mi southwest of Alder.

Drainage area.--27.2 sq mi.

Gage.--Recording since April 19, 1921.

Stage-discharge relation.--Defined by current-meter measurements below 1,300 cfs and extended by velocity-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1921	Dec. 30, 1920	6.15	1,920
1922	Dec. 11, 1921	6.4	2,020
1923	Jan. 7, 1923	6.38	2,220
1924	Dec. 6, 1923	5.69	1,800
1925	Nov. 19, 1924	5.1	1,440
1926	Dec. 23, 1925	4.15	975
1927	Jan. 2, 1927	5.4	1,680
1928	Nov. 24, 1927	5.45	1,680
1929	Dec. 10, 1928	4.43	1,210
1930	Dec. 14, 1929	4.55	1,270
1931	Feb. 18, 1931	5.50	1,670
1932	Feb. 26, 1932	6.6	2,310
1933	Nov. 10, 1932	5.10	1,470
1934	Dec. 20, 1933	6.8	2,430
1935	Jan. 22, 1935	5.90	1,890
1936	Jan. 12, 1936	4.93	1,370
1937	Apr. 14, 1937	5.75	1,830
1938	Dec. 28, 1937	5.6	1,720
1939	Jan. 2, 1939	4.9	1,370
1940	Dec. 15, 1939	6.00	1,950
1941	Jan. 18, 1941	4.93	1,550
1942	Dec. 19, 1941	5.35	1,880
1943	Nov. 23, 1942	5.95	2,400

NISQUALLY RIVER BASIN

(63) Mashel River near La Grande, Wash.

Location.--Lat 46°51'27", long. 122°18'12", in NE¼ sec. 21, T. 16 N., R. 4 E., 2 mi upstream from mouth and 2 mi northeast of La Grande.

Drainage area.--79 sq mi.

Gage.--Recording. Datum of gage is 619.35 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 2,200 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions and regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1941	Jan. 18, 1941	5.81	1,320
1942	Dec. 19, 1941	7.16	4,040
1943	Mar. 28, 1943	6.68	2,660
1944	Dec. 3, 1943	6.14	1,720
1945	Feb. 7, 1945	6.28	1,910
1946	Nov. 26, 1945	6.59	2,460
1947	Dec. 11, 1946	9.30	7,980
1948	Nov. 7, 1947	7.14	3,900
1949	Feb. 17, 1949	7.00	2,660
1950	Feb. 24, 1950	7.26	2,700
1951	Feb. 11, 1951	7.20	3,200

(64) Ohop Creek near Eatonville, Wash.

Location.--Lat 46°52'50", long. 122°16'38", in SE¼ sec. 10, T. 16 N., R. 4 E., 400 ft downstream from Lynch Creek, 600 ft downstream from outlet of Ohop Lake, and 1 mi northwest of Eatonville.

Drainage area.--35.0 sq mi.

Gage.--Recording. Datum of gage is 519.8 ft above mean sea level (from stadia traverse).

Stage-discharge relation.--Defined by current-meter measurements below 1,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Natural regulation by Ohop Lake.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1928	Jan. 3, 1928	2.97	511
1929	Dec. 10, 1928	2.05	288
1930	Mar. 24, 1930	2.50	416
1931	Apr. 1, 1931	3.29	666
1932	Mar. 5, 1932	3.52	732
	Change in datum		
1942	Dec. 20, 1941	4.80	840
1943	Nov. 23, 1942	4.05	485
1944	Dec. 3, 1943	3.66	286
1945	Apr. 12, 1945	3.78	344
1946	Jan. 5, 1946	4.54	659
1947	Dec. 11, 1946	5.97	1,600
1948	Feb. 26, 1948	3.62	429
1949	Dec. 9, 1948	4.56	892
1950	Feb. 25, 1950	3.86	600
1951	Feb. 11, 1951	4.55	1,080

NISQUALLY RIVER BASIN

(65) Tanwax Creek near McKenna, Wash.

Location.--Lat 46°52'00", long. 122°27'10", in NW¼NE¼ sec. 20, T. 16 N., R. 3 E., a quarter of a mile upstream from mouth and 7 mi southeast of McKenna.

Drainage area.--27.2 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 300 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Natural regulation by several lakes.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Apr. 11, 1945	2.41	181
1946	Jan. - 1946	2.99	282
1947	Dec. 15, 1946	3.20	328
1948	Feb. 26, 1948	2.62	206
1949	Dec. 10, 1948	3.12	310
1950	Feb. 25, 1950	2.89	261

PUYALLUP RIVER BASIN

(66) Puyallup River near Electron, Wash.

Location.--Lat 46°54'10", long. 122°02'00", in NE¼NW¼ sec. 3, T. 16 N., R. 6 E., 1,000 ft upstream from Puget Sound Power and Light Co.'s flume headworks, a quarter of a mile downstream from Mowich River, and 10 mi southeast of Electron.

Drainage area.--93 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 6,800 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1911	Nov. 10, 1910	4.6	3,200
1914	Jan. 4, 1924	4.05	2,610
1915	Nov. 13, 1914	3.25	2,070
1916	Dec. 21, 1915	4.4	2,900
1917	July 17, 1917	3.30	1,970
1918	Dec. 18, 1917	6.4	4,800
1919	Jan. 23, 1919	6.8	3,610
1920	Dec. 24, 1919	4.47	1,890
1921	Dec. 30, 1920	5.72	2,670
1922	Dec. 12, 1921	6.65	4,560
1923	Jan. 6, 1923	6.45	4,350
1925	Dec. 11, 1924	5.18	2,830
	Change in datum		
1945	Feb. 7, 1945	7.64	4,590
1946	Dec. 21, 1945	7.15	3,830
1947	Dec. 11, 1946	8.75	9,160
1948	Nov. 7, 1947	8.16	6,580
1949	Nov. 23, 1948	7.02	3,320

PUYALLUP RIVER BASIN

(67) Puyallup River near Orting, Wash.

Location.--Lat 47°02'30", long. 122°12'20", in SW¼ sec. 17, T. 18 N., R. 5 E., 4 mi south of Orting and 7½ mi upstream from Carbon River.

Drainage area.--170 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 8,100 cfs. Stage-discharge relation shifts frequently.

Remarks.--Water diverted for Electron power plant is returned to river above gage. Negligible regulation by power plant at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1932	Feb. 26, 1932	8.98	6,950
1933	Nov. 13, 1932	11.3	11,800
1934	Dec. 10, 1933	11.87	12,800
1935	Nov. 5, 1934	9.02	8,900
1936	June 7, 1936	6.95	4,850
1937	Apr. 14, 1937	7.37	4,640
1938	Apr. 18, 1938	9.14	8,680
1939	Feb. 15, 1939	7.64	5,110
1940	Dec. 15, 1939	8.04	5,600
1941	Nov. 29, 1940	7.90	5,600
1942	Dec. 19, 1941	8.22	6,700
1943	Nov. 23, 1942	9.18	7,450
1944	Dec. 3, 1943	8.85	5,800
1945	Jan. 7, 1945	7.70	5,240
1946	Dec. 28, 1945	7.60	5,530
1947	Dec. 11, 1946	7.87	11,200
1948	Nov. 7, 1947	7.66	8,300
1949	Feb. 17, 1949	6.60	4,720
1950	Nov. 27, 1949	7.80	9,720
1951	Feb. 11, 1951	8.0	6,200

(68) Puyallup River at Alderton, Wash.

Location.--Lat 47°11'05", long. 122°13'45", at highway bridge, on line between sec. 25, T. 20 N., R. 4 E., and sec. 30, T. 20 N., R. 5 E., 1 mi north of Alderton.

Drainage area.--438 sq mi.

Gage.--Nonrecording gage read once daily 1916-27. Recording gage 1944-51.

Stage-discharge relation.--Defined by current-meter measurements below 14,000 cfs and extended by logarithmic plotting.

Remarks.--All diversions returned to river above gage. Negligible regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1916	Dec. 22, 1915	8.60	12,800
1917	Dec. 13, 1916	5.90	6,630
1918	Dec. 18, 1917	12.6	19,300
1919	Jan. 23, 1919	10.0	12,200
1920	Jan. 28, 1920	6.75	8,360
1921	Dec. 30, 1920	7.58	11,200
1922	Dec. 12, 1921	11.5	21,200
1923	Jan. 6, 1923	8.7	15,000
1924	Feb. 12, 1924	6.50	10,200
1925	Dec. 11, 1924	5.86	8,380
1926	Dec. 21, 1925	5.25	6,930
1927	Oct. 17, 1926	4.40	5,770
	Change in datum		
1944	Dec. 3, 1943	54.39	14,600
1945	Jan. 7, 1945	53.59	12,700
1946	Dec. 29, 1945	54.23	13,900
1947	Dec. 11, 1946	56.80	22,600
1948	Nov. 8, 1947	54.42	14,600
1949	Feb. 17, 1949	53.12	10,600
1950	Nov. 27, 1949	53.74	12,500
1951	Feb. 11, 1951	54.89	16,200

PUYALLUP RIVER BASIN

(69) Puyallup River at Puyallup, Wash.

Location.--Lat 47°12'20", long. 122°19'30", in NE¼ sec. 20, T. 20 N., R. 4 E., 1 mi northwest of Puyallup and 7 mi upstream from mouth.

Drainage area.--948 sq mi.

Gage.--Recording. Datum of gage since November 1935 is at mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 22,000 cfs and extended by logarithmic plotting.

Remarks.--All diverted water returned to river above gage. Flood water regulated by Mud Mountain reservoir on White River since 1944. Negligible regulation by Lake Tapps and Electron power plant at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1915	Nov. 3, 1914	26.6	9,390	37	1.11
1916	Dec. 22, 1915	31.9	22,500	16	2.56
1917	Dec. 13, 1916	28.12	14,400	31	1.32
1918	Dec. 18, 1917	34.15	40,500	2	20.50
1919	Jan. 23, 1919	32.04	36,400	5	8.20
		Change in datum			
1920	Jan. 28, 1920	10.4	16,500	28	1.46
1921	Dec. 30, 1920	13.6	24,900	14	2.93
1922	Dec. 13, 1921	17.05	35,600	6	6.83
1923	Jan. 6, 1923	14.98	31,000	10	4.10
1924	Feb. 12, 1924	12.0	21,700	19	2.16
1925	Dec. 11, 1924	10.70	18,600	22	1.86
1926	Dec. 23, 1925	9.4	15,800	29	1.41
1927	Oct. 16, 1926	9.43	14,500	30	1.37
1928	Nov. 25, 1927	13.55	25,400	13	3.15
1929	June 14, 1929	7.17	8,610	38	1.08
1930	Mar. 25, 1930	6.92	8,390	39	1.05
1931	Apr. 1, 1931	11.13	19,800	21	1.95
1932	Feb. 26, 1932	16.0	33,000	9	4.56
1933	Nov. 13, 1932	17.1	37,800	4	10.25
1934	Dec. 10, 1933	21.4	57,000	1	41.00
1935	Oct. 25, 1934	15.82	39,500	3	13.67
		Change in datum			
1936	June 8, 1936	16.49	14,000	32	1.28
1937	Apr. 15, 1937	18.12	17,800	25	1.64
1938	Apr. 18, 1938	23.64	33,900	7	5.86
1939	Feb. 15, 1939	16.68	13,000	34	1.21
1940	Feb. 10, 1940	15.86	11,500	35	1.17
1941	Nov. 29, 1940	18.80	18,400	23	1.78
1942	Dec. 19, 1941	20.48	22,500	17	2.41
1943	Nov. 23, 1942	21.56	25,700	12	3.42
1944	Dec. 3, 1943	19.67	19,900	20	2.05
1945	Jan. 7, 1945	20.23	21,800	18	2.28
1946	Dec. 29, 1945	22.14	23,800	15	2.73
1947	Dec. 11, 1946	25.78	33,800	8	5.12
1948	Nov. 8, 1947	19.60	17,700	26	1.58
1949	Feb. 17, 1949	17.86	14,000	33	1.24
1950	Mar. 4, 1950	18.40	17,400	27	1.52
1951	Feb. 11, 1951	23.0	30,600	11	3.73

PUYALLUP RIVER BASIN

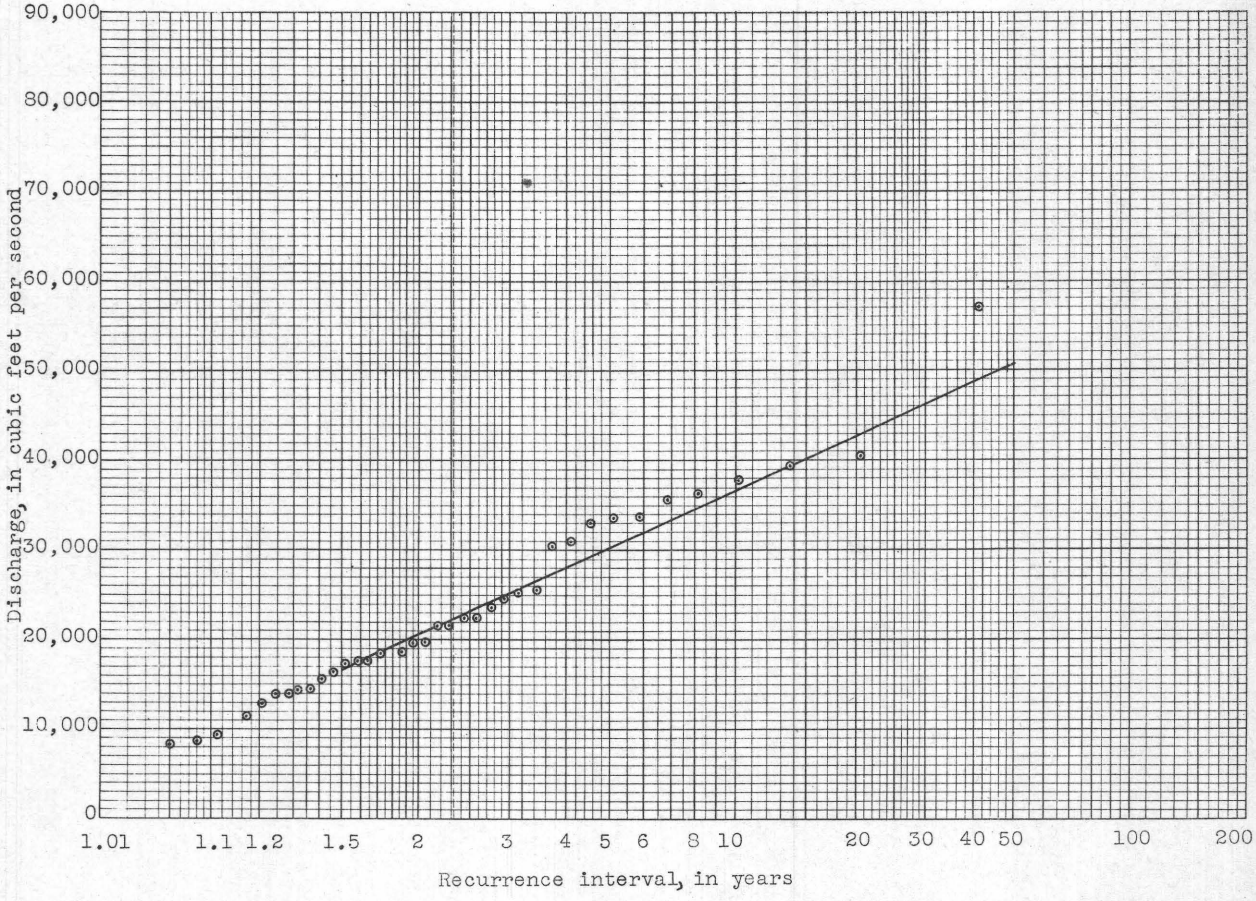

Figure 20.--Frequency of annual floods, Puyallup River at Puyallup, Wash.

(70) Kapowsin Creek near Kapowsin, Wash.

Location.--Lat 46°59'45", long. 122°11'45", in NE¼ sec. 5, T. 17 N., R. 5 E., half a mile downstream from Kapowsin Lake and 1½ mi east of Kapowsin.

Drainage area.--23 sq mi.

Gage.--Recording. Datum of gage is 561 ft above mean sea level (from stadia traverse).

Stage-discharge relation.--Defined by current-meter measurements below 525 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Natural regulation by Kapowsin Lake.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1928	Jan. 4, 1928	3.31	302	21	1.95
1929	Mar. 29, 1929	2.56	149	38	1.08
1930	Feb. 15, 1930	2.68	189	34	1.21
1931	Apr. 2, 1931	3.20	283	23	1.78
1932	Mar. 6, 1932	3.78	393	19	2.16
1942	Dec. 19, 1941	5.09	546	7	5.86
1943	Nov. 24, 1942	4.34	324	20	2.05
1944	Dec. 4, 1943	3.56	168	36	1.14
1945	Apr. 11, 1945	3.44	160	37	1.11
1946	Jan. 5, 1946	4.69	397	17	2.41
1947	Dec. 12, 1946	5.69	605	4	10.25
1948	Feb. 26, 1948	4.02	260	25	1.64
1949	Dec. 10, 1948	4.78	417	14	2.93
1950	Feb. 26, 1950	4.63	420	13	3.15
1951	Feb. 12, 1951	5.75	710	3	13.67

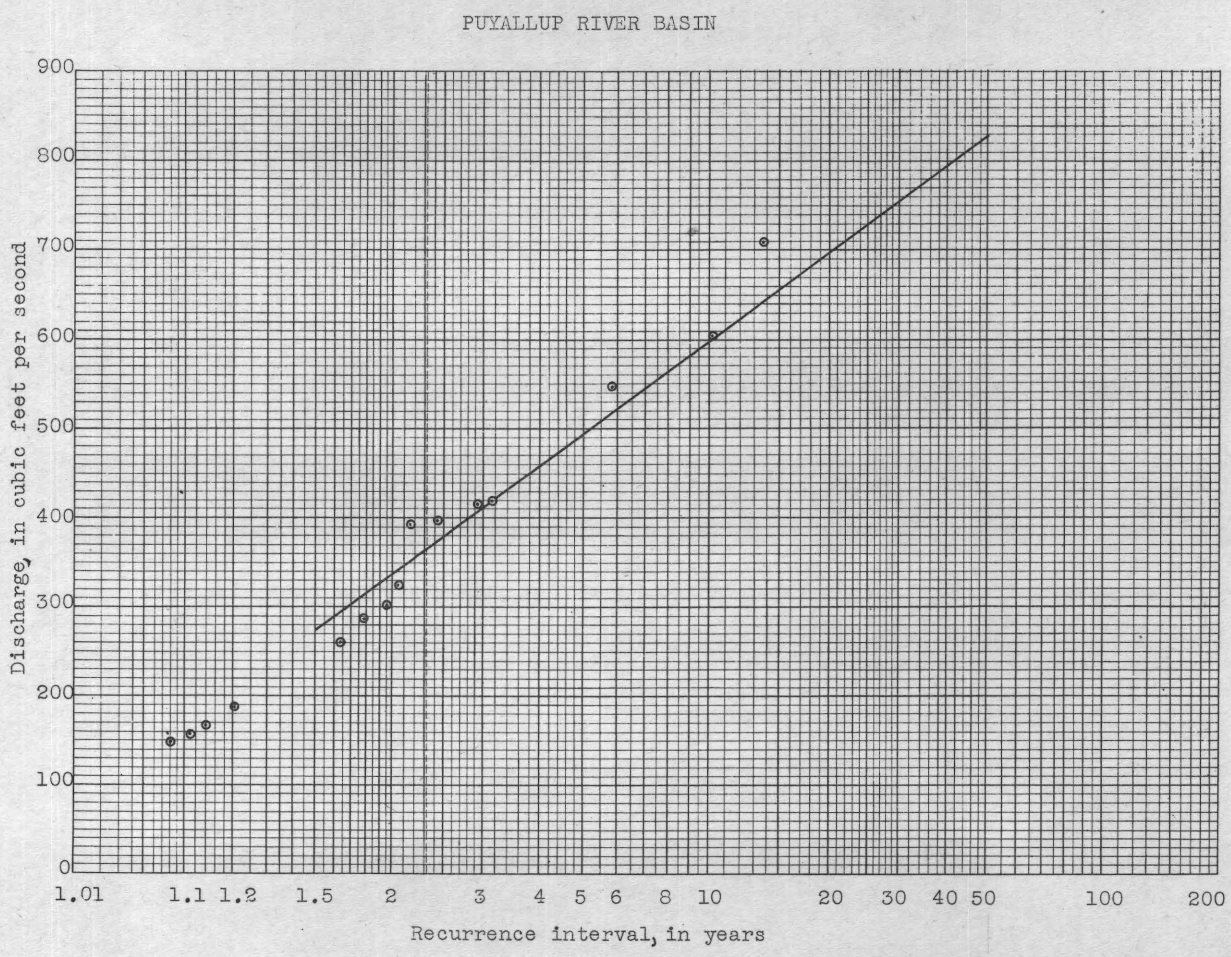

Figure 21.--Frequency of annual floods, Kapowsin Creek near Kapowsin, Wash.

(71) Carbon River near Fairfax, Wash.

Location.--Lat 47°01'30", long. 122°02'00", in SW¼ sec. 22, T. 18 N., R. 6 E., 1¼ mi northwest of Fairfax and 12 mi upstream from Voights Creek.

Drainage area.--81 sq mi.

Gage.--Nonrecording in 1912. Recording since April 1929.

Stage-discharge relation.--Defined by current-meter measurements below 4,500 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

PUYALLUP RIVER BASIN

(71) Carbon River near Fairfax, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1912	Nov. 19, 1911	10.5	3,200	19	2.16
	Change in datum				
1930	Feb. 5, 1930	5.13	1,770	40	1.02
1931	Mar. 31, 1931	6.07	2,340	28	1.46
1932	Feb. 26, 1932	7.74	4,390	13	3.15
1933	Nov. 13, 1932	8.5	5,370	5	8.20
1934	Dec. 9, 1933	10.2	8,030	1	41.00
1935	Oct. 25, 1934	7.75	5,030	7	5.86
1936	June 7, 1936	4.51	2,550	25	1.64
1937	Apr. 14, 1937	3.98	1,810	39	1.05
1938	Apr. 18, 1938	6.98	5,560	4	10.25
1939	Dec. 7, 1938	4.73	2,640	22	1.86
1940	May 1, 1940	3.87	1,810	38	1.08
1941	Nov. 29, 1940	5.80	4,040	16	2.56
1942	Dec. 19, 1941	4.75	2,580	24	1.71
1943	Nov. 23, 1942	6.35	4,760	10	4.10
1944	Dec. 3, 1943	6.57	5,020	8	5.12
1945	Jan. 7, 1945	6.10	4,370	14	2.93
1946	Dec. 28, 1945	6.25	4,500	11	3.73
1947	Dec. 11, 1946	6.97	5,960	3	13.67
1948	Nov. 7, 1947	6.15	4,330	15	2.73
1949	Nov. 23, 1948	4.60	2,440	27	1.52
1950	Nov. 27, 1949	5.40	3,470	18	2.28
1951	Feb. 9, 1951	6.10	4,480	12	3.42

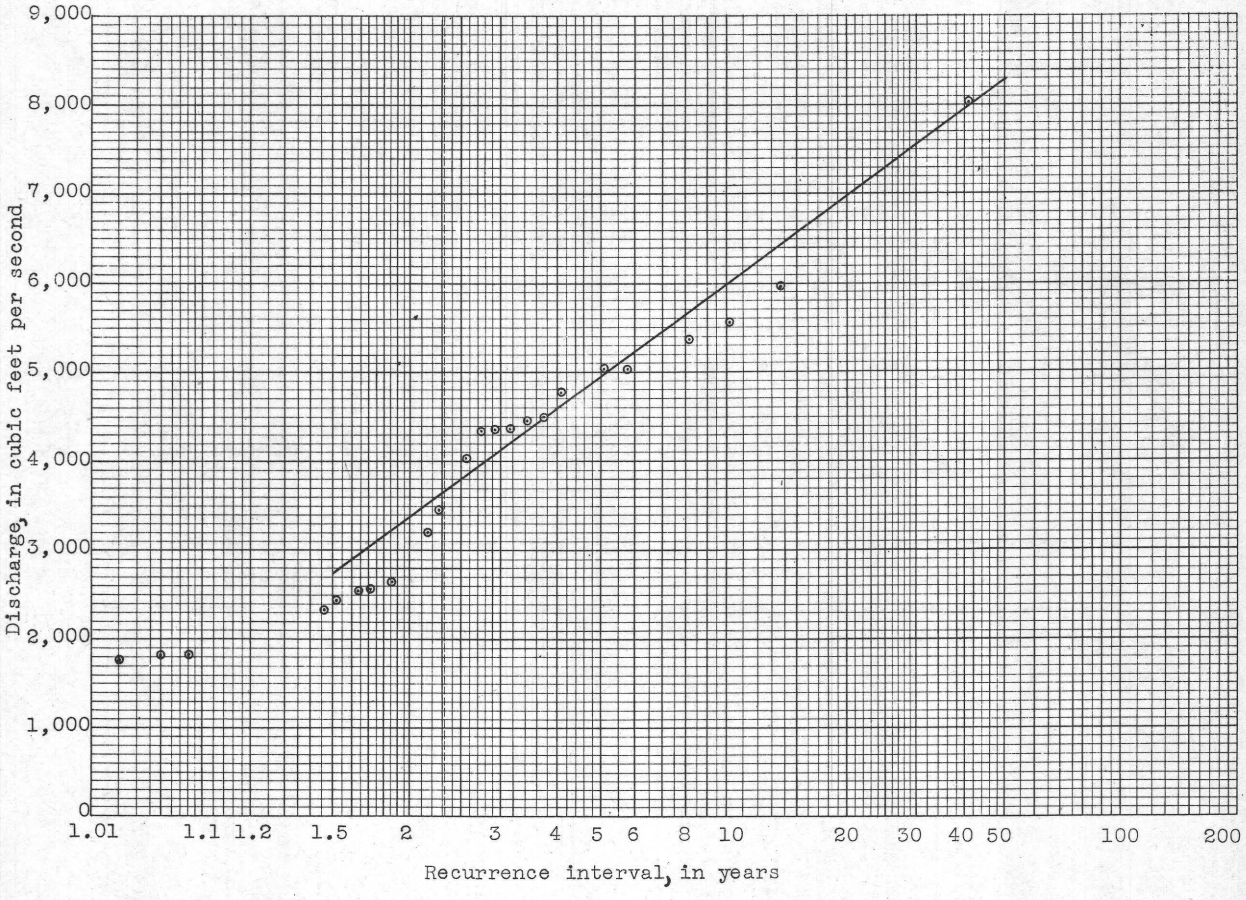

Figure 22.--Frequency of annual floods, Carbon River near Fairfax, Wash.

PUYALLUP RIVER BASIN

(72) White River at Greenwater, Wash.

Location.--Lat 47°08'50", long. 121°38'50", in SE¼ sec. 10, T. 19 N., R. 9 E., three-quarters of a mile southeast of Greenwater, three-quarters of a mile upstream from Greenwater River, and 25 mi upstream from Buckley.

Drainage area.--216 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 4,200 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Feb. 19, 1930	-	2,000
1931	Mar. 31, 1931	4.81	2,740
1932	Feb. 26, 1932	7.73	7,110
1933	Nov. 13, 1932	6.9	5,700
1934	Dec. 21, 1933	9.38	12,100
1935	Nov. 5, 1934	6.15	5,440
1936	May 14, 1936	4.59	2,470
1937	June 21, 1937	5.08	4,210
1938	Apr. 18, 1938	5.66	5,440
1939	May 29, 1939	4.59	2,470
1940	Nov. 16, 1939	4.16	1,780
1941	Nov. 29, 1940	4.80	2,690
1942	Dec. 2, 1941	4.69	2,500
1943	Nov. 23, 1942	5.79	4,110
1944	Dec. 3, 1943	4.66	2,500
1945	Jan. 7, 1945	5.45	4,080
1946	Dec. - 1945	6.17	5,620
1947	Dec. 11, 1946	6.98	7,460
1948	May 28, 1948	5.52	5,000
1949	May 13, 1949	5.22	4,220
1950	Nov. 27, 1949	6.57	8,800
1951	Feb. 11, 1951	5.90	5,550

(73) White River near Buckley, Wash.

Location.--Lat. 47°09'05", long. 121°57'00", in SW¼NW¼ sec. 8, T. 19 N., R. 7 E., 0.7 mi upstream from Red Creek, 3 mi east of Buckley, and 8 mi downstream from Clearwater River.

Drainage area.--403 sq mi.

Gage.--Recording. Datum of gage is at mean sea level, datum of 1929, since 1939.

Stage-discharge relation.--Defined by current-meter measurements below 9,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Since 1944 flow regulated by Mud Mountain Reservoir for flood control. Records for 1929-33 at site 3 mi upstream. Records for 1912 and 1923 computed on basis of records for White River at Buckley.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1912	Nov. 19, 1911	-	13,000
1923	Jan. 6, 1923	-	12,900
1929	May 24, 1929	8.95	4,280
1930	Mar. 25, 1930	9.43	4,870
1931	Mar. 31, 1931	12.74	9,850
1932	Feb. 26, 1932	17.5	17,000
1933	Nov. 13, 1932	17.2	16,500
	Change in datum		
1939	Mar. 24, 1939	803.18	4,270
1940	Feb. 10, 1940	803.48	4,060
1941	Nov. 29, 1940	805.67	7,600
1942	Dec. 19, 1941	805.94	7,550
1943	Nov. 23, 1942	806.77	9,950
1944	Dec. 3, 1943	805.45	7,320
1945	Jan. 7, 1945	806.30	8,820
1946	Dec. 29, 1945	807.22	10,600
1947	Dec. 11, 1946	807.70	12,300
1948	Nov. 8, 1947	805.76	7,580
1949	May 12, 1949	805.54	6,950
1950	Nov. 28, 1949	805.63	7,580
1951	Feb. 12, 1951	806.70	9,650

PUYALLUP RIVER BASIN

(74) Greenwater River at Greenwater, Wash.

Location.--Lat 47°09'15", long. 121°38'00", in NW¼NW¼ sec. 11, T. 19 N., R. 9 E., 1 mi upstream from mouth and 1 mi east of Greenwater.

Drainage area.--74 sq mi.

Gage.--Nonrecording gage prior to May 1929; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 1,900 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1912	Nov. 19, 1911	-	2,800
1930	Mar. 25, 1930	4.16	753
1931	Apr. 1, 1931	4.63	850
1932	Feb. 26, 1932	5.33	1,490
1933	Nov. 16, 1932	6.40	2,200
1934	Dec. 9, 1933	9.24	4,140
1935	Jan. 23, 1935	5.20	1,320
1936	May 5, 1936	4.48	840
1937	May 4, 1937	4.34	748
1938	Apr. 18, 1938	5.33	1,410
1939	Dec. 8, 1938	4.80	1,110
1940	Feb. 10, 1940	4.02	567
1941	Nov. 29, 1940	4.40	773
1942	June 11, 1942	4.61	924
1943	Nov. 23, 1942	4.60	920
1944	Dec. 3, 1943	4.01	575
1945	Jan. 7, 1945	4.75	990
1946	Dec. 28, 1945	5.64	1,760
1947	Dec. 11, 1946	7.50	3,520
1948	May 28, 1948	5.52	1,890
1949	May 13, 1949	5.09	1,540
1950	June 17, 1950	4.85	1,210
1951	Feb. 11, 1951	4.79	1,130

DUWAMISH RIVER BASIN

(75) Green River near Palmer, Wash.

Location.--Lat. 47°17'40", long. 121°49'20", in SW¼NW¼ sec. 20, T. 21 N., R. 8 E., 1⅛ mi upstream from diversion dam and intake of Tacoma water-supply system, 2½ mi downstream from North Fork and 4 mi southeast of Palmer.

Drainage area.--231 sq mi.

Gage.--Recording. Datum of gage is 912.6 ft above mean sea level (river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 21,400 cfs and extended by logarithmic plotting.

Remarks.--Flood of December 1917 was said to have reached a depth of 15 ft over the diversion dam of the city of Tacoma (estimated discharge 30,000 cfs). No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1918	Dec. - 1917	-	30,000	1	41.00
1932	Feb. 26, 1932	17.65	17,400	4	10.25
1933	Nov. 13, 1932	16.54	14,900	8	5.12
1934	Dec. 9, 1933	19.4	21,700	3	13.67
1935	Oct. 25, 1934	15.75	13,400	11	3.73
1936	Jan. 4, 1936	12.37	7,080	33	1.24
1937	Apr. 14, 1937	11.40	5,580	37	1.11
1938	Apr. 18, 1938	15.74	13,200	13	3.15
1939	Dec. 7, 1938	11.89	6,300	34	1.21
1940	Feb. 10, 1940	10.93	5,040	39	1.05
1941	Nov. 29, 1940	13.05	8,070	26	1.58
1942	Dec. 19, 1941	12.92	7,900	27	1.52
1943	Nov. 23, 1942	14.68	11,200	16	2.56
1944	Dec. 3, 1943	16.18	14,600	9	4.56
1945	Jan. 7, 1945	15.8	13,600	10	4.10
1946	Dec. 28, 1945	14.84	11,400	15	2.73
1947	Dec. 11, 1946	19.95	23,200	2	20.50
1948	Nov. 7, 1947	13.29	8,510	24	1.71
1949	Feb. 17, 1949	12.61	7,340	29	1.41
1950	Mar. 4, 1950	13.64	9,050	20	2.05
1951	Feb. 9, 1951	16.17	16,000	6	6.83

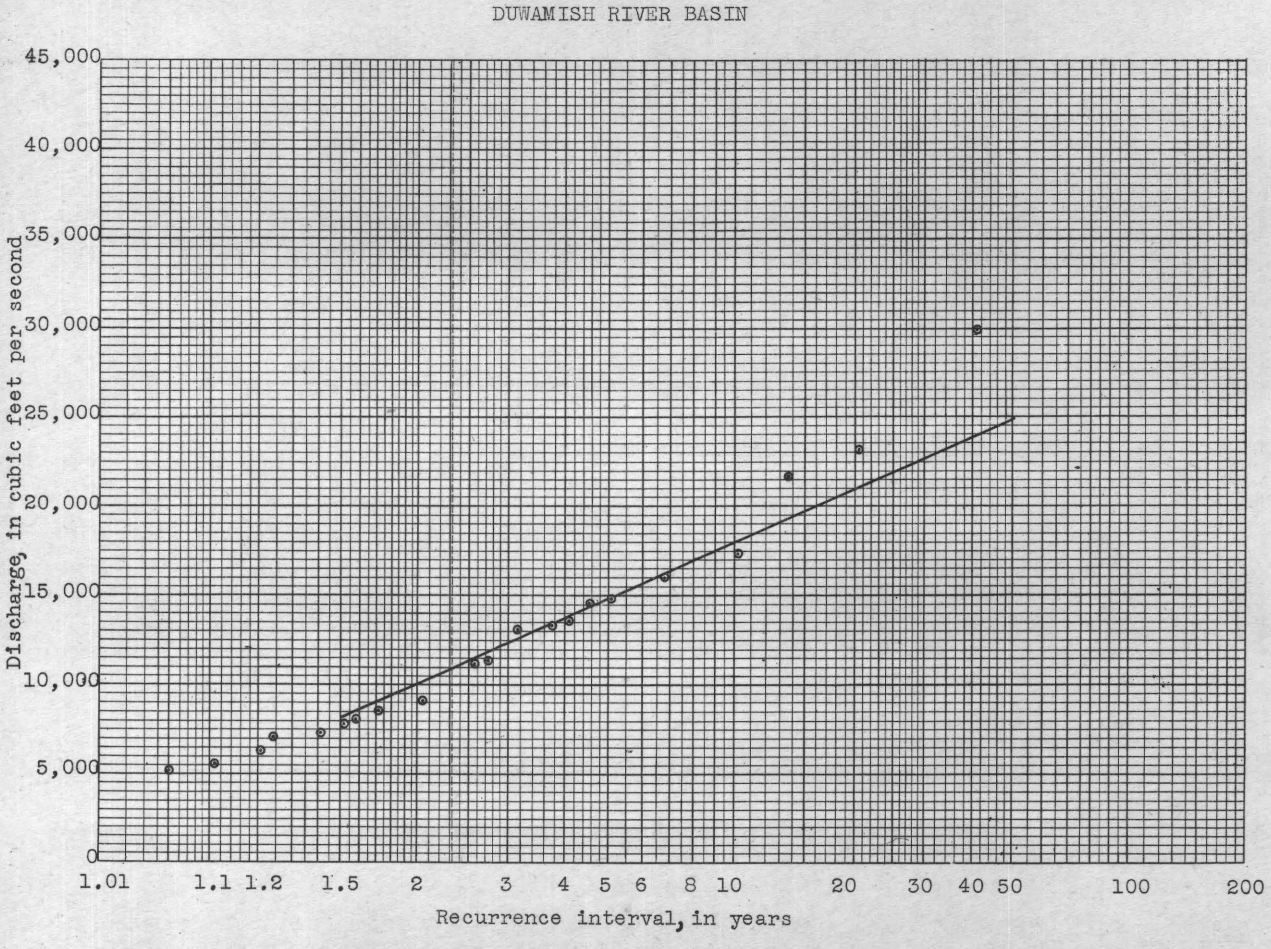

Figure 23.--Frequency of annual floods, Green River near Palmer, Wash.

(76) Green River near Black Diamond, Wash.

Location.--Lat 47°17'00", long. 122°03'30", in NW¼ sec. 28, T. 21 N., R. 6 E., at highway bridge three-quarters of a mile upstream from Newaukum Creek and 3 mi southwest of Black Diamond.

Drainage area.--286 sq mi.

Gage.--Nonrecording gage read twice daily prior to November 1944; recording thereafter. Datum of gage is 158.5 ft above mean sea level (river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Negligible diversion at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1940	Feb. 10, 1940	5.32	4,710
1941	Nov. 29, 1940	6.55	8,680
1942	Dec. 19, 1941	6.46	8,360
1943	Nov. 23, 1942	7.38	11,000
1944	Dec. 3, 1943	7.74	12,000
1945	Jan. 7, 1945	8.22	14,400
1946	Dec. 29, 1945	7.85	11,100
1947	Dec. 11, 1946	11.24	21,100
1948	Nov. 8, 1947	6.89	8,730

DUWAMISH RIVER BASIN

(77) Green River near Auburn, Wash.

Location.--Lat 47°18'15", long. 122°12'10", in lot 3, sec. 17, T. 21 N., R. 5 E., 1½ mi east of Auburn and 2 mi downstream from Big Soos Creek.

Drainage area.--386 sq mi.

Gage.--Recording. Datum of gage is at mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 20,000 cfs.

Remarks.--Negligible diversion at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1927	Apr. 15, 1937	61.37	6,820	35	1.17
1938	Apr. 18, 1938	65.88	14,400	10	4.10
1939	Dec. 8, 1938	60.25	5,420	38	1.08
1940	Feb. 10, 1940	59.90	5,150	39	1.05
1941	Nov. 29, 1940	61.60	7,290	34	1.21
1942	Dec. 19, 1941	62.43	9,310	25	1.64
1943	Nov. 23, 1942	63.42	10,900	19	2.16
1944	Dec. 3, 1943	64.60	12,900	15	2.73
1945	Jan. 7, 1945	64.98	13,600	12	3.42
1946	Dec. 29, 1945	64.31	12,800	16	2.56
1947	Dec. 11, 1946	68.16	22,000	2	20.50
1948	Nov. 8, 1947	62.21	8,960	27	1.52
1949	Feb. 17, 1949	62.51	9,470	24	1.71
1950	Mar. 4, 1950	63.82	11,800	17	2.41
1951	Feb. 10, 1951	67.00	17,700	4	10.25

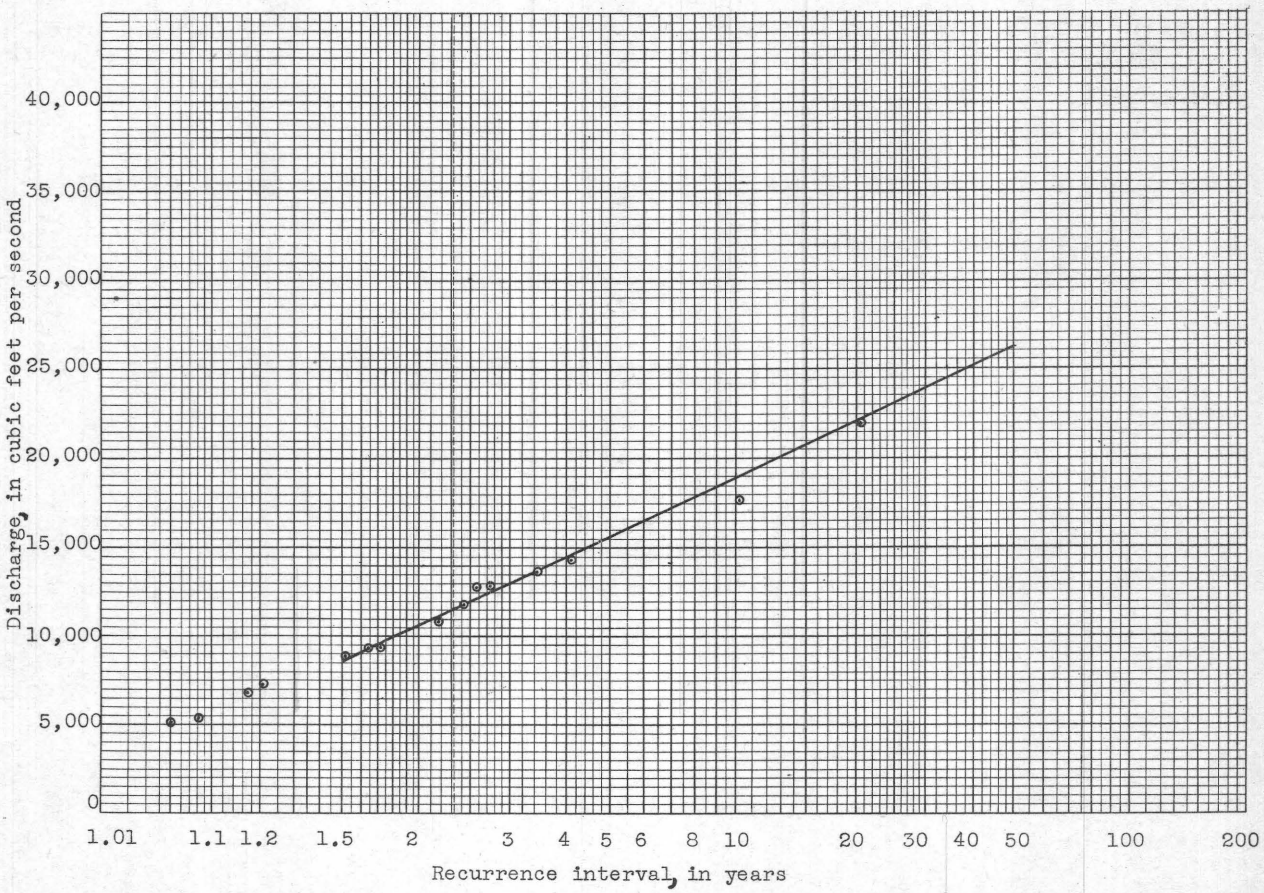

Figure 24.--Frequency of annual floods, Green River near Auburn, Wash.

LAKE WASHINGTON BASIN

(78) North Fork Cedar River near Lester, Wash.

Location.--Lat 47°19'00", long. 121°29'30", in S½ sec. 11, T. 21 N., R. 10 E., at falls 1½ mi upstream from South Fork and 7½ mi north of Lester.

Drainage area.--8.8 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 340 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Jan. 7, 1945	7.37	1,600
1946	Oct. 25, 1945	5.85	768
1947	Dec. 11, 1946	7.08	1,000
1948	Oct. 19, 1947	-	645
1949	May 12, 1949	5.91	590
1950	Nov. 27, 1949	6.92	960
1951	Feb. 9, 1951	7.60	1,300

(79) Cedar River below Bear Creek, near Cedar Falls, Wash.

Location.--Lat 47°20'40", long. 121°33'00", in SE¼SE¼ sec. 32, T. 22 N., R. 10 E., 500 ft downstream from Bear Creek and 12 mi southeast of Cedar Falls.

Drainage area.--25.4 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 850 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 28, 1945	5.40	1,100
1947	Dec. 11, 1946	6.32	1,940
1948	May 28, 1948	5.70	1,250
1949	May 13, 1949	5.50	1,090
1950	Nov. 27, 1949	6.00	1,510
1951	Feb. 9, 1951	6.30	1,800

LAKE WASHINGTON BASIN

(80) Cedar River near Cedar Falls, Wash.

Location.--Lat 47°22'20", long. 121°37'30", in SE¼SW¼ sec. 23, T. 22 N., R. 9 E., 2 mi upstream from Cedar Lake and 8 mi southeast of Cedar Falls.

Drainage area.--41.8 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,700 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 28, 1945	7.18	2,160
1947	Dec. 14, 1946	9.81	3,840
1948	Nov. 7, 1947	6.73	1,920
1949	May 13, 1949	5.93	1,470
1950	Nov. 27, 1949	7.63	2,460
1951	Feb. 11, 1951	10.98	4,680

(81) Cedar River at Cedar Falls, Wash.

Location.--Lat 47°25'10", long. 121°47'20", in sec. 4, T. 22 N., R. 8 E., three-quarters of a mile downstream from Seattle municipal power plant at Cedar Falls and 3 mi downstream from Cedar Lake.

Drainage area.--86 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 3,800 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Considerable regulation by Cedar Lake Reservoir at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1915	Apr. 5, 1915	6.30	910
1916	Mar. 12, 1916	7.48	1,800
1917	June 17, 1917	7.78	2,000
1918	Dec. 19, 1917	11.4	6,290
1919	Jan. 23, 1919	6.9	1,280
1920	Jan. 31, 1920	6.06	776
1921	Jan. 5, 1921	6.02	748
1922	Dec. 12, 1921	10.52	4,500
1923	Jan. 10, 1923	8.72	2,790
1924	Feb. 12, 1924	6.44	915
1925	Feb. 7, 1925	7.61	1,880
1926	Jan. 21, 1926	6.22	765
1927	June 10, 1927	6.90	1,210
1928	Jan. 13, 1928	9.33	3,430
1929	Apr. 29, 1929	6.14	714
1930	May 4, 1930	6.56	964
1931	Mar. 14, 1931	6.30	802
1932	Mar. 19, 1932	7.25	1,740
1933	Nov. 17, 1932	8.7	3,050
1934	Dec. 22, 1933	11.5	6,120
1935	Jan. 25, 1935	9.61	3,270
1936	May 16, 1936	7.96	1,940
1937	June 20, 1937	7.64	1,600
1938	Nov. 29, 1937	8.07	2,020
1939	Jan. 25, 1939	7.07	1,100
1940	Mar. 8, 1940	7.44	1,310
1941	Nov. 28, 1940	6.75	742
1942	June 15, 1942	6.85	822
1943	June 10, 1943	6.98	924
1944	May 24, 1944	6.92	866
1945	Jan. 7, 1945	7.02	946
1946	May 29, 1946	7.32	1,140
1947	Dec. 14, 1946	9.45	2,880
1948	Nov. 12, 1947	7.77	1,380
1949	May 16, 1949	7.72	1,340
1950	Mar. 5, 1950	8.53	2,020
1951	Feb. 11, 1951	10.87	4,300

LAKE WASHINGTON BASIN

(82) Cedar River near Landsberg, Wash.

Location.--Lat 47°23'45", long. 121°56'50", in sec. 17, T. 22 N., R. 7 E., 1 3/4 mi upstream from Landsberg and intake of Seattle water-supply system, and 12 mi downstream from Cedar Lake.

Drainage area.--138 sq mi.

Gage.--Nonrecording gage prior to 1914; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 6,000 cfs and extended by logarithmic plotting.

Remarks.--Records for daily mean discharges only are available for periods 1896-98 and 1902-12 at sites about 2 mi downstream. These have been increased 10 percent to approximate the momentary discharge and make them comparable with later records. Negligible diversion at flood stage. Considerable regulation of the smaller peaks by operation of Cedar Lake Reservoir since January 1905. Flood of November 19, 1911 due to dam break.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1896	Jan. 9, 1896	7.6	3,200
1897	Nov. 15, 1896	10.9	5,850
1898	Nov. 19, 1897	9.5	4,750
1902	Dec. 24, 1901	3.2	2,850
1903	Jan. 5, 1903	5.6	6,600
1904	Jan. 15, 1904	2.6	2,100
1905	May 24, 1905	2.7	2,200
1906	Jan. 25, 1906	2.6	2,100
1907	Nov. 15, 1906	8.6	12,500
1908	- - -	-	4,950
1909	Jan. 20, 1909	2.5	2,000
1910	Nov. 24, 1909	-	7,000
1911	- - -	-	3,700
1912	Nov. 19, 1911	-	15,000
	Change in datum		
1915	Apr. 5, 1915	7.47	1,330
1916	Mar. 10, 1916	9.75	2,640
1917	June 17, 1917	9.0	2,220
1918	Dec. 29, 1917	13.55	7,500
1919	Jan. 22, 1919	9.6	3,160
1920	Jan. 28, 1920	7.8	1,860
1921	Feb. 11, 1921	7.9	1,920
1922	Dec. 12, 1921	12.03	5,960
1923	Jan. 10, 1923	10.3	4,160
1924	Feb. 12, 1924	9.2	3,100

Water year	Date	Gage height (ft)	Discharge (cfs)
1925	Feb. 8, 1925	8.83	2,740
1926	Jan. 5, 1926	7.56	1,720
1927	Jan. 2, 1927	7.67	1,820
1928	Jan. 13, 1928	10.95	4,860
1929	Mar. 31, 1929	3.07	1,180
1930	Jan. 4, 1930	3.16	1,350
1931	Mar. 31, 1931	2.92	1,200
1932	Feb. 26, 1932	5.9	4,860
1933	Jan. 8, 1933	5.5	4,300
1934	Dec. 22, 1933	7.7	7,520
1935	Jan. 25, 1935	5.45	4,160
1936	May 17, 1936	3.44	1,900
1937	June 20, 1937	3.34	1,800
1938	Nov. 29, 1937	3.91	2,360
1939	Feb. 15, 1939	3.04	1,500
1940	Mar. 7, 1940	3.43	1,880
1941	Nov. 28, 1940	2.52	1,050
1942	Dec. 19, 1941	3.42	1,830
1943	Nov. 23, 1942	3.70	2,140
1944	May 24, 1944	2.92	1,380
1945	Feb. 7, 1945	3.55	1,970
1946	Dec. 28, 1945	3.60	2,040
1947	Dec. 14, 1946	5.44	4,190
1948	Nov. 11, 1947	3.50	1,940
1949	Feb. 17, 1949	3.30	1,750
1950	Mar. 5, 1950	4.56	3,110
1951	Feb. 11, 1951	6.94	6,100

LAKE WASHINGTON BASIN

(83) South Fork Cedar River near Lester, Wash.

Location.--Lat 47°18'30", long. 121°31'00", in SE¼ sec. 15, T. 21 N., R. 10 E., about three-quarters of a mile upstream from mouth and 7 mi northwest of Lester.

Drainage area.--6.0 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 230 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Jan. 7, 1945	4.86	878
1946	Dec. 28, 1945	3.64	398
1947	Dec. 11, 1946	4.79	630
1948	Nov. 7, 1947	4.58	540
1949	May 13, 1949	3.82	305
1950	Nov. 27, 1949	5.92	585
1951	Feb. 9, 1951	6.06	655

(84) Rex River near Cedar Falls, Wash.

Location.--Lat 47°21'10", long. 121°39'50", in NE¼NW¼ sec. 33, T. 22 N., R. 9 E., 2½ mi upstream from mouth and Cedar Lake and 7 mi southeast of Cedar Falls.

Drainage area.--13.0 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 680 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 28, 1945	6.20	1,400
1948	Nov. 7, 1947	5.48	930
1949	Nov. 23, 1948	5.31	812
1950	Nov. 27, 1949	5.97	1,220
1951	Feb. 11, 1951	6.27	1,440

LAKE WASHINGTON BASIN

(85) Rock Creek near Maple Valley, Wash.

Location.--Lat 47°22'50", long. 122°01'00", in NE¼ sec. 22, T. 22 N., R. 6 E., at mouth 2 mi southeast of Maple Valley.

Drainage area.--12.6 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 110 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Jan. 7, 1946	2.32	72
1947	Dec. 14, 1946	2.82	105
1948	Feb. 27, 1948	2.12	87
1949	Dec. 12, 1948	1.86	72
1950	Mar. 5, 1950	3.84	200
1951	Feb. 9, 1951	4.28	230

(86) May Creek near Renton, Wash.

Location.--Lat 47°31'10", long. 122°11'10", in SE¼SE¼ sec. 32, T. 24 N., R. 5 E., 1 mi upstream from mouth and 2½ mi north of Renton.

Drainage area.--13.0 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 360 cfs.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 29, 1945	3.14	131
1947	Dec. 14, 1946	3.45	174
1948	Jan. 2, 1948	3.01	148
1949	Feb. 17, 1949	3.98	401
1950	Mar. 4, 1950	3.97	354

LAKE WASHINGTON BASIN

(87) Issaquah Creek near Issaquah, Wash.

Location.--Lat 47°28'55", long. 122°02'10", in W½ sec. 15, T. 23 N., R. 6 E., 3½ mi south of Issaquah and 4 mi upstream from East Fork Issaquah Creek.

Drainage area.--22.1 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 590 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 28, 1945	2.68	452
1947	Dec. 14, 1946	3.45	675
1948	Feb. 26, 1948	3.02	540
1949	Feb. 17, 1949	4.64	1,120
1950	Mar. 4, 1950	3.60	800
1951	Feb. 9, 1951	4.6	1,550

(88) Sammamish River near Redmond, Wash.

Location.--Lat 47°40'10", long. 122°07'25", in NE¼ sec. 11, T. 25 N., R. 5 E., 500 ft downstream from Bear Creek and half a mile west of Redmond. Prior to November 14, 1946, staff gage at site on left shore of Sammamish Lake 0.6 mi upstream from outlet and 1.8 mi south of Redmond.

Drainage area.--140 sq mi.

Gage.--Nonrecording gage prior to 1947; recording thereafter. Datum of recording gage was 32.13 ft above mean lower low water at Seattle (Corps of Engineers bench mark). On July 9, 1947, datum was lowered about 1½ ft.

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Negligible diversions at flood stage. Natural regulation by Sammamish Lake.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1940	Mar. 9, 1940	6.05	689
1941	Jan. 20, 1941	3.59	370
1942	Dec. 23, 1941	6.85	672
1943	Apr. 5, 1943	5.77	541
1944	Feb. 17, 1944	3.35	307
1945	Apr. 12, 1945	6.32	620
1946	Jan. 9, 1946	7.17	704
	Change in datum		
1947	Dec. 15, 1946	6.40	924
	Change in datum		
1948	Jan. 10, 1948	7.63	860
1949	Feb. 24, 1949	7.30	846
1950	Mar. 6, 1950	8.35	1,360
1951	Feb. 11, 1951	9.17	1,700

LAKE WASHINGTON BASIN

(89) Sammamish River at Bothell, Wash.

Location.--Lat 47°45'00", long. 122°11'30", in NW¼SE¼ sec. 8, T. 26 N., R. 5 E., in Bothell, a quarter of a mile downstream from North Creek and 4¼ mi upstream from mouth.

Drainage area.--199 sq mi.

Gage.--Recording. Datum of gage is at mean lower low water at Seattle (Corps of Engineers bench mark).

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Negligible diversions and regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1940	Mar. 5, 1940	30.10	878
1941	Jan. 18, 1941	29.75	752
1942	Dec. 23, 1941	31.07	1,030
1943	Mar. 28, 1943	30.04	872
1944	Apr. 25, 1944	27.74	510
1945	Feb. 8, 1945	30.36	922
1946	Feb. 6, 1946	30.68	1,070
1947	Feb. 2, 1947	31.81	1,290
1948	Jan. 8, 1948	31.40	1,210
1949	Feb. 22, 1949	32.12	1,570
1950	Mar. 6, 1950	31.60	1,630
1951	Feb. 12, 1951	32.00	1,860

(90) North Creek near Bothell, Wash.

Location.--Lat 47°47'30", long. 122°11'50", on line between secs. 29 and 32, T. 27 N., R. 5 E., 2 mi north of Bothell and 2½ mi upstream from mouth.

Drainage area.--18.7 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 230 cfs and extended by slope-area method.

Remarks.--Negligible diversions and regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Feb. 27, 1946	3.87	280
1947	Feb. 2, 1947	5.29	420
1948	Oct. 19, 1947	4.47	323
1949	Feb. 22, 1949	6.04	455
1950	Jan. 22, 1950	5.08	365
1951	Feb. 9, 1951	4.02	310

SNOHOMISH RIVER BASIN

(91) South Fork Skykomish River near Index, Wash.

Location.--Lat 47°48'20", long. 121°32'40", in NE¼ sec. 29, T. 27 N., R. 10 E., 600 ft upstream from Sunset Falls, 2 mi upstream from confluence with North Fork, and 2 mi southeast of Index.

Drainage area.--355 sq mi.

Gage.--Nonrecording gage read once daily prior to September 1920 and from October 1921 to March 1935. Recording gage used September 1920 to October 1921 and after March 1935. Datum of gage is 574.76 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 17,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Record for 1897 estimated.

SNOHOMISH RIVER BASIN

(91) South Fork Skykomish River near Index, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1897	- - -	27.6	70,000
1903	Jan. 3, 1903	17.4	26,000
1904	Dec. 1, 1903	11.4	10,200
1905	Nov. 22, 1904	11.0	9,470
1912	Nov. 19, 1911	17.0	24,800
1914	Jan. 6, 1914	17.0	24,800
1915	Nov. 3, 1914	11.2	11,400
1916	Oct. 31, 1915	12.3	13,500
1917	June 24, 1917	11.65	12,800
1918	Dec. 18, 1917	22.6	57,000
1919	Dec. 14, 1918	16.0	26,200
1920	Nov. 15, 1919	16.5	26,400
1921	Feb. 11, 1921	14.7	21,000
1922	Dec. 12, 1921	22.8	45,000
1923	Dec. 24, 1922	14.0	19,200
1924	Feb. 12, 1924	21.8	43,500
1925	Dec. 11, 1924	14.0	19,200
1926	Dec. 23, 1925	13.60	18,200
1927	Oct. 6, 1926	13.4	17,700
1928	Jan. 12, 1928	17.5	29,400
1929	Oct. 9, 1928	9.70	9,490
1930	Feb. 5, 1930	10.40	10,900
1931	Feb. 18, 1931	10.50	11,200
1932	Feb. 26, 1932	21.5	49,000
1933	Nov. 13, 1932	20.0	42,000
1934	Dec. 21, 1933	-	53,000
1935	Oct. 25, 1934	19.26	35,400
1936	May 16, 1936	11.60	11,800
1937	Dec. 18, 1936	12.85	14,400
1938	Apr. 18, 1938	17.32	27,700
1939	Jan. 1, 1939	14.0	17,200
1940	Dec. 15, 1939	13.28	15,400
1941	Nov. 29, 1940	12.22	13,000
1942	Dec. 2, 1941	12.0	12,600
1943	Nov. 23, 1942	15.37	21,200
1944	Dec. 3, 1943	20.8	41,900
1945	Jan. 7, 1945	17.56	28,200
1946	Oct. 25, 1945	14.26	18,400
1947	Dec. 11, 1946	16.37	24,700
1948	Oct. 19, 1947	17.14	26,900
1949	May 13, 1949	12.52	13,800
1950	Nov. 27, 1949	19.20	33,700
1951	Feb. 9, 1951	19.29	34,700

(92) Skykomish River near Gold Bar, Wash.

Location.--Lat 47°50'15", long. 121°40'00", in SW¼ sec. 9, T. 27 N., R. 9 E., 2 mi southeast of Gold Bar and 5 mi upstream from Wallace River.

Drainage area.--535 sq mi.

Gage.--Nonrecording prior to November 1, 1928; recording thereafter. Datum of recording gage is 210.01 ft above mean sea level, unadjusted.

Stage-discharge relation.--Defined by current-meter measurements below 32,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	Oct. 9, 1928	10.55	18,800
1930	Feb. 5, 1930	10.44	15,800
1931	Jan. 28, 1931	14.08	35,100
1932	Feb. 26, 1932	20.7	74,400
1933	Nov. 13, 1932	19.5	66,100
1934	Dec. 21, 1933	21.3	79,000
1935	Oct. 24, 1934	18.28	58,400
1936	May 16, 1936	10.91	19,400
1937	Dec. 18, 1936	12.19	25,300
1938	Apr. 18, 1938	16.37	47,200
1939	Jan. 11, 1939	12.92	28,900
1940	Dec. 15, 1939	-	21,000
1941	Nov. 28, 1940	11.38	21,600
1942	Dec. 2, 1941	11.30	21,100
1943	Nov. 23, 1942	14.08	35,000
1944	Dec. 3, 1943	19.40	65,400
1945	Jan. 7, 1945	16.43	47,400
1946	Oct. 25, 1945	13.95	34,500
1947	Dec. 11, 1946	14.86	40,200
1948	Oct. 19, 1947	15.67	45,300
1949	Nov. 23, 1948	11.70	22,300
1950	Nov. 27, 1949	17.50	56,500
1951	Feb. 10, 1951	19.00	68,000

SNOHOMISH RIVER BASIN

(93) Snohomish River at Snohomish, Wash.

Location.--Lat 47°54'32", long. 122°06'00", in SE¼ sec. 13, T. 28 N., R. 5 E., on downstream end of drawrest of bridge No. 205 on State Highway 1A in Snohomish. Auxiliary gage at county road trestle over railroad tracks, 2 mi west of Snohomish and 2½ mi downstream from base gage.

Drainage area.--1,700 sq mi.

Gage.--Recording. Datum of each gage is 10.00 ft below mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Negligible diversion or regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1942	Dec. 19, 1941	22.80	33,400
1943	Nov. 24, 1942	25.86	56,600
1944	Dec. 3, 1943	26.90	64,400
1945	Jan. 7, 1945	26.7	61,000
1946	Oct. 25, 1945	26.67	55,800
1948	Oct. 19, 1947	27.10	58,700
1949	Nov. 24, 1948	24.87	47,000
1951	Feb. 10, 1951	30.05	148,000

(94) Beckler River near Skykomish, Wash.

Location.--Lat 47°44'20", long. 121°19'10", in SW¼ sec. 18, T. 26 N., R. 12 E., a quarter of a mile downstream from Eagle Creek, 2¼ mi upstream from mouth, and 3 mi northeast of Skykomish.

Drainage area.--95 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 4,400 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Record for 1950 from high-water mark.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Feb. 5, 1930	5.71	2,380
1931	Jan. 28, 1931	7.15	4,050
1932	Feb. 26, 1932	9.10	10,000
1933	Nov. 13, 1932	9.6	10,900
1947	Dec. 11, 1946	7.88	5,790
1948	Oct. 19, 1947	8.33	6,580
1949	May 13, 1949	7.01	4,140
1950	Nov. 27, 1949	9.40	9,600

SNOHOMISH RIVER BASIN

(95) North Fork Skykomish River at Index, Wash.

Location.--Lat 47°49'20", long. 121°32'50", in SE¼ sec. 17, T. 27 N., R. 10 E., on highway bridge at Index, 1 3/4 mi above mouth.

Drainage area.--149 sq mi.

Gage.--Nonrecording gage read once daily.

Stage-discharge relation.--Defined by current-meter measurements below 4,700 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Flood of December 21, 1933 reached an observed stage of 10.3 ft (discharge 20,400 cfs). Unofficial reports indicate that the maximum stage was possibly as much as 2 ft higher (possible discharge 26,400 cfs).

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1911	Nov. 21, 1910	10.4	10,100
1912	Nov. 20, 1911	10.83	10,700
1914	Jan. 6, 1914	9.3	10,500
1915	Nov. 2, 1914	8.5	9,100
1916	Oct. 31, 1915	7.0	6,400
1917	Nov. 9, 1916	7.7	7,660
1918	Dec. 29, 1917	-	17,000
1919	Dec. 14, 1918	7.5	11,900
1920	Nov. 15, 1919	9.6	16,800
1921	Feb. 11, 1921	7.15	10,900
1922	Dec. 12, 1921	-	18,000
1930	Feb. 5, 1930	6.20	5,160
1931	Jan. 27, 1931	7.80	9,080
1932	Feb. 26, 1932	10.5	21,000
1933	Nov. 13, 1932	8.80	15,900
1934	Dec. 21, 1933	10.30	20,400
1935	Jan. 24, 1935	9.0	16,500
1936	June 8, 1936	5.13	4,830
1937	June 2, 1937	5.30	4,670
1938	Nov. 8, 1937	8.46	13,800
1947	Dec. 11, 1946	7.42	9,430
1948	May 28, 1948	6.56	7,720

(96) Troublesome Creek near Index, Wash.

Location.--Lat 47°54'00", long. 121°23'50", in NE¼ sec. 21, T. 28 N., R. 11 E. (unsurveyed), a quarter of a mile above mouth and 9 mi northeast of Index. Discharge measurements made 1¼ and 2 mi above.

Drainage area.--10.4 sq mi at measuring section.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 750 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Feb. 5, 1930	3.95	632
1931	Jan. 27, 1931	4.78	1,100
1932	Feb. 26, 1932	7.54	2,220
1933	Nov. 13, 1932	5.80	1,620
1934	Dec. 21, 1933	7.00	2,300
1935	Jan. 24, 1935	5.33	1,480
1936	May 16, 1936	2.87	486
1937	Dec. 18, 1936	3.45	740
1938	Apr. 18, 1938	3.95	940
1939	Oct. 12, 1938	3.40	720
1940	Dec. 15, 1939	2.98	438
1941	Oct. 10, 1940	3.36	575

SNOHOMISH RIVER BASIN

(97) Olney Creek near Gold Bar, Wash.

Location.--Lat 47°56'40", long. 121°42'30", in SW¼ sec. 6, T. 28 N., R. 9 E., 5½ mi north of Gold Bar and 6½ mi upstream from mouth.

Drainage area.--7.9 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 300 cfs and extended by slope-area method.

Remarks.--No diversion or regulation. Discharge of 3,540 cfs caused by release of water from pondage caused by a slide. Records for 1924-26 and 1930-33 computed on basis of records for Olney Creek near Startup.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1924	Feb. 12, 1924	-	1,200
1925	Dec. 10, 1924	-	1,150
1926	Oct. 27, 1925	-	1,260
1930	Feb. 1, 1930	-	1,370
1931	Sept. 13, 1930	-	745
1932	Feb. 26, 1932	-	1,900
1933	Nov. 16, 1932	-	1,660
1947	Oct. 25, 1946	6.30	2,550
1948	Oct. 2, 1947	4.55	965
1949	Nov. 23, 1948	4.50	930
1950	Oct. 9, 1949	4.54	965
1951	Feb. - 1951	6.10	3,540

(98) May Creek near Gold Bar, Wash.

Location.--Lat 47°51'30", long. 121°36'30", in NE¼ sec. 2, T. 27 N., R. 9 E., half a mile downstream from Lake Isabel and 4 mi east of Gold Bar.

Drainage area.--4.3 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 440 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Natural regulation by Lake Isabel.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	Oct. 9, 1928	2.83	138
1930	June 12, 1930	2.20	98
1932	Feb. 27, 1932	3.20	219
1933	Dec. 2, 1932	4.92	475
1934	Dec. 10, 1933	3.50	270
	Change in datum		
1947	Oct. 25, 1946	4.9	726

(99) Sultan River near Startup, Wash.

Location.--Lat 47°58'30", long. 121°46'30", in NE¼ sec. 28, T. 29 N., R. 8 E., 1½ mi upstream from intake of Everett water-supply system and 7½ mi north of Startup.

Drainage area.--75 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 3,000 cfs and extended by slope-area method.

Remarks.--No diversion or regulation. Records for 1912-26 and 1930-31 computed on basis of records for Sultan River near Sultan, Wash.

SNOHOMISH RIVER BASIN

(99) Sultan River near Startup, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1912	Nov. 18, 1911	-	12,500	21	1.95
1913	Sept. 4, 1913	-	6,350	37	1.11
1914	Jan. 6, 1914	-	8,750	30	1.37
1915	Apr. 2, 1915	-	8,750	31	1.32
1916	Dec. 8, 1915	-	7,100	35	1.17
1917	Nov. 9, 1916	-	7,450	34	1.21
1918	Dec. 18, 1917	-	17,500	13	3.15
1919	Dec. 4, 1918	-	11,200	26	1.58
1920	Nov. 15, 1919	-	17,300	14	2.93
1921	Feb. 11, 1921	-	12,300	22	1.86
1922	Feb. 12, 1921	-	21,000	5	8.20
1923	Jan. 6, 1923	-	13,300	20	2.05
1924	Feb. 12, 1924	-	18,000	12	3.42
1925	Dec. 10, 1924	-	11,700	23	1.78
1926	Dec. 23, 1925	-	9,000	29	1.41
1930	Feb. 1, 1930	-	6,100	38	1.08
1931	Jan. 27, 1931	-	8,750	32	1.28
1935	Oct. 24, 1934	16.05	27,000	3	13.67
1936	May 16, 1936	10.42	5,800	39	1.05
1937	Dec. 6, 1936	13.40	14,600	17	2.41
1938	Apr. 17, 1938	14.48	19,000	8	5.12
1939	May 28, 1939	12.6	11,600	24	1.71
1940	Oct. 4, 1939	11.56	8,600	33	1.24
1941	Oct. 10, 1940	12.65	11,600	25	1.64
1942	June 15, 1942	11.03	7,100	36	1.14
1943	Oct. 31, 1942	14.47	19,000	9	4.56
1944	Dec. 3, 1943	16.4	29,400	2	20.50
1945	Jan. 7, 1945	14.66	20,000	6	6.83
1946	Oct. 25, 1945	14.0	17,000	15	2.73
1948	Oct. 19, 1947	13.44	14,600	18	2.28
1949	Nov. 23, 1948	12.16	10,400	28	1.46
1950	Mar. 4, 1950	14.3	18,200	11	3.73
1951	Feb. 9, 1951	17.22	34,600	1	41.00

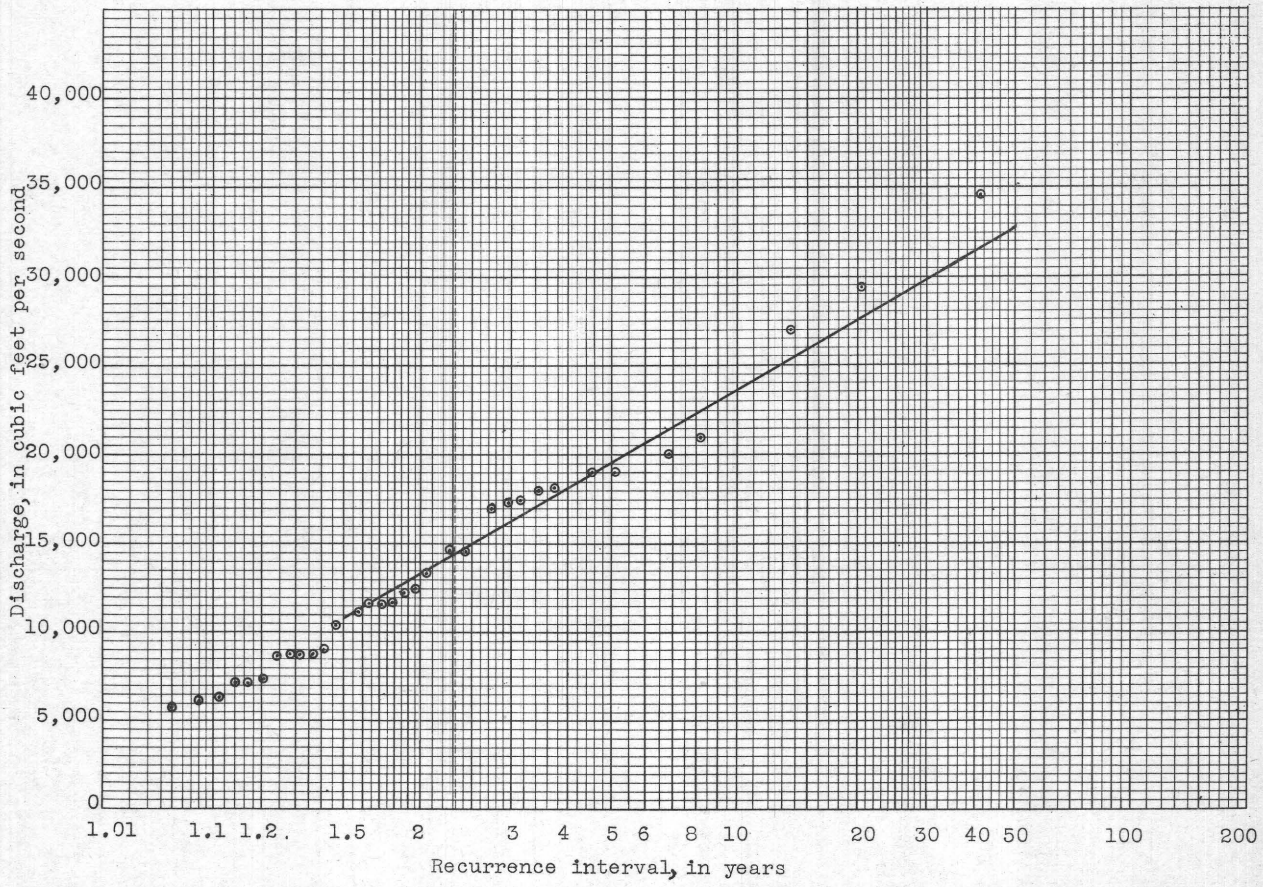

Figure 25.--Frequency of annual floods, Sultan River near Startup, Wash.

SNOHOMISH RIVER BASIN

(100) Middle Fork Snoqualmie River near North Bend, Wash.

Location.--Lat 47°31'00", long. 121°46'00", in sec. 34, T. 24 N., R. 8 E., at highway bridge 1½ mi north of North Bend. Prior to August 7, 1915, gages at different sites half a mile above confluence with North Fork; August 7, 1915 to September 30, 1926, at site 1 mi southeast of North Bend.

Drainage area.--173 sq mi.

Gage.--Recording gage September 1912 to June 1926. Nonrecording gage read once daily before and after this period.

Stage-discharge relation.--Defined by current-meter measurements below about 5,000 cfs at the various sites, and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1912	Nov. 18, 1911	-	18,000
1914	Oct. 10, 1913	8.0	12,900
1915	Nov. 3, 1914	6.19	8,160
	Change in datum		
1916	Mar. 9, 1916	8.21	8,900
1917	June 24, 1917	7.04	6,540
1918	Dec. 18, 1917	12.2	18,300
1919	Dec. 14, 1918	10.1	13,700
1920	Nov. 15, 1919	8.50	10,300
1921	Dec. 30, 1920	9.2	11,800
1922	Dec. 12, 1921	11.9	17,300
1923	Dec. 24, 1922	9.80	12,700
1924	Feb. 12, 1924	-	14,000
1925	Dec. 11, 1924	9.02	10,600
1926	Jan. 5, 1926	8.57	9,760
	Change in datum		
1930	Feb. 1, 1930	7.3	5,490
1931	Jan. 28, 1931	8.40	8,510
1932	Feb. 26, 1932	13.5	18,100

(101) Snoqualmie River near Tolt, Wash.

Location.--Lat 47°39'55", long. 121°55'30", in sec. 9, T. 25 N., R. 7 E., 100 ft downstream from highway bridge, 1 mi northwest of Tolt and 2 mi downstream from Tolt River.

Drainage area.--605 sq mi.

Gage.--Nonrecording gage read twice daily prior to December 20, 1933; recording thereafter. Datum of gage is at mean sea level (unadjusted).

Stage-discharge relation.--Defined by current-meter measurements. Slope is a factor at high stages.

Remarks.--No diversion. Negligible regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1930	Feb. 5, 1930	7.62	14,800	37	1.11
1931	Jan. 28, 1931	10.51	27,400	20	2.05
1932	Feb. 26, 1932	15.3	51,000	1	41.00
1933	Nov. 13, 1932	14.54	45,400	7	5.86
1934	Dec. 10, 1933	15.83	41,000	9	4.56
1935	Oct. 25, 1934	15.4	47,100	6	6.83
1936	May 16, 1936	-	16,100	36	1.14
1937	Apr. 15, 1937	9.60	17,200	34	1.21
1938	Apr. 18, 1938	14.57	38,800	11	3.73
1939	Dec. 8, 1938	11.2	22,900	26	1.58
	Change in datum				
1940	Dec. 16, 1939	52.46	18,900	33	1.24
1941	Nov. 29, 1940	53.18	20,000	29	1.41
1942	Dec. 19, 1941	52.71	19,700	31	1.32
1943	Nov. 24, 1942	55.69	30,300	16	2.56
1944	Dec. 3, 1943	58.13	48,400	4	10.25
1945	Jan. 8, 1945	57.02	32,000	15	2.73
1946	Oct. 26, 1945	54.42	23,500	25	1.64
1947	Dec. 11, 1946	56.57	32,600	14	2.93
1948	Oct. 19, 1947	54.78	24,800	23	1.78
1949	Nov. 24, 1948	53.06	20,200	28	1.46
1950	Mar. 4, 1950	56.16	30,100	17	2.41
1951	Feb. 10, 1951	59.14	50,000	2	20.50

SNOHOMISH RIVER BASIN

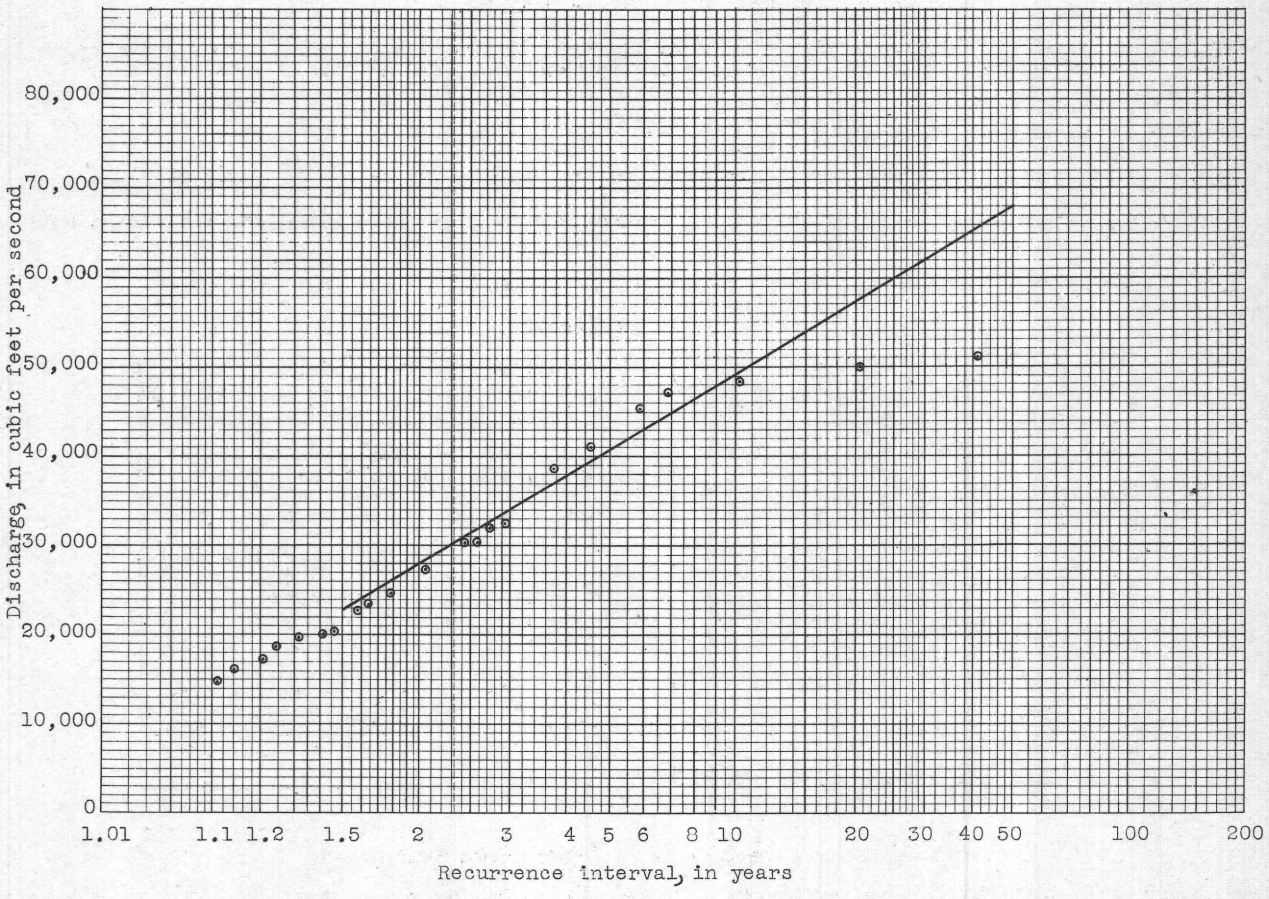

Figure 26.--Frequency of annual floods, Snoqualmie River near Tolt, Wash.

(102) North Fork Snoqualmie River near Snoqualmie Falls, Wash.

Location.--Lat 47°37'10", long. 121°42'35", in SW¼ sec. 30, T. 25 N., R. 9 E., 1 mi upstream from Calligan Creek.

Drainage area.--65 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,100 cfs and extended by logarithmic plotting.

Remarks.--No diversions or regulation. Peak discharge estimated for October 25, 1934.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1930	Feb. 1, 1930	11.27	4,190
1931	Jan. 28, 1931	10.75	4,030
1932	Feb. 26, 1932	17.5	8,020
1933	Nov. 17, 1932	14.6	6,700
1934	Nov. 2, 1933	14.7	6,780
1935	Oct. 25, 1934	-	8,400
1936	May 16, 1936	9.76	3,350
1937	Dec. 6, 1936	10.74	4,010
1938	Apr. 7, 1938	14.60	6,860
1939	Dec. 7, 1938	11.59	4,610
1940	Nov. 7, 1939	10.37	3,710
1941	Nov. 28, 1940	12.94	5,500
1942	Dec. 19, 1941	10.40	3,710
1943	Nov. 23, 1942	15.63	7,660
1944	Dec. 3, 1943	15.31	7,420
1945	Jan. 7, 1945	16.3	8,320
1946	Oct. 25, 1945	12.73	5,310
1947	Dec. 11, 1946	13.75	6,190
1948	Oct. 19, 1947	12.9	5,470
1949	Nov. 23, 1948	11.59	4,470

SNOHOMISH RIVER BASIN

(103) North Fork Snoqualmie River near North Bend, Wash.

Location.--Lat 47°32'20", long. 121°44'20", in NE¼ sec. 26, T. 24 N., R. 8 E., 2 mi above mouth and 3½ mi northeast of North Bend. Prior to September 26, 1916 an eighth of a mile above mouth.

Drainage area.--105 sq mi at mouth.

Gage.--Nonrecording gage read once daily prior to September 1912; recording gage thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 2,600 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1909	June 2, 1909	8.0	5,170
1911	Nov. 21, 1910	10.0	6,580
1912	Nov. 18, 1911	14.5	11,100
1914	Oct. 11, 1913	9.34	5,910
1915	Apr. 2, 1915	7.66	4,320
1916	Mar. 9, 1916	8.80	6,000
	Change in datum		
1917	June 24, 1917	6.35	3,750
1918	Dec. 18, 1917	10.80	9,890
1919	Jan. 23, 1919	-	5,700
1920	Nov. 15, 1919	-	5,000
1921	Feb. - 1921	-	5,500
1922	Dec. 12, 1921	9.9	8,630
1923	Dec. 24, 1922	9.05	7,370
1924	Feb. 12, 1924	-	9,000
1925	Dec. 10, 1924	8.71	6,830
1926	Dec. 23, 1925	8.5	6,550
1930	Feb. 1, 1930	6.47	4,610
1931	Jan. 28, 1931	6.60	4,610
1932	Feb. 26, 1932	11.55	11,000
1933	Nov. 17, 1932	9.9	9,250
1934	Dec. 9, 1933	10.0	8,930
1935	Oct. - 1934	11.4	11,500
1936	May 16, 1936	6.12	3,730
1937	Dec. 6, 1936	6.71	4,760
1938	Apr. 18, 1938	9.44	8,630

(104) South Fork Snoqualmie River at North Bend, Wash.

Location.--Lat 47°29'40", long. 121°47'20", in NE¼ sec. 9, T. 23 N., R. 8 E., at North Bend 2 mi upstream from mouth. At site 3½ mi upstream October 1916 to September 1926 and February 1929 to October 1948. Prior to 1916 gage half a mile upstream.

Drainage area.--84 sq mi.

Gage.--Nonrecording gage prior to September 1912; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 6,400 cfs and extended by logarithmic plotting. Stage discharge relation shifts frequently.

Remarks.--No diversion or regulation. Water over gage for several days in November 1909 (discharge probably greater than that of October 25, 1934).

SNOHOMISH RIVER BASIN

(104) South Fork Snoqualmie River at North Bend, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1909	June 1, 1909	4.2	1,960	-	-
1911	Nov. 21, 1910	8.1	5,340	-	-
1912	Nov. 19, 1911	7.5	4,840	19	2.16
1914	Jan. 7, 1914	4.60	2,500	35	1.17
1915	Nov. 3, 1914	4.8	2,670	32	1.28
1916	Mar. 10, 1916	5.25	3,100	28	1.46
	Change in datum				
1917	June 16, 1917	6.54	2,200	37	1.11
1918	Dec. 18, 1917	10.76	5,400	14	2.93
1919	Jan. 23, 1919	10.2	4,970	18	2.28
1920	Nov. 15, 1919	8.5	3,570	25	1.64
1921	Dec. 30, 1920	9.47	4,410	22	1.86
1922	Dec. 12, 1921	10.8	6,780	9	4.56
1923	Jan. 7, 1923	10.0	5,500	12	3.42
1924	Feb. 12, 1924	10.56	6,460	11	3.73
1925	Dec. 12, 1924	9.31	4,540	21	1.95
1926	Dec. 23, 1925	7.75	3,160	26	1.58
1930	Feb. 19, 1930	5.77	1,900	40	1.02
1931	Jan. 28, 1931	7.16	2,810	30	1.37
1932	Feb. 26, 1932	11.18	7,600	3	13.67
1933	Nov. 13, 1932	10.90	7,100	7	5.86
1934	Dec. 22, 1933	11.1	7,430	4	10.25
1935	Oct. 25, 1934	11.2	7,620	2	20.50
1936	May 16, 1936	5.96	2,420	36	1.14
1937	Dec. 19, 1936	6.43	2,810	31	1.32
1938	Apr. 18, 1938	9.65	5,410	13	3.15
1946	Oct. 25, 1945	8.83	5,200	16	2.56
1947	Dec. 11, 1946	9.70	6,490	10	4.10
1948	Oct. 19, 1947	8.13	4,320	23	1.78
1949	Nov. 24, 1948	6.62	2,910	29	1.41
1950	Nov. 27, 1949	8.85	5,190	17	2.41

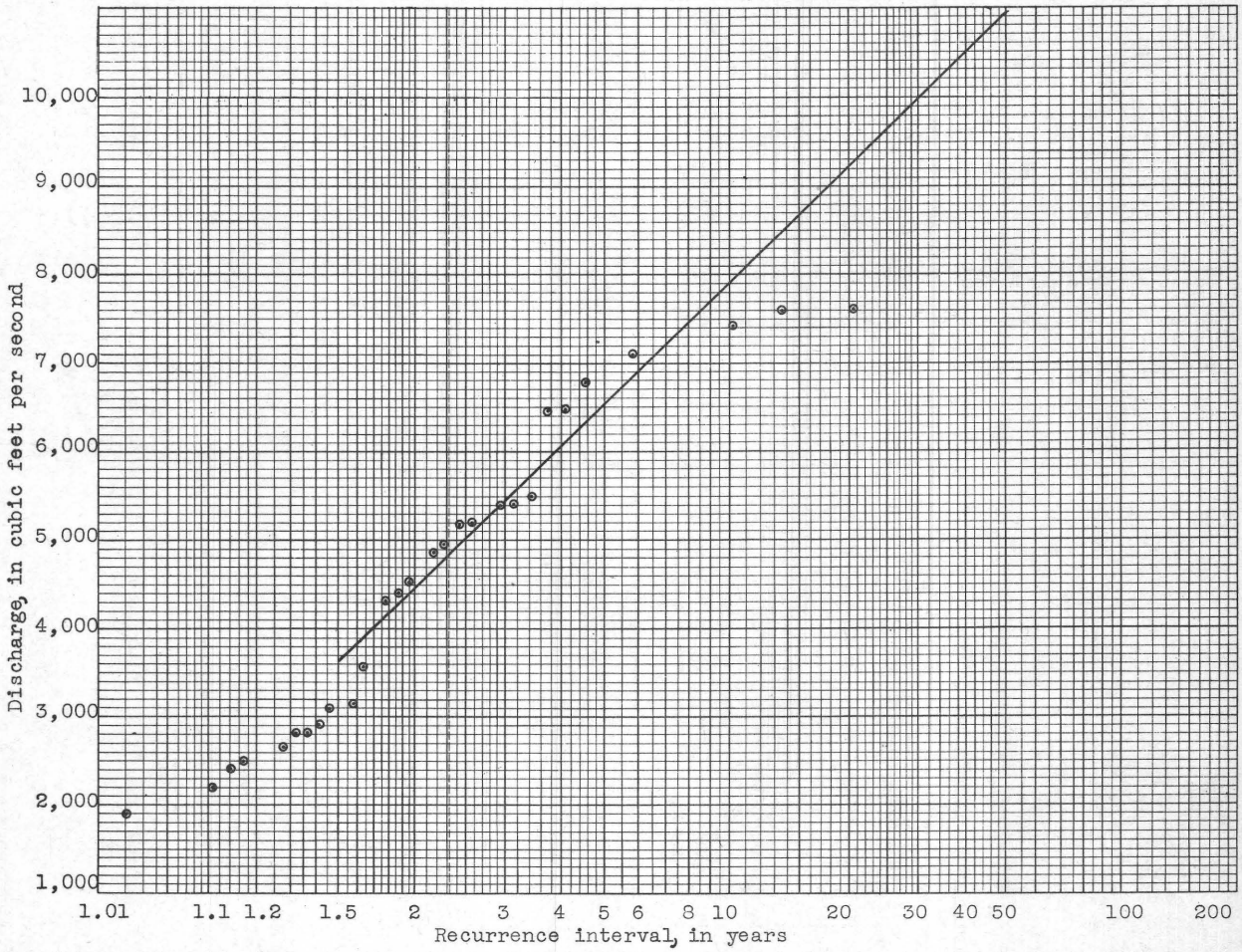

Figure 27.--Frequency of annual floods, South Fork Snoqualmie River at North Bend, Wash.

SNOHOMISH RIVER BASIN

(105) Raging River near Fall City, Wash.

Location.--Lat 47°32'25", long. 121°54'10", on west line sec. 27, T. 24 N., R. 7 E., 2 mi southwest of Fall City and 2½ mi upstream from mouth.

Drainage area.--31.2 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,200 cfs and extended by slope-area method.

Remarks.--Negligible diversion at flood stage. No regulation. Record for 1951 obtained from high-water mark.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 28, 1945	4.67	1,380
1947	Dec. 11, 1946	4.97	1,650
1948	Oct. 19, 1947	5.20	1,850
1949	Feb. 17, 1949	5.60	2,200
1950	Mar. 4, 1950	5.35	2,050
1951	Feb. 9, 1951	6.76	3,420

(106) Tolt River near Tolt, Wash.

Location.--Lat 47°41'45", long. 121°49'20", in S½NE¼ sec. 31, T. 26 N., R. 8 E., 500 ft downstream from the Forks and 6 mi northeast of Tolt.

Drainage area.--80 sq mi.

Gage.--Recording. Datum of gage is about 348 ft above mean sea level (river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 3,800 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	Oct. 9, 1928	7.10	3,280
1931	Oct. 6, 1930	6.85	3,250
	Change in datum		
1938	Apr. 18, 1938	11.51	9,750
1939	Nov. 16, 1938	9.33	4,800
1940	Nov. 7, 1939	9.30	4,680
1941	Nov. 28, 1940	10.75	8,250
1942	Dec. 19, 1941	9.50	5,190
1943	Oct. 31, 1942	11.95	11,400
1944	Dec. 2, 1943	11.24	9,210
1945	Jan. 7, 1945	12.14	11,700
1946	Oct. 25, 1945	9.31	4,960
1947	Oct. 25, 1946	10.94	8,450
1948	Oct. 19, 1947	10.59	7,720
1949	Nov. 23, 1948	10.33	7,250
1950	Mar. 4, 1950	11.54	10,600
1951	Feb. 9, 1951	13.10	16,700

SNOHOMISH RIVER BASIN

(107) Pilchuck River near Granite Falls, Wash.

Location.--Lat 48°03'15", long. 121°57'25", in SE¼ sec. 30, T. 30 N., R. 7 E., 200 ft upstream from road bridge and 2 mi south of Granite Falls.

Drainage area.--53 sq mi.

Gage.--Nonrecording prior to July 10, 1946; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 4,100 cfs and extended by slope-area method.

Remarks.--Negligible diversion at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	May 24, 1944	7.05	4,030
1945	Jan. 7, 1945	9.20	6,280
1946	Oct. 25, 1945	10.28	7,930
1947	Oct. 25, 1946	8.92	5,890
1948	Oct. 19, 1947	8.09	4,700
1949	Feb. 17, 1949	7.54	4,560
1950	Feb. 24, 1950	8.01	5,420
1951	Feb. 9, 1951	8.61	6,760

STILLAGUAMISH RIVER BASIN

(108) South Fork Stillaguamish River near Granite Falls, Wash.

Location.--Lat 48°06'10", long. 121°56'40", in SW¼NW¼ sec. 8, T. 30 N., R. 7 E., 1½ mi upstream from Canyon Creek and 2 mi northeast of Granite Falls.

Drainage area.--119 sq mi.

Gage.--Nonrecording gage at lower site; recording since 1929.

Stage-discharge relation.--Defined by current-meter measurements below 8,800 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Records for 1914 and 1915 at site below Canyon Creek.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1914	Nov. 24, 1913	9.9	10,000	31	1.32
1915	May 18, 1915	6.9	5,360	40	1.02
	Change in datum				
1929	Oct. 9, 1928	12.44	12,000	27	1.52
1930	Feb. 1, 1930	10.8	9,040	35	1.17
1931	Jan. 27, 1931	12.72	12,500	23	1.78
1932	Feb. 26, 1932	19.68	26,700	2	20.50
1933	Nov. 13, 1932	16.37	19,900	9	4.56
1934	Dec. 21, 1933	15.1	17,300	13	3.15
1935	Jan. 24, 1935	16.99	21,100	6	6.83
1936	May 16, 1936	9.88	7,620	38	1.08
1937	Dec. 6, 1936	13.60	14,400	20	2.05
1938	Apr. 18, 1938	14.13	15,400	17	2.41
1939	Oct. 12, 1938	12.88	13,100	22	1.86
1940	Dec. 15, 1939	11.52	10,500	30	1.37
1941	Oct. 10, 1940	10.76	9,240	34	1.21
1942	Dec. 19, 1941	10.30	8,340	37	1.11
1943	Nov. 23, 1942	12.6	12,500	24	1.71
1944	Dec. 3, 1943	15.84	18,700	11	3.73
1945	Jan. 7, 1945	15.54	18,100	12	3.42
1946	Oct. 25, 1945	13.87	16,200	15	2.73
1947	Oct. 25, 1946	16.30	21,700	5	8.20
1948	Oct. 19, 1947	15.09	23,400	3	13.67
1949	Oct. 7, 1948	10.84	9,810	32	1.28
1951	Feb. 9, 1951	18.10	37,000	1	41.00

STILLAGUAMISH RIVER BASIN

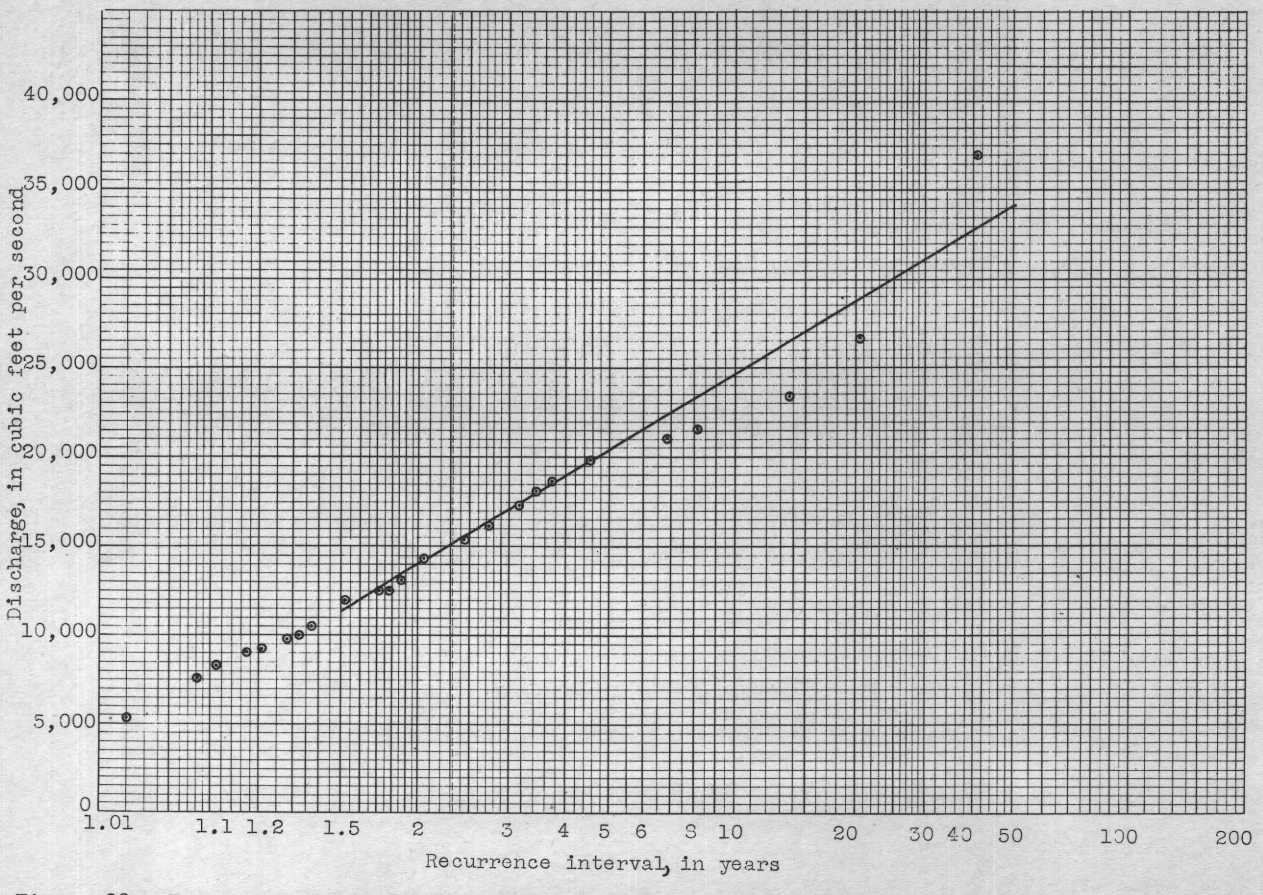

Figure 28.--Frequency of annual floods, South Fork Stillaguamish River near Granite Falls, Wash.

(109) South Fork Stillaguamish River above Jim Creek, near Arlington, Wash.

Location.--Lat 48°09'55", long. 122°03'55", in SW¼ sec. 17, T. 31 N., R. 6 E., 1½ mi upstream from Jim Creek and 3 mi southeast of Arlington.

Drainage area.--199 sq mi.

Gage.--Recording. Datum of gage is 80.00 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 22,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1937	Dec. 22, 1936	19.31	13,600
1938	Apr. 17, 1938	23.27	25,200
1939	Oct. 12, 1938	21.60	20,200
1940	Dec. 15, 1939	19.35	14,200
1941	Oct. 10, 1940	19.56	14,700
1942	Dec. 19, 1941	18.07	11,100
1943	Oct. 31, 1942	21.57	18,700
1944	Dec. 3, 1943	23.88	24,200
1945	Jan. 7, 1945	24.79	26,500
1946	Oct. 25, 1945	24.35	25,400
1947	Oct. 25, 1946	26.07	29,900
1948	Oct. 19, 1947	24.57	26,000
1949	Nov. 23, 1948	19.68	13,700
1950	Dec. 28, 1949	23.41	20,900
1951	Feb. 9, 1951	27.32	27,000

STILLAGUAMISH RIVER BASIN

(110) Jim Creek near Arlington, Wash.

Location.--Lat 48°10'30", long. 122°03'55", in SE¼NW¼ sec. 17, T. 31 N., R. 6 E., 1 mi upstream from mouth and 3 mi southeast of Arlington.

Drainage area.--48.9 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,900 cfs, and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1938	Dec. 28, 1937	8.32	3,340
1939	Jan. 1, 1939	6.40	2,040
1940	Mar. 30, 1940	5.74	1,620
1941	Nov. 29, 1940	7.08	2,470
1942	June 15, 1942	5.80	1,680
1943	Nov. 15, 1942	5.80	1,680
1944	Dec. 3, 1943	5.55	1,570
1945	Jan. 7, 1945	7.53	2,750
1946	Oct. 25, 1945	9.20	4,060
1947	Oct. 25, 1946	8.77	3,690
1948	Oct. 19, 1947	7.76	2,960
1949	Oct. 4, 1948	7.87	3,030
1950	Dec. 28, 1949	9.28	4,730
1951	Feb. 10, 1951	7.47	2,900

(111) North Fork Stillaguamish River near Arlington, Wash.

Location.--Lat 48°15'45", long. 122°02'45", in SE¼NW¼ sec. 16, T. 32 N., R. 6 E., 6 mi northeast of Arlington, 7 mi upstream from mouth, and 8 mi downstream from Deer Creek.

Drainage area.--269 sq mi.

Gage.--Recording. Datum of gage is 89.34 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 22,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	Oct. 9, 1928	9.70	14,300
1930	Feb. 5, 1930	9.38	12,800
1931	Jan. 23, 1931	11.10	22,100
1932	Feb. 26, 1932	12.7	27,700
1933	Nov. 13, 1932	12.1	24,600
1934	Dec. 21, 1933	11.4	21,100
1935	Jan. 24, 1935	11.73	22,600
1936	Jan. 4, 1936	9.08	10,800
1937	Dec. 13, 1936	9.33	12,000
1938	Dec. 28, 1937	11.34	22,300
1939	Jan. 1, 1939	9.89	15,400
1940	Dec. 15, 1939	9.21	12,600
1941	Oct. 10, 1940	8.38	9,760
1942	Dec. 19, 1941	9.55	14,200
1943	Nov. 23, 1942	10.34	17,200
1944	Dec. 3, 1943	11.03	19,200
1945	Jan. 7, 1945	11.64	21,800
1946	Oct. 25, 1945	12.02	23,600
1947	Jan. 24, 1947	13.10	27,500
1948	Oct. 19, 1947	11.46	21,000
1949	Feb. 17, 1949	9.51	12,600
1950	Dec. 28, 1949	12.32	25,000
1951	Feb. 11, 1951	13.58	32,000

SKAGIT RIVER BASIN

(112) Skagit River near Newhalem, Wash.

Location.--Lat 48°45', long. 121°02', in sec. 30, T. 38 N., R. 14 E., 1¼ mi upstream Ruby Creek, 11 mi northeast of Newhalem, and 24 mi northeast of Marblemount.

Drainage area.--765 sq mi, of which 390 sq mi are in Canada.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 13,000 cfs and extended by velocity-area method.

Remarks.--No diversion or regulation. Records for 1920-29 computed on basis of records for Skagit River below Ruby Creek near Newhalem; and records for 1940-42 computed on basis of records for Skagit River above Devils Creek near Newhalem.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1920	July 1, 1920	-	9,800
1921	June 7, 1921	-	19,600
1922	Dec. 12, 1921	-	35,600
1923	June 8, 1923	-	14,900
1924	Feb. 12, 1924	-	20,400
1925	May 19, 1925	-	18,000
1926	Apr. 30, 1926	-	5,800
1927	June 7, 1927	-	17,300
1928	May 23, 1928	-	17,300
1929	May 23, 1929	-	10,600
1930	June 11, 1930	9.5	8,270
1931	May 2, 1931	10.2	9,860
1932	Feb. 27, 1932	15.9	25,700
1933	June 16, 1933	13.1	17,300
1934	Apr. 24, 1934	12.0	14,300
1935	Nov. 5, 1934	13.05	17,000
1936	May 31, 1936	11.11	12,000
1937	June 3, 1937	11.39	12,700
1938	May 26, 1938	11.74	13,600
1939	May 29, 1939	11.13	12,100
1940	May 24, 1940	-	7,000
1941	Oct. 21, 1940	-	5,000
1942	Dec. 3, 1941	-	7,800

SKAGIT RIVER BASIN

(113) Skagit River at Newhalem, Wash.

Location.--Lat 48°40', long. 121°15', in SE¼ sec. 21, T. 37 N., R. 12 E., at power plant of city of Seattle at Newhalem, a quarter of a mile upstream from Newhalem Creek. Records for 1915-21 obtained at Reflector Bar 6 mi upstream.

Drainage area.--1,160 sq mi, of which 390 sq mi is in Canada.

Gage.--Staff gage read twice daily prior to May 1914 and from October 1921 to June 1923. Recording gage for rest of period.

Stage-discharge relation.--Defined by current-meter measurements below 26,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Partial regulation by Diablo Reservoir since 1929 (usable capacity 76,220 acre-ft) and by Ruby Reservoir since 1940 (usable capacity 102,600 acre-ft to 1945; increased capacity since), at flood stage. Records for 1915-21 at Reflector Bar are corrected to discharge at Newhalem on basis of ratio of square roots of drainage areas. Discharges during period 1942-51 corrected by comparison with Skagit River near Concrete. Records prior to 1911 were taken from Stewart report (unpublished) and is for Reflector Bar station.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1820	-	20.5	115,000
1856	-	18.5	95,000
1898	Nov. 18, 1897	12.5	48,000
1910	Nov. 29, 1909	15.4	70,000
1911	June 14, 1911	11.7	24,800
1912	May 15, 1912	10.00	19,100
1913	June 3, 1913	12.10	26,200
1914	Jan. 6, 1914	9.80	18,400
1915	Apr. 3, 1915	-	12,200
1916	June 17, 1916	-	30,300
1917	June 16, 1917	-	20,300
1918	Dec. 29, 1917	-	38,400
1919	May 27, 1919	-	24,900
1920	July 1, 1920	-	16,100
1921	June 7, 1921	-	31,800
1922	Dec. 21, 1921	94.2	60,000
1923	June 9, 1923	89.1	21,400
1924	Feb. 12, 1924	90.85	31,400
1925	May 20, 1925	89.65	25,400
1926	Apr. 30, 1926	85.68	9,220
1927	June 8, 1927	89.56	26,000
1928	May 21, 1928	89.75	27,200
1929	Oct. 9, 1928	89.15	23,600
1930	June 11, 1930	86.9	13,400
1931	May 2, 1931	87.53	15,500
1932	Feb. 27, 1932	92.84	45,000
1933	June 15, 1933	90.15	28,200
1934	Apr. 23, 1934	89.64	25,000
1935	Jan. 25, 1935	90.82	30,300
1936	May 31, 1936	89.27	22,400
1937	June 3, 1937	89.32	22,500
1938	Oct. 28, 1937	89.69	24,400
1939	May 29, 1939	89.3	22,400
1940	May 23, 1940	87.56	15,100
1941	Oct. 20, 1940	88.12	17,100
1942	May 26, 1942	-	22,100
1943	May 27, 1943	-	17,300
1944	June 12, 1944	-	19,700
1945	May 31, 1945	-	22,400
1946	May 27, 1946	-	27,600
1947	May 25, 1947	-	23,400
1948	June 15, 1948	-	26,200
1949	May 15, 1949	-	17,600
1950	June 29, 1950	-	38,700
1951	Feb. 10, 1951	-	35,700

SKAGIT RIVER BASIN

(114) Skagit River near Concrete, Wash.

Location.--Lat 48°32', long. 121°46', in sec. 16, T. 35 N., R. 8 E., at dalles 2 mi downstream from Baker River and 2½ mi southwest of Concrete.

Drainage area.--2,700 sq mi, of which 390 sq mi is in Canada.

Gage.--Recording. Datum of gage is 130.00 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 135,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion. Partial regulation by Lake Shannon on Baker River since 1927 and by Diablo and Ruby Reservoirs on Skagit River since 1929 and 1940 respectively. Historical data prior to 1925 were taken from revised Stewart report (unpublished).

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1820	-	-	400,000
1856	-	-	280,000
1897	-	-	230,000
1909	-	-	220,000
1918	Dec. 30, 1917	33.0	190,000
1922	Dec. 13, 1921	34.9	210,000
1925	Dec. 12, 1924	19.75	92,500
1926	Dec. 23, 1925	13.6	51,600
1927	Oct. 16, 1926	19.34	88,900
1928	Jan. 12, 1928	20.2	95,500
1929	Oct. 9, 1928	17.25	74,300
1930	June 7, 1930	10.01	32,200
1931	June 26, 1931	15.09	60,600
1932	Feb. 27, 1932	27.30	147,000
1933	Nov. 13, 1932	22.9	116,000
1934	Dec. 22, 1933	20.9	101,000
1935	Jan. 25, 1935	25.2	131,000
1936	June 3, 1936	15.00	60,000
1937	June 19, 1937	16.28	68,300
1938	Oct. 28, 1937	32.16	89,600
1939	May 29, 1939	30.7	79,600
1940	Dec. 15, 1939	25.70	48,200
1941	Oct. 19, 1940	26.20	51,000
1942	Dec. 2, 1941	30.17	76,300
1943	Nov. 23, 1942	26.69	54,000
1944	Dec. 3, 1943	28.49	65,200
1945	Feb. 8, 1945	29.35	70,800
1946	Oct. 25, 1945	34.0	102,000
1947	Oct. 25, 1946	31.14	82,200
1948	Oct. 19, 1947	32.99	95,200
1949	May 13, 1949	26.97	55,700
1950	Nov. 27, 1949	40.80	154,000
1951	Feb. 10, 1951	39.00	139,000

(115) Beaver Creek near Newhalem, Wash.

Location.--Lat 48°47', long. 121°05', in sec. 14, T. 38 N., R. 13 E., three-quarters of a mile upstream from Ross Reservoir, 3½ mi north of Ross Dam on Skagit River, and 10½ mi northeast of Newhalem.

Drainage area.--63 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1940	May 24, 1940	4.97	1,480
1941	Oct. 19, 1940	7.34	3,290
1942	Dec. 2, 1941	7.76	3,620
1943	July 4, 1943	5.11	1,550
1944	Dec. 3, 1943	4.63	1,280
1945	May 31, 1945	5.32	1,720
1946	Oct. 26, 1945	7.57	3,450
1947	Oct. 25, 1946	5.33	1,760
1948	May 28, 1948	6.37	2,490

SKAGIT RIVER BASIN

(116) Ruby Creek near Newhalem, Wash.

Location.--Lat 48°43', long. 121°00', in SE¼ sec. 5, T. 37 N., R. 14 E., 2 mi upstream from mouth and 12 mi northeast of Newhalem.

Drainage area.--203 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 5,600 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1931	May 14, 1931	12.47	3,570
1932	Feb. 27, 1932	14.15	6,730
1933	June 14, 1933	14.09	6,510
1934	Apr. 23, 1934	13.74	4,920
1935	Nov. 5, 1934	-	3,460
1936	June 2, 1936	13.92	4,850
1937	June 2, 1937	13.51	4,480
1938	May 25, 1938	13.12	4,530
1939	May 28, 1939	13.08	4,650
	Change in datum		
1940	May 23, 1940	6.91	3,070
1941	Oct. 20, 1940	5.88	1,630
1942	May 25, 1942	7.69	4,650
1943	June 9, 1943	7.45	4,160
1944	May 15, 1944	6.4	2,370
1945	May 30, 1945	7.56	4,360
1946	May 27, 1946	7.43	4,160
1947	May 8, 1947	7.50	4,260
1948	May 27, 1948	9.20	9,920
1949	May 15, 1949	7.65	5,340
	Change in datum		
1950	Nov. 27, 1949	10.95	8,640
1951	May 23, 1951	7.50	4,170

(117) Thunder Creek near Newhalem, Wash.

Location.--Lat 48°40', long. 121°04', in SE¼ sec. 23, T. 37 N., R. 13 E. (unsurveyed), half a mile upstream from backwater from Diablo Reservoir, 8 mi east of Newhalem, and 20 mi northeast of Marblemount. Prior to 1931 gage a quarter of a mile upstream from mouth, published as Thunder Creek near Marblemount.

Drainage area.--98 sq mi at present site. 111 sq mi at former site.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,900 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Discharges for years 1920-30 at lower gage site are corrected to upper site by ratio of square roots of drainage areas.

SKAGIT RIVER BASIN

(117) Thunder Creek near Newhalem, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1920	Sept. 11, 1920	-	4,380	18	2.28
1921	June 7, 1921	-	4,110	21	1.95
1922	Dec. 12, 1921	-	9,720	1	41.00
1923	June 9, 1923	-	2,670	32	1.28
1924	Feb. 12, 1924	-	5,050	12	3.42
1925	Dec. 12, 1924	-	3,470	27	1.52
1926	July 5, 1926	-	2,470	36	1.14
1927	Oct. 16, 1926	-	7,060	5	8.20
1928	May 22, 1928	-	3,130	29	1.41
1929	Oct. 9, 1928	-	6,260	7	5.86
1930	July 13, 1930	-	2,370	37	1.11
1931	June 26, 1931	8.2	4,160	20	2.05
1932	Feb. 26, 1932	11.3	8,780	3	13.67
1933	Nov. 13, 1932	9.27	5,540	11	3.73
1934	July 16, 1934	8.82	4,440	16	2.56
1935	Jan. 25, 1935	9.82	6,230	8	5.12

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1936	May 30, 1936	8.30	3,800	23	1.78
1937	June 21, 1937	7.34	2,650	33	1.24
1938	Oct. 28, 1937	11.0	6,500	6	6.83
1939	May 28, 1939	9.14	4,300	19	2.16
1940	May 23, 1940	6.63	2,060	40	1.02
1941	Oct. 20, 1940	9.56	4,790	14	2.93
1942	Oct. 3, 1941	8.15	3,080	30	1.37
1943	July 10, 1943	7.10	2,300	38	1.08
1944	Sept. 20, 1944	7.43	2,510	35	1.17
1945	Sept. 4, 1945	7.67	2,720	31	1.32
1946	Oct. 25, 1945	8.68	3,600	26	1.58
1947	Oct. 25, 1946	9.74	5,550	10	4.10
1948	Oct. 19, 1947	8.90	4,410	17	2.41
1949	May 13, 1949	7.06	2,560	34	1.21
1950	Nov. 27, 1949	12.14	8,900	2	20.50
1951	Feb. 10, 1951	8.53	3,870	22	1.86

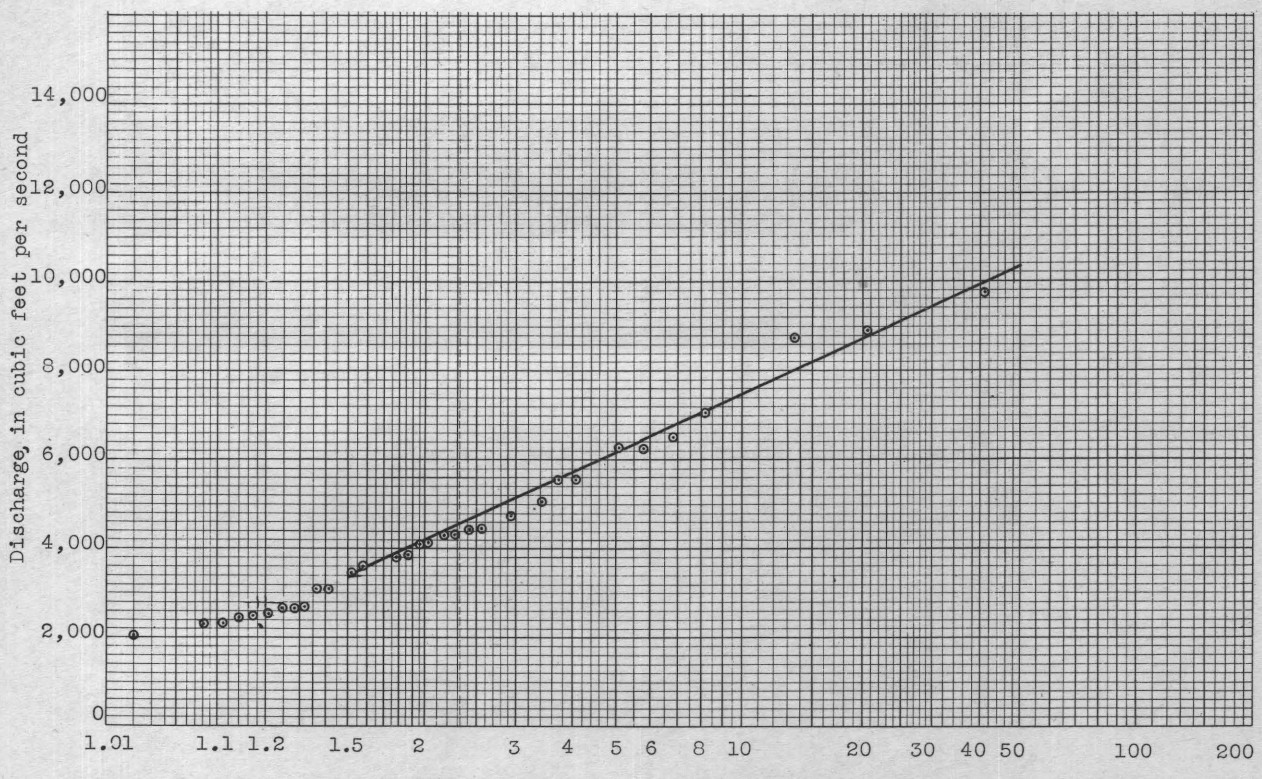

Figure 29.--Frequency of annual floods, Thunder Creek near Newhalem, Wash.

SKAGIT RIVER BASIN

(118) Stetattle Creek near Newhalem, Wash.

Location.--Lat 48°43'40", long. 121°09'30", in NE¼ sec. 6, T. 37 N., R. 13 E., three-quarters of a mile upstream from mouth, 5½ mi northeast of Newhalem, and 18½ mi northeast of Marblemount.

Drainage area.--21.4 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 920 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1934	Oct. 23, 1933	7.17	2,020
1935	Nov. 5, 1934	10.4	4,520
1936	June 2, 1936	4.78	1,010
1937	June 18, 1937	5.50	1,370
1938	Oct. 28, 1937	7.34	3,220
1939	May 28, 1939	6.64	2,560
1940	Nov. 30, 1939	5.10	1,130
1941	Oct. 19, 1940	6.03	1,940
1942	Dec. 2, 1941	6.77	2,680
1943	June 17, 1943	4.70	870
1944	Dec. 3, 1943	5.62	1,510
1945	Feb. 7, 1945	6.10	1,980
1946	Oct. 25, 1945	7.16	3,210
1947	Oct. 24, 1946	5.85	1,740
1948	Oct. 19, 1947	6.80	2,730
1949	Oct. 7, 1948	5.87	1,740
1950	Nov. 26, 1949	9.70	8,580
1951	Feb. 10, 1951	6.00	2,650

(119) Bacon Creek near Marblemount, Wash.

Location.--Lat 48°35', long. 121°24', on line between secs. 20 and 21, T. 36 N., R. 11 E., at highway bridge a quarter of a mile upstream from mouth and 4½ mi north of Marblemount.

Drainage area.--50 sq mi.

Gage.--Nonrecording.

Stage-discharge relation.--Defined by current-meter measurements below 2,000 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Dec. 3, 1943	3.91	2,510
1945	Feb. 7, 1945	5.62	5,510
1946	Oct. 25, 1945	6.20	7,000
1947	Oct. 24, 1946	5.88	6,480
1948	Oct. 19, 1947	5.67	5,670
1949	Oct. 7, 1948	4.65	3,300
1950	Nov. 26, 1949	7.13	18,100

(120) Cascade River at Marblemount, Wash.

Location.--Lat 48°31'45", long. 121°23'30", in SW¼ sec. 9, T. 35 N., R. 11 E., 2 mi east of Marblemount and 2½ mi upstream from mouth. Gage a quarter of a mile downstream from Marble Creek and 8 mi upstream from mouth, 1910-12.

Drainage area.--180 sq mi.

Gage.--Nonrecording gage read twice daily prior to October 1928; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 5,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation. Discharges for period 1910-12 at upper site were corrected to discharges at lower site by ratio of square roots of drainage areas. Records for 1820, 1897, and 1917 were taken from Stewart report (unpublished).

SKAGIT RIVER BASIN

(120) Cascade River at Marblemount, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1820	-	22.0	46,000	-	-
1897	-	20.0	40,000	-	-
1910	Nov. 29, 1909	15.0	28,600	-	-
1911	Nov. 21, 1910	8.6	13,800	-	-
1912	June 19, 1912	6.85	8,900	19	2.16
1918	Dec. - 1917	17.2	32,000	1	41.00
	Change in datum				
1929	Oct. 9, 1928	9.20	10,700	10	4.10
1930	June 7, 1930	5.43	2,740	40	1.02
1931	Jan. 27, 1931	6.55	4,480	33	1.24
1932	Feb. 26, 1932	9.88	12,900	4	10.25
1933	Nov. 13, 1932	9.02	10,400	11	3.73
1934	Nov. 2, 1933	8.06	8,050	22	1.86
1935	Nov. 5, 1934	9.40	11,500	7	5.86
1936	June 2, 1936	7.07	5,760	28	1.46
1937	June 3, 1937	6.59	4,760	32	1.28
1938	Oct. 28, 1937	8.62	8,810	20	2.05
1939	May 28, 1939	8.19	7,870	23	1.78
1940	Dec. 15, 1939	5.87	3,190	39	1.05
1941	Oct. 19, 1940	6.58	4,430	34	1.21
1942	Dec. 2, 1941	7.66	6,730	26	1.58
1943	June 17, 1943	6.26	3,820	36	1.14
1944	Dec. 3, 1943	6.98	5,210	30	1.37
1945	Jan. 7, 1945	6.62	4,430	35	1.17
1946	Oct. 25, 1945	8.84	9,620	16	2.56
1947	Oct. 25, 1946	9.54	11,600	6	6.83
1948	Oct. 19, 1947	9.33	11,000	9	4.56
1949	May 13, 1949	7.14	5,420	29	1.41
1950	Nov. 27, 1949	11.47	17,800	2	20.50
1951	Feb. 10, 1951	8.89	9,650	15	2.73

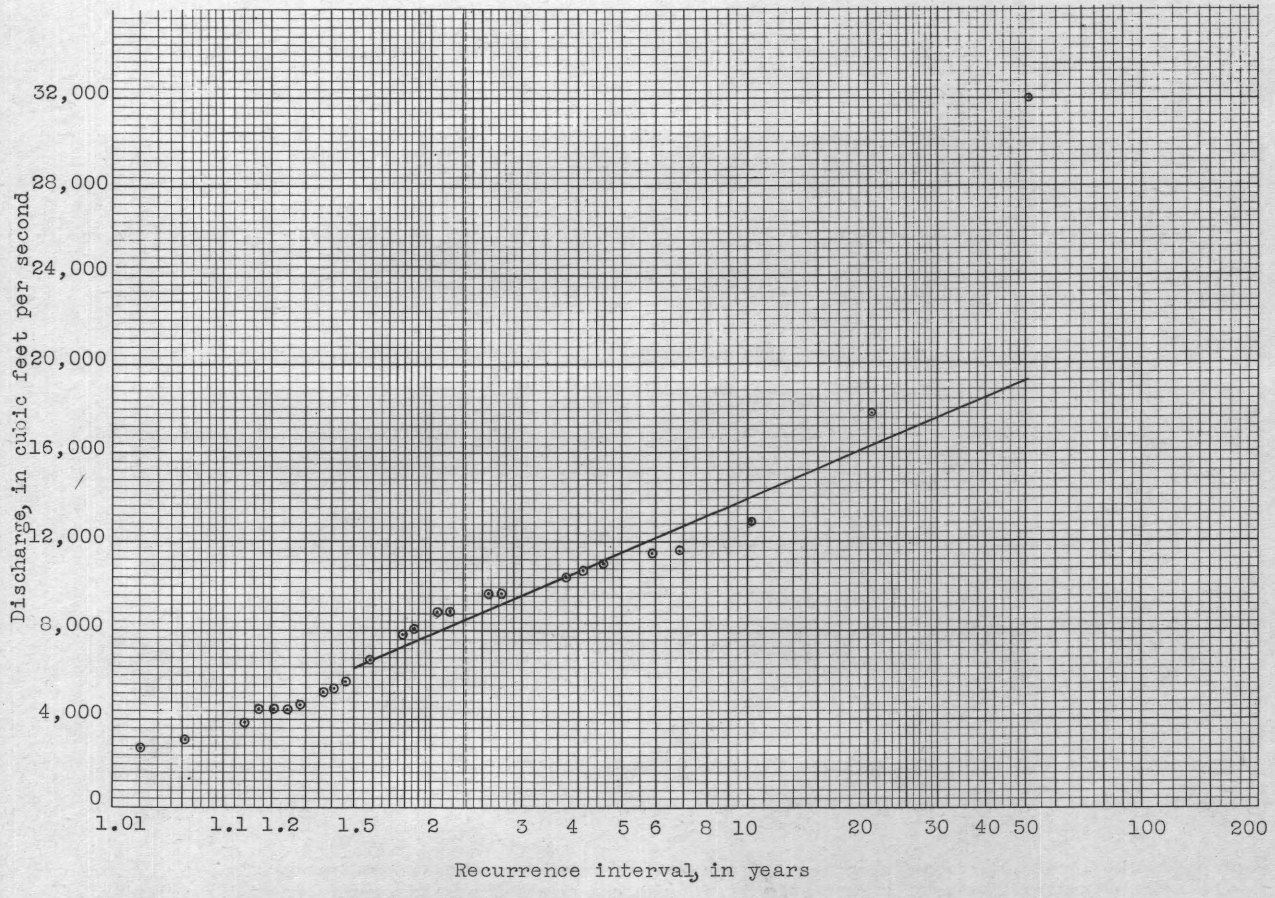

Figure 30.--Frequency of annual floods, Cascade River at Marblemount, Wash.

SKAGIT RIVER BASIN

(121) Sauk River above Whitechuck River, near Darrington, Wash.

Location.--Lat 48°10'00", long. 121°27'45", in NW¼ sec. 24, T. 31 N., R. 10 E., half a mile upstream from Whitechuck River and 9½ mi southeast of Darrington.

Drainage area.--152 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 6,200 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1918	Dec. 29, 1917	13.3	21,000
1919	Dec. 14, 1918	7.9	8,430
1920	Nov. 15, 1919	9.0	10,800
1921	Oct. 4, 1920	8.1	8,960
1922	Dec. 12, 1921	14.65	23,000
1929	Oct. 9, 1928	7.50	7,030
1930	Feb. 5, 1930	6.35	5,060
1931	Jan. 27, 1931	7.72	7,410
1932	Feb. 26, 1932	13.0	20,000
1933	Nov. 13, 1932	10.3	13,000
1934	Dec. 21, 1933	12.05	17,300
1935	Jan. 25, 1935	10.41	13,200
1936	May 16, 1936	6.26	4,400
1937	June 3, 1937	6.19	4,310
1938	Apr. 18, 1938	8.23	8,240
1939	May 29, 1939	7.60	7,010
1940	Dec. 15, 1939	6.71	5,480
1941	Oct. 18, 1940	5.94	4,180
1942	Dec. 2, 1941	7.61	7,220
1943	Nov. 23, 1942	7.06	6,230
1944	Dec. 3, 1943	9.00	10,300
1945	Feb. 7, 1945	8.40	8,940
1946	Oct. 25, 1945	8.00	8,250
1947	Oct. 25, 1946	8.50	9,250
1948	Oct. 19, 1947	9.68	13,500
1949	May 13, 1949	6.52	5,660
1950	Nov. 27, 1949	14.90	30,200

(122) Sauk River at Darrington, Wash.

Location.--Lat 48°14'40", long. 121°35'00", in SW¼ sec. 24, T. 32 N., R. 9 E., half a mile southeast of Darrington.

Drainage area.--293 sq mi.

Gage.--Nonrecording gage read once daily.

Stage-discharge relation.--Defined by current-meter measurements below 7,700 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation. Gage heights are from graphs based on gage readings. Records for 1820, 1897, and 1910 are taken from Stewart report (unpublished).

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1820	-	-	48,000
1897	-	-	44,000
1910	-	-	40,000
1915	Apr. 2, 1915	8.83	22,200
1916	Dec. 8, 1915	7.40	14,900
1917	June 16, 1917	5.90	7,390
1918	Dec. 29, 1917	15.0	36,000
1919	Oct. 27, 1918	8.90	13,000
1920	Nov. 15, 1919	10.5	17,200
1921	Oct. 4, 1920	9.3	14,100
1922	Dec. 12, 1921	15.0	36,000
1923	Dec. 24, 1922	8.60	13,500
1924	Feb. 12, 1924	12.1	23,800
1925	Feb. 2, 1925	7.60	10,800
1926	Jan. 5, 1926	7.4	10,300
1929	Oct. 9, 1928	-	10,000
1930	Feb. 5, 1930	6.15	7,280
1931	Jan. 23, 1931	7.6	10,800
1932	Feb. 26, 1932	16.0	36,000

SKAGIT RIVER BASIN

(123) Sauk River near Sauk, Wash.

Location.--Lat 48°25'15", long. 121°33'45", in NW¼ sec. 19, T. 34 N., R. 10 E., 5 mi upstream from mouth, 5 mi southeast of Sauk, and 8 mi downstream from Suiattle River.

Drainage area.--714 sq mi.

Gage.--Recording. Datum of gage is 226 ft above mean sea level (river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 40,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	Oct. 9, 1928	9.33	21,800
1930	Feb. 5, 1930	7.99	15,200
1931	Jan. 28, 1931	9.32	21,800
1932	Feb. 26, 1932	15.83	68,500
1933	Nov. 13, 1932	12.62	42,500
1934	Dec. 22, 1933	14.40	56,600
1935	Nov. 5, 1934	13.54	49,400
1936	June 3, 1936	8.33	16,600
1937	June 3, 1937	8.15	15,900
1938	Apr. 13, 1938	10.78	29,900
1939	Jan. 1, 1939	9.96	25,200
1940	Dec. 15, 1939	9.00	20,000
1942	Dec. 2, 1941	6.80	19,000
1943	Nov. 23, 1942	8.85	19,500
1944	Dec. 3, 1943	9.02	29,900
1945	Feb. 8, 1945	10.80	26,800
1946	Oct. 25, 1945	10.28	25,000
1947	Oct. 25, 1946	9.96	33,200
1948	Oct. 19, 1947	11.74	35,900
1949	May 13, 1949	9.03	19,700
1950	Nov. 27, 1949	16.63	79,100
1951	Feb. 10, 1951	15.00	62,700

(124) Suiattle River near Mansford, Wash.

Location.--Lat 48°21'50", long. 121°29'30", in N½ sec. 10, T. 33 N., R. 10 E., 2½ mi downstream from Big Creek and 4 mi north of Mansford.

Drainage area.--335 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 15,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1939	May 29, 1939	9.79	9,680
1940	Dec. 15, 1939	7.97	5,580
1941	Oct. 18, 1940	7.83	4,980
1942	Oct. 3, 1941	9.78	9,100
1943	June 30, 1943	8.82	7,200
1944	Dec. 3, 1943	9.47	8,850
1945	Feb. 8, 1945	9.70	9,520
1946	Oct. 25, 1945	10.90	12,900
1947	Oct. 25, 1946	12.86	19,800
1948	Oct. 19, 1947	12.33	18,000
1949	May 13, 1949	9.89	9,900
1950	Nov. 27, 1949	15.60	30,700

SKAGIT RIVER BASIN

(125) Baker River below Anderson Creek near Concrete, Wash.

Location.--Lat 48°39'45", long. 121°40'40", in SE¼ sec. 30, T. 37 N., R. 9 E., 350 ft downstream from Anderson Creek and 11 mi northeast of Concrete.

Drainage area.--184 sq mi.

Gage.--Staff gage read once a day or less prior to September 1915; recording gage thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 8,000 cfs and extended by velocity-area studies.

Remarks.--No diversion or regulation. Discharge for 1897 flood estimated as 35,000 cfs for plotting purposes. Records for 1820, 1897, and 1909 were taken from Stewart report (unpublished).

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1820	-	16.0	50,000
1897	-	13.5	36,700
1909	-	15.3	46,200
1912	June 25, 1912	7.0	6,280
1913	Sept. 4, 1913	7.6	7,750
1914	Jan. 6, 1914	12.6	24,900
1915	Apr. 2, 1915	9.5	17,200
1916	Feb. 15, 1916	8.87	14,800
1917	July 16, 1917	7.21	8,200
1918	Dec. 29, 1917	13.7	36,800
1919	Dec. 4, 1918	9.70	18,700
1920	Nov. 15, 1919	9.93	19,600
1921	Oct. 4, 1920	9.74	18,700
1922	Dec. 12, 1921	10.80	23,600
1923	Dec. 24, 1922	8.1	11,800
1924	Jan. 31, 1924	11.90	28,500
1925	Dec. 12, 1924	-	17,000
1929	Oct. 8, 1928	10.15	20,900
1930	Feb. 18, 1930	6.88	7,390
1931	Jan. 23, 1931	9.90	19,600

(126) Alder Creek near Hamilton, Wash.

Location.--Lat 48°32', long. 121°57', in N½ sec. 18, T. 35 N., R. 7 E., at railroad trestle, three-quarters of a mile upstream from mouth and 2 mi east of Hamilton.

Drainage area.--8.8 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 400 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Dec. 3, 1943	2.92	137
1945	Jan. 7, 1945	4.28	458
1946	Oct. 25, 1945	3.47	265
1947	Dec. 11, 1946	2.61	404
1948	Oct. 19, 1947	2.57	241
1949	Dec. 1, 1948	2.77	256
1950	Dec. 27, 1949	3.26	477
1951	Feb. 10, 1951	3.98	640

SAMISH RIVER BASIN

(127) Samish River near Burlington, Wash.

Location.--Lat 48°32'35", long. 122°20'25", in NW¼ sec. 7, T. 35 N., R. 4 E., at highway bridge half a mile downstream from Friday Creek and 5 mi north of Burlington.

Drainage area.--88 sq mi.

Stage-discharge relation.--Defined by current-meter measurements below 5,700 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversion and regulation at flood stage.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Dec. 3, 1943	4.44	1,130
1945	Jan. 7, 1945	7.77	3,640
1946	Oct. 25, 1945	9.78	4,310
1947	Dec. 11, 1946	7.67	2,750
1948	Oct. 19, 1947	5.14	1,210
1949	Feb. 17, 1949	10.44	4,990
1950	Dec. 28, 1949	11.90	6,000
1951	Feb. 10, 1951	10.20	3,800

(128) Friday Creek near Burlington, Wash.

Location.--Lat 48°34'25", long. 122°20'15", in NE¼NE¼ sec. 31, T. 36 N., R. 4 E., 1 3/4 mi upstream from mouth and 6 mi north of Burlington.

Drainage area.--37.1 sq mi.

Gage.--Recording.

Stage-discharge relation --Defined by current-meter measurements below 250 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversion at flood stage. Natural regulation by Samish Lake.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Dec. 3, 1943	3.12	195
1945	Jan. 7, 1945	6.28	960
1946	Oct. 25, 1945	-	1,090
1947	Dec. 11, 1946	4.03	825
1948	Jan. 4, 1948	3.40	537

NOOKSACK RIVER BASIN

(129) Nooksack River above Cascade Creek, near Glacier, Wash.

Location.--Lat 48°54'20", long. 121°50'50", in NW¼ sec. 1, T. 39 N., R. 7 E., a quarter of a mile upstream from Cascade Creek, half a mile downstream from Dead Horse Creek, 4½ mi east of Glacier, and 6 mi upstream from Glacier Creek.

Drainage area.--105 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 2,600 cfs and extended by slope-area method.

Remarks.--No diversion. Negligible regulation at flood stage. Records for 1935-37 computed on basis of records for Nooksack River near Glacier.

NOOKSACK RIVER BASIN

(129) Nooksack River above Cascade Creek, near Glacier, Wash.--Continued

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)	Order (M)	Recurrence interval (yr)
1935	Nov. 5, 1934	-	8,810	9	4.56
1936	June 11, 1936	-	4,240	29	1.41
1937	June 21, 1937	-	6,150	21	1.95
1938	Oct. 28, 1937	10.28	9,670	6	6.83
1939	May 28, 1939	7.53	5,100	25	1.64
1940	Dec. 10, 1939	7.39	4,950	26	1.58
1941	Oct. 19, 1940	8.32	6,300	19	2.16
1942	Dec. 2, 1941	9.02	7,450	14	2.93
1943	July 3, 1943	5.86	3,250	38	1.08
1944	Dec. 3, 1943	6.37	3,900	33	1.24
1945	Dec. 5, 1944	7.23	4,100	31	1.32
1946	Oct. 25, 1945	8.66	8,490	12	3.42
1947	Oct. 24, 1946	7.60	6,100	22	1.86
1948	Oct. 19, 1947	7.95	6,690	16	2.56
1949	Oct. 4, 1948	6.64	3,540	35	1.17
1950	Nov. 26, 1949	10.42	10,800	5	8.20
1951	Feb. 10, 1951	7.12	4,500	27	1.52

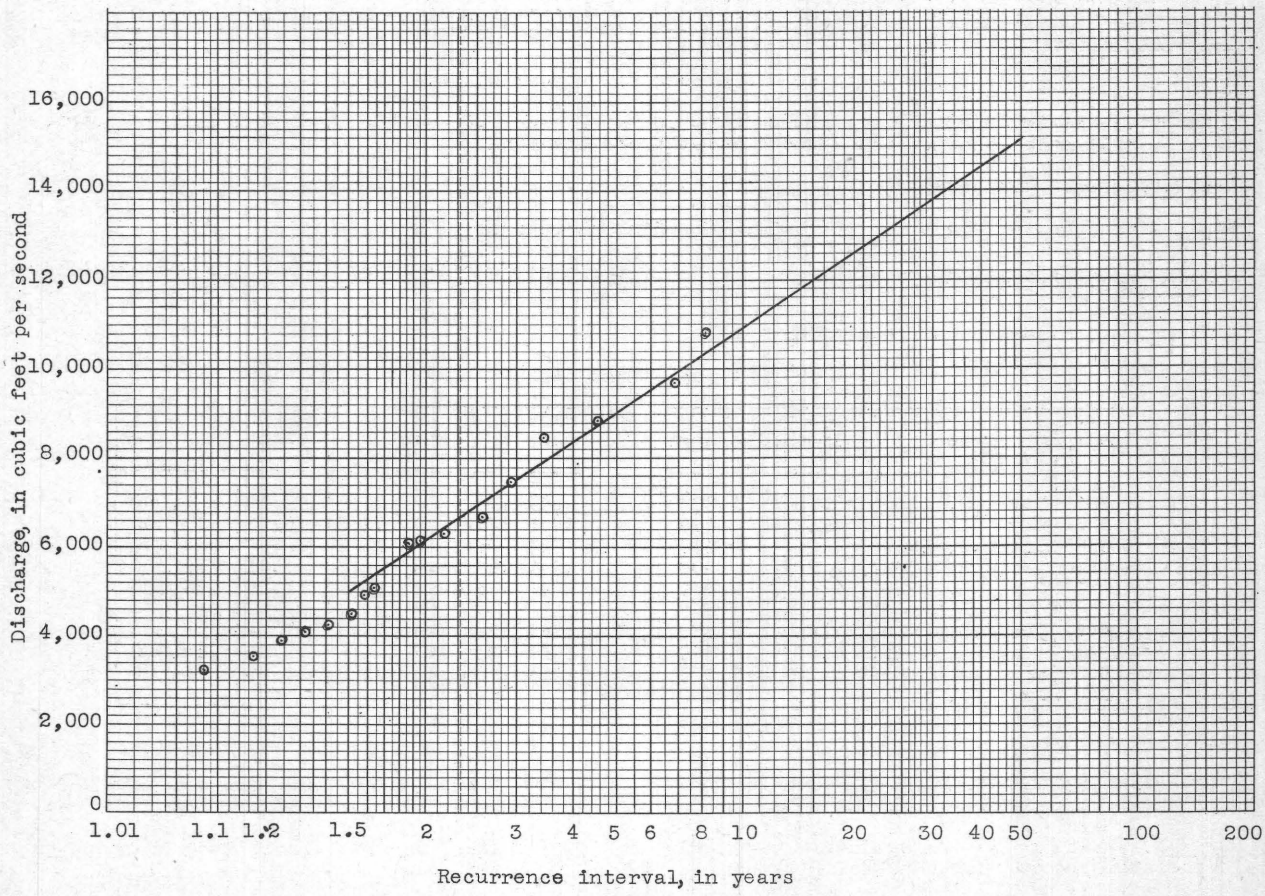

Figure 31.--Frequency of annual floods, Nooksack River above Cascade Creek near Glacier, Wash.

NOOKSACK RIVER BASIN

(130) Nooksack River at Deming, Wash.

Location.--Lat 48°48'35", long. 122°12'15", in lot 12, sec. 6, T. 38 N., R. 5 E., 800 ft downstream from South Fork and 1 mi southeast of Deming.

Drainage area.--580 sq mi.

Gage.--Recording. Datum of gage is 203.6 ft above mean sea level, datum of 1929.

Stage-discharge relation.--Defined by current-meter measurements below 25,000 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1936	May 4, 1936	8.75	12,100
1937	Dec. 22, 1936	10.81	20,100
1938	Oct. 28, 1937	13.21	30,400
1939	Jan. 1, 1939	11.41	23,000
1940	Dec. 15, 1939	9.16	13,300
1941	Jan. 18, 1941	9.50	14,400
1942	Dec. 2, 1941	9.73	15,100
1943	Jan. 15, 1943	10.00	16,300
1944	Dec. 3, 1943	11.85	23,800
1945	Jan. 7, 1945	12.88	29,000
1946	Oct. 25, 1945	14.74	38,000
1947	Oct. 25, 1946	13.13	29,900
1948	Oct. 19, 1947	13.41	31,400
1949	Nov. 23, 1948	9.20	12,900
1950	Nov. 27, 1949	15.11	36,500
1951	Feb. 10, 1951	15.69	43,300

(131) South Fork Nooksack River near Wickersham, Wash.

Location.--Lat 48°39'50", long. 122°07'50", in lot 2, sec. 26, T. 37 N., R. 5 E., three-quarters of a mile above Skookum Creek and 4 mi east of Wickersham.

Drainage area.--103 sq mi.

Gage.--Nonrecording prior to July 1934; recording thereafter.

Stage-discharge relation.--Defined by current-meter measurements below 10,300 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1935	Nov. 5, 1934	9.95	11,200
1936	May 4, 1936	6.51	3,770
1937	Dec. 6, 1936	8.88	8,470
1938	Oct. 28, 1937	10.70	12,900
1939	Jan. 1, 1939	8.49	7,760
1940	Dec. 15, 1939	7.81	6,380
1941	Jan. 18, 1941	7.26	5,340
1942	Nov. 13, 1941	8.26	7,370
1943	Jan. 14, 1943	8.75	8,430
1944	Dec. 3, 1943	9.10	9,090
1945	Jan. 7, 1945	10.10	11,300
1946	Oct. 25, 1945	11.38	14,400
1947	Oct. 24, 1946	11.81	15,600
1948	Oct. 18, 1947	11.26	14,400
1949	Feb. 16, 1949	7.14	4,850
1950	Nov. 27, 1949	12.00	17,000
1951	Feb. 10, 1951	11.89	16,600

Stations from which nonhomogeneous records were obtained

This section contains a brief description and tabulation of all annual flood-peak records that were nonhomogeneous.

WIND RIVER BASIN

Panther Creek near Carson, Wash.

Location.--Lat 45°48'00", long. 121°52'00", in SW¼ sec. 25, T. 4 N., R. 7½ E., a third of a mile upstream from Cedar Creek and 6 mi north of Carson.

Drainage area.--30.1 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,500 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 7, 1945	5.0	2,150
1946	Dec. 28, 1945	4.86	2,030
1947	Dec. 15, 1946	4.58	1,830
1948	Jan. 7, 1948	5.1	2,230
1949	Feb. 17, 1949	4.16	1,500
1950	Feb. 24, 1950	4.67	1,880
1951	Feb. 9, 1951	4.67	1,920

COWLITZ RIVER BASIN

South Fork Toutle River at Toutle, Wash.

Location.--Lat 46°19'20", long. 122°41'45", in SW¼NW¼ sec. 28, T. 10 N., R. 1 E., half a mile southwest of Toutle, 1½ mi upstream from mouth, and 3 mi downstream from Johnson Creek.

Drainage area.--118 sq mi.

Gage.--Recording. Datum of gage is at mean sea level (from river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 4,600 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1940	Dec. 15, 1939	56.50	5,820
1941	Jan. 18, 1941	55.39	3,880
1942	Dec. 19, 1941	56.99	6,770
1943	Nov. 23, 1942	57.32	6,490
1944	Dec. 3, 1943	56.34	4,560
1945	Feb. 7, 1945	57.84	7,290

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Dec. 28, 1945	57.20	6,140
1947	Dec. 11, 1946	58.54	8,710
1948	Mar. 22, 1948	56.78	4,720
1949	Feb. 17, 1949	57.23	5,600
1950	Mar. 5, 1950	57.30	7,670
1951	Feb. 11, 1951	56.85	6,200

CHEHALIS RIVER BASIN

Rock Creek at Cedarville, Wash.

Location.--Lat 46°52'05", long. 123°18'25", in SW¼SW¼ sec. 15, T. 16 N., R. 5 W., 0.2 mile downstream from Williams Creek, 1 mi west of Cedarville, and 1¼ mi upstream from mouth.

Drainage area.--24.8 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 800 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1945	Feb. 7, 1945	12.55	1,440
1946	Dec. 28, 1945	10.04	1,000
1947	Feb. 2, 1947	11.72	1,310
1948	Mar. 22, 1948	10.76	1,140
1949	Feb. 17, 1949	12.22	1,370
1950	Dec. 28, 1949	12.31	1,390
1951	Feb. 9, 1951	13.77	1,640

HUMPTULIPS RIVER BASIN

Humptulips River near Humptulips, Wash.

Location.--Lat 47°13'45", long. 123°56'30", in NE¼ sec. 17, T. 20 N., R. 10 W., at abandoned bridge site, 1 mi southeast of Humptulips, 2½ mi upstream from Stevens Creek, and 3¼ mi downstream from Forks.

Drainage area.--125 sq mi.

Gage.--Nonrecording gage prior to March 1, 1950; recording thereafter. Datum of gage is 117.4 ft above mean sea level (river-profile survey).

Stage-discharge relation.--Defined by current-meter measurements below 9,800 cfs and extended by slope-area method.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1934	Dec. 9, 1933	9.7	13,800
1943	Apr. 1, 1943	7.90	9,800
1944	Dec. 3, 1943	9.60	13,600
1945	Feb. 7, 1945	11.02	16,900
1946	Apr. 11, 1946	8.02	10,000
1947	Jan. 25, 1947	9.62	15,200
1948	Dec. 23, 1947	8.24	11,800
1949	Feb. 22, 1949	9.8	16,600
1950	Nov. 26, 1949	10.5	18,600
1951	Feb. 9, 1951	11.19	20,500

SKOKOMISH RIVER BASIN

Skokomish River near Potlatch, Wash.

Location.--Lat 47°19'00", long. 123°11'05", in NW¼NW¼ sec. 15, T. 21 N., R. 4 W., half a mile upstream from U. S. Highway 101, 2 3/4 mi downstream from North Fork, 4 3/4 mi southwest of Potlatch, and 5½ mi upstream from mouth.

Drainage area.--237 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 18,000 cfs and extended by logarithmic plotting.

Remarks.--Practically entire flow of North Fork is diverted at dam no. 2 and returned to sea through Cushman power plant no. 2. No regulation except as indicated under diversion.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Dec. 3, 1943	8.85	11,400
1945	Feb. 7, 1945	11.21	16,700
1946	Apr. 11, 1946	7.33	9,320
1947	Feb. 14, 1947	9.59	14,100
1948	Oct. 19, 1947	12.97	15,100
1949	Feb. 22, 1949	11.57	11,900
1950	Nov. 27, 1949	14.51	19,200
1951	Feb. 10, 1951	14.30	18,600

TAHUYA RIVER BASIN

Tahuya River near Belfair, Wash.

Location.--Lat 47°29'40", long. 122°54'20", in SE¼SE¼ sec. 10, T. 23 N., R. 2 W., 3½ mi downstream from Panther Creek and 5 mi northwest of Belfair.

Drainage area.--16.5 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 490 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Apr. 11, 1946	5.14	428
1947	Feb. 14, 1947	6.23	622
1948	Oct. 19, 1947	5.81	544
1949	Feb. 22, 1949	7.97	900
1951	Feb. 9, 1951	7.41	780

CHAMBERS CREEK BASIN

Chambers Creek below Leach Creek, near Steilacoom, Wash.

Location.--Lat 47°12', long. 122°32', in NE¼NE¼ sec. 27, T. 20 N., R. 2 E., a quarter of a mile downstream from Leach Creek, 1½ mi downstream from outlet of Steilacoom Lake, and 3 mi northeast of Steilacoom.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 680 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. Negligible regulation by gates at outlet of Steilacoom Lake at flood stage, natural regulation by Steilacoom Lake.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Feb. 6, 1944	2.17	128
1945	Apr. 8, 1945	2.38	166
1946	Jan. 7, 1946	3.00	348
1947	Feb. 2, 1947	2.92	323
1948	Jan. 14, 1948	2.47	281
1949	Feb. 17, 1949	2.46	321
1950	Mar. 4, 1950	3.06	611
1951	Feb. 11, 1951	3.12	661

LAKE WASHINGTON BASIN

Bear Creek at Redmond, Wash.

Location.--Lat 47°40'10", long. 122°06'30", in NE¼ sec. 12, T. 25 N., R. 5 E., half a mile east of Redmond and three-quarters of a mile upstream from mouth.

Drainage area.--47.0 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 380 cfs and extended by logarithmic plotting.

Remarks.--Negligible diversions at flood stage. No regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1946	Feb. 6, 1946	5.57	363
1947	Feb. 2, 1947	6.10	416
1948	Feb. 26, 1948	5.45	349
1949	Feb. 22, 1949	6.44	444
1950	Mar. 5, 1950	6.52	654

SNOHOMISH RIVER BASIN

Wallace River at Gold Bar, Wash.

Location.--Lat 47°51'50", long. 121°41'45", in NE¼ sec. 6, T. 27 N., R. 9 E., at county road crossing, a quarter of a mile north of Gold Bar and 1¼ mi upstream from Olney Creek.

Drainage area.--19.8 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 930 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1929	June 15, 1929	2.85	470
1930	Feb. 1, 1930	6.64	1,630
1931	Jan. 27, 1931	6.60	1,630
1932	Feb. 26, 1932	8.25	2,590
1933	Dec. 2, 1933	8.00	2,560
	Change in datum		
1947	Oct. 25, 1946	8.20	1,580
1948	Oct. 19, 1947	7.83	1,380
1949	Nov. 23, 1948	8.09	1,480
1950	Mar. 4, 1950	7.98	1,500
1951	Feb. 9, 1951	8.90	1,960

STILLAGUAMISH RIVER BASIN

Deer Creek at Oso, Wash.

Location.--Lat 48°17'10", long. 121°55'50", in sec. 5, T. 32 N., R. 7 E., 1¼ mi above Oso and mouth.

Drainage area.--71 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,130 cfs and extended on basis of velocity-area studies.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1918	Dec. 18, 1917	10.05	9,300
1919	Dec. 4, 1918	9.7	7,850
1920	Nov. 15, 1919	9.9	8,490
1921	Feb. 11, 1921	-	6,000
1922	Dec. 12, 1921	11.7	10,400
1923	Oct. 25, 1922	9.5	7,230
1924	Feb. 11, 1924	10.4	8,490
1925	Dec. 10, 1924	9.50	7,230
1926	Dec. 23, 1925	8.60	6,170
1927	Oct. 16, 1926	8.25	5,640
1928	Jan. 12, 1928	9.4	7,290
1929	Nov. 9, 1928	8.53	6,030
1930	Dec. 13, 1929	8.2	5,640

SKAGIT RIVER BASIN

Day Creek near Lyman, Wash.

Location.--Lat 48°30'05", long. 122°02'40", in NW¼ sec. 28, T. 35 N., R. 6 E., at county highway bridge, three-quarters of a mile upstream from mouth and 2½ mi southeast of Lyman.

Drainage area.--38.1 sq mi.

Gage.--Recording.

Stage-discharge relation.--Defined by current-meter measurements below 1,250 cfs and extended by logarithmic plotting.

Remarks.--No diversion or regulation.

Annual flood peaks

Water year	Date	Gage height (ft)	Discharge (cfs)
1944	Dec. 3, 1943	7.60	3,780
1945	Jan. 7, 1945	7.85	4,310
1946	Nov. 14, 1945	7.77	4,310
1947	Oct. 24, 1946	8.12	4,530
1948	Oct. 18, 1947	7.94	4,420
1949	Feb. 16, 1949	6.85	3,330
1950	Dec. 28, 1949	8.35	5,570
1951	Feb. 9, 1951	7.72	4,510

MISCELLANEOUS FLOOD PEAKS

The following table is a list of extreme maximum flood peaks, which were determined by indirect methods in ungaged areas and used to help develop the enveloping curve, figure 10.

Data for peak discharge determinations at miscellaneous points

No.	Gaging station	Date	Discharge (cfs)	Drainage area (sq mi)	Second-feet per sq mi
A	Bagley Creek near Sequim	Feb. 16, 1949	436	5.3	82.3
B	Grays River near Grays River.....	Feb. 22, 1949	13,900	64.0	217.2
C	West Fork Grays River near Grays River.	Feb. 22, 1949	3,700	16.3	227.0
D	Peabody Creek near Port Angeles.....	Feb. 16, 1949	273	1.8	151.7
E	Siebert Creek near Sequim.....	Feb. 16, 1949	1,290	17.0	75.9
F	Skamokawa Creek near Skamokawa.....	Feb. 17, 1949	2,280	17.4	131.0

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