A Methodology Study To Develop Evaluation Criteria For Wild And Scenic Rivers

WATER for IDAHO

Report of

Flood Control Subproject

by
John J. Peebles

Water Resources Research Institute
University of Idaho
Moscow, Idaho
February, 1970

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INTRODUCTION

On October 2, 1968, Public Law 90-542, was passed by the 90th Congress. This public law provides for a National Wild and Scenic Rivers System. It also indicates that the policy of the Federal Government is to include selected rivers, which with their immediate environment possess outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, and that these rivers shall be preserved in their free flowing condition and shall be protected for the benefit and enjoyment of present and future generations.

The act provides for two categories under which specific rivers will be preserved or studied for possible preservation. Included in the first category are rivers authorized for immediate inclusion in the National Wild and Scenic Rivers System ("Instant Rivers"). Two such rivers, the Middle Fork of the Salmon River and the Middle Fork of the Clearwater River are located in Idaho. The second category includes rivers designated to be studied for possible inclusion in the System ("Study Rivers"). Five rivers in Idaho qualify for study under the second category, namely the main stem of the Salmon River, and the Bruneau, St. Joe, Priest, and Moyie Rivers.

The act specifies three classes of wild rivers: wild, scenic, and recreational. A wild river is one which applies to a river free from impoundments, with shorelines essentially primitive, and with waters non-polluted. A scenic river is a river free from impoundments, with shorelines or watersheds still largely primitive and undeveloped, but which is accessible in places by roads. A recreational river is one which is readily accessible by roads and railroads, which may have development along the shorelines, and which may have undergone some impoundment or diversion in the past. Public Law 90-542 sets a ten-year time limit on classification studies after which recommendations on the disposition of the study rivers are to be made to the Congress.

It is recognized that little valid methodology has been developed for evaluating rivers for wild or scenic classification. While methodology is a means to an end, it is none-the-less the key to developing techniques and criteria for classifying rivers for potential inclusion into a wild or scenic rivers system. In view of this, the Water Resources Research Institute of the University of Idaho, through a specially organized Scenic Rivers Study Unit, is involved in developing a methodology to evaluate wild rivers. This study has as its goal establishing criteria which can be used to identify and determine the economic, esthetic, scenic, and other values of wild rivers. The primary emphasis of this study will be focused for the next few years on the Salmon River in Idaho. This river, which originates in central Idaho, is about 410 miles long and enters the Snake River 49 miles above Lewiston, Idaho. The average annual runoff of the Salmon River is about 8,000,000 acre-feet.

The portion of the Salmon designated as a study river is from its mouth to the town of North Fork. However, the Institute also will include that portion of the river above North Fork and the major tributaries in the methodology study for two reasons. First, because any economic development--impoundments, dredging, diversion, logging, etc.--would affect the main stem wild river section. Second, because an economic study has to include all of the activity in the river basin to be meaningful in this area. This latter consideration also involves what may happen in the river area if and when the Salmon is selected as a wild river. A wild river status would affect all levels of economic development, as well as sociological patterns, in the area. Some economic activities such as recreational enterprises would tend to grow, whereas other activities, such as logging might tend to be restricted or controlled depending upon whether the river was classified as wild, scenic, or recreational.

The purpose of the methodology study is to develop information pertinent to decision-making and planning as it pertains to the selection, use, and management of wild and scenic river systems. The methodology study has four broad objectives:

1. Inventory present quantities and qualities of natural resources in the river basin area, and estimate future quantities and qualities of these resources, establishing their values in both situations.
2. Identify, describe, and quantify, where possible, benefits from scenic beauty, personal enrichment, and other esthetic experiences derived from the river.
3. Develop a series of models to evaluate or determine the resource use pattern consistent with a wild rivers system, and the resource use pattern which would exist under various levels of development in the river basin area.
4. Present recommendations for alternative uses of resources for the entire river basin area, restrictions if classification is applicable, and the economic and social ramifications of each of the alternatives considered.

The plan for the methodology study is to divide the research work into a series of subprojects, each covering an important economic activity related to the river. These subprojects consist of eleven resource and service functions:

1. Forest and range resources
2. Minerals
3. Outdoor recreation
4. Commercial fisheries
5. Irrigation
6. Water for municipal and industrial use
7. Water quality control
8. Hydroelectric power
9. Flood control
10. Navigation
11. Transportation and access

Once the above subprojects have been completed, a series of economic models will be developed which will make relatively accurate estimation of costs and benefits for each of the resources included in the subprojects, and also permit direct comparisons of costs and benefits of alternative resource uses. This technique will be modified and extended to make economic estimates of future resource use and values. These forecasts of future resource use will be extended to the years 2000 and 2020, consistent with the projection of the Columbia-North Pacific Region Comprehensive Framework Study.

It is at this stage of the analysis that the overall purpose of the methodology study will be realized. This purpose is to make an economic evaluation of the Salmon River in its natural state. The evaluation will be made consistent with the present levels of resource use indicated by the subprojects. This evaluation at the current level of resource use will then be compared with simulated levels of development on the river, and within the river basin area. At this stage of the analysis it will be possible to include in the study certain general considerations such as population and economic growth, and the demand for recreation, electricity, timber, minerals, and other resources in the area in the future.

Two general evaluations of the river resource base can then be made. First, the current and projected levels of economic activity based on the status quo. Second, a determination of the benefits foregone as a result of maintaining the river in its natural free-flowing state. Efforts throughout the study will be to try to identify and quantify the esthetic and personal enhancement values for which the expressed national desire is to protect and conserve.

The writer of this report has been assigned the task of preparing information for the navigation and flood control subprojects, the latter being the subject of this report. The objectives of the flood control study are:

1. To determine the flood control needs within the Salmon Basin.
2. To determine the potential for flood control storage in the Salmon Basin based on the needs of the entire Columbia Basin.
3. To determine the impact of flood control storage and channel control on the Salmon River as a wild river either in total or in segments.

The principal sources of information for the flood control study are:

1. Climatological Handbook - Columbia Basin States, Meteorological Committee - Pacific Northwest River Basins Commission, 1969.
2. Stream-flow records, U.S. Geological Survey.
3. Idaho Water Resource Inventory, Idaho Water Resource Board, 1968.
4. "Magnitude and Frequency of Floods in the United States: Part 13. Snake River Basin", U.S. Geological Survey Water Supply Paper 1688, 1963.
5. Post-flood reports, U.S. Corps of Engineers.
6. House Document 531, 81st Congress, 2nd Session, 1948.
7. House Document 403, 87th Congress, 2nd Session, 1958.
8. Preliminary draft of material on Subregion 6 for Flood Control Appendix to Columbia-North Pacific Region Comprehensive Framework Study.

The flood control subproject was scheduled for completion February 1, 1970.

HYDROLOGIC CHARACTERISTICS OF SALMON BASIN

Salmon River drains 14,557 square miles of central Idaho, including portions of the Sawtooth, Bitterroot, and numerous other mountain ranges (Figure 1). The stream heads in the Smoky Mountains at approximately elevation 8,000. The mean elevation of the basin is about 7,000 feet with a range from 902 feet at the confluence with the Snake River to 12,662 feet at the peak of Mount Borah in the Lost River Range.

From the headwaters, Salmon River flows north and west a distance of about 30 miles and enters the lower end of Stanley Basin near the town of Stanley. Downstream from Stanley, the river enters a reach composed of alternating valleys and rocky canyons through which it flows easterly a distance of 35 miles to the confluence with the East Fork. The stream then flows generally north through large valleys in the vicinity of Challis and Salmon 106 miles to North Fork. From North Fork the river, turns westerly and flows in this general direction to Riggins, a distance of 150 miles. This central portion is characterized by narrow and precipitous canyons with only occasional widenings containing small bench lands. At Riggins, the river turns sharply to the north and continues generally in this direction for about 40 miles. It then veers to the west, bypasses the Seven Devils Mountains, and enters Snake River from the northeast. The upper half of this 87-mile reach contains alternating small valleys and canyons. The lower half consists mostly of narrow rocky canyons.

The main tributaries of the Salmon River are shown in the following tabulation:

Tributary	Area drained sq. miles	Enters Salmon River		
		At water elev.	From	At river mile
Little Salmon River	580	1710	South	86.7
South Fork	1300	2145	South	133.9
Middle Fork	2830	3005	South	198.5
Panther Creek	530	3195	South	210.1
Lemhi River	1270	3905	East	258.5
Pahsimeroi River	845	4625	East	304.0
East Fork	540	5350	South	343.0
Yankee Fork	195	5905	North	367.1
Valley Creek	147	6210	West	378.5

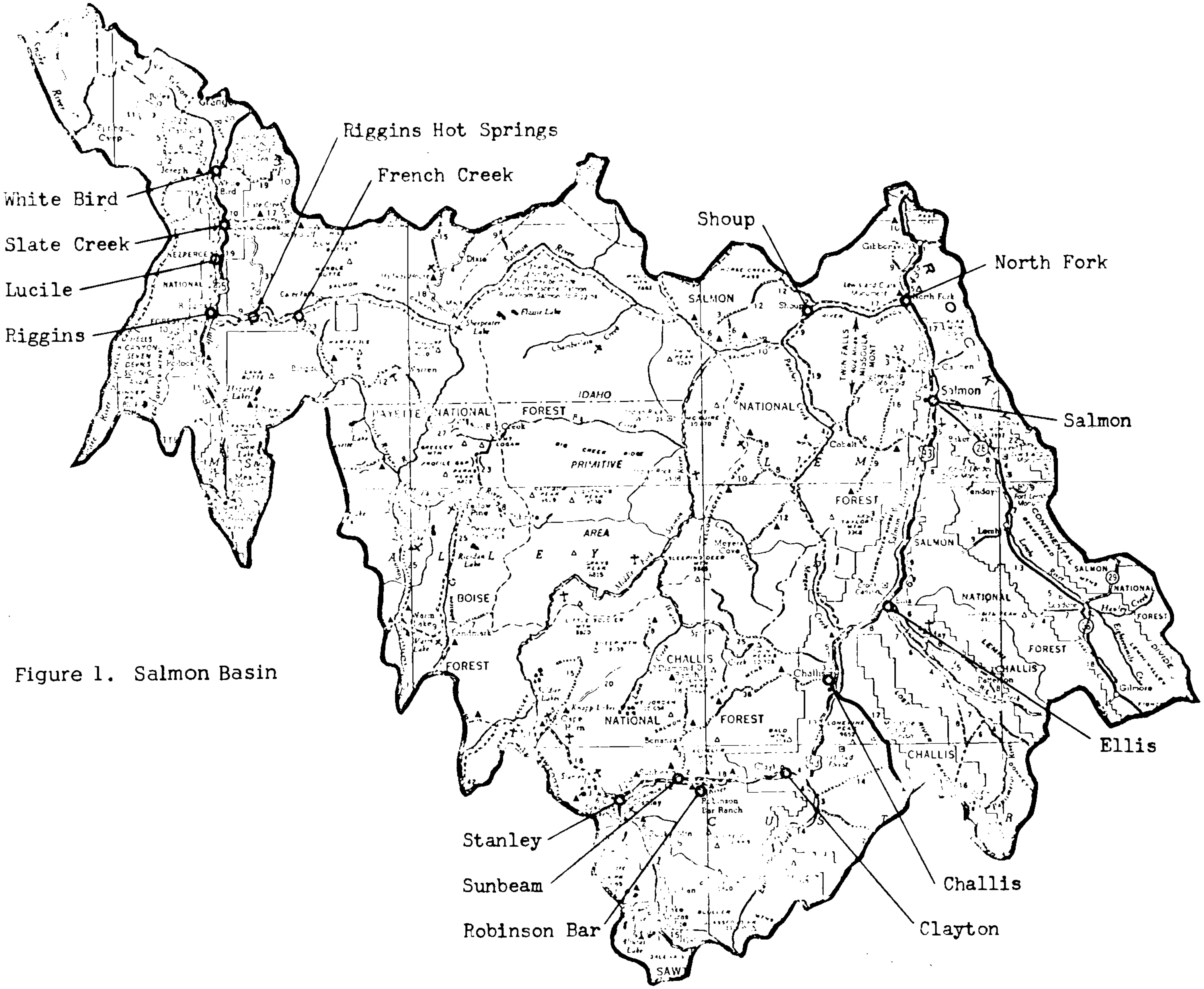

Figure 1. Salmon Basin

Approximately fifty percent of the Salmon Basin is drained by six major tributaries. The East Fork, Pahsimeroi, and Lemhi rivers drain the southeastern part of the basin, while the Middle Fork, South Fork, and Little Salmon rivers drain the large central area.

The orientation and location of Salmon Basin are such that moist air moving from the Pacific Ocean is subjected to orographic lifting before entering the area. The topography, moreover is such that little additional rise is occasioned in air-mass movement across the region. Over part of the basin, topographic features favor down-slope movement. These several stabilizing influences combine in such a manner as to result in a relatively low normal annual precipitation value. Over the more sheltered areas that are also of lower elevation, normal annual precipitation is less than 8 inches. Maximum annual values in excess of 50 inches occur over points of highest elevation. The greater part of the annual precipitation occurs during the winter months and thus shows the direct influence of the Pacific air masses. Except for brief periods when the basin is under the direct influence of continental air masses, temperatures are relatively mild.

Table 1 shows mean monthly and annual temperatures and maximum and minimum mean daily, monthly, and annual temperatures for the period 1931-1960, for selected stations in and adjacent to Salmon Basin. The highest temperature ever recorded in the basin was 115 degrees at Slate Creek in August of 1961. The lowest recorded temperature was -49 degrees at New Meadows in December of 1919.

Table 2 shows mean monthly and annual precipitation for the period 1931-1960, and maximum and minimum monthly and annual totals of record for selected stations in and adjacent to Salmon Basin. The average annual volume of precipitation on the basin is 20,047,000 acre-feet, which, if spread over the entire basin, would result in a depth of 25.8 inches. The greatest one-day total rainfall of record, 2.62 inches was observed at Big Creek in December of 1963. However, a one-day total of 3.01 inches was observed at Grangeville, which is slightly outside of Salmon Basin, in September of 1955.

Table 3 shows median, maximum, and minimum snow depths and water equivalents for snow courses in Salmon Basin.

The annual discharge pattern of Salmon River is very regular. High flows occur from April through July and low flows occur from August through March. Annual peak discharges occur in May or June, while minimum flows occur in the fall or winter. Practically all precipitation during the winter

Table 1. Mean monthly and annual temperatures and maximum and minimum mean daily, monthly, and annual temperatures, 1931-1960, for selected stations in and adjacent to Salmon Basin. Data from Pacific Northwest River Basins Commission.

Station	No. Yrs.	Statistic	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ann
Big Creek 1S	23	Mean	18.1	22.3	28.0	36.4	44.5	50.7	58.6	56.8	49.9	41.2	27.5	21.2	37.9
		Max	30.8	35.9	42.3	50.8	60.5	67.5	79.9	78.7	70.0	58.0	40.4	33.2	54.0
		Min	5.4	8.7	13.6	22.0	28.5	33.9	37.2	34.9	29.8	24.3	14.5	9.1	21.8
Challis	30	Mean	18.4	25.0	34.2	44.7	52.9	59.7	68.1	65.9	57.5	47.1	32.4	23.0	44.1
		Max	29.6	36.7	47.0	59.5	68.1	75.0	85.5	83.7	74.4	62.6	44.9	33.3	58.4
		Min	7.7	13.5	21.4	29.8	37.6	44.5	50.7	48.1	40.6	31.7	20.4	12.1	29.8
Grangeville 11SE	30	Mean	27.7	31.5	36.9	44.9	52.2	57.9	67.0	65.9	58.1	47.8	36.4	31.3	46.5
		Max	35.7	39.7	46.3	56.1	64.4	70.6	82.7	82.1	72.6	59.2	45.0	39.1	57.8
		Min	19.7	23.3	27.5	33.7	40.0	45.3	51.3	49.7	43.4	36.4	27.8	23.8	35.2
New Meadows RS	30	Mean	19.1	23.9	30.9	41.7	49.5	55.7	62.7	60.3	52.8	43.6	31.2	23.3	41.2
		Max	30.4	36.7	44.3	56.3	65.9	72.7	84.6	82.9	74.0	61.3	43.2	33.2	57.1
		Min	7.6	11.0	17.5	27.1	33.2	38.6	40.9	37.5	31.7	26.0	19.2	12.8	25.3
Riggins RS	23	Mean	33.6	39.3	44.9	53.1	60.2	66.1	76.1	74.7	67.0	53.3	42.3	37.1	54.1
		Max	41.0	48.4	56.2	66.6	74.7	80.6	93.1	92.1	83.0	67.7	50.9	44.1	66.5
		Min	7.6	11.0	17.5	27.1	33.2	38.6	40.9	37.5	31.7	26.0	19.2	12.8	25.3
Salmon	30	Mean	17.9	24.7	35.1	45.7	53.9	60.2	67.8	65.6	56.6	45.8	31.8	22.5	44.0
		Max	29.7	37.4	48.4	62.3	70.8	77.5	88.8	86.8	76.5	63.3	43.9	33.1	59.9
		Min	6.2	12.3	21.9	29.3	37.0	43.1	47.1	44.3	36.7	28.3	19.6	11.9	28.1

Table 2. Mean monthly and annual precipitation, 1931-1960, and maximum and minimum monthly and annual totals of record in inches for selected stations in and adjacent to Salmon Basin. Data from Pacific Northwest River Basins Commission.

Station	No. Yrs.	Statistic	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ann
Big Creek 1S	21	Mean	2.93	2.53	2.32	2.03	2.45	2.30	0.97	1.00	1.50	1.87	2.66	2.98	25.54
	29	Max	7.62	4.90	4.90	5.77	4.92	6.12	2.54	3.14	7.05	7.07	6.74	12.41	38.55
	29	Min	0.60	0.90	0.38	0.15	0.35	0.68	T	0.09	0.06	0.34	0.16	0.90	16.34
Challis	30	Mean	0.48	0.33	0.35	0.53	1.11	1.18	0.58	0.53	0.60	0.46	0.31	0.47	6.93
	52	Max	2.13	1.87	1.08	1.51	3.49	3.83	1.83	1.74	2.83	2.08	1.22	3.72	10.33
	52	Min	T	T	0.02	T	T	T	T	0.01	T	T	T	T	2.62
Grangeville 11SE	30	Mean	1.38	1.52	2.05	2.68	3.30	3.04	0.88	0.76	1.51	2.20	1.82	1.51	22.65
	73	Max	4.86	5.58	4.39	5.55	8.24	7.69	2.85	4.15	5.84	5.52	5.80	4.22	37.16
	73	Min	0.35	0.13	0.56	0.92	0.86	0.82	T	T	0.02	0.38	0.17	0.29	15.16
New Meadows RS	30	Mean	3.30	2.70	2.37	1.94	2.07	1.99	0.55	0.55	1.15	2.22	2.87	3.58	25.29
	63	Max	7.88	5.70	6.00	5.12	5.20	5.02	2.16	2.47	5.26	6.95	7.17	9.27	33.78
	63	Min	0.82	0.37	0.21	0.18	T	T	0.00	T	T	0.15	0.01	0.73	12.70
Riggins RS	30	Mean	0.90	1.22	1.49	1.54	2.08	1.91	0.62	0.56	1.02	1.42	1.37	1.33	15.46
	64	Max	4.63	3.54	3.20	3.07	5.30	4.13	2.48	2.31	4.18	4.50	3.26	3.45	22.40
	64	Min	0.03	0.11	0.20	0.30	0.15	0.31	0.00	T	0.03	0.13	0.02	0.11	9.77
Salmon	30	Mean	0.56	0.50	0.53	0.64	1.38	1.35	0.81	0.56	0.72	0.66	0.63	0.59	8.93
	60	Max	1.87	1.32	1.35	2.07	3.88	4.32	2.55	2.70	3.12	2.62	2.38	2.26	14.36
	60	Min	0.08	0.02	0.01	0.01	T	T	0.05	0.05	T	T	T	0.15	3.63

Table 3. Median, maximum, and minimum snow depths and water equivalents in inches for snow courses in Salmon Basin. Data from Pacific Northwest River Basins Commission.

Station	Location		February				March				April				May			
	T., R., S.	Elev.	Yrs	Med	Max	Min	Yrs	Med	Max	Min	Yrs	Med	Max	Min	Yrs	Med	Max	Min
Mill Creek Smt	03N17E08	8870									28	62	90	42	11	51	81	34
												21	37	12		20	39	10
Moose Creek	27N21E22	6200	20	43	67	26	28	48	69	29	29	46	67	30	15	32	48	14
				11	17	5		14	22	6		16	25	8		13	16	5
Redfish Lake	09N13E03	6600	15	25	52	13	17	31	49	24	17	33	47	16	10	2	22	0
				5	15	2		8	16	4		10	17	5		0	10	0
Vienna Mine	06N14E32	8900					16	90	139	63	16	100	126	68	15	91	115	63
								30	54	18		37	56	25		39	48	26
Williams Cr Smt	21N20E34	7800					26	42	58	24	29	46	62	27	10	37	56	8
								11	19	5		14	22	7		13	19	3

falls in the form of snow. No floods are known to have occurred as a result of rain runoff. The largest known flood on Salmon River occurred in June of 1894. The estimated peak discharge of this flood was 120,000 cubic feet per second (cfs) at the White Bird gauging station. The minimum observed flow of 1,580 cfs occurred at White Bird in December of 1932. Based on a 55-year period of record, Salmon Basin has an average annual runoff of 7,971,000 acre-feet, at the White Bird gauge. Maximum and minimum annual runoffs during that period were, respectively 12,470,000 acre-feet in 1965 and 4,200,000 acre-feet in 1931.

Table 4 is a summary of discharge records for selected gauging stations in Salmon Basin. Figures 2, 3, and 4, are, respectively, summaries of monthly and annual discharge for Salmon River near Challis, at Salmon, and at White Bird. Figure 5 is a generalized summary hydrograph of Salmon River at White Bird.

Table 4. Summary of discharge records for selected gauging stations in Salmon Basin. Data from U.S. Geological Survey.

Stream	Station	Station number	Gauge datum (feet)	Drainage area (sq. mi.)	Period of record	Discharge in cubic feet per second					Number of years
						Maximum	Date	Minimum	Date	Average	
Valley Creek	Stanley	13-2950	6221.81	147	1910-1913 1921-1967	2,000	24 May 56	40	30 Nov 29	198	50
Salmon River	Stanley	2955	6190.32	501	1925-1960	5,070	27 May 56	100	30 Nov 29	664	35
Yankee Fork	Near Clayton	2960	5950	195	1921-1949	3,360	12 June 21	10	6 Dec 27	197	27
Salmon River	Near Clayton	2965	5900	802	1921-1967	10,300	24 May 56	160	30 Nov 29	986	46
Salmon River	Near Challis	2985	5163.92	1,800	1928-1967	15,400	25 May 56	160	14 Dec 40	1,464	39
Pahsimeroi River	Near May	3020	4636.95	845	1929-1959	796	8 June 57	74	19 May 55	212	30
Salmon River	Salmon	3025	3911.14	3,760	1912-1916 1919-1967	16,500	25 May 56	242	8 Jan 37	1,929	52
Lemhi River	Salmon	3055	3950	1,270	1928-1943	2,400	3 June 36	14	23 July 31	246	15
Panther Creek	Near Shoup	3065	3264.96	529	1944-1967	2,740	25 May 56	22	17 Nov 58	250	23
Salmon River	Near Shoup	3070	3153.7	6,270	1944-1967	24,900	26 May 56	710	21 Aug 66	2,981	23
Middle Fork	Near Meyers Cove	3095	3640	2,020	1931-1939	17,000	10 June 33			1,821	8
South Fork	Near Warren	3140	2985	1,160	1931-1942	20,000	9 June 33	180	27 Dec 39	1,599	11
Salmon River	Near French Creek	3150	1908.92	12,270	1944-1956	88,600	24 May 56	1,790	27 Dec 52	10,520	12
Little Salmon River	Riggins	3165	1760	576	1951-1955 1956-1967	6,720	20 May 58	110	25 Oct 61	828	14
Salmon River	White Bird	3170	1412.65	13,550	1910-1917 1919-1967	106,000	24 May 56	1,580	11 Dec 32	11,010	55

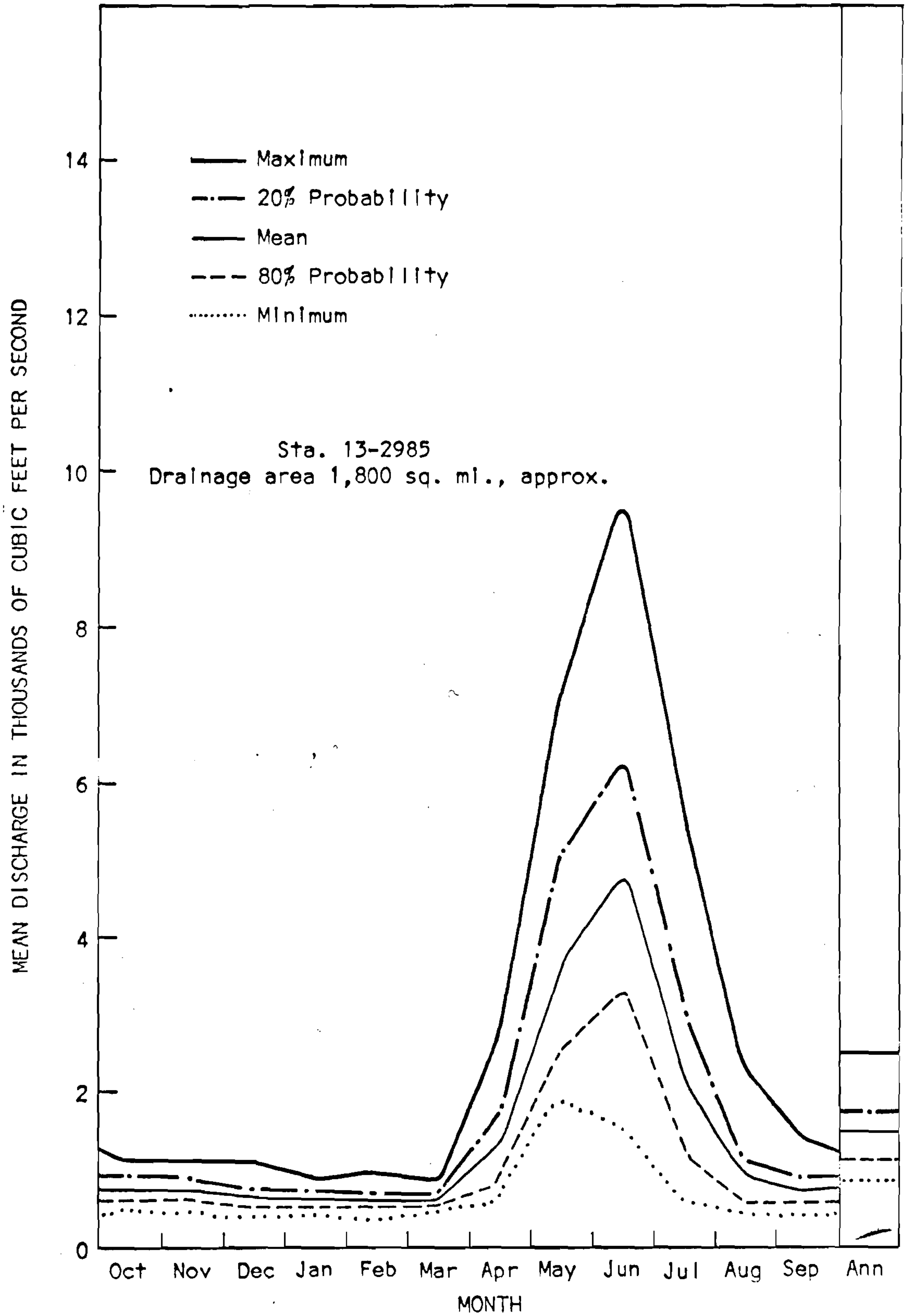

Figure 2. Summary of monthly and annual discharge for Salmon River near Challis for period 1929-1965. Data from U.S. Geological Survey.

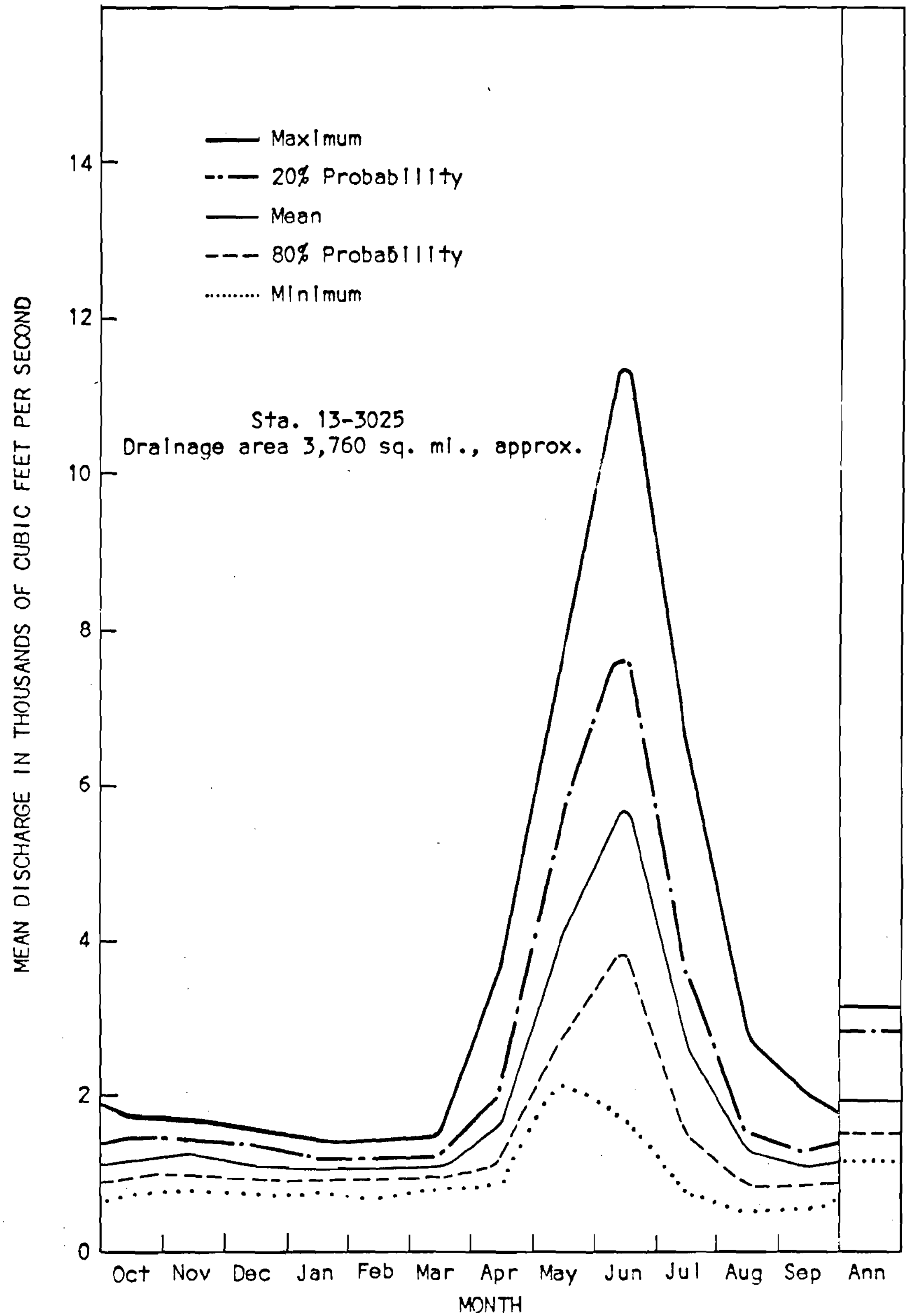

Figure 3. Summary of monthly and annual discharge for Salmon River at Salmon for period 1913-1916 and 1920-1965. Data from U.S. Geological Survey.

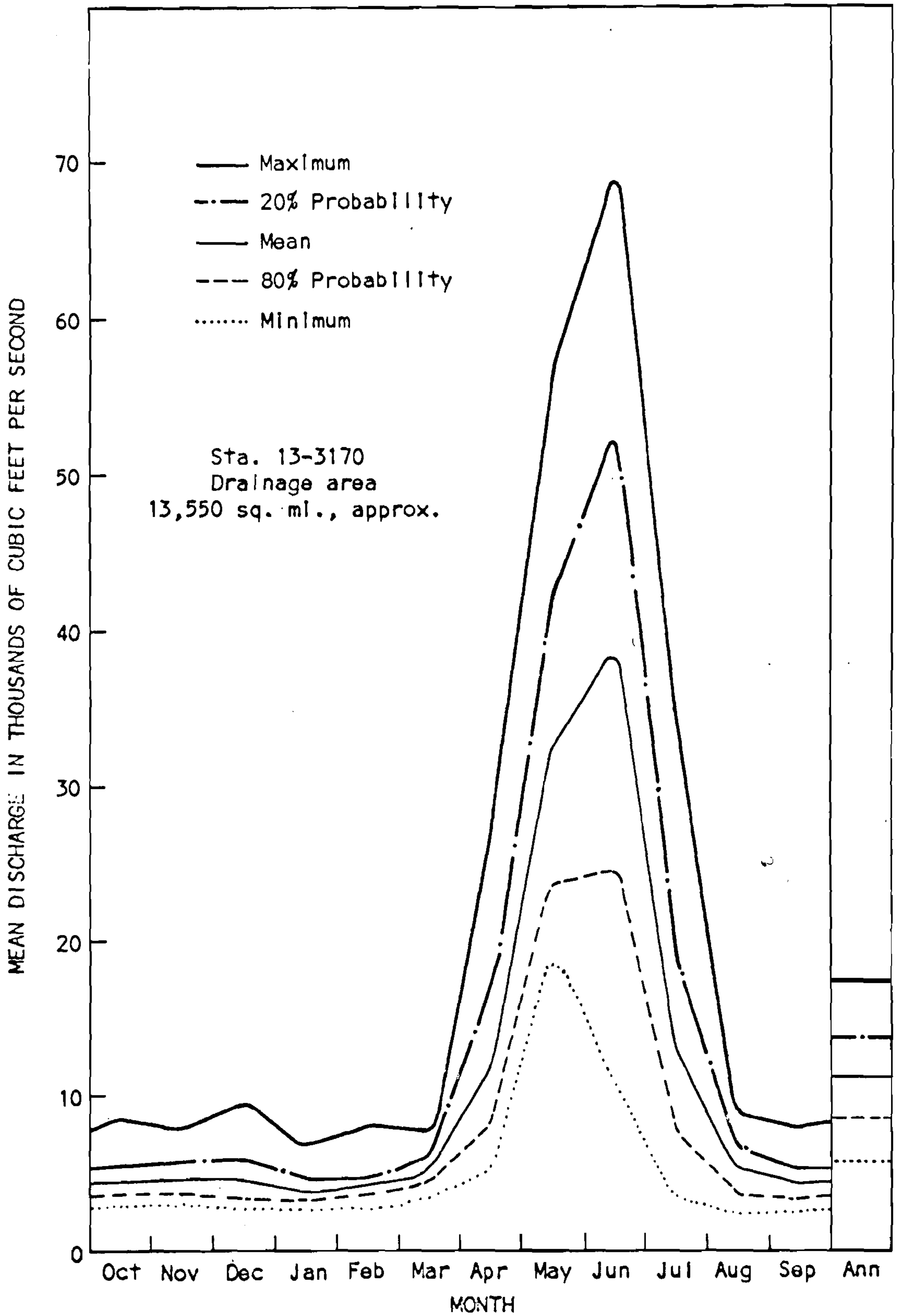

Figure 4. Summary of monthly and annual discharge for Salmon River at White Bird for period 1911-1917 and 1920-1965. Data from U.S. Geological Survey.

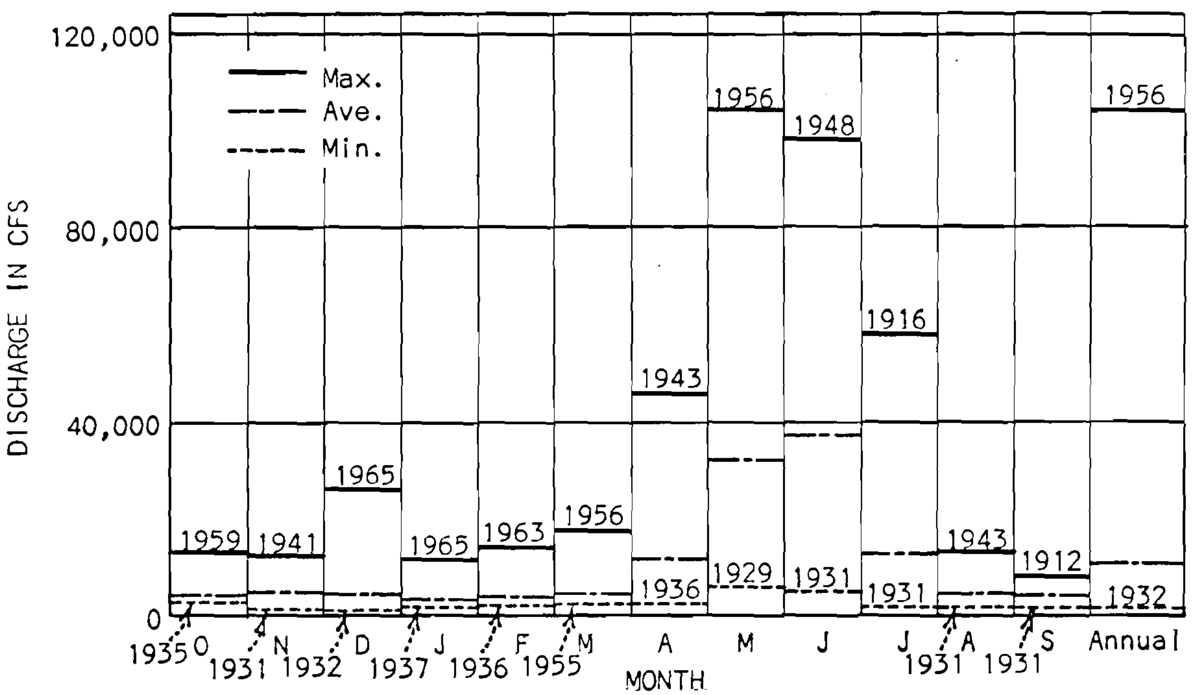

Figure 5. Generalized summary hydrograph of Salmon River at White Bird for period 1910-1917 and 1919-1966. Data from U.S. Corps of Engineers.

HISTORY OF FLOODING IN SALMON BASIN

In general, Salmon River and its tributaries have one high-water period of several months duration in each year. The runoff pattern is characteristic of snow fed streams in the Pacific Northwest. Snow accumulates in the mountains through the winter months and the high water period usually starts in April and extends through July. Crest stages on most of the tributaries occur in May or June. About 75 percent of the annual precipitation occurs in the period from November 1 to April 30. The magnitude of each annual flood is a function of the basin snow cover and the weather during April, May, and June. The greatest flood discharge from a given snow pack occurs when the basin temperatures remain below normal throughout the early spring and then turn abnormally warm about the middle of May for a period of several weeks. Maximum runoff rates result when warm rains occur during the last several days of the warm snow melt period.

In the one hundred year period, 1858 through 1957, there were 13 floods in the Columbia Basin whose unregulated peak discharges exceeded 800,000 cfs at The Dalles on Columbia River, the four largest being those of 1876, 1894, 1948, and 1956. There are no detailed records of streamflow on Salmon River prior to 1910, but the maximum known stage at White Bird, based on the present datum, was about 37.5 feet, resulting in an estimated discharge of 120,000 cfs. It seems almost certain that the flood of 1876 produced a peak discharge at White Bird in excess of 80,000 cfs, which is considered to be the lower limit of flood flow for Salmon River at this station. In addition to the floods of 1876, 1894, 1948, and 1956, the recorded peak discharge of the Salmon River at White Bird exceeded 80,000 cfs in 1913, 1916, 1921, 1928, 1933, 1957, 1958, and 1965. Information concerning these floods, and the floods of 1894, 1948, and 1956, are shown in Table 5.

Table 5. Peak stages and discharges in excess of 80,000 cfs for Salmon River at White Bird.

Water year	Date	Gauge height (feet)[a]	Discharge (cfs)
1894	June, 1894	37.5[b]	120,000
1913	May 28, 1913	19.7	81,200
1916	June 19, 1916	20.05	84,900
1921	June 9, 1921	21.18	88,800
1928	May 23, 1928	20.06[c]	81,600
1933	June 15, 1933	29.86	82,200
1948	June 3, 1948	32.95	103,000
1956	May 24, 1956	33.05	106,000
1957	June 6, 1957	30.39	82,400
1958	May 25, 1958	29.96	83,600
1965	June 12, 1965	32.18	96,600

[a] Datum changed in 1920 and 1931.
[b] Estimated on basis of present datum.
[c] May have been higher during period of no record, May 24-26, 1928.

1876 Flood.

The second largest flood of historical record at The Dalles on the Columbia River was that of June, 1876, but there is no known information concerning this flood in the Salmon Basin. However, at The Dalles this flood was only slightly greater in magnitude than the 1948 flood.

1894 Flood.

The flood of 1894 was preceded by a combination of hydrometeorological conditions, including heavy snow pack and rapid melt plus rainfall, all of which combined are considered to be probable maximums characteristic for Columbia Basin as a whole. For this reason, the 1894 flood has been used by the U.S. Corps of Engineers as the standard project flood for the main stem of Columbia River.

1948 Flood.

The magnitude of the 1948 flood was largely the result of weather conditions during April, May, and the first half of June rather than the slightly above normal snow cover on April 1. Temperatures were below normal in the first half and above normal in the second half of this period. In the first half of the period, cold air masses coming from a low pressure area, centered just north of Columbia River Basin, were unstable and in flowing over the mountainous terrain gave up moisture in the form of snow. This critical period was characterized by above normal precipitation.

During the warm period, mid-May to mid-June, a low pressure system was centered off the coast of northern California, farther south than usual. This warm maritime air was unstable and as it moved inland even a small orographic lift or convective lift due to insolation heating produced rain, and thunderstorms became general in Columbia Basin. During this period, large areas of the basin experienced temperatures in the 80's and 90's.

The runoff resulting from the warm period of mid-May to mid-June caused widespread flooding throughout Columbia Basin. The magnitude of the flood, in comparison with the maximum floods of record, varied considerably on various streams. Snake River and tributaries above Weiser had only moderate flood flows in 1948, and in most cases the peak discharge was about 50 percent of the maximum of record. Records for Snake River at Weiser, which are an index of the magnitude of the flow from Upper and Central Snake River basins, show a peak discharge in 1948 of 48,300 cfs as compared to 100,000 cfs, the maximum discharge of record, in March of 1910. (The flood of 1894 was considerably greater in magnitude.) At Clarkston, the maximum discharge in 1948 was 369,000 cfs. Only the flood of 1894 is known to have exceeded the 1948 flood on the lower Snake River. The estimated maximum discharge for the 1894 flood at Clarkston is 409,000 cfs. The fact that Snake River at Weiser had only an average annual discharge in 1948 as compared to a near-record flood at Clarkston indicates that major floods occurred on the intervening major tributaries, Salmon, Grande Ronde, and Clearwater rivers.

During the period of May 11 to 23, heavy rains in Salmon Basin caused flows to rise to endangering proportions at many points. In most locations, maximum river stages were reached during the last week in May. The maximum stage was reached at White Bird on June 3. On May 29, the Governor of Idaho declared a state of emergency to exist in the 10 northern counties of the State. On White Bird Creek, which enters Salmon River from the east at mile 53.6, continuous high water from May 1 to May 30, nullified all the flood-fighting efforts made by local forces during the early stages of the flood; washed out all levees and other works protecting the village of White Bird, population 300; destroyed about 50 percent of the village; and destroyed U.S. Highway 95 for a length of approximately two miles. On Slate Creek, at mile 66.1 of Salmon River, high water destroyed all of the flood protection works constructed by local forces over a long period of time, and threatened to destroy the major portion of the village. The flood fighting efforts of local residents were successful to the extent that they prevented destruction of any buildings.

1956 Flood.

During the 1955-56 water year, floods in Salmon Basin occurred both in the winter and in the spring. Excessive amounts of precipitation along the Pacific coastal areas during the ten-day period, December 18-27, 1955, caused disasterous floods on most streams. However, inland of the Cascade Mountain Range in Oregon, Washington, and Idaho, only a few rivers reached serious flood stages although almost every stream experienced a rise in flow as a result of heavy precipitation and snow melt from abnormally high temperatures in December. In general, during the first few days of the above period the precipitation in the inland area fell as snow, but on December 21 a warm air mass moved inland depositing heavy precipitation and lifting the freezing level to near 10,000 feet in elevation.

As a result of the heavy precipitation and snow melt, Little Salmon River had the largest winter flood in the experience of long-time residents, although this flood was exceeded by a snow melt and rain flood in June of 1948. There are only two precipitation records available for Little Salmon River Basin during the December flood. One record is for New Meadows Ranger

Station at an elevation of 3860 feet near the upper end of the basin and the other record is for Riggins Ranger Station near the mouth of the river at an elevation of 1840 feet. New Meadows received 4.55 inches of precipitation during the period from December 19 through December 23. For this same period, Riggins recorded only 1.39 inches. The maximum recorded 24 hour precipitation was 1.60 inches at New Meadows on December 22. At Riggins, a maximum temperature of 61 degrees was recorded on both December 22 and 23.

Although the discharge gauging station for Little Salmon River near Riggins had been discontinued in February of 1955, on the basis of a high-water mark on the old gauge, the U.S. Geological Survey estimated the peak discharge in December of 1955, as 7,000 cfs. Record keeping was resumed at the Riggins gauge in 1957 and the maximum recorded discharge is 6,720 cfs on May 20, 1958. The flood of June 1, 1948, was the largest flood experienced by most of the long-time residents of the basin. On the basis of slope-area measurements, the peak discharge of that flood near the mouth of the river has been estimated at 9,200 cfs.

Flooding occurred on Little Salmon River in December, 1955, in the area between the mouth of Round Valley Creek and the mouth of Little Salmon River, a reach of 25 miles. The flood plain of this flood is narrow and closely defined by the walls of the steep-sided canyon in which it is situated. It contains a number of cabins and several small farmsteads and is traversed throughout its length by U.S. Highway 95, the only north-south all-season route in this part of Idaho. Although the highway suffered by far the greatest damage, a number of buildings also were destroyed. Existing intermittent privately built levees were overtopped and completely ineffective during the December, 1955 flood.

The spring flood of 1956 in Salmon Basin was caused by the melting of an exceptionally heavy snow cover. Moderately heavy precipitation fell over most of the Columbia Basin during the fall months of October and November. Although September precipitation was generally light, the amounts increased in October. November precipitation averaged 150 to 200 percent of normal. Heavy precipitation followed in December to climax the fall trend toward increasing precipitation and the December total averaged about 200 percent of normal for the entire basin. In December, rain and abnormally warm temperatures in some areas served to saturate the soil to excessive depths even at high elevations. Again in January, the precipitation for the Columbia Basin was above average with most of the area receiving 150 to 200 percent of normal.

Many snow courses in the area had snow-water equivalents on April 1, which were a maximum of record or very near the maximum of record. In most cases, the snow-water equivalent was above average for April 1, varying up to 160 percent of average. River basins which had exceptionally high snow covers were in general the Upper Snake River and tributaries which head along the Continental Divide, the Big Wood, Boise, Payette, Weiser, and Salmon rivers which head in the Sawtooth Mountain Range and the Clearwater River which heads along the Bitterroot Mountain Range.

A brief warm period near the end of March caused some low elevation snow melt and most streams had increasing flows for a short period. This was followed by about ten days of below normal temperatures in which flow in all streams receded until temperatures began rising on about April 7. For the next two weeks, temperatures remained much above normal, which produced high stream flow throughout the basin. During the last few days of April and the first 15 days of May, a general low-pressure condition prevailed which was characterized by above normal precipitation and below normal temperatures. In Salmon Basin the precipitation amounts from about May 7 to May 9 were significant enough to cause flow to again rise after the drop caused by cold temperatures near the end of April and the first part of May. Beginning about May 15, general high-pressure conditions prevailed and, except for brief periods, temperatures remained high until the end of June. The Salmon River began rising rapidly on May 15 and crested on May 24. The peak discharge was augmented by rainfall which began on May 23.

The 1956 spring flood on Salmon River resulted in extensive flooding in the Challis area, 50 miles above Salmon, extending from the U.S. Highway 93 bridge two miles above Challis, to Cronks Canyon damsite, 12 miles below. There also was flooding in the vicinity of Salmon.

1957 Flood.

General flooding occurred in June of 1957 along Lemhi River in eastern Idaho. Its normal flow is quite small because the drainage area has low normal annual precipitation. High flows on the Lemhi are almost always caused by snow melting in the high mountains that exceed an elevation of 10,000 feet in places. Temperatures above normal after about May 22 caused rising flows in Lemhi River and the flows increased steadily until about June 7, when they reached peak discharges estimated to be about 2,600 cfs at Salmon and 1,830 cfs at the gauge near Lemhi. After June 7, the flood flows gradually receded until they reached near normal seasonal flows around June 25. This was probably the largest flood on Lemhi River during the previous 30 years, but records are not available to prove this statement. According to local residents and partial records, the 1957 flood was approached in magnitude in 1927, 1936, 1942, and 1951.

1964 Flood.

In 1964, although the peak discharge of the Salmon River at White Bird did not reach flood stage, a number of small tributaries in the lower part of the basin caused limited flooding on June 8 and 9. Water velocities estimated as high as 17 feet per second, occurred on White Bird Creek. On the basis of slope-area computations at White Bird, the U.S. Geological Survey estimated the peak discharge of White Bird Creek as 1,840 cfs from about 105 square miles. Rapid runoff also occurred from Slate Creek. A small privately owned irrigation dam failed on Lake Creek, a tributary entering Salmon River from the south at mile 93.0. The resultant surge of mud, rock, and debris, amounting to approximately 100,000 cubic yards, completely dammed Salmon River for about eight minutes.

1965 Flood.

In the 1964-65 season there was widespread flooding in the Snake River Basin in December of 1964. However, flooding was minor in Salmon Basin because the basin was sheltered from the rapid warming and abundant moisture experienced by other tributary basins along the mountain ranges to the south and also because of the high elevation of the basin. Some minor flooding was experienced on Little Salmon River and along Salmon River near Riggins. The peak flow of Salmon River at White Bird during this period was only 27,000 cfs.

In January of 1965, there was severe flooding on Grave and Rock Creeks. Grave Creek is a tributary of Rock Creek, the latter stream entering Salmon River from the north at mile 39.1. There were no other reports of flooding in the Salmon Basin in January. Because of the remoteness of much of the basin and the lack of inhabitants and communications it is possible that minor unreported flooding occurred along some small tributaries.

Runoff in June of 1965 was heavy in the Salmon Basin, especially in the upper reaches. In the vicinity of Salmon, the river was above flood stage through the entire month of June and was exceptionally high from June 8 to 15. The peak discharge of Salmon River at Salmon was 15,900 cfs, which is only slightly less than the maximum of a 52 year record which was 16,500 cfs. Flooding occurred at other locations in the upper basin, including Salmon River above Salmon, Lemhi River, and some other tributaries, but the flood plain is limited so the area inundated was not large. Some flooding also was experienced in intermittent reaches of the lower Salmon River during the period June 7 to 15.

Table 6 shows peak discharges at seven stations along the main stem of Salmon River for the floods of 1894, 1948, and 1956.

Table 6. Peak discharges along Salmon River for floods of 1894, 1948, and 1956.

Station	Station number	Drainage area (sq. mi.)	Peak discharge in cfs for flood of:		
			1894*	1948	1956
White Bird	13-3170	13,550	120,000	103,000	106,000
French Creek	3150	12,270	100,000	75,300	88,600
Shoup	3070	6,270	23,000	16,900	24,900
Salmon	3025	3,760	16,000	10,900	16,500
Challis	2985	1,800	14,000	10,300	15,400
Clayton	2965	802	10,000	7,060	10,300
Stanley	2945	355	6,000	4,090	5,070

* Estimated

The discharge values for the 1894 flood were estimated on the basis of a correlation between peak discharge values at the seven stations for the period of 1945 to 1956 and the 1894 flood peak of 120,000 cfs at the White Bird Station.

Figure 6 is a frequency curve of annual peak flows of Salmon River at White Bird for the period of 1894-1965 and Figure 7 shows hydrographs covering the months of April, May, and June for the 1948 and 1956 floods on Salmon River at White Bird.

Figures 8 through 11 show water surface profiles for the normal stage and for the estimated 1894 flood stage on Salmon River from the mouth to mile 393 near Obsidian. Both profiles are based on U.S. Geological Survey topographic maps and river plan-profile sheets. River mileage values were obtained from the River Mile Index published by the Columbia Basin Inter-Agency Committee in January of 1965. The normal stage profile was plotted by noting mileage values of contour crossings on the topographic maps. The 1894 flood stage was determined on the basis of the estimated discharge values of the seven stations shown in Table 6.

Figures 16 through 33 (in Appendix) show areas probably flooded by Salmon River in the 1894 flood in the vicinity of the following communities:

White Bird	French Creek	Ellis
Slate Creek	Shoup	Challis
Lucile	North Fork	Clayton
Riggins	Carmen	Robinson Bar
Riggins Hot Springs	Salmon	Sunbeam
		Stanley

The extent of the flood plain in these areas was estimated on the basis of the 1894 flood stage profile shown in Figures 7 through 11.

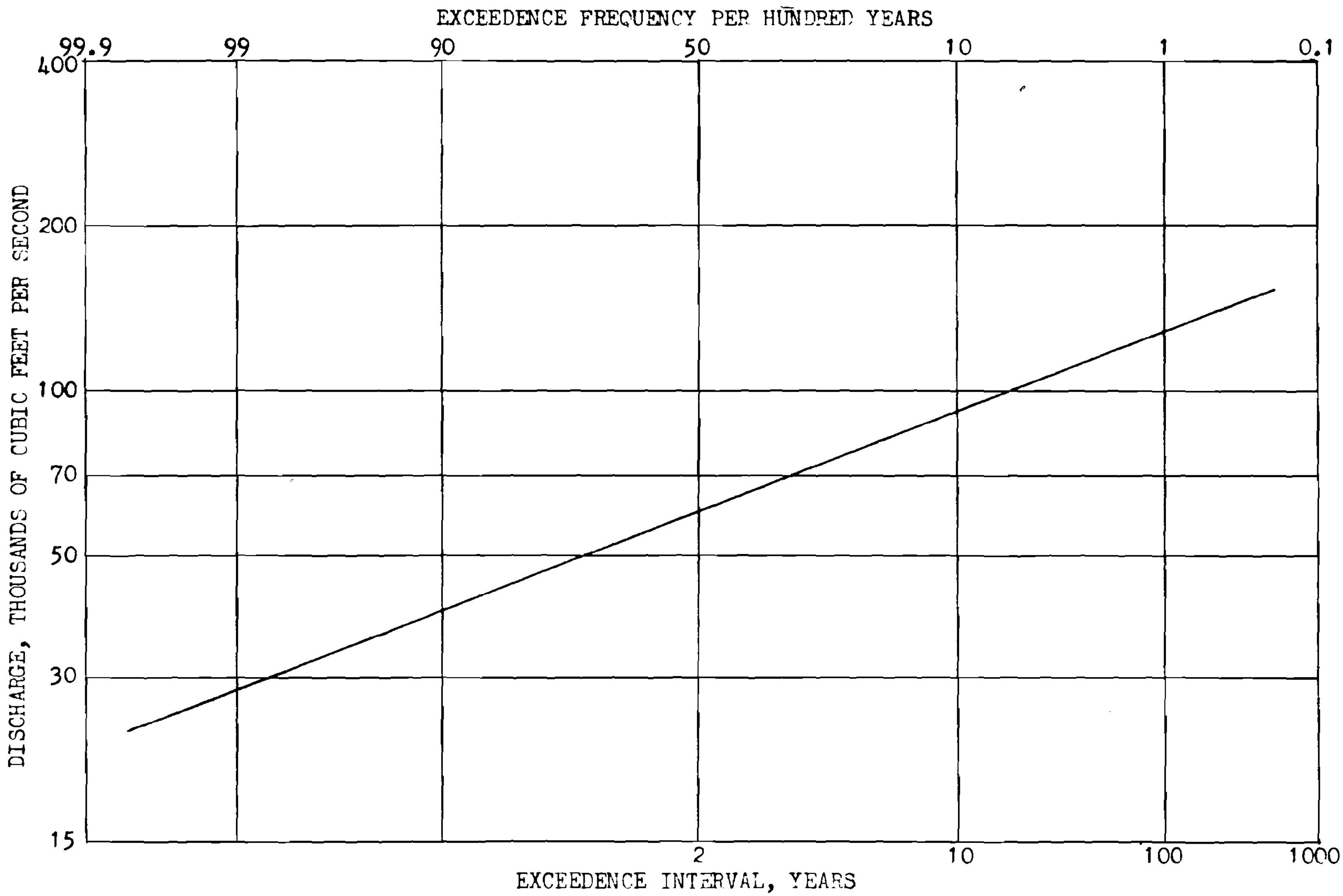

Figure 6. Frequency curve of annual peak flows of Salmon River at White Bird for period 1894-1965. Data from U.S. Corps of Engineers.

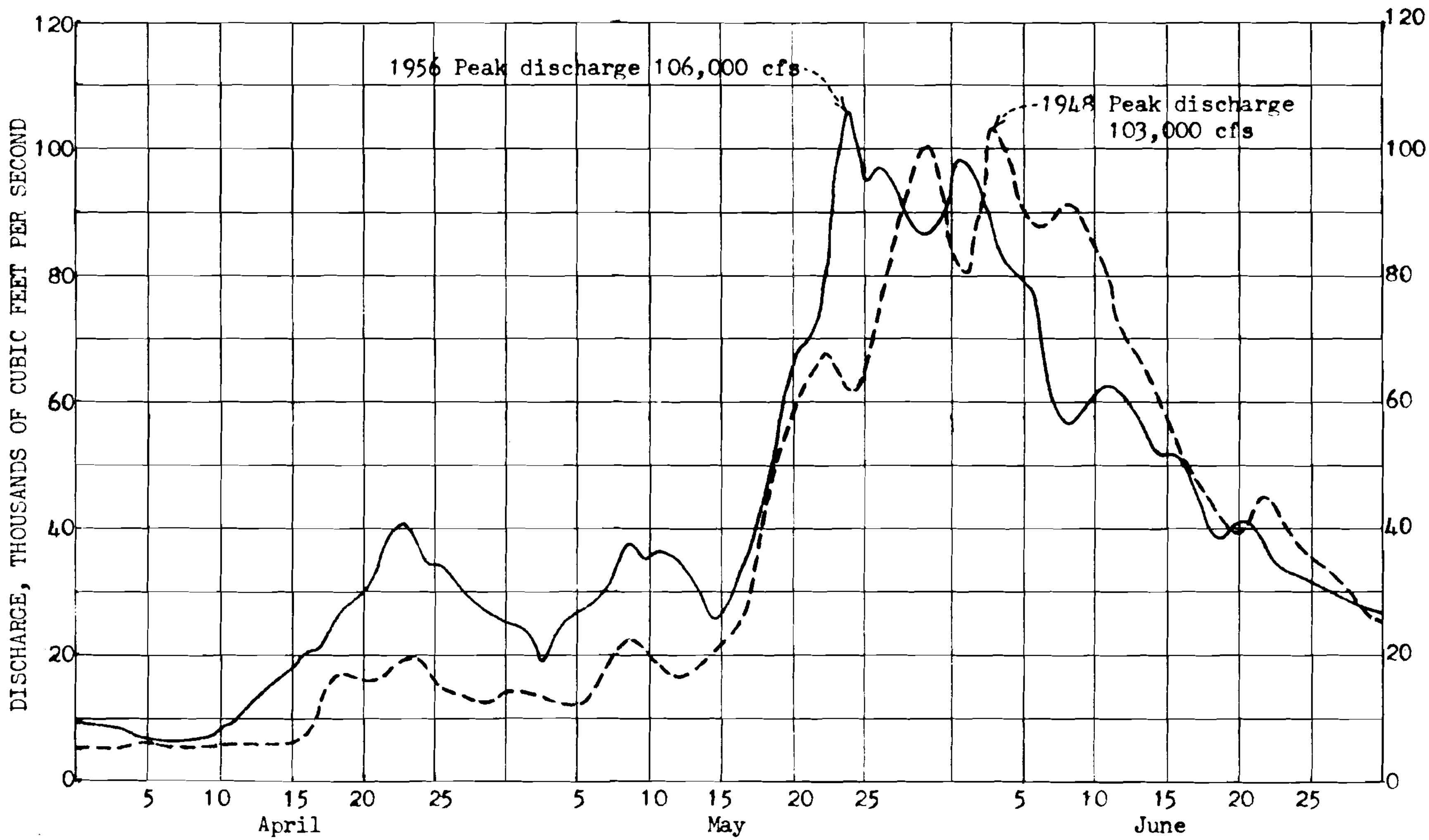

Figure 7. Flood hydrographs of Salmon River at White Bird. Data from U.S. Geological Survey.

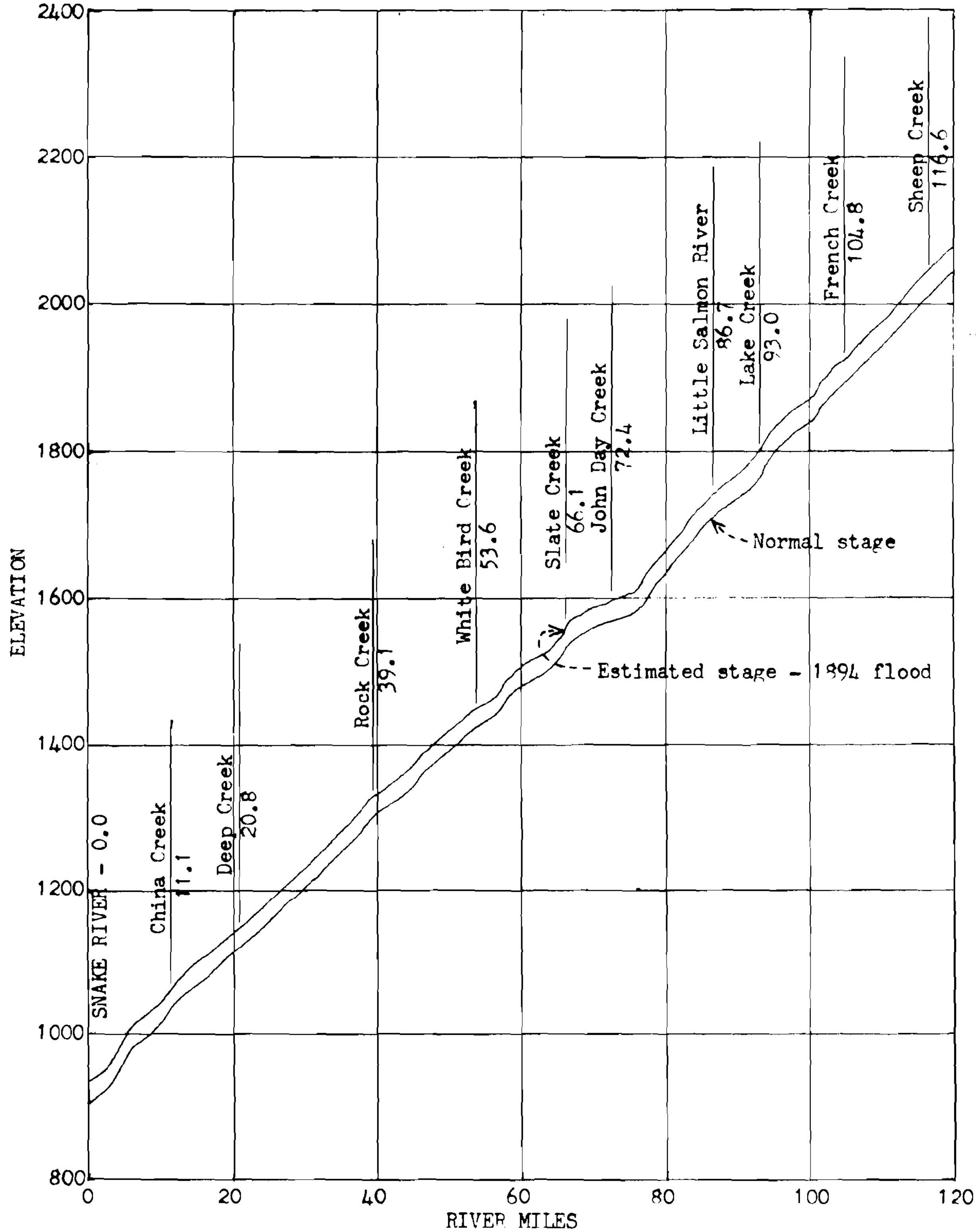

Figure 8. Water surface profiles of Salmon River from mouth to Sheep Creek.

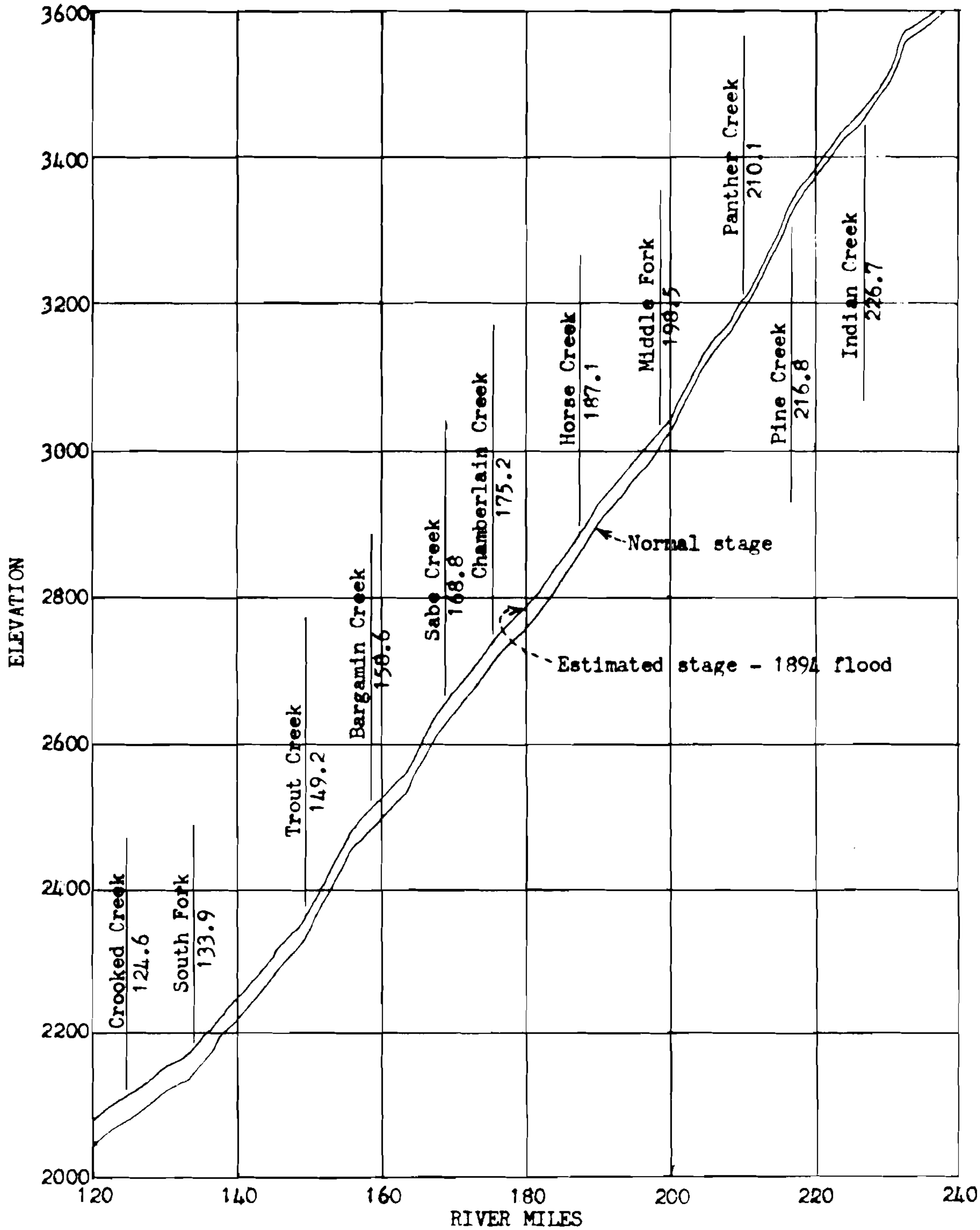

Figure 9. Water surface profiles of Salmon River from Sheep Creek to North Fork.

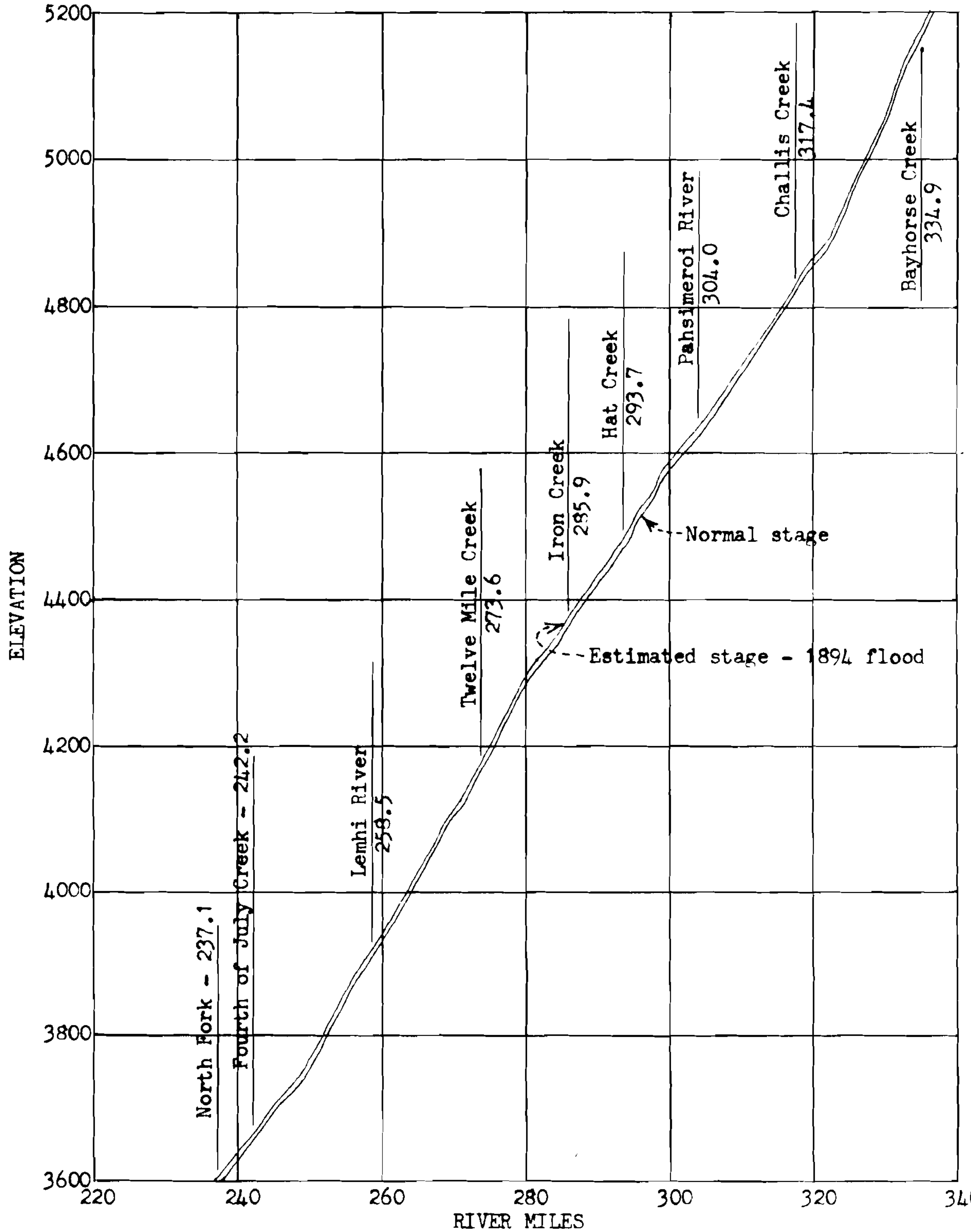

Figure 10. Water surface profiles of Salmon River from North Fork to Bayhorse Creek.

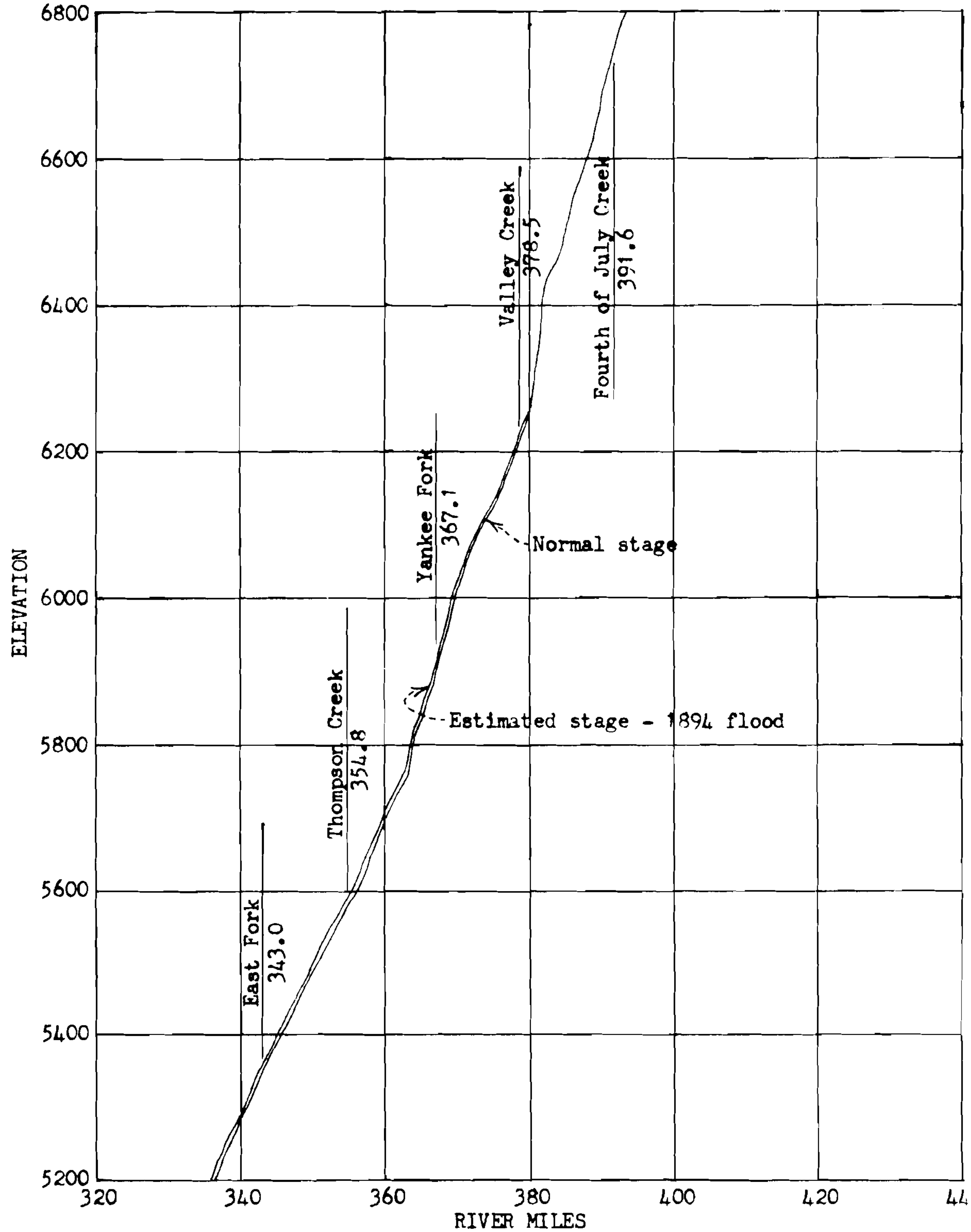

Figure 11. Water surface profiles of Salmon River from Bayhorse Creek to Fourth of July Creek.

FLOOD DAMAGES IN SALMON BASIN

Detailed evaluations of flood damages in Salmon Basin have been undertaken only in recent years. While there may have been newspaper accounts of damages resulting from the floods of 1876 and 1894, it is doubtful whether any financial data were reported. The damage values listed in this chapter were obtained from post-flood reports of the U.S. Corps of Engineers. These values are primarily for the localities where the greatest damages occurred. Although in some cases an attempt was made to determine the flood damages for the entire basin, it is very likely that minor damages at some localities were not reported.

Following a flood, Corps of Engineers personnel make extensive field surveys to obtain detailed hydrologic and economic data. These data, along with other information, are analyzed to determine flood damages, damages prevented by flood fights and developed projects, and damages preventable by authorized, recommended, and prospective projects. Often the wide extent of areas flooded prevent detailed surveys for all areas flooded, but an attempt is made to obtain detailed surveys of all major drainages and for those areas in which future flood control projects might be studied. Detailed surveys involve complete coverage and do not employ sampling techniques.

Salmon Basin is very sparcely settled, the largest communities being Salmon, Challis, New Meadows, and Riggins. The 1965 estimated populations of the ten largest communities are as follows:

Salmon	2,944	Meadows	250
Challis	732	Baker	200
New Meadows	647	Clayton	125
Riggins	588	Gibbonsville	125
White Bird	253	Leadore	112

Salmon River and its tributaries in general flow in well-defined channels with depths adequate for carrying flood waters with minimum overflow of river banks. Small tracts of land along the streams are recurrently covered by annual freshets, but usually these are in primitive areas with little or no developments. Exceptions to this occur where overbank flooding has resulted in damages in the upper reaches of the main stem between Challis and Shoup, along the main stem between Riggins and White Bird, along Little Salmon and Lemhi Rivers, and along lower White Bird Creek.

Figure 12 shows areas in Salmon Basin from which significant flood damage has been reported in the post-flood reports of the Corps of Engineers. These reports cover the floods of 1948, 1956, 1957, 1964, and 1965.

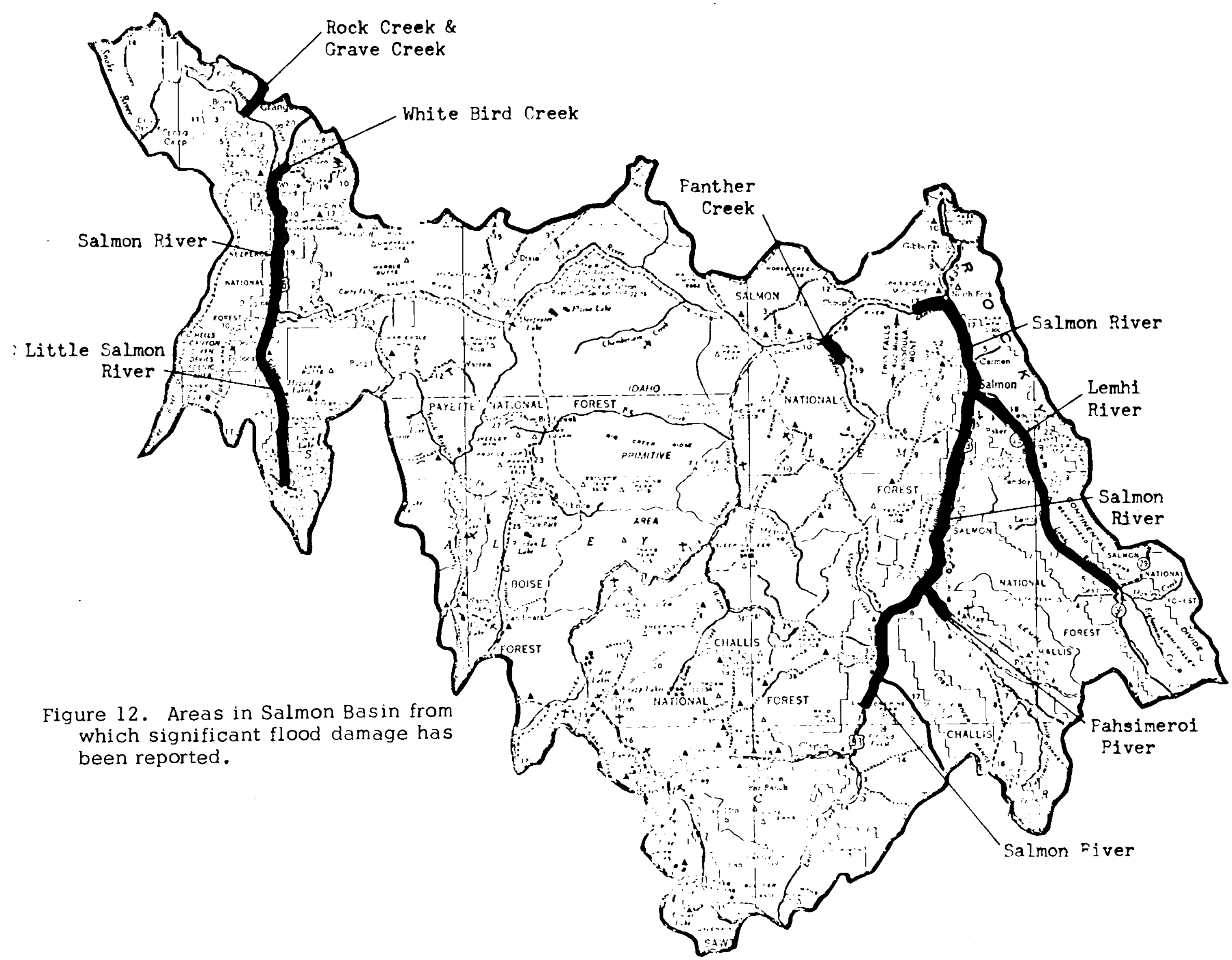

Figure 12. Areas in Salmon Basin from which significant flood damage has been reported.

1948 Flood.

The flood on Salmon River in 1948 was characterized by extremely high stream velocities resulting in serious bank erosion, topsoil erosion, damages to bridges and highways, and the loss of one life. Because this stream traverses generally rough and rugged territory through narrow valleys and precipitous canyons, improvements such as farms, roads, and bridges, which are situated in the flood plain are very vulnerable to high velocity flows. The total damages in the basin based on 1948 prices were evaluated at $546,000, consisting of $289,000 of damages to roads and bridges, $124,000 of damages to agricultural properties and $55,690 of damages to residential properties along the streams. The damage to roads and highways was greatly increased because of the fact that in many locations the flood eroded away the narrow bench on which the roadway was located and very expensive relocations were required.

Extensive damages in the basin were found only in two general areas. These were located along the headwaters in the vicinity of Salmon, extending upstream as far as Challis; along the lower reaches of the Lemhi River; and downstream as far as Shoup. Downstream from Shoup almost all of the way to Riggins, the river runs through a narrow, practically uninhabited canyon. From Riggins to White Bird and part way up Little Salmon River are winding valleys containing several irrigated farms. These areas suffered considerable damage. Heavy damage, including destruction of the only road serving a considerable area on both sides of Salmon River also occurred on Rock and Grave Creeks. The flood on White Bird Creek caused very severe damages in and near White Bird. Total damages on Salmon River consisted of $32,400 on the upper Salmon above Shoup, $44,100 below the canyon, $223,500 on Little Salmon River, $116,600 on White Bird Creek, $121,000 on Rock and Grave Creeks, and $7,400 elsewhere.

Areas flooded in the basin were as follows:

Agricultural lands including suburban home tracts	15,253 acres
Urban residential tracts	20
Waste lands	2,727
Total	18,000 acres

Flood damages by types and locations were as follows:

Agricultural property	$123,980
Residential property	55,690
Commercial property	24,900
Industrial property	34,900
Public property	2,300
Utilities	4,800
Transportation facilities	289,600
Flood control facilities	9,500
Total	$545,670

The following break-down was made of the agricultural damages:

Land damage	$23,400
Crops	16,750
Livestock	18,280
Improvements	53,900
Equipment	1,000
Irrigation and drainage	2,750
Increased cost of production	3,600
Other	4,300
Total	$123,980

The only available flood control protection in the basin was an earth dike about one-quarter mile in length which had been constructed to protect the village of White Bird on White Bird Creek.

1956 Flood.

As mentioned in the chapter on the history of flooding in Salmon Basin, winter flooding in the 1955-56 season occurred on Little Salmon River in December of 1955 in the area between the mouth of the river and the mouth of Round Valley Creek. A field survey of the area was made in March of 1956 after high water had subsided and when the extent of flood damages could be realistically appraised.

The State Highway was severely damaged at a number of locations, about 200 acres of land were flooded, and some buildings were destroyed. Total damages have been estimated at $685,000. The flood plain of this flood in this reach of Little Salmon River is narrow and closely defined by the walls of the steep-sided canyon in which it is situated. It contains a number of cabins and several small farmsteads and is traversed throughout its length by U.S. Highway No. 95. The total valuation of property in the flood plain of this flood has been estimated at $1,212,000. The greater part of this value is in the State Highway.

The Highway suffered by far the greatest damage. In several locations it was completely washed away and in others, so heavily eroded as to cause the roadbed to collapse. One bridge was severely damaged. The effects of the flood were so extensive that the highway was closed for nearly two weeks. Total damage to the highway, including traffic interruptions was estimated at $572,000.

At least one farmstead building group and seven rural residences or cabins were completely destroyed. Other farmstead building groups and cabins were flooded. Existing locally constructed levees suffered about $8,000 damage.

There are no reservoirs of significance on the Little Salmon River watershed. The existing intermittent privately built levees are minor in extent. These were overtopped and completely ineffective during the December 1955 flood.

The 1956 spring flood on Salmon River caused damages estimated at $250,000. There was extensive flooding in the Challis area, 50 miles above Salmon, extending from the U.S. Highway 93 bridge two miles above Challis, to Cronks Canyon damsite, 12 miles below. In this area, damages resulted from a sand and gravel overlay being deposited on cultivated and pasture lands from bank erosion, with new channel cuttings and accompanying damage to irrigation headworks and ditches. In the reach from Cronks Canyon damsite to 10 miles above Salmon, the damages were principally to U.S. Highway 93 which had one 800 foot section destroyed and many reaches badly eroded. Three local road bridges spanning Salmon River were destroyed in this reach. In the reach from 10 miles above Salmon to 20 miles below, various levees including the Salmon-Tomanovich levee protecting the town of Salmon were badly eroded. Damages prevented by levees protecting Salmon were estimated to be $80,000. The levees suffered damages estimated to be $30,000.

1957 Flood.

A field reconnaissance along Lemhi River was made during June , 1957, to determine the extent and character of the damages suffered by ranchers in the flooded area. Lemhi Valley is primarily an agricultural district producing large quantities of beef cattle, and sheep.

Approximately 700 acres composed of agricultural land and roads were inundated and suffered damage estimated at $135,000. Total value of property affected is estimated at $460,000 and includes roads, bridges, farm land, residences, and irrigation structures. Flooding occurred for approximately 48 hours and ranged in depth from three feet to a few inches.

Agricultural damage accounted for a major portion of the total and amounted to approximately $100,000. Pasture and alfalfa acreage suffered severe damage from erosion and siltation, irrigation structures were damaged, fences were washed away, and bridges were destroyed or badly damaged. Farm owners bordering the river spent considerable funds and effort cleaning the river channel of debris and gravel deposits after the flood waters receded.

Damage to State and county roads and bridges was estimated to be $34,000. State Highway 28 borders Lemhi River at many points and the high water caused considerable erosion to the roadbed. County roads were inundated, their surfaces were eroded in some areas and buried under several feet of debris in others.

Damage in Salmon, at the confluence of Lemhi and Salmon rivers was limited to an estimated $1,000 involving one residence.

There were no extensive flood protective works on Lemhi River. Individuals attempted to keep the channel clear adjacent to their property, but no cooperation existed between land owners. As a result, these scattered improvements offered little protection during the flood.

1964 Flood.

Rapid runoff of White Bird Creek and Slate Creek, both relatively small, steep, westward, flowing tributaries caused erosion damage along their downstream reaches. The flood fight on White Bird Creek was hampered by washout of a bridge which provided access to a quarry, so suitable rock for riprap was scarce. A 350-foot length of levee in White Bird was seriously threatened by erosion caused by high-velocity flow in the creek.

The failure of the dam on Lake Creek resulted in the complete destruction of two homes and adjacent buildings, a trailer house, and several cars and trucks. About five miles of forest service road and two bridges were destroyed on Lake Creek, and one bridge over Salmon River was damaged. One abutment of the Salmon River bridge was washed out, thereby isolating all upstream areas. Several small streams, primarily in Nez Perce National Forest, produced significant erosion damage. Except for the damage resulting from the Lake Creek dam failure, there was little or no flooding on the main stem of Salmon River.

It is estimated that damages at White Bird amounted to $27,000. Of this total, $10,000 is the estimated cost of the flood fight by local forces, $2,000 is the cost to the Corps of Engineers and $15,000 is the estimated amount of damage to the existing levee. On Slate Creek, damage to a sawmill and to three nearby houses was estimated to be $2,000. The U.S. Forest Service estimated that damages to roads, bridges, and other facilities in the Nez Perce and Payette National Forests amounted to $138,000 of which nearly $125,000 was caused by the Lake Creek dam failure. In addition, damage to private properties by the dam failure amounted to $35,000.

The timely and successful flood fight at White Bird prevented destruction of the levee and extensive damages to the town. If the local people and the Corps of Engineers had not expended a major effort to stem the levee cutting, it is probable that 300 to 400 feet of levee would have completely washed away. The White Bird levee and flood fight is estimated to have jointly prevented $180,000 in flood damages in the town of White Bird.

1965 Flood.

In the January, 1965 flood, the Grave Creek road, the only access road from Cottonwood to ranches in the area between Salmon and Snake rivers, suffered severe flood damage. The local highway district cleared much of the gravel-clogged channel in repair of this road. However, one reach upstream of the road repair area was in immediate need of channel cleaning of gravel and debris to prevent further damage to the county road from snowmelt runoff during the spring season. The Corps of Engineers cleared and renovated this reach of Grave Creek channel at a cost of $3,104. The only other flood damage reported in the basin for this period was $1,000 of damage to fish screens on Lemhi River.

In the June flood, the reach from the town of Challis to North Fork experienced damages estimated at $47,600 with some 200 acres flooded. Along the lower Lemhi River, damages were estimated at $19,400 with about 40 acres flooded. The following indicates the classification of damages:

Classification	Salmon River	Lemhi River	Total
Agricultural	$10,000	$ 5,200	$15,200
Public (fish facilities)		5,000	5,000
Roads, bridges	31,600	9,200	40,800
Emergency expenditures (city & county)	20,000		20,000
Totals	$61,600	$19,400	$81,000

Lemhi County, the City of Salmon, and the Corps of Engineers conducted an aggressive flood fight at Salmon. The emergency operations prevented substantial damage to the city sewage plant, swimming pool, several bridges, and other property and development. An existing levee prevented serious flooding in town, but some emergency work was required to prevent flanking of the levee by high water. The total damages prevented at Salmon were estimated at $132,000. It is considered that half of that total is creditable to the existing levee and half to the emergency flood fight.

Summary.

Table 7 is a summary of flood damages in Salmon Basin. Based on the values shown in this table, Figure 13 was prepared which is a plot of estimated flood damage in the Salmon Basin versus peak discharge at the White Bird gauging station. In preparing this chart, the damage values in Table 7 were adjusted to 1970 prices and were further increased, by using census assessed valuations, to reflect the 1970 level of development. By using this chart in conjunction with Figure 6, the frequency with which various estimated total basin damages will occur can be obtained. The following

Table 7. Summary of flood damages in Salmon Basin

Date	River	Gauge location	Area flooded (acres)	Peak discharge (cfs)	Damages[a]	Damages prevented[a]
May 48[b]	Salmon	White Bird	18,000	103,000	$546,000	$ 0
Dec 55	Little Salmon	Riggins	200	7,000[d]	685,000	0
May 56	Salmon	White Bird	NR[c]	106,000	250,000	80,000
Jun 57	Lemhi	Salmon	700	2,600[d]	135,000	0
Jun 64	Salmon	White Bird	NR[c]	79,000	202,000	80,000
Jan 65	Salmon	White Bird	NR[c]	27,000	1,000	
Jun 65	Salmon	White Bird	240	96,600	81,000	132,000

[a]Values shown are basin-wide and are based on development and price levels at the time of flood.

[b]One life lost.

[c]NR denotes records are not available

[d]Estimated value.

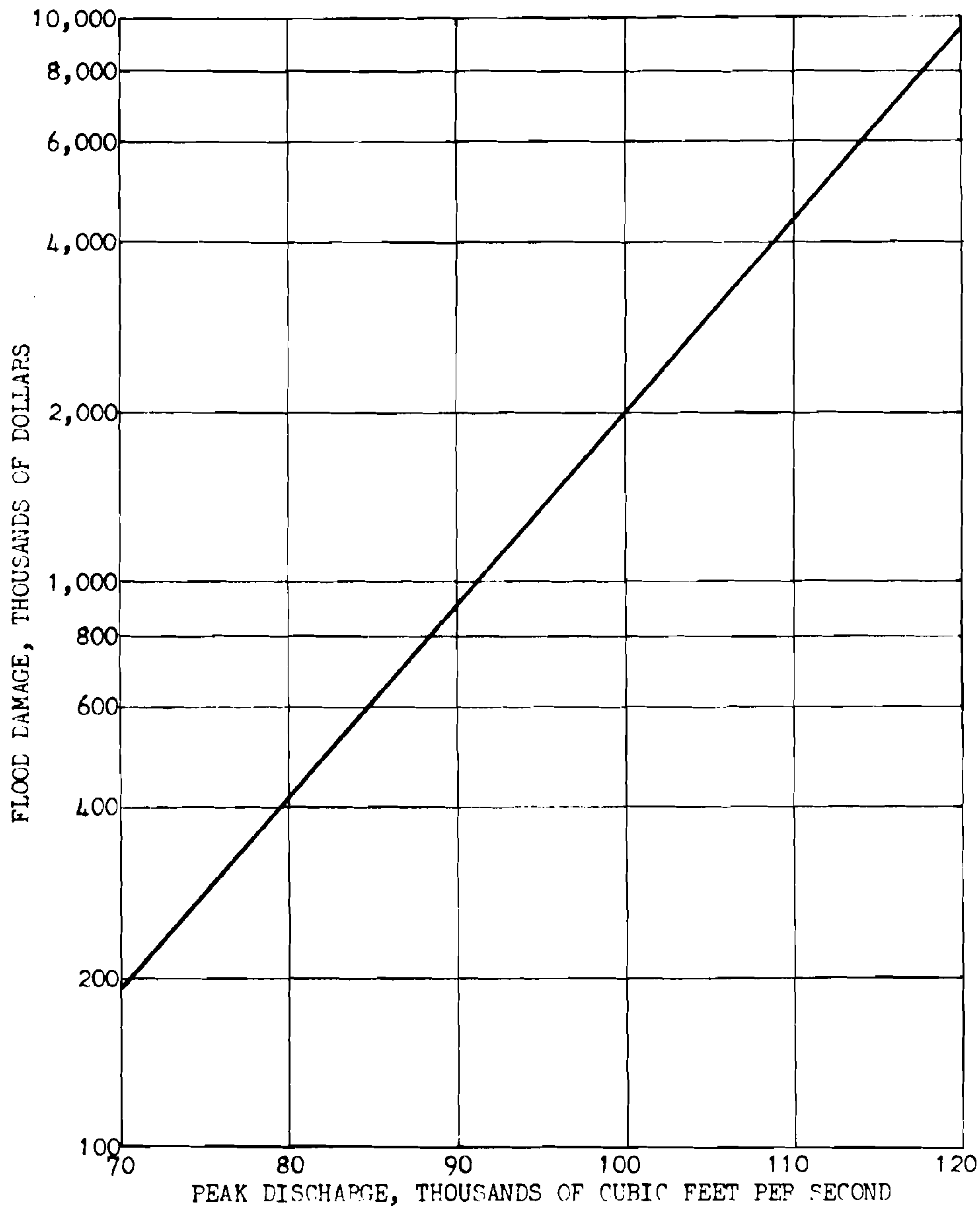

Figure 13. Estimated flood damage in Salmon Basin versus peak discharge at White Bird gauging station. Damages based on 1970 prices and 1970 level of development.

table shows the estimated average annual flood damage in Salmon Basin, under the 1970 level of development, and total damages projected to 1980, 2000, and 2020:

Agricultural	$ 40,000
Rural non-agricultural	3,000
Urban and related	20,000
Total for 1970 level of development	65,000
Total projected to 1980 level of development	90,000
Total projected to 2000 level of development	130,000
Total projected to 2020 level of development	200,000

FLOOD CONTROL NEEDS FOR LOWER COLUMBIA RIVER

Floods in Columbia River Basin cause damage to many localities. However, the major damage occurs in the areas along the 140-mile reach of Columbia River downstream from Bonneville Dam. About 60 percent of the overflow area in this reach is partially protected by levee and upstream storage regulation. Although the projects existing and under construction will afford some flood protection, extensive damage will still result from a major flood. Engineering and economic considerations limit safe levee capacity generally to a flow of 800,000 cfs at The Dalles, Oregon. Control to this flow has been considered an acceptable and desirable initial goal for flood regulation. Regulation of a flood of 1894 magnitude to a flow of 600,000 cfs at The Dalles is a desirable further goal in view of the trends of future flood plain use as well as the possibility that a considerably larger flood than the record flood of 1894 might occur, although very infrequently. Under present conditions, construction of facilities to regulate flows at The Dalles to less than 800,000 cfs cannot be justified because the benefit from additional upstream storage for flood control is only 11 cents per acre foot.*

By 1955 only a portion of the specific storages proposed for flood control in the Main Control Plan of House Document 531, 81st Congress, 2d Session, appeared to be attainable. A revised flood control plan for the lower river was therefore developed in House Document 403, 87th Congress, 2d Session. This plan took into consideration the changed conditions of reservoir storage, experience gained in flood regulation after the 1948 flood, and analysis of the 1956 flood effects on storage regulation and levee requirements. In addition, the soundness of the over-all plan of control by a combination of storage and levees was reviewed, and further analysis was made of the effect of irrigation depletions and natural lake storage on streamflow reduction.

A treaty between the United States and Canada relating to cooperative development of the water resources of Columbia River Basin was signed on January 17, 1961. Under this treaty, storage amounting to 15,500,000 acre-feet will be provided in Canada. Of this storage, 8,450,000 acre-feet will be usable for increasing flood protection in the United States. Also, the treaty provides that additional storage in Canada, in excess of the 8,450,000 acre-feet, and within the limits of existing facilities, will, on call, be

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*Written Communication, E. L. White, Pacific Northwest River Basins Commission, 1969.

operated as required to meet flood control needs during the period for which the call is made.

During the time that House Document 403 was being reviewed, the Canadian Treaty was in the process of ratification. On the basis of the treaty, projects previously proposed in House Document 403 were re-examined and those projects found not economically justified on a last added basis were eliminated.

As indicated in Table 8, reservoir projects existing and under construction in the United States presently provide a total of about 17,310,000 acre-feet of storage capacity usable for flood control in Columbia River Basin. This storage will regulate a flood of 1894 magnitude, the maximum of record, which had a flow of 1,240,000 cfs at The Dalles, to a flow of 800,000 cfs at that point, which is the initial objective for flood control on Columbia River. The 8,450,000 acre-feet of Canadian storage, plus the storage available at projects existing or under construction in the United States, assure control of flood flows of 1894 magnitude to about 700,000 cfs at The Dalles under virtually any foreseeable conditions of runoff sequences or areal distribution. The objective to control to 600,000 cfs at The Dalles will require a total of about 32,500,000 acre-feet of usable storage, or about 6,740,000 acre-feet in addition to the projects constructed or under construction in the United States and the Canadian Treaty projects.

A modified list of storage projects included in the Major Water Plan of House Document 403 is shown in Table 9. As indicated in the discussion of Table 8, the United States projects listed as "constructed" and "under construction" will provide 17,310,000 acre-feet of storage which is sufficient to attain the initial goal of regulating the 1894 flood to 800,000 cfs at The Dalles. Some of the projects listed as "potential" could be required to help fulfill the additional requirement of 6,740,000 acre-feet to attain the 600,000 cfs objective. It is possible that some of the on-call Canadian storage mentioned previously could be used as a portion of this increased storage requirement.

Table 8. Effect of storage facilities, existing, under construction, and proposed, on 1894 flood at The Dalles.

Storage conditions	1894 flood at The Dalles (cfs)	Usable storage (acre-feet)	
		Total required	Available from projects existing under construction, or proposed[a]
1. 1894 conditions	1,240,000		
2. Initial flood control objective	800,000	17,300,000	17,310,000[b]
3. Canadian Treaty storage added to storage existing and under construction	700,000	26,000,000	25,760,000[c]
4. Ultimate flood control objective at The Dalles	600,000	32,500,000	25,760,000[c]

[a]Amount of usable storage in any reservoir or system depends upon the degree of control exercised over the flood and the effects of other reservoirs in modifying inflows and timing of peak flows, so that available storage can be used effectively.

[b]Total for existing projects or projects under construction in the United States.

[c]Includes 8,450,000 acre-feet of Canadian Treaty storage to be made available prior to 1985.

Table 9. Reservoir storage projects listed under Major Water Plan of House Document 403, 87th Congress, 2d Session, modified to reflect Canadian Treaty storage and current conditions.

Project	River	Storage capacity (acre-feet): Total available	Storage capacity (acre-feet): Usable flood control storage, 1894 flood
CONSTRUCTED:			
Hungry Horse	So. Fk. Flathead	2,980,000	1,830,000
Grand Coulee	Columbia	5,230,000	5,230,000
Wanapum	Columbia	330,000	330,000
Priest Rapids	Columbia	170,000	170,000
Palisades (with Jackson Lake)	Snake	1,400,000	1,150,000
Anderson Ranch Arrowrock Lucky Peak	So. Fk. Boise Boise Boise	983,000	240,000
Deadwood Cascade	Deadwood N. Fk. Payette	812,000	420,000
Brownlee	Snake	1,000,000	1,000,000
John Day	Columbia	500,000	500,000
	Subtotal	13,405,000	10,870,000
UNDER CONSTRUCTION:			
Libby	Kootenai	5,010,000	5,010,000
Dworshak	N. Fk. Clearwater	1,430,000	1,430,000
	Subtotal	6,440,000	6,440,000
POTENTIAL:			
Flathead Lake Outlet Improvement	Flathead	1,220,000	690,000[a]
Knowles	Flathead	3,080,000	3,080,000
High Mountain Sheep	Snake	2,100,000	1,550,000
Lower Canyon	Salmon	2,500,000	2,500,000
Garden Valley	Payette	1,940,000	380,000[b]
	Subtotal	10,840,000	8,200,000
	Grand Total	30,685,000	25,510,000

[a]Increase in use of existing storage space for flood control.

[b]Increase in use of total flood control storage space in Payette River Basin.

FLOOD CONTROL NEEDS IN SALMON BASIN

The Salmon River is confined to narrow rocky canyons throughout most of its length. The relatively little development that exists in the basin is concentrated primarily in the vicinity of Challis, Salmon, Riggins, and White Bird. All of these towns have properties that are damaged by floods. There are a few scattered ranches along the Lemhi, Pahsimeroi, and Little Salmon rivers, and White Bird Creek, that have pasture lands in the flood plains.

There are no extensive flood protective works in Salmon Basin. The only dam ever constructed on the main stem of Salmon River was a concrete and timber structure about 25 feet high at mile 367.3 near the mouth of Yankee Fork. This dam was used in connection with a small hydroelectric plant to furnish power for the Sunbeam Mine. Mining activity ceased prior to 1930 and since then the dam has been breached and only a portion of the left abutment remains intact. There are many small storage reservoirs in the basin that are used for stock watering and for irrigation. However, these reservoirs are situated on small tributaries and are largely ineffective for flood control except very locally.

The City of Salmon is protected by a levee 1.2 miles long which was constructed by the Corps of Engineers in 1954. This levee suffered some damages in the 1956 flood. An emergency levee about one-fourth mile in length to protect the town of White Bird was completed on White Bird Creek by the Corps of Engineers in 1955. At numerous places in Salmon Basin individuals have built small earth dikes and have taken action necessary to keep clean that part of the particular stream channel that borders their property. In general, very little cooperation exists between land owners, and as a result these scattered improvements usually offer little protection during floods.

Measures that can be taken to help alleviate flood damages in Salmon Basin include storage, additional channel and levee works, non-structural measures and combinations of these measures. Most of the flood damages in the basin occur in the upper reaches--above the town of North Fork. Therefore, storage developments on the segments of Salmon River from North Fork to its confluence with the Snake River would contribute little to the control of flood damages in the basin. It is estimated that 1,300,000 acre-feet of storage in the upper part of the basin would afford complete flood control for the reach of Salmon River from Challis to North Fork. Storage developed below North Fork would contribute to the control of floods on the lower Columbia River.

A channel and levee project is needed to alleviate the flood problem in the vicinity of Challis. The existing channel project at Salmon protects that town from flows on Salmon River, but a portion of the town receives damages from high flows on Lemhi River. Either upstream storage on Lemhi River or channel work on the lower reach at Salmon is needed to alleviate flooding. Implementation of flood plain zoning possibly could reduce future damages in the Challis and Salmon areas.

Occasionally, there have been substantial flood damages on Little Salmon River. By far the greatest part of the damages have been inflicted on U.S. Highway 95 in the lower reaches of the stream. This portion of the stream basin is narrow, rocky, and steep-walled. In addition to the highway, there are several ranches and a number of homes, small business establishments, and resorts located along the stream bottom. A storage project in the upper reaches of Little Salmon is needed to protect these improvements from flood damages.

The only other area in Salmon Basin where floods cause substantial damages is on White Bird Creek at White Bird. For comprehensive protection there is a need for raising and strengthening the existing emergency levee. White Bird lies in the bottom of a narrow valley with little available land free from floods, so there appears to be little opportunity to reduce damages by non-structural means at this town.

FLOOD CONTROL RESERVOIR SITES IN SALMON BASIN

Salmon Basin has tremendous potential for storage development. However, most of the potential storage sites are located below North Fork where they would contribute little to flood damage reduction in the basin. House Document 531 listed and described 20 potential storage sites in Salmon Basin. The revised plan in House Document 403 reduced this number to one, the Lower Canyon Project, although the Freedom and Crevice sites also were described. While some flood control benefits would accrue to local areas along Salmon River, the primary purpose of storage allocated to flood control in the potential projects described in both documents was for the reduction of flood peaks in the lower Columbia River.

The preliminary draft of the material on Subregion 6 for the Flood Control Appendix of the Columbia North Pacific Region Comprehensive Framework Study* lists 15 potential storage sites in Salmon Basin including those of primary benefit to the lower Columbia as well as those of primary benefit to the basin. Table 10 contains information on all of the sites except those on Middle Fork Salmon River. Because Middle Fork has been designated as a wild and scenic river it is assumed that future development on that stream will not be considered. Figure 14 is a map of Salmon Basin showing the location of the potential storage sites listed in Table 10. Figure 15 is a condensed profile showing the portion of the projects on the main stem of Salmon River. Brief descriptions of the projects listed in Table 10 are given below:

Lower Canyon Project.

The Lower Canyon damsite is located on Salmon River about 0.5 miles above its confluence with Snake River. The site could be developed in conjunction with several alternative plans of development for Middle Snake River Basin. The analysis in House Document 403 considers the project in a plan including the High Mountain Sheep and China Garden projects. At maximum and normal pool elevation 1575, the reservoir would extend about 70 miles upstream on Salmon River to the Freedom damsite. The gross capacity of the reservoir at maximum pool level would be 3,700,000 acre-feet and the surface area would be 17,150 acres. Usable storage space for flood control and power would be 2,500,000 acre-feet with 208 feet of drawdown to elevation 1367.

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*Currently being prepared by the Columbia-North Pacific Technical Staff of the Pacific Northwest River Basins Commission.

Table 10. Potential flood-control storage sites in Salmon Basin.

Stream	Damsite	River mile	Effective height of dam* (ft)	Normal pool elevation (ft. above MSL)	Potential storage (acre-feet)	
					Total	Usable
Salmon River	Lower Canyon	0.5	665	1575	3,700,000	2,500,000
Salmon River	Freedom	69.3	222	1780	285,000	24,000
Little Salmon River	Round Valley	25.0	140		230,000	230,000
Salmon River	Crevice	99.7	510	2355	1,480,000	1,030,000
Salmon River	Crevice (alter.)	99.7	725	2570	3,980,000	2,300,000
South Fork Salmon River	Rattlesnake	12.4	446	3100	285,000	285,000
Secesh River	Long Gulch	18.6	236		183,000	91,000
Salmon River	Growler Rapids	149.0	305	2660	425,000	300,000
Salmon River	Black Canyon	170.0	332	2992	600,000	425,000
Salmon River	Pinnacle Peak	197.1	376	3368	790,000	445,000
Salmon River	Indianola	230.8	248	3750	365,000	265,000
Lemhi River	Texas Creek				19,000	19,000
Salmon River	Pahsimeroi	301.5	297	4890	1,500,000	1,042,000
Challis Creek	Challis Creek				10,600	10,600

*From low water elevation to normal pool elevation.

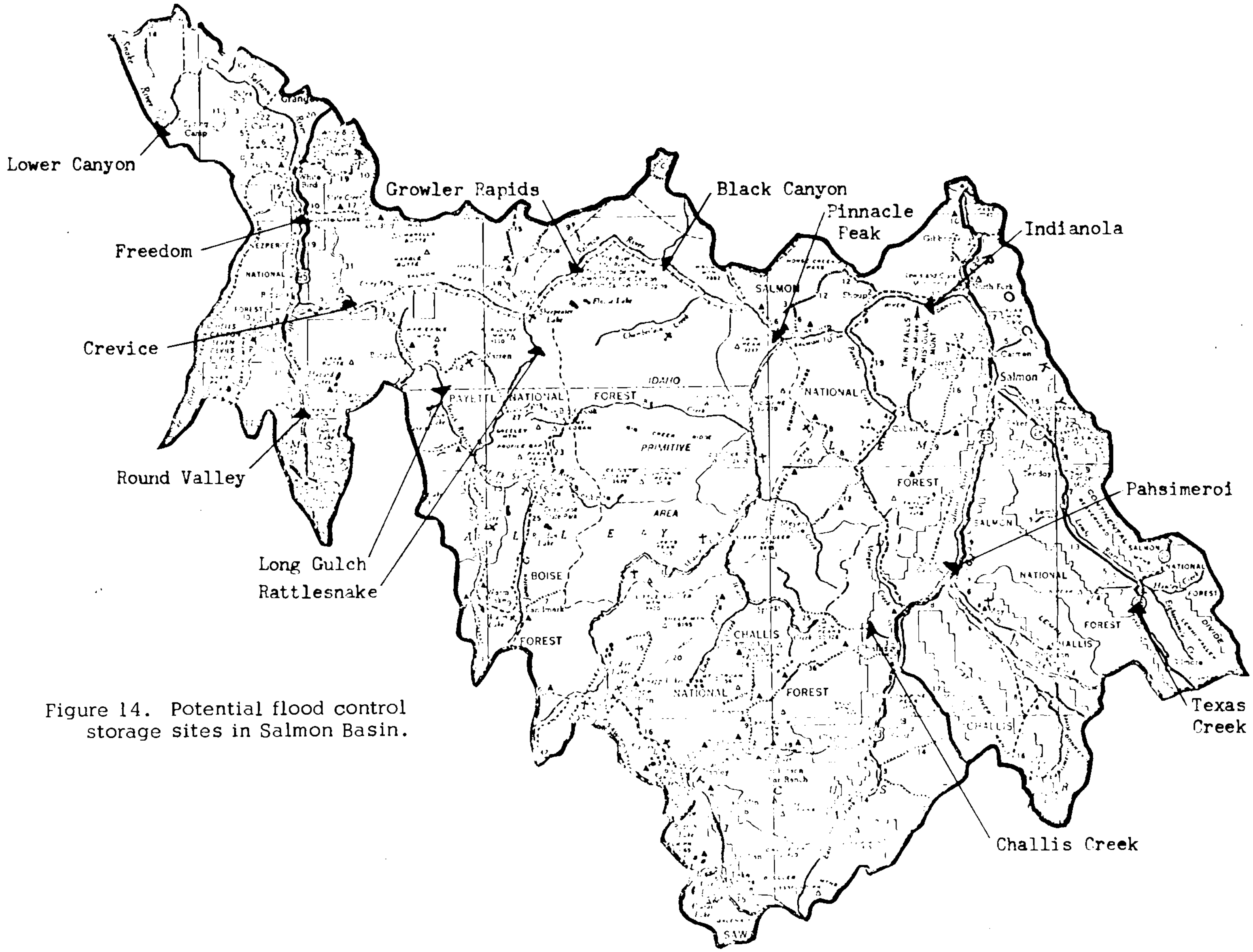

Figure 14. Potential flood control storage sites in Salmon Basin.

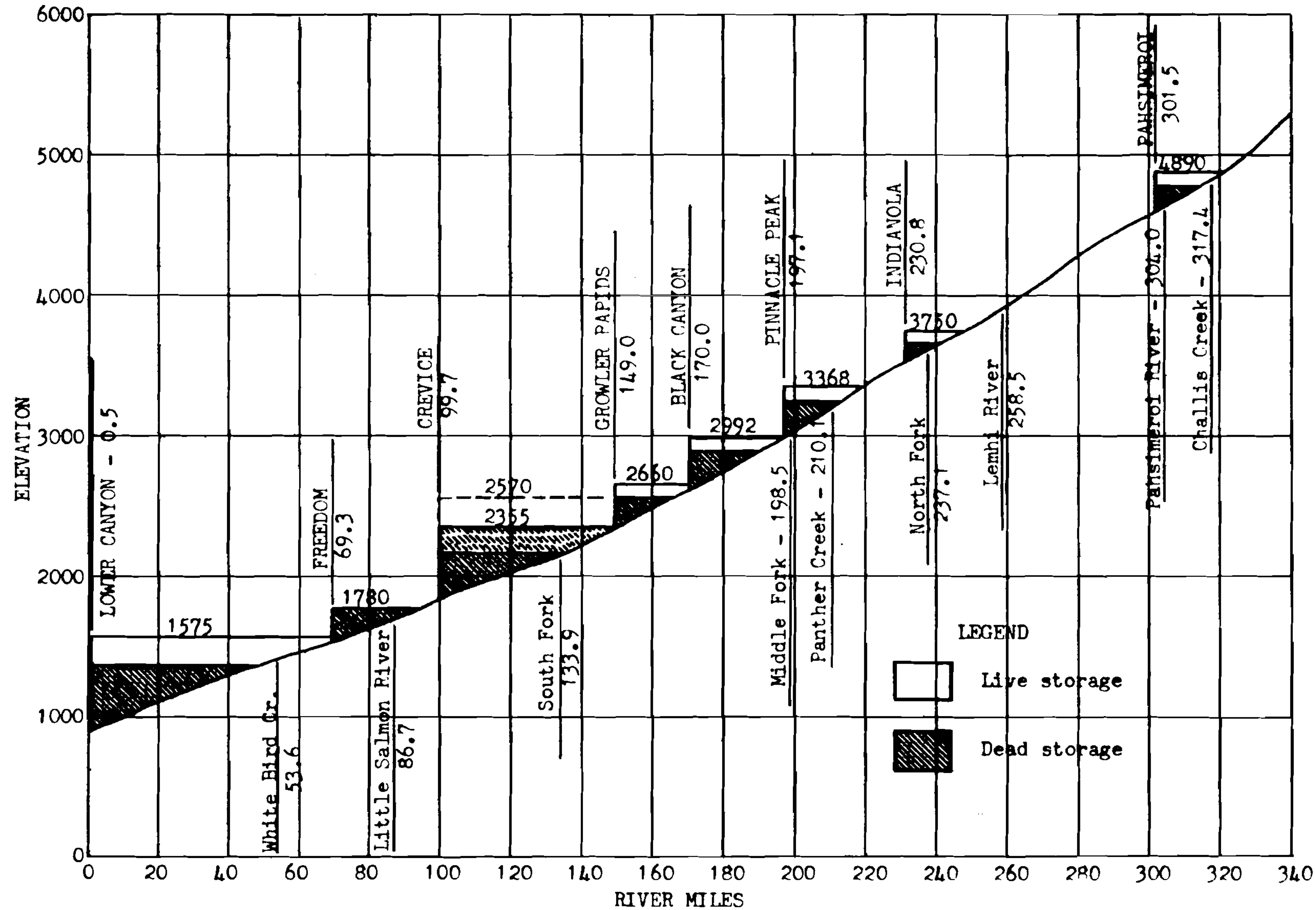

Figure 15. Condensed profile of Salmon River showing potential flood control storage projects.

Fish facilities and outlet works would be designed to function initially at this minimum pool level. With possible later addition of storage upstream at the Crevice site, reservoir drawdown could be reduced to 130 feet, providing 1,800,000 acre-feet of usable storage, without alteration of the initial project. The dam structure would be of the rockfill type containing approximately 25,000,000 cubic yards of embankment material. The structural height of the dam would be about 700 feet and its crest length at elevation 1585 would be 2200 feet.

Freedom Project.

Freedom damsite is located on Salmon River at mile 69.3 about 17 miles downstream from Riggins and 3 miles above White Bird. This project, which would be located next downstream from the Crevice project, would be primarily a head development for power production with only enough storage to regulate releases from Crevice and to control inflow below that location. Normal pool would be at elevation 1780 at which level the reservoir would extend 24 miles up Salmon River to a point 7 miles below Riggins. The pool level is limited to 1780 in order not to cause major disruption to the town of Riggins. The gross capacity at this elevation would be 285,000 acre-feet and with a 10-foot drawdown, 24,000 acre-feet of pondage would be available for stream regulation and power operation. The surface area of the reservoir at maximum pool level would be 2,900 acres. The dam is planned as a concrete-gravity type of structure with a maximum height of 300 feet from foundation to crest and a crest length at elevation 1793 of 650 feet.

Round Valley Project.

The Round Valley damsite is located on Little Salmon River at mile 25, about 12 miles north of New Meadows. Preliminary studies show that about 230,000 acre-feet of storage could be developed at this site. This amount of storage would require a dam 140 feet high, measured from low water to normal pool. The reservoir formed by a dam of this height would have a maximum surface area of about 4,400 acres. A storage of 230,000 acre-feet could provide complete regulation of the runoff from the drainage area above the Round Valley site. This storage would be available with 100 percent drawdown of the pool.

Crevice Project.

The Crevice damsite is located on Salmon River at mile 99.7, about 13 miles upstream from Riggins. A project at this location was described in House Document 531 and this is the uppermost site on Salmon River which was investigated for House Document 403. The site is one of the most outstanding in Salmon Basin. The reservoir proposed in House Document 531 would extend upstream 49 miles to the tailwater at the Growler Rapids damsite, and to the Raines damsite on South Fork Salmon River. The total storage at normal pool elevation 2355 would be 1,480,000 acre-feet and the reservoir surface area at this elevation would be 8,000 acres. Based on a drawdown of about 179 feet, usable storage for flood control and power generation would be 1,030,000 acre-feet. The dam would be a straight, gravity type, concrete, non-overflow section, about 620 feet in maximum height from foundation to top of roadway, and would have a crest length of approximately 1,100 feet.

A considerably larger project at the Crevice site, which would inundate the Growler Rapids site, was proposed in House Document 403. The normal and maximum pool elevation was raised to 2570 and at this level the reservoir would extend about 65 miles up Salmon River and about 10 miles up South Fork Salmon River. The gross storage capacity of the reservoir at elevation 2570 would be 3,980,000 acre-feet and the surface area would be 16,000 acres. Usable storage for flood control and power would be 2,300,000 acre-feet with a drawdown of 212 feet to pool elevation 2358. The dam would be a rockfill type of structure with an effective height of 725 feet and a maximum height of approximately 780 feet from foundation to crest elevation 2580. The crest length of the dam would be 1,800 feet.

Rattlesnake Project.

The Rattlesnake damsite is located on South Fork Salmon River at mile 12.4, immediately downstream from the mouth of Rattlesnake Creek. The dam considered for the Rattlesnake site would be about 446 feet in height, measured from low water to normal pool. The reservoir formed by a dam of this height would have a maximum surface area of 1,550 acres and a total storage capacity of 285,000 acre-feet at normal pool elevation 3100. Operation of Rattlesnake Reservoir for stream-flow regulation alone would permit utilization of the entire available storage. The regulation thus made possible would increase prime power at downstream plants and would result in system power benefits in excess of those that would accrue from incremental power generations at the Rattlesnake site. For this reason, development considered for the site would be for storage alone.

Long Gulch Project.

The Long Gulch damsite is located on Secesh River about 18.6 miles upstream from the confluence with South Fork Salmon River. The dam considered for the Long Gulch site would be about 236 feet in maximum height. The reservoir thus impounded would have a surface area of 1,970 acres and a total capacity of about 183,000 acre-feet. Usable storage, based on a drawdown of about 59 feet, would be about 91,000 acre-feet.

Growler Rapids Project.

The Growler Rapids damsite is located on Salmon River near river mile 149, about 15 miles above the confluence with South Fork Salmon River. Compared with sites in other reaches of the river, this site is not outstanding. The dam would be a concrete structure about 305 feet in height measured from low water to normal pool. The reservoir formed by a dam of this height would have a maximum surface area of 4,500 acres and a total storage capacity of 425,000 acre-feet at normal pool elevation 2660. The reservoir would extend upstream a distance of 21 miles to the Black Canyon damsite. The usable storage at the site, based on a drawdown of about 96 feet, would be 300,000 acre-feet.

Black Canyon Project.

The Black Canyon damsite is located on Salmon River at mile 170. In all characteristics the site appears to be one of the most outstanding on Salmon River. The dam considered for this site would be a concrete structure about 332 feet in height measured from low water to normal pool. The reservoir formed by a dam of this height would have a maximum surface area of 6,500 acres and a total storage capacity of 600,000 acre-feet at normal pool elevation 2992. The reservoir would extend upstream a distance of 27 miles to the Pinnacle Peak damsite. The usable storage at the site, based on a drawdown of about 97 feet, would be 425,000 acre-feet.

Pinnacle Peak Project.

The Pinnacle Peak damsite is located on Salmon River at mile 197.1, about 2 miles downstream from the mouth of Middle Fork Salmon River. The dam considered would be a concrete structure 376 feet high from low water to normal pool. The reservoir formed by a dam of this height would have a maximum surface area of 5,200 acres, and a total storage capacity of 790,000 acre-feet at normal pool elevation 3368. The reservoir would extend up the main stem a distance of 27 miles to a point 6 miles downstream from the Indianola damsite and 17 miles up Middle Fork Salmon River. The usable storage at the site, based on a drawdown of about 119 feet would be 445,000 acre-feet.

Indianola Project.

The Indianola damsite is located on Salmon River at mile 230.8, about 7 miles downstream from the mouth of North Fork Salmon River. Located near the head of the Salmon River canyon, this site presents a good opportunity for effectively regulating flows on Salmon River. The dam would have a height of about 248 feet from low water to normal pool elevation 3750. The reservoir formed by a structure of this height would have a maximum surface area of about 4,500 acres, and a total storage capacity of 365,000 acre-feet. The reservoir would extend upstream a distance of about 18 miles. Based on a drawdown of 87 feet, the usable storage at the site would be 265,000 acre-feet. The physical features of the Indianola site would permit construction of a dam 150 feet higher than that considered.

Texas Creek Project.

The U.S. Bureau of Reclamation has studied the construction of several small reservoirs in the upper part of Lemhi River Basin. One of the sites is on Texas Creek about 6 miles south of Leadore. The dam considered by the Bureau would create a reservoir with a storage capacity of about 19,000 acre-feet. The site is suitable for an earthfill structure.

Pahsimeroi Project.

The Pahsimeroi or Cronks Canyon damsite is located on Salmon River at mile 301.5, about 3 miles below the mouth of Pahsimeroi River. The geological features at this site are very favorable for construction of a high dam. The dam considered would be a concrete gravity structure about 297 feet high from low water to normal pool elevation 4890. The reservoir formed by this structure would have a maximum surface area of about 14,000 acres and a total storage capacity of 1,500,000 acre-feet. The reservoir would extend upstream a distance of 22 miles on Salmon River and a distance of 7 miles on Pahsimeroi River. Almost complete regulation of the runoff from the drainage area above the damsite would be accomplished by the reservoir storage dapacity. Based on a drawdown of 104 feet, the usable storage would be 1,042,000 acre-feet.

Challis Creek Project.

The U.S. Bureau of Reclamation has considered the construction of a storage dam on Challis Creek about 6 miles upstream from Salmon River. The dam would create a reservoir with a capacity of 10,600 acre-feet.

Costs and benefits of flood control projects.

Table 11 shows annual costs and benefits of potential flood-control storage projects in Salmon Basin. Recent cost-benefit analyses were available on only a few of the projects shown. Volume 1 of House Document 403, particularly Table 49 and descriptions of potential projects, was used as a guide in estimating the project annual costs and allocations to flood-control. Benefits to Salmon Basin are based on the fact that storage projects below North Fork would have negligible flood control benefit to the basin with the exception of the Round Valley project on Little Salmon River. Basin benefits were computed on the basis of total average annual damages of $65,000 as shown in the chapter on flood damages. Benefits to lower Columbia River are based on 11 cents per acre-foot of storage as indicated in the chapter on flood control needs for lower Columbia River. All cost and benefit values have been adjusted to 1970 prices.

Table 11. Annual costs and benefits of potential flood-control storage projects in Salmon Basin. Cost and benefit values based on 1970 prices.

Project	Stream	River mile	Flood control storage (acre-feet)	Approximate annual cost of storage		Approximate annual flood control benefits to:	
				Total	Allocation to flood control	Salmon Basin	Lower Columbia River
Lower Canyon	Salmon River	0.5	2,500,000	$13,000,000	$3,100,000	N[1]	$275,000
Freedom	Salmon River	69.3	24,000	200,000	30,000	N	2,600
Round Valley	Little Salmon River	25.0	230,000	1,600,000	320,000	$10,000	25,000
Crevice	Salmon River	99.7	1,030,000	6,000,000	1,400,000	N	113,000
Crevice (alter.)	Salmon River	99.7	2,300,000	12,000,000	2,900,000	N	253,000
Rattlesnake	So. Fk. Salmon River	12.4	285,000	1,900,000	390,000	N	31,000
Long Gulch	Secesh River	18.6	91,000	700,000	120,000	N	10,000
Growler Rapids	Salmon River	149.0	300,000	2,000,000	410,000	N	33,000
Black Canyon	Salmon River	170.0	425,000	2,800,000	580,000	N	47,000
Pinnacle Peak	Salmon River	197.1	445,000	2,900,000	600,000	N	49,000
Indianola	Salmon River	230.8	265,000	1,800,000	360,000	N	29,000
Texas Creek	Lemhi River		19,000	150,000	20,000	1,000	2,100
Pahsimeroi	Salmon River	301.5	1,042,000	6,000,000	1,400,000	44,000	115,000
Challis Creek	Challis Creek		10,600	100,000	10,000	500	1,200
Totals[2]			7,636,600	$43,150,000	$9,830,000	$55,500	$839,900

[1] N = Negligible

[2] Totals include alternate plan for Crevice project and do not include Growler Rapids project (see Figure 15).

IMPACT OF POTENTIAL FLOOD CONTROL FACILITIES ON WILD AND SCENIC RIVERS CONCEPT FOR SALMON RIVER

Flood control facilities constructed in Salmon Basin would fall under two categories, namely, those which would be of primary benefit to the lower Columbia River and those which would be of primary benefit to Salmon Basin. Storage projects would be beneficial to both categories, but channel and levee works and non-structural measures would principally benefit Salmon Basin.

Flood control projects of primary benefit to lower Columbia River.

While any storage project in Salmon Basin would be beneficial to flood control on the lower Columbia River, primary benefits would result from construction of the larger projects listed in Table 10 for the portion of the basin below North Fork. Table 9 shows that projects constructed and presently under construction in the United States will provide storage adequate to meet the initial goal of regulating the 1894 flood to 800,000 cfs at The Dalles. Assuming that Canadian Treaty storage projects are constructed on schedule, the 1894 flood should be controlled to 700,000 cfs by 1985. Neither of these conditions involves storage in Salmon Basin, although Salmon River contributes on the average about 10 percent of the flood volume at The Dalles.

In order to attain the future goal of regulating flows at The Dalles to 600,000 cfs, additional storage amounting to 6,740,000 acre-feet will be required in Columbia River Basin. If most of the potential projects listed in Table 9 are retained for consideration toward attaining the goal of 600,000 cfs, and the on-call Canadian storage proves to be a significant amount, it is possible that storage in Salmon Basin would not be required. However, if on-call Canadian storage proves to be small in magnitude, and if some of the potential projects listed in Table 9 are eliminated for one reason or another, it may be necessary to consider, in addition to Lower Canyon, some of the other potential storage sites listed in Table 10 to attain the 600,000 cfs objective. It should be emphasized that all of these have been studied as multipurpose projects. While some benefit would accrue to flood control, under present conditions, the greatest benefit from these projects would come from power production.

There is no way of predicting which, if any, of the potential Salmon Basin storage projects would be constructed for future flood control. More than likely, future projects would be constructed primarily for power production and any benefits to flood control would be incidental. In view of these considerations, brief descriptions of the effect on Salmon River of all of the potential projects listed in Table 10 on Salmon River downstream from North

Fork are given below. In addition to inundation of land and improvements upstream from the dam, the construction of any of these projects would, of course, cause changes in the regime of the stream including reductions in peak discharges, increases in low water flows, and changes of temperature of the water in the reservoir area and in the stream below the dam.

Lower Canyon Project. Although the surface area of the reservoir site at maximum pool elevation 1575 is 17,150 acres, the estimated requirements for flowage are 18,500 acres based on a 5-foot freeboard and 20 percent allowance for blocked taking lines, reservoir access, and recreation areas. Most of the lands subject to inundation lie in the deep and rugged canyon of lower Salmon River and are inaccessible by ordinary means of transportation. However, about 13 miles of U.S. Highway 95 and 8 miles of county roads in the upstream portion of the reservoir area would require relocation. Relocation of the U.S. Forest Service facilities at Slate Creek would be required.

No national forest land would be inundated by the project, but the Forest Service considers that construction of the project would have an important impact on administration activities of the Service and on timber use and access to a large area. The proposed relocation of roads and administrative facilities of the Forest Service would minimize adverse effects.

The reach of the river that would be inundated by the Lower Canyon project does not contain significant spawning areas. However, it would intercept all anadromous fish migrating into the Salmon River. Some big game inhabit the reservoir and adjacent areas, but the nature of the topography is not conducive to heavy concentrations. The gravel bars and shoal areas of the natural stream are utilized by waterfowl.

Freedom Project. The lands that would be inundated by Freedom reservoir are primarily used for grazing. Improvements within the area affected by the project consist of some ranch developments and a limited number of commercial and residential structures. Approximately 17 miles of U.S. Highway 95, 10 miles of county roads and 3 miles of Forest Service roads would require relocation. Although almost no national forest land would be inundated by the reservoir, access to forest lands would be affected by the flooding of roads.

Salmon River in this reach is utilized by anadromous fish as a migratory route to and from their spawning areas farther upstream. Based on limited information, it is believed that little spawning takes place in the reservoir area. A few big game animals inhabit the area.

Crevice Project. As proposed in House Document 403, the Crevice reservoir would extend upstream about 65 miles. The surface area at maximum pool would be 16,000 acres, all of which is within the Nez Perce and Payette National Forest boundaries. The portion of the reservoir from river mile 138 upstream lies within the Selway-Bitterroot Wilderness Area and the Idaho Wilderness Area. At maximum pool elevation 2570, the reservoir would extend 27 miles into these areas and would inundate 4,000 acres. The north shore of the reservoir, from mile 153 upstream would lie within the boundary of the Salmon River Game Preserve. Reduction in the height of the Crevice dam by 356 feet to approximately pool elevation 2214, in order to avoid any encroachment upon the wilderness area, would result in major reductions in benefits without proportional reduction in costs.

Lands subject to inundation lie in a deep and rugged canyon with only the downstream 10 miles accessible by road. Present use is for grazing and hay production to the extent possible on the steep rocky slopes. Small irrigated tracts along the river are used primarily for raising winter feed for livestock. Improvements within the reservoir area consist of two sets of farm headquarters, one combination lodge and store, and numerous miners' and hunters' cabins. The reservoir also would inundate sections of Forest Service trails, roads, and telephone lines which would have to be relocated.

The Crevice project would intercept all anadromous fish migrating into Salmon Basin except for the limited number that utilize Little Salmon River. The limited information available indicates that very little spawning takes place within the project area, but detailed studies are needed to determine more definitely the spawning areas of the entire lower reach of Salmon River.

The valley throughout the project area is used to some extent by wildlife, especially elk and deer, during the winter months. Further studies are needed to determine the impact of the project on the wildlife resources. One likely problem would be the impediment that the reservoir would present to cross-river migration by game animals.

Growler Rapids Project. This project would inundate about 4,500 acres of land nearly all of which is within the Nez Perce and Payette National Forests. One ranch, some mining property, several cabins, and a trail along Salmon River are within the flowage area. The project occupies a steep, rugged canyon in a remote portion of central Idaho and its construction should have little effect on administrative policies of the Forest Service. All of the project lies within the Selway-Bitterroot Wilderness Area and the Idaho Wilderness Area. The north shore of the reservoir, from mile 153 upstream, would be within the Salmon River Game Preserve. Anadromous fish use this portion of the Salmon River as part of their route to upstream spawning areas.

Some big game animals inhabit the area, especially in the winter season.

Black Canyon Project. The reservoir behind Black Canyon Dam would have a surface area of 6,500 acres all of which would fall within the boundaries of the Bitterroot, Payette, and Salmon National Forests. A large part of the reservoir would occupy an extremely rugged canyon with relatively no improvements. In the upper part of the reservoir a few buildings, some trails, about 6 miles of low-class Forest Service road, and a small amount of grazing land would be flooded. The south shore of the reservoir would lie within the Idaho Wilderness Area. The north shore, up to mile 173, would lie in the Salmon River Game Preserve and, up to mile 187, within the Selway-Bitterroot Wilderness Area. The remoteness of the project would cause little disruption to Forest Service administration practices. This portion of the Salmon River is used by anadromous fish in their journey to spawning areas. The limited information available indicates that little spawning takes place within the project area. Parts of the project area are used by wildlife, mostly for winter grazing.

Pinnacle Peak Project. This project would flood about 5,200 acres of land, nearly all of which is within the Salmon National Forest. The project occupies a remote section of Idaho, but its construction might somewhat effect administrative policies of the Forest Service in that access to timber harvesting areas would be affected by the flooding of roads. About 20 miles of medium-class and 6 miles of low-class Forest Service roads would be inundated. In addition, a small number of buildings scattered up and down the river, several bridges, and some grazing land are within the reservoir flowage. Anadromous fish use the Salmon River in the project area as part of their migratory route to spawning areas upstream. Some big game animals inhabit the low lands within the project boundaries, especially for winter grazing.

Indianola Project. The reservoir behind Indianola dam would include approximately 4,500 acres, most of which is land within the Salmon National Forest and land administered by the U.S. Bureau of Land Management. The town of North Fork, several ranches, some mining property, a number of buildings in the flood plain, and utility lines would be flooded. About 12 miles of U.S. Highway 93 and 6 miles of Forest Service road would require relocation. Most of the land that would be flooded is used for grazing purposes. This portion of Salmon River is used by anadromous fish in their journey to upstream spawning areas. Parts of the project area are used by wildlife, mostly for winter feeding.

Flood control projects of primary benefit to Salmon Basin.

Most of the flood damages along Salmon River occur above the town of North Fork. Thus, for maximum flood control benefit to the basin, storage facilities should be constructed in the upper reaches of Salmon River and along the tributaries. Particularly vulnerable locations in the basin should be protected by additional channel and levee works, non-structural measures, and combinations of these protective measures. While the portion of Salmon River above North Fork is not under study for inclusion in the wild and scenic rivers system, extensive storage works in these reaches would affect flow patterns downstream from North Fork. Flood peaks would be reduced, low water flows would be increased, and water quality parameters such as temperature and turbidity would likely be altered. As a result, the flow in Salmon River below North Fork would be modified and the stream would no longer be a "wild" river.

Protection from floods in Salmon Basin above North Fork can be attained by construction of storage projects listed in Table 10 and by construction of channel and levee works in local trouble spots. Construction of the Pahsimeroi Project on Salmon River would contribute largely to fulfillment of the 1,300,000 acre-foot requirement for flood control protection for the reach of the river from Challis to North Fork. The Challis Creek Project plus channel and levee work at Challis should alleviate the danger of flood damages in that locality. The Texas Creek Project with perhaps some channel work on Lemhi River in the lower reach should result in the complete protection of the City of Salmon from flood damages. In addition to storage and channel works, establishment of flood plain zoning in the Challis and Salmon areas could further reduce the chances of flood damages.

To obtain complete flood control protection in Salmon Basin, the Round Valley Project should be constructed to prevent future flood damages along the lower reaches of Little Salmon River. The existing levee at White Bird should be raised and strengthened to protect White Bird from the ravages of White Bird Creek.

APPENDIX

Flood plain maps showing areas probably flooded by Salmon River in 1894 flood.

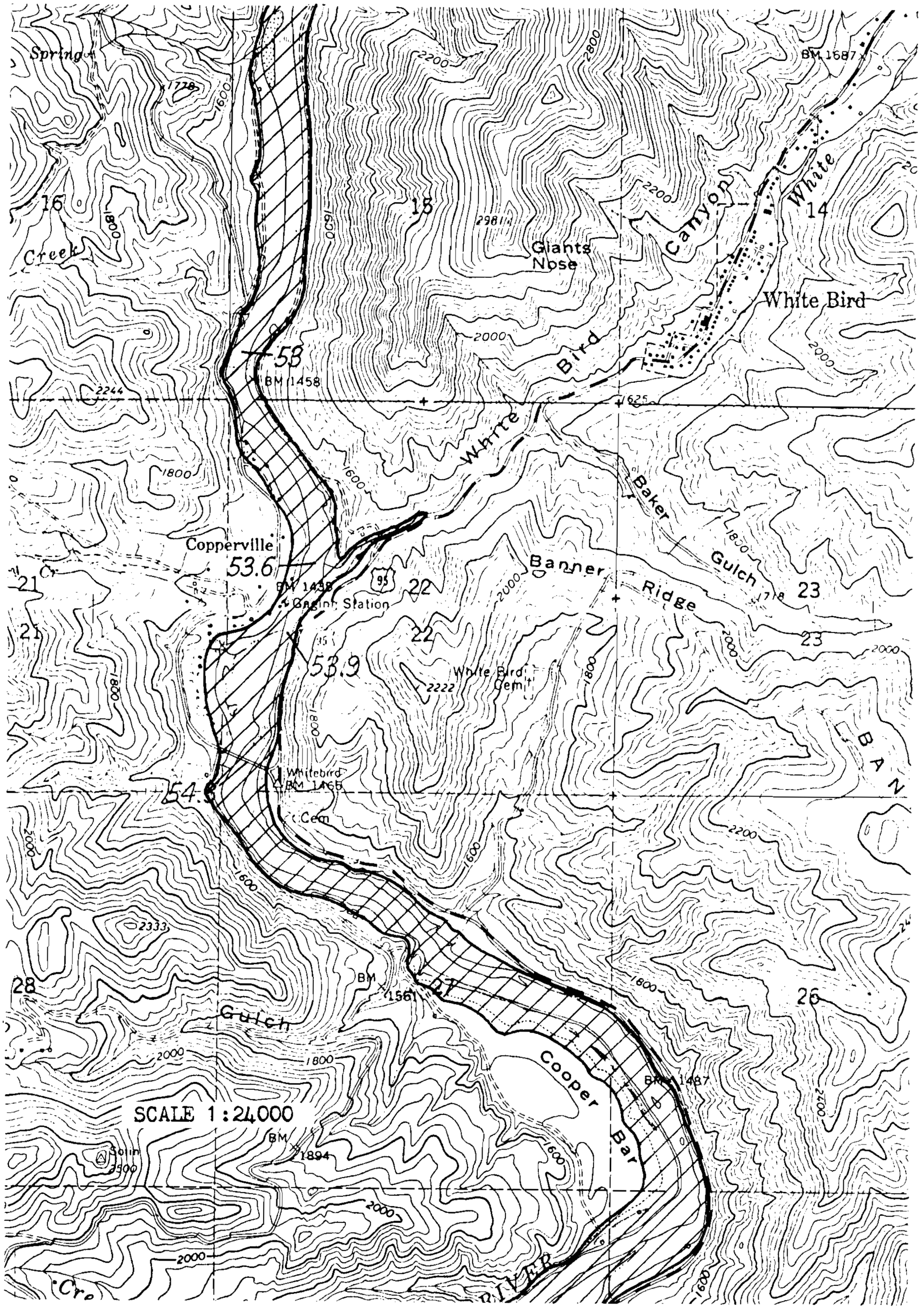

Figure 16. Areas near White Bird probably flooded by Salmon River in 1894 flood.

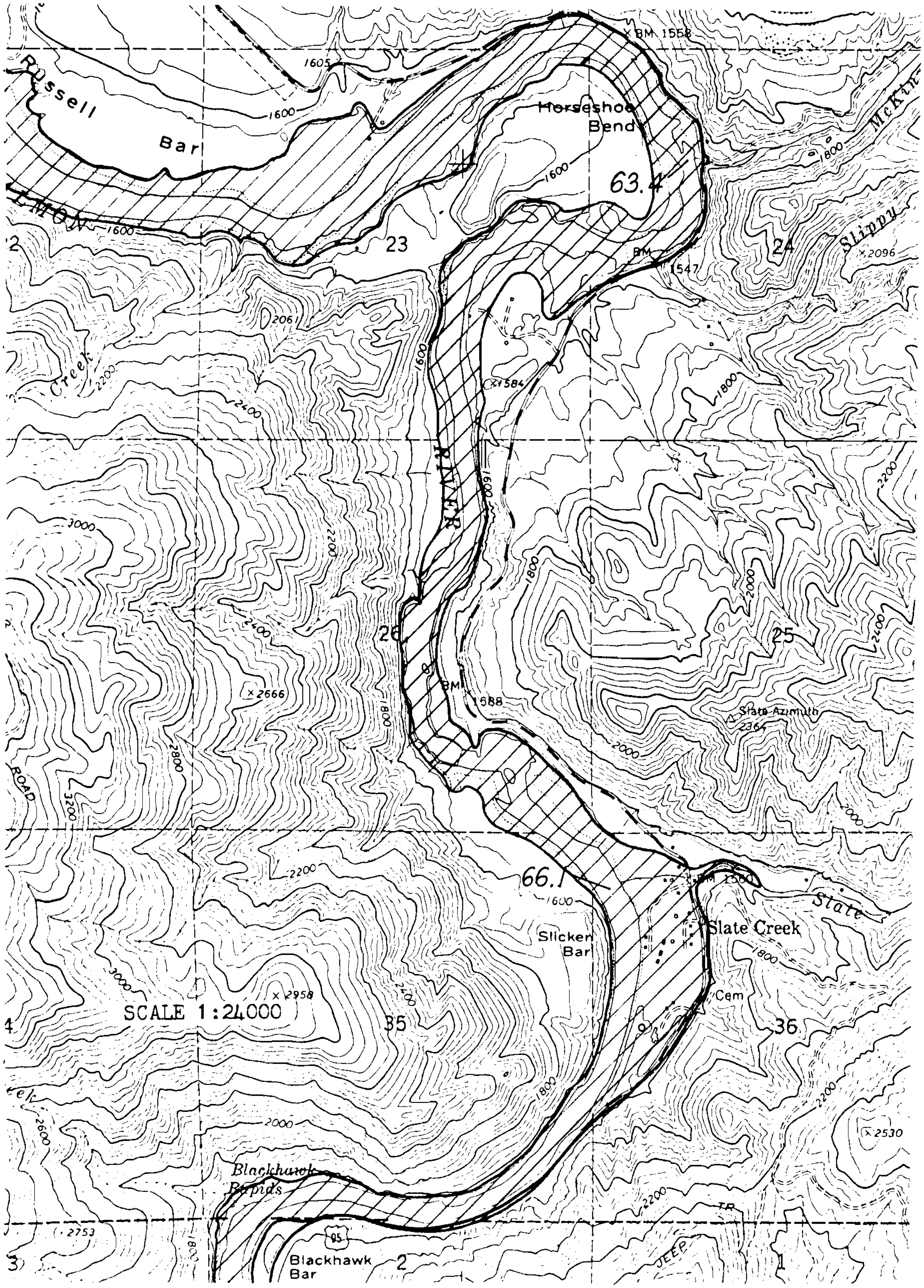

Figure 17. Areas near Slate Creek probably
flooded by Salmon River in 1894 flood.

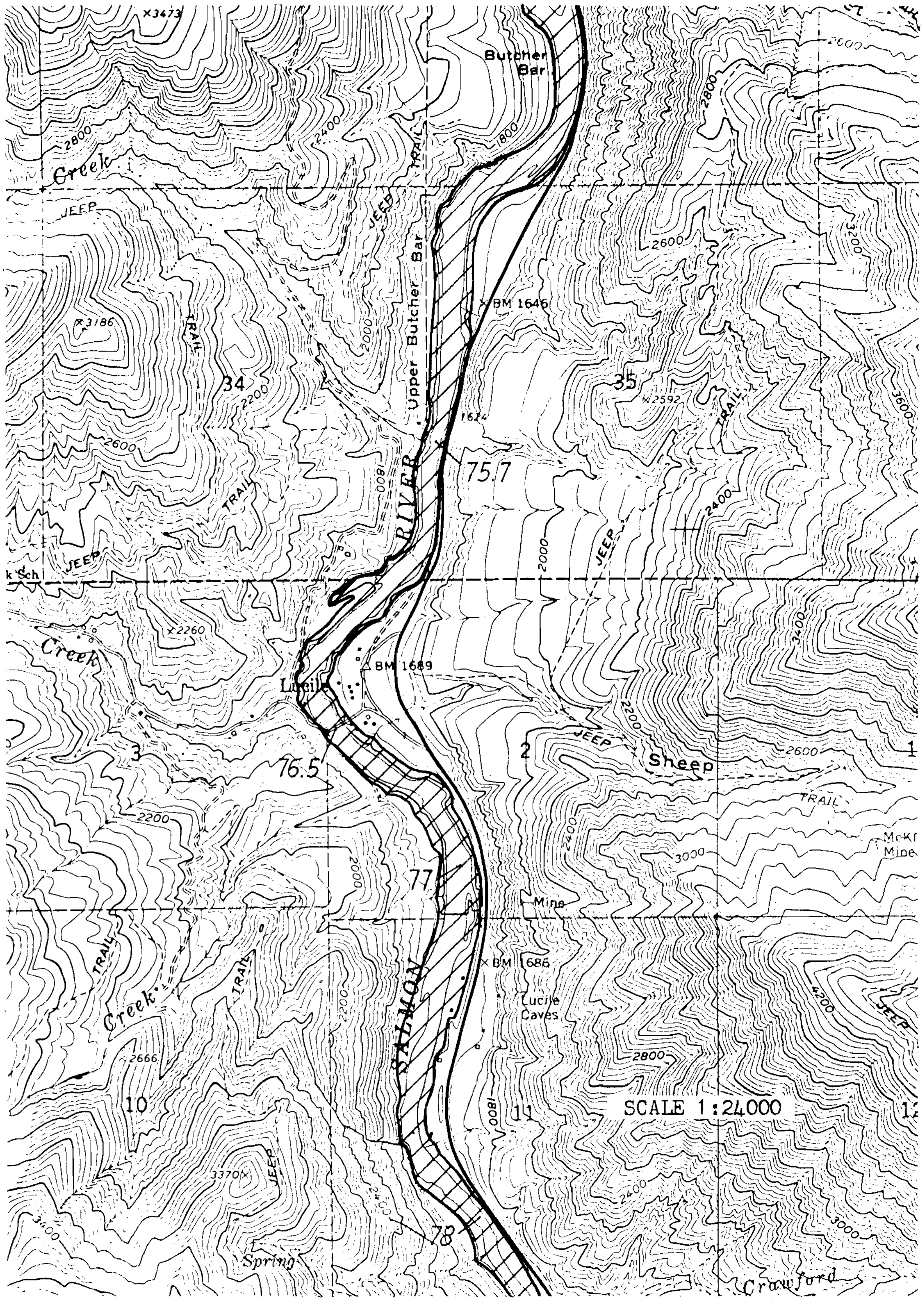

Figure 18. Areas near Lucile probably flooded by Salmon River in 1894 flood.

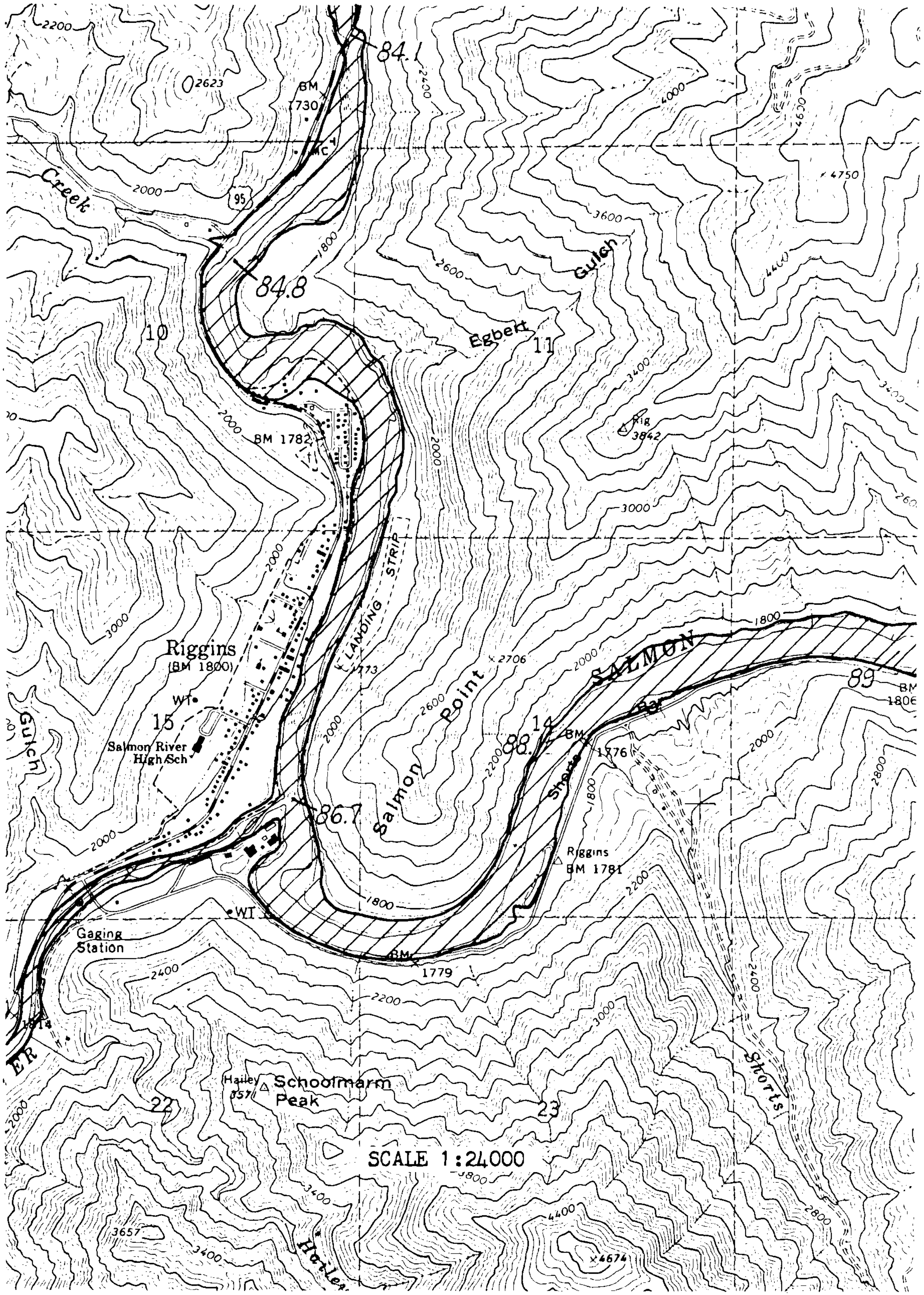

Figure 19. Areas near Riggins probably flooded by Salmon River in 1894 flood.

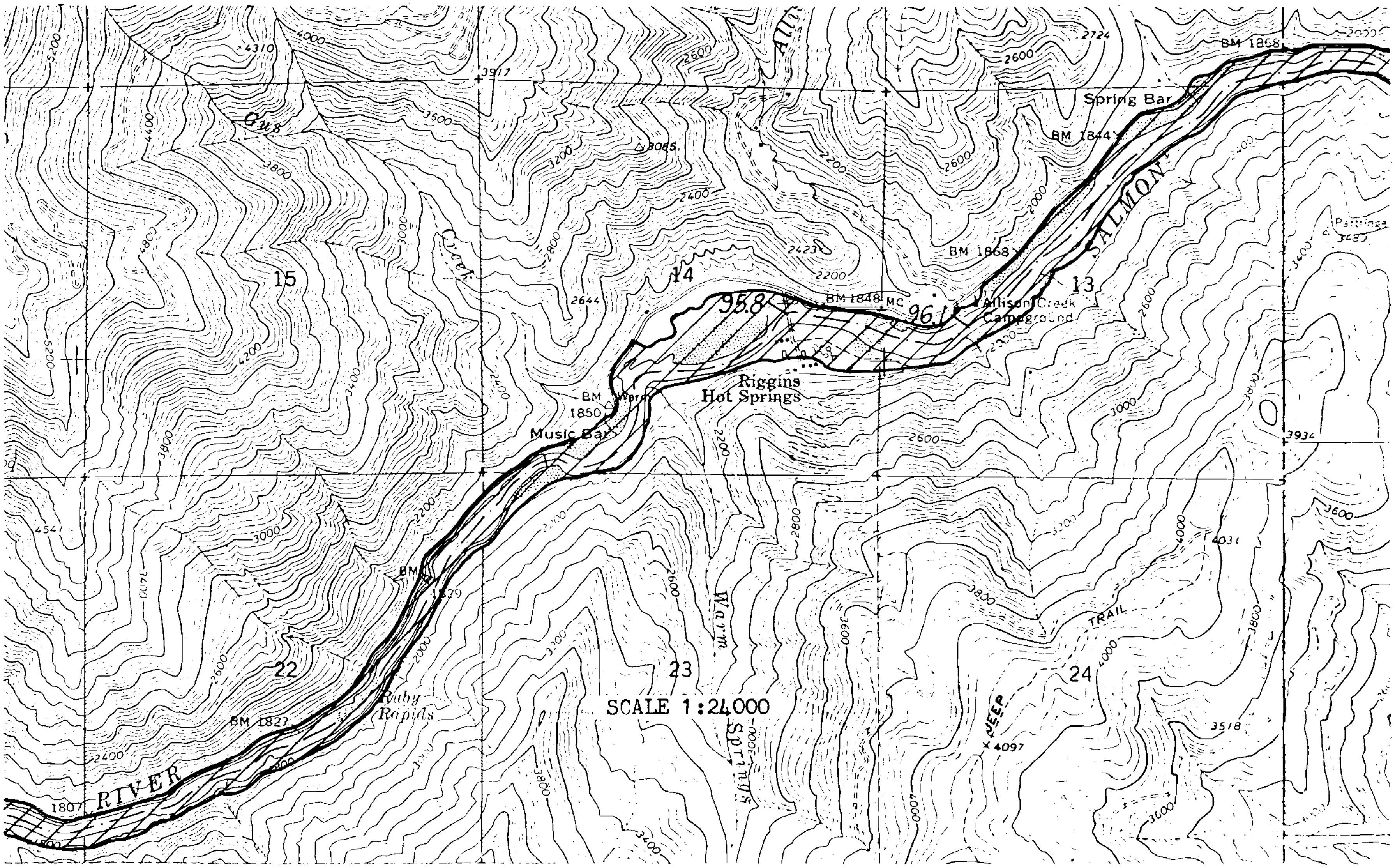

Figure 20. Areas near Riggins Hot Springs probably flooded by Salmon River in 1894 flood.

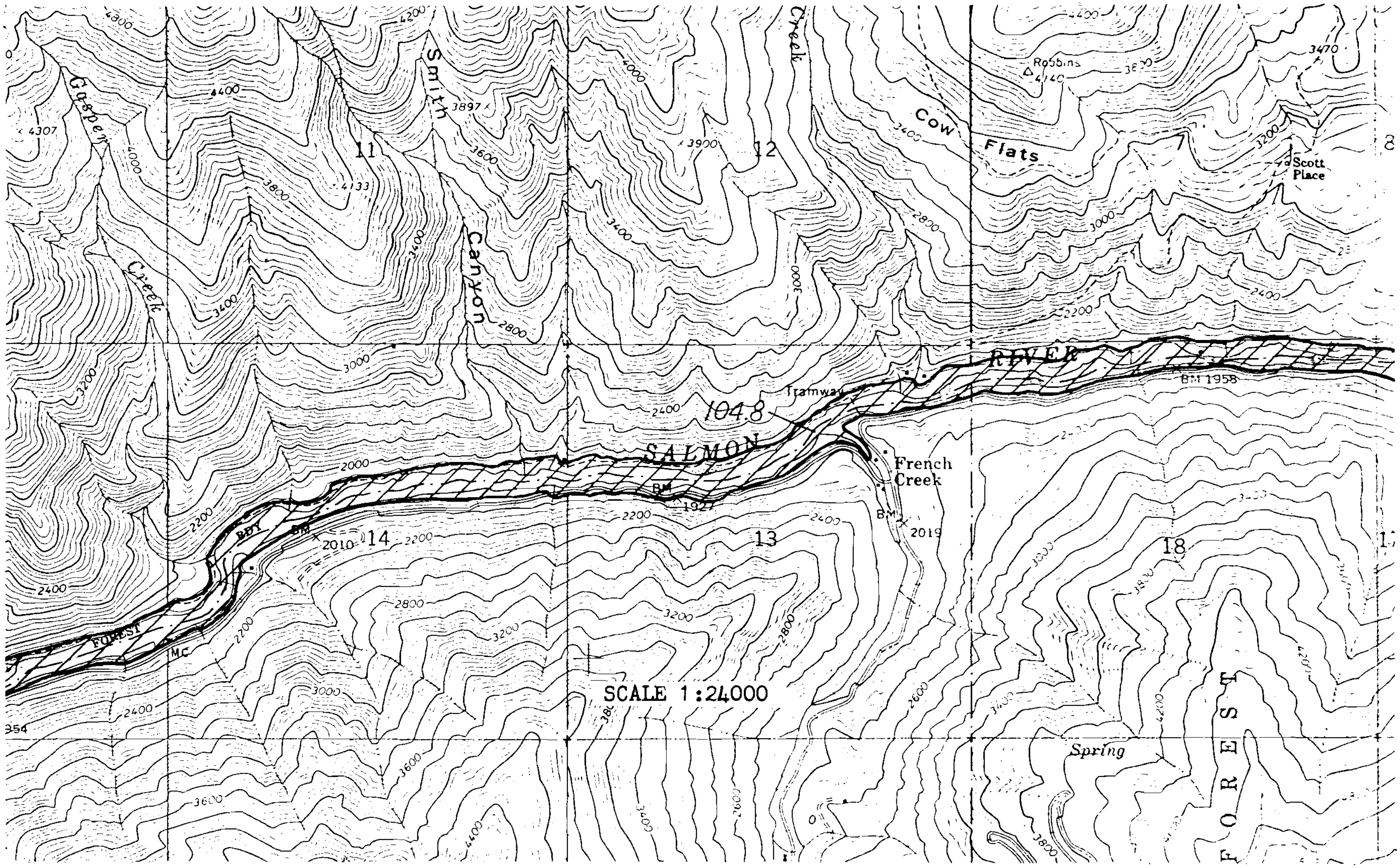

Figure 21. Areas near French Creek probably flooded by Salmon River in 1894 flood.

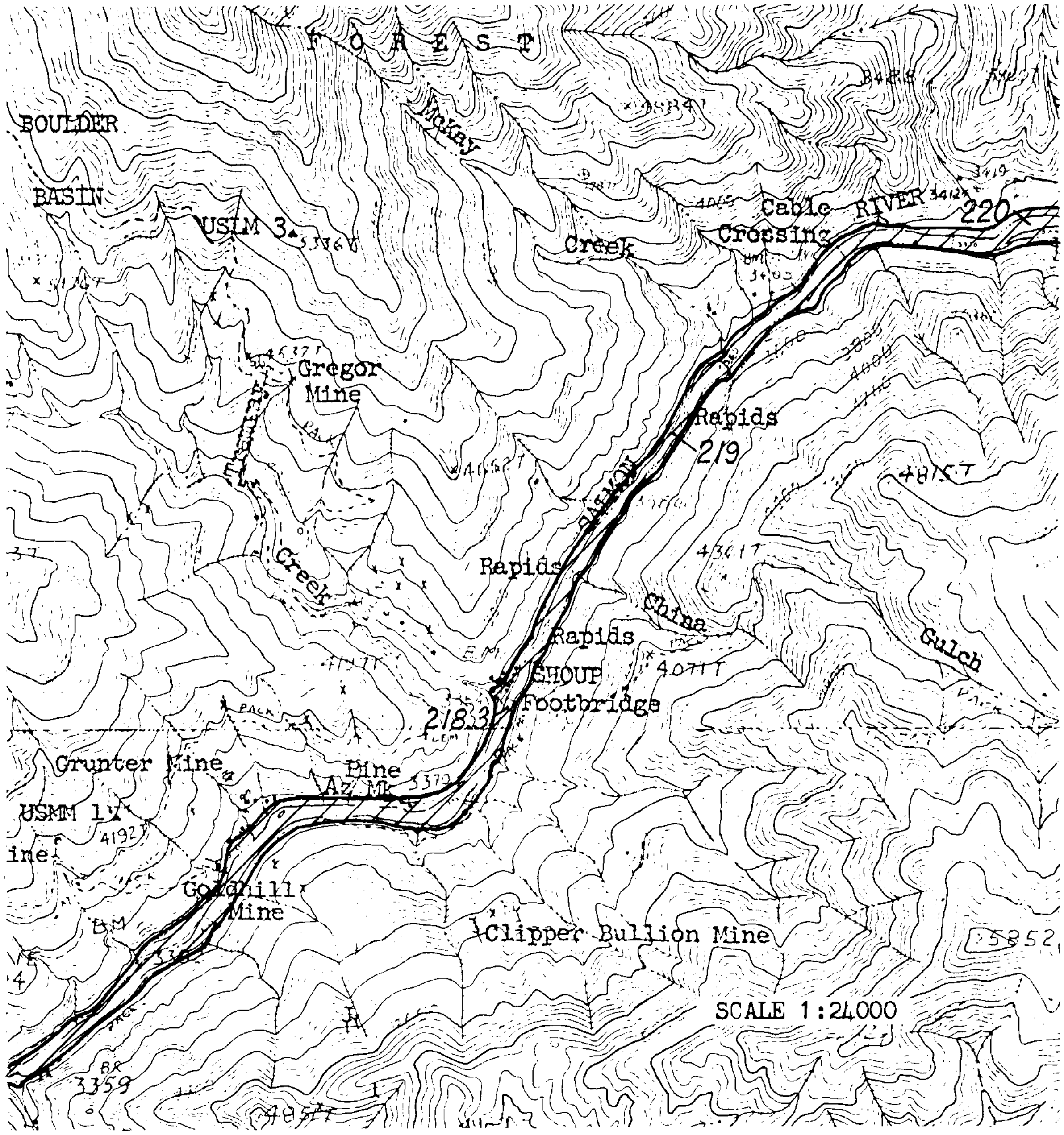

Figure 22. Areas near Shoup probably flooded by Salmon River in 1894 flood.

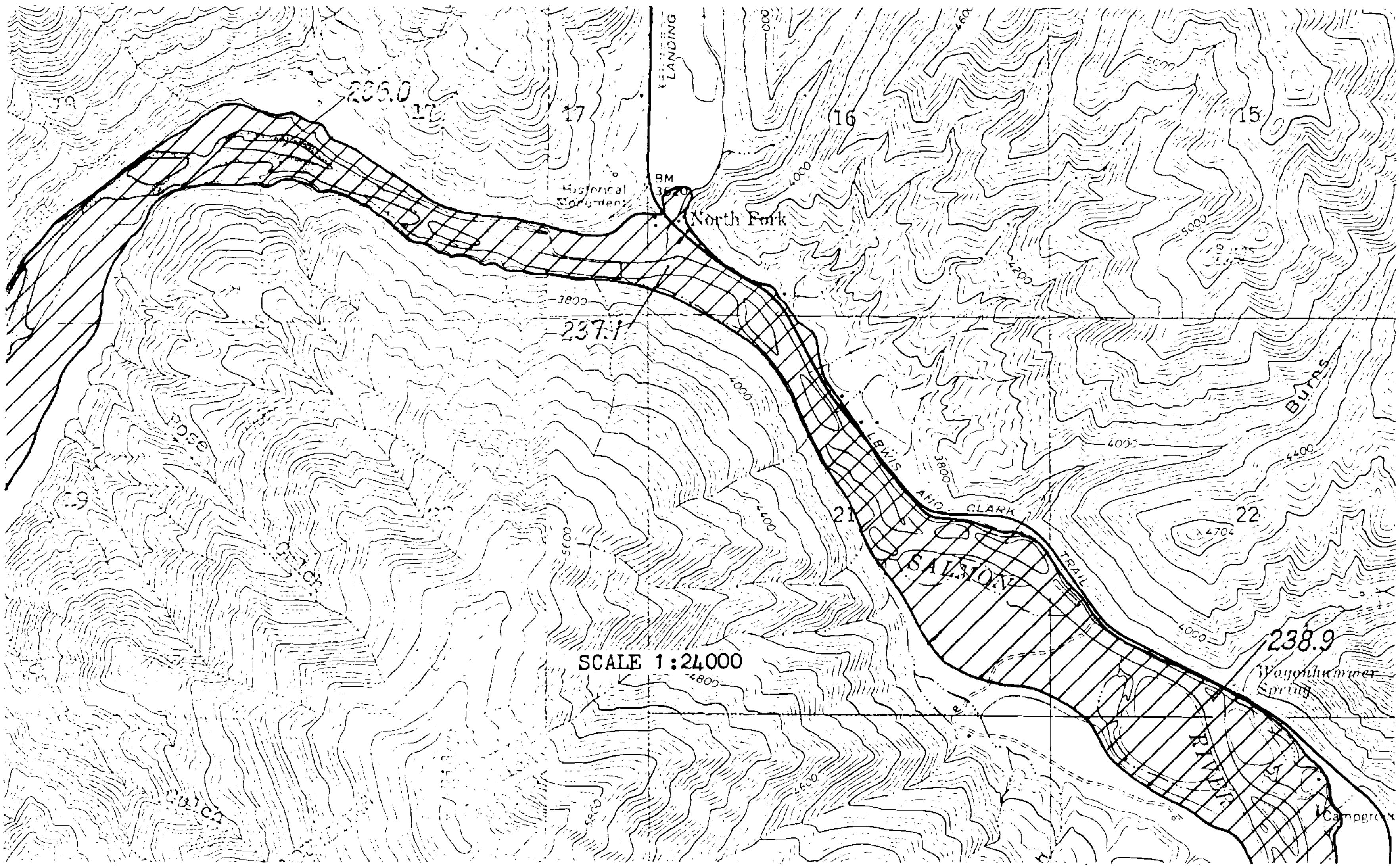

Figure 23. Areas near North Fork probably flooded by Salmon River in 1894 flood.

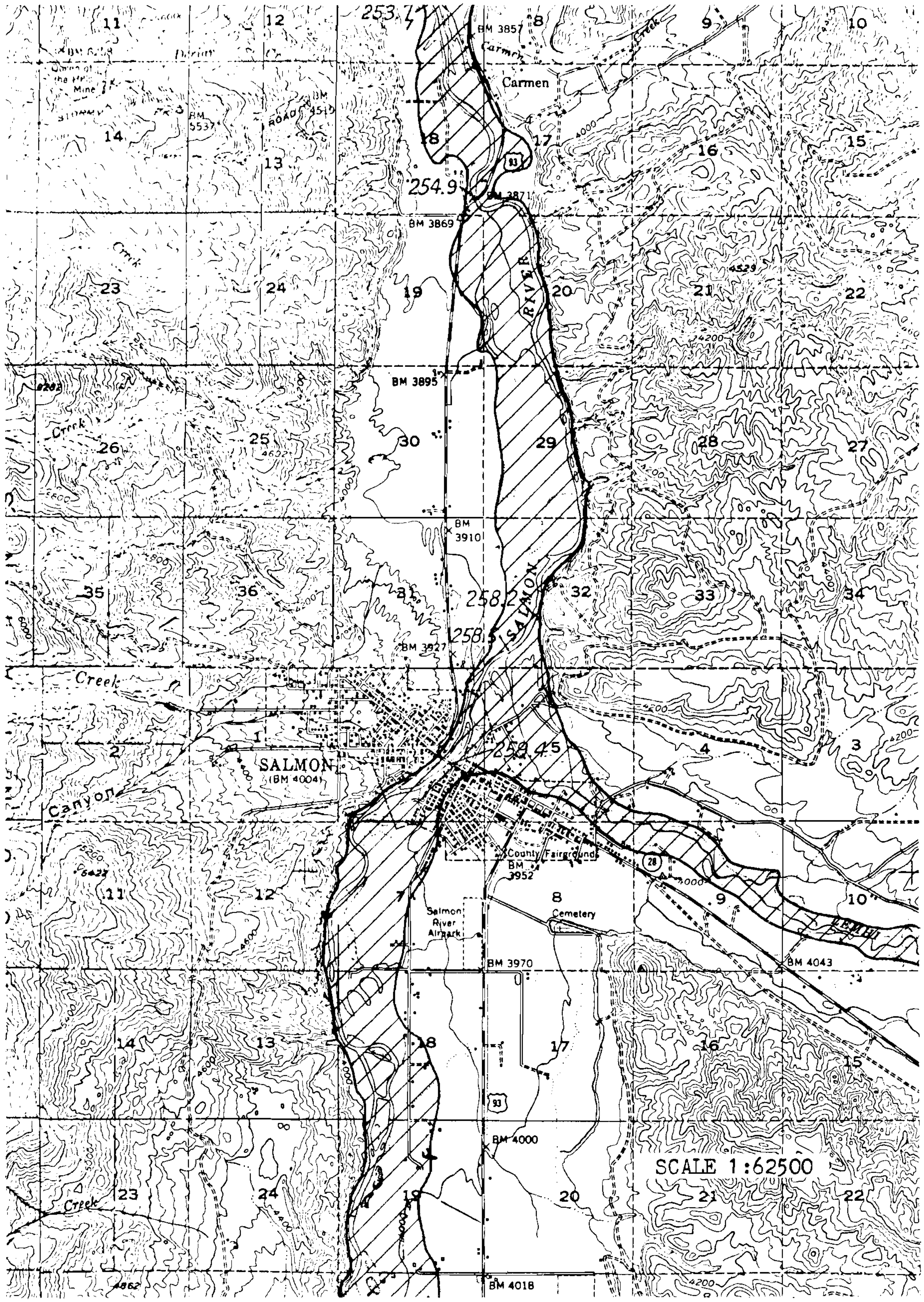

Figure 24. Areas near Salmon probably flooded by Salmon and Lemhi Rivers in 1894 flood.

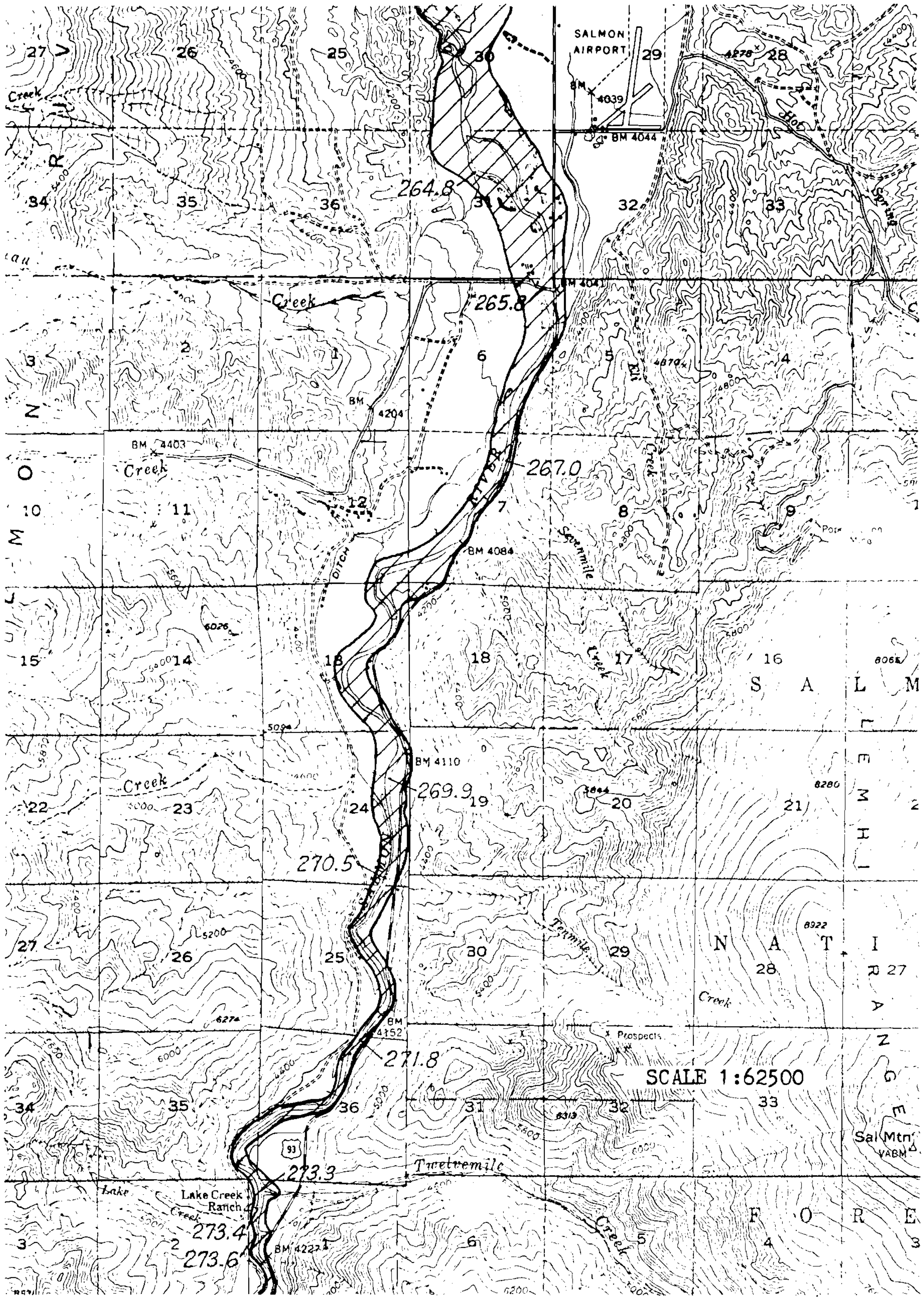

Figure 25. Areas south of Salmon probably flooded by Salmon River in 1894 flood.

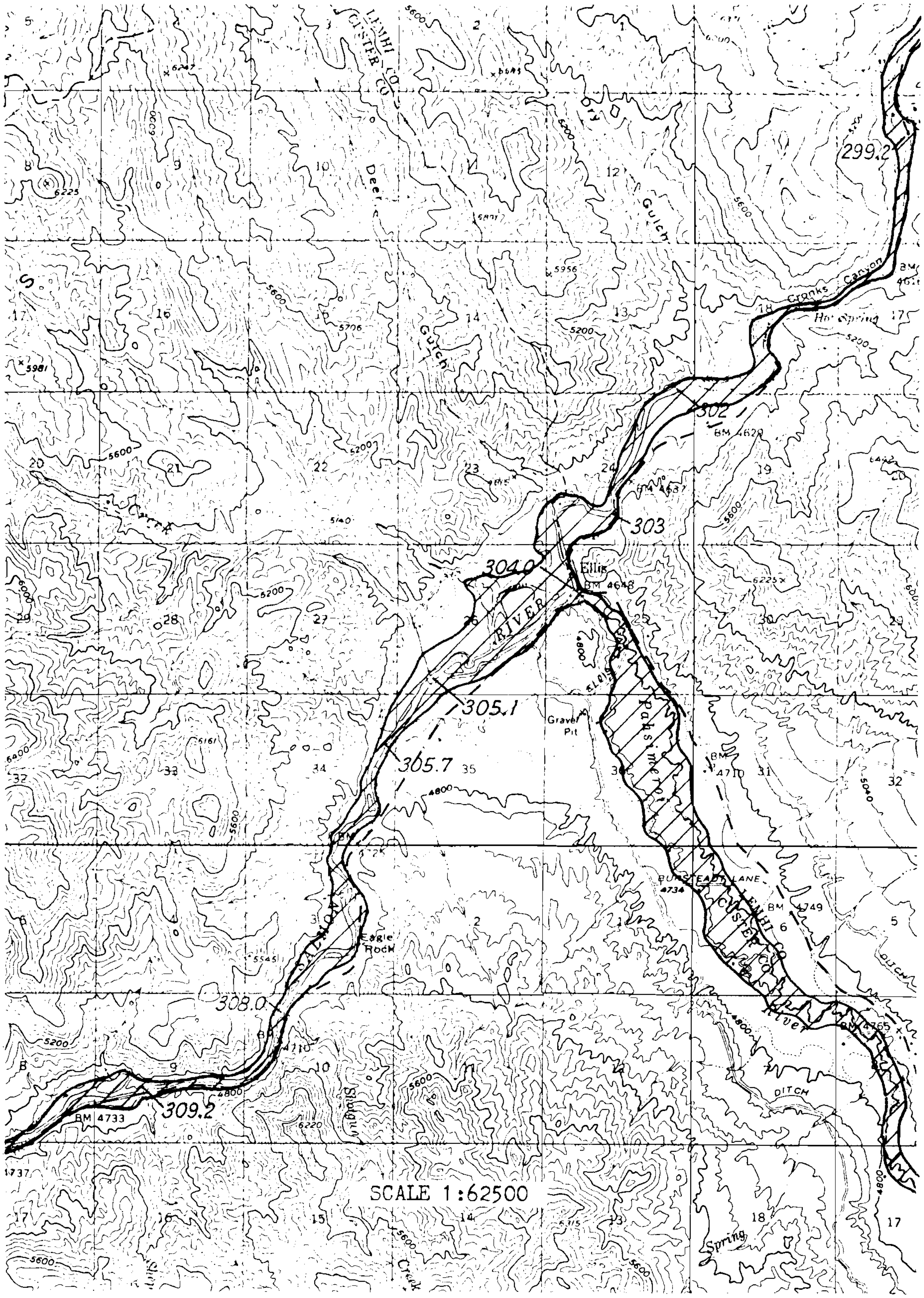

Figure 26. Areas near Ellis probably flooded by Salmon and Pahsimeroi Rivers in 1894 flood.

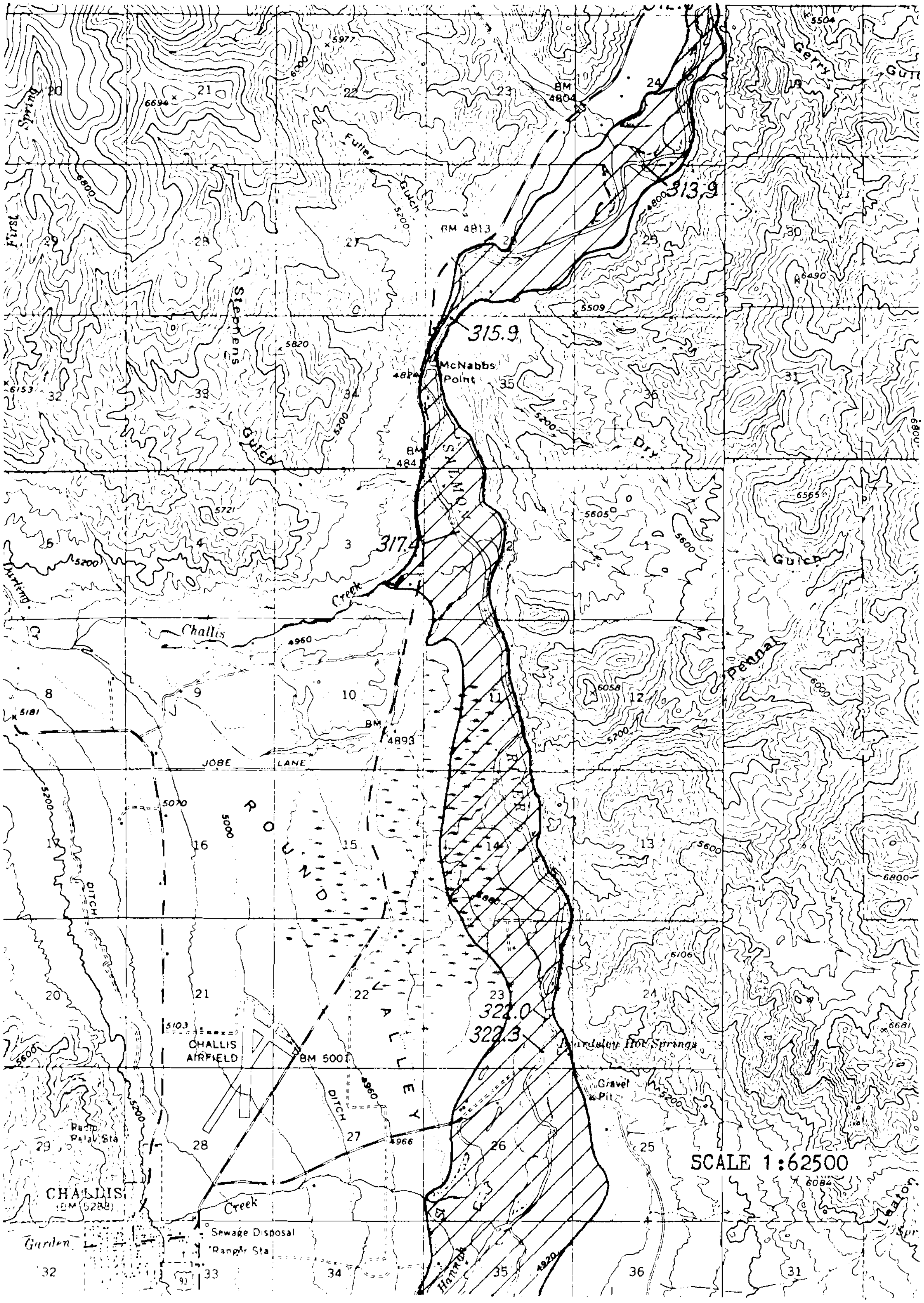

Figure 27. Areas north of Challis probably flooded by Salmon River in 1894 flood.

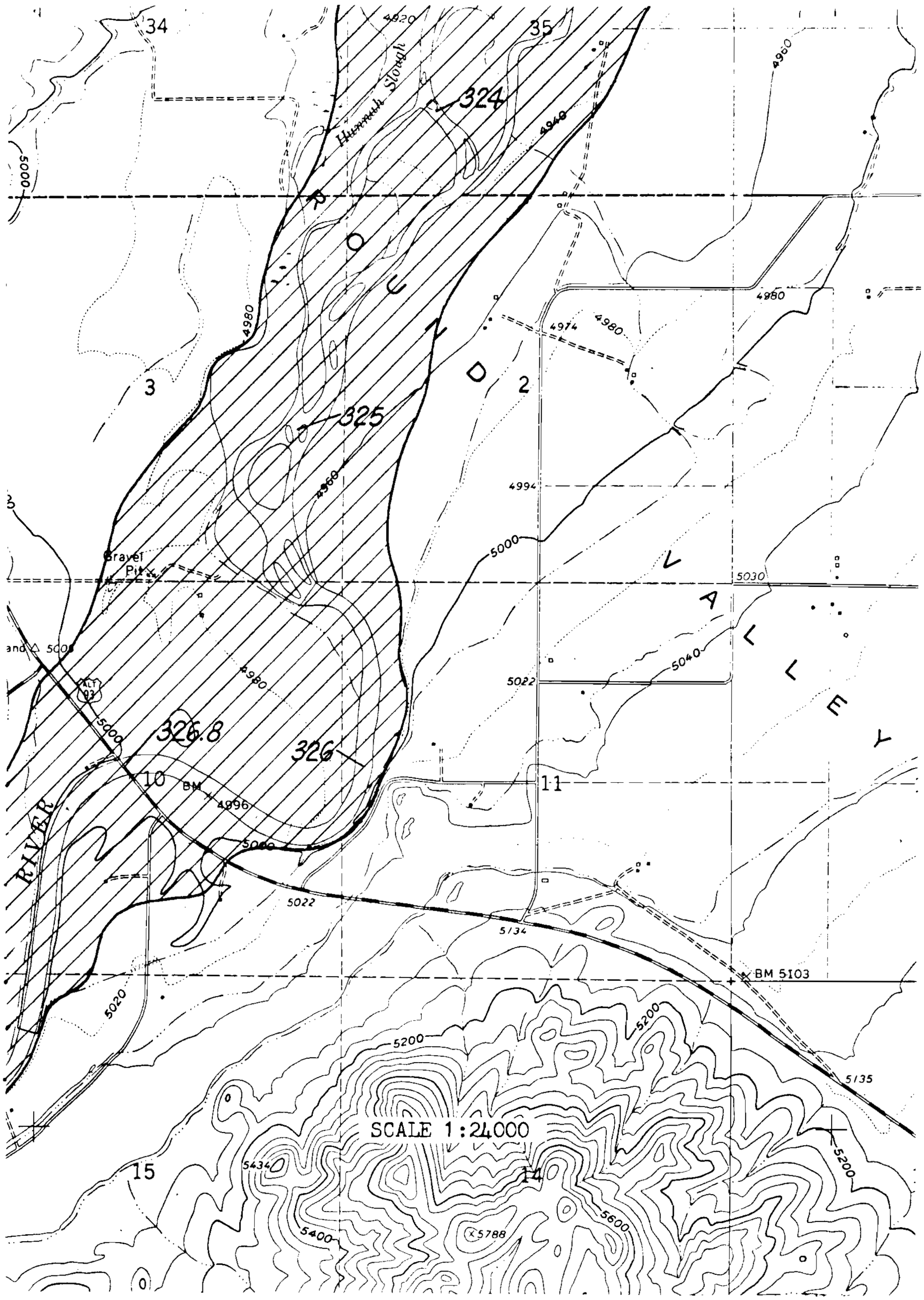

Figure 28. Areas south of Challis probably flooded by Salmon River in 1894 flood. Sheet 1 of 2.

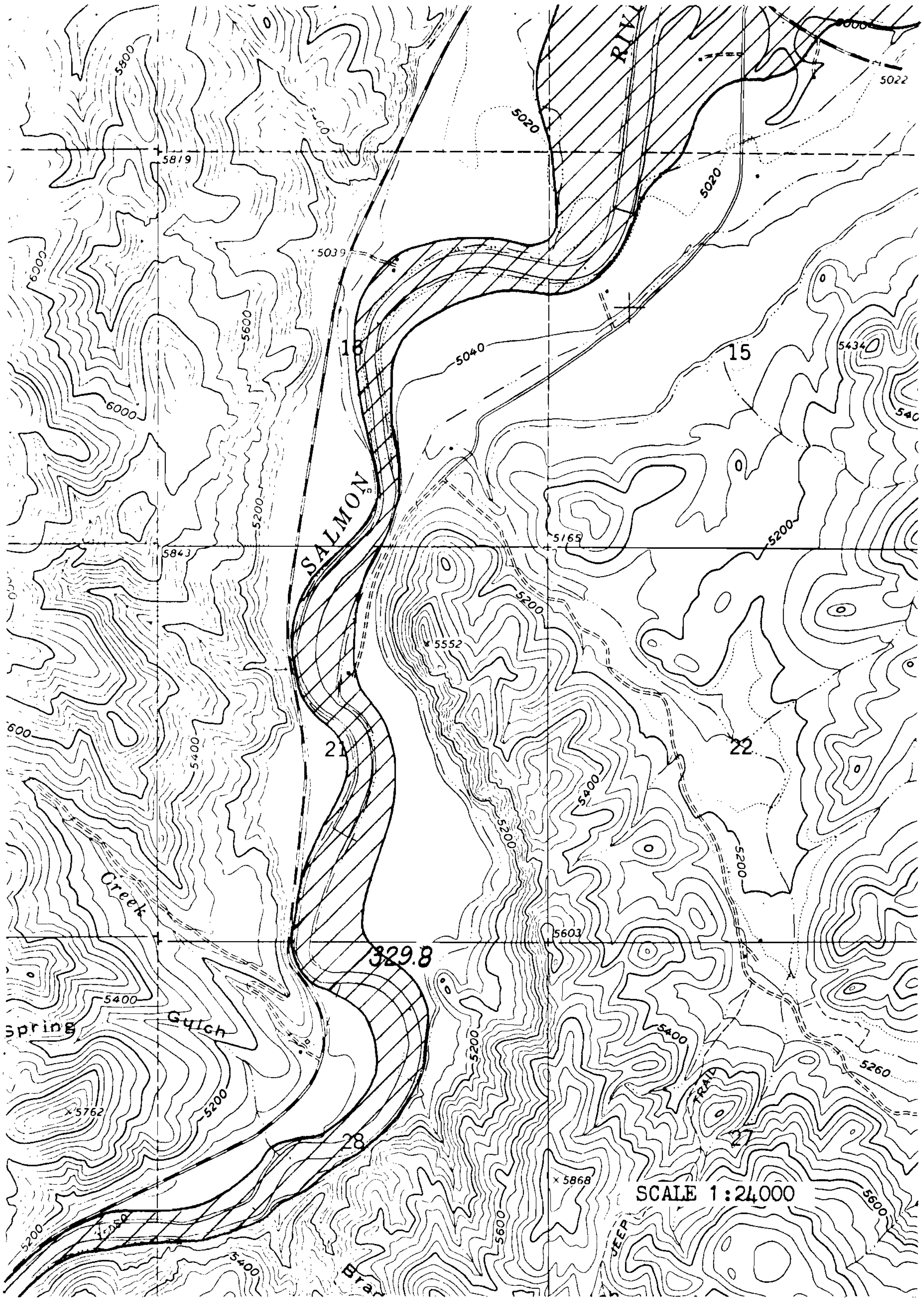

Figure 29. Areas south of Challis probably flooded by Salmon River in 1894 flood. Sheet 2 of 2.

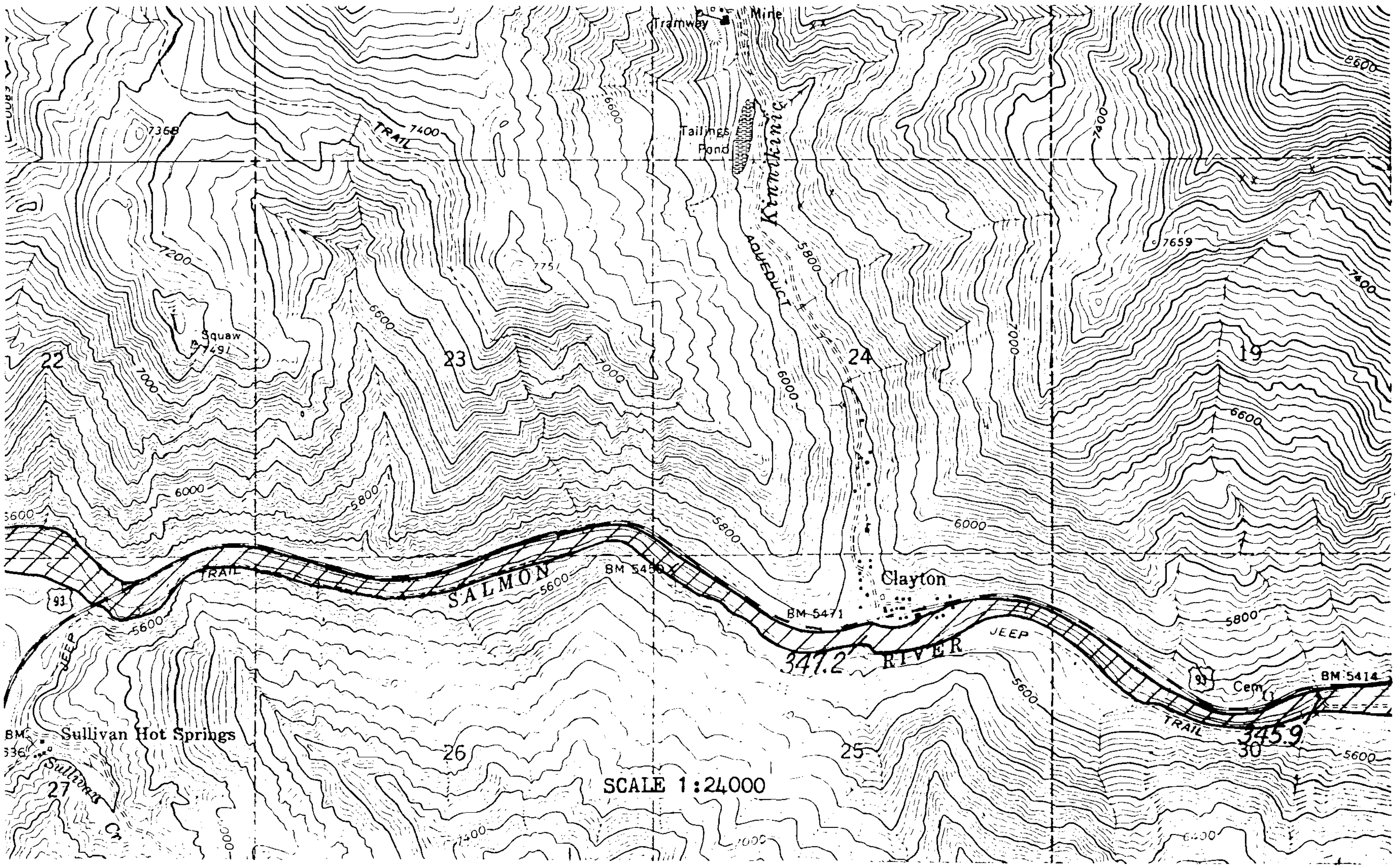

Figure 30. Areas near Clayton probably flooded by Salmon River in 1894 flood.

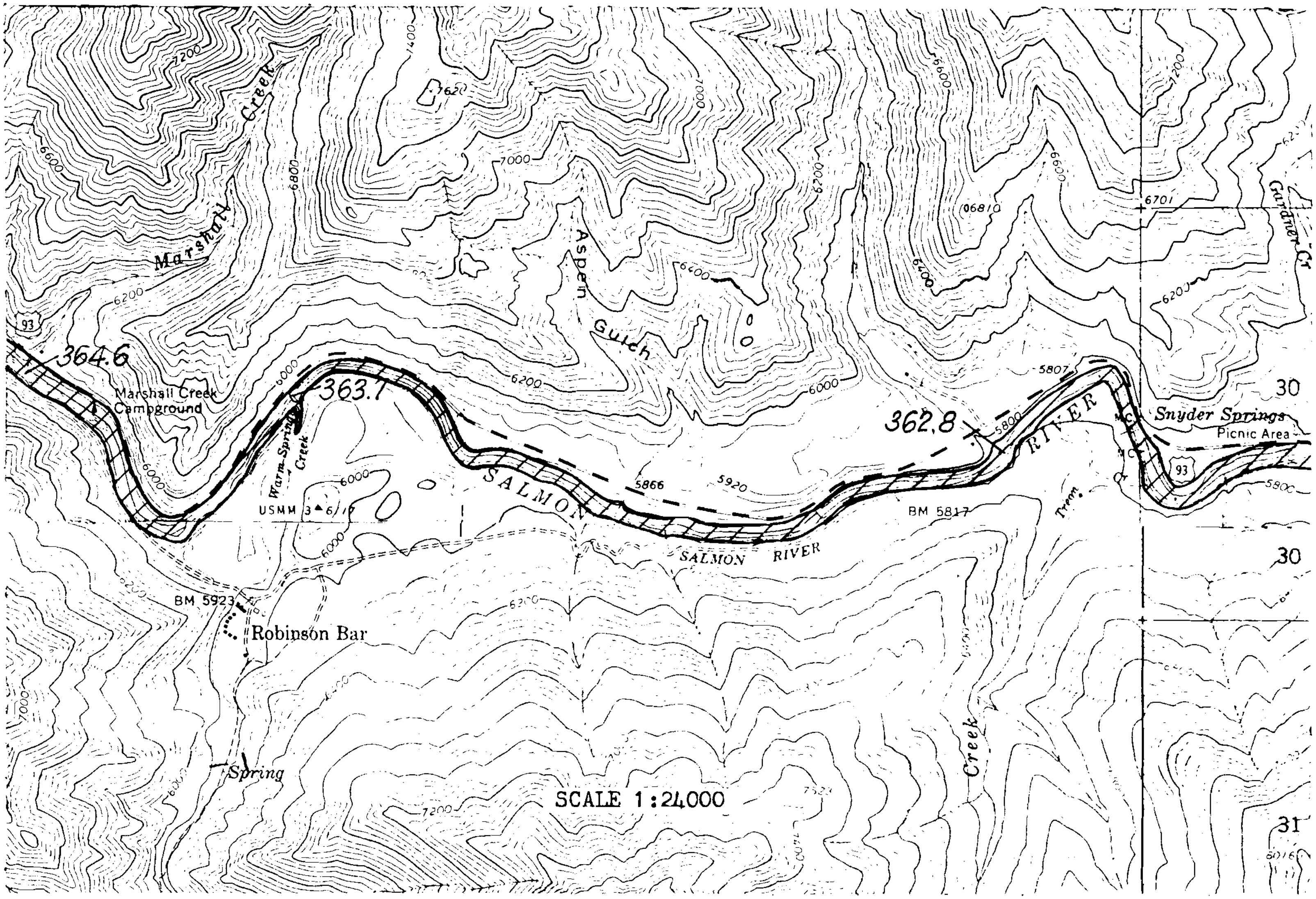

Figure 31. Areas near Robinson Bar probably flooded by Salmon River in 1894 flood.

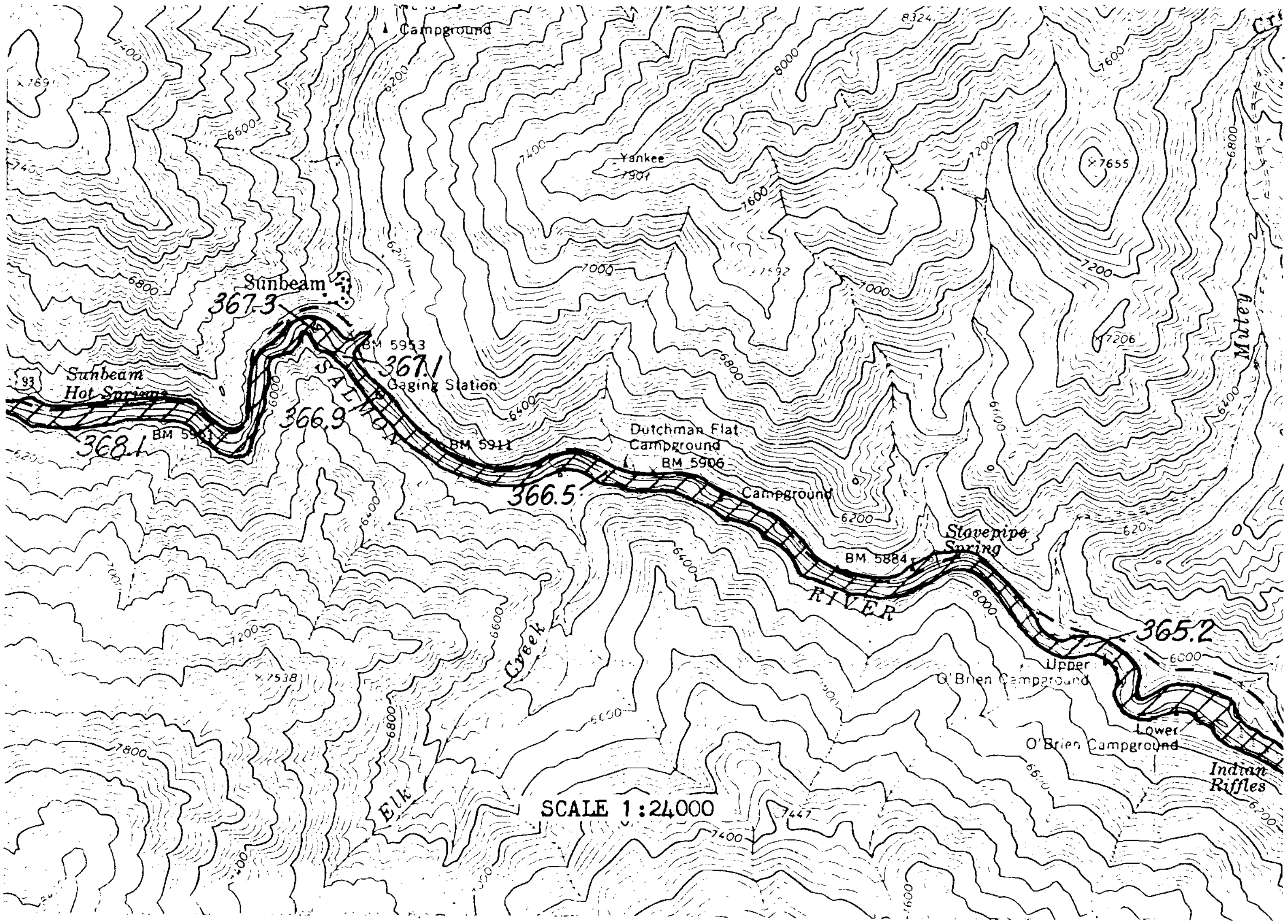

Figure 32. Areas near Sunbeam probably flooded by Salmon River in 1894 flood.

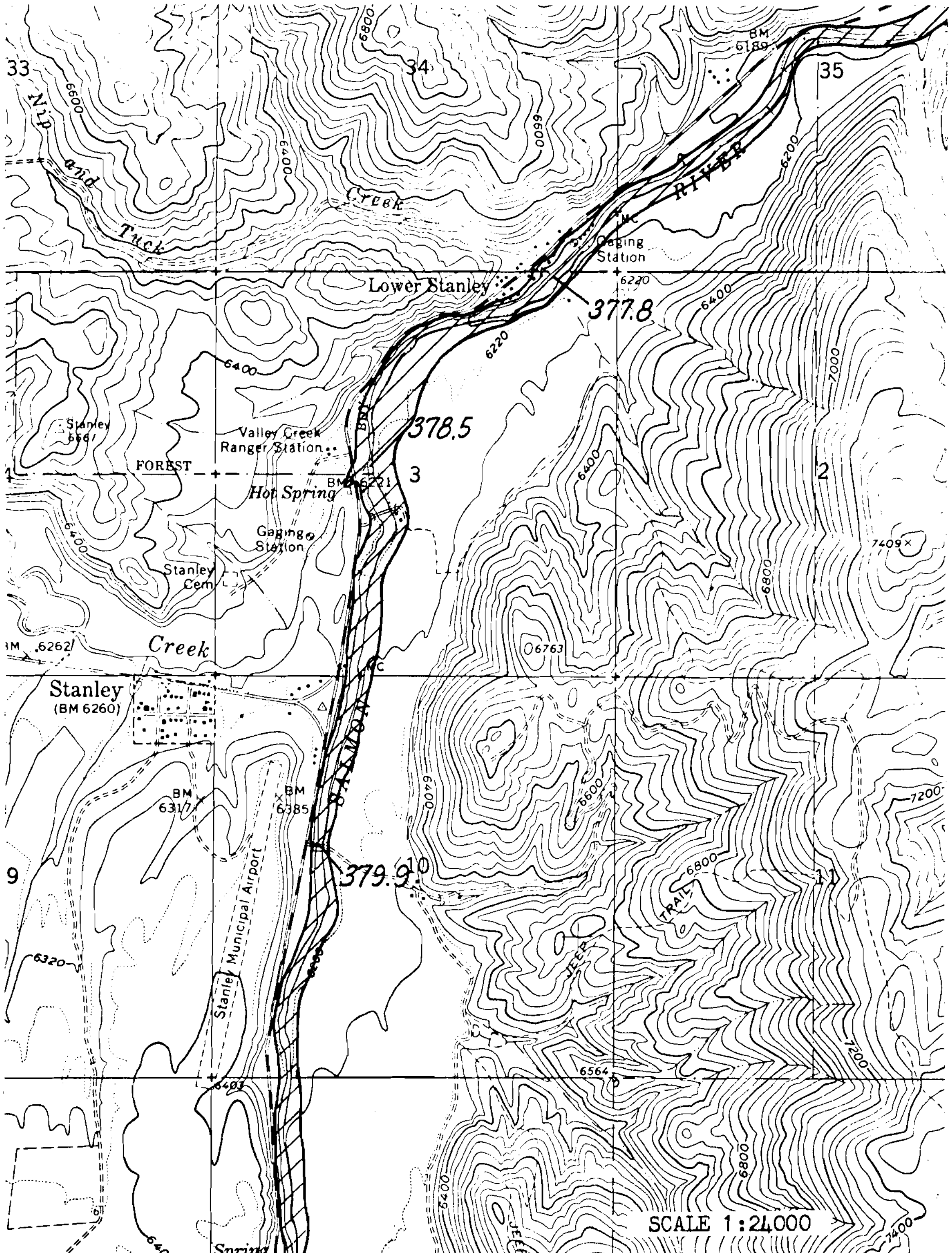

Figure 33. Areas near Stanley probably flooded by Salmon River in 1894 flood.