DRAFT

INITIAL WATERSHED ASSESSMENT
WATER RESOURCES INVENTORY AREA 49
OKANOGAN RIVER WATERSHED

Open file Report 95-14

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Introduction

This report is the product of a recent initiative by the Department of Ecology (Ecology) to assess the availability of ground and surface water for each watershed within Washington State. This initiative is part of a larger overall effort to make the water rights decision making process more efficient. The watershed assessment process will not only reduce the time needed to make decisions, but also will allow Ecology to make better informed decisions based on a more comprehensive understanding of each watershed. Ecology also believes these reports will be useful to local governments for planning purposes.

The scope of this report was limited to a review of existing information. No new field work or data collection efforts Were conducted. Numerous data exist providing information on the geology and groundwater resources of the Okanogan area. The information is primarily in the form of reports and maps by the United States Geological Survey (USGS), the State of Washington Department of Natural Resources (DNR) and the State of Washington Department of Ecology (Ecology). Other sources of data include Master's Theses performed in the area, water well logs on file with Ecology, and miscellaneous data collected by various agencies. A complete list of the data reviewed for this report is contained in the bibliography.

Watershed Description

Area Description

The Okanogan River Watershed (WRIA 49) is located in Okanogan County. It extends north and south from the Canadian border to the Columbia River, and encompasses about 2,100 square miles within the State of Washington (see Map 1). Another approximately 6,000 square miles is located within the Canadian province of British Columbia and about 300 square miles is drained by the Pasayten and Ashnola Rivers in northwestern Okanogan County. The Pasayten and Ashnola Rivers drainage are not part of the WRIA 49. The Okanogan River itself flows through Osoyoos Lake, which extends across the international boundary, and continues southward to empty into the Columbia River near Brewster. However, an even greater inflow from Canada is from the Okanogan's major tributary, the Similkameen River. The Similkameen crosses the border west of the Okanogan and enters the Okanogan River near the south end of Osoyoos Lake.

Within Washington State, the Okanogan River Watershed is about 65 miles long and averages about 35 miles wide. The eastern and western boundaries of the basin are steep, jagged ridgelines at elevations ranging from 1,500 feet to more than 5,000 feet above the basin floor. From the mountain ridges, lateral ridges extend toward the valley floor, tapering to gentler slopes as they reach the lower elevations. Streams fed by runoff from rain and snowmelt flow down the valleys between the lateral ridges.

The floodplain of the Okanogan River valley averages about a mile in width, and descends from an elevation of about 920 feet at the international boundary to about 780 feet at the river's confluence with the Columbia River. Osoyoos Lake occupies the northernmost 4 miles of the valley floor and extends several miles into Canada Multiple natural terraces - formed mostly of glacially deposited gravel - rise locally as much as 500 feet about the valley floor to the foot of, and between, the lateral ridges.

The soils in the watershed include shallow to moderately deep, mildly alkaline to strongly acid sandy loam and silt loam. These soils are formed from volcanic ash and pumice (ejected from Glacier Peak to the west centuries ago), glacial till and outwash, alluvium, lake sediments, and wind-laid silts.

Watershed Subbasins

The Okanogan River Watershed was divided into 32 subbasins. The subbasins are shown in Map 1. Table 1 lists the subbasins, their area and which stream they are tributary to. The subbasins represent the division of management by Ecology's Water Resources Program in the watershed.

Land Use

Land use can affect the demand for and use of water. Some land uses, such as irrigated agriculture, require large amounts of water on a seasonal basis. Other land uses, such as residential or range lands, require less water.

Land use in the Okanogan River Watershed includes agriculture, range, timber, residential and recreation. Some industrial and commercial uses exist, primarily around Brewster. The Colville Indian Reservation, located in the southeast part of the watershed, comprises the largest contiguous block of land, covering 412,000 acres or about 28 percent of the watershed (Pacific Northwest River Basins Commission, 1977). Another 28 percent of the watershed is in public ownership, including 10 percent owned by the U.S. Forest Service, 14 percent owned by the State of Washington, 3 percent owned by the Bureau of Land Management, and the rest owned by miscellaneous agencies. The remaining 44 percent of the watershed is under private ownership.

It is estimated that 36,000 to 40,000 acres of irrigated agriculture exists in the watershed. Population growth in the area was moderate until the early 1990s, when the population increased by 6.1 percent from 1990 to 1993. The residential population is divided between small cities and towns (approximately 40 percent of the population) and unincorporated areas (approximately 60 percent).

Table 1
Okanogan River Watershed Subbasins

	Name	Area (square miles)	Tributary to:
lA	Okanogan River - Lower	155.2	Columbia River
1B	Okanogan River - Middle	82.0	Okanogan River - Upper
1C	Okanogan River - Upper	16.5	Okanogan River - Middle
2	Chihwist Creek	40.8	Okanogan River - Lowe:
3	Loup Loup Creek	62.5	Okanogan River - Lower
4	Tallant Creek	12.8	Okanogan River - Lower
5	Salmon Creek	167.4	Okanogan River - Lower
6	Johnson/Scotch Creek	77.5	Okanogan River - Lower
7	Aeneas Creek	8.6	Okanogan River - Middle
8	Whitestone Creek	57.0	Columbia River
9	Sinlahekin Creek	127.2	Similkameen River
10	Similkameen River	91.9	Okanogan River - Middle
11	Nine Mile Creek	14.8	Okanogan River - Upper
12	Tonasket Creek	60.3	Okanogan River - Upper
13	Antoine/Whiskey Cache Creek	75.8	Okanogan River - Middle
14	Siwash Creek	44.6	Okanogan River - Middle
15	Bona arte Creek	146.4	Okanogan River - Middle
16	Chewilken Creek	26.7	Okanogan River - Lower
17	Tunk Creek	71.0	Okanogan River - Lower
18	Wanacut Creek (CIR)*	19.0	Okanogan River - Lower
19	Omak Creek (CIR)*	133.2	Okanogan River - Lower
20	Toats Coulee Creek	134.6	Sinlahekin Creek
21	Starzman Lake	17.4	Columbia River
22	Pine Creek/Wa on Road Coulee	69.5	Okanogan River - Lower
23	Horse Springs Coulee	38.7	Okanogan River - Middle
24	Mosquito Creek	7.5	Okanogan River - Middle
25	Choaka Lake	16.8	Sinlahekin Creek
26	Whitestone Lake	54.7	Okanogan River - Middle
27	Indian Dan Canon	17.1	Columbia River
28	Whitestone Coulee	11.5	Okanogan River - Middle
29	Duck Lake	5.3	Johnson Creek
30	Omak Lake (CIR)*	229.9	Okanogan River - Lower
31	Baker Creek	7.0	Flows into Canada
	Total	2102.2	

*CIR - Located in Colville Indian Reservation

Table 2
1993 Population Estimates

Cities And Towns	1993 Population Estimate
Brewster	1,645
Conconully	~172
Okanogan	2,390
Omak	4,150
Oroville	1,515
Tonasket	985

A graph showing the trend in population growth in Okanogan County is shown in Figure 1. The population growth of the entire State of Washington is included on Figure 1 for comparison. The population growth in the county was moderate until the early 1990's, when growth accelerated. The population growth in the period of 1990-1993 was 6.1 percent (1994 Washington State Almanac).

Climate and Precipitation

Climate in the lower parts of the Okanogan River Valley is semiarid whereas in the mountains it can be classed as subhumid. Characteristics of the climate include fairly large seasonal temperature extremes and daily temperatures and precipitation that vary widely between different parts of the area. The lowest temperatures and greatest precipitation generally occur at the higher altitudes. Annual precipitation averages less than 12.5 inches in the main valley and more than 40 inches on the highest ridges. Temperature data are not available for the higher elevations, but in the valley recorded temperatures range from a high of 112°F (Fahrenheit) to a low of -31 °F.

Records from two climatological stations (Omak and Conconully) in the watershed show a slight increasing trend in precipitation. Figures 2 and 3 illustrate the trends in precipitation over the last 30 to 50 years for the two stations. An analysis of state-wide precipitation trends was performed by Ecology (Barker, 1995). The conclusions from that report was that precipitation in eastern Washington was generally above the average since the 1940's except for a period in the mid 1970's. An extended period of below average precipitation occurred in the 1920's through about 1940.

Water Usage In The Okanogan River Watershed

Irrigation Water Use

The Okanogan River Watershed contains approximately 36,000 to 40,000 acres of irrigated area (Kelly, pers. comm., 1994). About 60 percent of that acreage (24,421 acres) is contained within irrigation districts or ditch companies. A listing of the districts and companies located within the Okanogan River Watershed is contained in Table 3. Table 3 also contains information on their irrigated acreage and approximate water use. The numbers were obtained from sources such as a survey performed in 1989 by the Okanogan Conservation District, through a telephone survey and from the Bureau of Reclamation (1991).

Table 3
Irrigation District
Water Users

District Name	Location	No. Acres	Estimated Annual Water Use
Aeneas Lake Irrigation District	Tonasket	1,325	N/A
Alta Vista Irrigation District	Okanogan	40,	N/A
Black Bear Ditch Co.	Loomis	100	N/A
Brewster Flat Irrigation District	Brewster	2,432	6,600 ac-ft
Helensdale Irrigation District	Malott	206	N/A
Methow/Okanogan Irrigation District	Brewster	280	N/A
Okanogan Irrigation District	Okanogan	5,032	15,000 ac-ft
Oroville Tonasket Irrigation District	Oroville	10,000	40,000 ac-ft
Pleasant Valley Users Association	Okanogan	2,000	N/A
Whitestone Irrigation District	Loomis	3,006	9,300 ac-ft

ac-ft = acre-feet
N/A - Information not available in existing data sources or was not found in telephone survey.

Municipal Water Use

The Okanogan County Planning Department conducted a survey of water users in the County, including municipal and private water districts and companies. Washington State Department of Health also maintains information on water systems. A list of the known water districts and companies within the study area is contained in Table 4. No information was readily available to determine the annual water use or source of water for each water system.

Industrial and Commercial Water Use

The primary industrial and commercial uses of water in the Okanogan River watershed are for fruit packing and log storage. No records of water use for these categories were found. The primary location of fruit packing warehouses is near Brewster.

Table 4
Municipal Water Users

Water District/Company	Location	Number Connections	Population Served
Appleway Trailer Court Water System	Tonasket	n/a	n/a
Aston Estates Water System	Omak	n/a	n/a
Brewster City Water System	Brewster	630	1,633
Brewster Flat Domestic Water Association	Brewster	138	414
Coleman Butte Water Association	Omak	90	250
Colville Indian Agency Water System, Malott Community Water System, Albert Orr Water System, Disautel Community Water System, Omak HUD Trailer Court Water System	Various Locations	n/a	n/a
Crumbacher Estates Water System	Tonasket	32	95
Duck Lake Water Association	Omak	65	184
East Lake Water Association	Oroville	n/a	n/a
Emanuel Heights Water System	Brewster	n/a	n/a
Homestead Mobile Home Park	Okanogan	32	80
Johnson Creek Water Users Association	0mak	n/a	n/a
Loomis Water Users Association	Loomis	84	200
M-J Trailer Ranch Water System	Okanogan	n/a	n/a
Oakes Mobile Home Court Water System, Pinecrest Water System	Tonasket	55	150
Okanogan Water Department	Okanogan	650	2,380
Omak Water Department	Omak	1,706	4,150
Oroville Water Department	Oroville	833	2,190
Progressive Flat Water Association	Okanogan	42	140
Riverside Water System	Riverside	97	250
Sandflat Water Association	Omak	24	72
Suncrest Plat Water System	Omak	73	170
Tonasket Water System	Tonasket	533	985
Vista View Water Users Association	Omak	n/a	n/a

Surface Water

Watershed Hydrology

Rain and snow that fall in the Okanogan River Watershed within Washington State and inflow from the Similkameen and Okanogan River furnish nearly all the fresh water supply in the Okanogan River Watershed. Groundwater is an additional source, but probably is of small magnitude, entering the upper end of the watershed from Canada or laterally from adjacent watersheds.

A majority of the annual precipitation in the Okanogan River Watershed falls in the winter and remains as snow. After remaining for several month as winter snowpack, the spring melt releases the water over a relatively short period of time in May and June. In addition to supplying streamflows, a significant portion of the melting snow infiltrates into the soil to become groundwater. The groundwater then slowly discharges to rivers and tributary streams, providing a relatively low but constant base flow discharge for the remainder of the year.

In arid climates such as the Okanogan Valley, most all of the precipitation from a storm that occurs during the warm months either evapotranspires or is soaked up in the shallow soil layer. Only a small amount of precipitation makes it to the streams outside of the spring and early summer months. Evapotranspiration is the process of evaporation from water and soil surfaces and transpiration by vegetation. Evaporation and transpiration also reduces the amount of water, from precipitation that becomes available as streamflow, storage in lake and reservoirs, and recharge of groundwater. The continual movement of precipitation, surface water runoff, infiltration, surface and subsurface storage, groundwater discharge, and evapotranspiration between the earth and atmosphere is referred to as the hydrologic cycle. An illustration of the hydrologic cycle is shown in Figure 4.

A generalized yearly water budget for the Okanogan River Watershed is summarized in Table 5. Based on records compiled from 1939-1969, the estimated mean precipitation over the Okanogan River Watershed is 17.5 inches, or about 2 million acre-feet of water. About 2.1 million acre-feet of water enters the watershed from Canada as streamflow; about 75 percent of this amount is from the Similkameen River. The outflow from the watershed is estimated to be 2.2 million acre-feet. In the Okanogan River Watershed the amount of water lost to evapotranspiration is nearly equal to the total precipitation input. Therefore, streamflow in the Okanogan River is increased only slightly by precipitation that falls within the watershed. The loss of groundwater by subsurface migration probably occurs across only a narrow band of unconsolidated materials at the south end of the basin (see Groundwater section). The quantity of water entering the watershed at the international boundary is approximately the same as that which leaves the watershed at the Columbia River.

Table 5
Yearly Water Budget for Okanogan River Watershed

Basin Flows	Average Volume Acre-Feet per Year
Inflow	
- Precipitation	2,000,000
- Surface Water	2,100,000
- Groundwater	NA
Outflow	
- Evapotranspiration	1,900,000
- Surface Water	2,200,000
- Groundwater	NA

NA - Data are not available to calculate groundwater inflow and outflow. Source: Walters (1974).

Available Data

Streamflow in the Okanogan River Watershed was measured and recorded at many gauging stations located on the Okanogan and Similkameen Rivers and associated tributaries. However, because most gauges are located near the lower ends of stream basins, measured streamflow are very much affected by water usage for irrigation, water supply, and other activities. This has resulted in reduced streamflow rates and/or modified seasonal runoff patterns. An analysis to determine what the natural streamflow characteristics would be in the absence of human activities has not been conducted on any streams in the Okanogan River Watershed and was beyond the scope of this assessment report. Therefore, the analysis of streamflows is based on data that reflects and incorporates changes caused by historical water usage.

Streamflow gauging stations with continuous historical flow records are summarized in Table 6. Although many streams in the Okanogan River Watershed were gauged at various times during this century, only four gauges are currently operating; three on the Okanogan River and one on the Similkameen River. The period of record on these large river stations (termed primary stations in this report) are very good, ranging from 37 to 84 years in length with continuous records dating as far back as 1911.

Data on the remaining perennial streams in the Okanogan River Watershed are very limited. Continuous records on these streams are generally shorter than ten years in length. In addition, records from many stations date from many years ago. For example, the only data available for Salmon Creek is for the period of 1912-1922. None of the streamflow gauges on these smaller streams in the Okanogan River Watershed remained in operation after the 1970's. Therefore, it would be difficult to assess the status of current streamflows in these streams. The location of streamflow gauging stations are shown on Map 1.

Monthly average flows for the stations listed in Table 6 are tabulated in Appendix A.

Table 6
Available Recorded Streamflow Data in Okanogan River Watershed

Name and Location	. USGS Gauge	Drainage Area (sq mi)	River Mile (mi)	Period of Record	Upstream Irrigation or Diversions (acres)
Okanogan River at Oroville	12439500*	3,210	77.3	1943-1994	44,000 acres in BC
Okanogan River near Tonasket	12445000*	7,280	50.8	1911-1994	55,000 acres in BC 10,700 acres in WA
Okanogan River at Malott	12447200*	8,100	17	1966-1994	55,000 acres in BC 22,000 acres in WA
Okanogan River near Malott	12447300	8,200	13	958-1967	55,000 acres in BC 22,000 acres in WA
Sinlahekin Creek near Loomis	12441500	86.6	---	1903-1905	Unknown
Sinlahekin Creek at Twin Bridges near Loomis	12441000	75.5	---	1921-1923	Unknown
Sinlahekin Creek above Chopaka near Loomis	12442300	256	---	1957-1966	Whitestone Canal and some irrigation
Similkameen River at Nighthawk	12442500*	3,550	15.8	1929-1994	2900 acres in WA 10700 acres in BC
Tonasket Creek at Oroville	12439300	60.1	0.7	1974-1975 1978-1980	Some irrigation
Toats Coulee Creek near Loomis	12442000	130	---	1921-1925 1957-1970	None
Whitestone Irrigation Canal near Loomis	12442200	---	---	1957-1970	Diverts from Toats Coulee Creek
Oroville-Tonasket Irrigation Canal near Oroville	12443000	---	---	1922-1928	Diverts from Similkameen River
Whitestone Creek near Tonasket	12444100	55.4	---	1959-1972	Regulated at Whitestone Lake
Bonaparte Creek near Wauconda	12444490	96.6	---	1968-1973	Several small diversions
Salmon Creek. near Conconully	12446500	121	---	1912-1922	Unknown
Omak Creek near Omak	12445900	119	---	1972-1974 1977-1979	Many small diversions

* - Indicates currently active stream gauge

Average Annual Flows

Historical average annual flows at the four primary streamflow stations (on the Okanogan and Similkameen Rivers) are shown in Figures S-8. The data are also tabulated in Appendix A. Average annual flows for the primary stations are summarized in Table 7. The graphs depict the long term trend of annual runoff at various locations on these rivers. Trends in annual runoff are depicted by a straight line calculated using a linear regression analysis. Also shown on these graphs are total annual precipitation at Omak. Comparison of runoff to precipitation can indicate whether streamflow trends are related to climatic trends. It should be noted that most of the streamflow in the Okanogan River Watershed originates in Canada. The volume of runoff is more closely related to snowpack in the upper watershed than precipitation at Omak.

Based on data trends shown in these graphs, it is concluded that average annual flows on the Okanogan and Similkameen Rivers have not changed significantly over the period of streamflow gauging. The slight increasing or decreasing trends shown on these graphs are very small and show no consistent pattern from gauge to gauge. Precipitation over this period, as measured at Omak, has a slight increasing trend but is also very small.

Table 7
Average Annual Flows
at Primary Gauging Stations

Station	Average Annual Flow	
	(cfs)	(ac-ft)
Okanogan River at Oroville	670	483,900
Okanogan River near Tonasket	2,907	2,101,100
Okanogan River at Malott	3,009	2,175,000
Similkameen River near Blackhawk	2,315	1.672,800

Cfs - cubic feet per second

Monthly Flow Exceedences

To determine how streamflows have varied historically throughout the year, a statistical analysis using recorded daily streamflows was performed. The analysis produces low, median and high flow exceedence probability estimates for incremental dates during the year. Low flow is defined as the 90 percent exceedence probability, and is equal to the flow rate that occurred 9 years out of 10 for a particular period of time. Median flow is defined as the 50 percent exceedence probability, and is equal to the flow rate that occurred 5 years out of 10. High flow is defined as the 10 percent exceedence probability, and is equal to the flow rate that occurred 1 year out of 10.

Figures 9-18 present the results of the monthly flow exceedence analysis. The analysis was conducted on the four primary stream gauges (Figures 9-12) and six tributary stream gauges

(Figures 13-18). The data are also tabulated in Appendix A. The WAC minimum instream flows that have been established on the four primary stream gauges are also shown on Figures 9-12. The flow exceedence curves on the four primary streamflow gauges show the peak annual flows occurring in late May and early June, and minimum annual flows occurring in early fall to mid winter. Flow rates decrease by about ninefold on average between the times of peak runoff and minimum flows on the Okanogan River near Tonasket, and on the Similkameen River. Flows on the Okanogan River at Oroville are attenuated by Lake Osoyoos and therefore vary less widey. The volume of runoff on the Okanogan River for the months of May through July averages 65 percent of the total annual runoff.

Streamflow patterns on the remaining six tributaries reflect different levels of water use impacts. Toats Coulee Creek is very much dominated by spring melt and is not affected by upstream water use. Sinlahekin Creek, located downstream of Toats Coulee Creek, has similar runoff characteristics, but the records reflects diversion: of up to 40-50 cfs by the Whitestone Irrigation District. Bonaparte and Omak Creeks, which have some upstream diversion for irrigation, have more runoff during late winter and spring, reflecting their lower elevations. Whitestone and Salmon Creeks are regulated and are used to convey flows for irrigation and their flow exceedance curves show high, steady flow from May - October during the irrigation season from upstream reservoirs.

Low Flows

Trends in late summer and fall streamflows do not always correspond to trends in annual flows because the majority of runoff volume occurs during the period of spring runoff. Trends in low flows are best evaluated by examining the historical trend in annual 7-day flows. The 7-day low flow is defined as the average of the seven lowest consecutive flow days in each year.

Historical 7-day low flows with their trends for the four primary streamflow stations are shown in Figures 19-22. Annual average flows are also shown on these graphs to enable comparison of annual average and annual low flow trends. In general, annual 7-day low flows have remained essentially unchanged on the middle and lower Okanogan River and on the Similkameen River. However, a trend of decreasing annual low flows was found for the Okanogan River above the Similkameen River confluence. The trend line shows annual low flows decreasing by about a third since the 1940's. Streamflows at that location originate entirely in Canada, and the apparent decrease in low flows can probably be attributed to an increase in irrigated acreage there.

Excursions of WAC Minimum Instream Flows

Figures 9-12 section compare minimum instream flows established in Chapter 173-549 WAC to the monthly flow exceedence curves. In general, the minimum instream flow falls between the 90 percent (low) and 50 percent (median) flow exceedence lines during the non-spring runoff season, and below the 90 percent flow exceedence line during the period of spring runoff (except at Okanogan River at Oroville).

A summary of average monthly and annual WAC minimum instream flow excursions is contained in Table 8. This summary represents a comparison of the WAC instream flows to the record of available streamflow data. The number of excursions varies considerably from year to year depending on the natural variability of streamflow.

Table 8
Summary of Excursions of WAC Minimum Instream Flows

	Percent of Time Instream Flow Not Met			
Month	**Okanogan River at Malott**	**Okanogan River near Tonasket**	**Okanogan River at Oroville**	**Similkameen River near Nighthawk**
January	27.9%	23.2%	34.7%	27.3%
February	16.9%	18.7%	29.8%	16.9%
March	20.4%a	20.0%	31.6%	16.8%
APB	9.1%	10.5%	30.8%	9.0%
May	2.7%	2.0%	19.8%	3.0%
June	13.3%	9.7%	26.9%	11.0%
JAY	19.6%	14.8%	29.5%	22.0%
August	25.8%	19.4%	27.2%	23.9%
September	23.4%	18.5%	21.2%	24.2%
October	21.7%	18.7%	20.9%	34.5%
November	22.8%	20.4%	33.9%	25.3%
December	29.4%	24.4%	33.5%	33.9%
Annual	16.4%	16.7%	28.3%	20.7%

The number of excursions from WAC minimum instream flows during the historical streamflow record are shown in Figures 23-26. The total number of minimum instream flow excursions are shown as both annual and June through September totals. Historical trends calculated using a linear regression equation are also shown. In general, an increasing trend of minimum instream flow excursions is evident on all three locations on the Okanogan River. The trends in total annual excursions are increasing faster than the June-September excursions, indicating that winter flows are being affected more than summer flows. The increasing trend in June-September excursions is very slight and is probably not significant. Excursions of minimum instream flows on the Similkameen River appear to be decreasing over time.

Hydrogeology

Geology

The bedrock geology is composed primarily of granitic, andesitic, metamorphosed sedimentary and basaltic rocks. These rocks form a complex arrangement of geologic terrains, that are, in places, highly fractured, folded and faulted. The fractured rocks do contain water and can yield it to wells and springs, but these yields are generally low. The possible exception to the low bedrock yield would be in the south-central portion of the study area, in a triangular area between the Okanogan River, Omak Lake and the Columbia River where flood basalts of the Columbia River Basalt Group are present. Basalt aquifers are known to produce large quantities of water in locations throughout eastern Washington, however as the Okanogan River Watershed is at the edge of the flows only in a few places is it thick enough to yield more than a few gallons per minute (Walters, 1974)

During the last large scale glaciation, more than 10,000 years ago, the entire Okanogan drainage was overridden by the Okanogan Lobe of the Cordilleran ice sheet. As the glacier melted it deposited sequences of silt, sand, gravel, and cobbles. These sequences of unconsolidated materials are generally present as valley fill and along valley walls as terraces. More recently modern rivers have scoured the bedrock and glacial deposits and redeposited them as additional sand and gravel terraces and plains. A review of well logs, and previous reports indicates that the valley fill and terrace deposits may be more than 500 feet thick in areas. Walters (1974) indicates localized deposits of "blue clay" are found throughout the Okanogan Valley, and in some areas extend to bedrock. The "blue clay" deposits yield little or no water.

Aquifer Characteristics

The bedrock underlying the Okanogan River Valley is effectively impermeable and can be regarded as the floor of the ground water reservoir. While wells within the valley do penetrate the bedrock, yields are generally low, and are not considered viable sources for significant ground water development. The primary source of groundwater within the Okanogan River Watershed is in the alluvial and glacioflucial sediments that fill the bottom of most of the river and stream valleys. A map of the areas where alluvial and glacial fill is present, and may have potential for groundwater development is contained in Appendix B. Appendix B also contains geologic cross-sections of the Okanogan and Similkameen River valleys, derived from well logs. Walters (1974) estimates that 75 percent of the groundwater stored in unconsolidated deposits in the watershed is within the Okanogan River corridor. Recharge to the aquifer is primarily in the form of rainfall infiltration, and interaction with surface water bodies; lakes, rivers, and streams. Individual well yields vary from virtually nothing to reportedly as high as 5,000 gallons per minute (gpm). Several pump tests have been performed in the Okanogan River Watershed, with estimates of transmissivity ranging from less than 50,000 gallons per day per foot (gpd/ft) to over 500,000 gpd/ft.

Groundwater/Surface Water Interaction

Reports indicate that groundwater and surface water interact throughout the watershed, depending on the subarea's morphology. For example Packard, Sumioka, and Whiteman (1983) identified four groundwater segments in the Bonaparte Creek subbasin; each of which is closely connected with surface water. Along some of the reaches, flow is from the ground into the streams; in other reaches the reverse is true. Robinson and Noble (1991) present a well test west of Tonasket, where because of a thick layer of silt and clay between the surface and the aquifer, they hypothesize that the use of the aquifer may have little or no effect on instream flow of the river. In all of these cases, interaction between surface water and groundwater within the watershed is largely dependent on the highly variable geologic conditions. Ultimately most all groundwater eventually flows to surface water or another aquifer, most of which eventually discharges into the Okanogan River. To say that any new well will have an effect upon instream flows, is stretching the limits of our knowledge to the utmost, but it is generally agreed upon that continued development of the groundwater resources within the Okanogan River Watershed will ultimately result in loss of water in shallow existing wells and lower water levels in various surface water bodies.

Groundwater Status

Currently there are 2,417 groundwater claims for the Okanogan River Watershed totaling 42,086 acre-feet/year, 905 groundwater permits and certificates totaling 70,705 acre-feet/year, and 81 groundwater applications totaling 24,821 gpm. The majority of claims; permits, certificates, and applications exist along the main Okanogan River corridor. Walters (1974) estimated that the total aquifer storage within the Okanogan River Watershed is in excess of 4,500,000 acre-feet. However, the accessibility to much of this water is not known, as an undetermined amount of this water is stored within fine-grained deposits that do not yield water in sufficient quantities to be developed.

Water Demand

Water Rights Permits and Certificates

Since the adoption of the state surface and groundwater codes, the only means of acquiring a water right within the state is by filing for, and receiving, a Permit and/or subsequent Certificate from Ecology or one of its predecessors. One exception is allowed under the domestic exemption to the groundwater code (RCW 90.44). For this portion of the report only Permits and Certificates were used.

When a water user or future water user (applicant) expects to use any amount of surface water for any purpose, or in the case of groundwater (well) use more than 5,000 gallons per day for domestic, stock watering, industrial purposes and/or irrigation of more than 1/2 acre; the applicant must file a Water Right Application with Ecology. If Ecology determines that water is available for a beneficial use, that the use will not impair other rights and is not detrimental to public interest, it issues a Water Right Permit, which allows the applicant to proceed with the project. Upon project completion Ecology issues a Certificate documenting the actual perfected, authorized water use.

A summary of surface water and groundwater rights permits and certificates issued in the Okanogan River Watershed is contained in Table 9 and are divided by subbasin in Tables 10 and 11. These data represent "paper" rights for active permits and certificates. Paper rights generally do not give a good indication of actual consumptive use for several reasons: including many permits do not use their full allocation, irrigation usage varies seasonally and yearly depending on weather, domestic usage by individuals is not represented (i.e., exempt groundwater wells) and there may be significant illegal usage of water.

The historical growth of water rights appropriations in the Okanogan River basin is shown in Figures 27 and 28. The graphs show that the appropriation rate for both surface and groundwater continued was relatively constant during the last few decades, but has leveled out since the mid 1980's.

The purpose of use for water rights permits is also summarized in Table 9 and shown graphically in Figures 29 and 30. In the Okanogan River Watershed the vast majority of surface water rights issued are for irrigation use, representing 98 percent of the total quantity. Groundwater rights issued for irrigation use represents 56 percent of the total quantity of groundwater rights. Domestic and municipal water supply uses represent most of the remaining groundwater rights. Water rights issued for irrigation usage comprises 81 percent of the total quantity of surface and groundwater rights issued in the Okanogan River Watershed. Although a total of 78,485 acres of irrigation is identified by the surface water and groundwater permits, Natural Resource Conservation Service data indicate that only 36,000 to 40,000 acres are currently being irrigated in the Okanogan River Watershed.

Maps 2 and 3 illustrate the distribution of Water Rights Permits and Certificates within the Okanogan River Watershed.

Table 9
Summary of Water Rights Permits and Certificates

Type and Purpose of Use	Qi Instantaneous Rate		Qa Annual Quantity		Permit Holders		Irrigated acres
	cfs	Percent of Total	ac-ft/yr	Percent of Total	Number	Percent of Total	
Surface Water Permits and Certificates							
Domestic	34	3%	688	1%	109	13%	2
Irrigation	996	88%	105,414	98%	470	56°k	67,443
Municipal	2	0%	0	0%	1	0%	0
Stock Watering	12	1%	468	0%	224	27%	0
Other	89	8%	590	1%	33	4%	576
Subtotal	**1,133**	**100%**	**107,160**	**100%**	**837**	**100%**	**68,021**
Groundwater Permits and Certificates							
Comm/Indust.	2	1%	1,214	2%	9	1%	p
Domestic	132	33%	9,050	13%	514	57%	
Irrigation	196	49%	39,344	56%	307	34%	10,437
Municipal	52	13%	19,078	27%	31	3%	0
Stock Watering	7 ~	2%	492	1%	23	3%	p
Other	12	3%	1;527	2%	21	2%	27
Subtotal	**401**	**100%**	**70,705**	**100%**	**905**	**100%**	**10,464**
Total	**1,534**	**---**	**177,864**	**---**	**1742**	**---**	**78,485**

Table 10
Surface Water Rights, Claims and Applications in Okanogan Watershed Subbasins

	Subbasin	Permits and Certificates Qi (cfs)	Permits and Certificates Qa (ac-ft/ r)	Permits and Certificates Number	Claims Qi (cfs)	Claims Qa (ac-ft/yr)	Claims Number	Applications Q1 (cfs)	Applications Q8 (ac-ft/yr)	Applications Number
1A	Okanogan River - Lower	327.3	44 460	202	85.5	16 916	199	50.9	0	19
1B	Okanogan River - Middle	115.4	8 736	96	13.6	2 642	64	8.8	0	3
IC	Okanogan River - Upper	10.6	1 832	32	4.3	814	48	0.3	0	1
2	Chiliwist Creek -	11.8	2 688	21	5.6	1 006	66	0.0	0	0
3	Loup Loup Creek	0.1	58	4	2 366.9	473 168	116	0.0	0	1
4	Tallant creek	0.2	16	3	9.6	1,860	33	0.0	0	0
5	Salmon Creek	2.9	576	89	407.8	81 336	137	0.0	0	0
6	Johnson/Scotch Creek	24.5	10 911	28	12.3	2 296	94	0.0	0	0
7	Aeneas Creek	0.2	14	2	3.6	718	5	0.0	0	0
8	Whitestone Creek	0.1	7	13	4.0	674	71	0.0	0	0
9	Sinlahekin Creek	206.1	12 009	54	3.3	418	124	0.0	0	1
10	Similkameen River	223.1	2 674	35	10.8	2 070	60	1.5	0	1
11	Nine Mile Creek	0.0	2	1	6.3	1,236	17	0.0	0'	0
12	Tonasket Creek	0.2	5	13	2.7	408	70	0.0	0	0
13	Antoine/Whiskey Cache Creek	7.0	693	20	9.0	1,642	91	0.5	0	2
14	Siwash Creek	0.1	10	9	6.5	1 250	27	0.1	0	2
15	Bonarte Creek	26.1	4 768	124	26.5	5 132	106	1.4	0	2
16	Chewilken Creek	0.0	3	3	2.3	410	27	0.0	0	0
17	Tunk Creek	1.6	168	22	8.8	1 554	112	0.7	0	2
18	Wanacut Creek CIR *	0.0	0	0	0.1	16	1	0.0	0	0
19	Omak Creek CIR *	1.0	243	4	1.8	332	18	0.0	0	0
20	Toats Coulee Creek-	109.2	1 352	9	2.1	214	107	0.0	0	0
21	Starzman Creek	0.7	170	3	0.2	24	11	0.0	0	0
22	Pine Creek	1.1	9	7	23.1	4 464	91	0.2	0	3
23	Horse Springs Coulee	1.1	302	4	11.5	2 230	41	0.0	0	0
24	Mosquito Creek	0.1	1	3	0.3	54	4	0.0	0	0
25	Choaka Lake	2.4	762	6	0.3	34	17	0.0	0	0
26	Whitestone Lake	24.3	7 894	22	9.2	1 758	48	0.0	0	0
27	Indian Dan Canon	0.0	0	0	1.0	158	20	0.0	0	0
28	Whitestone Coulee	0.0	0	0	0.0	4	2	0.0	0	0
29	Duck Lake	22.8	6 781	4	1.2	234	5	0.0	0	0
30	Omak Lake CIR *	1.0	4	3	3.2	536	56	0.0	0	0
31	Baker Creek	0.0	0	0	1.0	182	31	0.0	0	n
	Total	1,121.0	107,149	836	3,044.4	605,790	1,919	64.4	0	37

Note: Small differences between this table and Table 9 are due to incomplete information on section-township-range data in the WRIS database.

Table 11
Groundwater Rights, Claims and Applications in Okanogan Watershed Subbasins

		Permits and Certificates			Claims			Applications		
	Subbasin	**Qi (gpm)**	**Qa (ac-ft/yr)**	**Number**	**Qi (gpm)**	**Qa (ac-**	**Number**	**Qi (gpm)**	**Qa (ac-ft/yr)**	**Number**
1A	Okanogan River - Lower	85 377	32 764	365	27 495	11 220	776	11 792	21	37
1B	Okanogan River - Middle	17 982	6 146	104	20 655	8 438	440	1 505	0	7
1C	Okanogan River - Upper	6 880	5 422	44	4 131	1 462	237	1 900	0	4
2	Chiliwist Creek	560	420	2	99	22	11	45	0	1
3	Lout) Loup Creek	350	18	3	45	10	5	410	0	1
4	Tallant Creek	239	79	7	891	336	35	0	0	0
5	Salmon Creek	9 134	3 147	39	7 056	2 846	190	845	0	5
6	Johnson/Scotch Creek	6 766	2 646	36	5 742	2 430	93	190	0	2
7	Aeneas Creek	1705	731	6	1 494	652	8	459	0	2
8	Whitestone Creek	1 720	680	7	495	200	16	200	0	1
9	Sinlahekin Creek	5 375	2 972	12	2 682	1 182	11	1,800	0	2
10	Similkameen River	7,318	2 996	21	9 207	4 022	49	0	0	0
11	Nine Mile Creek	1 310	406	2	126	- 28	14	0	0	0
12	Tonasket Creek	460	223	3	1 368	448	84	0	0	0
13	Antoine/Whiskey Cache Creek	1460	638	9	837	230	76	0	0	0
14	Siwash Creek	1 837	795	9	585	230	16	20	p	1
15	Bona ante Creek	3 358	1 182	39	2 691	1 106	54	425	0	5
16	Chewilken Creek	0	0	0	144	32	16	0	0	0
17	Tunk Creek	74	4	2	1 728	718	31	30	0	1
18	Wanacut Creek CIR *	0	0	0	9	2	I	0	0	0
19	Omak Creek CIR *	5	2	1	135	48	7	0	0	0
20	Toats Coulee Creek	3	1	1	738	324	3	0	0	0
21	Starzman Creek	2 680	835	19	576	224	20	450	0	2
22	Pine Creek	5 683	1 229	22	432	130	34	3 080	0	3
23	Horse Springs Coulee	4 026	1 994	11	81	20	9	0	0	0
24	Mosquito Creek	10	1	1	45	10	5	0	0	0
25	Chopaka Lake	453	3	2	0	0	0	0	0	0
26	Whitestone Lake	3 122	1 360	21	756	248	50	100	0	1
27	Indian Dan Canyon	, 715	11	5	630	280	1	370	0	2
28	Whitestone Coulee	2 115	722	4	549	242	2	0	0	0
29	Duck Lake	9 126	2 959	106	10 278	4 484	78	1 200	0	4
30	Omak Lake CIR *	480	320	1	936	394	14	0	0	0
31	Baker Creek	5	1	1	288	68	31	0	0	0
	Total	180,325	70,705	905	102,924	42,086	2,417	24,821	21	81

Note. Small differences between this table and Table 9 are due to incomplete information on section-township-range data in the WRIS database.

Water Rights Claims

The Claims Registration Act, Chapter 90.14 RCW, sought to document existing surface water and groundwater uses prior to adoption of the State Surface Water Code, Chapter 90.03 RCW, and the State Groundwater Code, chapter 90.44 RCW. These laws were adopted in 191? and 1945 respectively. During the Claims Registration period, water users completed a long form to claim detailed uses for domestic and irrigation needs, and completed a short form for a single domestic use with up to 1/2 acre non-commercial lawn and garden.

While the accuracy of the data on some Claims is questionable, the final determination of the validity and extent associated with a Claim registered in accordance with RCW 90.14 ultimately lies with the Superior Court through the general adjudication process provided for by Sections 90.03.110 through 90.03.240. Therefore, for the purpose of this report, the quantities shown on the Claims documents were used. If a Claim did not specify a water quantity, Ecology used the estimates that are summarized in Table 12 below:

Table 12
Estimates Used for Claims Not Specifying a Water Quantity

Use	Groundwater	Surface Water
Single domestic use (up to 1/2 acre)	9 gallons per minute (gpm) instantaneous use and two acre-feet annual use	0.02 cubic feet per second (cfs) instantaneous use and two acre-feet annual use
Irrigation (per acre)	9 gpm instantaneous use and four acre-feet annual use	0.02 cfs instantaneous use and four acre-feet annual use

Water rights claims received by Ecology for the Okanogan River Watershed are summarized in Table 13 and are also detailed by subbasin in Tables 10 and 11. Surface water claim volumes are much greater than surface water permits volumes. Surface water claims in a few subbasins (i.e., Loup Loup Creek and Salmon Creek) have very large quantities that greatly exceed current or even potential usage. Quantities of groundwater claims are less than those for groundwater permits in most subbasins, but are still significant.

The distribution of Water Rights Claims in the Okanogan River Watershed is illustrated in Maps 4 and 5.

Table 13
Summary of Water Rights Claims

Type	Qi Instantaneous Rate (cfs)	Qa Annual Quantity (ac-ft/yr)	Number of Claims
Surface Water	3,044	605,790	1,919
Groundwater	230	42,086	2,417
Total	3,274	647,876	4336

Water Rights Applications

Pending groundwater and surface water applications are summarized by subbasin in Tables 10 and 11. Thirty seven applications for surface water permits are pending requesting a total of 64.4 cfs. Most of the applications (19 applications for 50.9 cfs) are for a point of diversion on the lower Okanogan River. The middle reach of the Okanogan River has 3 applications for 8.8 cfs, while the rest of the watershed has 15 applications for 4.7 cfs. Applications for groundwater permits total 81 for 24,821 gpm (55.3 cfs). Again, a large number of the applications are located on the lower reach of the Okanogan River (11,792 gpm), but many additional applications are located in subbasins higher up in the watershed. Eleven applications for 3,405 gpm are located within the middle and upper reaches of the Okanogan River, while 33 applications for 9,624 gpm are on file for 15 of the tributary subbasins.

The distribution of Water Rights Applications in the Okanogan River Watershed is illustrated in Figures 6 and 7.

Instream Flows

Minimum instream flows were established by rule for three reaches (called stream management units) on the Okanogan River and one reach on the Similkameen River in 1976. The minimum instream flows are set in Chapter 173-549 WAC (included in Appendix C). Chapter 173 - 549 WAC also stipulates that all remaining perennial streams in the Okanogan River Watershed be subject to a May 1 to October 1 closure for protection of instream values. The upper Okanogan stream management unit (located upstream of the confluence with the Similkameen River) is closed to further consumptive appropriation from June 15 to August 31 with the exception of single domestic and stock watering use. With few exceptions, these instream flows do not affect water rights that were in existence prior to 1976, single domestic and stockwater use, and nonconsumptive uses that are compatible with the purposes of the instream flows.

Table 14 lists the four stream reaches affected by the minimum instream flow criteria set in Chapter 173-549 WAC. Control stations are USGS streamflow gauging stations. Minimum instream flow rates for each reach are tabulated in Table 15.
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Table 14 .
WAC Stream Management Units in Okanogan River Watershed

Unit Name	Control Station Name and Number	River Mile and Location	Affected Stream Reach
Lower Okanogan	Okanogan River at Malott, 12447200	RM 17.0 Sec 9, T32N, R5E	Okanogan River confluence with Wells Pool to confluence of Chewilken Creek
Middle Okanogan	Okanogan River near Tonasket, 12445000	RM 50.8 Sec 8, T36N, R27E	Okanogan River confluence of Chewilken Creek to confluence of Similkameen River
Upper Okanogan	Okanogan River at Oroville, 12439500	RM 77.3 Sec 27, T27N, R26E	Okanogan River confluence of Similkameen River to Osoyoos Lake
Similkameen	Similkameen River at Nighthawk, 12447500	RM 18.8 Sec 7, T40N, R26E	Similkameen River mouth to Canadian border

Table 15
WAC Minimum Instream Flow Requirements in Okanogan River Watershed

Month	Day	Minimum Instream Flow from WAC (cfs)			
		Lower Okanogan (Sta.12447200 at Malott)	Middle Okanogan (Sta.12445000 near Tonasket)	Upper Okanogan (Sta.12439500 at Oroville)	Similkameen (Sta.12442600 at Nighthawk)
Jan	1	860	800	320	400
	15	830	800	320	4pp
Feb	1	820	800	320	4pp
	15	850	800	320	4pp
Mar	1	880	800	320	425
	15	900	800	320	450
Apr	1	925	910	330	510
	15	1100	1070	340	640
May	1	1750	1200	350	1100
	15	3800	3800	500.	3400
Jun	1	3800	3800	500	3400
	15	3800	3800	500	3400
Jul	1	2100	2150	420	1900
	15	1200	1200	350	1070
Aug	1	800	840	320	690
	15	600	600	300	440
Sep	1	620	600	300	400
	15	7pp	600	300	400
Oct	1	750	730	330	450
	15	960	9pp	370	500
Nov	1	950	900	370	500
	15	950	900	320	500
Dec	1	930	900	320	500
	15	900	850	320	450

Environmental Assessment

Water Quality

The Okanogan River is designated Class A (excellent) status by the State of Washington (Standards for Surface Waters, Chapter 173-201A 130 WAC,1992). This classification requires the Okanogan River to meet or exceed the standards for all designated beneficial uses, including: water supply, stock watering, fish and shellfish, wildlife habitat, and commerce and navigation. Water quality standards have been developed to maintain these beneficial uses. Notably, dissolved oxygen shall exceed 8.0 mg/L; temperature shall not exceed 18.0 degrees Celsius; pH shall be within the range of 6.5 to 8.5; and toxic concentrations shall be below levels which adversely affect water uses, public health, or aquatic biota (as per WAC 173-201A-040 and WAC 173-201A-050).

The 303(d) report (Butkus, S., 1994) is a list submitted by the Department of Ecology to the U.S. Environmental Protection Agency (EPA) as required by Section 303(d) of the Clean Water Act. The list contains all those surface water body segments that fail to meet state water quality standards. The Okanogan River was included on the list because of failures to meet water quality standards including temperature, dissolved oxygen, pH, and fecal coliform bacteria. The greatest number of standard exceedences occur during the summer months, when water temperatures have been measured at levels that exceed the standard, and dissolved oxygen levels fall below the minimum standard.

In addition to the water quality standard violations listed in the 303(d) report, data from USGS station 12447200 (Okanogan River at Malott, Washington) indicate additional periods of non-compliance with standards. Trends in data for water years 1983-1993 show a consistent late summer water temperature criteria violation (annual violations from 1983-1993). Dissolved oxygen criteria were not met in late summer (August) of 1979, and 1986-1988. Fecal coliform criteria were exceeded in 1984 (October 13), 1986 (June 4), and 1987 (October, June, August).

In addition, the data indicates consistent violations of water quality criteria for lead and mercury. Metals criteria for the State of Washington are hardness dependent and are calculated for acute (short-term) and chronic (long-term) exposures. Because samples obtained from the Okanogan River were characterizing baseline conditions, chronic criteria were calculated, which are lower than acute criteria. Chronic lead criteria were exceeded for the sampling periods in 1983 and 1984 (November, February, June, August), and at least one sampling period for 1985, 1986, 1989, and 1990. Chronic mercury criteria were exceeded for all sampling periods in 1983, and at least one period in 1984, 1987, 1988, and 1991. A summary of water quality parameter exceedences is listed in Table 16.

Table 16
Exceedences from Water Quality Standards

Monitoring Stations Location	Monitoring Station	Parameters Exceeding Standards	Description of Parameter
Okanogan River at Malott, WA, River mile 13.1	Ecology ambient monitoring station 49A070	Temperature	8 excursions beyond criteria between 1/1/90 and 1/1/92.
Okanogan River at Malott, WA	USGS station 12447200	Temperature	4 excursions beyond criteria between 7/1/87 and 7/1/91.
Okanogan River at Malott, WA, River mile 13.1	Ecology ambient monitoring station 49A070	Dissolved oxygen	2 excursions beyond criteria between 1/1/90 and 1/1/92.
Okanogan River at Malott, WA, River mile 13.1	Ecology ambient monitoring station 49A090	Fecal coliform	2 excursions beyond criteria between 1/1/90 and 1/1/92.
Okanogan River at the City of Okanogan, WA, River mile 26.0	Ecology ambient monitoring station 49A090	Temperature	3 excursions beyond criteria between 1/1/88 and 1/1/92.
Okanogan River at Oroville, WA. River mile 78.0	Ecology ambient monitoring station 49A190	Temperature	6 excursions beyond criteria between 1/1/88 and 1/1/92.
Okanogan River at Malott, WA, River mile 13.1	Ecology ambient monitoring station 49A070	pH	11 excursions beyond criteria between 1/1/88 and 1/1/92.

Fisheries

Several sources of information were reviewed to identify key fish populations of management concern in the Okanogan River Watershed. These sources included: 1) the Washington Department of Fisheries' "Washington State Salmon and Steelhead Stock Inventory" (SASSI) database (WDF 1992); 2) the Washington Department of Wildlife's (WDW) "Washington River Inventory System" (WARIS) GIS database; 3) the WDW's "Salmon and Steelhead Production Plan for the Methow and Okanogan Rivers Subbasin" (WDW 1990); and 4) the American Fisheries Society's Pacific salmon "stocks at risk" report (Nehlsen et al. 1991). The latter document was prepared as part of the Columbia Basin System Planning program, and was co-authored by the Confederated Tribes and Bands of the Yakima Indian Nation, the Confederated Tribes of the Colville Indian Reservation, and the WDF. In addition, fish biologists with state and federal agencies and the Douglas County P.U.D. were contacted to identify the key fish populations and management issues of concern in the Okanogan River Watershed. The agencies contacted included Ecology, the Washington Department of Fish and Wildlife (WDFW), the U.S. Forest Service (USFS), the U.S. Army Corps of Engineers (COE), and the U.S. Fish and Wildlife Service (USFWS).

Species present in the Okanogan River Watershed are summarized in Table 17. Based upon these sources, three anadromous fish populations were identified to be of greatest concern in the Okanogan River Watershed. These fish populations are:

- Chinook Salmon *(Oncorhynchus tshawytscha)*, summer race;
- Steelhead Trout *(Oncorhynchus mykiss)*, summer race; and
- Sockeye Salmon *(Oncorhynchus nerka).*

Although several other species of game fish are found within the Okanogan River Watershed, including rainbow trout and smallmouth bass, fisheries management programs have been primarily aimed at the three species mentioned above. Bull trout *(Salvelinus confluentus)*, a candidate species for the Federal Threatened and Endangered Species List, have not been found in the Okanogan River Watershed according to surveys conducted by the U.S. Forest Service (pers. comm., Jim Spotts, USFS).

A life history bar chart showing the timing of entry, spawning, emergence, rearing and outmigration of the anadromous fish populations in the Okanogan River Watershed is shown in Table 18.

<u>Summer Chinook Salmon</u>

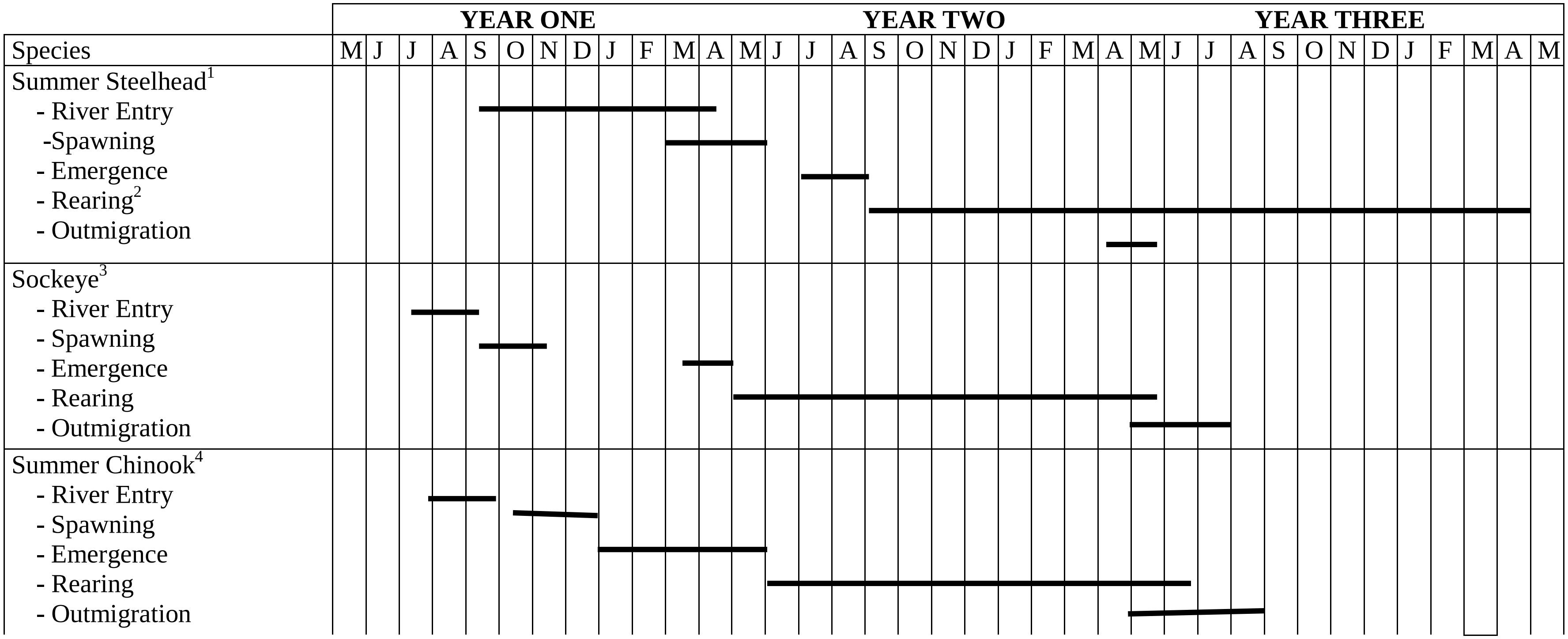
Summer Chinook populations were historically abundant in the mainstem and tributaries of the middle and upper Columbia River .drainage, .including populations endemic to the Okanogan and Similkameen rivers. However, the development of hydroelectric projects on the mainstem and tributaries of the Columbia and Okanogan Rivers has contributed to the reduction of these runs. Currently, summer chinook salmon management within the Okanogan River Watershed is conducted to support natural propagation of the fish inhabiting the upstream reaches of the mainstem Okanogan River and the Similkameen River below Enloe Dam (there is no summer chinook production above Enloe Dam). The run size for summer chinook within the watershed averaged 532 in 1977 and 617 in 1985 (these averages may include some stray hatchery fish).

Table 17
Summary of Species Present and Major Factors Limiting Anadromous Fish Populations in the Okanogan River Watershed

Location	Species Present	Low Flow	Water Quality	Migration Barriers	Other Constraints
Okanogan River (Lower Mainstem)	Chinook Summer Race	Yes	Poor	Thermal, irrigation, diversions.	Sedimentation, cover, high temperatures.
Okanogan River (Lower Mainstem)	Sockeye	-	-	Thermal, irrigation, diversions.	High temperatures.
Okanogan River (Lower Mainstem)	5teelhead	_	_	diversions.	Sedimentation, cover, high temperatures, flow, low velocity.
Okanogan River (Lower Tributaries)	Steelhead	-	Good	Irrigation, diversions.	Cover, flow, access.
Okanogan River (Upper Mainstem)	Chinook Steer Race	Yes	Fair	Thermal, irrigation, diversions.	Sedimentation, cover, .high temperatures, quality and quantity of spawning gravel.
Okanogan River (Upper Mainstem)	Sockeye	-	-	Thermal, irrigation, diversions.	-
Okanogan River (Upper Mainstem)	Steelhead	_	_	Thermal, irrigation, diversions.	Sedimentation, cover, high temperatures, gravel quality, low velocity.
Okanogan River (Upper Tributaries)	Steelhead	Yes	Fair	Irrigation, diversions.	Sedimentation, cover, high temperatures, gravel quantity.
Similkameen River (Mainstem)	Chinook Summer Race	Yes	Fair - Good	-	Sedimentation, gravel quantity.
Simikameen River (Mainstem)	Steelhead	-	-	Enloe Dam	Sedimentation, cover/habitat, gravel quantity.

Source: WDW Methow and Okanogan Subbasin Plan, September, 1990.

Table 18
Life history of fish populations in the Okanogan River Watershed.



1 Due to insufficient data on natural steelhead in the Okanogan River Watershed, population characteristics for emergence, outmigration, and rearing are derived from Wells Hatchery steelhead information.
2 Steelhead juveniles rear for 2 to 4 years before outmigration in the spring.
3 Some Sockeye juveniles remain in Osoyoos Lake for a second year before outmigration.
4 Characteristics of Okanogan River Watershed summer Chinook are not documented. Therefore, because of their presumed life history similarities, characteristics for Wells Dam Hatchery fish are presented in lieu of Okanogan River Watershed Data.

Due to the depressed nature of these runs, the Washington Department of Fisheries (WDF) has restricted the harvest of summer Chinook within the watershed (WDW 1990).

Fish within the watershed are subject to poor water quality and low flow conditions as well as critically high water temperatures during summer months. The acceleration of erosion and sedimentation within the Okanogan River Watershed has also resulted in diminished rearing habitat and a substantial decrease in the availability of quality spawning areas. Factors affecting summer Chinook populations in several Okanogan River Watershed locations are presented in Table 17.

It has been determined by the Washington Department of Wildlife (WDW) that Spring Chinook are extinct in the Okanogan River Watershed. The loss of this race has been attributed to the decline in tributary spawning and rearing areas (WDW 1990).

Steelhead Trout

The Okanogan and Similkameen Rivers and specifically their tributaries have historically supported productive steelhead trout populations. Although the cause for the reduction of steelhead within the Okanogan River Watershed has not been specifically determined, major dams on the Columbia River, commercial fishing pressures, and tributary impoundments are likely associated with their decline.

Okanogan steelhead were mixed with other upper Columbia River stocks during the Grand Coulee Fish Maintenance Project` During this project fish from several upper Columbia River basins were trapped and released into adjacent basins. Population counts of steelhead were historically collected at the Rock Island Dam and included stocks from the Okanogan, the upper Columbia, and 3 other tributaries to the upper Columbia River. The counts conducted in the 1950s averaged 3, 722 fish (WDW 1990).

In response to warm water temperature, steelhead enter the Okanogan River Watershed in mid-September through early April. These higher temperatures may also be the reason that winter "drop back" seen in steelhead in adjacent basins may not occur in the Okanogan River Watershed. Spawning in the mainstem occurs from mid-March through late May. Concurrent spawning occurs within in the first ten miles of the Similkameen River below Enloe Dam. Other tributary spawning is limited by low flows and diversion channels (WDW 1990).

The primary factors affecting steelhead populations within the Okanogan River Watershed are high summer and early fall water temperatures, extensive deterioration of quality riparian and instream habitat, sedimentation, and the loss of tributary reaches for spawning and rearing due to diversion projects (WDW 1990; pens. comet., Jim Spotts, U.S. Forest Service).

Steelhead within the Okanogan River Watershed are a mixed stock The Wells Salmon and Steelhead Hatchery has planted smolts in the basin since 1983. Due to the relatively limited number of natural fish identified in the watershed it is believed that hatchery fish have exerted genetic influence on the wild population (WDW 1990).
Sport anglers and tribal harvests are permitted on the Okanogan and Similkameen Rivers. Steelhead harvest protection measures are directed at juveniles on the Similkameen River and

adults on both the Okanogan and Similkameen. The Washington Department of Wildlife patrols during harvest times on the Similkameen River from June through April. Fishing on the Okanogan is permitted year round Factors affecting steelhead trout populations in several Okanogan River Watershed locations are presented in Table 17.

Sockeye Salmon

Historically sockeye salmon inhabited several of the lake systems within the mid and upper Columbia River and its tributaries. The development of nine hydroelectric projects, and construction of impassable diversions within these watersheds has significantly reduced fish access to spawning areas. Today, Osoyoos Lake and Lake Wenatchee are the only two lakes inhabited by sockeye within this region (WDW 1990).

Sockeye salmon inhabit and spawn in Osoyoos Lake but spawn primarily in the upper mainstem of the Okanogan River located above the lake. Migration up the Okanogan River begins in late July through early August and continues until fish reach the lake in late August to early September. Fish counts of upstream migrants for 1980 through 1987 averaged 38,848 individuals, however, the number of these fish that actually survive to spawn is unknown. Spawning activity within the basin generally peaks in late October. Fry emerge in late March through early April and generally rear for one year before outmigration. (WDW 1990)

Fish migrating upstream encounter warm water temperatures during the late summer months that can result in delayed migration. This thermal barrier can lead to reduced spawning fitness and disease related mortality. In addition to high water temperatures, fish are further affected by poor instream flows, tributary and mainstem irrigation diversions, sedimentation, and poor water quality. During the summer months, the water temperature in Osoyoos Lake averages approximately 23° C and anoxic conditions can exist to a depth of 30 feet within the southern lake basin (pers. comm., Rick Klinge, Douglas County PUD).

There is no tribal fishery on the Okanogan, however, natives can fish for sockeye above Osoyoos Lake. Sockeye originating in the Okanogan River Watershed are thought to comprise approximately 50 percent of the commercial harvest on the lower Columbia River (WDW 1990). Factors affecting sockeye populations in several Okanogan Watershed locations are presented in Table 17.

Status of Fish Stocks

Fish population and stock data from the American Fisheries Society (AFS) Threatened and Endangered Fishery Stock Report (Nehlsen et al. 1991) and the Washington State Salmon and Steelhead Inventory (SASSI) were reviewed. The status of stocks in the Okanogan River Watershed as given in the AFS and SASSI reports is presented in Table 19.

Table 19
Comparison of American Fisheries Society List and Salmon and Steelhead Stock Inventory.

Water Body	Stock	AFS Status	AFS Factors	SASSI Status	SASSI Origin	SASSI Type
Okanogan River	Chinook Salmon Summer race	*Special Concern*	1	Depressed	Native	Wild
Okanogan River	Sockeye Salmon	*Special Concern*	1	Healthy	Native	Wild
Okanogan River	Steelhead Trout Summer race	*High Risk*	1,4	Depressed	Mixed	Wild

Water Body

The water body is the river, creek, lake (etc.) that is named in the respective reports as being the place of origin for the identified stock (i.e., where the stock returns to spawn).

Stock

The term stock defines the population of fish that spawn in a particular season and do not breed with other fish that spawn in a different basin during a different season. These populations contain specific genetic differences that have adapted to the specific characteristics of the water body and season in which they spawn.

AFS Status

The American Fisheries Society has established a list of at high risk (A), at moderate risk (B), or of special concern (C) salmon, steelhead, and sea-run cutthroat trout stocks. Stocks and their rating identified on the AFS list for the Okanogan River are presented above.

AFS Factors

The American Fisheries Society developed a list of factors that are currently most threatening to the stocks identified in the AFS Status list. The two factors presented in Table 19 are:

1. The present or threatened destruction, modification, or curtailment of stocks habitat or range, as well as mainstem passage and flow problems, and predation during reservoir passage or residence.

2. Other natural or human-created factors affecting the stocks continued existence, such as hybridization, introduction of exotic or translocated species, predation not primarily associated with mainstem passage and flow problems, and competition. This category includes poor ocean survival conditions, as well as negative interactions with hatchery fish, such as hybridization, competition and disease.

SASSI Status

The WDF Salmon and Steelhead Stock Inventory has established a set of status ratings ranging from Healthy to Extinct. The rating "depressed" presented in Table 19, defines a stock of fish w1iose production is below levels that are based on available habitat and natural variation in survival rates, but above a level that is likely to result in permanent damage to the stock.
SASSI Origin

Fish Stock origin definitions were developed to attempt to categorize the genetic history of stocks. The assessments of stock origin presented in Table 19 should be considered primary until additional information confirms or refutes the current designations. The definitions of the designations presented in Table 19 are:

1. Native - a stock that has become established outside of its original range.

2. Mixed - a stock that has undergone significant genetic change, hybridization, and/or originated from commingling native and non-native parents.

SASSI Type

This classifications refers to the type of spawning and rearing activity that produced the fish. The definition of the Type presented in Table 19 is:

1. Wild - a stock that is sustained by natural spawning and rearing in the natural habitat, regardless of rearing parentage (includes native).

Spawning Habitat

Salmonid spawning areas in the Okanogan River Watershed were identified from the WDW WARIS database. Habitat suitable for salmonid spawning are widely distributed throughout the Okanogan River Watershed, and include the following areas:

- Okanogan River (entire mainstem section from confluence with Columbia River to Osoyoos Lake);
- Chiliwist Creek (mainstem);

- Summit Creek (mainstem and tributaries);
- Salmon Creek (lower mainstem and tributaries above Conconully Lake);
- Omak Creek (lower mainstem);
- Johnson Creek (mainstem);
- Tunk Creek (mainstem); - .
- Aeneas Creek (mainstem);
- Bonaparte Creek (mainstem);
- Antoine Creek (mainstem);
- Tonasket Creek (lower mainstem);
- Ninemile Creek (mainstem);
- Similkameen River (entire mainstem section from confluence with Okanogan River to
- international border);
- Sinlahekin Creek (mainstem above Palmer Lake and all major tributaries).

Water Quality Impacts

Areas in the Okanogan River Watershed where fish production is limited by water quality were identified from the Wash Dept. of Wildlife's Washington River Inventory System (WARTS) database. Water quality factors which can potentially limit the fish populations addressed in the WARIS database include pollution, high temperatures, dissolved gasses, turbidity, and low flows due to withdrawals or natural conditions. Areas of the Okanogan River identified in the WARIS database where water quality factors are annually impacting fish populations include:

- Okanogan River (entire mainstem section from confluence with Columbia River to Osoyoos
- Lake);
- Salmon Creek (lower mainstem);
- Summit Creek (lower mainstem section and upper tributaries);
- Tallant Creek (lower mainstem);
- Omak Creek (lower mainstem);
- Tunk Creek (mainstem);
- Aeneas Creek (mainstem);
- Bonaparte Creek (mainstem);
- Antoine Creek (mainstem);
- Mosquito Creek (mainstem);
- Tonasket Creek (mainstem);
- Similkameen River (lower mainstem); and
- Sinlahekin Creek (Palmer Lake to confluence with Toots Coulee Creek).

Fisheries biologists with the U.S. Forest Service (Okanogan National Forest) and the Wash. Dept. of Fish and Wildlife cited high water temperatures as the most pervasive water quality factor limiting salmonid populations in the Okanogan River Watershed. The upstream migration of adult sockeye is stopped and the Okanogan River becomes a thermal block when the water temperature reaches f9° F to 70° F (Caldwell, pers. comm. 1995).

The Washington Dept. of Ecology (Ecology) currently operates Zosel Dam on Osoyoos Lake near Oroville, Washington for the benefit of fish populations in the lower Okanogan River

(Brad Caldwell, Ecology, pers. comm. Jan. 31, 1995). Operation of this' dam is conducted according to an international treaty with Canada. The operation of the dam for flow and temperature control in the Okanogan River is limited by the volume and temperature of inflow from Canada. Zosel Dam is currently limited to a fluctuation of 1 ft, and thus has only a very limited ability to regulate flows in the lower Okanogan River.

Sediment Impacts and Habitat Degradation

Spawning and rearing habitats for summer chinook salmon and summer steelhead trout have been seriously degraded by sedimentation in many areas of the Okanogan River Watershed. Sources of sediment include heavy loads of sand and silt derived from the upper Similkameen River, agricultural activities and irrigation runoff, overgrazing, and logging (WDW 1990). Spawning gravels in the lower Okanogan River are heavily impacted by sediments. These lower reaches of the Okanogan River may be especially important to fall chinook salmon, which have been observed to spawn in this section of the river during spawning surveys conducted by the Yakima Indian Nation (Kohn 1988). Agriculture, grazing, and logging activities has resulted in channel widening, increased sedimentation of spawning gravels and interstitial areas of substrates important to salmonid fry and juveniles. Loss of the riparian vegetative corridor has also resulted in higher water temperatures.

Potential Flow Impacts and Recommended Minimum Instream Flows

Fish populations in the Okanogan River Watershed are potentially limited by both low and high flows. Flows in both the Okanogan and Similkameen Rivers are characterized by a low flow period extending from late-August to early-April, and a high flow period extending from late-April to early-September. To reduce the impacts of low flows on fisheries resources, the Washington Dept. of Ecology established minimum instream flow requirements in the lower, middle, and upper reaches of the Okanogan River, as well as in the Similkameen River (Tables 14 and 15). These minimum instream flow requirements were set in 1977 probably according to "watershed ranking" or flow-frequency techniques used by the state water and fisheries resource agencies at that time (pers. comm., Brad Caldwell, Ecology). Use of habitat based instream methods, including the Instream Flow Incremental Method (IFIM), were not fully developed and implemented for setting flow recommendations until the early 1980's. Minimum instream flow requirements for the Okanogan River were established on a semi-monthly basis, and range from 860 to 3,800 cfs in the lower and middle Okanogan River, 320 to 500 cfs in the upper Okanogan River, and 400 to 3,400 cfs in the Similkameen River.

Analysis of flow frequency relationships developed from USGS gaging station records suggest that low flows may periodically impact fish populations in the Okanogan and Similkameen Rivers. Low flow conditions which fall below the recommended minimum instream flow values occur on a frequent basis in these river systems. Flows in the both the Okanogan and Similkameen Rivers which do not meet minimum instream flow requirements 100 days or more on an annual basis occur approximately every three or four years, based upon flow records for the past 30 years. These substandard flow conditions occur throughout the year, and thus potentially impact the spawning and rearing lifestages of summer chinook salmon and summer steelhead trout. Effects on natural fish production in the Okanogan River Watershed has been partially attributed to low flow conditions resulting from water diversions (WDW 1990). Low flows occurring in combination with high water temperatures may limit rearing habitat for juvenile salmonids at many locations in the watershed.

The USFWS completed a MM study in 1988 for both the lower Similkameen and Upper Okanogan Rivers. However, final analysis of this data. does not appear to have been completed, and flow recommendations were not developed based upon the results of this study (pers. comet., Steve Fransen, USFWS). The results of this study could probably be used to recommend monthly instream flow requirements for the Similkameen and Okanogan Rivers which may be more appropriate for protecting fish habitat quality than the flow requirements currently published in the Washington Administrative Code (WAC).

Conclusions

The following conclusions can be drawn from the information contained in this report:

- The Okanogan River Watershed within Washington State (WRIA 49) encompasses about 2,100 square miles. It's headwaters are located within British Columbia, Canada. The total drainage area of the Okanogan River is about 8,400 square miles. Principal land uses in WRIA 49 are agriculture, rangeland, forestry,. residential development and recreation. Mean annual precipitation within the portion of the Okanogan -River Watershed located within the State of Washington is about 17:5 inches. Most all of the streamflow in the Okanogan River is contributed by the Okanogan and Similkameen Rivers flowing out of British Columbia.
- There is 36,000 to 40,000 acres of irrigated area within WRIA 49. Water use for that acreage is not available, but is estimated to be in the range of 140,000 to 160,000 acre-feet per year. Other water uses such as residential use much less water than irrigation.
- Total annual streamflow in the Okanogan River averages about 2.1 million acre-feet (measured at the U.S.G.S. gauging station located at Malott). A majority of that flow (more than 60 percent) occurs in the spring and early summer from snowmelt runoff.
- A total of 1,534 cfs and 177,864 acre-feet per year in Water Rights Permits and Certificates have been issued in WRIA 49. Of that total, 1,133 cfs and 107,160 acre-feet per year are Surface Water Permits and Certificates, and 401 cfs and 70,704 acre-feet per year are Groundwater Permits and Certificates. Irrigation is by far the largest type of water user, with about 98 percent of the volume of the Surface Water Permits and Certificates, and 56 percent of the volume of Groundwater Permits and Certificates. An additional 4,336 Surface Water and Groundwater Claims have been registered for a total of 3,273 cfs and 647,876 acre-feet per year. Surface Water Claims in a few subbasins vastly exceed available supply and therefore distort this number: There are currently 118 Water Rights Permit Applications on file at Ecology, requesting a total of 119.6 cfs. Most of those applications are for a point of use along the middle and lower mainstem of the Okanogan River.
- Groundwater resources are present primarily within the sand and gravel material that fills the bottom of most of the river and stream valleys. The aquifers present within the watershed are generally considered to be in hydraulic connection with the surface water bodies; streams, rivers and lakes. However, insufficient data exists to fully characterize the relationship between surface and groundwater along the Okanogan River and its subbasins. Scattered data indicates that some locations may have deep confined aquifers within the fill material that may not be in connection with nearby surface water. Continued development of groundwater resources may effect existing wells and surface water bodies.
- Water quality sampling indicates that criteria for lead and mercury have been consistently exceeded. Chronic lead and mercury criteria were exceeded in sampling results reviewed from 1983 to 1991.

- Salmonid fish populations in the Okanogan River Watershed are limited by a number of factors, including passage impacts due to dams and thermal barriers present in both the upper Columbia River and the Okanogan River system, water quality problems including high water temperatures, habitat degradation due to sedimentation and loss of riparian vegetation, and low flows.

- Nine Columbia River dams and associated smolt and adult mortality impacts have substantially reduced the production of anadromous .fish in the Okanogan River Watershed from historic levels. Upstream passage into the Okanogan River is hindered by thermal barriers which form at Wells Dam in the Columbia River and in the lower section of the Okanogan River during the late summer and early fall.

- Sediment has substantially degraded fish spawning and rearing habitat throughout the Okanogan River Watershed. The greatest sediment impacts have been observed ire the lower reaches of the mainstem Okanogan River. Significant amounts of silt enter the Okanogan River, much of it from agricultural sources. Sediment is also derived from grazing and logging activities conducted in the watershed.

- The water quality factor which is most limiting to salmonid populations in the Okanogan River Watershed is water temperature. Unsuitable water temperatures to salmonids (> 20°C) occur frequently during the summer months in the Okanogan River Watershed. Higher water temperatures in this watershed have been attributed to cattle grazing and resulting loss of streamside cover, warming by irrigation return waters, and low flow conditions during the summer. Relationships between flow and water temperatures have not been analyzed in this watershed. However, low flows resulting from diversions has been found to significantly elevate the water temperature in many rivers due to reductions in hydraulic travel time and increased water surface area relative to volume.

- Minimum instream flows established by rule generally fall between the 90 percent (low) and 50 percent (median) exceedance flows of the Okanogan and Similkameen Rivers. However flows in the Okanogan and Similkameen Rivers frequently fall below minimum instream flow levels. On these two rivers, hydrologic conditions that result in the minimum instream flow requirement being not met for 100 days or more in the year occur approximately every three or four years. On average, streamflow in the Okanogan River falls below the minimum flow standard 60 days per year at Malott and Tonasket, and 100 days per year at Oroville. On the Similkameen River, minimum instream flows are not met 75 days of the year. A trend of increasing excursions below the minimum instream flows is apparent for the three gauging stations on the Okanogan River. The excursions are becoming more frequent in winter time than in summertime. Low flow conditions, in conjunction with habitat degradation due to sedimentation and higher water temperatures, probably limit fi;3h production in the Okanogan River Watershed, especially for the spawning and rearing lifestages of steelhead trout and summer Chinook salmon.

Recommendations

The following recommendations for further action are made based on the information contained in this report:

- Prepare detailed water budgets for sub-basins or reaches of the Okanogan River on which permit applications are outstanding and water availability issues cannot be resolved with this report. The water budgets should review surface and groundwater hydrology, existing uses and minimum instream flows to determine the availability of water and impacts from use.
- Because the distribution of the majority of runoff from the watershed (spring time) does not correspond to the time of peak use (late summer), the use of storage reservoirs to augment flows in the Okanogan River should be studied The storage reservoirs should be designed and managed to prevent adverse impacts to water quality and aquatic habitat. • A more in-depth analysis of the available groundwater resources including:
- A field verification survey of existing wells and approximate groundwater consumption.
- A more detailed review of really extensive water well logs on file to attempt to define any confining units and relationships between the subbasins and the main Okanogan River corridor.
- Perform geophysical surveys across the main valley to further define the extend of the valley fill materials and water bearing geologic units.
- Perform aquifer testing in areas of high groundwater demand (areas with a large number of applications) to further define aquifer parameters and, relationships with surface water and existing water users.
- Fisheries management recommendations should be developed from instream flow studies completed in the Similkameen and Okanogan Rivers in 1988 by the U.S. Fish and Wildlife Service. The results of those studies need to be analyzed to develop flow recommendations which would be more suitable than those published in the Washington Administrative Code (WAC). The recommended baseflows for the Okanogan River Watershed published in the WAC were based upon monthly flow exceedance data and salmonid life history information in 1977. The habitat based MM (Instream Flow Incremental Methodology) analysis employed in the 1988 instream flow studies may provide more realistic baseflow recommendations to maintain fish habitat quality in the Okanogan and Similkameen rivers.
- Relationships between flow and water temperature need to be evaluated. Although water temperature has been cited as a limiting factor to salmonid production in the Okanogan River Watershed, the effect of low flows under current and future water rights allocations on water temperatures in this system have not been not been identified. Water temperature modeling

might be helpful in determining if low flows result in higher temperatures in the Okanogan River.

- Effects of flows on thermal barriers pint in the lower Okanogan River and at Wells Dam need to be evaluated. These thermal barriers prevent upward migration of steelhead and summer Chinook salmon into the Okanogan River from the Columbia River during; the summer and early fall.

Bibliography

Atwater, Brian F.; Rinehart, C. Dean, 1984. Preliminary Geologic Man of the Colville Indian Reservation. Ferry and Okanogan Counties. Washington. U.S. Geological Survey Open-File Report 84-389, 20 P., 4 plates.

Bureau of Reclaimation, 1951. Okanogan River Basin. Washington Reconnaissance Report. United States Department of Interior, Boise, Idaho.

Bureau of Reclamation, 1991. Summary Statistics, Water and Related Data. United States Department of Interior, Denver, Colorado.

Butkis, Steve. Water Quality in Washington State (Section 03(d) of the Federal Clean Water Act). Washington Department of Ecology F-WQ-94-37, Olympia, WA

Chapter 173-201A, November, 1992. Washington Administrative Codes, Water Quality Standards for Surface Waters of the State of Washington.

Chapter 173-549, 1976. Washington Administrative Codes, Water Resources Program in the Okanogan River Basin. WRTA 49.

Clark, Bob, 1994. Personal Communication. (Memo on Water Purveyors in Okanogan County). Okanogan County Office of Planning and Development, Okanogan, Washington.

Cooperative Extension Service, 1975. Washington Climate for Chelan. Douglas and Okanogan Counties. Washington State University, College of Agriculture, Pullman, Washington.

Fox, James R. and Christopher Hodgkin, 1994. Washington State Almanac. Public Sector Information, Ins., Eugene, Oregon.

Fox, K. F., Jr., 1978. Geologic Map of the Mt. Bonaparte Quadrangle. Okanogan County Washington. U.S. Geological Survey Open-File Report 78-732, 2 sheets, scale 1:48,000.

Fox, K. F., Jr., 1970. Geologic Map of the Oroville Quadrangle. Okanogan County, Washington. U.S. Geological Survey Open-File Report 70-128, 3 sheets, scale 1:62,500:

Fox, K F., Jr.; Rinehart, C. D., 1968. Geologic Map of the Loomis Quadrangle., Okanogan County, Washington. U.S. Geological Survey Open-File Report 68-105, 2 sheets, scale 1:48,000.

Gulick, Charles W.; Korosec, Michael A., compilers, 1990. Geologic Map of the Omak 1:000.000 Quadrangle. Washington. Washington Division of Geology and Earth Resources Open File Report 90-12, 52 p., 1 plate

Kelley, Randy, 1995. Personal Communication. (Memo on Okanogan River Basin Irrigated Areas and Irrigation Districts). United States Department of Agriculture, Natural Resources Conservation Service, Okanogan, Washington.

Kohn, Mike, 1988. Spring and Summer Chinook Spawning Ground Surveys: Methow and Okanogan River Basins. Yakima Indian Nation Fisheries Resource Management. Dec. 1988. 44p.

MacNish, R. D., 1977. Seepage Tests on No Name Creek. Colville Indian Reservation. Washington. May 12-13, 1977. U.S. Geological Survey Open-File Report 77-618, 8p., I plate.

Menser, Fred J., Jr., 1982. Bedrock Geologic Map. Central Okanogan Range. Wash.. with. a Note on the Gravity of the Central Okanogan Range, Washington, by C. A. Swanberg. Western States College Foundation, Geological Society of America, Volume 94, No. 4, Page 471-498.

Minard, James P., 1985. Geologic Map of Quaternary Deposits of the Pothole Quadrangle, Okanogan County, Washington. U. S. Geological Survey Miscellaneous Field Studies Map MF-1680, 1 sheet, scale 1:24,000.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich, 1991. Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon. Idaho. and Washington. Fisheries 16(2):4-21.

Pacific Northwest River Basins Commission, December 1977. The Okanogan River Basin Level B Study of the Water & Related Land Resources (Revised). Vancouver, Washington.

Packard, F. A.; Sumioka, S. S.; Whitman, K. J., 1983. Ground Water-Surface Water Relationships in the Bonaparte Creek Basin, Okanogan County, Washington, 1979-80. U. S. Geological Survey Open-File Report 82-172, 46 p-

Pearson, R. C., 1967. Geologic Map of the Bodie Mountain Quadrangle. Ferry and Okanogan Counties- Washington. U. S. Geological Survey Geologic Quadrangle Map GQ-638, 1 sheet, scale 1:62,500, with 4 p. text.

Rinehart, C. Dean; Greene, Robert C., 1988. Geologic Map of the Northwestern Three-Fourths of the Aeneas Quadrangle. Okanogan and Ferry Counties, Washington. U.S. Geological Survey Open-File Report 88-281, 18 p., I plate.

Rinehart, C. D.; Fox, K. F., Jr., 1976. Bedrock Geology of the Conconully Quadrangle, Okanogan County. Washington. U.S. Geological Survey Bulletin 1402, 5 8 p.

Rinehart, C. D.; Fox, K. F., Jr., 1970. Geologic Map of the Conconully Quadrangle, Okanogan County, Washington. U.S. Geological Survey Open-File Report 70-277, 3 sheets, scale 1-:48,000.

Russell, R. H.; Eddy, P. A., 1972. Geohydrologic Evaluation of Aeneas Lake-Horse Springs Coulee. Okanogan County, Washington. Washington Department of Ecology Technical Report 72-2, 31 p., 2 plates.

Sims, Frances R., 1984. Bedrock Geology of the Omak Quadrangle and the Northeast Portion of the Ruby Quadrangle, Okanogan County, Washington. University of Idaho Master of Science thesis, 93 p., 1 plate.

Soil Conservation Service, 1971. Soil Survey. Okanogan County Area, Washington. United States Department of Agriculture, Spokane, Washington.

Staatz, M. H., 1964. Geology of the Bald Knob Quadrangle. Ferry and Okanogan Counties. Washington. U.S. Geological Survey Bulletin 1161-F, 79 p., I plate.

Stoffel, Keith L., McGrode, Michael F., compilers, 1990. Geologic Map of the Robinson Mtn- 1:100.000Quadrangle, Washington. Washington Division of Geology and Earth Resources Open File Report 90-5, 39 p., I plate.

Stoffel, Keith L., compiler, 1990. Geologic Map of the Republic 1:100.000 Quadrangle, Washington. Washington Division of Geology and Earth Resources Open File Report 9040, 62 p., 1 plate.

Stoffel, Keith L., compiler, 1990. Geologic Map of the Oroville 1:100,000 Quadrangle, Washington. Washington Division of Geology and Earth Resources Open File Report 90-11, 58 p., 1 plate.

Stoffel, K. L.; Joseph, N. L.; Waggoner, S. Z.; Gulick, C. W.; Korosec, M. A.; Bunning, B. B., 1991. Geologic Map of Washington--Northeast Quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-39, 3 sheets, scale 1:250,000, with 36p. text.

U.S. Geological Survey, various years. Water Resources Data Washington.

Walters, Kenneth, 1974. Water in the Okanogan River Basin, Washington. Water Supply Bulletin 34, Washington State Department of Ecology, Olympia, Washington.

Washington State Department of Ecology, July 1976. Water Resources Management Program, Okanogan River Basin (Water Resources Inventory Area 49). State of Washington, Olympia, Washington.

Washington State Department of Fisheries, 1992. Washington State Salmon and Steelhead Stock Inventory. Washington Dept. of Fisheries, Washington Dept. of Wildlife, and Western Washington Treaty Indian Tribes. State of Washington, Dept. of Fisheries. Olympia, Washington.

Washington State Department of Wildlife, 1990. Methow and Okanogan Rivers Subbasin Salmon and Steelhead Production Plan. Columbia Basin System Planning. Wash. Dept. of Wildlife. Olympia, Washington. 159 p.

Washington State Water Resources Association, 1994-95. Member Directory and Handbook. Yakima, Washington.

Yates, Richard and Charity Yates, 1994. 1994 Washington State Yearbook. Public Sector Information, Inc., Eugene, Oregon.

Figures

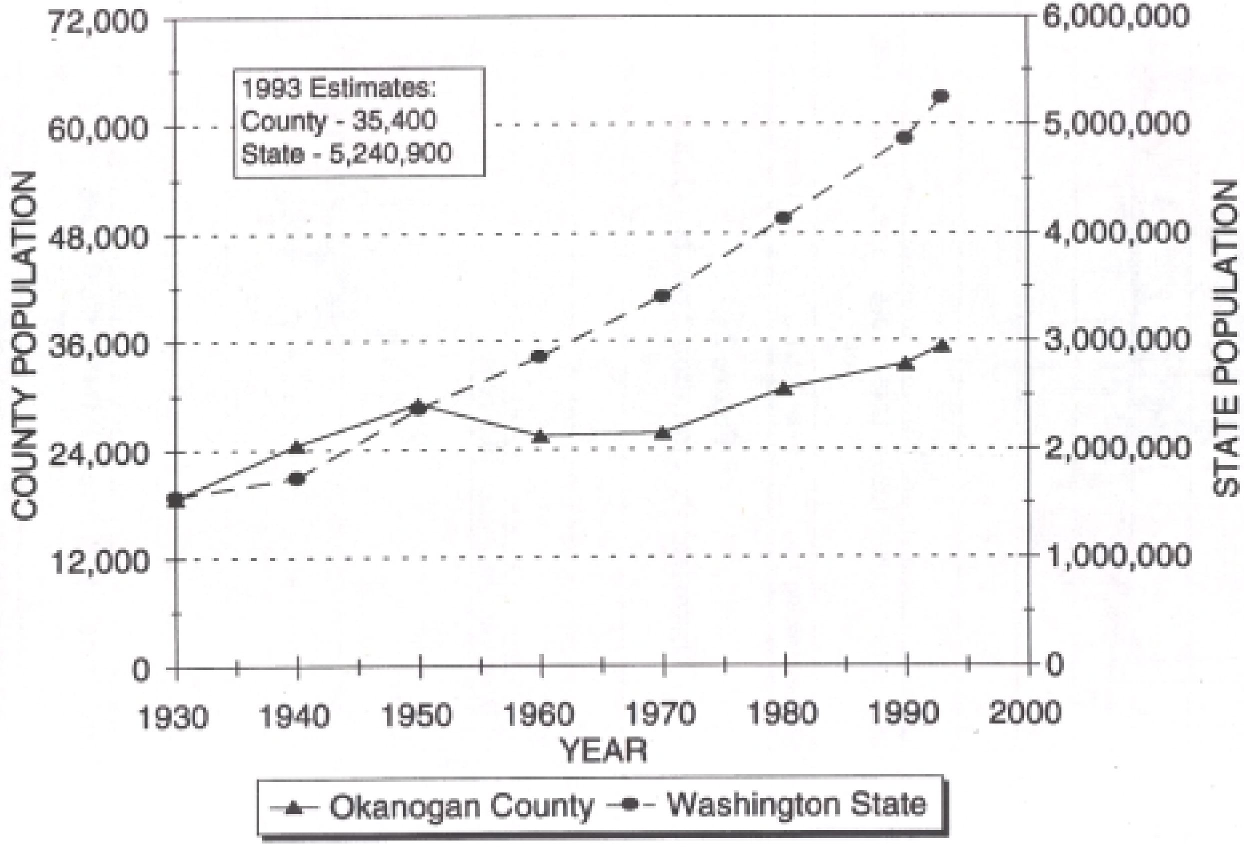


Figure 1
Population Growth in Okanogan County

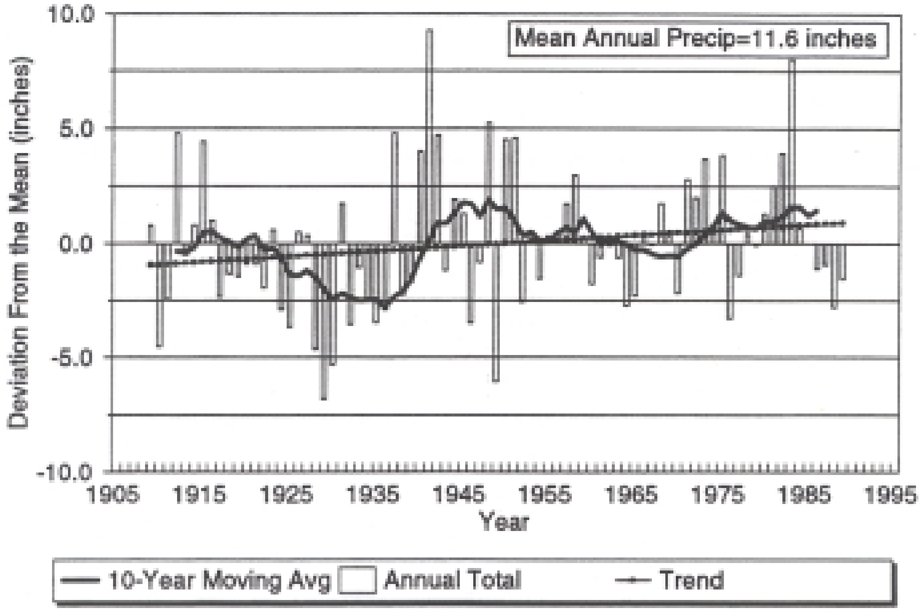


Figure 2
Historical Precipitation Trends - Omak

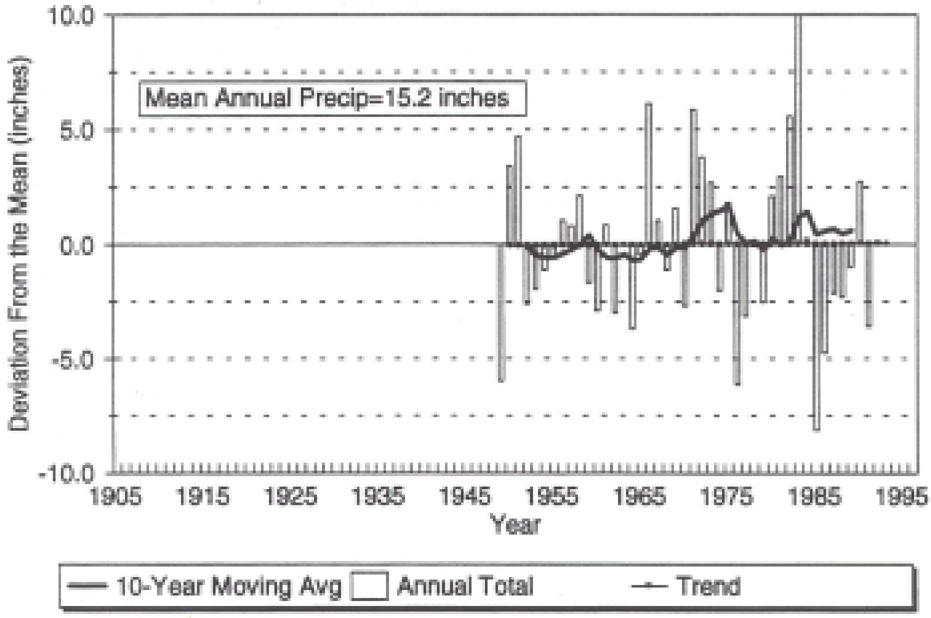


Figure 3
Historical Precipitation Trends - Conconully

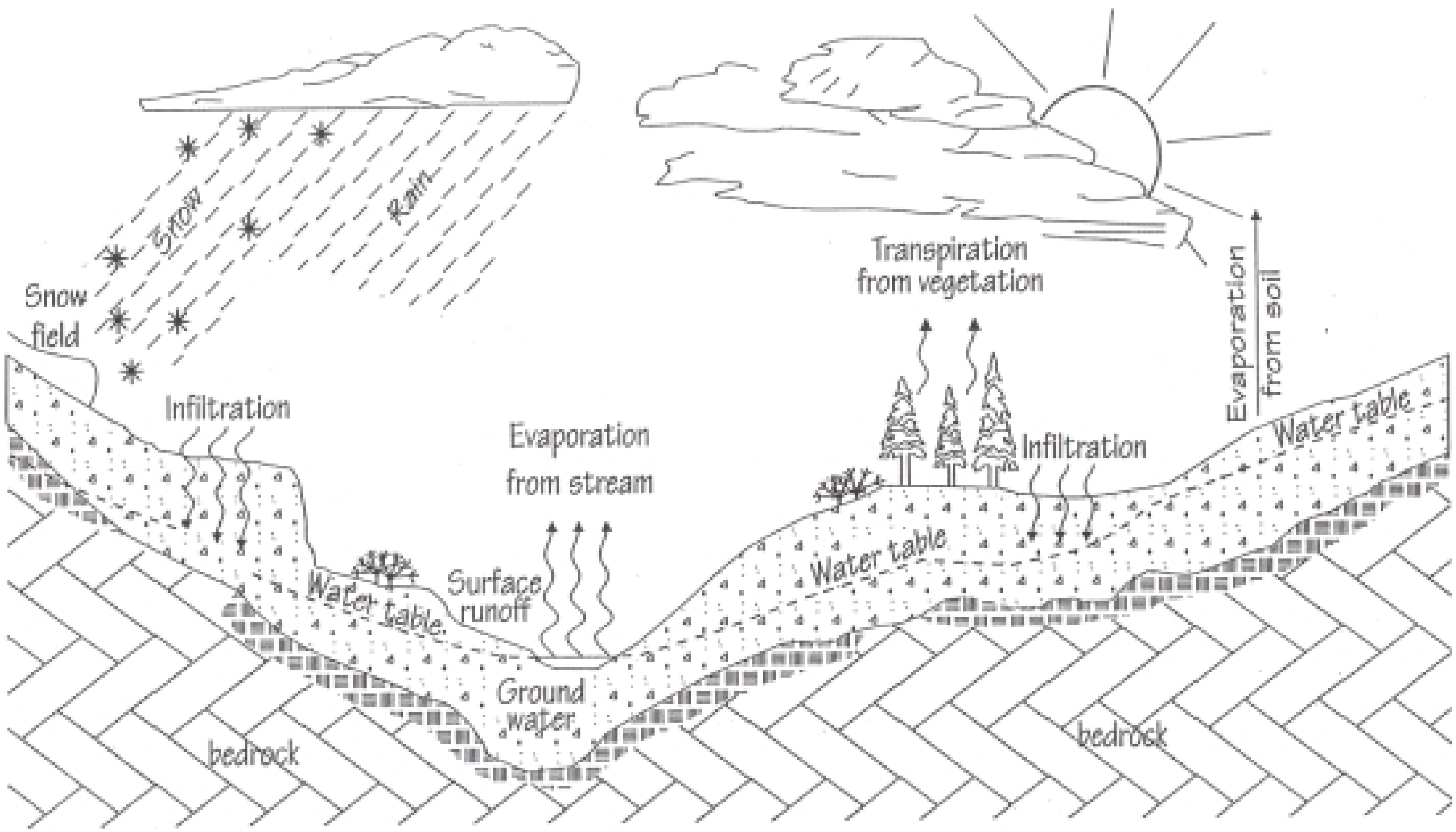


Figure 4
The Hydrologic Cycle
Okanogan River Watershed

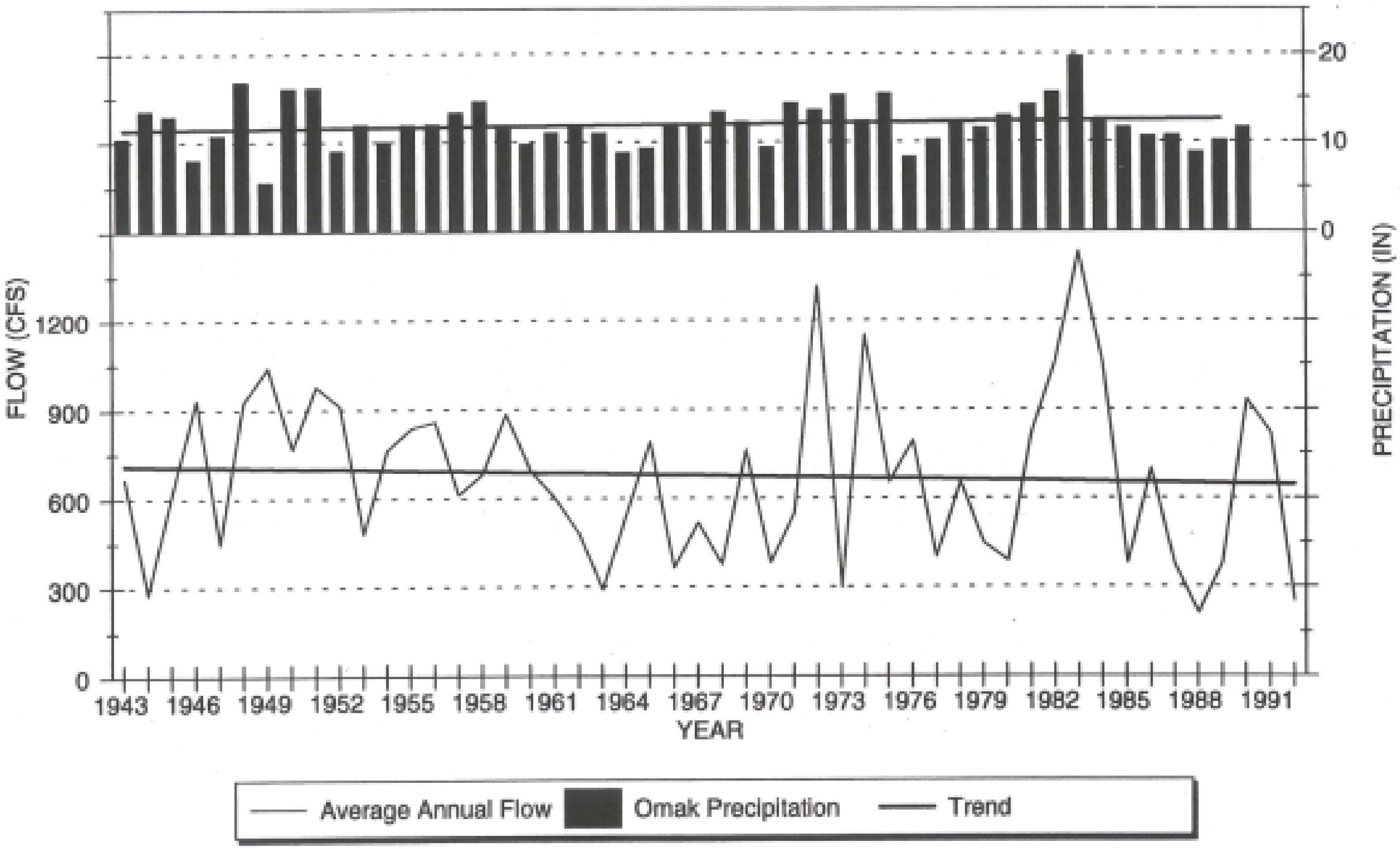


Figure 5
Okanogan River at Oroville
Average Annual Flows

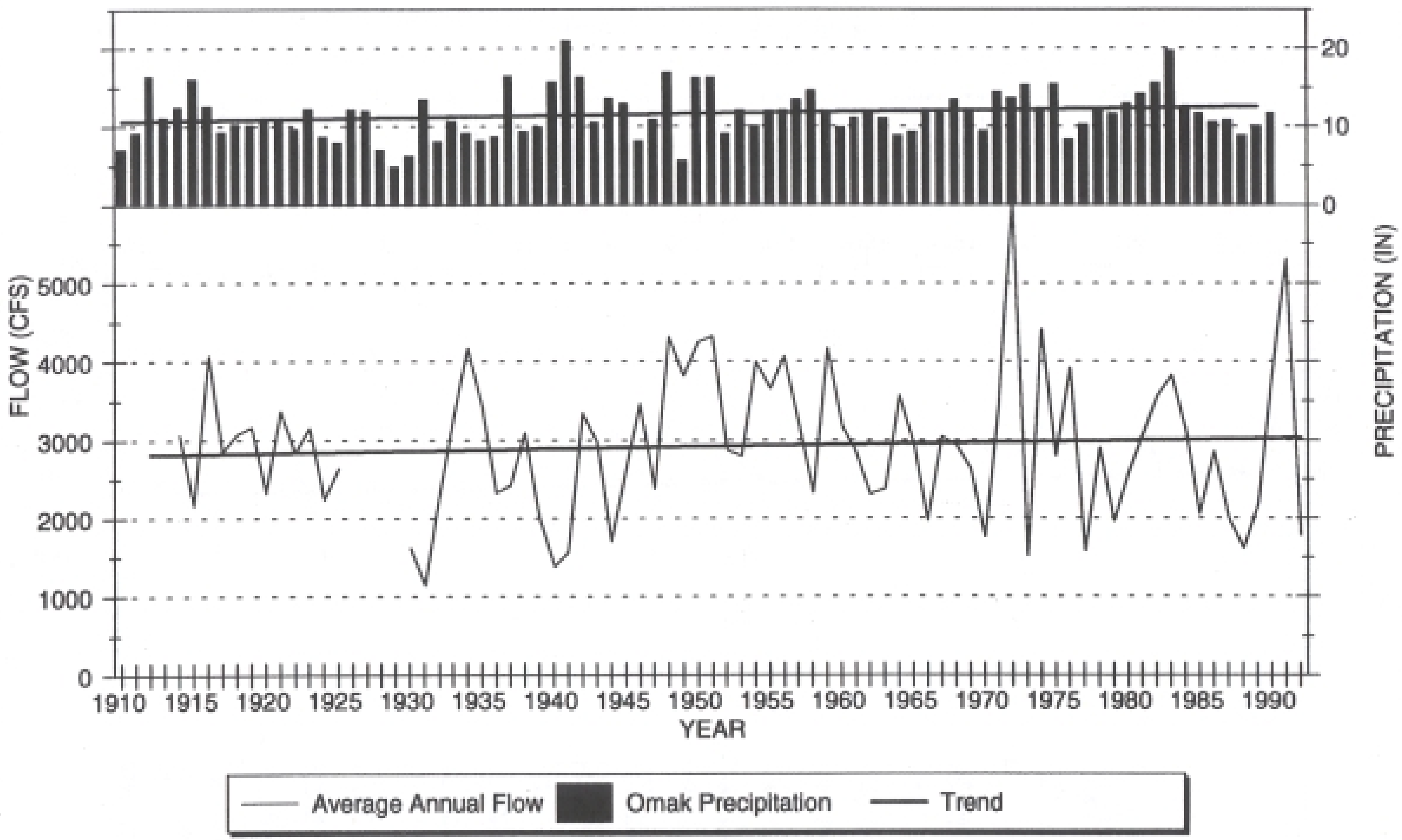


Figure 6
Okanogan River Near Tonasket
Average Annual Flows

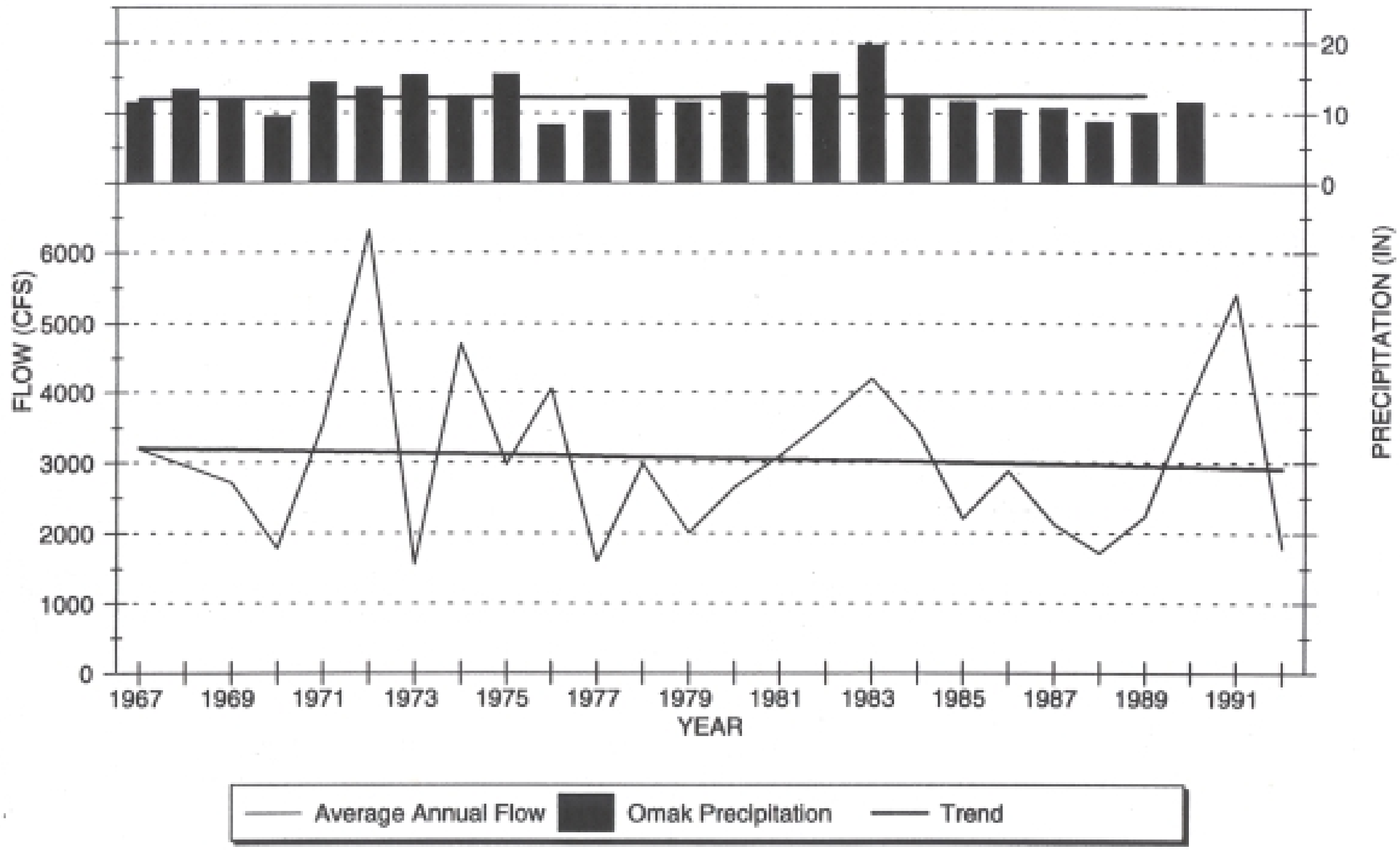


Figure 7
Okanogan River at Malott
Average Annual Flows

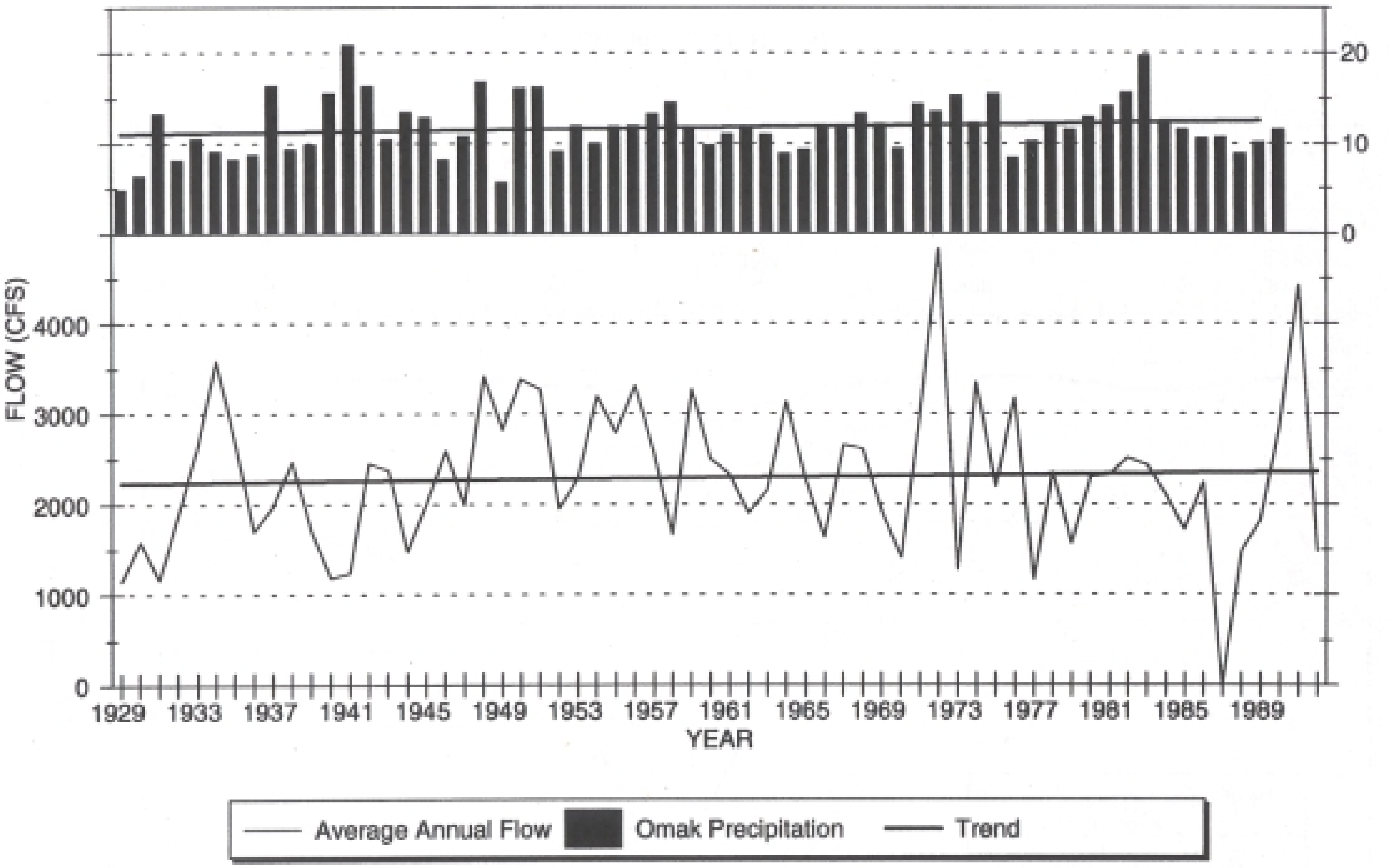


Figure 8
Similkameen River Near Blackhawk
Average Annual Flows

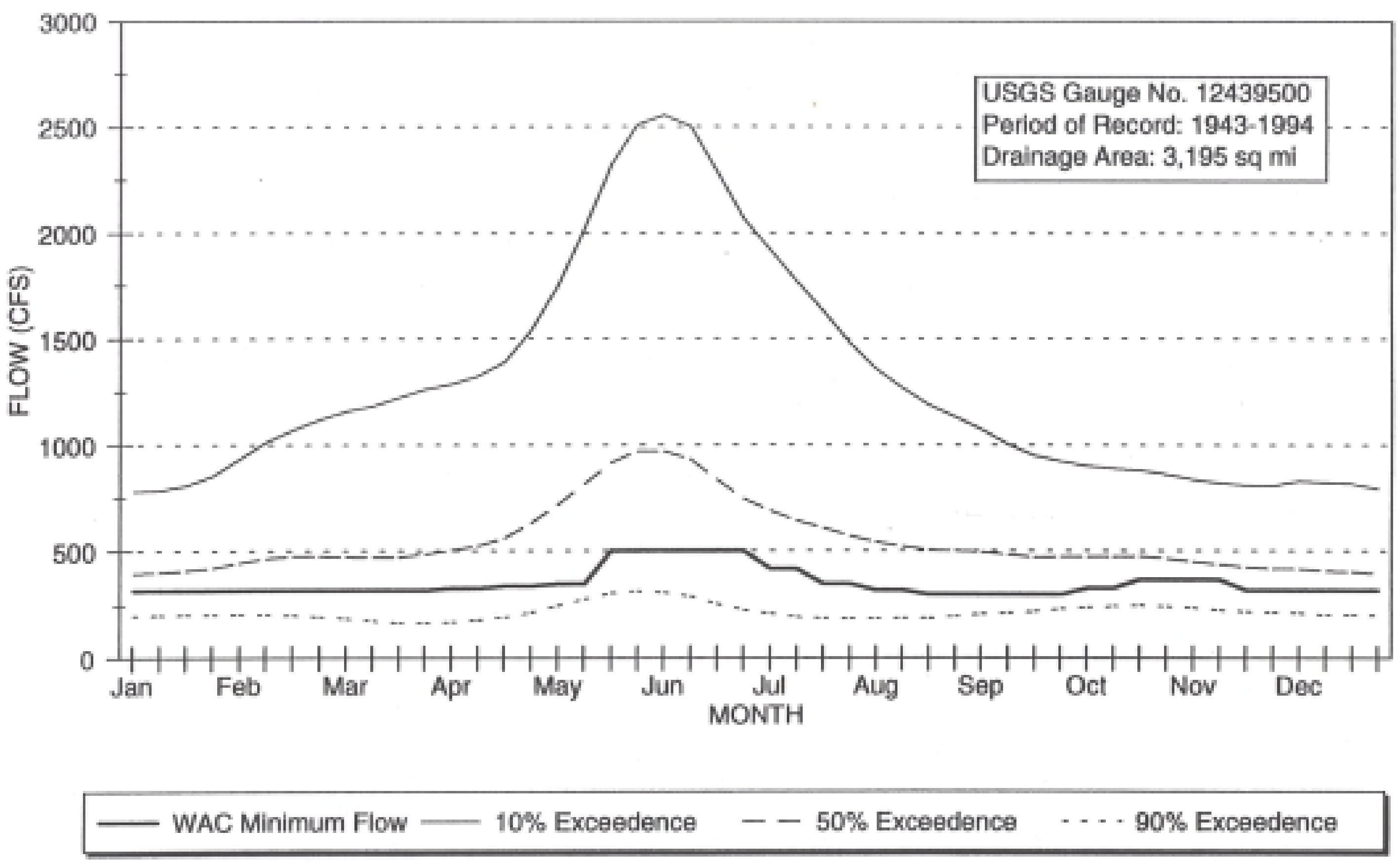


Figure 9
Okanogan River at Oroville
Monthly Flow Exceedence

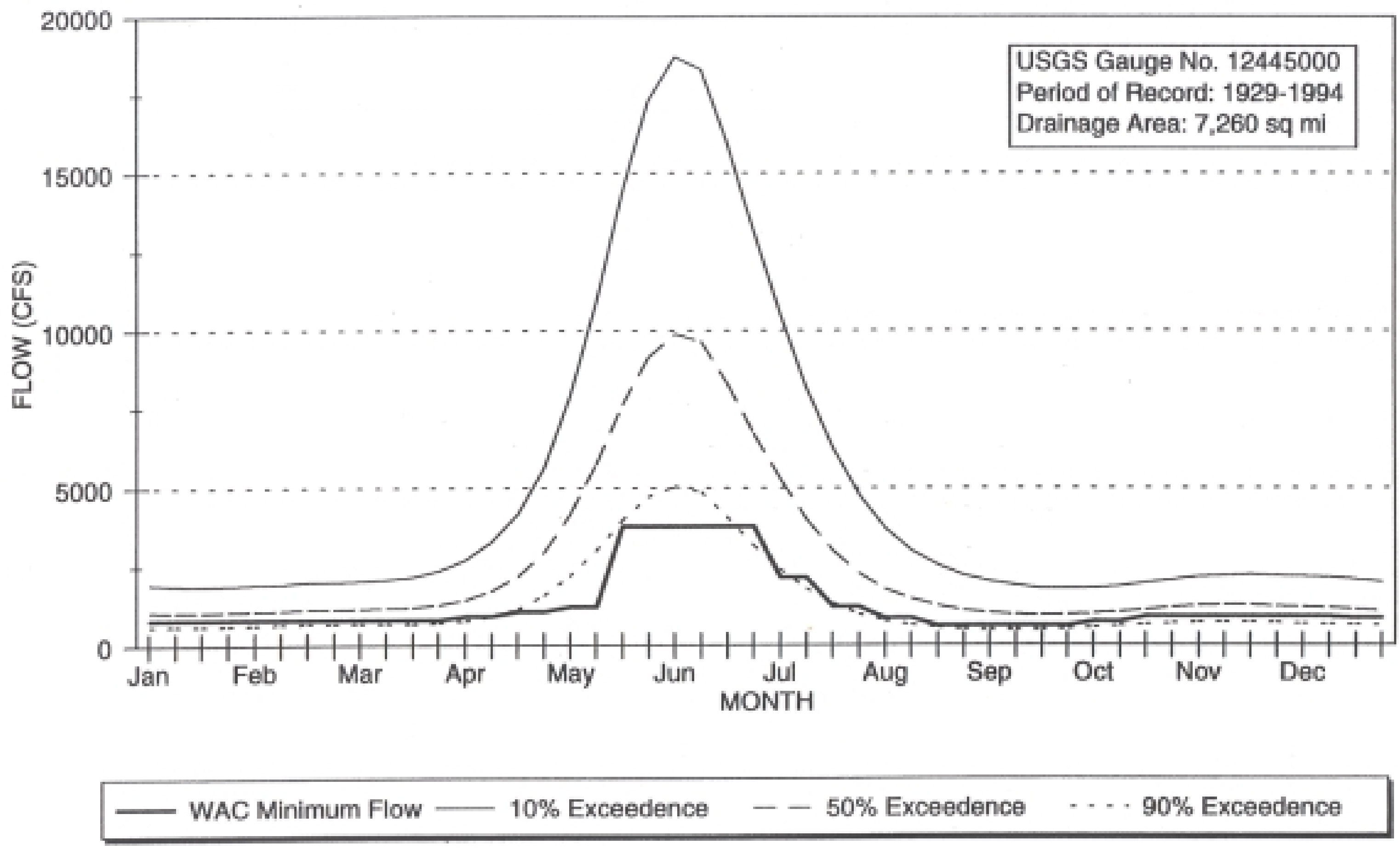


Figure 10
Okanogan River Near Tonasket
Monthly Flow Exceedence

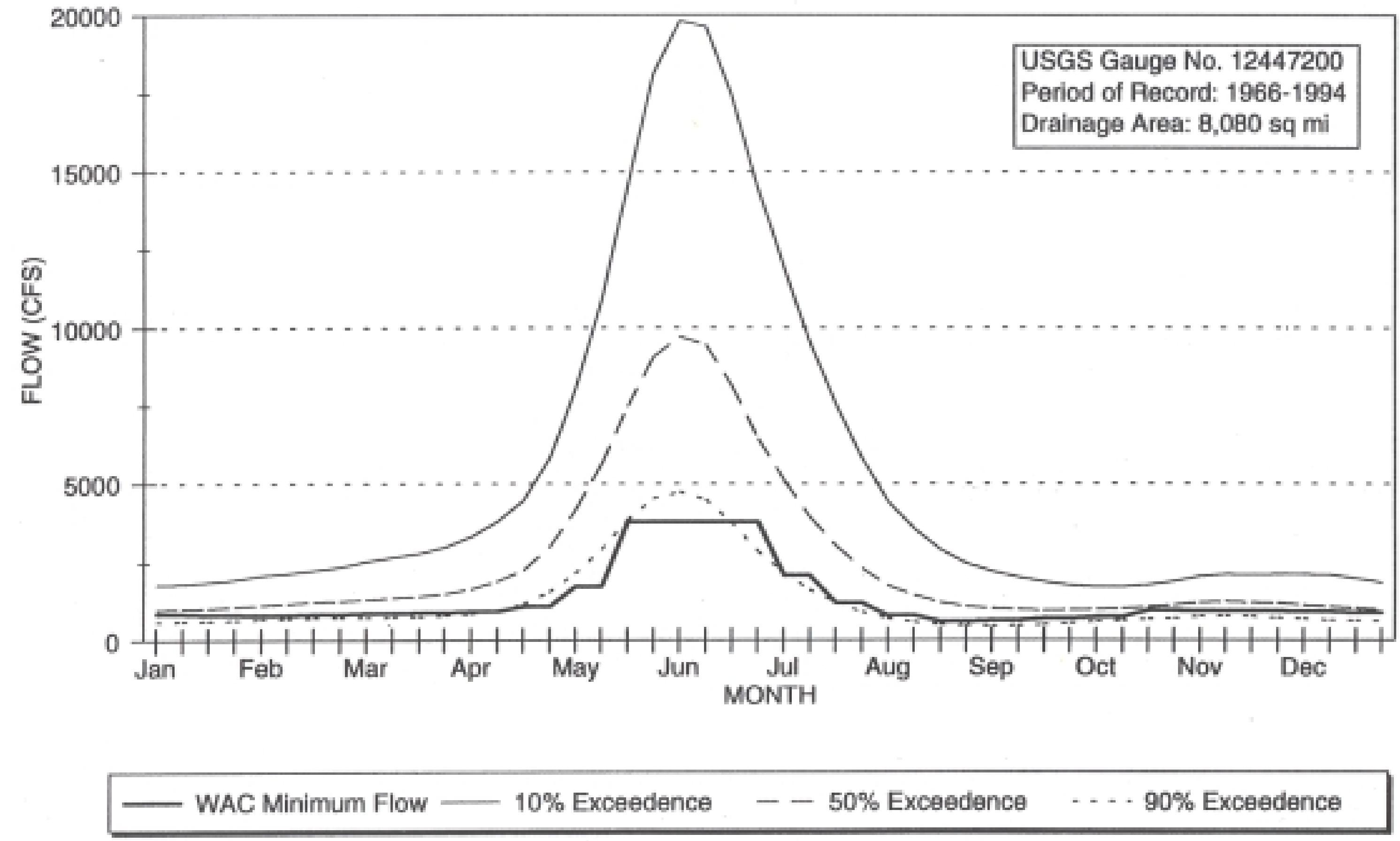


Figure 11
Okanogan River at Malott
Monthly Flow Exceedence

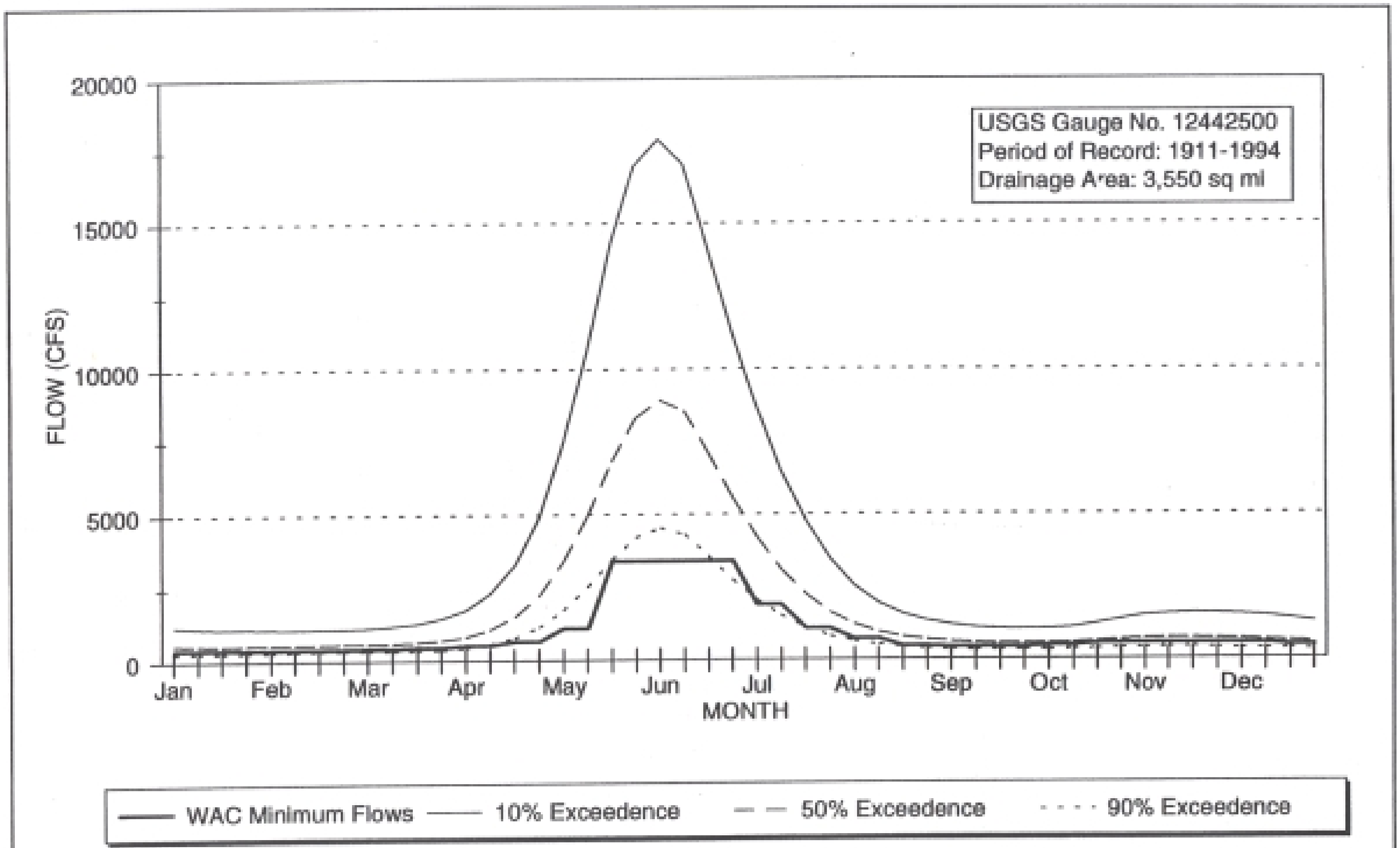


Figure 12
Similkameen River
Monthly Flow Exceedence

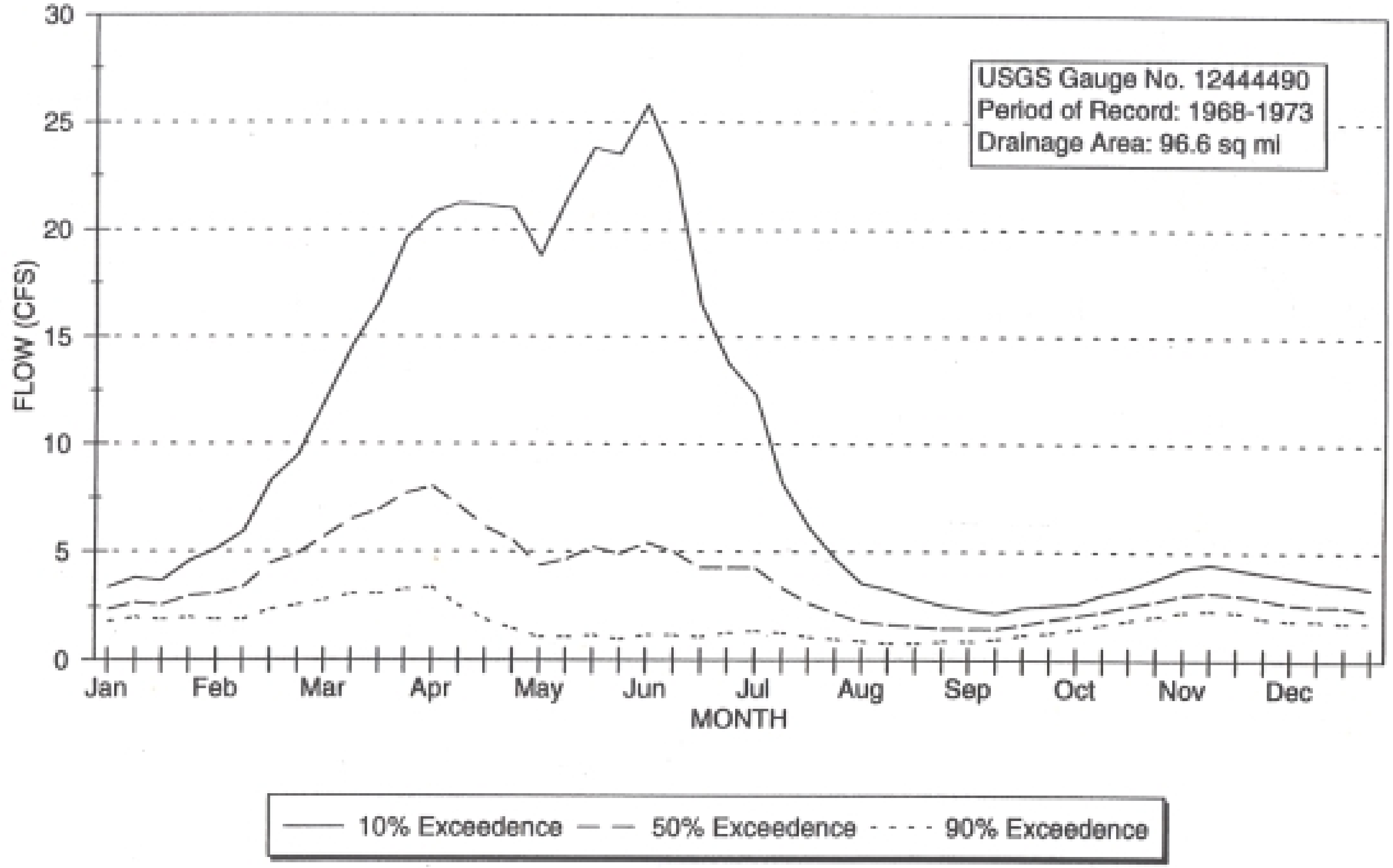


Figure 13
Bonaparte Creek
Monthly Flow Exceedence

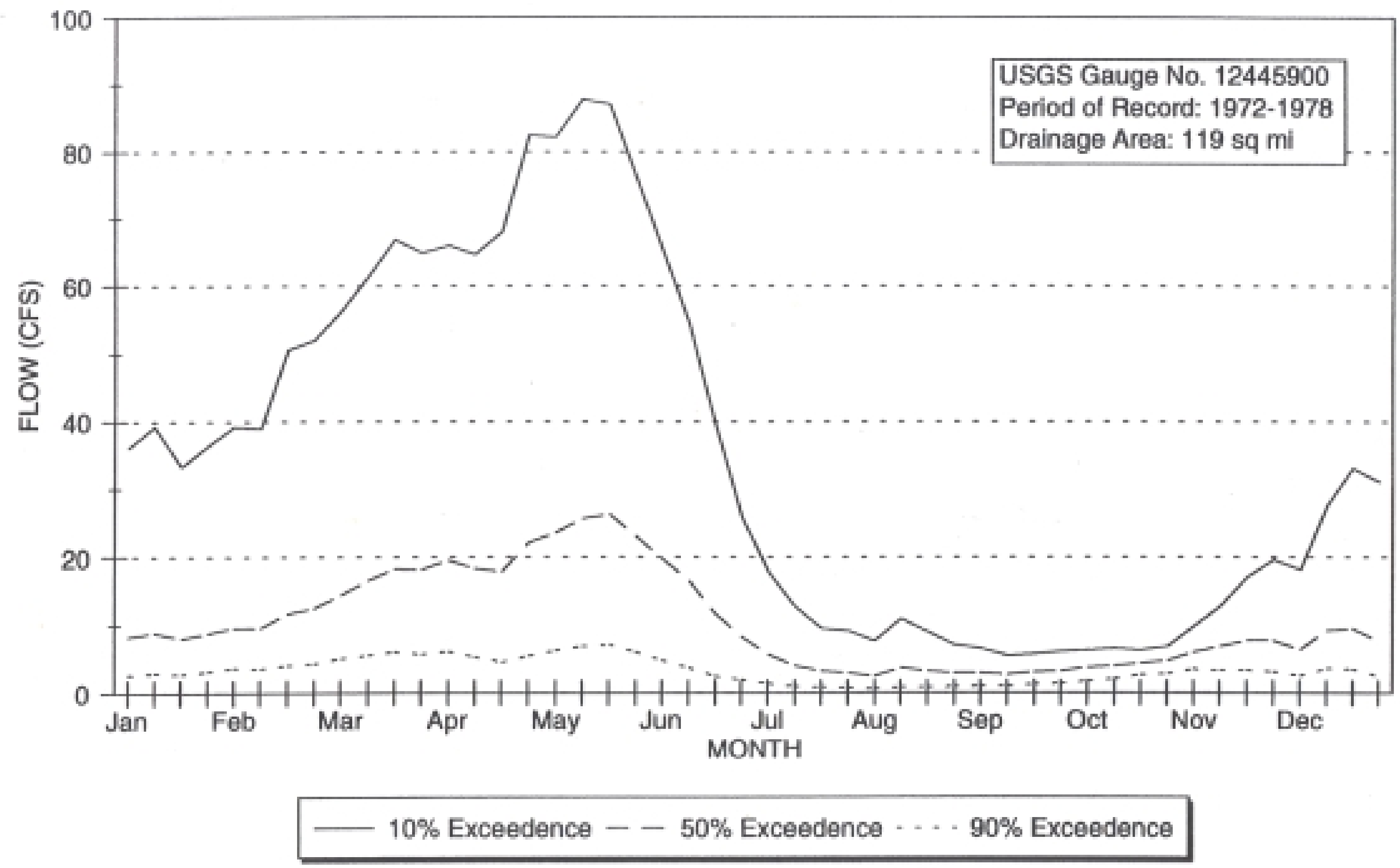


Figure 14
Omak Creek
Monthly Flow Exceedence

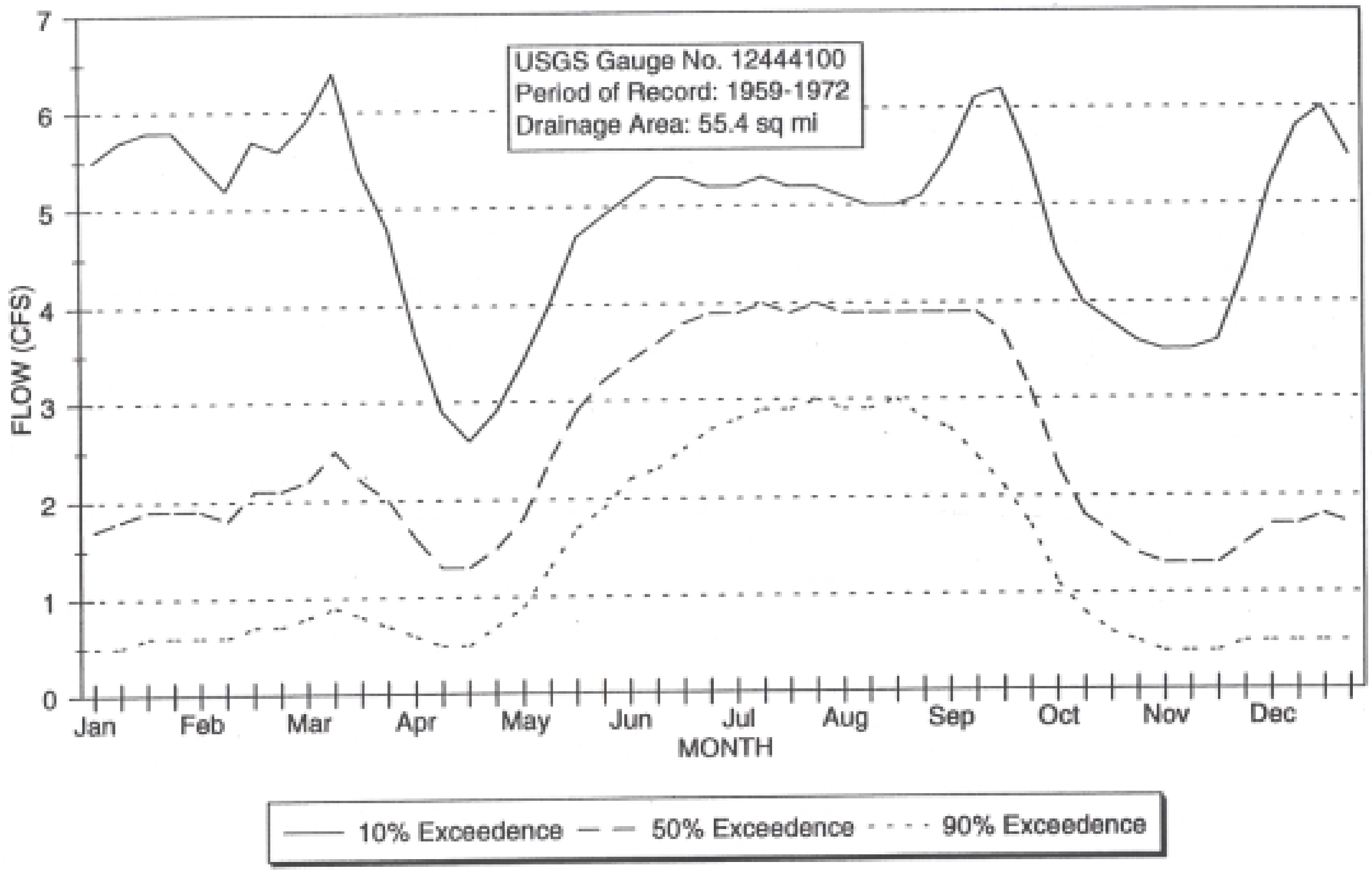


Figure 15
Whitestone Creek Near Tonasket
Monthly Flow Exceedence

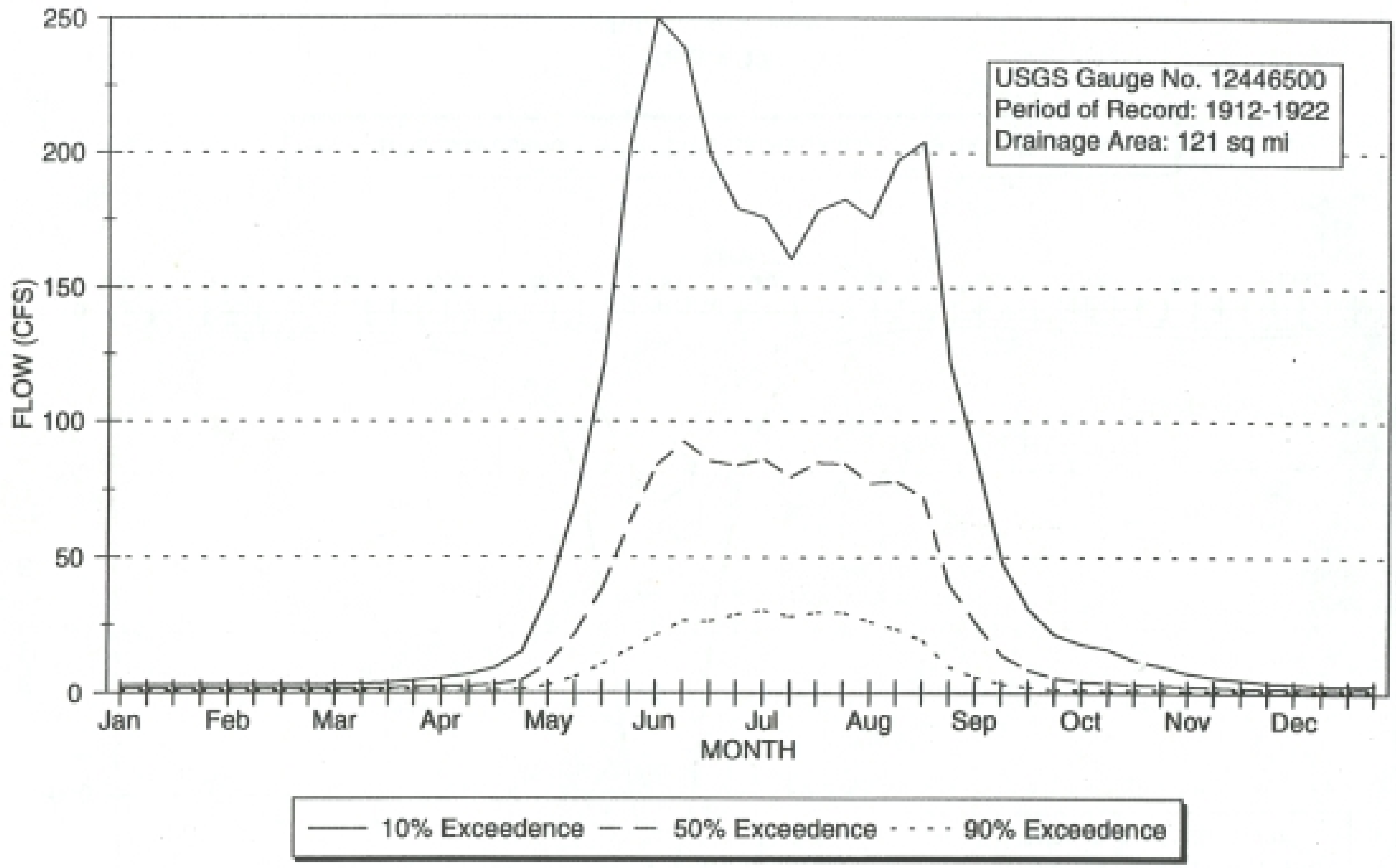


Figure 16
Salmon Creek Near Conconully
Monthly Flow Exceedence

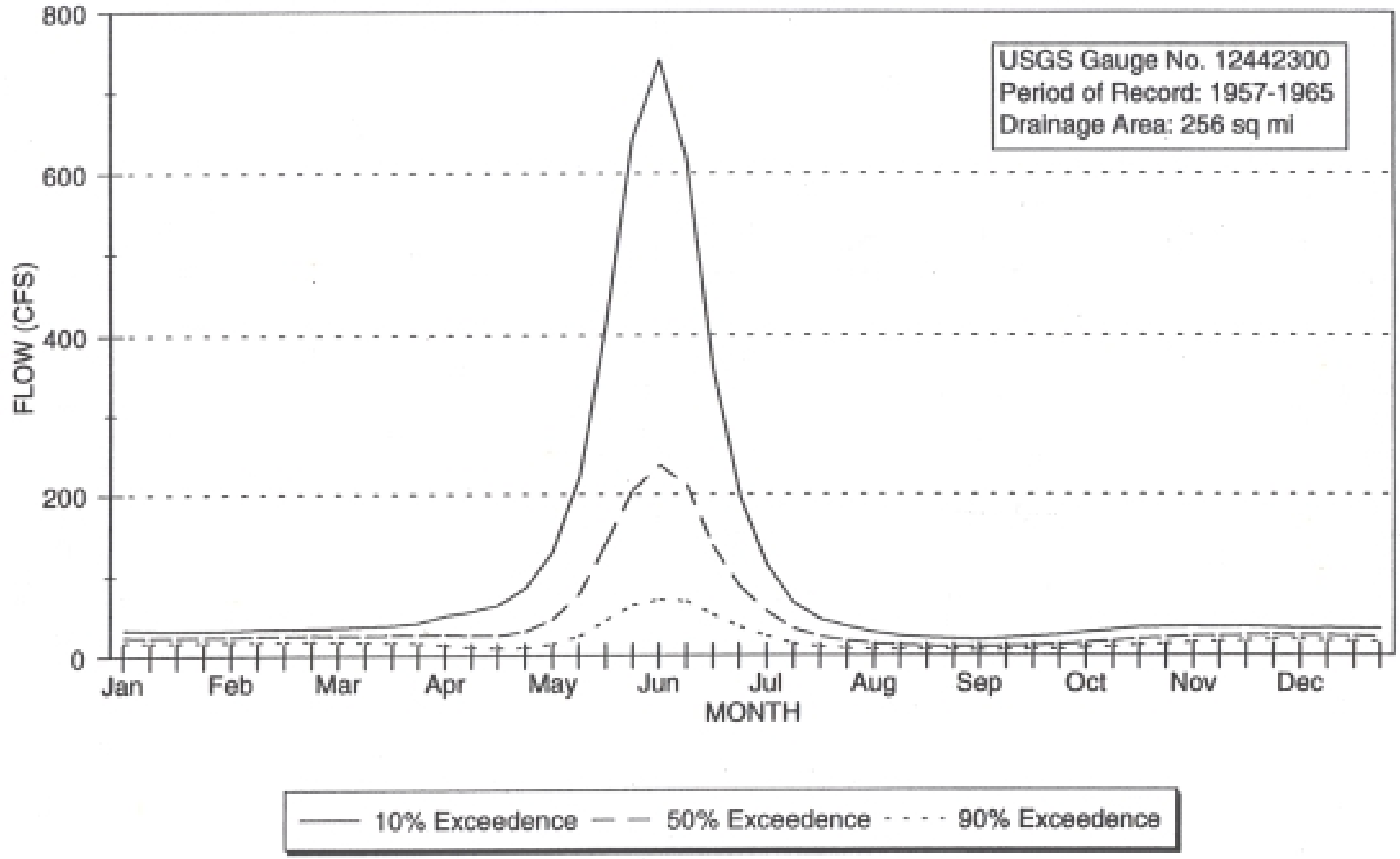


Figure 17
Sinlahekin Creek
Monthly Flow Exceedence

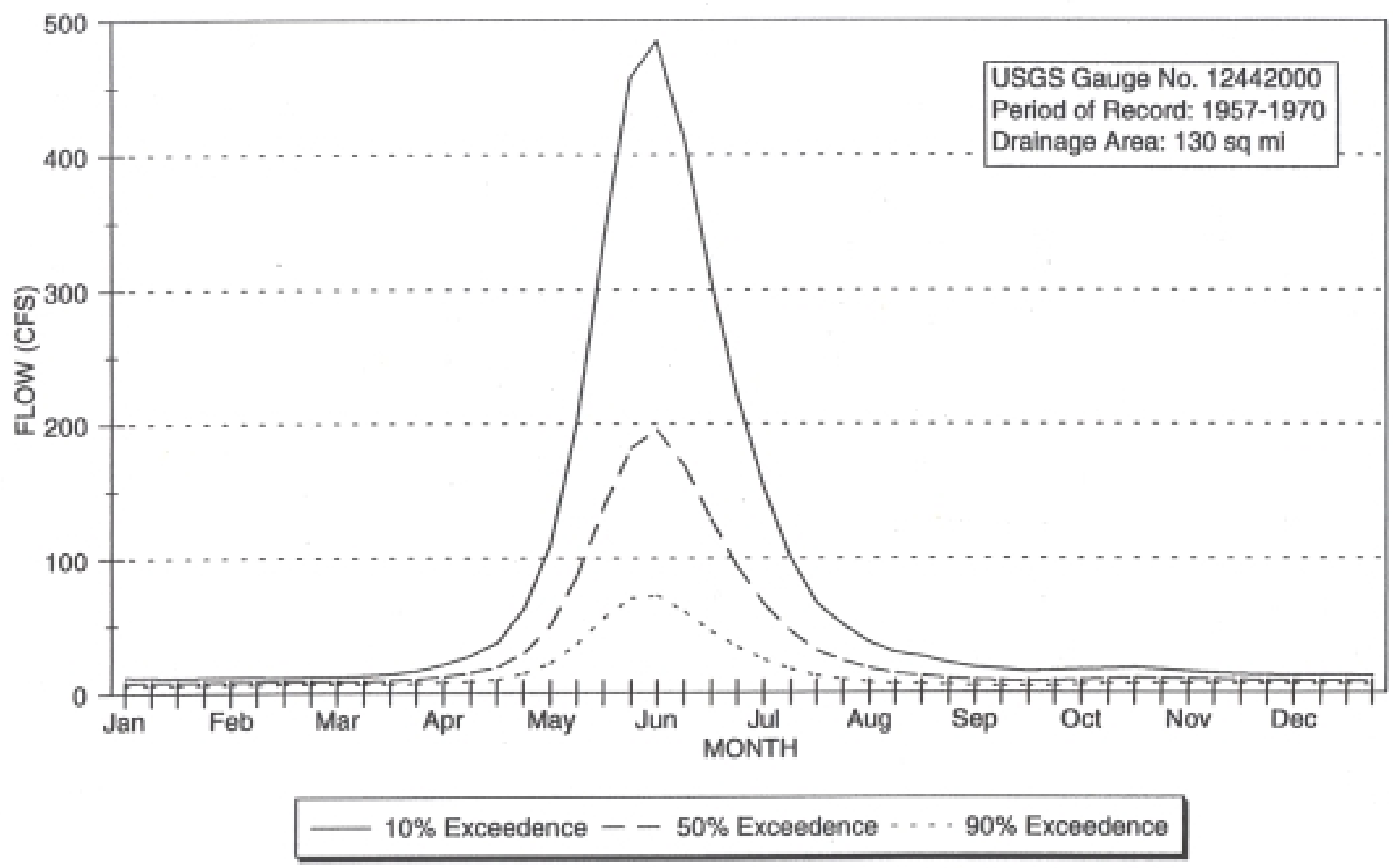


Figure 18
Toats Coulee Creek
Monthly Flow Exceedence

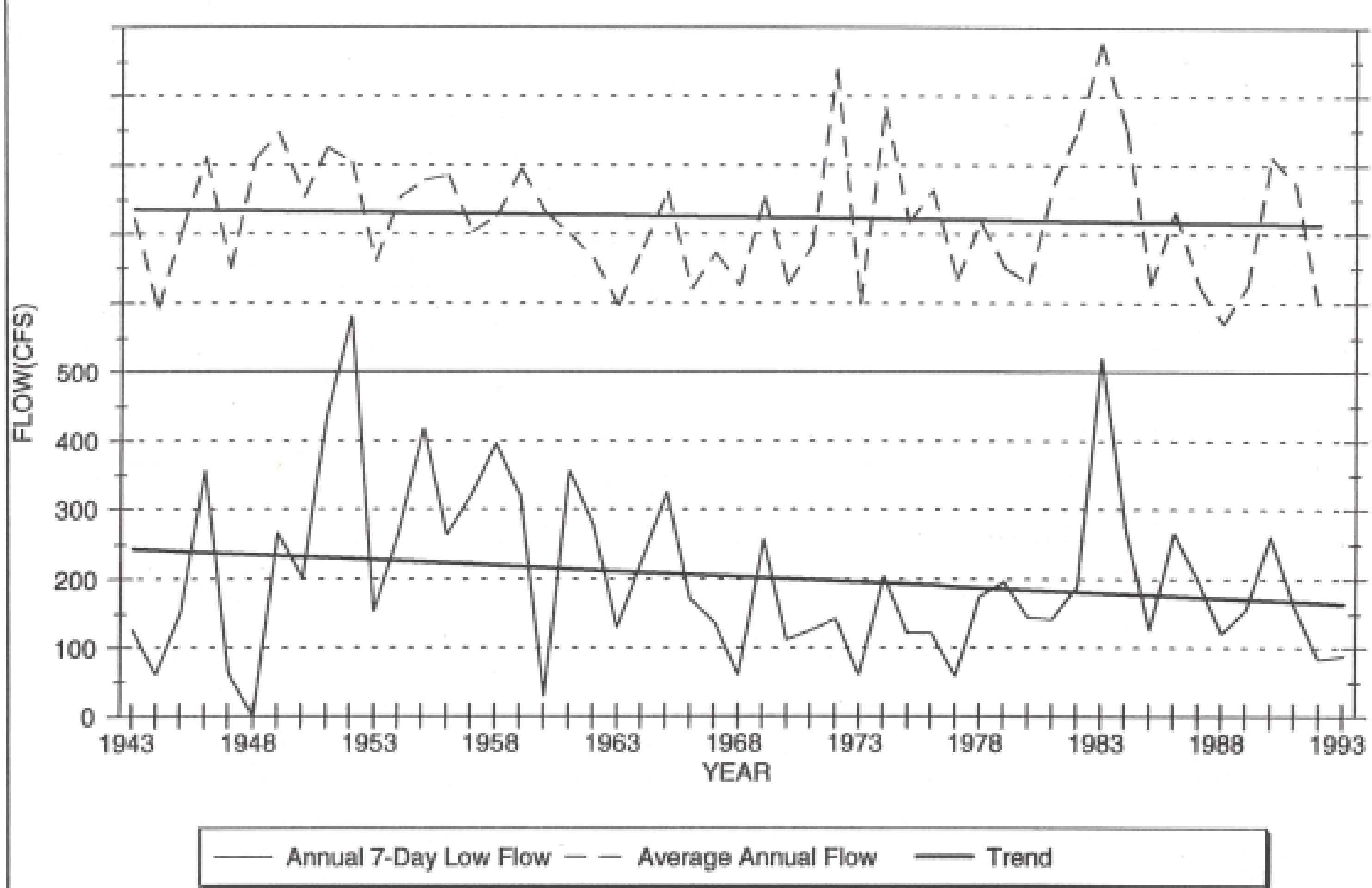


Figure 19
Okanogan River at Oroville
Historical Annual and 7-Day Low Flows

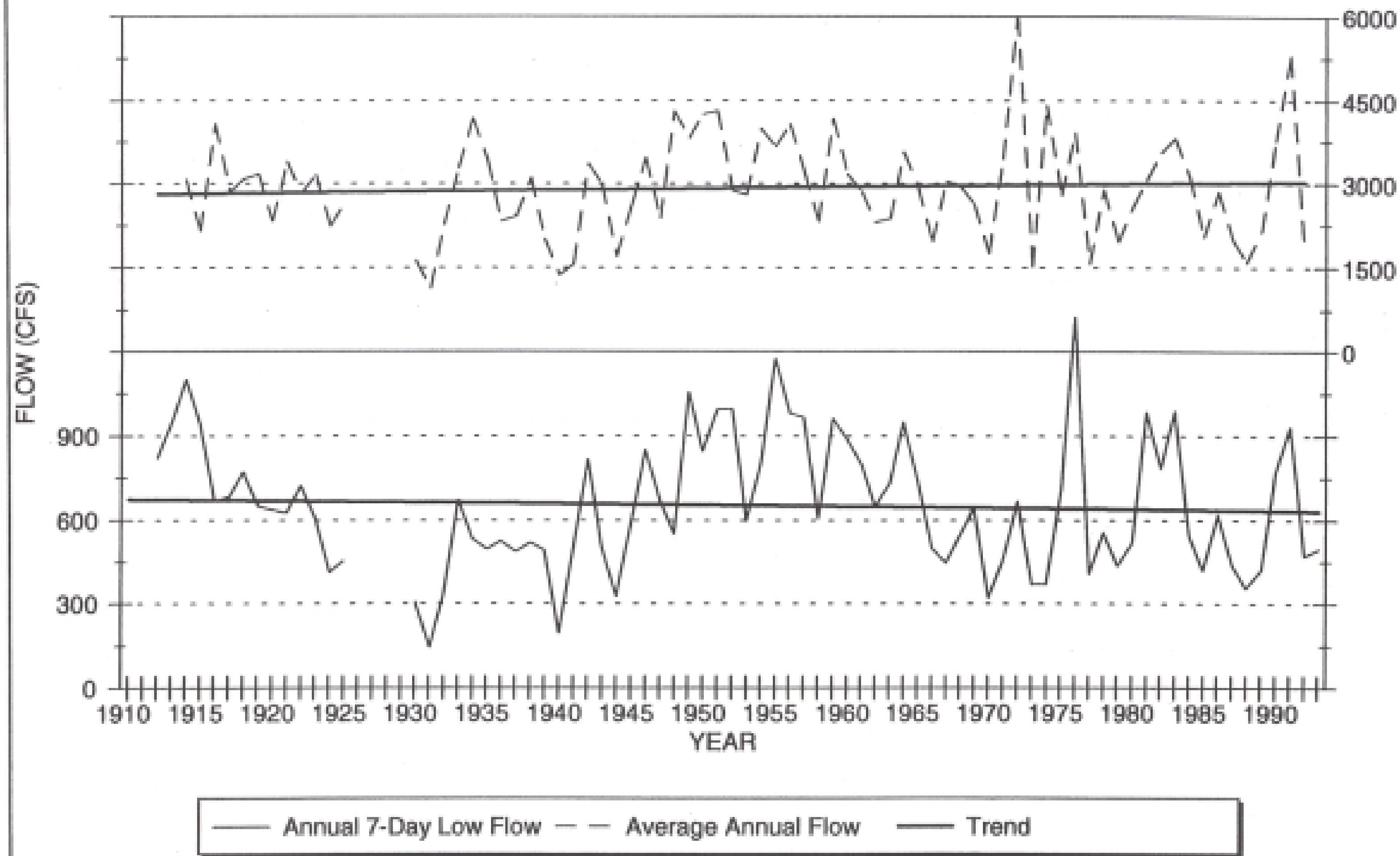


Figure 20
Okanogan River Near Tonasket
Historical Annual and 7-Day Low Flows

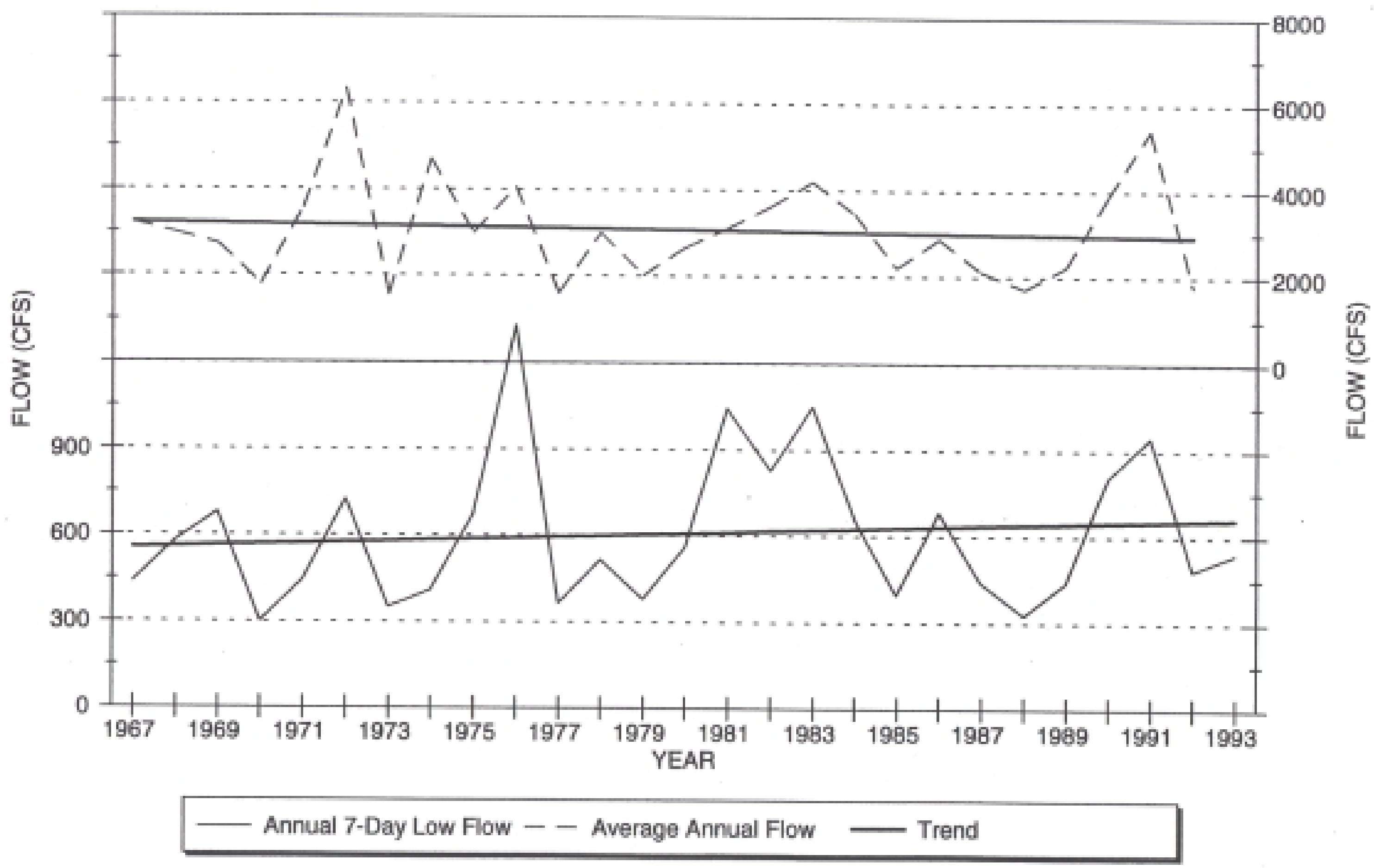


Figure 21
Okanogan River at Malott
Historical Annual and 7-Day Low Flows

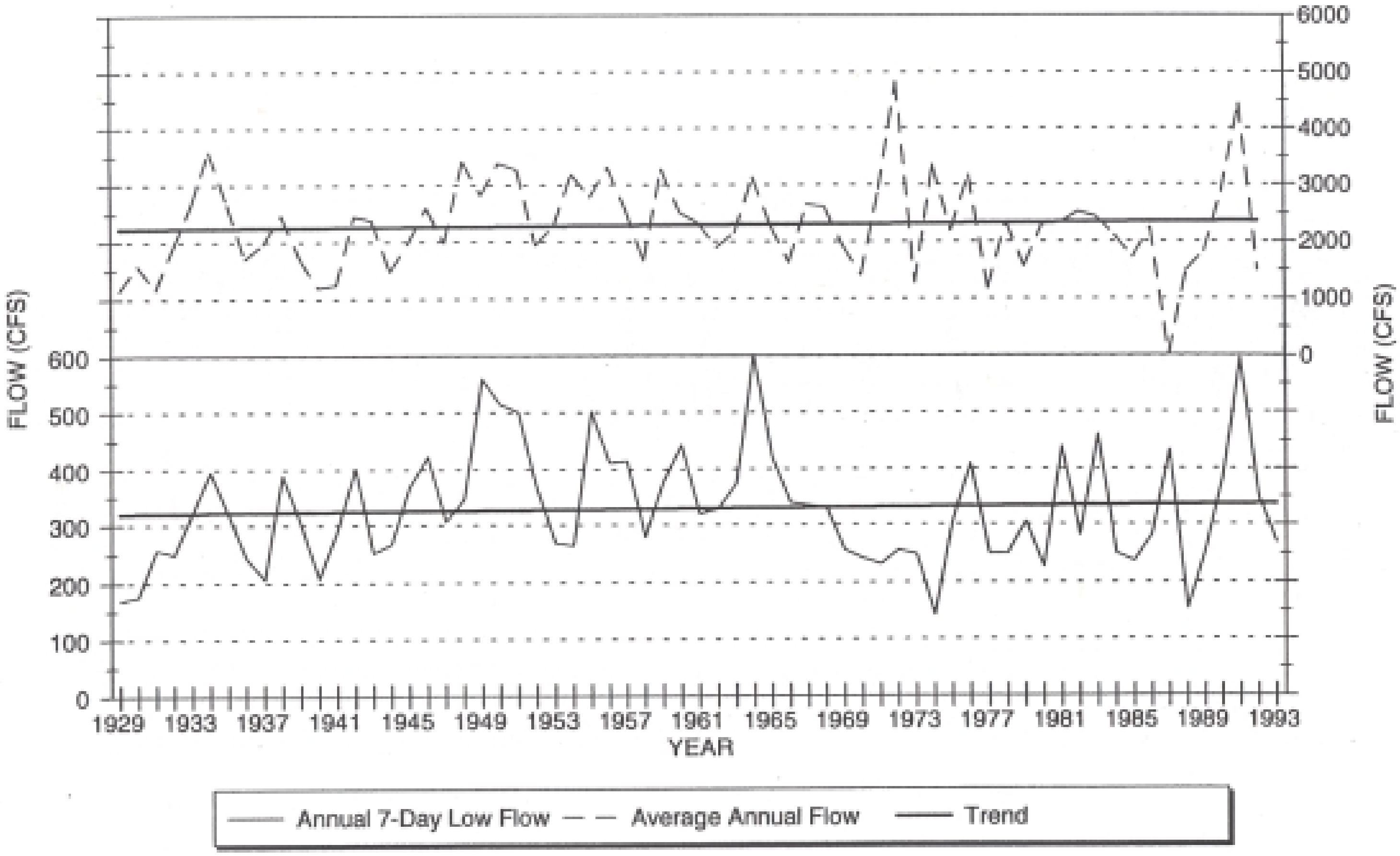


Figure 22
Similkameen River Near Nighthawk
Historical Annual and 7-Day Low Flows

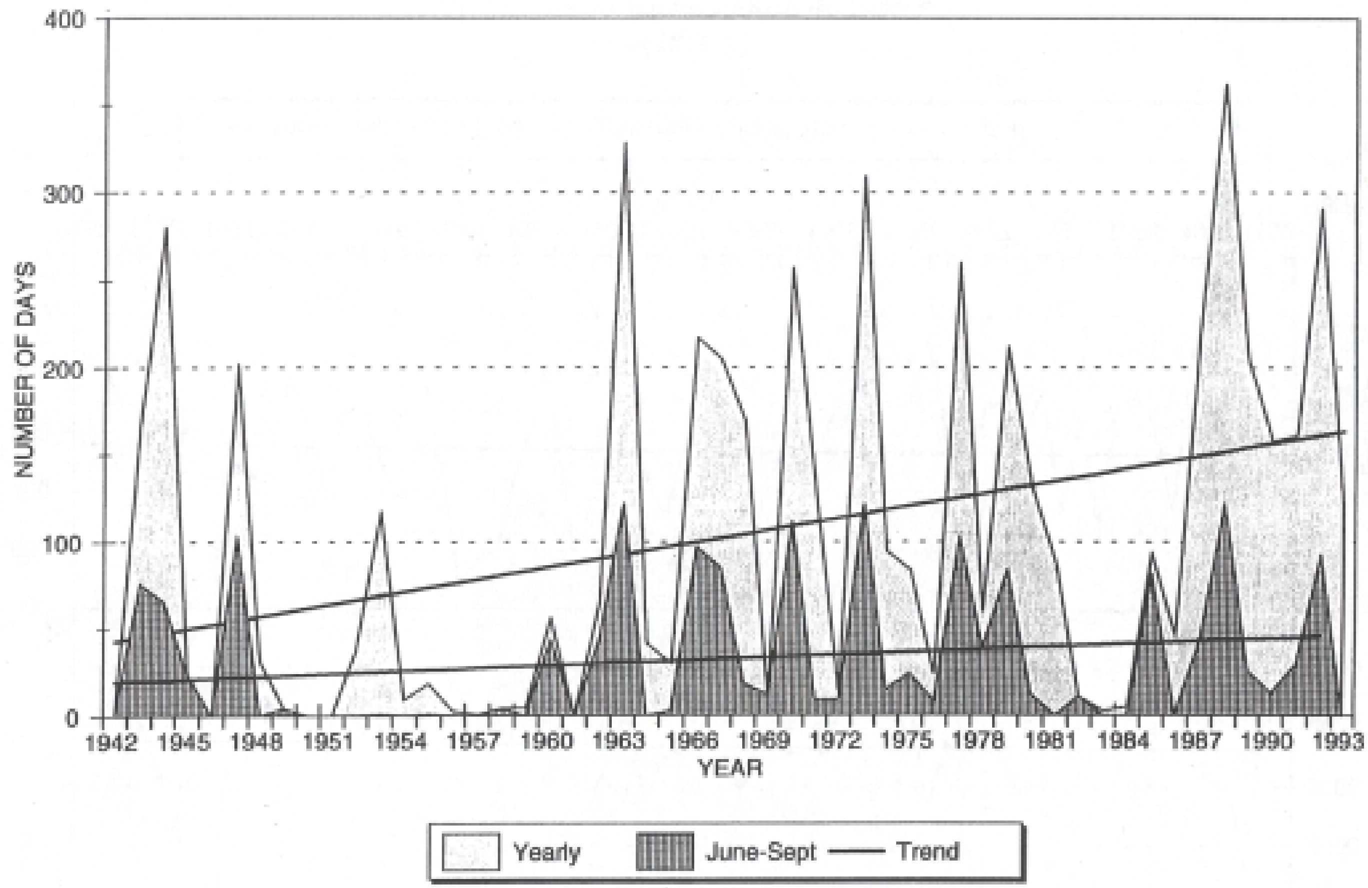


Figure 23
Okanogan River at Oroville
Days in Year Minimum Flow Not Reached

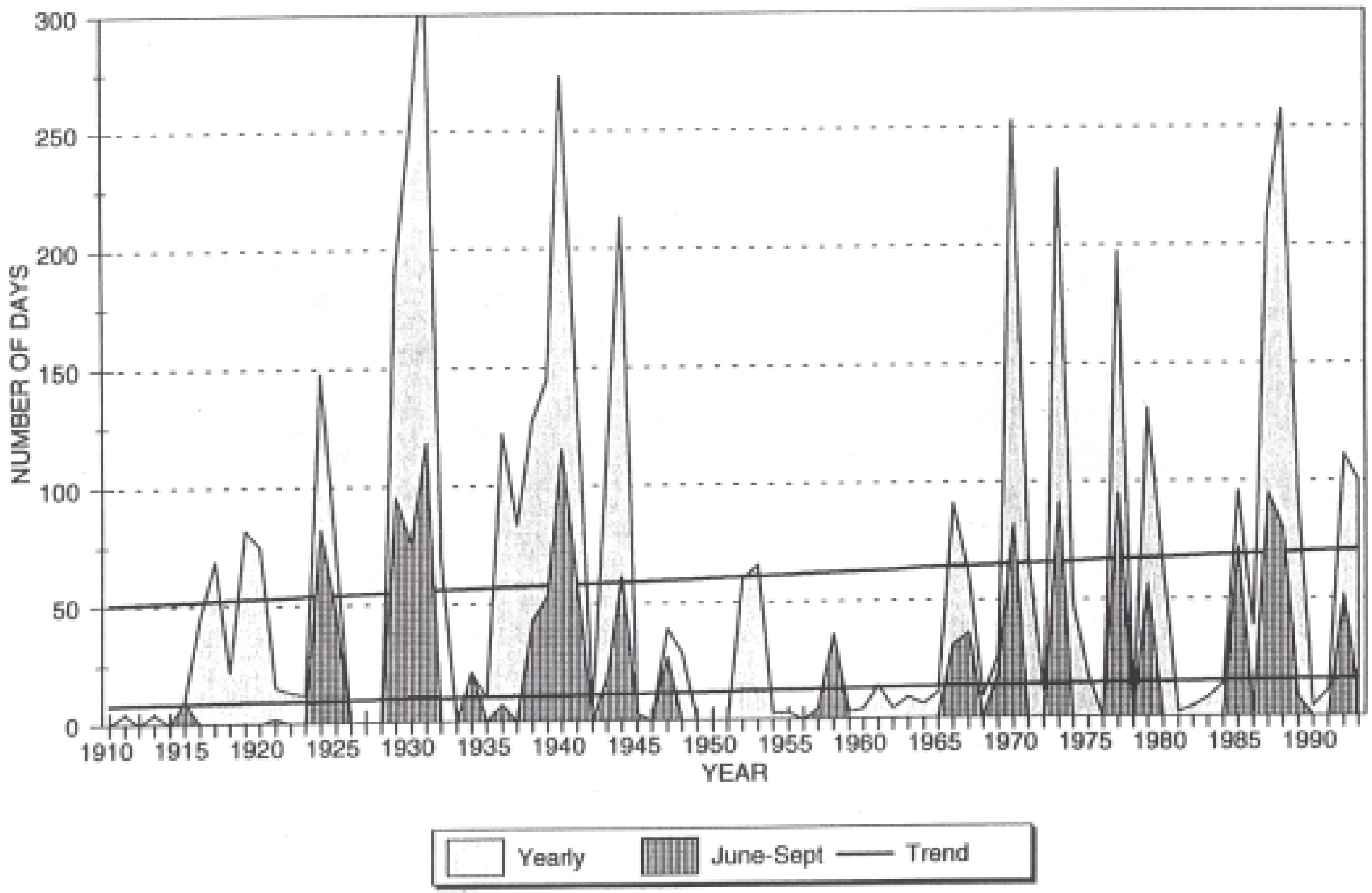


Figure 24
Okanogan River Near Tonasket
Days in Year Minimum Flow Not Reached

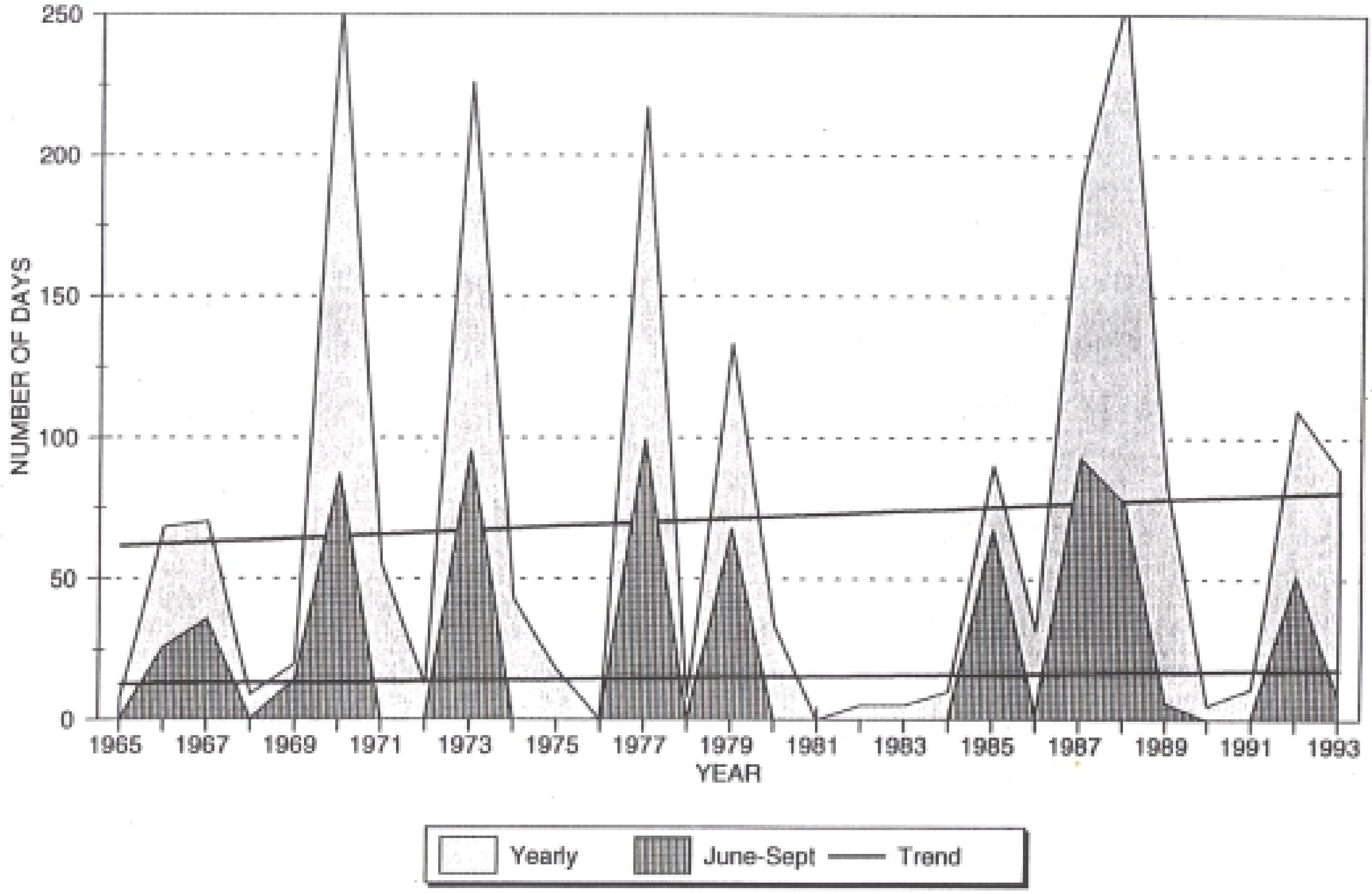


Figure 25
Okanogan River at Malott
Days in Year Minimum Flow Not Reached

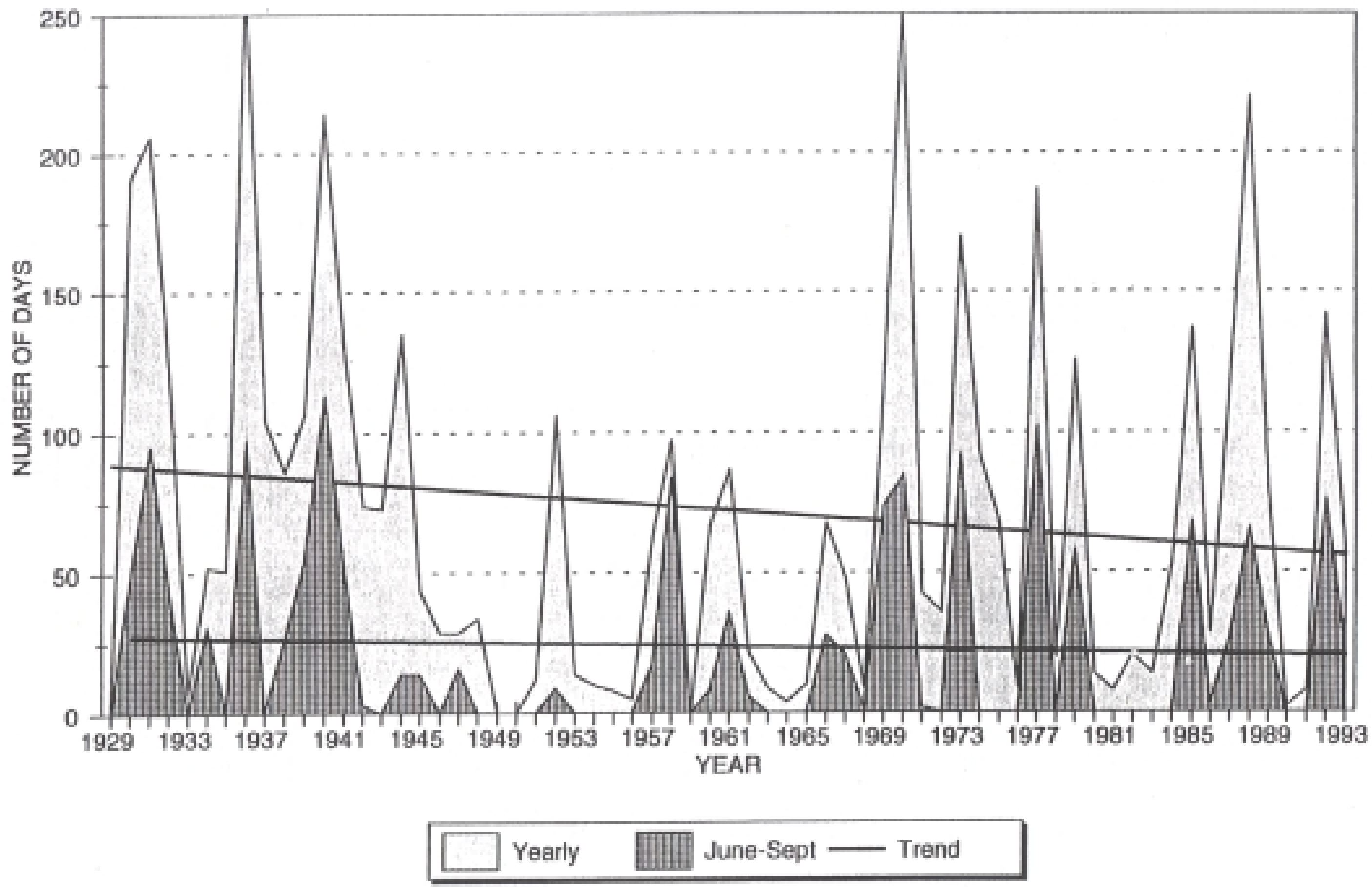


Figure 26
Similkameen River Near Nighthawk
Days in Year Minimum Flow Not Reached

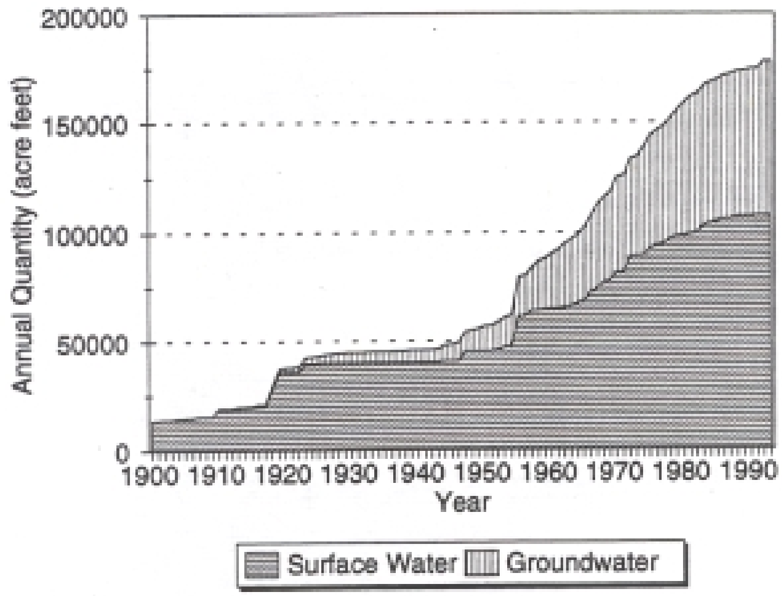


Figure 27
Historical Growth of Water Rights Appropriations in Okanogan River Watershed
Total Annual Quantity

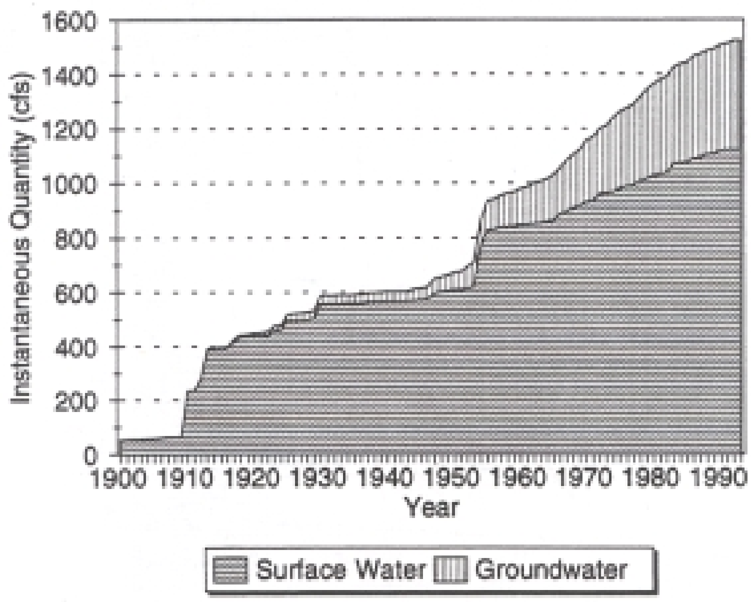
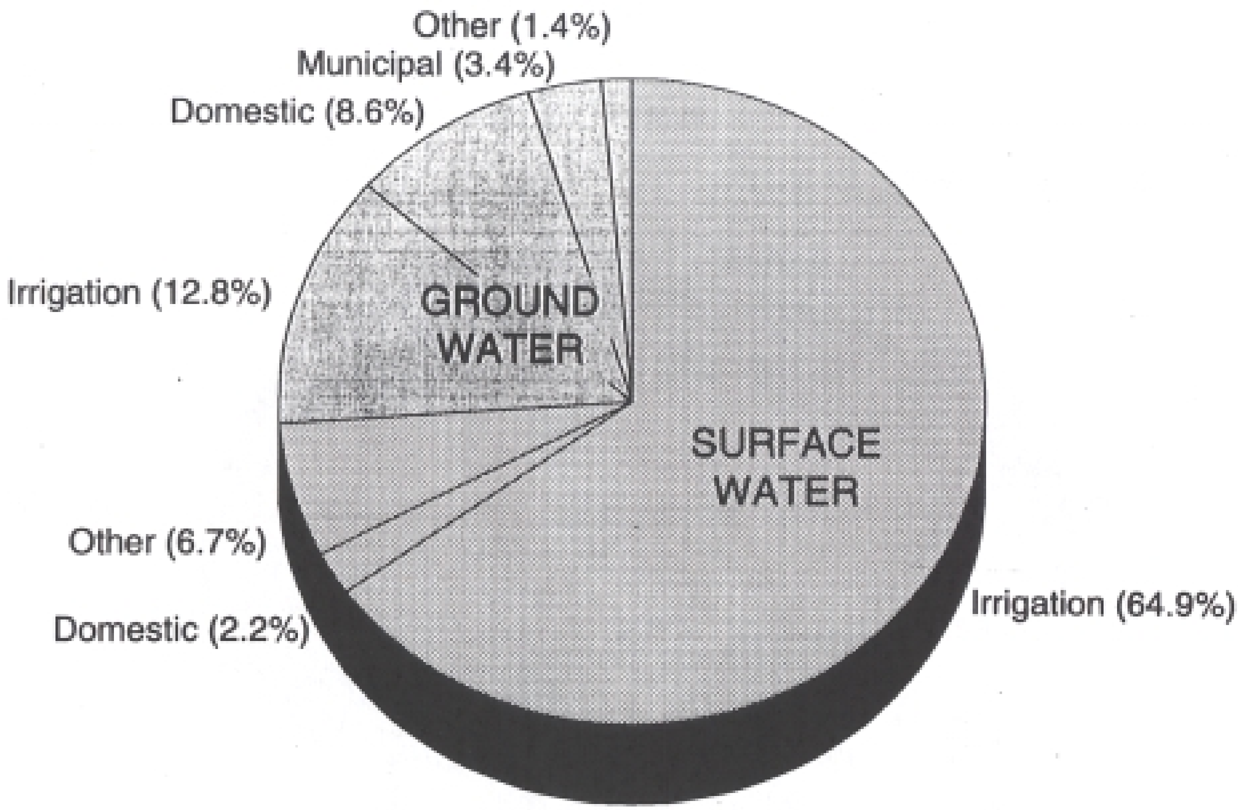
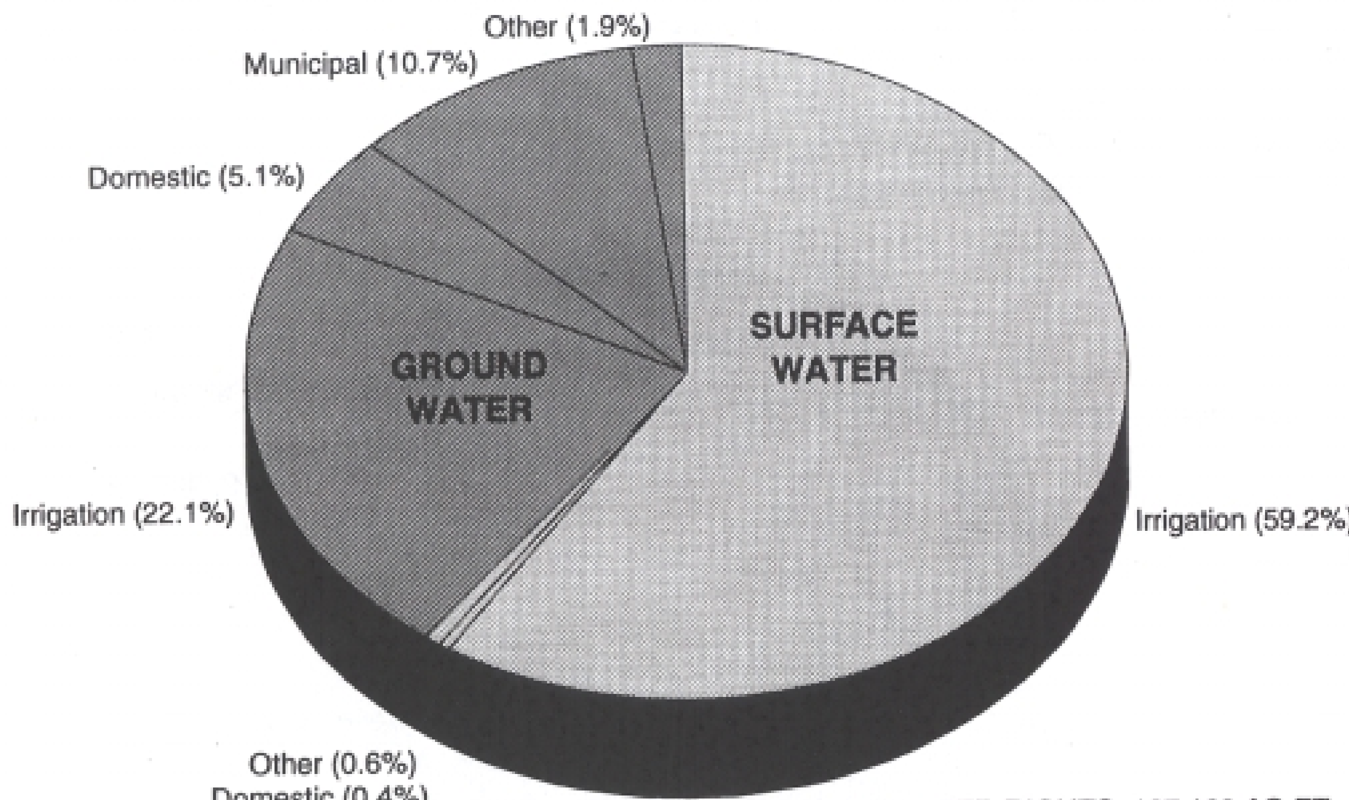


Figure 28
Historical Growth of Water Rights Appropriations in Okanogan River Watershed
Total Instantaneous Rate



SURFACE WATER RIGHTS: 1,133 CFS
GROUND WATER RIGHTS: 401 CFS
TOTAL RIGHTS: 1,534 CFS

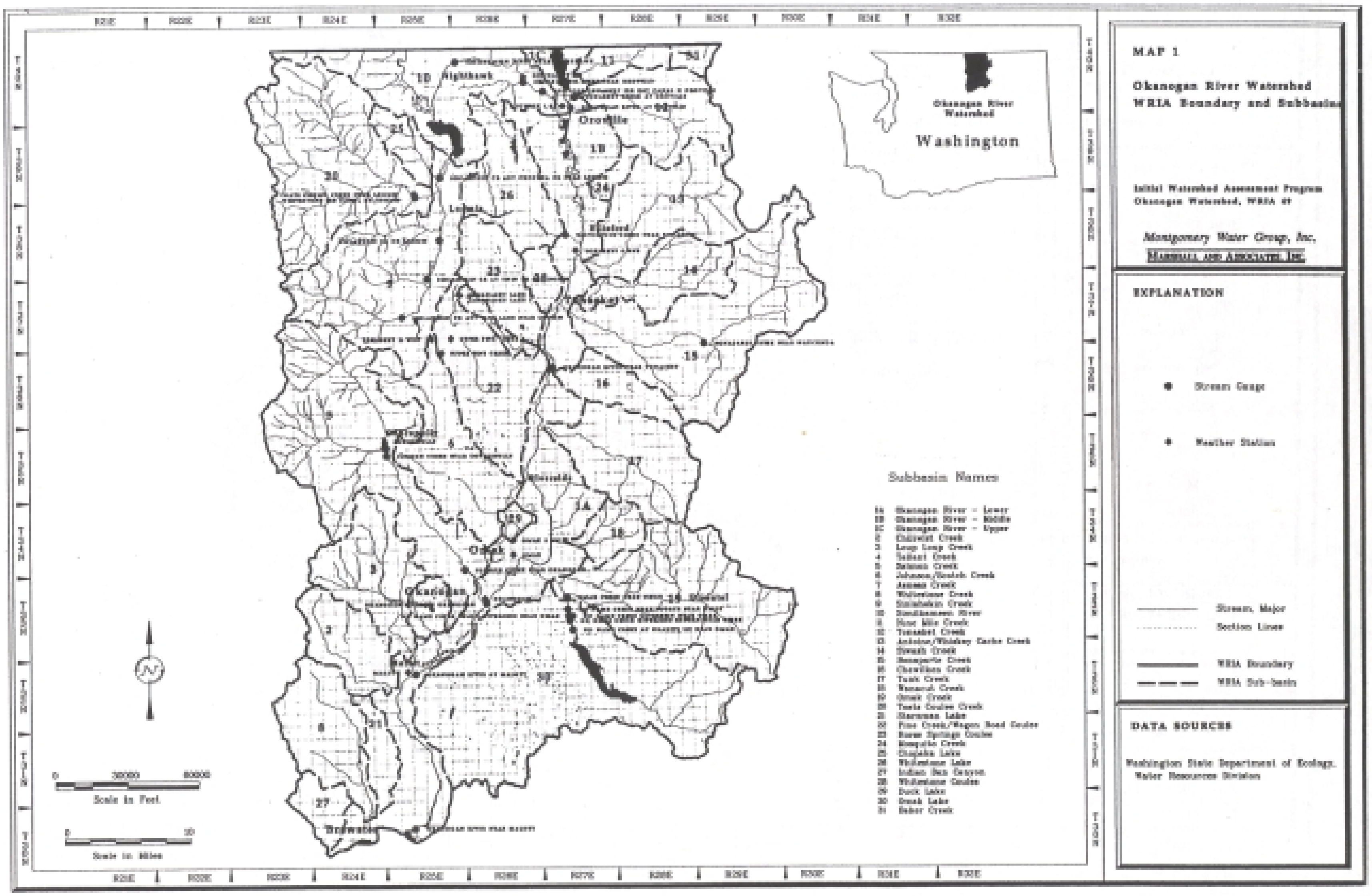
Figure 29
Water Rights in Okanogan River Watershed
Total Instantaneous Rate

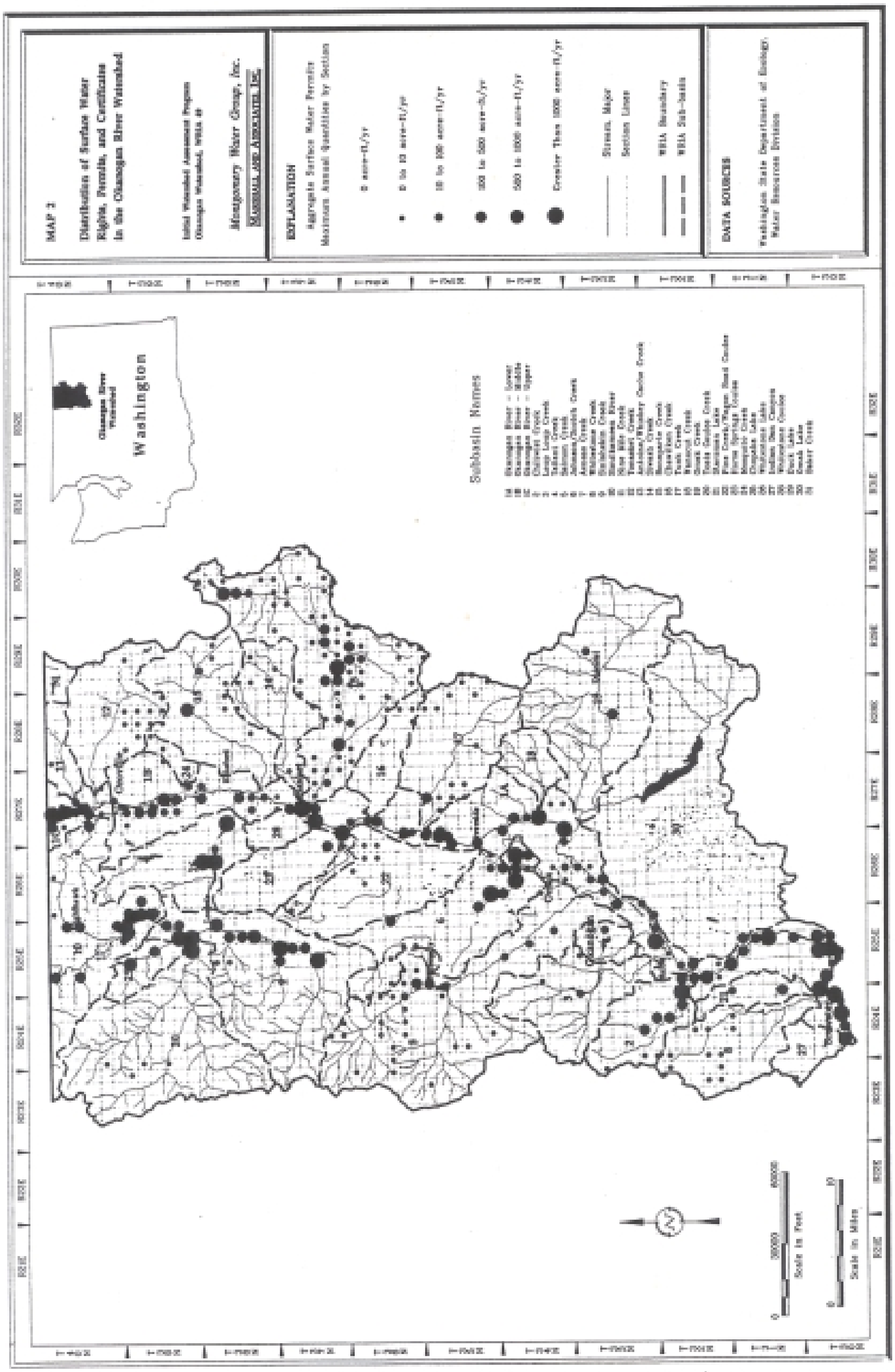


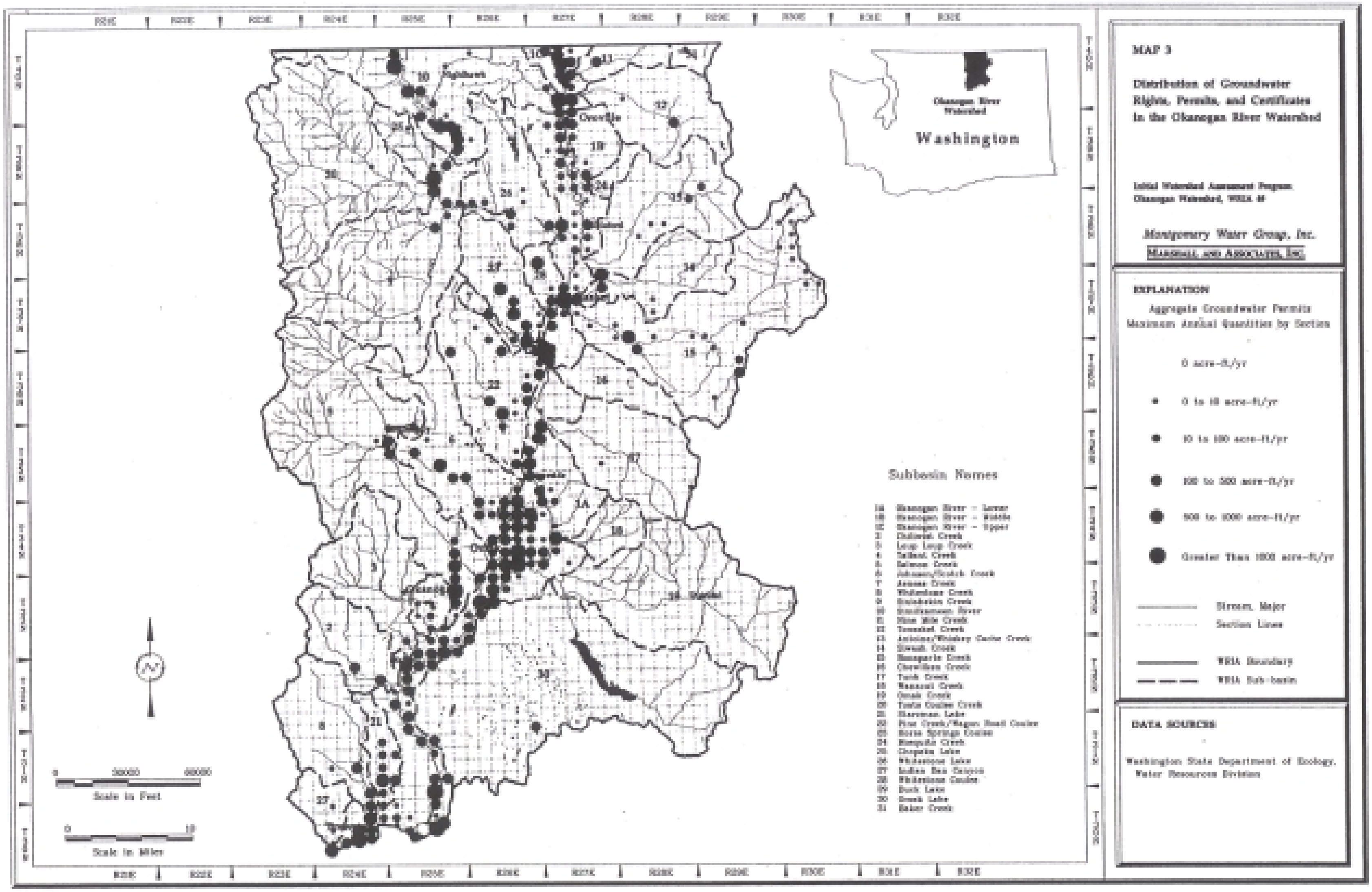
SURFACE WATER RIGHTS: 107,160 AC-FT
GROUNDWATER RIGHTS: 70,705 AC-FT
TOTAL RIGHTS: 177,864 AC-FT

Figure 30
Water Rights in Okanogan River Watershed
Total Annual Quantity

Maps


MAP 1
Okanogan River Watershed
WRIA Boundary and Subbasins
Initial Watershed Assessment Program
Okanogan Watershed, WRIA 49
Montgomery Water Group, Inc.
Marshall and Associates, Inc.
EXPLANATION
Stream Gauge
Weather Station
Stream, Major
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology, Water Resources Division
Okanogan River Watershed
Washington
Subbasin Names
1A Okanogan River - Lower
1B Okanogan River - Middle
1C Okanogan River - Upper
2 Chiliwist Creek
3 Loup Loup Creek
4 Tallant Creek
5 Salmon Creek
6 Johnson/Scotch Creek
7 Aeneas Creek
8 Whitestone Creek
9 Sinlahekin Creek
10 Similkameen River
11 Nine Mile Creek
12 Tonasket Creek
13 Antoine/Whiskey Cache Creek
14 Siwash Creek
15 Bonaparte Creek
16 Chewiliken Creek
17 Tunk Creek
18 Wanacut Creek
19 Omak Creek
20 Tunk Coulee Creek
21 Starzman Lake
22 Pine Creek/Wagon Road Coulee
23 Horse Springs Coulee
24 Mosquito Creek
25 Chopaka Lake
26 Whitestone Lake
27 Indian Dan Canyon
28 Whitestone Coulee
29 Duck Lake
30 Crenk Lake
31 Baker Creek
Oroville
Nighthawk
Loomis
Tonasket
Riverside
Omak
Okanogan
Malott
Brewster
Scale in Feet
Scale in Miles


MAP 2
Distribution of Surface Water Rights, Permits, and Certificates in the Okanogan River Watershed
Initial Watershed Assessment Program
Okanogan Watershed, WRIA 49
Montgomery Water Group, Inc.
Marshall and Associates, Inc.
EXPLANATION
Aggregate Surface Water Permits
Maximum Annual Quantities by Section
0 acre-ft/yr
0 to 10 acre-ft/yr
10 to 100 acre-ft/yr
100 to 500 acre-ft/yr
500 to 1000 acre-ft/yr
Greater Than 1000 acre-ft/yr
Stream, Major
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology, Water Resources Division
Washington
Okanogan River Watershed
Subbasin Names
Scale in Feet
Scale in Miles


MAP 3
Distribution of Groundwater Rights, Permits, and Certificates in the Okanogan River Watershed
Initial Watershed Assessment Program Okanogan Watershed, WRIA 49
Montgomery Water Group, Inc.
Marshall and Associates, Inc.
EXPLANATION
Aggregate Groundwater Permits Maximum Annual Quantities by Section
0 acre-ft/yr
0 to 10 acre-ft/yr
10 to 100 acre-ft/yr
100 to 500 acre-ft/yr
500 to 1000 acre-ft/yr
Greater Than 1000 acre-ft/yr
Stream, Major
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology, Water Resources Division
Okanogan River Watershed
Washington
Subbasin Names
1A Okanogan River - Lower
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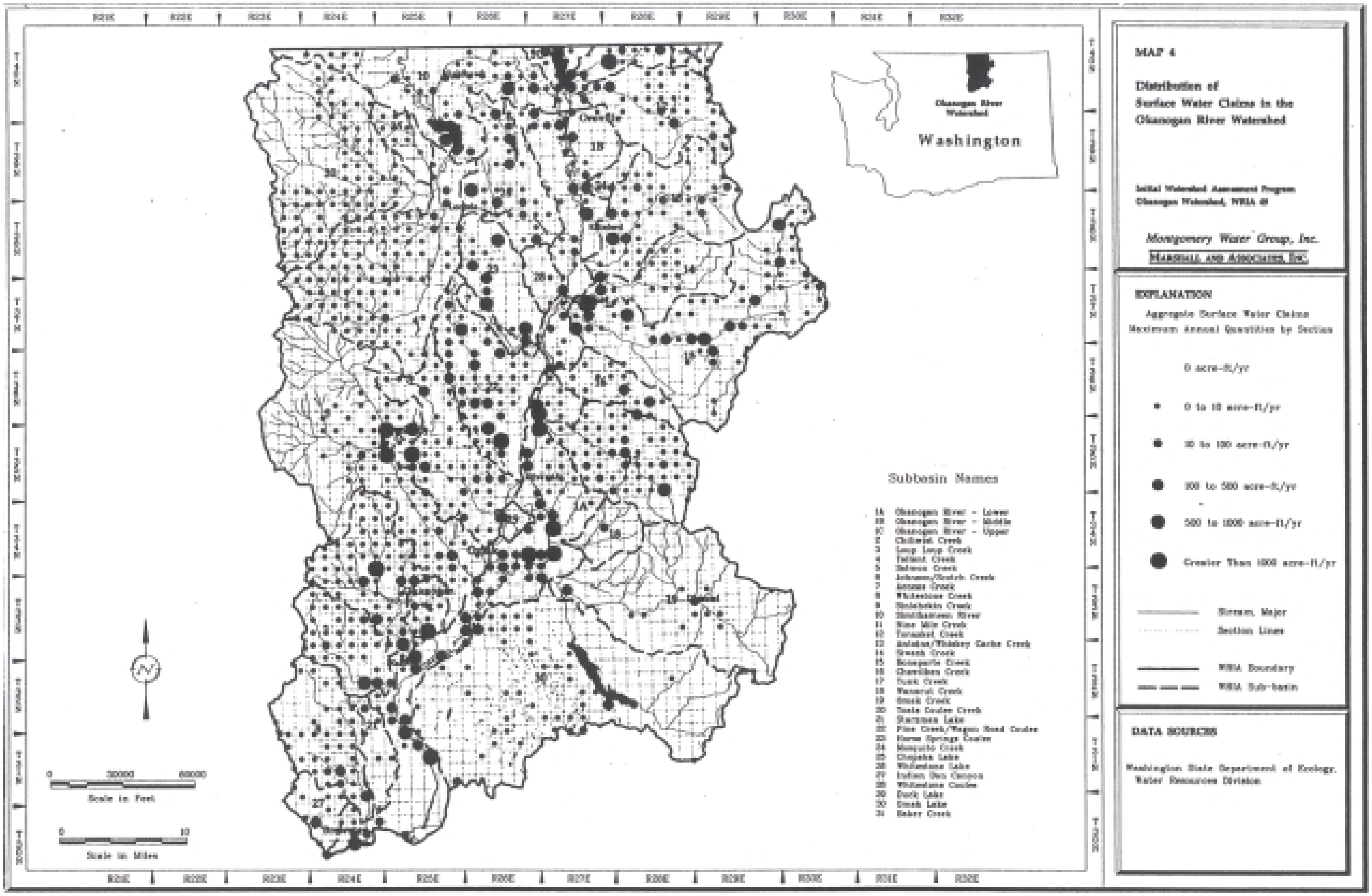
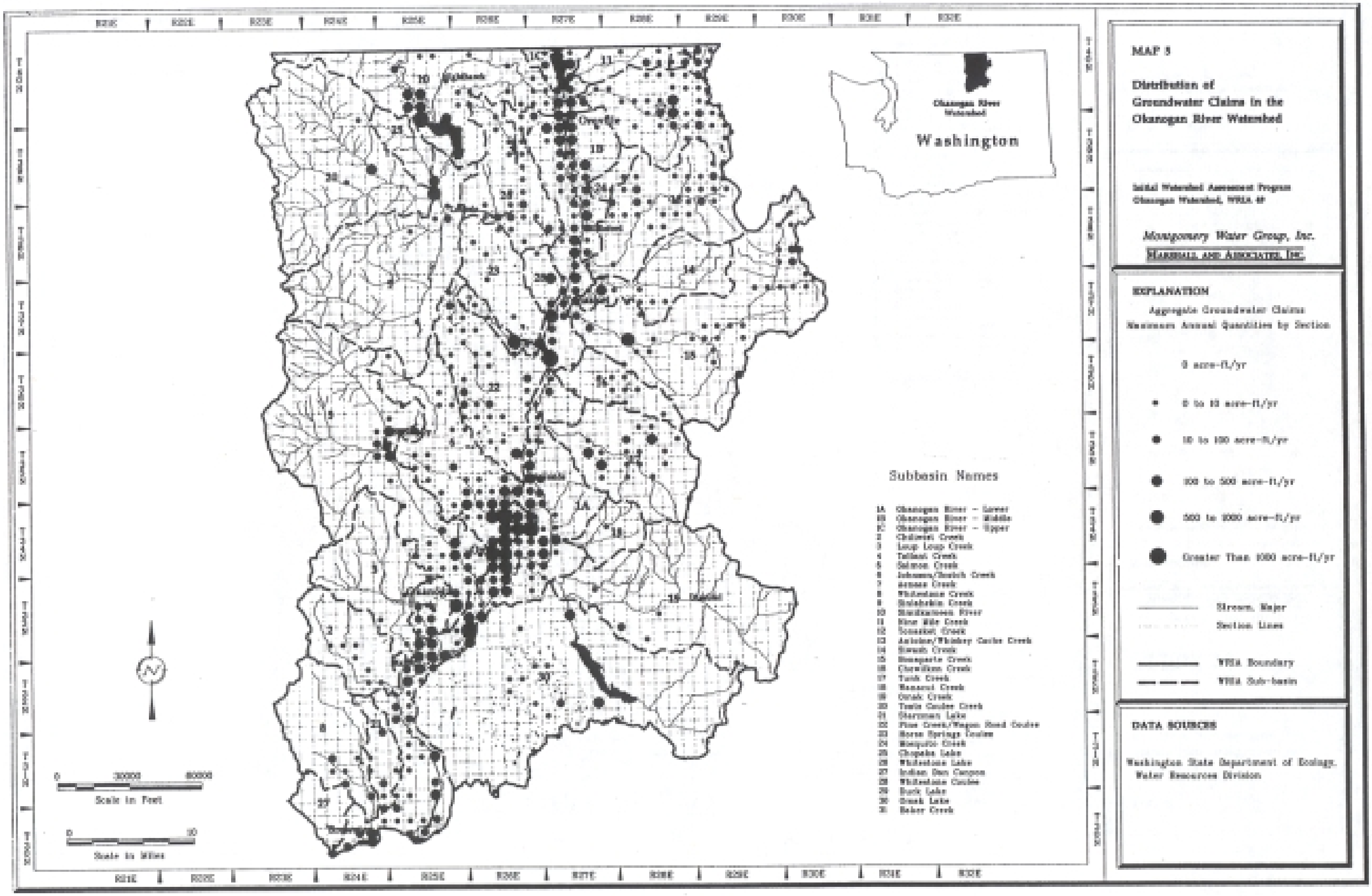
7 Aeneas Creek
8 Whitestone Creek
9 Sinlahekin Creek
10 Similkameen River
11 Nine Mile Creek
12 Tonasket Creek
13 Antoine/Whiskey Cache Creek
14 Siwash Creek
15 Bonaparte Creek
16 Chewiliken Creek
17 Tunk Creek
18 Wannacut Creek
19 Omak Creek
20 Toats Coulee Creek
22 Pine Creek/Wagon Road Coulee
23 Horse Springs Coulee
24 Mosquito Creek
25 Chopaka Lake
26 Whitestone Lake
27 Indian Dan Canyon
28 Whitestone Coulee
29 Duck Lake
31 Baker Creek
Scale in Feet
Scale in Miles


MAP 4
Distribution of
Surface Water Claims in the
Okanogan River Watershed
Initial Watershed Assessment Program
Okanogan Watershed, WRIA 49
Montgomery Water Group, Inc.
Marshall and Associates, Inc.
EXPLANATION
Aggregate Surface Water Claims
Maximum Annual Quantities by Section
0 acre-ft/yr
0 to 10 acre-ft/yr
10 to 100 acre-ft/yr
100 to 500 acre-ft/yr
500 to 1000 acre-ft/yr
Greater Than 1000 acre-ft/yr
Stream, Major
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology,
Water Resources Division
Washington
Subbasin Names
Scale in Feet
Scale in Miles


MAP 5
Distribution of Groundwater Claims in the Okanogan River Watershed
Initial Watershed Assessment Program
Okanogan Watershed, WRIA 49
Montgomery Water Group, Inc.
Marshall and Associates, Inc.
EXPLANATION
Aggregate Groundwater Claims
Maximum Annual Quantities by Section
0 acre-ft/yr
0 to 10 acre-ft/yr
10 to 100 acre-ft/yr
100 to 500 acre-ft/yr
500 to 1000 acre-ft/yr
Greater Than 1000 acre-ft/yr
Stream, Major
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology, Water Resources Division
Washington
Okanogan River Watershed
Subbasin Names
1A Okanogan River - Lower
1B Okanogan River - Middle
1C Okanogan River - Upper
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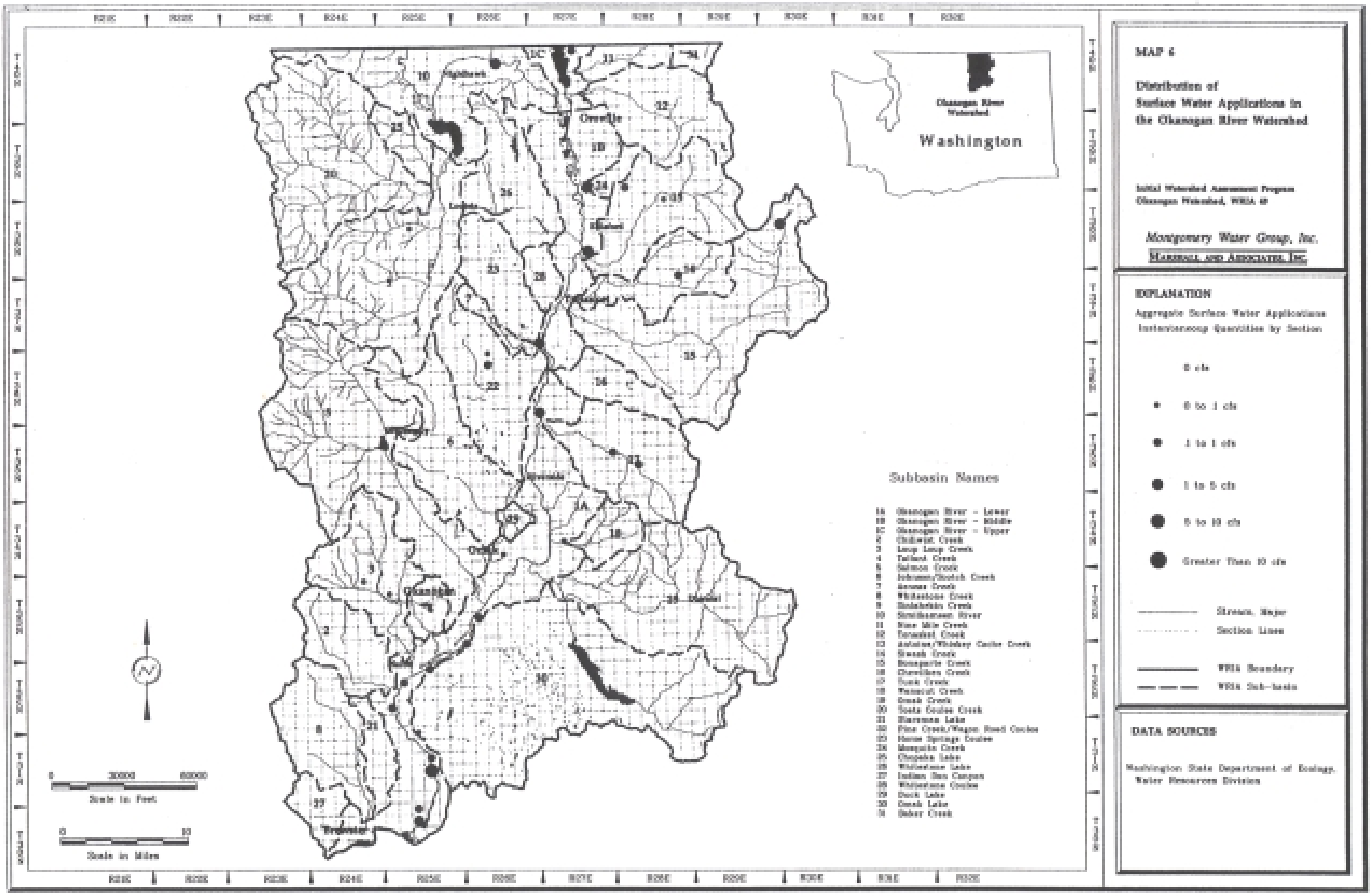
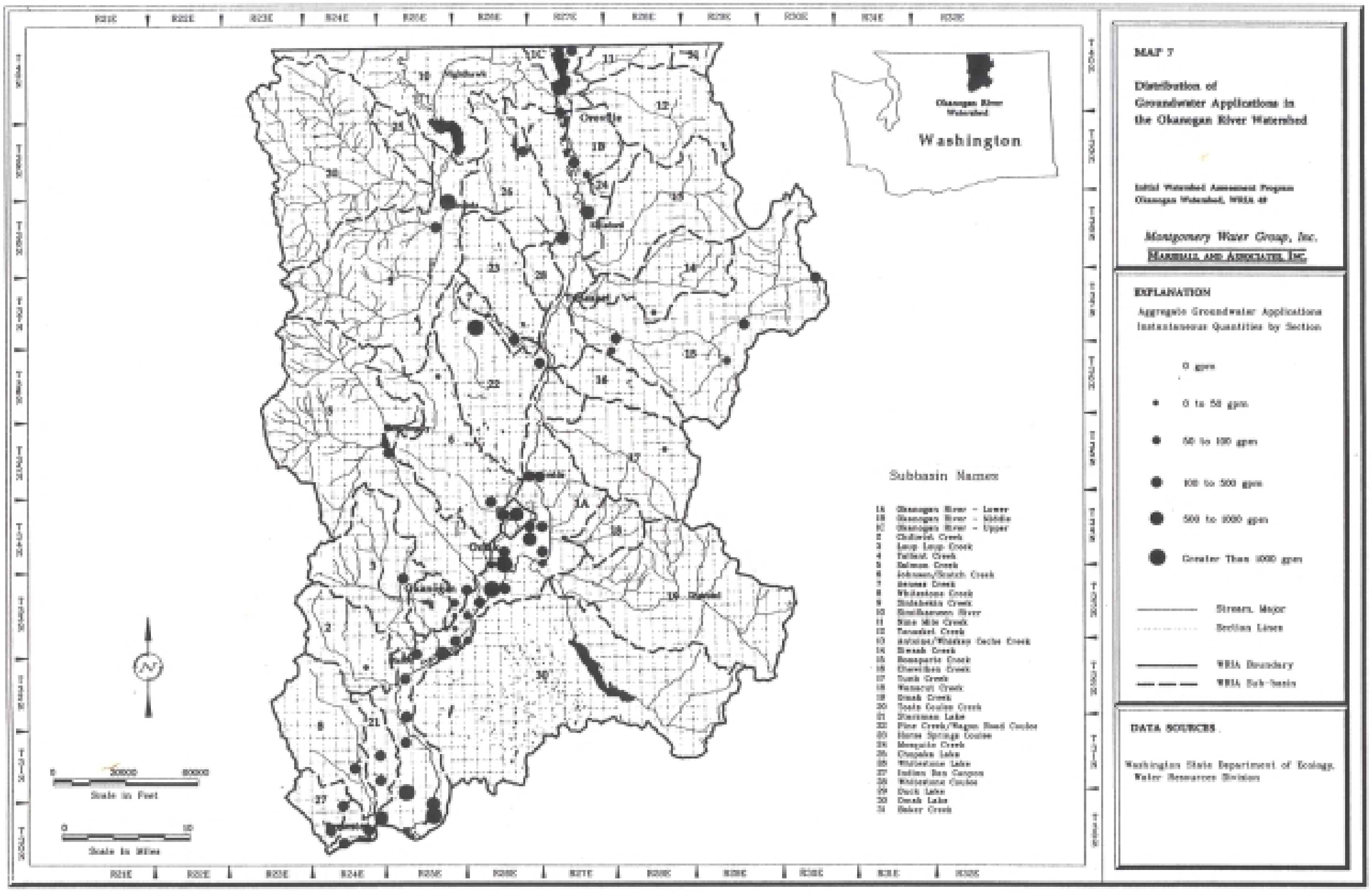
10 Similkameen River
11 Nine Mile Creek
12 Tonasket Creek
13 Antoine/Whiskey Cache Creek
14 Siwash Creek
15 Bonaparte Creek
16 Chewiliken Creek
17 Tunk Creek
18 Wanacut Creek
19 Omak Creek
20 Toats Coulee Creek
22 Pine Creek/Wagon Road Coulee
23 Horse Springs Coulee
24 Mosquito Creek
25 Chopaka Lake
26 Whitestone Lake
27 Indian Dan Canyon
28 Whitestone Coulee
29 Duck Lake
30 Omak Lake
31 Baker Creek
Scale in Feet
Scale in Miles


MAP 6
Distribution of
Surface Water Applications in
the Okanogan River Watershed
Montgomery Water Group, Inc.
Washington
Subbasin Names
EXPLANATION
0 cfs
Greater Than 10 cfs
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology,
Water Resources Division
Scale in Feet
Scale in Miles


MAP 7
Distribution of Groundwater Applications in the Okanogan River Watershed
Montgomery Water Group, Inc.
EXPLANATION
Aggregate Groundwater Applications Instantaneous Quantities by Section
0 gpm
0 to 50 gpm
50 to 100 gpm
100 to 500 gpm
500 to 1000 gpm
Greater Than 1000 gpm
Stream, Major
Section Lines
WRIA Boundary
WRIA Sub-basin
DATA SOURCES
Washington State Department of Ecology, Water Resources Division
Washington
Oroville
Omak
Okanogan
Subbasin Names
1A Okanogan River - Lower
1B Okanogan River - Middle
1C Okanogan River - Upper
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4 Tallant Creek
5 Salmon Creek
6 Johnson/Scotch Creek
7 Aeneas Creek
8 Whitestone Creek
9 Sinlahekin Creek
10 Similkameen River
11 Nine Mile Creek
12 Tonasket Creek
13 Antoine/Whitley Coulee Creek
14 Siwash Creek
15 Bonaparte Creek
16 Chewiliken Creek
17 Tunk Creek
18 Wannacut Creek
19 Omak Creek
20 Soda Coulee Creek
22 Pine Creek/Wagon Road Coulee
23 Horse Springs Coulee
24 Mosquito Creek
25 Chopaka Lake
26 Whitestone Lake
27 Indian Dan Canyon
29 Duck Lake
30 Omak Lake
31 Baker Creek
Scale in Feet
Scale in Miles

Appendix A

Tabulated Streamflow Records and Statistics

OKANOGAN WRIA
STREAMFLOW EXCEEDENCES

	Okanogan River at Malott			Okanogan River near Tonasket			Okanogan River at Oroville		
Period	90% (cfs)	50% (cfs)	10% (cfs)	90% (cfs)	50% (cfs)	10% (cfs)	901yo (cfs)	50% (cfs)	10% (cfs)
1 Jan	594	1006	1807	594	107,4	1924	202	399	783
2	613	1025	1821	591	1056	1878	203	403	785
3	632	1057	1879	591	1048	1858	205	410	807
4	650	1095	1970	606	1065	1878	205	423	855
5 Feb	682	1155	2094	623	1088	1914	209	447	936
6	700	1190	2167	641	1107	1939	209	467	1013
7	725	1242	2269	660	1138	1990	204	477	1071
8	724	1268	2378	657	1137	2002	195	477	1118
9 Mar	736	1324	2543	657	1151	2040	187	476	1159
10	749	1376	2668	658	1167	2087	176	472	1185
11	757	1426	2797	661	1191	2173	168	472	1221
12	788	1513	3006	691	1273	2376	167	484	1262
13 Apr	849	1657	3318	760	1423	2718	173	502	1287
14	966	1893	3785	904	1709	3278	179	523	1324
15	1169	2270	4470	1158	2187	4181	192	559	1391
16	1573	3014	5835	1575	2967	5633	217	628	1540
17 May	2165	4147	8035	2194	4149	7881	248	713	1742
18	2936	5638	10893	3037	5774	10913	280	817	2022
19	3853	7483	14534	3974	7617	14384	307	917	2319
20	4514	9064	18097	4713	9140	17285	318	' 973	2510
21 Jun	4717	9720	19812	5044	9895	18708	311	972	2552
22	4495	9453	19634	4858	9656	18302	293	934	2501
23	3770	8149	17452	4085	8325	15980	260	839	2294
24	2866	6450	14470	3186	6708	13180	229	744	2067
25 Jul	2171	5102	11923	2419	5265	10540	210	687	1918
26	1639	3953	9544	1801	4005	8192	196	641	1771
27	1221	3030	7505	1324	3012	6259	189	605	1625
28	911	2312	5787	988	2286	4774	185	570	1478
29 Aug	702	1782	4440	768	1783	3737	185	541	1360
30	578	1451	3551	632	1450	3022	187	521	1268
31	498	1224	2912	545	1228	2539	188	502	1189
32	466	1101	2491	498	1094	2220	198	500	1133
33 Sep	462	1033	2215	475	1012	2009	208	496	1075
34	472	991	2032	470	967	1879	214	482	1003
35	498	969	1876	479	949	1798	221	473	951
36	544	980	1781	509	970	1791	233	476	925
37 Oct	588	997	1726	545	1002	1808	241	475	902
38	627	1026	1732	584	1045	'1848	247	475	888
39	678	1088	1802	640	1124	1960	250	477	884
40	718	1145	1904	678	1187	2074	246	467	863
41 Nov	768	1227	2066	706	1234	2171	238	452	839
42	780	1246	2133	715	1250	2208	229	439	821
43	767	1228	2114	712	1254	2228	221	426	812
44	737	1202	2135	689	1227	2197	216	418	809
45 Dec	687	1153	2129	663	1196	2178	214	419	832
46	649	1108	2117	640	1165	2149	207	409	823
47	632	1058	2000	624	1129	2075	206	406	817
48	606	999	1867	604	1089	1994	202	397	793

	Similkameen River			Omak Creek			Salmon Creek		
Period	90% (cfs)	50% (cfs)	10% (cfs)	90% (cfs)	50% (cfs)	10% (cfs)	90% (cfs)	50% (cfs)	10% (cfs)
1 Jan	292	560	1188	2.7	8.3	36.1	0.9	1.6	3.1
2	291	544	1144	3.0	9.0	39.3	0.9	1.7	3.1
3	291	532	1111	2.8	8.1	33.3	0.9	1.7	3.1
4	301	537	1109	3.2	8.9	36.4	0.9	1.6	3.1
5 Feb	312	543	1103	3.7	9.7	39.2	0.9	1.6	3.1
6	325	547	1086	3.6	9.7	39.0	0.9	- 1.6	3.1
7	339	562	1093	4.1	11.8	50.6	0.9	1.6	3.1
8	344	570	1109	4.3	12.6	52.0	0.9	1.6	3.1
9 Mar	345	579	1142	5.1	14.5	56.3	0.9	1.7	3.3
10	347	595	1186	5.6	16.6	61.4	0.9	1.7	3.5
11	356	625	1277	6.1	18.3	66.9	1.0	1.9	3.9
12	381	692	1461	5.8	18.2	64.9	1.1	2.2	4.8
13 Apr	438	815	1755	6.2	19.5	66.0	1.0	2.4	5.7
14	558	1064	2322	5.4 '	18.4	64.6	1.0	2.7	7.1
15	780	1502	3285	4.6	17.9	68.0	1.1	3.2	9.4
16	1158	2250	4906	5.5	22.1	82.5	1.5	4.9	15.4
17 May	1738	3404	7408	6:3	23.5	822	3.1	10.9	36.6
18	2541	4984	10616	6.9	25.7	87.8	6.2	22.0	70.9
19	3473	6831	14305	7.1	26.2	87.1	10.9	38.9	120.8
20	4212	8282	16978	6.1	23.0	76.4	16.3	62.8	202.5
21 Jun	4537	8906	17917	4.8	19.7	65.4	21.5	84.0	249.9
22	4312	8529	17058	3.7	16.5	54.3	26.6	92.6	239.0
23	' 3567	7130	14265	2.5	11.8	39.5	26.5	85.6	198.8
24	2736	5550	11301	1.9	8.3	25.8	29.0	84.1	179.1
25 Jul	2058	4221	8709	1.4	5.7	17.8	30.4	86.3	175.8
26	1523	3114	6501	0.9	4.0	12.9	28.3	79.8	160.6
27	1100	2252	4758	0.8	3.3	9.6	29.6	85.0	178.3
28	804	1630	3453	0.7	3.0	9.2	29.7	84.6	182.7
29 Aug	609	1208	2543	0.6	2.5	7.7	26.2	77.4	175.7
30	486	936	1937	0.8	3.7	11.0	23.7	78.0	197.1
31	406	760	1553	0.8	3.3	9.1	19.5	72.1	204.1
32	361	657	1316	0.9	3.0/	7.1	9.9	40.0	121.9
33 Sep	329	589	1169	1.0	3.0	6.6	6.1	26.0	87.0
34	312	549	1086	1.0	2.7	5.5	3.4	14.0	48.0
35	303	527	1039	1.3	3.1	5.8	2.1	8.6	31.1
36	301	518	1020	1.4	3.3	6.2	1.3	5.6	21.6
37 Oct	308	525	1036	1.8	3.8	6.4	1.0	4.3	18.1
38	316	542	1088	2.1	4.0	6.6	0.9	3.9	16.2
39	343	593	1208	2.7	4.4	6.4	1.0	3.3	12.3
40	364	641	1351	2.9	4.8	6.9	1.0	3.0	10.0
41 Nov	380	682	1485	3.5	6.1	9.8	0.9	2.5	7.6
42	385	698	1544	3.4	6.9	12.9	0.9	2.2	6.1
43	381	699	1570	3.4	7.8	17.1	0.8	1.8	5.0
44	367	683	1559	3.2	7.8	19.6	0.7	1.6	4.1
45 Dec	347	655	1519	2.6	6.5	18.2	0.7	1.6	3.6
46	332	629	1466	3.6	9.3	27.6	0.8	1.5	3.1
47	322	601	1373	3.5	9.6	33.0	0.9	1.6	2.9
48	303	562	1266	2.5	7.7	31.0	0.9	1.6	3.0

Period	Toats Coulee Creek 90% (cfs)	50% (cfs)	10% (cfs)	Whitestone Creek near Tonasket 90% (cfs)	50% (cfs)	10% (cfs)	Sinlahekin River 90% d(cfs)	50% (cfs)	10% (cfs)
1 Jan	5.8	8.2	12.3	0.5	1.7	5.5	18.3	24.7	33.8
2	5.7	8.1	11.9	0.5	1.8	5.7	17.5	23.7	32.2
3	5.7	8.1	11.8	0.6	1.9	5.8	17.3	23.4	31.7
4	6.0	8.2	12.0	0.6	1.9	5.8	17.7	23.8	32.1
5 Feb	6.1	8.2	11.9	0.6	1.9	5.5	17.8	24.0	32.3
6	6.2	8.3	12.1	0.6	1.8	5.2	17.9	24.8	34.2
7	6.5	8.4	11.8	0.7	2.1	5.7	18.9	25.4	34.2
8	6.5	8.5	11.9	0.7	2.1	5.6	18.8	25.5	34.7
9 Mar	6.4	8.4	12.1	0.8	2.2	5.9	18.1	25.1	35.2
10	6.3	8.5	12.8	0.9	2.5	6.4	17.4	24.9	36.4
11	6.3	9.1	14.1	0.8	2.2	5.4	17.0	25.6	38.2
12	6.7	10.1	16.3	0.7	2.0	4.8	16.2	26.0	41.5
13 Apr	7.6	12.2	20.8	0.6	1.6	3.7	13.8	26.6,	49.3
14	8,.3	14.7	27.1	0.5	1.3	2.9	10.8	25.2	54.7
15	9.8	18.8	37.1	0.5	1.3.	2.6	9.2	25.0	63.5
16	14.3	29.8	62.5	0.7	1.5	2.9	10.4	30.5	84.7
17 May	21.8	49.2	109.3	0.9	1.8	3.4	14.6	45.1	128.4
18	36.5	86.7	202.6	1.3	2.4	4.0	24.6	76.9	222.5
19	55.8	139.3	338.1	1.7	2.9	4.7	44.7	140.7	418.5
20	69.8	181.6	457.3	1.9	3.2	4.9	62.7	205.4	641.9
21 Jun	71.6	195.4	484.4	2.2	3.4	5.1	70.5	236.4	740.6
22	60.0	169.0	412.4	2.3	3.6	5.3	68.7	210.7	618.2
23	45.8	129.1	307.4	2.5	3.8	5.3	50.6	136.6	358.1
24	33.5	93.3	220.5	2.7	3.9	5.2	35.9	86.3	195.9
25 Jul	24.2	65.1	151.0	2.8	3.9	5.2	24.2	54.8	113.7
26	17.3	45.6	100.3	2.9	4.0	5.3	15.6	33.9	66.1
27	12.5	31.1	66.3	2.9	3.9	5.2	11.5	23.8	45.4
28	9.7	23.4	49.8	3.0	4.0	5.2	9.6	19.1	36.8
29 Aug	7.7	17.6	37.2	2.9	3.9	5.1	8.2	15.3	28.9
30	6.5	14.0	29.5	2.9	3.9	5.0	7.6	13.3	24.3
31	6.0	12.4	26.3	3.0	3.9	5.0	7.5	12.5	22.5
32	5.3	10.4	X1.7	2.8	3.9	5.1	7.2	11.8	21.0
33 Sep	4.8	9.1	18.6	2.7	3.9	5.5	6.9	11.3	19.9
34	4.5	8.5	17.0	2.4	3.9	6.1	7.4	12.1	21.6
35	4.5	8.0	15.6	2.1	3.7	6.2	7.8	12.9	23.4
36	4.9	8.5	16.4	1.7	3.1	5.5	8.4	14.0	25.6
37 Oct	5.6	9.4	17.0	1.1	2.3	4.5	9.9	16.1	29.1
38	6.2	9.9	17.1	0.8	1.8	4.0	11.4	18.0	31.8
39	7.0	10.9	18.1	0.6	1.6	3.8	13.3	20.7	35.0
40	7.0	10.6	16.9	0.5	1.4	3.6	15.3	22.5	35.7
41 Nov	7.0	10.2	15.6	0.4	1.3	3.5	17.2	24.2	36.4
42	6.9	9.7	14.6	0.4	1.3	3.5	18.4	24.7	36.2
43	6.6	9.1	13.7	0.4	1.3	3.6	19.3	25.4	36.5
44	6.6	9.0	13.3	0.5	1.5	4.3	19.7	25.5	35.4
45 Dec	6.4	8.8	12.8	0.5	1.7	5.2	19.6	25.1	33.6
46	6.0	8.4	12.7	0.5	1.7	5.8	18.8	24.9	34.3
47	5.9	8.4	12.7	0.5	1.8	6.0	18.0	24.3	33.7
48	5.6	8.1	12.3	0.5	1.7	5.5	17.5	23.7	33.1

	Bonaparte Creek		
Period	90% (cfs)	50% (cfs)	10% (cfs)
1 Jan	1.8	2.4	3.4
2	2:0	2.7	3.8
3	1.9	2.6	3.7
4	2.0	3.0	4.6
5 Feb	1.9	3.1	5.1
6	1.9	3.4	5.9
7	2.4	4.5	8.3
8	2.6	4.9	9.5
9 Mar	2.8	5.7	12.0
10	3.1	6.5	14.6
11	3.1	6.9	16.6
12	3.3	7.7	19.6
13 Apr	3.4	8.0	20.8
14	2.6	7.1	21.2
15	1.9	6.1	21.1
16	1.5 .	5.5	21.0
17 May	1.1	4.4	18.8
18	1.1	4.7	21.5
19	1.2	5.2	23.8
20	1.0	4.9	23.5
21 Jun	1.2	5.4	25.8
22	1.2	5.0	22.9
23	1.1	4.3	16.5
24	1.3	4.3	13.8
25 Jul	1.4	4.3	12.3
26	1.3	3.4	8.2
27	1.1	2.7	6.1
28	1.0	2.2	4.7
29 Aug	0.9	1.8	3.6
30	0.8	1.7	. 3.3
31	0.8	1.6	2.9
32	0.9	1.5	2.6
33 Sep	0.9	1.5	2.4
34	1.0	1.5	2.2
35	1.2	. 1.7	2.5
36	1.3	1.9	2.6
37 Oct	1.5	2.1	2.7
38	1.7	2.3	3.1
39	1.9	2.6	3.4
40	2.1	2.8	3.8
41 Nov	2.3	3.1	4.3
42	2.4	3.2	4.5
43	2.3	3.1	4.3
44	2.0	2.9	4.1
45 Dec	1.9	2.7	3.9
46	1.9	2.6	3.7
47	1.8	2:6	3.6
48	1.8	2.4	3.4

OKANOGAN RIVER AT OROVILLE, WASH. USGS STATION: 12439500
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1943	962.5	1047.3	891.2	584.4	596.8	505.0	916.6	1020.2	802.3	380.5	155.8	140.4	666.9
1944	201.3	224.4	193.3	183.7	228.9	129.7	185.3	322.6	910.8	501.2	166.5	81.7	277.5
1945	188.4	258.0	436.3	530.5	500.1	542.7	659.7	1474.6	1501.1	668.8	448.7	288.6	624.8
1946	473.3	648.7	921.4	822.0	640.8	783.3	923.7	1711.3	1528.0	1074.2	825.5	836.4	932.4
1947	903.2	835.5	762.9	611.5	413.2	242.7	175.4	457.2	335.9	125.9	193.3	310.5	447.3
1948	372.6	366.3	465.4	624.0	418.5	274.3	475.1	1208.1	2454.3	1509.4	1455.8	1482.0	925.5
1949	1430.3	1550.7	1403.9	1190.0	1138.6	1039.7	930.1	1567.3	762.8	452.4	465.1	538.6	1039.1
1950	548.3	543.0	468.0	402.9	609.99	884.0	877.2	1200.5	1886.3	748.5	572.1	423.9	763.7
1951	559.5	606.8	673.7	769.2	868.5	878.9	1179.8	1929.7	1386.7	1193.2	868.4	805.6	976.7
1952	855.9	872.0	745.0	736.8	917.4	748.8	1034.9	1818.1	1024.5	844.6	632.4	700.8	910.9
1953	713.3	340.8	279.9	231.0	282.4	213.3	256.2	870.5	788.3	613.3	545.6	643.4	481.5
1954	571.7	615.1	661.9	628.2	869.4	748.6	526.1	724.9	904.9	1070.6	880.5	920.3	760.2
1955	745.5	810.5	874.3	829.9	778.9	663.7	b49.9	801.9	1332.3	917.9	783.7	826.5	834.6
1956	525.6	394.4	339.2	510.9	565.3	800.5	1045.1	1643.0	1778.3	1521.6	704.0	454.8	856.9
1957	494.9	475.2.	555.9	561.3	491.4	475.1	503.4	1195.0	828.7	626.3	463.9	656.7	610.6
1958	769.5	571.7	615.7	586.3	556.6	578.0	1081.7	1288.9	683.2	467.1	427.0	521.0	678.9
1959	489.3	457.8	470.6	609.4	632.1.	849.1	909.3	1767.4	2122.0	1178.1	542.2	575.8	883.6
1960	555.1	1046.9	1281.0	1113.7	844.1	333.1	527.4	683.5	514.2	351.4	449.2	561.4	688.4
1%1	594.6	567.1	557.8	532.2	416.8	380.8	445.7	919.5	1267.8	514.6	476.8	532.4	600.5
1962	549.7	394.2	390.4	349.1	369.4	452.7	824.0	826.5	599.3	335.3	341.1	387.5	484.9
1963	418.5	352.6	377.3	365.3	300.5	201.6	247.1	348.8	262.0	224.9	150.2	243.7	291.0
1964	303.2	293.5	247.2	235.3	423.1	473.1	558.1	655.1	1165.8	719.5	642.5	748.6	538.7
1965	641.3	456.0	436.2	380.5	644.8	877.6	1078.1	1674.5	1712.0	634.2	385.1	532.1	787.7
1966	553.2	426.2	307.3	434.0	372.5	287.3	440.0	388.6	291.3	280.4	237.0	334.4	362.7
1967	258.7	221.9	298.1	373.4	300.7	665.3	786.5	1129.7	1407.9	312.2	242.9	212.7	517.5
1968	249.9	179.6	150.4	162.4	209.7	185.0	115.2	512.7	1390.6	478.6	436.3	431.4	375.2
1969	582.9	645.3	361.4	793.2	780.7	932.8	1038.0	1762.9	824.1	480.4	423.4	513.2	761.5
1970	613.9	452.5	424.4	417.1	261.6	348.5	380.1	745.6	242.7	185.0	217.3	265.0	379.5
1971	210.8	148.1	149.5	168.3	140.5	135.3	1088.3	1204.7	1754.7	642.6	471.0	479.8	550.0
1972	425.8	274.4	387.6	786.8	938.8	1493.9	1803.0	2071.5	2684.1	2250.6	1815.5	866.1	1316.5
1973	429.9	484.3	453.8	348.2	2%.1	148.0	278.4	320.6	201.9	144.6	231.7	234.0	297.6
1974	264.5	235.3	246.1	225.3	724.7	1648.9	2110.7	27%.5	2075.0	1994.5	1123.6	341.5	1148.9
1975	516.5	366.5	269.7	260.5	941.2	1462.9	1177.8	606.0	982.7	333.7	377.5	506.5	650.1
1976	818.1	406.9	321.5	447.5	1009.5	893.4	629.4	880.6	750.9	1419.8	1008.7	911.5	791.5
1977	593.2	1008.4	794.5	357.6	348.9	74.1	246.7	443.7	229.1	126.4	231.6	345.4	400.0
1978	453.8	324.0	233.2	303.6	881.8	903.9	873.1	1604.5	1023.1	348.5	329.7	561.2	653.4
1979	664.7	928.2	808.1	466.1	416.3	330.9	264.4	393.3	263.2	218.0	250.0	372.1	447.9
1980	451.0	331.0	229.4	218.0	218.4	209.1	223.2	579.3	587.9	651.5	413.4	525.4	386.5
1981	483.4	453.3	517.1	453.5	294.1	185.3	223.8	1222.8	2388.3	1739.0	1192.9	654.1	817.3
1982	601.8	468.4	437.2	422.6	895.9	1267.1	1418.7	1846.8	983.6	1279.2	1659.7	1411.2	1057.7
1983	578.8	547.0	550.8	749.0	1185.4	1917.7	2474.7	2869.7	2191.3	1859.0	1293.2	961.1	1431.5
1984	556.9	432.0	390.3	495.3	1009.2	1081.4	1156.2	2028.7	2199.0	1528.7	1032.5	702.2	1051.0
1985	432.8	481.1	392.8	419.2	421.1	386.6	409.0	427.5	300.5	198.3	255.8	418.3	378.6
1986	418.5	400.7	363.4	279.7	459.6	795.5	519.4	1419.1	1276.5	836.2	1093.6	491.0	6%.1
1987	407.0	492.5	434.5	251.4	341.2	408.2	250.9	323.4	117.1	259.0	.0	.0	.0
1988	349.5	205.1	276.7	250.8	244.2	177.0	163.5	205.2	197.7	140.0	165.7	179.9	212.9
1989	178.5	208.8	219.6	169.0	232.3	172.2	391.7	375.5	794.7	776.7	428.5	565.4	376.1
1990	543.4	312.8	308.5	321.3	378.4	328.5	314.2	611.4	3106.7	2439.0	1845.8	670.3	931.7
1991	332.3	286.6	237.5	299.4	1095.0	1424.3	337.4	1707.6	1865.0	1021.4	926.9	282.2	818.0
1992	322.8	287.1	282.5	279.8	290.4	330.6	179.0	180.0	111.2	264.2	157.1	346.2	252.6
1993	383.2	255.2	212.8	210.8	232.9	191.7	178.2	1275.6	833.9	1496.6	1990.0	.0	.0
AVG	520.5	490.0	472.7	465.7	557.4	616.9	695.7	1098.9	1129.9	791.7	648.7	546.8	669.6

OKANOGAN RIVER NEAR TONASKET, WASH.
USGS STATION: 12445000
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1911	.0	.0	.0	.0	.0	.0	.0	.0	11075.3	4461.6	1748.1	1382.0	.0
1912	1072.9	997.0	1048.4	1020.0	1004.8	8b9.0	1526.0	8118.1	7626.7	4101.6	2157.7	1585.7	2594.0
1913	1257.1	1283.7	1131.3	.0	.0	947.7	1680.0	7162.9	12219.7	5152.3	2296.5	1614.7	.0
1914	1627.1	1591.0	1371.9	1517.4	1226.1	1249.4	3328.0	9481.3	8645.3	3986.1	1612.6	1160.0	3066.4
1915	1287.7	1504.0	1111.0	972.3	1068.6	1076.9	3177.7	5417.7	4583.0	2673.2	1898.4	1182.3	2162.7
1976	1192.3	1431.0	1051.3	771.0	1118.3	1862.3	2849.0	9637.4	15570.0	8726.8	2975.2	1707.0	4069.3
1917	1199.0	988.0	840.5	794.5	808.3	862.8	885.5	5982.3	13146.7	5788.1	1848.1	1137.3	2856.8
1918	1015.5	1167.0	1000.3	2321.0	1176.4	979.0	2334.0	9168.7	11374.7	3641.0	1803.5	928.0	3075.8
1919	1023.2	1080.0	890.3	935.8	857.3	903.9	2378.9	10105.2	11682.0	5336.1	1755.5	1072.4	3168.4
1920	853.2	1158.9	903.3	867.7	1095.3	788.0	844.0	4738.7	8294.7	5745.5	1680.0	945.5	2326.2
1921	1865.2	1180.3	896.7	817.6	919.4	1166.8	1755.0	9830.3	14557.3	5114.5	1600.3	823.4	3377.2
1922	1227.1	1642.3	1989.4	1606.7	1292.5	1376.5	1548.0	6996.8	11921.3	2611.9	981.3	816.0	2834.1
1923	986.9	1108.7	979.0	1283.9	985.9	1027.5	2344.7	9046.5	11720.0	5238.1	1873.9	1217.0	3151.0
1924	1177.1	1156.3	1042.4	858.1	1656.9	1325.5	1437.3	10201.3	5337.3	1601.4	628.9	451.5	2239.5
1925	754.9	806.0	1230.4	1290.6	7466.4	799.5	3597.3	11360.3	6933.0	2168.7	743.3	476.1	2635.5
1929	.0	.0	.0	.0	.0	.0	.0	3893.2	5525.7	1331.4	405.7	270.3	.0
1930	415.9	412.9	398.8	359.9	581.4	529.0	3242.3	5094.5	5661.0	1838.6	515.4	364.6	1617.9
1931	442.4	587.9	443.2	439.5	600.5	525.1	770.1	5630.3	2730.0	908.4	231.5	334.8	1137.0
1932	403.2	662.6	491.5	398.0	882.9	2055.2	2918.7	8616.1	6838.0	2272.9	915.1	695.9	2262.5
1933	886.5	1870.7	1851.9	1503.9	1035.5	916.5	1984.3	7196.8	13270.0	5942.6	1811.6	1086.0	3279.7
1934	2112.6	3233.3	2437.1	2011.0	1860.7	2855.5	13223.0	12268.7	6214.3	2113.9	1055.1	626.2	4167.6
1935	950.3	2203.3	1754.8	1388.4	2889.3	1896.1	2010.7	9282.6	10705.7	4727.4	1881.0	1251.3	3411.7
7936	1311.9	1358.7	1198.7	943.9	612.9	700.7	2942.5	8845.2	6484.0	1929.7	884.5	705.5	2326.5
1937	842.3	895.3	827.7	503.9	532.1	704.4	1258.0	6485.5	11952.3	3381.6	958.5	730.8	2422.7
1938	1058.5	1495.7	1414.5	1394.2	1345.4	1657.7	3840.7	11859.0	9384.3	2388.4	711.0	574.0	3093.6
1939	736.0	783.8	820.8	927.2	610.5	848.6	2945.7	7356.1	5535.3	2320.6	695.8	516.2	2008.1
1940	657.6	928.6	1253.2	715.3	675.4	703.7	2236.0	5219.0	2963.7	605.0	318.8	231.0	1375.6
1941	710.5	712.3	739.3	700.0	686.6	956.9	3054.0	3790.0	3720.3	1553.4	662.0	1491.7	1564.7
1942	2756.5	2181.3	2306.8	1800.3	1515.0	1008.0	2897.3	8631.6	9639.7	3932.3	2063.5	1406.3	3344.9
1943	1351.6	1575.7	1598.4	1114.8	1316.8	1100.5	3766.3	6467.4	10172.3	5422.5	1270.4	575.3	2977.7
1944	655.1	730.6	594.4	491.5	656.4	538.6	944.3	4747.4	7925.3	2005.0	600.7	514.6	1700.3
1945	764.1	892.8	1025.8	1192.9	1261.9	1120.5	1338.7	8148.4	11251.0	2796.1	1029.5	706.7	2627.4
7946	1117.3	1807.3	1550.5	1414.2	1175.7	1408.4	2964.0	13318.7	9786.7	3941.6	1614.8	1335.3	3452.9
1947	1454.8	1445.0	1326.1	1143.8	951.3	1023.4	2941.0	9161.3	5761.3	1741.7	824.3	757.4	2377.6
1948	1193.9	1223.3	1188.1	1259.4	1050.6	748.0	1620.3	10978.1	20450.3	5024.8	3928.4	3038.7	4308.7
1949	2788.4	2556.0	2170.6	1865.2	1805.4	1768.4	3689.0	15529.0	8336.3	2659.0	1348.7	1197.0	3809.4
1950	1336.1	2200.0	2525.8	1166.5	1567.5	2381.9	2575.3	8762.3	19356.7	6151.6	1965.8	963.5	4246.1
1951	1383.9	1812.3	2341.6	1983.9	2380.0	27.4	-4583.3	15706.1	11595.3	4595.8	1708.4	1659.3	4314.8
1952	1745.8	1765.3	1358.7	1246.5	1526.6	1328.7	3093.3	10555.8	6458.7	3073.5	1292.9	1084.7	2877.5
1953	1072.0	777.8	673.7	757.2	950.0	770.0	1384.2	9323.2	10508.3	4607.4	1556.8	1210.9	2799.3
1954	1440.6	1635.3	1458.7	1140.6	1570.4	1307.4	1343.3	9937.1	12936.7	9510.3	3031.3	2513.0	3985.4
1955	2092.9	2618.3	2419.0	1744.8	1468.6	1264.8	1507.7	4627.4	15165.0	7179.4	2317.1	1402.3	3650.6
1956	1781.6	2653.0	1364.6	1449.7	1119.7	1540.6	3552.7	14464.5	13015.7	4952.9	1692.9	1097.4	4057.1
1957	7657.1	1629.3	7691.0	1163.9	1262.1	1322.3	1694.3	16011.0	7601.0	2325.5	1265.2	1138.3	3230.1
1958	1325.2	1206.0	1204.8	1169.4	1188.2	1194.2	2060.0	9862.9	5521.7	1689.4	727.7	814.1	2330.3
1959	7318.4	1432.0	1988.1	1824.8	1459.3	1814.2	3057.7	10967.4	16660.0	6081.0	1589.7	1809.7	4166.8
1960	2849.4	3193.7	3105.5	1895.2	1681.4	1343.5	3655.0	6968.4	8717.3	2630.0	1019.5	992.6	3170.9
1%1	1094.5	1155.3	990.6	1109.0	1138.2	1103.7	1836.0	8294.2	73270.7	2403.5	1007.7	847.0	2853.7
1962	1208.1	964.5	895.2	1064.7	1732.9	1120.0	2863.0	5455.2	7925.0	2644.8	1105.5	772.6	2312.6
1963	1034.6	1412.4	1571.6	1100.4	1653.9	1260.6	1476.0	5779.4	6909.3	3638.1	1469.7	1172.0	2373.2
1964	1282.7	1527.7	1722.9	7538.4	1294.8	1235.5	1851.7	5320.6	16508.0	6563.5	2008.7	1873.0	3560.6
1965	2051.3	1423.3	1025.5	1087.7	1307.9	1575.2	2467.0	7887.7	11221.7	2840.6	1158.6	1154.6	2933.4
1966	1220.6	1413.0	949.4	1013.7	920.7	782.8	2291.3	5750.0	5271.0	2499.4	794.2	665.8	1964.3
1967	870.3	958.9	7229.3	1096.1	974.6	1235.0	7459.3	6977.4	16753.3	3702.6	876.8	472.5	3045.5
1968	819.1	1690.4	1036.7	1551.6	2173.1	2046.5	1353.7	7453.2	11146.7	3690.3	1226.0	1044.4	2936.0
1969	1232.9	1411.9	916.7	1324.2	1283.9	1515.5	2549.7	10848.1	6927.0	1984.5	765.0	808.5	2630.7
1970	7346.8	1167.3	952.0	772.8	742.3	799.3	911.8	4751.7	7375.7	1284.4.	457.7	512.5	1756.2
1971	666.0	553.6	534.3	609.7	1298.6	859.4	2152.4	12938.7	14252.0	4956.8	1473.9	962.7	3438.2
1972	1157.2	986.3	841.9	1190.3	1383.3	2984.8	4191.3	16192.3	27723.3	10209.7	3644.2	1767.4	6022.7
1973	1261.9	1133.0	872.4	816.7	810.6	685.2	1025.3	4958.7	4310.3	1369.0	475.3	485.5	1516.9
1974	785.6	869.2	836.1	1002.8	1407.5	2337.7	4124.0	10075.5	19566.7	8211.3	2717.1	939.7	4406.1
1975	1063.2	952.6	819.5	825.4	1552.2	2101.3	1984.7	5423.5	12261.3	4167.1	1280.1	7111.5	2795.2
1976	1470.3	1640.7	2237.4	1655.5	2107.9	1810.0	2189.0	10288.1	10409.7	7383.9	3563.2	2184.7	3911.7
1977	1352.9	1729.3	1504.5	962.6	1046.2	624.7	1526.6	4230.6	38%.0	992.1	478.2	580.1	1577.0
1978	827.5	933.8	1035.7	888.4	1456.4	1644.5	2%7.0	7998.1	10373.3	3477.1	1210.5	1950.0	2896.9
1979	1627.4	2276.7	1590.3	976.5	1010.4	1063.6	1153.5	6471.0	4435.3	1534.0	567.4	827.4	1961.1
1980	758.9	707.9	1051.0	711.6	808.6	834.3	2305.6	10749.0	7957.7	2856.8	1024.3	1082.8	2570.7
1981	1077.4	1259.3	2529.0	2563.5	1310.4	1131.0	1544.1	7860.0	8934.7	5031.0	2337.9	1207.3	3065.0
1982	1349.0	7271.3	1016.8	995.6	1457.3	1879.0	2043.7	7540.3	13113.3	6676.1	3057.7	2241.7	3553.5
1983	1565.8	1299.0	1277.7	1532.3	1872.5	2977.1	4488.3	11219.7	9941.7	5201.9	2545.8	1857.0	3814.9

1984	1227.1	1472.0	925.9	2499.7	2090.3	2132.3	2633.7	4703.5	11893.3	4807.1	1900.6	1219.3	3125.4
1985	976.4	1103.3	821.1	932.3	928.0	919.0	2138.7	7375.2	6775.3	1292.1	505.4	808.6	2047.9
1986	1110.4	1186.3	873.2	759.1	1086.5	2521.9	3085.7	7823.2	10424.7	2835.2	1635.8	911.7	2854.5
1987	994.4	1250.3	1070.9	803.5	875.1	1212.6	2492.7	9186.1	3615.0	1261.1	614.4	463.7	1986.6
1988	566.1	507.0	562.6	525.8	566.1	549.9	2085.8	6273.9	5027.3	1675.2	546.0	399.8	1607.1
1989	629.4	942.3	692.6	532.0	680.5	708.5	.2565.6	7160.6	7298.0	2349.0	1234.2	1186.4	2164.9
1990	1117.8	2316.2	2154.8	1229.7	1031.4	1063.0	4232.3	7114.5	14320.0	6207.1	2981.0	1438.0	3767.1
1991	1478.4	4618.0	2309.4	1512.9	2963.9	3130.6	4083.7	14638.7	15766.7	8951.0	2941.0	1188.3	5298.5
1992	954.8	1140.6	986.7	902.2	1141.4	1873.2	3188.7	5077.7	2650.0	1942.3	762.7	725.9	1778.8
1993	858.4	860.5	547.4	617.4	587.9	771.5	1316.3	8469.0	4790.7	4195.2	4835.0	.0	.0
AVG	1207.5	1406.5	1274.2	1154.1	1240.7	1321.6	2530.2	8471.4	9868.9	3835.2	1508.6	1069.1	2907.3

OKANOGAN RIVER AT MALOTT, WA
USGS STATION: 12447200
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1966	.0	.0	868.9	1162.6	1052.3	877.8	2333.3	5743.9	5361.7	2557.1	812.4	693.9	.0
1967	913.1	1047.7	1321.6	1198.7	1027.9	1320.6	1574.0	7072.6	17606.7	3923.5	913.5	458.8	3198.2
1968	838.7	1738.0	1001.6	1580.3	2241.7	2127.4	1430.7	7336.5	11189.7	3815.8	1229.4	1076.0	2%7.2
1969	1240.6	1464.3	1008.2	1358.1	1344.6	1652.3	2722.0	11041.0	7144.3	2024.8	806.4	831.5	2719.8
1970	1378.7	1223.6	1039.8	877.2	800.5	844.6	975.3	4657.4	7419.3	1301.4	456.3	513.4	1790.6
1971	728.0	602.8	565.5	675.5	1365.0	972.5	2173.0	13113.5	14830.0	5081.3	1516.5	1023.3	3553.9
1972	1229.4	1070.6	923.2	1270.3	1485.9	3079.4	4370.3	16421.6	29290.0	109187.7	3786.1	1879.7	6316.2
1973	1366.5	1251.7	912.6	815.8	880.9	776.7	1063.8	4925.2	4383.7	1390.8	480.3	493.3	1561.8
1974	812.8	911.4	947.1	1032.7	1527.9	2641.6	4787.3	11111.0	20180.0	8661.9	2846.5	991.2	4704.3
1975	1106.4	1016.5	897.6	879.3	1573.6	2127.4	2125.0	5812.3	13120.7	4555.5	1323.4	1132.8	2972.5
1976	1504.8	1701.7	2307.7	1750.0	2189.3	1865.2	2181.3	10655.5	10898.3	7661.0	3656.8	2232.3	4050.3
1977	1390.6	1772.0	1579.7	1025.8	1120.1	692.3	1450.9	4319.0	3957.3	938.2	434.1	552.8	1602.7
1978	834.8	910.2	1027.6	957.4	1436.8	1659.4	2963.3	8278.1	10956.3	3670.6	11%.2	1930.3	2985.1
1979	1637.7	2281.3	1652.3	1004.8	1035.4	1144.2	1203.7	6660.3	4601.7	1521.5	524.3	824.4	2007.6
1980	794.8	786.2	1064.9	794.1	1114.1	970.2	2372.5	10737.4	8183.7	2929.4	1082.4	1135.7	2663.8
1981	1155.8	1337.3	2543.5	2675.8	1462.9	1323.9	1600.7	7521.0	9023.0	5046.8	2291.3	1248.9	3102.6
1982	1413.5	1358.3	1101.9	1056.5	1553.9	2002.6	2153.0	7620.3	13092.7	6779.0	3077.7	2321.3	3627.6
1983	1713.9	1451.3	1430.0	1686.1	2144.3	3946.1	5750.7	11841.9	10388.3	5333.9	2725.5	1991.0	4200.3
1984	1391.0	1729.7	1100.3	2970.0	2347.9	2575.5	3161.7	5237.4	12278.7	5235.8	2070.3	1388.0	3457.2
1985	1246.1	12%.0	898.1	999.0	1042.1	1052.9	2342.7	7519.4	7248.7	1427.4	497.6	843.6	2201.1
1986	1186.0	1310.3	950.6	822.9	1102.8	2755.2	3235.7	7249.0	10276.3	2926.5	1744.2	1036.6	2883.0
1987	1120.3	1399.0	1251.6	934.8	-1016.3	1427.9	2559.7	9491.6	3913.7	1356.1	624.2	470.1	2130.4
1988	604.9	573.8	644.9	540.0	618.4	600.8	2136.8	6698.1	5595.7	1784.1	522.6	372.4	1724.4
1989	645.0	1007.4	744.1	594.5	770.5	855.3	2321.2	7402.6	7684.7	2394.2	1227.9	1234.3	2240.1
1990	1135.0	2309.0	2189.4	1295.8	11.01.4	1122.9	4239.0	7277.7	14903.3	6656.5	3030.3	1538.4	3899.9
1991	1495.0	4746.7	2400.0	1605.8	2978.9	3190.3	4051.7	14773.9	16083.3	9399.4	3018.4	1199.4	5411.9
1992	967.2	1179.2	1064.3	979.4	1214.5	1849.0	3083.7	5162.9	2624.7	1908.1	784.6	729.2	1795.6
1993	892.0	920.5	616.9	695.8	681.4	808.1	1315.4	8667.7	4978.3	4202.3	5040.0	.0	.0
AVG	1138.6	1422.1	1216.2	1187.1	1365.4	1652.2	2559.9	8369.6	10257.7	4123.9	1704.3	1116.4	3009.5

OKANOGAN RIVER NEAR MALOTT, WASH.
USGS STATION: 12447300
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1958	.0	.0	.0	.0	.0	.0	2340.0	10326.5	5829.7	1825.8	788.6	860.1	.0
1959	1397.7	1520.0	2117.7	1884.5	1499.3	1903.5	3005.3	11119.7	16856.7	6462.6	1727.7	1915.3	4284.2
1960	2954.8	3304.7	3221.3	1941.9	1770.3	1387.7	3598.0	6877.4	8841.3	2723.9	1073.7	1067.2	3230.2
1%1	1208.1	1289.0	1102.6	1185.8	1297.9	1240.6	1990.0	8466.5	14251.7	2511.9	1070.1	899.8	3042.8
1962	1302.6	1056.6	973.2	1279.7	2031.4	1242.6	2864.3	5429.4	8280.0	2751.6	1151.6	829.9	2432.7
1963	1141.0	1483.7	1699.0	1237.4	1962.9	1400.3	1630.7	5827.7	7200.3	3711.0	1561.3	1267.3	2510.2
1964	1355.4	1625.3	1844.2	1630.6	1368.6	1302.9	1864.0	5159.7	16950.0	6732.6	1980.0	1854.0	3638.9
1%5	2070.3	1501.0	1101.3	1148.4	1403.6	1712.3	2480.3	7945.5	11631.7	2%1.9	1218.8	1216.0	3032.6
1966	1273.5	1487.7	1023.0	1159.7	1053.9	887.4	2289.3	5647.7	5315.0	2507.4	821.3	710.4	2014.7
1%7	939.3	1069.5	1325.2	1232.9	1058.6	1309.5	1581.7	6951.9	17606.7	0.0	.0	.0	.0
AVG	1515.9	1593.1	1600.8	1411.2	1494.0	1376.3	2364.4	7375.2	11276.3	3576.5	1265.9	1180.0	3002.5

SIMILKAMEEN RIVER NEAR NIGHTHAWK, WASH.
USGS STATION: 12442500

FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1929	656.5	516.7	371.0	247.0	217.1	345.4	426.6	3956.1	5222.0	1190.0	376.5	269.0	1149.5
1930	330.3	305.7	285.4	214.8	441.6	466.1	3469.7	5230.6	5622.7	1739.5	532.7	391.1	1585.8
1931	415.5	484.1	352.6	351.6	472.5	496.2	910.6	6063.9	2764.7	945.1	327.8	410.8	1166.3
1932	394.7	532.0	387.0	344.2	774.0	1369.3	2289.2	7957.4	6094.0	1652.7	568.5	373.6	1894.7
1933	522.6	1473.8	1065.4	702.1	495.8	530.7	1477.0	6268.7	12195.7	5031.6	1257.2	630.7	2637.6
1934	1595.2	2599.3	1661.0	1301.9	1140.7	2206.1	13514.3	11071.0	5376.7	_1516.4	644.8	440.5	3589.0
1935	488.9	1287.4	838.5	779.5	2235.0	1103.4	1315.3	8703.9	9597.7	3674.5	1242.8	617.0	2657.0
1936	498.0	490.5	462.0	405.3	264.8	408.6	2723.7	8002.6	5287.3	1158.1	385.3	322.6	1700.7
1937	311.0	310.0	312.9	218.2	282.1	407.9	593.7	5981.9	11219.0	2679.7	791.4	539.3	1970.6
1938	664.5	962.8	701.5	643.3	535.5	670.3	2535.8	11398.4	8385.0	2107.5	599.5	457.3	2471.8
1939	462.1	458.2	501.9	624.1	423.5	613.6	2513.3	6860.6	5114.7	2084.3	534.6	335.4	1710.5
1940	367.1	575.5	911.3	393.0	439.5	524.8	2060.1	5064.8	2794.7	665.4	295.4	218.8	1192.5
1941	489.5	440.5	418.0	374.9	345.1	574.5	2482.0	3423.9	3377.7	1317.2	587.3	1075.6	1242.2
1942	2180.0	1515.7	1441.0	765.4	660.6	543.6	2396.4	7937.4	8124.7	2489.0	892.3	468.4	2451.2
1943	405.6	473.9	604.7	432.0	590.2	544.3	2963.9	5904.2	9792.7	5127.7	1160.5	540.2	2378.3
1944	472.9	470.0	393.1	327.3	318.5	373.5	922.4	4785.8	6659.3	1815.3	690.1	478.8	1475.6
1945	577.3	577.6	501.0	545.0	634.6	473.0	632.6	7261.0	9423.3	2139.0	604.4	484.0	1987.7
1946	678.0	1152.3	665.7	553.7	491.4	538.7	1953.6	12254.8	8447.0	2987.1	833.5	529.5	2590.4
1947	528.7	521.4	478.9	442.2	518.4	756.4	2969.0	9277.1	5598.0	1611.9	684.0	480.1	1988.8
1948	761.5	837:2	682.1	513.9	466.1	445.7	1131.3	11131.6	17127.0	3668.1	2625.2	1607.7	3416.4
1949	1344.2	925.5	736.1	639.4	580.4	635.5	2809.0	14677.1	7528.3	2282.6	944.4	713.0	2817.9
1950	762.4	1737.5	1897.7	749.3	754.5	734.7	1012.7	7626.1	17976.7	5322.9	1418.5	618.1	3382.6
1951	810.8	1129.3	1636.8	1115.5	1392.9	988.2	3515.3	13976.5	9287.7	3561.0	951.2	851.1	3268.0
1952	861.5	814.4	541.9	455.8	536.6	539.5	2121.1	8616.1	5354.7	2265.5	752.2	445.9	1942.1
1953	329.6	337.8	319.8	447.8	608.9	492.8	1191.0	8531.0	9530.3	3932.3	1041.8	608.6	2281.0
1954	822.2	913.7	740.3	524.3	669.8	622.4	1013.6	9547.7	11651.3	8003.5	2195.5	1614.3	3193.2
1955	1185.5	1692.3	1369.7	778.1	599.1	532.8	744.2	4060.4	14086.0	6278.4	1490.4	617.6	2786.2
1956	1181.1	2211.7	1018.9	802.4	539.7	597.6	2902.8	13798.1	11142.0	3783.5	1057.6	665.4	3308.4
1957	1091.2	1070.8	1016.2	589.0	607.1	654.8	1228.3	14899.4	6653.7	1655.0	826.5	490.7	2565.2
1958	452.6	579.4	502.4	513.2	474.2	526.3	1059.0	8986.1	4795.3	1337.3	422.1	364.5	1667.7
1959	796.0	978.1	1437.7	1256.3		,735.8727.2	1956.6	9801.3	14330.0	4837.4	1086.8	1293.1	3269.7
1960	2265.2	2165.7	1655.8	735.2	751.4	878.3	3157.0	6499.7	8436.0	2327.9	684.3	509.0	2505.4
1961	466.0	525.7	392.3	513.7	635.7	631.6	1474.1	8126.8	12277.0	1956.7	613.0	384.3	2333.1
1962	613.5	483.8	427.2	733.6	1297.2	635.7	2160.6	4959.7	7693.3	2377.7	883.5	474.8	1895.1
1963	541.3	1025.2	1148.9	645.9	1322.1	1023.1	1303.0	5888.1	6907.0	3511.0	1463.2	1027.2	2150.5
1964	989.7	1243.6	1480.0	1292.8	842.1	684.9	1312.0	5272.6	15767.3	6084.2	1435.7	1169.3	3131.2
1965	1342.6	858.7	621.8	666.6	679.1	719.5	1562.7	6981.3	9937.0	2376.5	922.2	672.9	2278.4
1966	645.2	906.4	575.1	482.0	447.3	472.5	1838.3	5812.6	5141.0	2265.8	660.6	381.2	1635.7
1967	644.7	687.0	924.1	665.8	601.3	542.8	612.2	6565.1	16072.0	3431.3	776.8	379.9	2658.6
1968	565.1	1479.2	822.0	1307.0	1527.2	1702.3	1206.0	7647.4	10349.3	3266.1	836.5	647.3	2613.0
1969	672.5	745.6	577.2	494.8	448.2	449.1	1394.4	9736.8	6220.0	1604.8	467.5	331.6	1928.5
1970	644.2	627.4	439.0	336.0	416.4	417.5	566.6	4419.4	7285.7	1128.4	360.5	325.2	1413.9
1971	429.7	347.5	317.7	351.7	1021.2	722.3	1098.0	12443.2	12531.7	4287.4	996.1	501.1	2920.6
1972	633.7	635.0	436.6	411.8	461.1	1499.2	2377.7	15356.8	24910.0	8494.5	1897.7	882.3	4833.0
1973	750.5	610.6	444.5	446.3	454.4	453.8	807.9	5189.7	4263.3	1235.8	354.6	290.5	1275.2
1974	473.2	514.7	469.0	685.5	652.0	661.9	2048.7	8079.4	18326.7	6219.7	1488.5	549.7	3347.4
1975	425.2	442.8	422.6	415.8	410.3	430.1	599.8	5344.5	12238.0	4009.4	973.7	590.5	2191.9
1976	533.6	1083.7	1701.0	1049.0	981.3	668.7	1427.6	10408.1	10454.4	6060.6	2524.1	1158.6	3170.9
1977	643.4	580.5	548.6	524.3	606.1	504.0	1472.3	3871.6	3720.7	940.1	369.5	295.0	1173.0
1978	347.4	534.6	721.7	524.6	457.4	658.5	2166.7	7101.0	10162.3	3171.0	951.7	1379.5	2348.0
1979	943.5	1188.2	613.3	454.2	492.3	738.3	1009.0	6654.2	4349.0	1360.7	473.7	528.2	1567.1
1980	362.8	325.4	948.1	516.1	522.0	568.5	2339.1	10599.0	7669.7	2330.6	784.3	678.3	2303.7
1981	588.9	815.8	2184.9	2067.1	992.6	958.7	1500.3	6980.6	6606.0	3395.2	1227.1	596.1	2326.1
1982	742.4	731.2	507.9	487.8	549.7	554.8	730.0	6162.9	11986.0	5269.7	1509.1	906.1	2511.5
1983	987.1	695.5	739.0	785.9	674.7	989.5	2151.3	9090.6	7594.7	3275.2	1333.0	885.4	2433.5
1984	649.5	989.0	485.9	1972.8	1027.8	944.6	1340.1	2787.7	10029.7	3475.5	1024.6	586.8	2109.5
1985	602.9	523.1	334.5	408.4	34.6	433.8	1809.5	7434.2	6523.3	1243.7	396.6	469.0	1717.8
1986	714.6	755.3	495.2	466.7	672.7	1854.8	2753.0	7030.0	8728.0	2163.9	751.7	486.0	2239.3
1987	601.3	763.6	622.0	527.4	509.8	805.5	2586.3	9058.1	3693.7	1483.8	.0	.0	.0
1988	239.3	253.8	231.0	272.8	292.8	341.0	2088.8	6526.1	5187.7	1612.1	486.0	274.9	1483.9
1989	455.6	692.3	433.2	350.2	452.5	490.0	2103.6	7141.9	6646.7	1644.9	802.5	644.2	1821.5
1990	549.1	1993.6	1784.8	823.9	602.5	699.0	4135.3	6887.4	11075.7	3855.5	1153.2	734.0	2857.8
1991	1145.8	4531.3	1980.3	1211.6	1907.9	1606.8	3772.0	12764.8	13672.7	7753.9	1913.2	804.4	4422.1
1992	512.6	766.5	617.4	553.8	752.9	1489.3	3065.7	4975.2	2508.0	1594.1	598.4	383.1	1484.7
1993	425.2	532.0	312.6	408.4	354.1	507.5	1100.9	7526.8	3932.3	2784.5	2901.1	.0	.0
AVG	701.3	914.3	779.5	640.6	668.9	725.9	1998.5	7913.5	8822.4	3028.5	966.2	617.1	2314.7

TONASKET CREEK AT OROVILLE, WASH.
USGS STATION: 12439300

YEAR	OCT	NOV	DEC	JAN	FES	MAR	APR	NAY	JUNE	JULY	AUG	SEPT	AVG
1974	.0	.0	.0	2.2	2.3	2.3	2.3	2.5	2.1	2.2	2.3	2.0	.0
1975	1.9	2.0	2.2	2.1	2.4	2.4	2.6	.0	.0	.0	.0	.0	.0
1978	.0	.0	.0	.0	.0	.0	3.7	3.7	3.3	3.2	3.3	3.2	.0
1979	2.9	2.2	1.8	1.8	1.8	2.7	3.1	2.9	2.8	2.9	2.8	2.8	2.5
1980	2.8	2.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
AVG	2.5	2.3	2.0	2.0	2.1.	2.5	2.9	3.0	2.7	2.8	2.8	2.7	2.5

TOATS COULEE CREEK NEAR LOOMIS, WASH.
USGS STATION: 12442000 FLOW
(CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1921	21.9	12.2	8.9	7.1	7.1	8.3	13.3	264.5	257.7	46.9	8.7	7.4	55.3
1923	13.3	8.7	.0	.0	.0	.0	.0	154.0	245.8	90.3	24.1	10.4	.0
1924	13.2	9.4	7.8	.0	.0	.0	18.6	109.5	44.2	10.3	6.4	4.1	.0
1925	6.2	.0	.0	.0	.0	.0	25.7	146.6	78.0	13.8	5.4	3.9	.0
1926	.0	.0	.0	.0	.0	8.0	31.7	39.0	16.7	9.0	.0	5.0	.0
1957	.0	.0	.0	.0	.0	.0	.0	481.9	139.7	37.4	20.2	7.1	.0
1958	10.4	9.5	9.6	9.3	12.1	11.9	18.8	377.1	167.7	45.3	13.8	9.6	57.9
1959	11.6	11.7	12.4	20.1	11.9-	11.9	29.1	242.1	322.3	75.2	18.1	26.8	66.1
1960	25.5	14.7	11.2	7.4	9.6	17.1	35.8	154.3	199.1	34.4	15.1	9.1	44.4
1961	8.4	8.5	7.7	7.4	7.7	8.5	19.2	209.8	232.5	28.0	8.7	5.5	46.0
1962	6.9	6.3	6.0	5.4	6.5	6.2	27.3	87.1	113.8	28.6	16.6	5.8	26.4
1963	13.8	13.3	10.1	6.9	9.4	9.7	18.3	203.6	183.1	81.5	26.0	15.3	49.2
1964	10.5	11.1	12.5	11.8	10.6	10.1	14.1	104.9	242.8	67.5	22.6	11.6	44.2
1965	10.1	8.2	6.4	7.5	8.8	8.8	23.9	141.8	191.6	41.7	26.8	15.1	40.9
1966	10.1	8.3	7.5	7.0	7.6	8.8	26.0	101.8	64.6	28.8	9.6	8.9	24.1
1967	8.9	7.6	9.2	6.9	6.5	7.4	9.1	178.3	478.4	64.5	10.7	4.7	66.0
1968	9.4	8.2	7.8	10.7	10.3	10.6	13.0	186.9	163.2	54.7	14.9	9.7	41.6
1969	8.5	8.6	8.4	7.3	7.5	8.8	25.2	264.0	117.5	31.5	7.8	8.3	41.9
1970	10.5	9.3	7.0	8.1	7.9	7.7	9.4	116.7	130.1	16.4	10.0	.0	.0
AVG	11.7	9.7	8.8	8.8	8.8	9.6	21.1	187.6	178.4	42.4	14.8	9.3	42.6

SINLAHEKIN CR NR LOOMIS WASH
USGS STATION: 12441500
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1903	.0	.0	.0	.0	.0	.0	.0	.0	41.2	21.4	11.3	11.0	.0
1904	18.0	22.3	15.5	16.1	39.6	13.5	133.8	213.6	107.2	29.7	14.5	13.2	53.1
1905	19.4	22.6	19.7	21.8	31.4	20.2	.0	.0	.0	.0	.0	.0	.0
AVG	18.7	22.5	17.6	19.0	35.5	16.8	133.8	213.6	74.2	25.6	12.9	12.1	50.2.

OMAK CREEK NEAR OMAK,WASH.
USGSSTATION: 12445900F
LOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FES	MAR	APR	NAY	JUNE	JULY	AUG	SEPT	AVG
1972	.0	.0	.0	.0	.0	25.0	41.5	65.5	29.5	8.3	4.2	4.0	.0
1973	4.9	6.1	15.4	5.9	20.6	15.7	21.0	18.0	6.2	1.4	.3	2.6	9.8
1974	3.4	12.0	24.4	39.7	42.2	65.3	.0	.0	.0	.0	.0	.0	.0
1976	.0	.0	.0	.0	.0	.0	.0	.0	.0	3.3	5.8	3.7	.0
1977	4.7	5.6	4.5	4.5	6.0	7.2	6.9	6.2	6.8	.8	.5	1.1	4.6
1978	3.2	9.5	17.5	7.9	7.1	15.0	112.0	67.5	19.3	9.6	3.9	5.5	23.2
1979	5.3	7.8	.0	.0	.0	.0	.0	.0	.0	.0,	.0	.0	.0
AVG	4.3	8.2	15.4	14.5	19.0	25.6	45.4	39.3	15.4	4.7	3.0	3.4	16.5

WHITESTONE IRVCANAL NR LOOMIS WASH
USGS STATION: 12442200
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEE	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1957	.0	.0	.0	.0	.0	.0	5.8	33.2	34.7	30.1	16.8	8.5	.0
1958	7.8	.0	.0	.0	.0	.0	6.7	43.1	36.9	28.6	11.3	8.4	.0
1959	8.2	8.2	.0	.0	.0	.0	8.7	39.9	37.9	39.0	16.8	14.0	.0
1960	4.0	1.6	.0	.0	.0	.0	14.1	30.1	39.1	26.8	14.9	9.9	.0
1961	9.0	8.1	.0	.0	.0	.0	16.3	28.9	35.6	28.4	10.3	6.2	.0
1962	7.6	7.0	.0	.0	.0	3.1	22.9	35.0	44.0	28.5	16.7	5.7	.0
1963	1.1	.0	.0	.0	.0	8.0	15.1	40.5	46.9	39.2	23.6	15.9	.0
1964	8.4	.0	.0	.0	.0	.0	14.0	46.4	43.6	40.3	21.6	11.8	.0
1965	8.4	.0	.0	.0	.0	.0	23.2	48.2	43.9	34.1	24.1	14.3	.0
1966	8.1	.0	.0	.0	.0	.0	23.2	53.8	46.3	28.5	10.7	9.1	.0
1967	8.1	6.0	.0	.0	.0	.0	10.0	42.5	48.5	40.0	11.6	5.8	.0
1968	10.2	9.5	.0	.0	.0	9.9	13.4	48.7	47.9	30.5	11.6	7.1	.0
1969	3.4	.0	.0	.0	.0	.0	24.6	46.1	48.7	28.4.	8.1	7.5	.0
1970	9.6	10.9	.0	.0	.0	7.1	9.2	39.6	36.6	.0	.0	.0	.0
AVG	7.2	7.4	.0	.0	.0	7.0	14.8	41.1	42.2	32.5	15.2	9.6	14.8

SINLAHEKIN CR ABV CHOPAKA CR NEAR
LOOMIS, WASH. USGS STATION: 12442300
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEE	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1957	.0	.0	.0	.0	.0	.0	37.9	774.2	183.0	20.6	14.9	11.3	.0
1958	21.7	24.6	27.5	27.3	32.0	30.3	35.6	495.5	190.8	49.1	17.5	17.8	80.8
1959	23.5	27.3	29.9	43.5	28.8	36.8	51.4	351.5	406.1	62.2	19.9	38.9	93.3
1960	47.1	38.7	32.6	24.8	29.1	35.0	30.6	114.4	162.3	22.2	14.4	13.8	47.1
1961	17.2	21.5	20.8	21.6	27.3	27.3	21.1	222.0	267.1	18.3	10.8	12.0	57.2
1962	16.1	19.2	20.5	16.6	23.5	20.2	16.3	45.7	53.0	9.2	8.6	6.0	21.3
1963	263	28.9	26.4	20.6	20.1	15.2	16.6	237.7	183.1	61.4	12.5	10.5	54.9
1964	16.6	29.3	24.5	23.5	22.0	23.3	17.3	52.7	232.3	41.5	12.3	12.7	42.3
1965	18.4	23.0	18.4	21.2	22.9	24.3	24.7	90.9	121.9	13.5	12.1	12.3	33.6
1966	16.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
AVG	22.6	26.6	25.1	24.9	25.7	26.5	27.9	265.0	200.0	33.1	13.7	15.0	58.8

WHITESTONE CREEK NEAR TONASKET, WASH.
USGS STATION: 12444100
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FES	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1959	2.3	1.1	1.2	7.3	7.4	4.7	.9	4.2	3.0	4.1	5.1	4.3	3.8
1960	.7	.6	6.6	5.9	5.6	1.3	.8	1.7	3.2	3.6	4.2	6.0	3.4
1961	4.8	2.3	2.3	1.4	1.5	3.8	1.5	2.9	3.3	4.5	4.3	3.2	3.0
1962	2.1	2.2	2.3	2.4	1.1	.7	2.2	2.9	2.9	4.1	4.5	4.0	2.6
1963	1.5	.9	3.5	2.2	1:1	.9	.8	2.2	3.9	3.5	2.9	4.7	2.3
1964	1.7	1.1	4.2	3.8	2.6	1.3	.9	1.9	2.6	2.5	3.7	3.4	2.5
1965	2.0	1.2	1.7	.7	2.2	3.7	1.7	3.3	4.1	4.6	3.5	4.6	2.8
1966	2.9	.3	.9	2.0	1.2	2.2	1.1	3.8	4.3	5.0	3.7	3.6	2.6
1967	1.3	3.0	2.0	.7	2.0	6.3	.9	3.1	4.9	4.5	3.7	3.3	3.0
1968	1.2	.8	.7	2.2	2.4	3.0	1.6	3.1	3.4	5.2	4.4	2.4	2.5
1969	2.2	5.4	4.0	2.5	2.1	2.5	3.0	3.0	4.0	3.9	3.4	2.5	3.2
1970	.6	.5	1.2	1.7	1.5	3.0	1.3	3.0	3.7	3.2	3.3	3.4	2.2
1971	3.2	.6	.4	.5	2.2	2.4	3.0	4.0	5.6	2.7	3.5	4.2	2.7
1972	1.7	4.8	4.3	3.1	2.8	4.1	1.4	3.4	4.4	4.5	4.8	4.3	3.6
AVG	2.0	1.8	2.5	2.6	2.6	2.9	1.5	3.0	3.8	4.0	3.9	3.8	2.9

SALMON CREEK NEAR CONCONULLY, WASH.
USGS STATION: 12446500
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FES	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1912	4.6	2.7	1.5	1.3	.8	1.2	2.7	24.9	96.8	.86.7	68.7	2.2	24.5
1913	5.3	1.7	1.8	1.7	1.9	3.0	5.9	46.4	67.0	92.4	99.9	5.3	27.
1914	3.5	2.0	1.9	2.1	2.1	2.3	3.0	113.9	155.9	104.0	108.0	5.7	42.0
1915	1.9	2.1	2.1	2.7	2.8	2.8	11.5	151.6	127.6	97.7	117.8	14.8	44.6
1916	4.5	6.9	3.6	3.6	3.7	3.8	6.7	191.4	241.0	157.8	118.7	54.5	66.3
1917	8.4	12.5	2.8	2.8	2.8	2.8	2.9	29.5	165.0	139.4	125.8	30.7	43.8
1918	5.7	2.4	1.5	1.6	1.7	1.9	3.0	42.8	54.4	31.0	20.0	15.9	15.2
1919	10.8	.8	.8	1.0	.8	1.1	1.4	46.6	55.e	67.7	53.4	17.4	21.4
1920	.8	.8	.8	.8	.8	1.2	1.3	13.0	29.4	34.3	28.2	13.3	10.4
1921	7.7	.9	.9	1.2	1.4	1.4	1.7	46.4	83.5	87.7	85.9	43.8	30.2
1922	2.8	1.8	1.5	1.5	1.5	1.7	7.0	50.3	74.0	78.4	68.2	22.1	25.9
AVG	5.1	3.1	1.7	1.8	1.8	2.1	4.3	68.8	104.5	88.8	81.3	20.5	32.0

SINLAHEKIN CR AT TWIN BR NR LOOMIS WASH
USGS STATION: 12441000
FLOW (CFS)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1921	.0	.0	.0	.0	.0	.0	.0	151.0	75.9	10.4	3.0	3.6	.0
1922	4.6	3.7	.0	.0	.0	4.7	12.1	128.7	90.6	7.3	4.8	5.0	.0
1923	.0	.0	.0	.0	.0	.0	.0	30.5	47.7	17.7	4.1	3.9	.0
AVG	4.6	3.7	.0	.0	.0	4.7	12.1	103.4	71.4	11.8	4.0	4.2	18.3

BONAPARTE CREEK NEAR WAUCONDA, WASH.
USGS STATION: 12444490
FLOW (CFS)

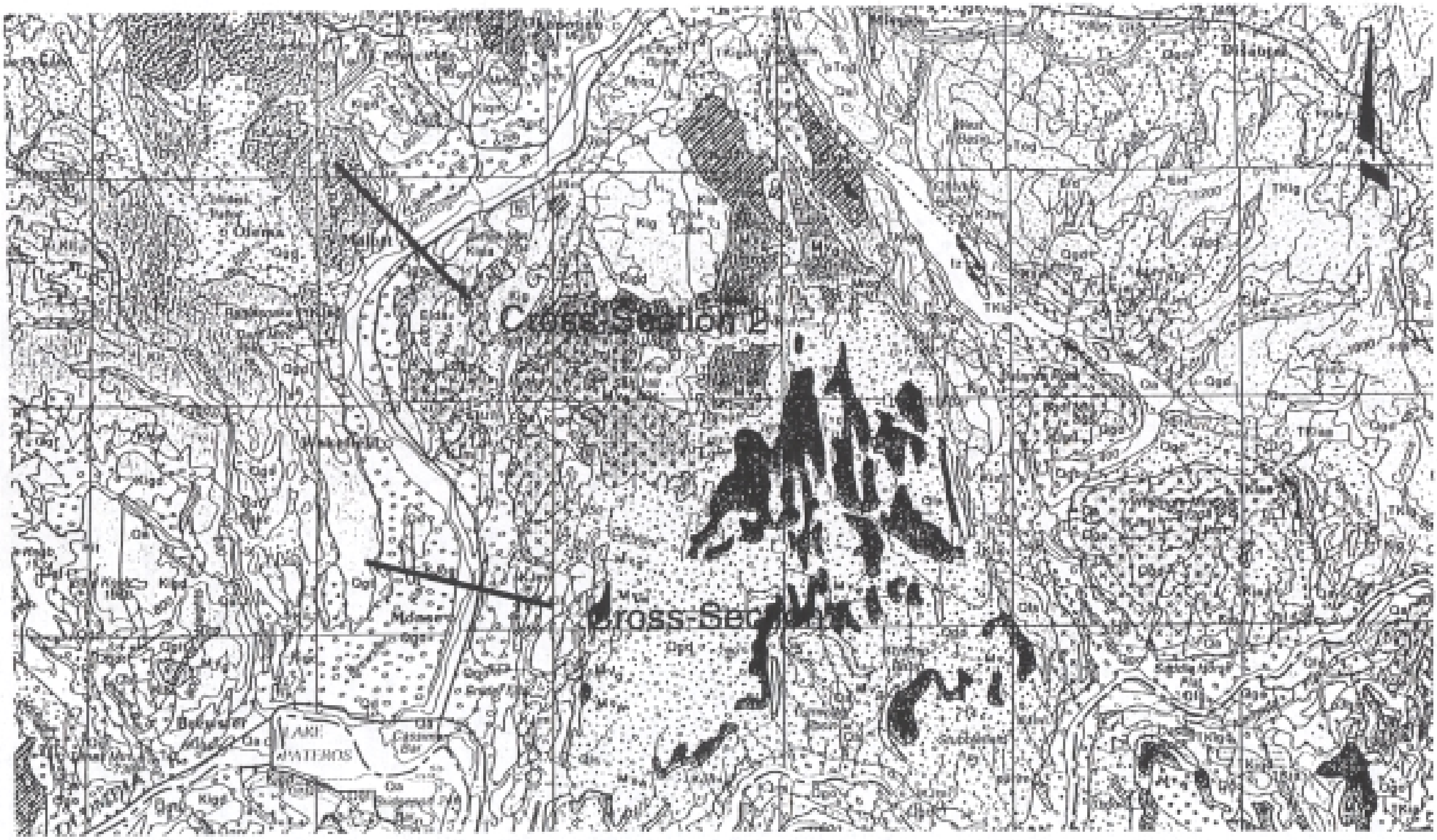
YEAR	OCT	NOV	DEC	JAN	FES	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1968	.0	.0	2.1	3.1	5.5	5.4	3.0	2.4	5.0	1.8	1.6	2.2	.0
1969	2.5	2.1	2.1	2.0	3.0	6.9	14.5	42.5	13.1	5.6	1.6	1.9	8.1
1970	3.2	3.8	3.3	2.8	4.1	7.2	7.3	1.4	1.5	1.9	1.0	1.4	3.2
1971	2.1	2.5	2.6	2.8	4.1	5.1	14.8	12.4	8.7	5.7	2.4	1.6	5.4
1972	2.3	3.4	2.3	2.2	3.1	12.8	5.1	7.1	12.0	2.8	2.4	1.5	4.7
1973	2.7	4.9	3.5	3.3	11.6	13.7	4.9	1.7	1.1	.0	.0	.0	.0
AVG	2.6	3.3	2.6	2.7	5.2	8.5	8.3	11.2	6.9	3.6	1.8	1.7	4.9

OROVILLE TONASKET IRR DST CANAL N OROVILLE WASH
USGS STATION: 12443000
FLOW (CFS)

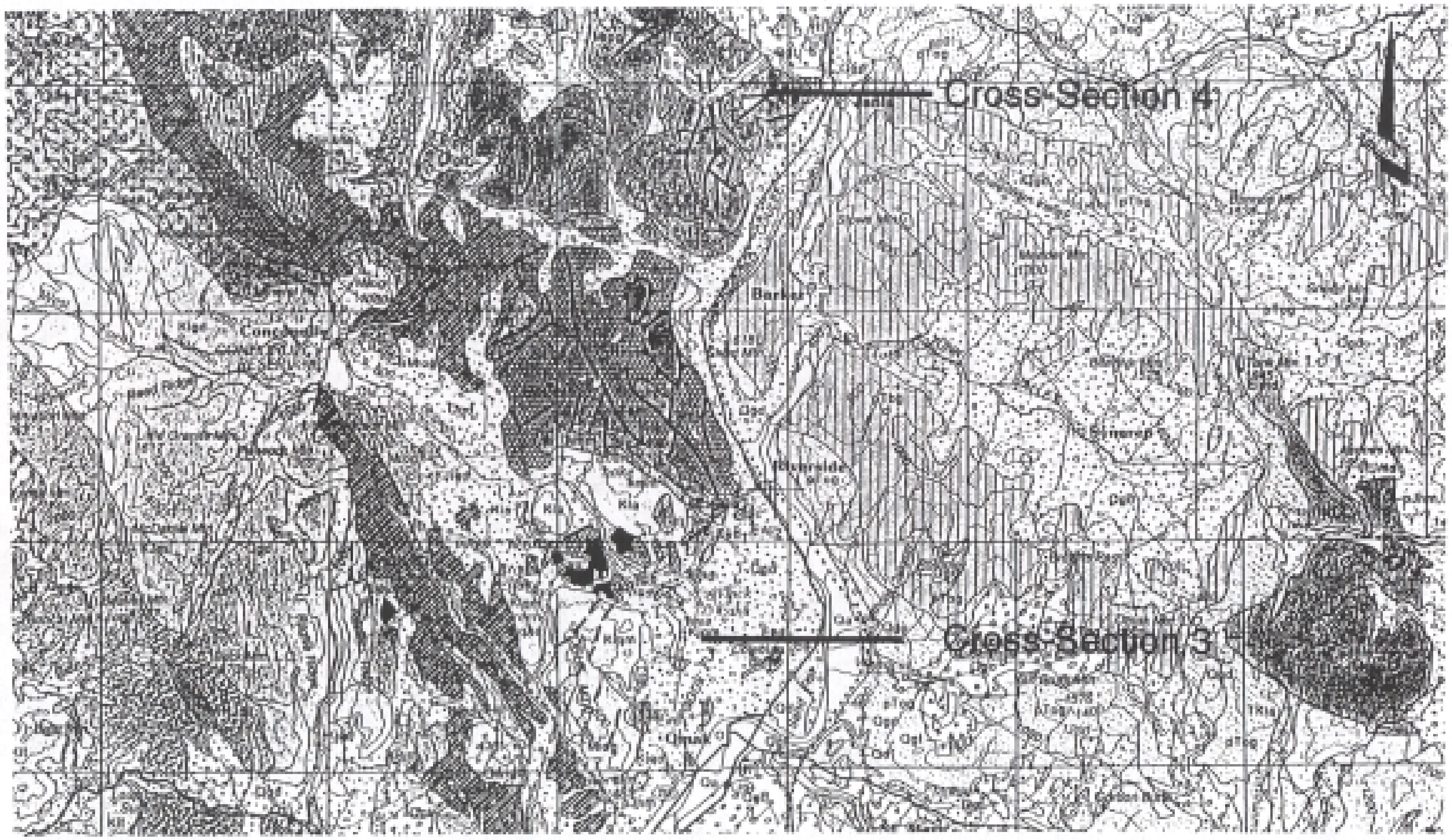
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	AVG
1922	.0	.0	.0	.0	.0	.0	26.3	94.0	143.5	162.5	136.8	108.3	.0
1923	.0	.0	.0	.0	.0	.0	12.0	95.4	103.3	128.9	147.6	120.0	.0
1924	.0	.0	.0	.0	.0	.0	53.6	140.7	163.7	140.7	146.5	133.0	.0
1925	.0	.0	.0	.0	.0	.0	51.5	136.7	142.3	163.6	162.9	143.3	.0
1926	.0	.0	.0	.0	.0	.0	60.2	127.3	136:6	160.3	148.6	96.7	.0
1927	.0	.0	.0	.0	.0	10.0	38.0	109.5	128.6	159.0	165.2	72.6	.0
1928	.0	.0	.0	.0	.0	.0	52.5	127.8	145.1	135.7	141.8	132.2	.0
AVG	.0	.0	.0	.0	.0	10.0	42.0	118.8	137.6	150.1	149.9	115.2	60.3

Appendix B

Geologic Cross-Sections



Geologic Map of Okanogan River Watershed (1 of 3)
Scale = 1:250,000



Geologic Map of Okanogan River Watershed (2 of 3)
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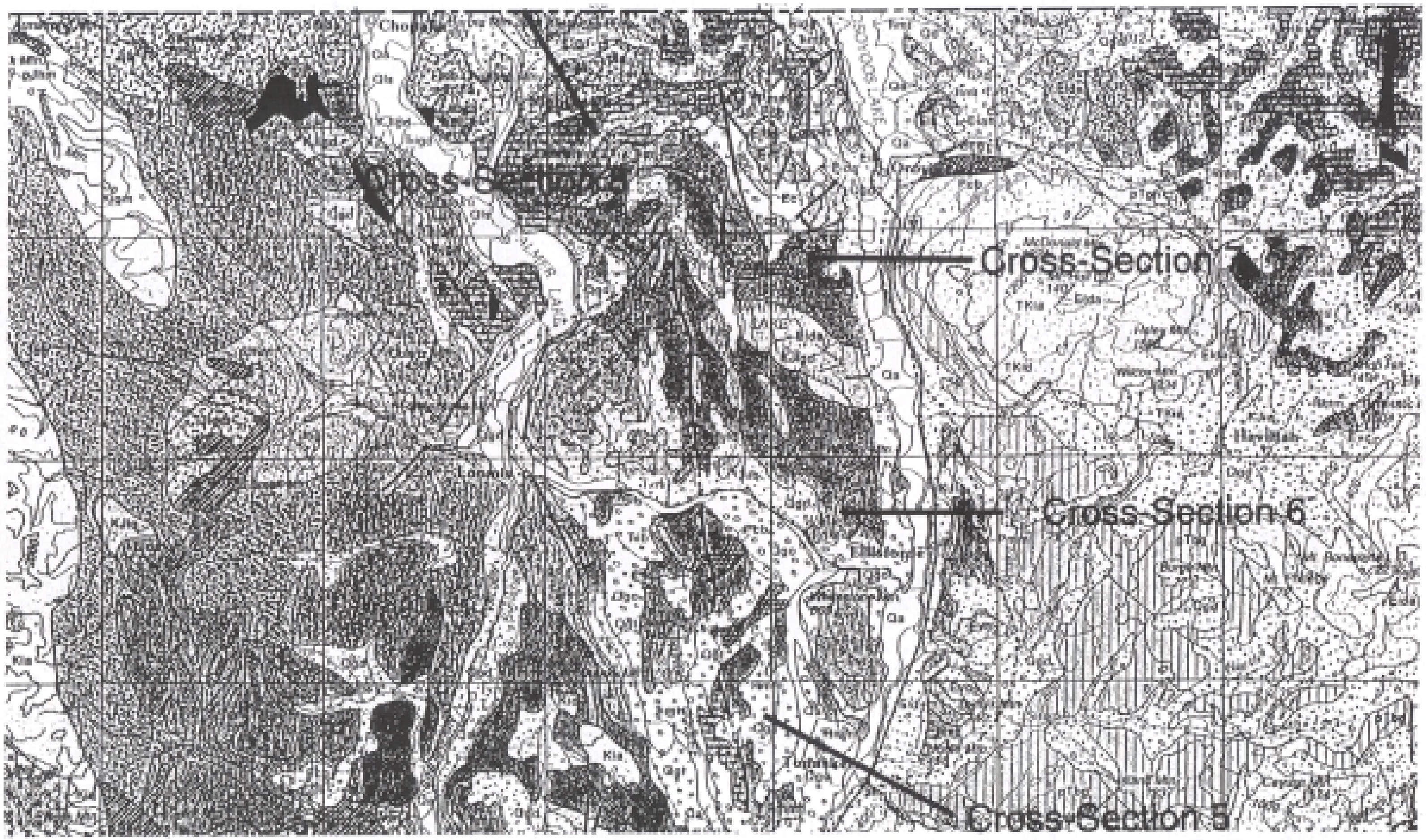
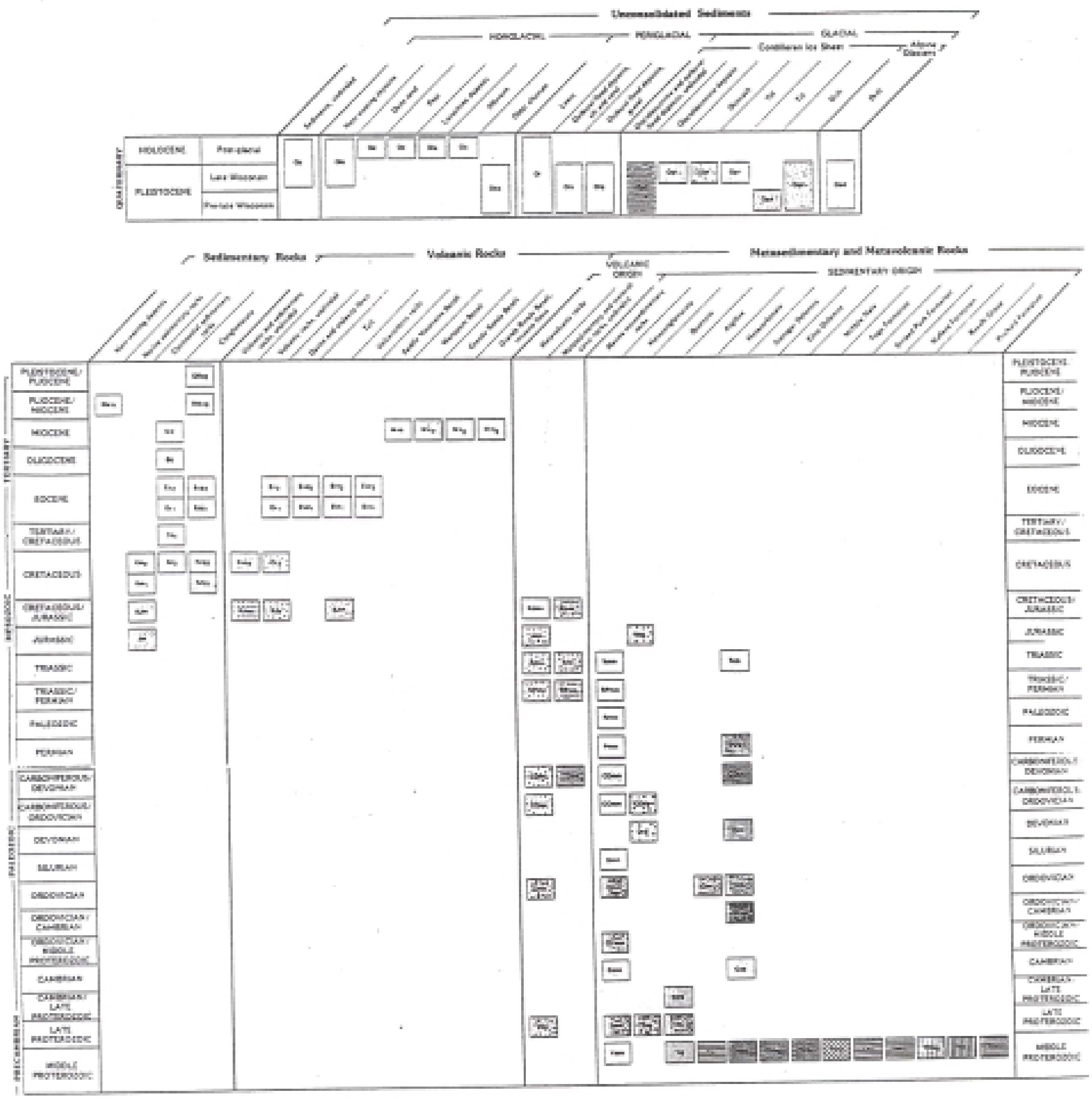
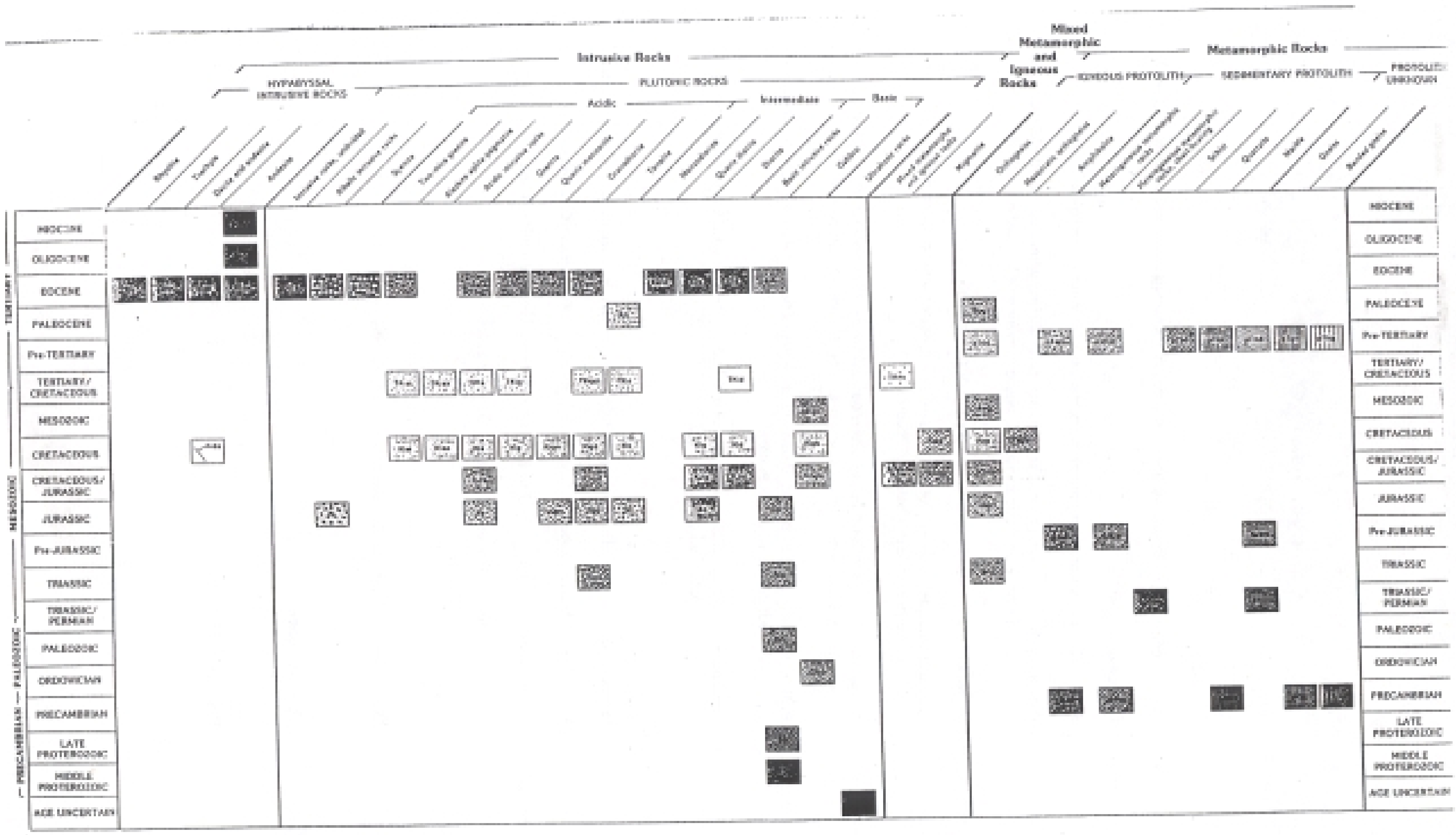


Geologic Map of Okanogan River Watershed (3 of 3)
Scale = 1:250,000

Key To Geologic Units*





* See Sheets 2 and 3 for detailed unit descriptions and chronologic and stratigraphic relations.

Compilation Responsibility by 1:100,000-scale Quadrangle

Geologic Symbols

Contact

Scratch boundary — Boundary between areas of reconnaissance and detailed mapping

Gradational contact

Fault — Dashed where approximately located: dotted where concealed

Dip-slip fault — Bar and ball on downthrown side: dashed where approximately located: dotted where concealed: queried where presence or character uncertain

Strike-slip fault — Arrows indicate direction of movement

Low-angle normal fault — Blocks on upper plate: dotted where concealed: queried where presence or character uncertain

Thrust fault — Sawteeth on upper plate: dashed where approximately located: dotted where concealed: queried where presence or character uncertain

Anticline — Direction of plunge shown where known: dashed where approximately located: dotted where concealed

Syncline — Direction of plunge shown where known: dashed where approximately located: dotted where concealed

Overturned anticline

Overturned syncline — Direction of plunge shown where known: dotted where concealed

Monocline — Dashed where approximately located: dotted where concealed

Approximate maximum extent of pre-late Wisconsin Cordilleran Ice Sheet

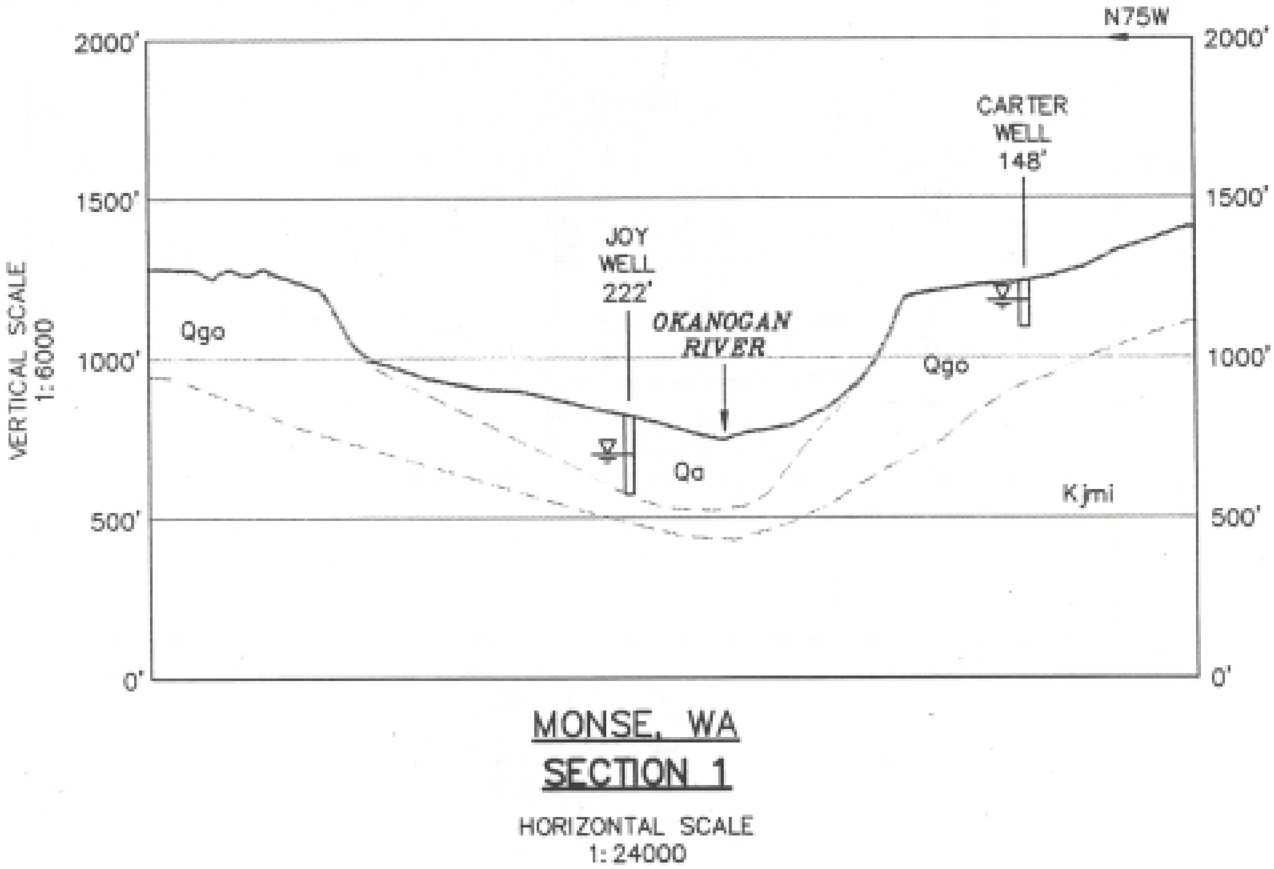
Maximum extent of the late Wisconsin Cordilleran Ice Sheet

Dike

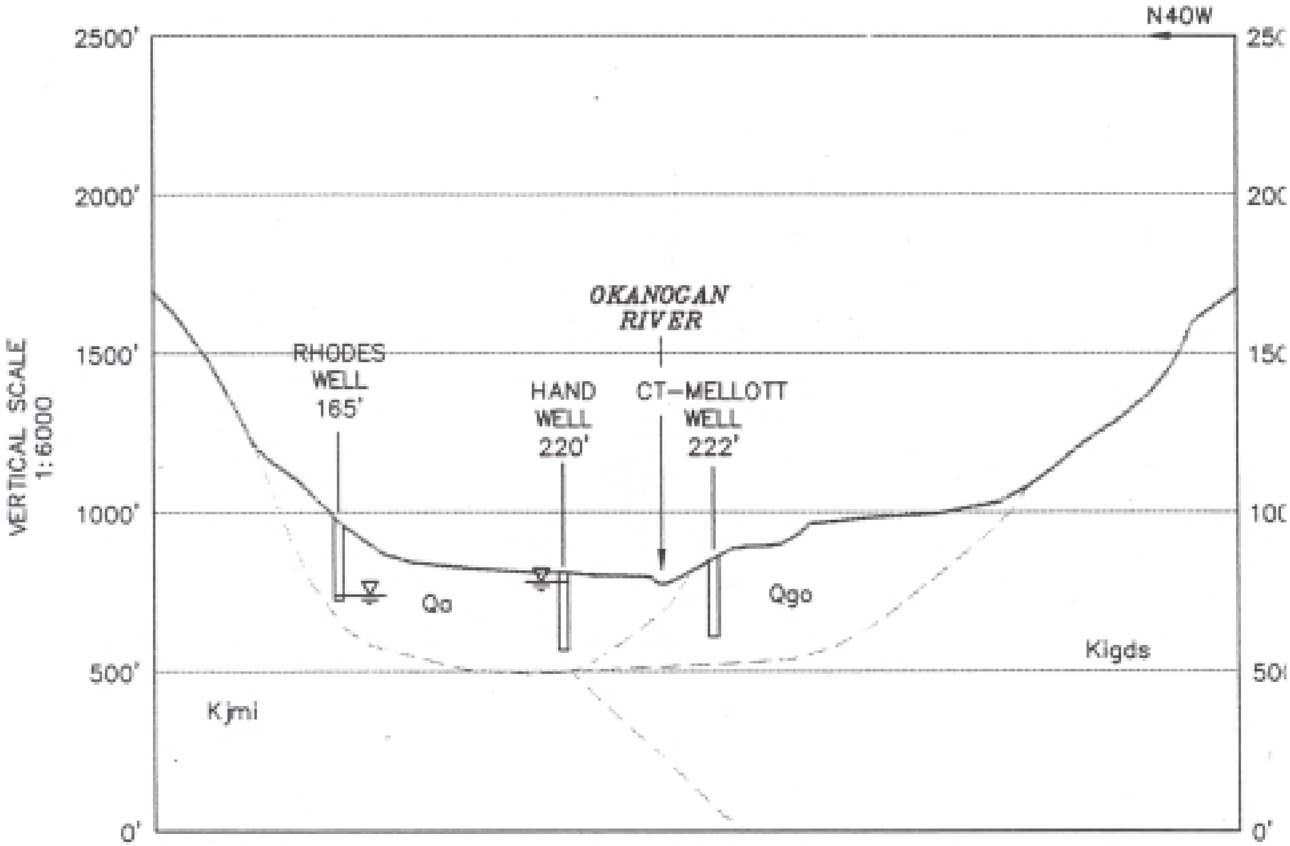
Dike swarm — Used for dike swarms of unit Eida only

Tectonic zone

Fracture zone



Okanogan River Watershed
Geologic Cross-sections

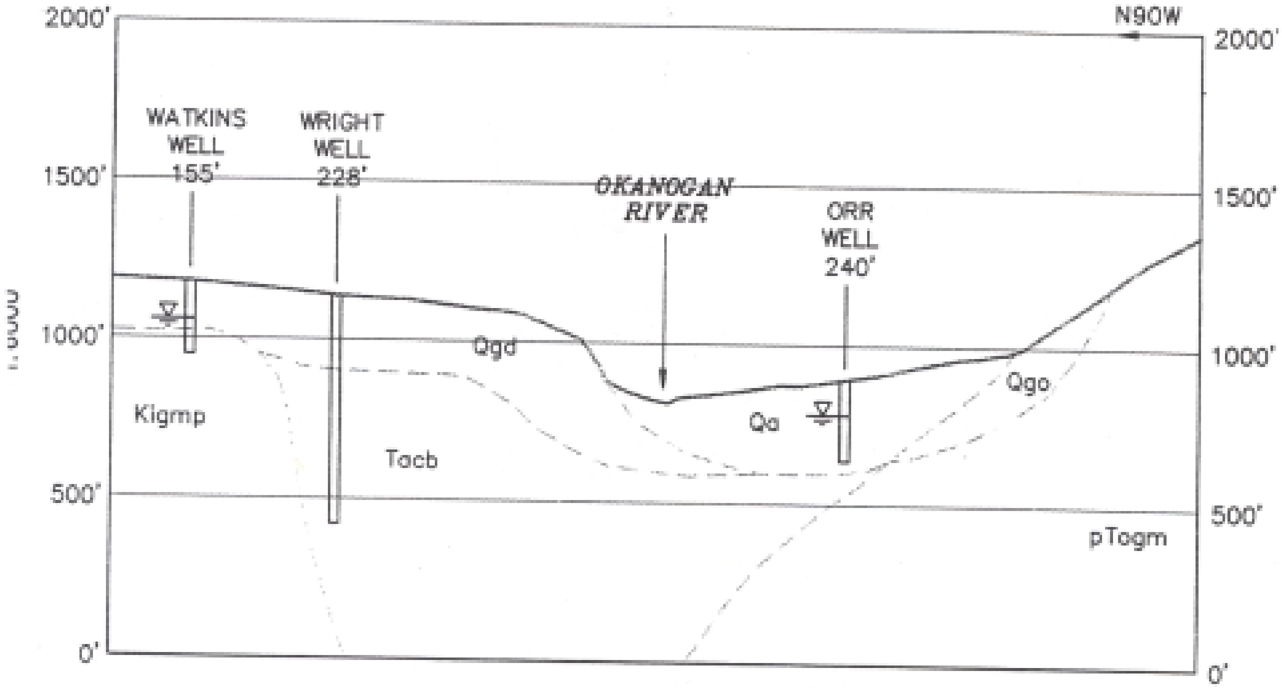


MALOTT, WA

SECTION 2

HORIZONTAL SCALE
1: 24000

Okanogan River Watershed
Geologic Cross-sections

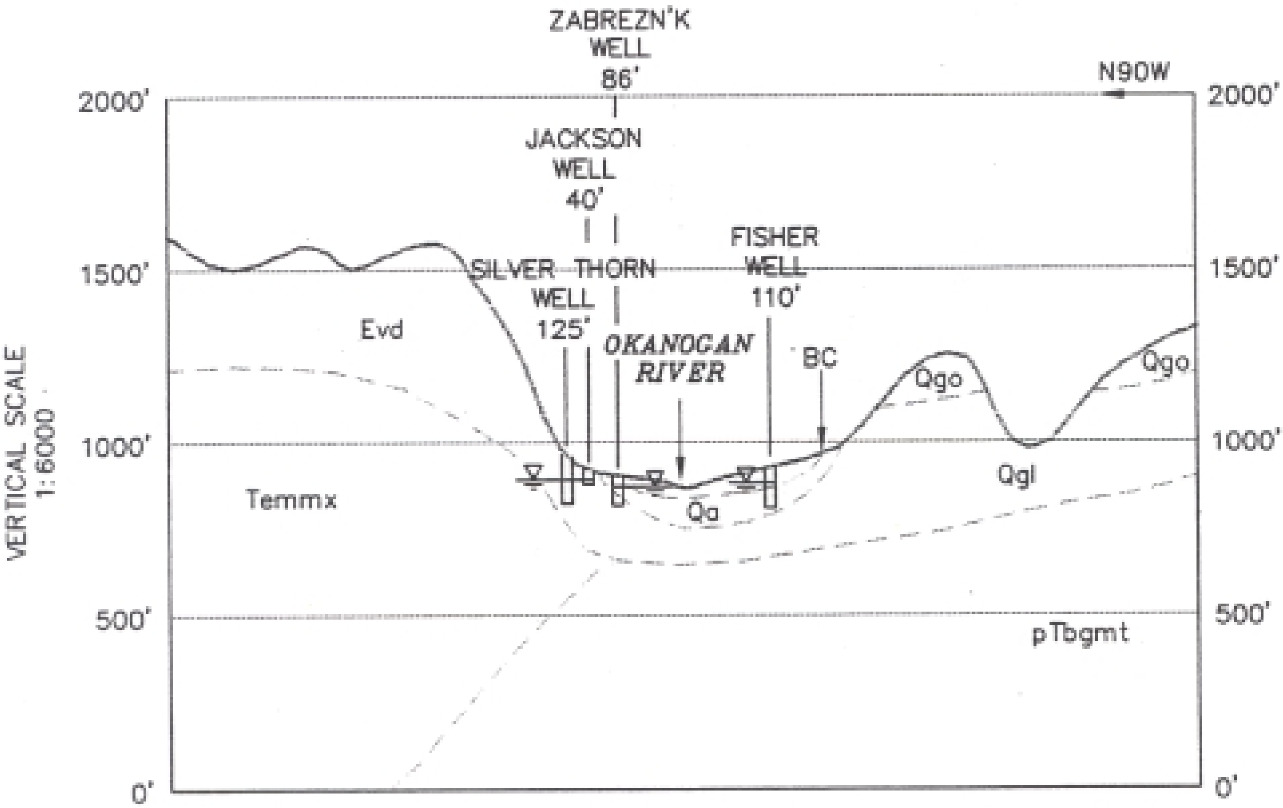


OMAK, WA

SECTION 3

HORIZONTAL SCALE
1: 24000

Okanogan River Watershed
Geologic Cross-sections

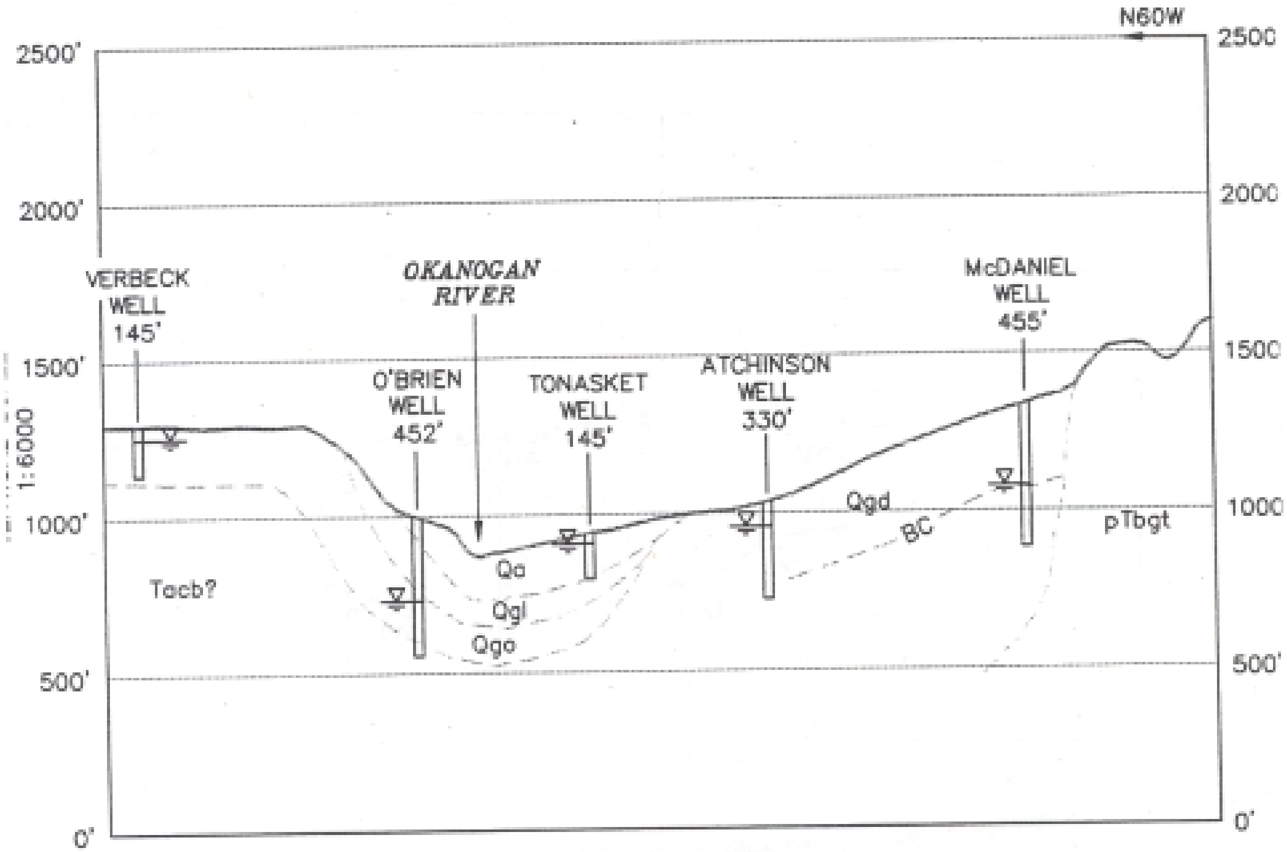


JANIS, WA

SECTION 4

HORIZONTAL SCALE
1:24000

Okanogan River Watershed
Geologic Cross-sections

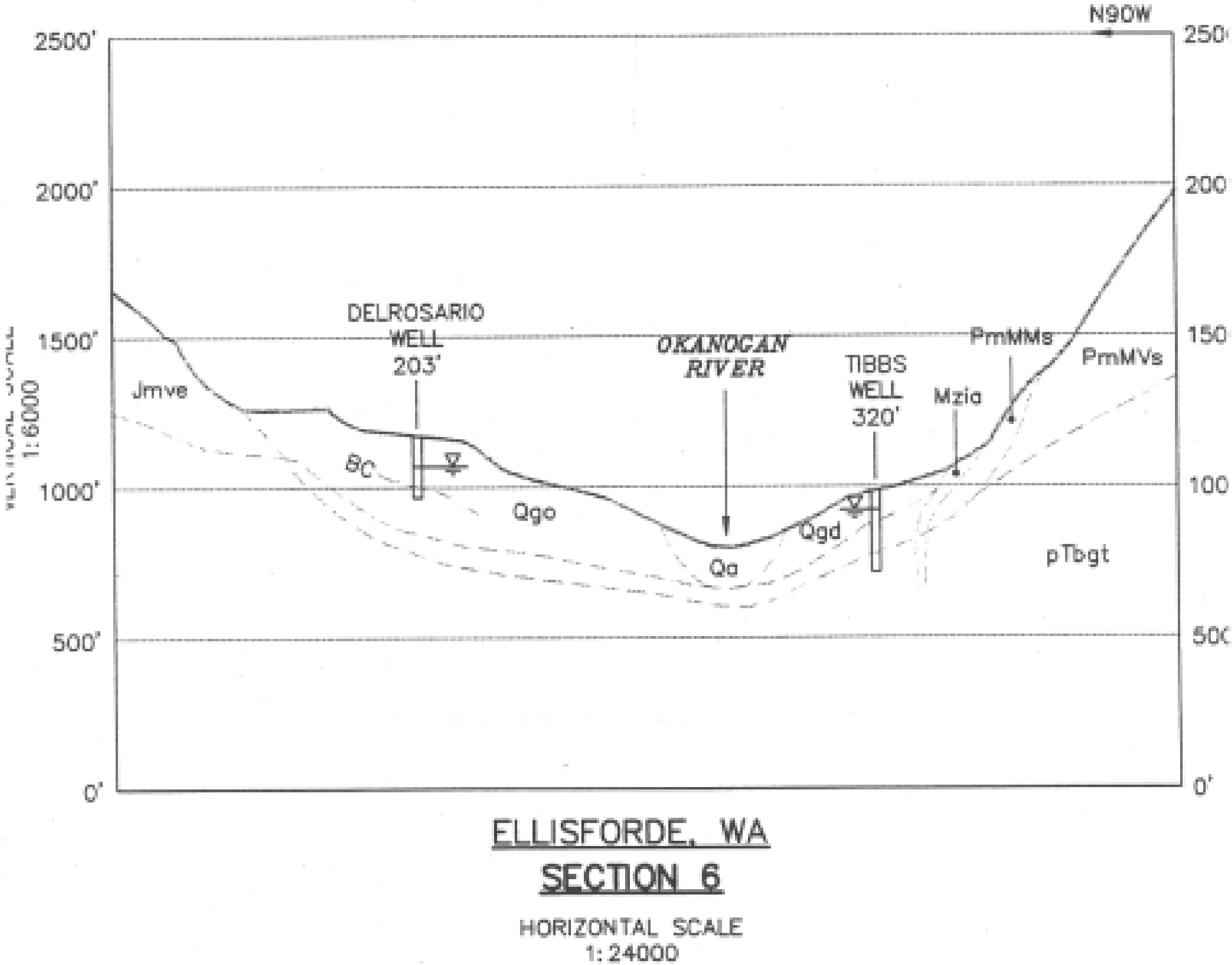


TONASKET, WA

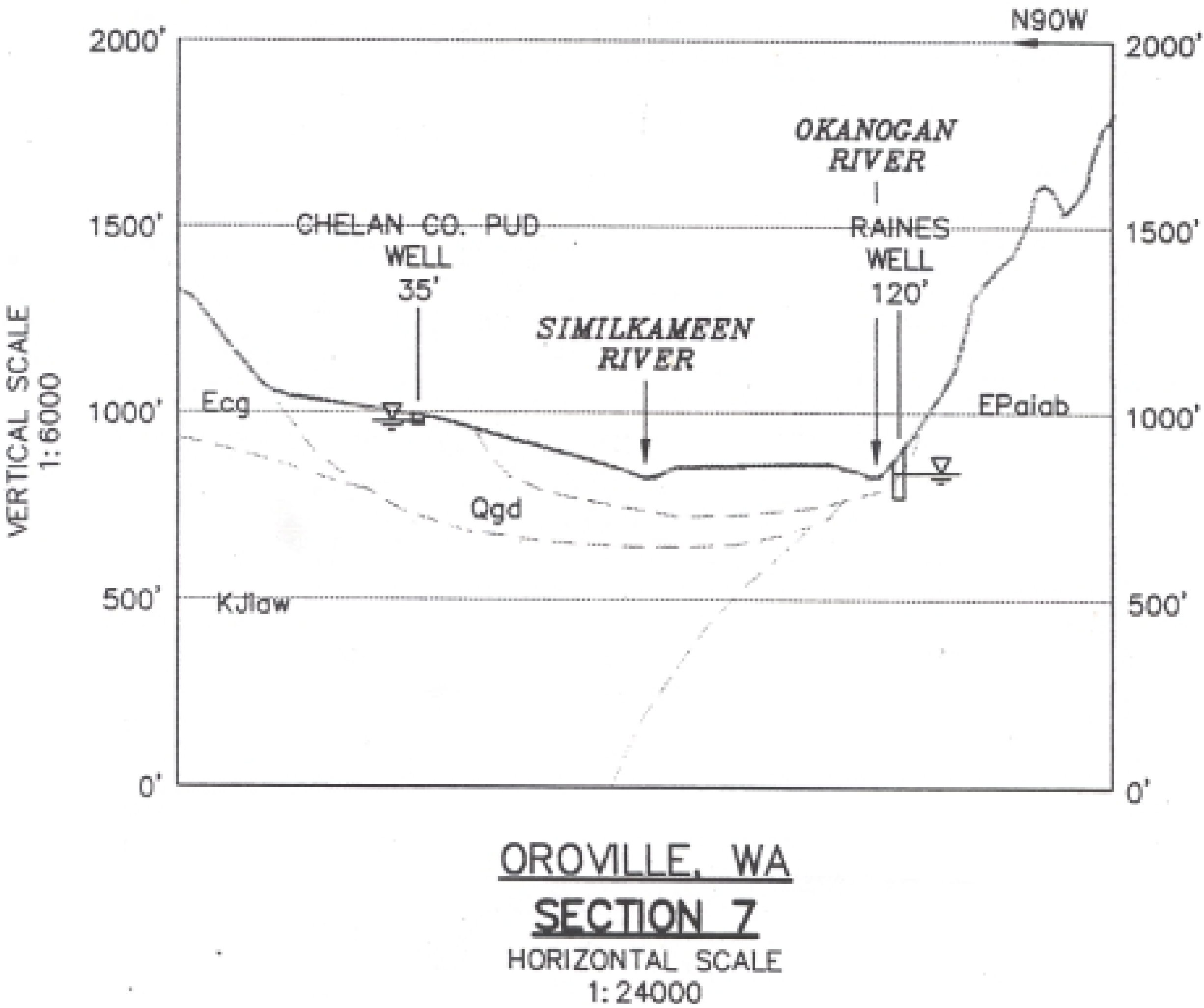
SECTION 5

HORIZONTAL SCALE
1:24000

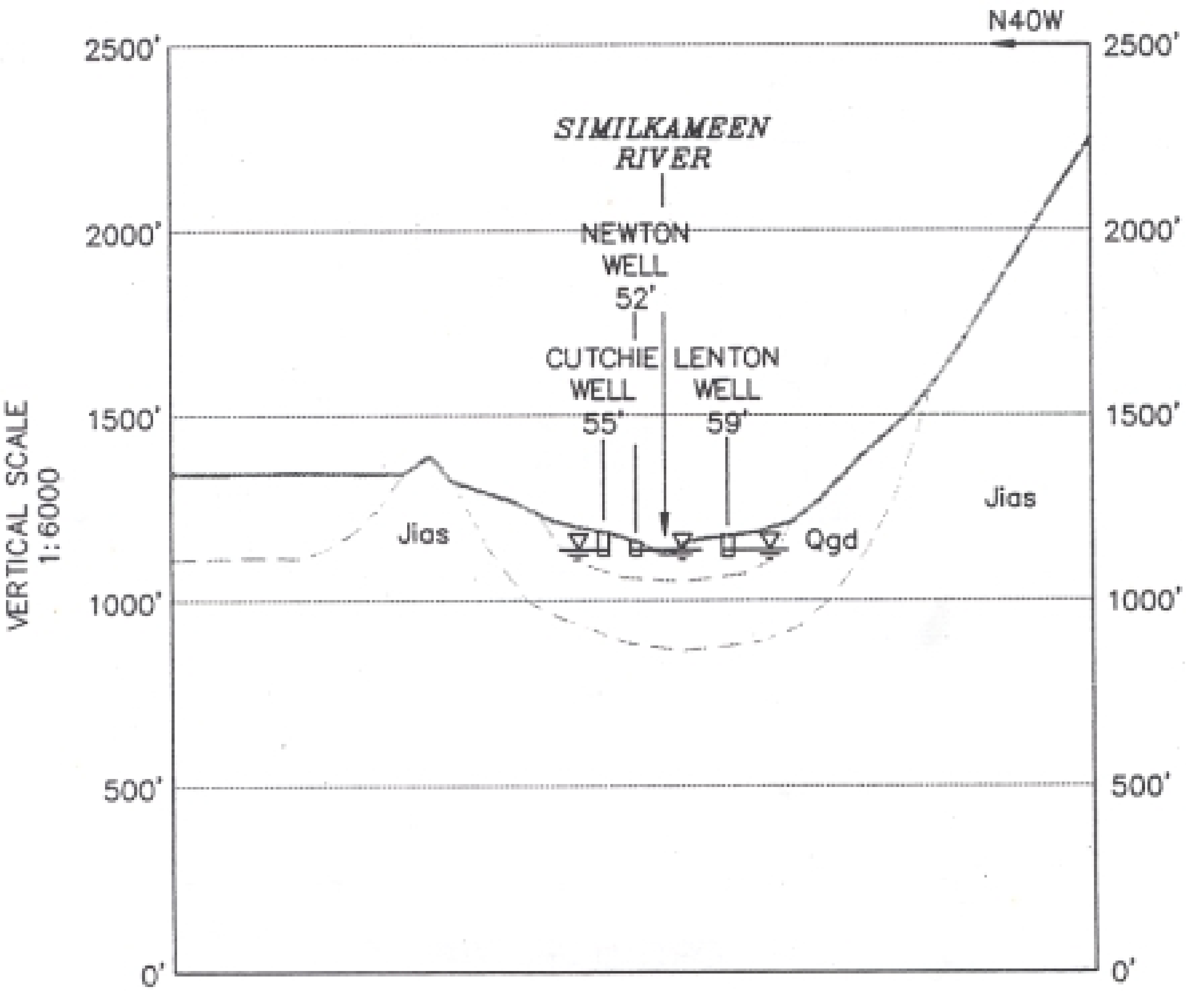
**Okanogan River Watershed
Geologic Cross-sections**



Okanogan River Watershed
Geologic Cross-sections



Okanogan River Watershed
Geologic Cross-sections



NIGHTHAWK, WA
SECTION 8
HORIZONTAL SCALE
1:24000

Okanogan River Watershed
Geologic Cross-sections

Appendix C

WAC Minimum Instream Flows WRIA 49

Chapter 173-549 WAC
WATER RESOURCES PROGRAM IN THE OKANOGAN RIVER BASIN, WRIA 49

DISPOSITION OF SECTIONS FORMERLY CODIFIED IN THIS CHAPTER

173-549-030 Future allocations-Reservation of surface water for beneficial uses. [Order DE 76-25, § 173-549-030. riled 7/14/76.1 Repealed by 84-13-076 (Order DE 84--15), riled 6/20/84. Statutory Authority: Chapters 90.54 and 90.22 RCW.

173- 5494)Q Priority of future water rights during times of water shortage. [Order DE 76-25, § 173-549-M, riled 7/14/76.1 Repealed by 84-13-076 (Order DE 84- 15), filed 6/20/84. Statutory Authority: Chapters 90.54 and 90.22 RCW.

173-549-450 Streams and lakes closed to further consumptive appropriations. [Order DE 76-25, § 173-549-050. filed 7/14/76.1 Repealed by 84-13-076 (Order DE W 15). riled 6/20/84. Statutory Authority: Chapters 90.54 and 90.22 RCW.

WAC 173-549-010 General provision. These rules apply to waters within the Okanogan River Basin (WRIA 49) as defined in WAC 173-500-040. This chapter is promulgated pursuant to chapter 90.54 RCW (the Water Resources Act of 1971) and chapter 90.22 RCW (Minimum water flows and levels) and in accordance with chapter 173-500 WAC (Water resources management program). [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549-010, filed 6/20/84; Order DE 76-25, § 173- 549-010, Filed 7/14/76.]

WAC 173-549-015 Purpose. Chapter 90.54 RCW (the Water Resources Act of 1971) requires that utilization and management of the waters of the state shall be guided by a number of fundamentals, including the following:

> "(I) Uses of water for domestic, stock watering, industrial, commercial, agricultural, irrigation, hydroelectric power production, mining, fish and wildlife maintenance and enhancement, recreational, and thermal power production purposes, and preservation of environmental and aesthetic values. and all other uses compatible with the enjoyment of the public waters of the state. arc declared to be beneficial." (RCW 90.54.020(1).)

The act further specifics that "Perennial rivers and streams of the state shall be retained with base flows necessary to provide for preservation of wildlife, fish. scenic, aesthetic and other environmental values, and navigational values." (RCW 90.54.020 (3)(a).)

The purpose of this chapter is to satisfy the requirements of RCW 90.54.020 (3)(a) while, at the same time, allowing the continued use of water for other beneficial uses such as agriculture, which is acknowledged as a vital activity greatly benefiting the citizens of the Okanogan Basin and the state of Washington. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13- 076 (Order DE 84-15), § 173-549-015, filed 6/20/84.1

WAC 173-549-016 Definition. For the purposes or this chapter, the term minimum instream flow shall be synonymous with the term base flow as defined in chapter 90.54 RCW and the term minimum flow as defined in chapter 90.22 RCW. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84- 13-076 (Order DF 84--15), § 173-549-016, riled 6/20/84.]

WAC 173-549-020 Establishment of minimum in-stream flows. (1) Minimum instream flows are established for stream management units with monitoring to take place at certain control points as follows:

Stream Management Unit Information

Stream Management Unit Name, Control Station Name and Number	Control Station Location by River Mile. Section, Township, Range	Affected Stream Reach
Lower Okanogan		
Okanogan R. at Malott (12447200)	17.0. 9-32- 25E	Okanogan River confluence with Wells Pool to confluence of Chewilken Cr.
Middle Okanogan		
Okanogan R. nr. Tonasket (12445000)	50.8. 8-36 27E	Okanogan River confluence of Chewilken Creek to confluence Similkameen River
Upper Okanogan		
Okanogan R. at Oroville (12439500)	77.3. 27-40-27E	Okanogan River confluence of Similkameen River to Osoyoos Lake

(6/9/88)

173-549-020 Okanogan River Basin-WRIA 49

Stream Management Unit Name, Control Station Name and NumberTownship. Range	Control Station Location by River Mile. Section.	Affected Stream Reach
Similkameen		
Similkameen R. at Nighthawk (12442500)	15.8. 7-40-26E	Similkameen River confluence with Okanogan River to Canadian Border

(2) Minimum instream flows established for the stream management units in WAC 173-549-020(1) are as follows:

Minimum Instream Flows in the Okanogan River
(All Figures in Cubic Feet Per Second)

Month	Day	Lower Okanogan 12447200	Middle Okanogan 1241500	Upper Okanogan 1 2442600	Similkameen 12439500
Jan	1	860	800	320	400
	15	830	800	320	400
Feb	1	820	800	320	400
	15	850	800	320	400
Mar	1	880	800	320	425
	15	900	800	320	450
Apr	1	925	910	330	510
	15	1.100	1.070	340	640
May	1	1.750	1.200	350	1,100
	15	3.800	3.800	500	3,400
Jun.	1	3.800	3.800	500	3.400
	15	3.800	3.800	500	3.400
Jul	1	2.100	2,150	420	1,900
	15	1.200	1,200	350	1.070
Aug	1	800	840	320	690
	15	600	600	300	440
Sept	1	620	600	300	400
	15	700	600	300	400
Oct.	1	750	730	330	450
	15	960	900	370	500
Nov	1	950	900	370	506
	15	950	900	320	500
Dec	1	930	900	320	500
	15	900	850	320	450

(3) Minimum instream flow hydrographs, as represented in WAC173-549-900, shall be used for definition of minimum instream flows on those days not specifically identified in WAC 173-549-020(2).

(4) Future consumptive water right permits hereafter issued for diversion of surface water from the mainstem Okanogan River and the Similkameen River shall be expressly subject to minimum instream flows established in WA6 173-.549-020 (1) through (3) except those de- scribed in WAC 173-549-070.

(5) Projects that would reduce the flow in a portion of a stream's length (e.g. hydroelectric projects that bypass a portion of a stream) will be considered consumptive only with respect to the affected portion of the stream. Such projects will be subject to instream flows as specified by the department. These flows may be those established in WAC 173-549-020 or, when 4propriate, may be flows specifically tailored to that particular project and stream reach. When studies are required to deter- mine such reach- and project-specific flow require- ments. the department may require the project proponent to conduct such studies. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13476 (Order DE 84-15), § 173-549-020, riled 6/20/84; Order DE 76- 25, § 173-549-020, filed 7/14/76.]

WAC 173-549-625 Stream closures. (1) Consistent with the provisions of chapter 90.54 RCW, it is the policy of the department to preserve an appropriate mini- mum instream flow in all perennial streams and rivers of the Okanogan River Basin for protection of instream values.

(2) In keeping with this policy, a partial year closure from May I to October I will be established on all perennial streams in the basin except those with established minimum instream flows as described in WAC 173-549-020.

(3) The upper Okanogan stream management unit as established in WAC 173-549-020(l) is closed to further consumptive appropriation from June 15 through August 31 with the exception of single-domestic use and stock- watering use, provided that no alternative source of supply is available.

(4) When a project (as described in WAC 173-549- 020(5)) is proposed on a stream that is closed to further appropriations, the department shall deny the water right application unless the project proponent can adequately demonstrate that the project does not conflict with the intent of the closure. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549-025, riled 6/20/84.]

WAC 173-549-027 Policy statement for future permitting actions. (1) Consistent with the provisions of chapter 90.54 RCW, it is the policy of the department to preserve an appropriate minimum instream flow in all perennial streams and rivers as well as the water levels in all lakes in the Okanogan River Basin by encouraging the use of alternate sources of water which include (a) ground water, (b) storage water, or (c) acquisition of existing water rights.

(2) All future permits to appropriate water from the Okanogan River, the Similkameen River and perennial tributaries shall be subject to the required flows at all downstream control stations as established in WAC 173-549-020. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-133-076 (Order DE 84-15), § 173-549- 027, riled 6/20/84.]

WAC 173-549-035 Lakes. (1) In future permitting actions relating to withdrawal of lake waters, lakes and ponds shall be retained substantially in their natural condition. In considering future water right applications, the department shall deny any application for surface or ground water which will result in a significant decrease in lake level or in the stream flow of any stream draining the lake, except that no decrease in stream flow shall be allowed during the May 1 - October I stream closure period.

(2) Notwithstanding the above, nothing in this chapter shall limit the utilization of waters stored for later release, provided such storage does not infringe upon existing rights or instream flow and is duly permitted under RCW 90.03.290 and 90.03.350.

(3) Any future water rights for waters from Osoyoos Lake or from ground waters determined to be in significant hydraulic continuity with Osoyoos Lake, issued after the effective date of this chapter and upon completion of the new Osoyoos Lake outlet control structure, shall be subject to the maintenance of a water surface level of 910.5 feet USCGS in Osoyoos Lake and said diversions shall be curtailed when the lake elevation drops below elevation 910.5 feet USCGS.

(4) Notwithstanding the provisions of this chapter, the construction and operation of the proposed new outlet control structure for Osoyoos Lake shall be consistent with the terms and conditions of the International Joint Commission Order of Approval signed on December 9. 1982, pursuant to the 1909 Boundary Waters Treaty. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549-035, filed 6/201-04.]

WAC 173-549-060 Ground water. If department investigations determine that there is significant hydraulic continuity between surface water and the proposed ground water source, any water right permit or certificate issued shall be subject to the same conditions as affected surface waters. If department investigations determine that withdrawal of ground water from the source aquifers would not interfere with stream flow during the period of stream closure or with maintenance of minimum instream flows, then applications to appropriate public ground waters may be approved. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549-.060, filed 6/20/84; Order DE 76-25, § 173-549-060, riled 7/14/76.1

WAC 173-549-070 Effect on prior rights and exemptions. (1) Nothing in this chapter shall affect any existing water rights including, among others, riparian, appropriative, and federal Indian and non-Indian reserved rights, existing on the effective date of this chapter, nor shall it affect existing rights relating to the operation of any navigation, hydroelectric, or water storage reservoir or related facilities.

(2) Single domestic use and stockwatering use shall be exempt from the provisions established in this chapter except that, when the cumulative impacts of numerous domestic diversions begins to significantly affect the quantity of water available for instream uses or the maintenance of lake levels, then any water rights issued after that time shall be issued only for in-house use if no alternative supply is available.

(3) Nonconsumptive uses which are compatible with the intent of the chapter may be approved. [Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549-070, riled 6/20/84, Order DE 76-25, § 173-549-070, riled 7/14/76.1

WAC 173-549-080 Future rights. No rights to divert or store public surface or ground waters of the Okanogan River Basin, WRIA 49, shall hereafter be granted which shall conflict with the purpose of this chapter except as provided in RCW 90.54.020 (3)(a). [Statutory Authority: Chapters 90.54 and 90.22 RCW- 84-13-076 (Order DE 84-15), § 173-549--080, filed 6/20/84.1

WAC 173-549-090 Enforcement. In enforcement of this chapter, the department of ecology may impose such sanctions as appropriate under authorities vested in it, including but not limited to the issuance of regulatory orders under RCW 43.27A.190 and civil penalties under RCW 90.03.600. [Statutory Authority: Chapters 43- .21B, 43.27A, 90.22 and 90.54 RCW. 88-13-037 (Order 88-11), § 173-549-090, filed 6/9/88. Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549-090, riled 6/20/84.1

WAC 173-549-095 Appeals. All final written decisions of the department of ecology pertaining to permits. regulatory orders, and related decisions made pursuant to this chapter shall be subject to review by the pollution control hearings board in accordance with chapter 43- .21 B RCW. [Statutory Authority: Chapters 43.21 B, 43- .27A, 90.22 and 90.54 RCW. 88-13-037 (Order 88. 11). § 173-549495, filed 6/9/88.1

WAC 173-549-100 Regulation review. The department of ecology shall initiate a review of the rules established in this chapter whenever new information, changing conditions, or statutory modifications make it necessary to consider revisions. [Statutory Authority: Chapters 43.21 B, 43.27A, .90.22 and 90.54 RCW. 88- 13-037 (Order 88-11), § 173--549-100, filed 6/9/88. Statutory Authority: Chapters 90.54 and 90.22 RCW. 84-13-076 (Order DE 84-15), § 173-549--100, filed 6/20/84.1