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Daniel J. Evans, Governor

DEPARTMENT OF ECOLOGY
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WATER-SUPPLY BULLETIN 38

Water in the Methow River Basin, Washington

By
KENNETH L. WALTERS and E. G. NASSAR

Prepared in Cooperation With
U. S. Geological Survey
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In recognition of a worldwide trend to adoption of the metric system of measurements (SI or System Internationale), the following factors are provided for conversion of English values used in this report to metric values:

Multiply	*By*	*To get*
Inches	25.40	millimetres (mm)
	2.540	centimetres (cm)
Feet (ft)	0.3048	metres (m)
Miles	1.609	kilometres (km)
Acres	0.004047	square kilometres (km^2)
Square miles (mi^2)	2.590	square kilometres (km^2)
Acre-feet (acre-ft)	1234.0	cubic metres (m^3)
Cubic feet per second (ft^3/s)	0.02832	cubic metres per second (m^3/s)
Gallons per minute (gal/min)	0.06309	litres per second (l/s)
	3.785	litres per second (l/min)

WATER IN THE METHOW RIVER BASIN, WASHINGTON

By Kenneth L. Walters and E. G. Nassar

INTRODUCTION

This report on the Methow River basin is the second in a series that describes results of studies of the hydrologic conditions in major river basins in Washington State. During this study—as in the first of the series, which pertained to the Okanogan River basin—existing data were interpreted to define (1) the amount of water available, (2) the quality or usability of the water, and (3) the frequency of seasonal water shortages and surpluses.

Existing records of hydrologic conditions provide considerable information on the availability and use of water in the Methow River basin. Such records, however, comprise virtually raw data scattered among several sources compiled over the years in differing formats and by several agencies with various approaches and goals. This report is the result of the collection, summarization, and interpretation of the readily available water information on the basin, for use in developing, protecting, and managing the area's water resources.

This report comprises three parts: Part A is a self-contained generalized report presenting basinwide information, and it also serves as an introduction to, and summary of, Part B, which is a more technical presentation of information on the hydrology of specific parts of the basin. Part C presents tabulations of the basic hydrologic data collected throughout the basin since the early 1900's. Part A contains certain estimated values without qualification or substantiation, whereas Parts B and C include the basic data and the interpretations and assumptions used to make the estimates.

The U.S. Geological Survey prepared the report as part of a program of studies in cooperation with the State of Washington Department of Ecology. The studies provide scientific information needed by the Department to efficiently and wisely manage the water resources of the State.

PART A: GENERAL HYDROLOGIC CONDITIONS

Description of the Basin

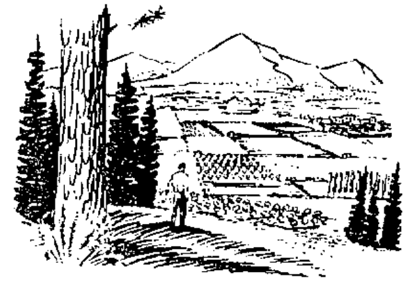
The Land, Climate, and People

The Methow River basin lies immediately south of the Canadian border in the northeastern part of the Cascade Range, between the crest of the Cascade Range and the Okanogan River basin (fig. A1). The basin occupies most of the western one-third of Okanogan County in eastern Washington and covers an area of 1,794 sq mi (square miles).

The Methow River main stem flows southeasterly for about 60 miles to the Columbia River at Pateros. The main stem is formed by the confluence of the West Fork Methow River and Robinson Creek, and is joined a short distance downstream by Lost River. The principal tributary streams are the Chewack River (drainage area, 525 sq mi) and the Twisp River (drainage area, 247 sq mi). The Chewack River originates near the Canadian border and flows almost due south for about 36 miles to the Methow River at Winthrop. The Twisp River originates near the crest of the Cascade Range and flows southeasterly and easterly for about 27 miles to the Methow River at Twisp.

Except for the floor and adjacent river terraces of the downstream reaches of the major valleys, the Methow River basin is mostly mountainous. The mountains along the basin boundaries range in altitudes from about 7,000 feet to about 9,000 feet above mean sea level. The mouth of the Methow River is at Pateros at an altitude of 775 feet.

The climate of the Methow River basin is characterized by great variations in temperature and precipitation from place to place (fig. A2). In general, the greatest precipitation and lowest temperatures occur in the higher mountains. Some localities near the crest of the Cascade Range receive more than 80 inches of precipitation a year (fig. A2), while the valley floor near Pateros receives only about 10 inches a year. Average annual precipitation for the entire basin is about 32 inches (U.S. Weather Bureau, 1965). At the station of the U.S. Weather Service at Winthrop (fig. A2), the highest recorded yearly temperatures during the period 1921-70 ranged from 34°C (Celsius) or 93°F (Fahrenheit) to 41°C (106°F) and averaged 38°C (100°F), and the lowest yearly temperatures during the same period ranged from -17°C (1°F) to -44°C (-48°F), and averaged -28°C (-19°F). The highest temperatures usually occur in July and the lowest in January. The frost-free growing season in the central part of the Methow River valley is normally from about mid-May to mid-September. Temperatures at higher altitudes in the basin have not been recorded.



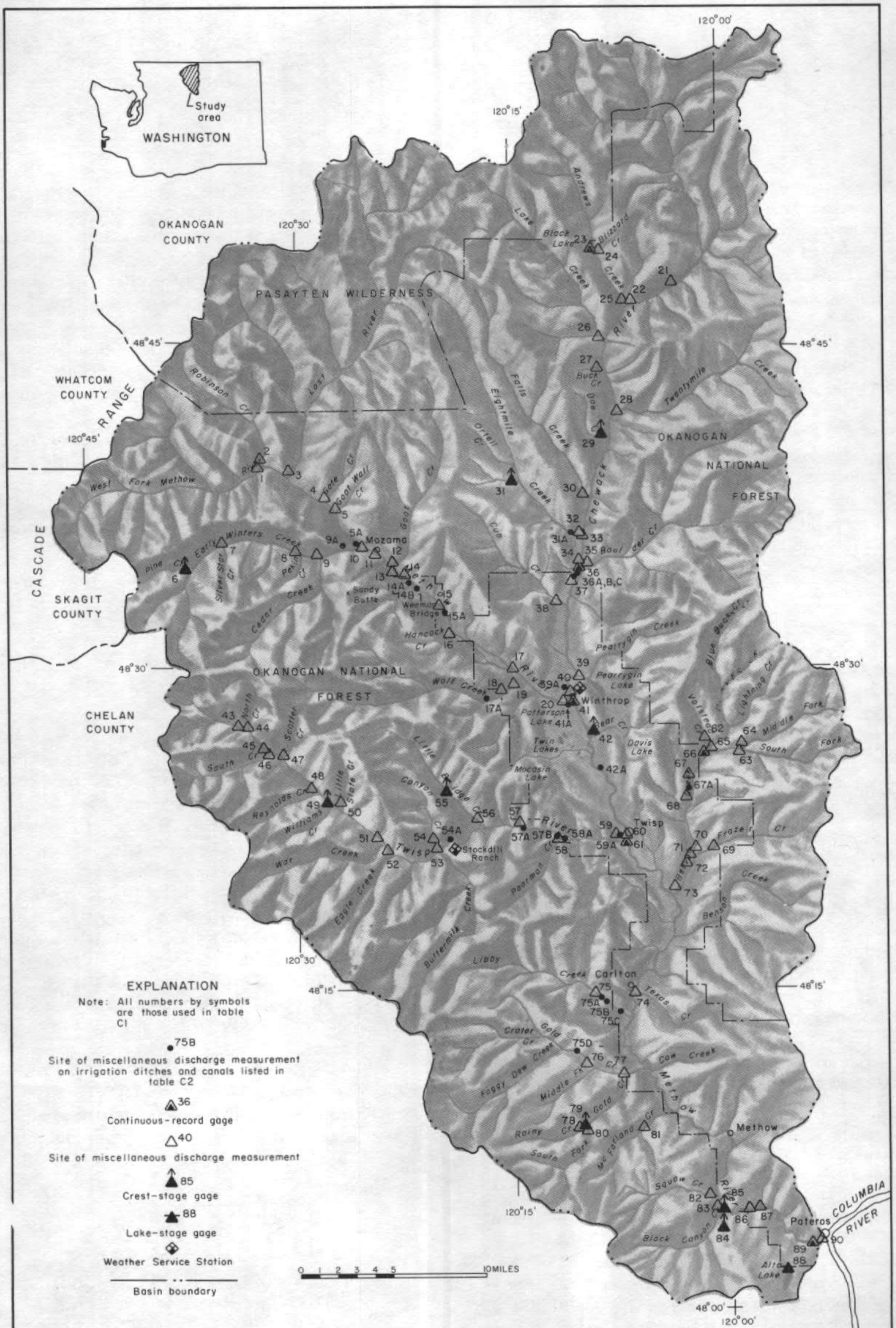


FIGURE A1. Methow River basin and locations of data-collection sites.

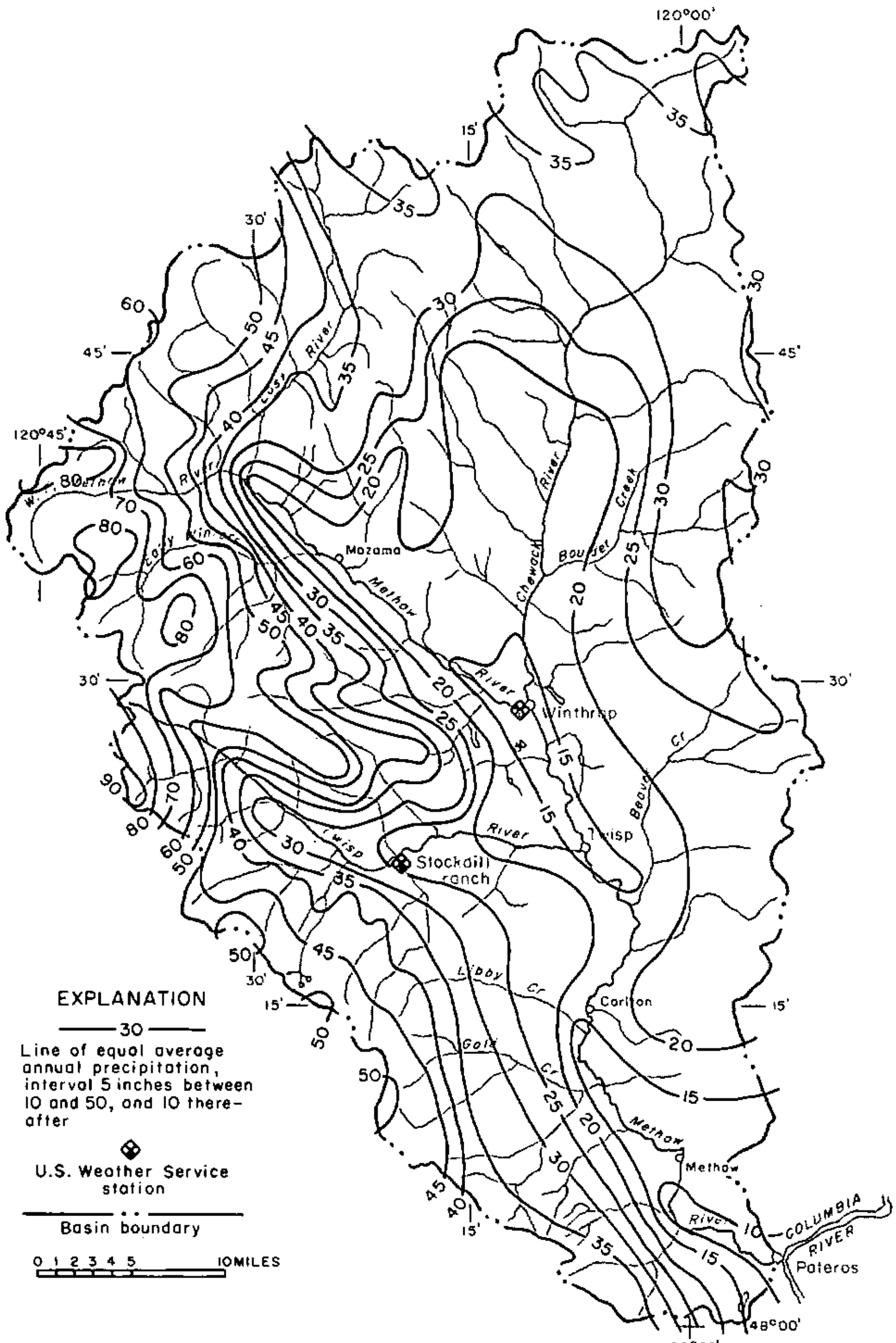


FIGURE A2. Areal distribution of average annual precipitation in the Methow River basin. Data from U.S. Weather Bureau (1965).

Much of the basin is forest covered and devoted to forest products and cattle grazing, or is designated as a wilderness recreational area (Pasayten Wilderness). Farming is restricted to the more fertile valley bottom lands and adjacent river terraces, and irrigation—chiefly of orchards—is practiced extensively. In essence, the Methow River basin is unique; the basin is one of the most pristine in the State, as there has been little manmade modification of the streams, and the population is not large—about two people per square mile. It should be noted that over 50 percent of the economy of the area is generated by the extensive wildlife and fisheries resources which provide the basis for the recreation or tourist trade.

The population of the Methow River basin is concentrated principally on the main-stem valley floor between Mazama and Pateros. The 1971 population of the incorporated towns and cities of the basin was as follows: Twisp, 777; Pateros, 486; and Winthrop, 340. Slightly more people live in the towns than in the remainder of the basin.

Geology, Vegetation, Agriculture, and Recreation

The bedrock of the Methow River basin is exposed or only thinly covered everywhere except beneath, or immediately adjacent to, the floors of the major valleys (pl. B9 in part B). Granite is the most common type of bedrock, but a wide variety of other igneous, metamorphic, and sedimentary rock types are also present. The rocks are folded and faulted, resulting in a complex pattern of rock types of vastly different ages.

Several times during the Pleistocene Epoch or "Ice Age" glacial ice covered the entire basin except for some of the highest peaks. Upland areas of the basin were periodically scoured and rounded by the action of the ice, and mantled by relatively thin glacial deposits left behind. In contrast, thick accumulations of clay, sand, and gravel were deposited along the lower slopes and bottoms of the major valleys. In many parts of the basin where drainage was diverted, large blocks of ice were buried; when this ice melted, many lakes were formed in the resulting depressions. According to Wolcott (1964), the Methow River basin contains 184 lakes and ponds ranging in surface area from a fraction of an acre to 192 acres. Today, many of these lakes are well known as good fishing grounds and often yield limits of trout and whitefish. Some of the better known fishing lakes are Pearrygin, Moccasin, Davis, Patterson, Big Twin, and Little Twin.

Since the disappearance of the glaciers, the many rivers and smaller streams of the Methow River basin have eroded and redeposited some of the glacial deposits. In many parts of the basin this erosional-depositional process is still active.

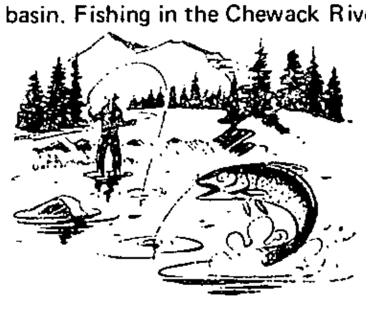
About 75 percent of Methow River basin is forested with trees of commercial value (Berger, 1962). Douglas fir, spruce, and lodgepole pine are the most common trees at moderate altitudes. Ponderosa pine occurs at lower altitudes adjacent to the nonforested lowlands, and noncommercial smaller trees, shrubs, and grasses occur mostly at the highest altitudes.

Agriculture is one of the principal contributors to the economy of the valleys in the Methow River basin. Apples and pears once were the principal crops of the Twisp River valley and of the Methow River valley south of Twisp, but the extremely low temperatures that prevail during the winter months repeatedly have caused extensive damage to the orchards. The latest widescale damage occurred during the winter of 1968 when temperatures as low as −46°C (−51°F) in places ruined hundreds of acres of orchards; as a result of this many farmers have gone out of business or have changed to different crops.

There are 37 recreation sites in the Okanogan National Forest which in 1970 showed a maximum daily use by about 3,200 persons. Following the opening of the North Cross-State Highway in September 1972, an increase in use of recreation facilities of at least 500 percent is anticipated, and more facilities will be needed. A ski area is located about 10 miles east of Twisp. Another ski-area development, perhaps quite large, is being planned at Sandy Butte west of Mazama; however, the anticipated opening of this facility is 5 or 10 years in the future. In addition, a substantial amount of land subdivision for recreational property is underway, with plots, commonly advertised as "ranchettes," being usually 5 to 40 acres in size and generally near a river or its tributaries. Notable subdivisions are along the main stem of the Methow River, the Twisp River, and Foggy Dew Creek.

Hunting is good throughout most of the Methow River basin. Perhaps the best mule-deer hunting in the State can be found in some parts of the basin, and at the higher altitudes there are significant numbers of mountain goats. For the bird hunter, the concentration of the blue grouse population is said by some to be the greatest in the western United States. Other birds found in sufficient numbers for successful hunting are valley quail, ruffled grouse, sharptail grouse, Chukar partridge, and pheasant. Two rare and endangered species that retain significant footholds on survival in the area are Harlequin ducks, which nest in and near marshy, damp areas, and whitetail jackrabbits, which can still be seen by the observant eye.

Fishing also attracts many sportsmen throughout the Methow River basin. Fishing in the Chewack River drainage



is quite good. The main stem is planted with migrant steelhead and the catch is excellent. In addition, there is extensive planting of legal-size rainbow trout for immediate catching. There also is a good return of king salmon and occasional sockeye. Fishing in the Methow River drainage above Winthrop also is generally good. Large numbers of legal-size rainbow trout are planted and the catch is significant. Steelhead are generally caught in the main stem and there is a good return of salmon—especially kings. The southern part of the Methow River basin also attracts fishermen. Rainbow trout are planted in the Methow and Twisp Rivers, and in Beaver and Gold Creeks. There is a good steelhead return due to planting of migratory fish in the Methow and Twisp Rivers and a significant number of king salmon also return. Lake fishing also is usually quite productive in this area. Big Twin, Little Twin, Davis, and Moccasin Lakes all are known as good producers of trout and whitefish.

Hydrology of the Basin

Precipitation in the form of rain and snow is the source of virtually all[1] fresh water in the Methow River basin. The quantity of water from precipitation that becomes available for streamflow, storage in lakes and surface reservoirs, and recharge to ground-water aquifers is reduced by evaporation from surface-water bodies and transpiration by plants (combined under the term "evapotranspiration"). Evapotranspiration has first access to precipitation soon after it falls (at the land surface or as soil moisture), and under arid conditions evapotranspiration may claim the entire amount. Evapotranspiration also takes its toll as water moves through the basin, whether the water moves in stream channels or underground within the root zone of plants.

While a large part of precipitation remains as winter snowpack for several months before the melting process begins, some of the rainfall that escapes evapotranspiration may remain in the basin only a very short time before leaving as stream runoff. Also, some rainfall may percolate downward to recharge the ground-water body, where it might remain for periods ranging from a few days to centuries. Still another part of the precipitation may be stored temporarily in lakes or reservoirs to be discharged later as streamflow. The hydrologic cycle, or the process of the exchange of water between the earth and atmosphere, is diagrammatically illustrated in Figure A3.

Ground and surface water and soil moisture are related in ways other than by their common source, precipitation. Streams flowing over permeable materials lose water to the ground-water body if the stream level is above the adjacent water table. This recharge of the ground-water body may occur naturally, or may be induced by lowering of the water table near the stream by pumping from wells. On the other hand, if the water table is higher than the stream level, ground water discharges into the stream channels; this occurs in much of the Methow River basin and sustains the flow of the streams during the dry summer and early-fall months.

Precipitation and Inflow

The mean annual precipitation over the Methow River basin, based on records for 1930-57 (U.S. Weather Bureau, 1965), is estimated to be 32.1 inches, or about 3 million acre-feet, of water. Annual precipitation during 1922-70 averaged 13.58 inches near Winthrop, and during 1920-61 averaged 17.54 inches at Stockdill Ranch near Twisp. Precipitation patterns at the above two stations are depicted in figure A4.

Although no U.S. Weather Service stations are maintained in the high mountains, precipitation there locally exceeds 80 inches annually (fig. A2).

Average precipitation during the growing season (April-September), for the period 1931-60, is 4.57 inches near Winthrop and 5.20 inches near Twisp. Because of cooler temperatures at the higher altitudes, the mountainous regions of the basin receive more of their precipitation as snow, which remains on the ground until late spring, before melting and running off to the streams. Thus, the mountainous regions contribute a major part of the water for the basin during the growing season.

Ground-water inflow into the basin is considered insignificant as it is limited to the areas along the topographic divide, where the rocks are of very low permeability.

Surface Water

The Methow River basin is composed of three major subareas, the Chewack River drainage, the Methow River upstream from Winthrop, and the southern drainage.

Chewack River drainage.—The Chewack River drainage contains the Chewack River and its tributaries which drain the northeastern part of the basin from the Canadian border to Winthrop. Although the Chewack River drains more area than does the Methow River above Winthrop, it discharges considerably less water than the latter, because its basin receives considerably less precipitation. Over the Methow River drainage above Winthrop, annual precipitation ranges from 15 to 80 inches, while over the Chewack River drainage precipitation ranges from 15 to 35 inches (fig. A2).

In the Chewack River drainage there are 61 lakes and ponds, with a total surface area of 581.2 acres (Wolcott, 1964, p. 344-388). Of these, three lakes (an unnamed lake 2.8 miles north of Winthrop, Pearrygin Lake, and Black Lake) have a total area of 301 acres; the remaining 58 lakes and ponds range in size from small puddles to 19.9 acres. Thirty-three lakes lie at altitudes between 5,000 and 7,400 feet and 28 are between 1,880 and 4,169 feet.

Most of the Chewack River water that is used for irrigation is diverted from the river below its confluence with Boulder Creek, and the major part of this water—87.11 cfs (cubic feet per second) as measured August 31-September 1, 1971—is used to irrigate farms south of Winthrop. The diverted water is carried through the Chewack Canal, and the Skyline, Jones-Boulder, and Fulton Ditches. A comparatively small diversion is made from

[1] Locally, the surface water or topographic divides may not coincide exactly with the ground-water divides, and minor amounts of ground-water migration may occur between adjacent topographic basins.

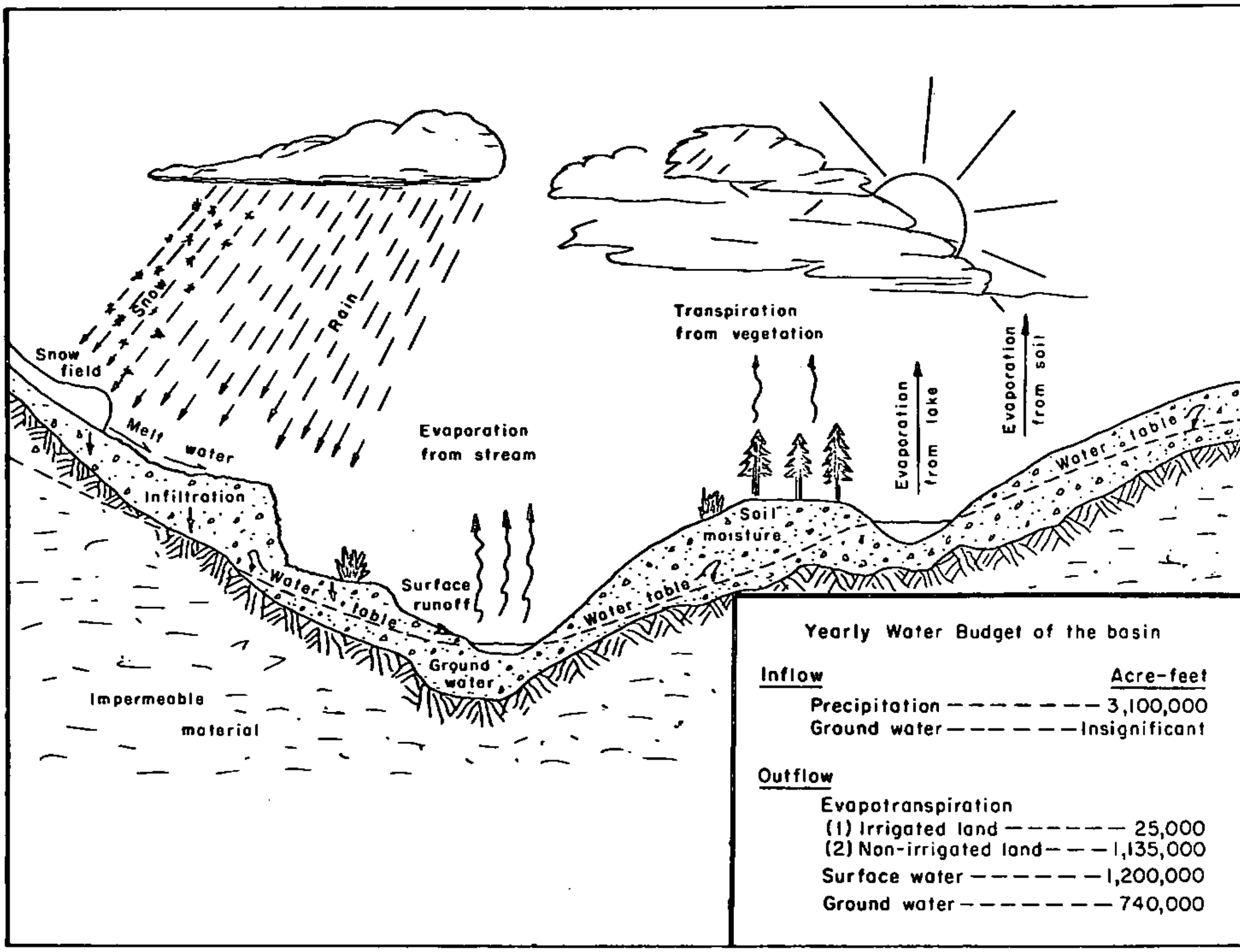


FIGURE A3. Diagrammatic sketch of the hydrologic cycle in the Methow River basin.

Eightmile Creek—by way of Eightmile Ditch—about a quarter of a mile above its mouth.

Methow River upstream from Winthrop.—The Methow River drainage upstream from Winthrop includes the West Fork Methow River, Lost River, Methow River, Early Winters Creek, Goat Creek, and Wolf Creek, which drain most of the northwestern part of the basin from the crest of the Cascade Range to Winthrop. The drainage also contains 36 lakes and ponds, which have a total area of 157.4 acres (Wolcott, 1964, p. 343-376). Six of the lakes range in area from 9.0 to 20.9 acres and 30 are under 6.6 acres. Twenty-one lakes and ponds lie at altitudes between 6,000 and 7,100 feet, 13 are between 4,100 and 5,850 feet, and two are between 2,000 and 2,860 feet, Patterson Lake, among others, is considered an excellent fishing lake.

As of 1971, six ditches carry the bulk of water, 93.77 cfs as measured during August 25-27, 1971, diverted from the Methow River upstream from Winthrop. However, this water is used to irrigate land both upstream and downstream from Winthrop. The ditches include (1) the Early Winters Ditch, which diverts from Early Winters Creek, (2) the Kumn-Holaway, McKinney Mountain, and Foghorn Ditches, and a ditch diverting below Weeman Bridge, all of which divert from Methow River, and (3) a ditch diverting from Patterson Lake. The main source of water in Patterson Lake comes by way of a ditch from Wolf Creek, the headworks of which is about 3 miles northwest of Patterson Lake.

Southern drainage.—This drainage includes the Twisp River, Beaver Creek, Libby Creek, and Gold Creek, which drain most of the southern part of the basin, from Winthrop to Pateros. Twisp River, the second largest tributary stream in the Methow River basin, has a drainage area of 247 square miles and flows southeasterly from the Cascade Range to the Methow River near Twisp. Annual precipitation over the Twisp River basin ranges from more than 80 inches along the crest of the Cascade Range to about 15 inches at Twisp.

This part of the Methow River basin—excluding the Twisp River basin—contains 47 lakes and ponds which have a total area of 784.8 acres. Alta, Paterson, Big Twin, Little Twin, and Davis Lakes cover 470.7 acres, or 60 percent of

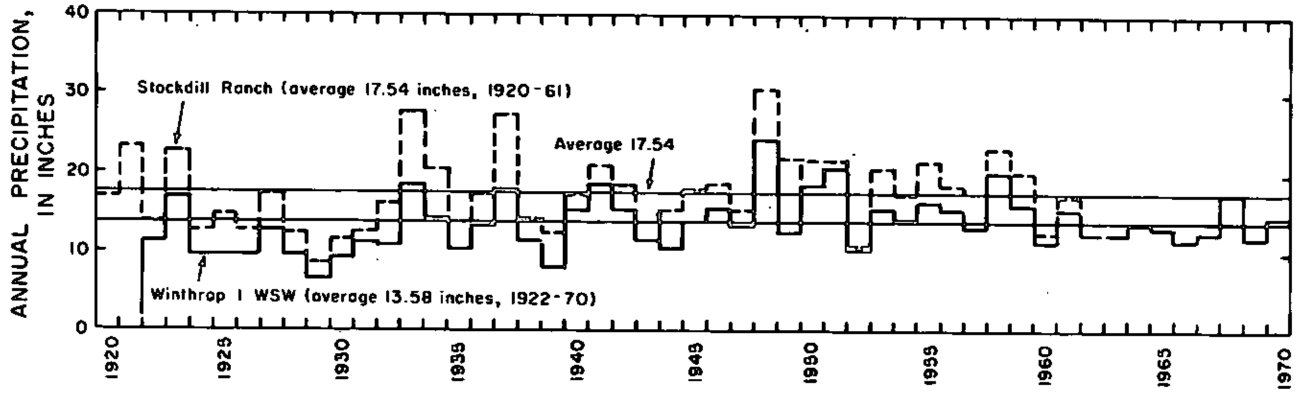


FIGURE A4. Annual precipitation patterns at two locations in the Methow River basin.

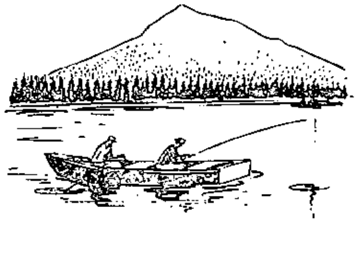
the total lake area. The remaining 43 lakes range in area from less than 1 acre to 33.1 acres. Eighteen lakes are at altitudes between 4,000 and 7,000 feet and the remaining 29 are between 1,163 and 3,400 feet.

The Twisp River basin has about 40 lakes and ponds, which have a total area of 237.7 acres. The lakes range in surface area from an acre to 27.1 acres. Four lakes are located at altitudes between 1,950 and 4,000 feet and the remaining 36 are between 4,800 and 6,900 feet.

Four small ditches diverting water from the Twisp River and one canal diverting water from the Methow River, supply the irrigation needs in the Twisp River basin and south along the Methow River valley to the vicinity of Carlton. The one diversion from the Methow River (as of 1971) carries over 84 percent (51.9 cfs) of the combined total (61.5 cfs) of the four small ditches. Of the four small ditches, the Twisp Power Ditch and Twisp-Methow Valley Irrigation District Ditch carry considerably more water than the Elmer Johnson Ditch and an unnamed ditch which diverts from the Twisp River just downstream from Poorman Creek.

The area northeast of Twisp is drained by Beaver Creek whose basin receives between 15 and 25 inches of precipitation annually (fig. A2). Water from Beaver Creek is used extensively for irrigation, both through ditches and pumping directly from the stream; the total amount of diversion is not known. The flow measured in 1971 in one ditch was 2.25 cfs.

The extreme southern part of the Methow River basin—south of Carlton—is drained by Libby, Gold, McFarland, Squaw, and Black Canyon Creeks. Precipitation over the basins of these streams ranges from 10 inches along the Methow River to 50 inches on the high mountain slopes (fig. A2). The combined diversions from Libby and Gold Creeks were 5.78 cfs in 1971. The total acreage irrigated in this area is about the same as that in the Beaver Creek basin.



Streamflow patterns.—The high- and low-flow periods of streams in the Methow River basin are distinctly separated. As discussed in part B of the report, the high-flow period extends from April through July and the low-flow period from August through March. Gaging stations with representative discharge records show that discharges during April through July are about four times those of August through March or 80 percent of the annual runoff. Total average discharge during May and June alone is 75 percent of that during the entire high-flow period.

The high flows result mostly from the spring melting of the winter snowpack, along with spring rains. While precipitation in the basin is practically confined to the period October-June, most of it occurs as snow during the colder period November-February. Warmer temperatures starting in April initiate melting of the snowpacks and the beginning of the high-flow period. Rains concurrent with the thaw constitute a minor contribution during the high-flow season.

Streamflow during the months September-February consists of flow derived mainly from seepage into the stream from the ground-water reservoir.

The Ground-Water Reservoir

Alluvial and glacial deposits, ranging from only a few feet to several hundred feet in thickness, constitute almost the entire ground-water reservoir in the Methow River basin. The deposits occur in greatest thickness principally in the bottoms and along the lower slopes of the major valleys. Sand and gravel layers in these deposits comprise the principal aquifers yielding appreciable quantities of water to wells, but silt, clay, and glacial till are important as confining beds.

Bedrock consisting of a wide variety of granitic, metamorphic, and sedimentary rock types underlies the alluvial and glacial deposits or is exposed at the surface. The bedrock can be regarded as the floor of the ground-water reservoir, although fracture and joint zones, where saturated below the water table, locally may yield small quantities of water to wells and springs.

The general availability of ground water is indicated in figure A5. As the map shows, ground-water supplies sufficient for domestic use can be obtained from sand and

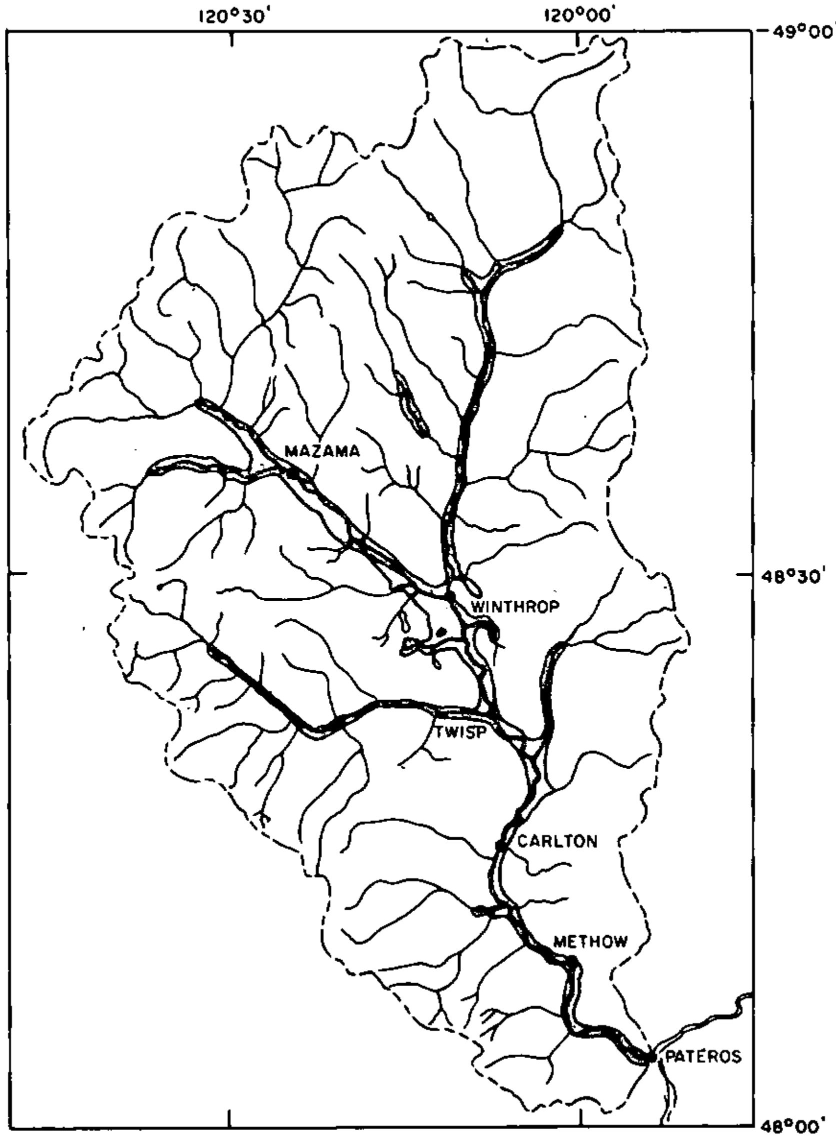


FIGURE A5. Areas (shaded) in the Methow River basin where ground water occurs in sufficient quantity for domestic and irrigation use.

gravel only along major streams. In areas where saturated deposits are sufficiently thick and permeable, ground-water supplies are adequate for irrigation. In the bedrock outcrops along slopes and in the uplands, ground-water supplies are meager and generally inadequate even for stock or domestic use.

Evapotranspiration and Outflow

Water leaves the Methow River basin as streamflow and subsurface flow, and by evapotranspiration. In most river basins, the amount of water that leaves the basin is subject to less accurate estimation than that entering the basin largely because evapotranspiration cannot be defined as closely as precipitation. However, because of the great variation in annual precipitation within short distances in the Methow River basin, the mean annual precipitation perhaps can be determined no more accurately than evapotranspiration.

The amount of water that leaves the basin as streamflow is represented by that gaged near the mouth of the Methow River at Pateros during the period 1903-20, and 6.7 miles above the mouth near Pateros during 1959-70. The mean annual discharges at the two stations are about 1,200,000 and 1,100,000 acre-feet, respectively.

The evapotranspiration rate is dependent on the availability of water and, except in irrigated areas of the Methow River basin, cannot average more than the rate of precipitation. During much of the growing season in nonirrigated parts of the basin, soil moisture is deficient to the point that there is very little water available for evapotranspiration. At Winthrop, estimates of total seasonal evapotranspiration from all sources for several types of crops were made by Molenaar, Criddle, and Pair (1952) as follows: alfalfa, 23.5 inches; grass pasture, 22.1 inches; small grains, 16.4 inches; orchards, 19.3 inches; and potatoes, 19.7 inches. According to maps prepared by the

U.S. Weather Bureau and the U.S. Department of Agriculture (written commun., 1962), the mean annual evapotranspiration from nonirrigated areas of the Methow River basin ranges from about 8 to 16 inches. With average evapotranspiration rates of 20 inches per year for the 15,000 acres of irrigated land, and 12 inches per year for nonirrigated areas, the total evapotranspiration for the basin amounts to about 1,160,000 acre-feet per year. The amount of water that leaves the basin as subsurface underflow—precipitation minus surface flow and evapotranspiration—is about 740,000 acre-feet per year, or about 660 million gallons per day. The cross-sectional area and transmissivity of the materials underlying the lower end of the Methow River valley do not appear to be great enough to accommodate such a volume, which suggests that either the mean annual precipitation on the basin may actually be less than the assumed 32.1 inches, or the total evapotranspiration may be greater than was estimated.

Quality of the Water

All natural water contains chemical substances in solution, with the type and concentration of substances depending on the type of rock materials with which the water has been in contact. Ground water commonly is in contact with rock materials longer than is surface water and, therefore, usually is more highly mineralized.

The chemical character of water in the Methow River basin is known only from repeated sampling of the Methow River near Pateros during July 1959-September 1970, and from a few analyses of ground water. Chemical analyses of the collected samples appear in tables C6 and C7, in part C of the report.

Water of the Methow River at Pateros is of the calcium magnesium bicarbonate type, and is suitable for most common uses. However, because different uses of water require different standards of quality, the water quality should be considered on the basis of intended use. For example, water to be used in the home should have no unpleasant taste or odor, and should be free of harmful microorganisms. The mineral content of water used for some industrial applications must be very low.

All water samples from the Methow River and the few samples of ground water that were analyzed were within the recommended standards set by the U.S. Public Health Service (1962) for chemical quality of drinking-water supplies.

The dissolved-mineral content (known technically as the dissolved-solids content) of water in the Methow River was fairly constant. The concentrations usually were in the range of 75 to 125 mg/l (milligrams per liter), with the greatest concentrations usually occurring at times of low flow.

Water Temperature

The temperature of water in a stream is largely influenced by the exposure to the sun, the volume of flow, and the type of use that returns water to the stream.

Records of water temperature were collected continuously on the Methow River near Pateros (station 12449950) during the period October 30, 1968-October 31, 1970; the trends illustrated in figure A6 represent a typical yearly pattern. The daily maximum and minimum, and monthly average water temperatures were evaluated from the record and are presented in table C8 in part C of the report. Table C9 contains a list of air and water temperatures obtained when discharge measurements, and (or) inspections were made on various streams in the basin, and on Alta Lake.

During the period October 30, 1968-October 31, 1970, the water temperature of the Methow River near Pateros fluctuated between 32° and 74°F or 0° and 23.5°C. The daily temperature fluctuations, generally 2° to 10°F (1.1° to 5.6°C), were largest during the period March-October, when the greatest amount of energy is received from the sun. During the period November-February, daily fluctuations in water temperature were as much as 6°F (3.4°C). However, during the last part of December, and the first part of February, water temperature remained at or near 32°F (0°C).

Data are not available on temperatures on ground water in the basin. However, ground-water temperatures are usually about the same as the mean annual air temperature, which is about 47°F (8.5°C) at Methow and 45°F (7.0°C) at Winthrop. Figure A7 illustrates the trends in air temperature at Methow during the 1970 water year.

Floods and Low Flows

Heavy winter snowpack and rapid springtime melting are major causes of floods in the Methow River basin. A typical flood results from the melting in late spring of the snowpack accumulated in the winter months. However, the magnitude of the flood depends primarily on weather conditions prevailing subsequent to snow accumulation; the historic flood of May-June 1948 exemplifies these conditions, as described below.

Above normal precipitation between October 1947 and April 1948 produced snowpacks also above normal. Air temperatures during April and early May were below normal; as a result, melting of the snow in high mountains was delayed. Also, contrary to normal trends, the water content of snowpacks increased during April and early May. This was followed by sustained above-normal temperatures after May 16. In addition, during May 1-29, precipitation totals of 4.26 inches (3.30 inches above normal), and 4.93 inches (3.97 inches above normal) were recorded at Winthrop and Mazama, respectively. Thus, all the elements favoring a major flood occurred.

Figure A8 shows a comparison between weather conditions and discharge for the period May 10-June 25, 1948, including the flood on May 29, as recorded at the gaging station on the Methow River at Twisp.

The flood of May 29, 1948 is believed to be the highest in magnitude since that of 1894. The Methow River basin was very sparsely settled before the turn of the century, and therefore damage from the 1894 flood was probably insignificant. However, the flood of 1948 caused considerable damage locally as it did over much of the Columbia River basin. In the Methow valley it isolated the towns of Methow, Twisp, and Winthrop, and six State highway bridges were destroyed or rendered unusable. Sections of

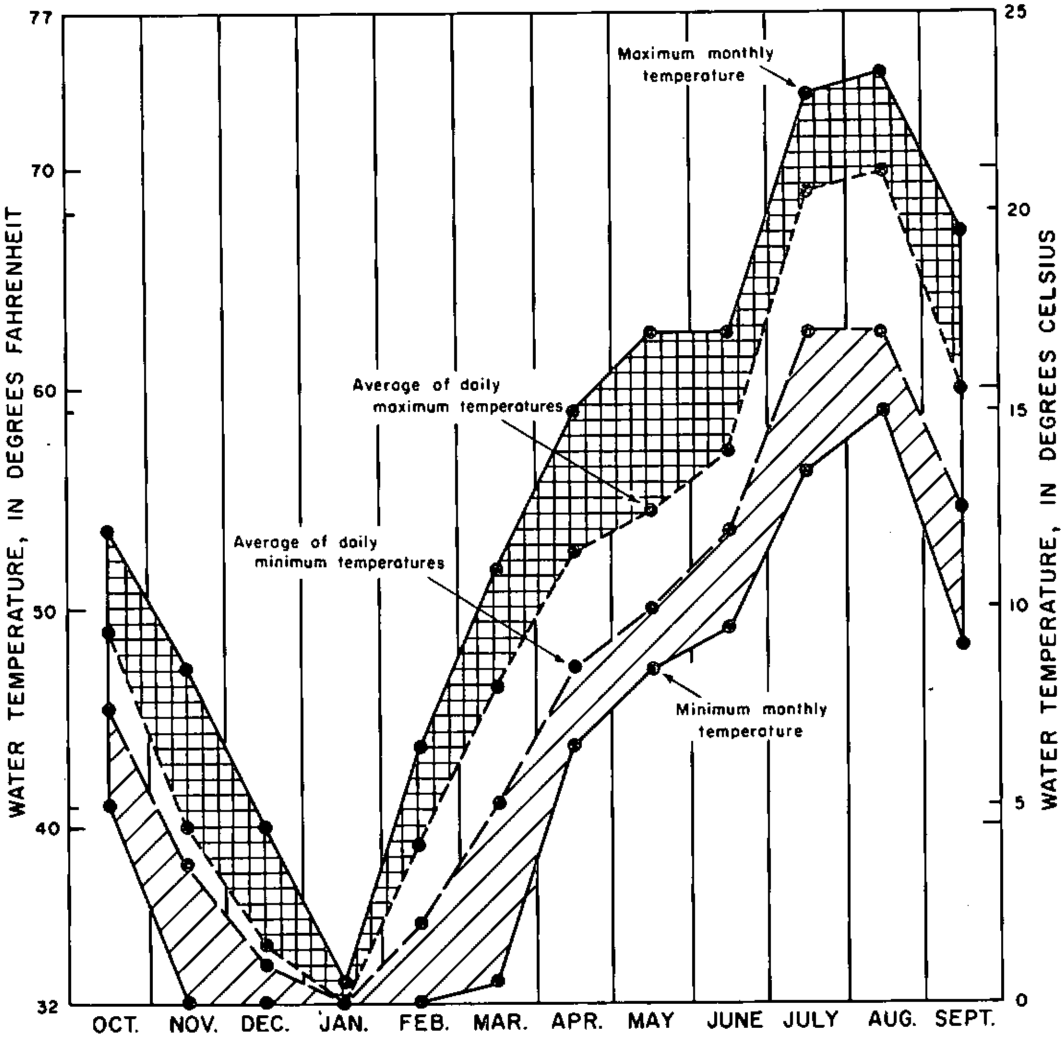


FIGURE A6. Trends in water temperature, Methow River near Pateros (12449950), for the period Oct. 1, 1969–Sept. 30, 1970.

the highway were washed out, and many orchards and homes were completely destroyed. Eleven weeks elapsed before the main highway was opened to traffic (U.S. Geological Survey, 1949, p.9).

Information on the magnitude and frequency of occurrence of floods in different areas of the basin is essential to the design of flood-control structures and bridge openings, and to the determination of channel capacities, roadbed elevations, and flood-plain zoning. This information is included in the technical part of the report (part B).

The low-flow characteristics of the Methow River basin, as for any basin, are of particular interest to the planners of municipal and industrial water-supply projects, and of projects dealing with fish propagation, supplemental irrigation, waste disposal, and draft-storage studies—in fact almost any water use. Unless low-flow characteristics of a stream are fully understood, establishment of any diversionary uses could result in (1) depletion of irrigation-water supplies at times of greatest demand, (2) changes in water volumes and temperature making the streams unfit for fish propagation, and (3) decreased efficiency in the disposal and dilution of liquid wastes. Low-flow characteristics are discussed in detail in part B.

The low-flow period of streams in the Methow River basin extends from August through March. Although most streams are perennial, streamflow during the low-flow period amounts only to about 20 percent of the total annual flow, as shown by records collected on the Methow River and Beaver Creek.

Low-flow frequency and flow-duration curves, discussed in part B, were employed to assess the low-flow characteristics of streams in the study area.

Use and Management of the Water

The streams and lakes in the Methow River basin are used for recreation, irrigation, fish propagation, and miscellaneous industrial purposes including lumber processing. By far, irrigation has been the most important withdrawal use of surface water, with about 100,000 acre-feet being diverted annually for this purpose. During 1971 the total withdrawal of surface water was approximately 108,600 acre-feet, and withdrawal of ground water was about 5,900

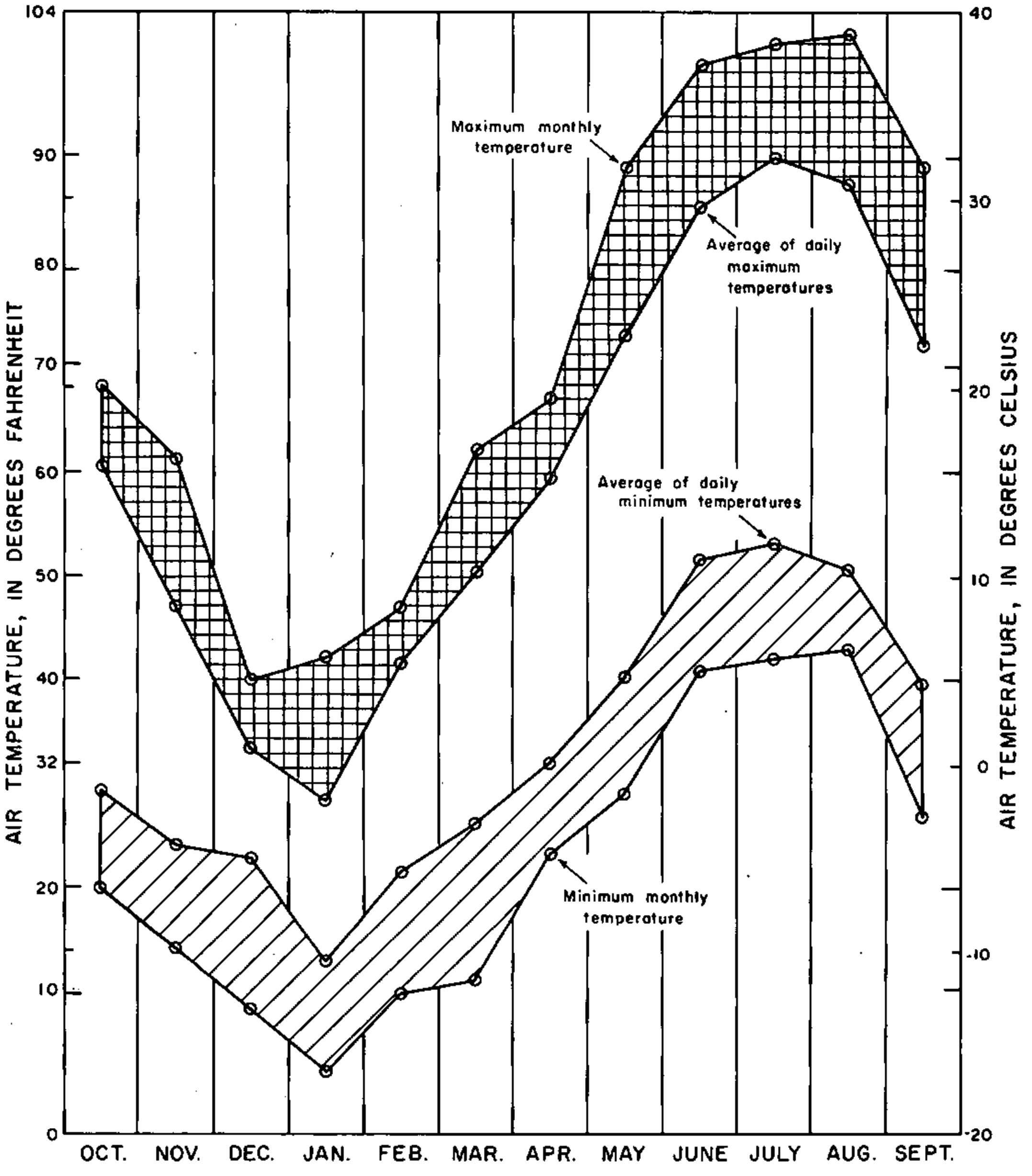


FIGURE A7. Trends in air temperature at U.S. Weather Service station at Methow, during the period Oct. 1, 1969–Sept. 30, 1970.

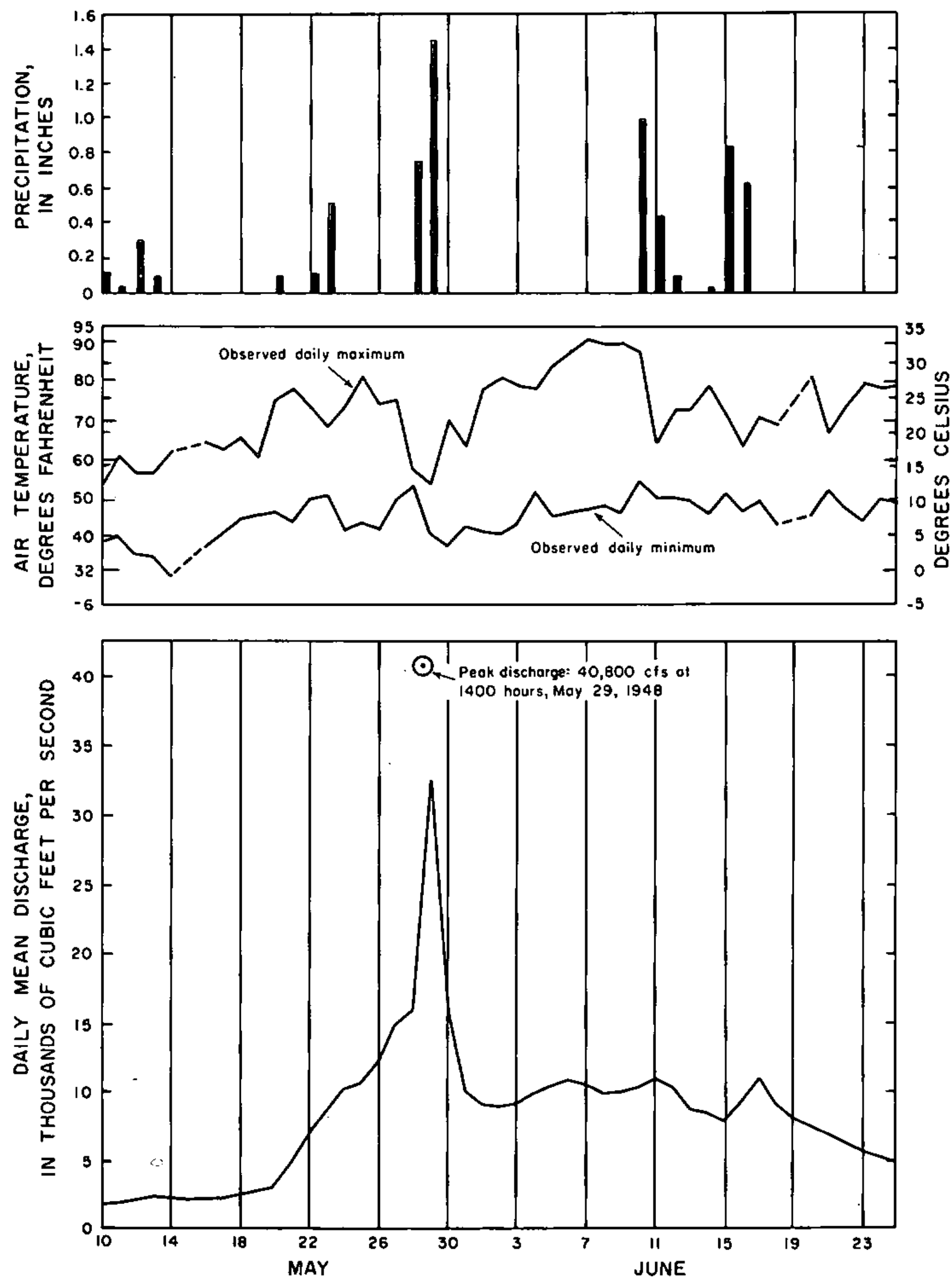


FIGURE A8. Weather conditions near Winthrop, and discharge of Methow River at Twisp (12449500), for the period May 10–June 25, 1948.

acre-feet.[2] Most of the ground water is used for irrigation and industrial purposes. Only 0.5 percent—entirely from ground-water sources—of all the water used in the basin is for public supply. The relative importance of surface and ground water as sources of supply, and the relative amount of each used in various purposes are shown in figure A9.

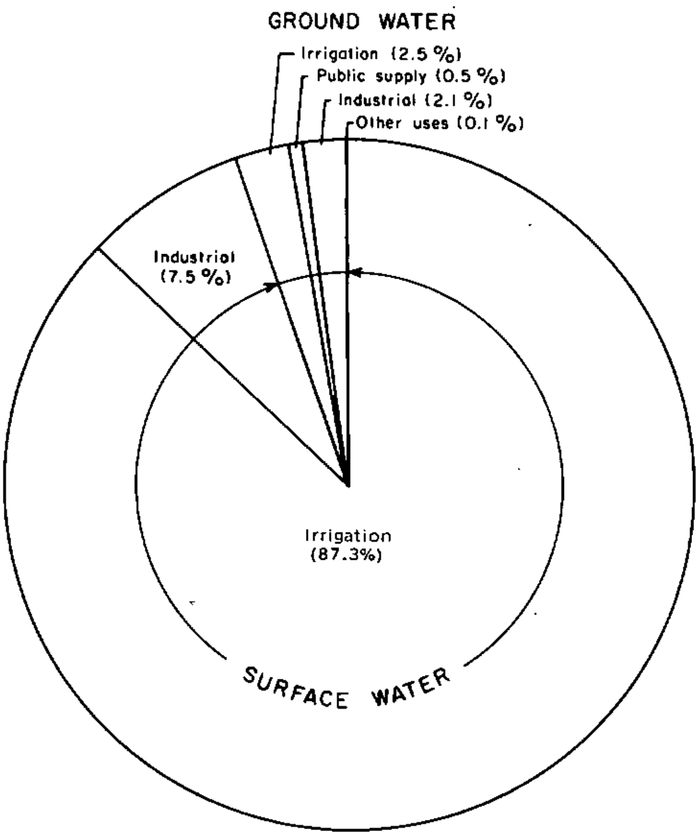


FIGURE A9. Uses of surface and ground water in the Methow River basin, 1971. Total quantity used is about 115 acre-feet.

Although systems for conveyance of irrigation water vary in degree of efficiency, it is reported that the loss by leakage from untreated earth canals and ditches in the Methow River basin was about 35,735 acre-feet (45 percent) of 79,348 acre-feet entering that system (Pacific Northwest River Basins Commission, 1971, p. 172). This reported loss explains why about 100,000 acre-feet per year is required from surface-water sources to irrigate only about 14,000 acres in the basin.

Upstream from Winthrop, water is diverted from the Methow and Chewack Rivers and from Early Winters and Wolf Creeks.[3] About 9 percent of this water is used for fish propagation and most of the remaining 91 percent is used to irrigate about 5,000 acres, a large part of which is downstream from Winthrop.

Between Winthrop and Twisp, additional diversions from Bear Creek, Davis Lake, Methow River, and Twisp River amount to about 50 percent of the diversions made upstream from Winthrop. This diverted water, along with that diverted upstream from Winthrop, is used to irrigate about 7,400 acres north of Twisp and about 2,000 acres between Twisp and the vicinity of Carlton (fig. A1).

In the Beaver Creek basin northeast of Twisp about 1,600 acres are irrigated by the waters of Beaver and Frazer Creeks.

The land east of the Methow River and south of Carlton is irrigated by direct pumpage from the Methow River with about 3,000 acres being irrigated downstream from Carlton. Land west of the river and downstream from Carlton is irrigated by several diversions from Libby, Gold, McFarland, Squaw, and Black Canyon Creeks; supplemental irrigation water comes through direct pumpage from the Methow River or from shallow dug wells close to the Methow River.

About 1,000 acres in the Methow River basin are irrigated from ground-water sources. In some areas located near the ends of canals and ditches, ground water is used only because the surface-water canals are not dependable. Ground water also is used for public supply, domestic and stock supply, and industrial supply. About 12 percent of the total ground-water pumpage is for domestic and public supplies, 47 percent is for irrigation, and 41 percent is for industrial supply, namely fish propagation.

The bulk of the water used for industries—mainly lumber processing—comes from surface water. The major industrial user is a lumber company in Twisp, which diverts about 6,000 acre-feet a year directly from the Methow River.

Potential for Future Water Development

Large quantities of fresh water are available from both surface- and ground-water sources in the Methow River basin but some problems on availability do exist. The basin's average annual precipitation of 32.1 inches provides a good supply for its streams which are well distributed over the entire basin. However, irrigation diversions may literally dry up some stream reaches in years of below average summer flows.

Use of water did not vary appreciably for many years in the past. Because of the easy access to surface water, as of 1971, only about 5.2 percent of the water used comes from underground sources.

Most of the fertile land in the basin can be irrigated economically from surface water. Future improvements of the canals and ditches, if made, will reduce the quantities of water wasted and will allow irrigation of much more land or the use of the water for other purposes. Although ground water is presently used for irrigation of only about 7 percent of the irrigated land, in some places it is used as an alternative because of the unreliability of some of the ditches and canals.

[2]Based on field data and discharge measurements made August-October 1971, and appropriated water rights as recorded by the State of Washington.

[3]Water diverted from Wolf Creek is stored in Patterson Lake from which it is released later during the irrigation season.

Information available on public-supply and residential wells indicates that the yield from ground-water reservoirs is good in areas adjacent to main streams, especially in that part of the basin north of Carlton and south of Winthrop, where the alluvium in the valley bottoms is probably several hundred feet thick. Yields from city wells located in the alluvial aquifers at Twisp and Winthrop are reported to be in excess of 1,000 (gallons per minute). As recharge to the alluvial aquifers comes primarily from streams, upstream diversions will have a direct bearing on water-table fluctuations. Water levels will rise in areas near canals and ditches, and will decline where streamflow is diminished by upstream diversions.

With the opening of the North Cross-State Highway, greater uses and demands of water are expected to occur in the Methow River basin, especially in the areas north of Winthrop suited for various recreational developments. However, in some mountainous areas much of this future demand for water is not likely to be satisfied by local streams and lakes or by readily available ground-water supplies. Such demands would require comprehensive localized studies to appraise the subsurface geology and availability of ground water, along with more detailed information on the amount and variability of streamflow.

PART B: TECHNICAL ANALYSIS OF HYDROLOGIC DATA

Surface Water

The first systematic measurements of streamflow in the Methow River basin were made during July 1903—September 1920 with the establishment of a staff gage with twice-daily readings on the Methow River about 1 mile above the mouth at Pateros. Similar measurements, involving establishment of staff gages that were read once daily, were made during October 1912—September 1913 on the Chewack River at Winthrop, January—October 1912 on the Methow River near Winthrop, and April 1920—September 1921 on the Chewack River just below Boulder Creek.

The first water-stage recorder was installed June 1919 at the gaging station on the Methow River at Twisp; this station was operated continuously until September 30, 1962. In all, streamflow has been measured at 90 locations on 49 streams, either continuously through the use of water-stage recorders or intermittently by miscellaneous discharge measurements. Miscellaneous streamflow measurements were made as early as November 1911 on the Chewack and Methow Rivers near Winthrop, and on the Twisp River at Twisp; since then most miscellaneous measurements were made to check flow in irrigation ditches and canals. Irrigation water was measured in 23 ditches and canals 218 times, mostly during the period 1920—1943. In 1971, continuous streamflow records were being collected on: (1) Andrews Creek near Mazama, station 12447390, which was established June 1968; (2) Methow River at Winthrop, station 12448500, established August 1971; (3) Beaver Creek below South Fork, station 12449600; established April 1960; and (4) Methow River near Pateros, station 12449950, established April 1959.

Indirect measurements to determine the annual peak flows have been made at nine crest-stage gage sites since the mid-1950's, and, following the 1948 historic flood, slope-area measurements of peak discharge were made on the Methow River and several of its tributaries. All crest-stage gages listed in table C1, except those for Bear Creek and Methow River tributary No. 1, are still being maintained. Also, altitudes of the surface of Alta Lake have been monitored continuously since November 1954.

Tables C1, C2, and C3 (in part C of this report) list all the data-collection sites, with their locations, drainage areas, and lengths and types of records collected. Table C1 contains a complete record of all miscellaneous streamflow measurements, including the indirect measurements; table C2 contains a complete record of all miscellaneous streamflow measurements, including the indirect measurements; table C2 contain those measurements made on irrigation ditches and canals; and table C3 contains monthly and annual discharges at all gaging stations in the Methow River basin. Daily discharge records through the 1965 water year for any of the gaging stations can be found in U.S. Geological Survey water-supply papers. Records for 1966-70 are in annual reports entitled "Water Resources Data for Washington, Part I."

The value of the miscellaneous measurements and (or) short-term records collected in the Methow River basin is realized in limited comparisons of discharges from different tributary basins. For example, a comparison of that part of the record collected on Chewack River at Winthrop (number 40 on fig. A1) and Methow River at Winthrop (number 41 on fig. A1) for the same period in 1912 is shown in the table below.

The lower discharge of the Chewack River (drainage area of 525 sq mi) relative to that of the Methow River upstream from Chewack River (drainage area of 480 sq mi) stems primarily from the difference in precipitation over the two drainages. Precipitation over the Chewack River basin ranges from 15 to 35 inches annually, compared to 15 to 80 inches over the Methow River basin above the confluence with the Chewack River (fig. A2).

Percentages that are comparable to those in the above table were noted from the pairs of miscellaneous measurements made once yearly during 1911, 1913, 1915, and 1971, and twice during 1919. The percentages from the measurements made in 1911, 1913, and 1915 are 56, 50, and 59, respectively, and those from the measurements made in 1919 are 32 and 43, respectively. Of the measurements made in 1919, the pair giving the 32-percent ratio was made during the peak of the irrigation season when diversion in the Chewack Canal alone was measured to be 43.0 cfs (table C2). The increase to the 43-percent ratio

Station Name	Number on Figure A1	Drainage Area (sq. mi.)	Monthly Mean Discharge During 1912 (cfs)					
			May	June	July	Aug.	Sept.	Oct.
Methow River near Winthrop	41	1,007	4,250	3,050	941	459	364	285
Chewack River at Winthrop	40	525	1,080	931	286	131	126	94.1
Methow River above Chewack River (discharge considered equivalent to the difference between the above two stations)	..	480	3,170	2,120	655	328	238	191
Percentage ratio of the monthly mean discharge of Chewack River at Winthrop to that of Methow River above Chewack River. Effects from upstream diversions are not accounted for.			34	44	44	40	53	49

could have resulted from reductions in diversion of irrigation water, as those measurements were made on October 2, 1919, when the irrigation season drew to a close. The low 29-percent ratio shown by measurements made September 25, 1971, may be analyzed on the same basis as those made in 1919 that showed the 32-percent ratio; the volume of irrigation water diverted from Chewack River above Winthrop was measured at 87.11 cfs on September 1, 1971 (table C2).

Some of the streamflow characteristics that need definition in the planning and development of surface-water resources—besides the maximum and minimum discharges of water available—are the frequencies and durations of selected flood discharges and low flows. The statistical tool used to relate recurrence intervals to peak flows, mimimum flows, or average flows for selected periods of time, is the frequency curve. Construction of the frequency curve was accomplished through a computer by use of the "Log Pearson Type III" distribution method. The use of this method was recommended by the Water Resources Council (1967). Annual peak flows, low flows, or average flows of selected durations were analyzed statistically, and the corresponding frequency curves, relating discharges to recurrence intervals, were computed and plotted.

It should be noted that recurrence intervals, as in all frequency studies, are averages and by no means imply any regularity of recurrence. For example, a 25-year flood occurring in any particular year may be followed by another such flood the very next year, or not for perhaps another 40 years. Thus, in the above example the intervals are an average probability calculated on a long-term basis. A better concept of the recurrence interval is the probability of occurrence. For example, a discharge having 20-year recurrence interval has a 5-percent (reciprocal of the recurrence interval) probability of being exceeded in any future year.

Table B1 presents a streamflow summary showing the mean, maximum, and minimum monthly and annual discharges recorded at four gaging stations having the longest periods of record. For the station on the Methow River at Twisp (12449500), the average discharge during the low-flow period of August through March is about 29 percent that of the average annual discharge and only about 12 percent of the average discharge during the high-flow period of April through July. The average discharge for May and June alone represents about 364 percent of that of the average annual discharge. These relationships do not vary appreciably for the other three stations listed in table B1.

The varying effects of temperature and precipitation on streamflow are shown in figure B1. Here, monthly average air temperature and precipitation, as recorded at the Winthrop Weather Service station (fig. A1), are compared with the frequency distribution of monthly mean discharges having a 2-year recurrence interval for the gaging station on the Methow River at Twisp (12449500).

As mentioned above, the high-flow period is shown to occur during the period April through July. As the bulk of precipitation, mostly in the form of snow, occurs during the period October-March, the factor generating high flows no doubt is temperature; streamflow starts to increase in April as temperature becomes high enough to initiate melting of the snowpack and, as temperature continues to rise, streamflow increases and reaches its peak during May and June. By the end of July almost all the snow generally has been melted, signaling the start of the low-flow season which lasts through March of the following year.

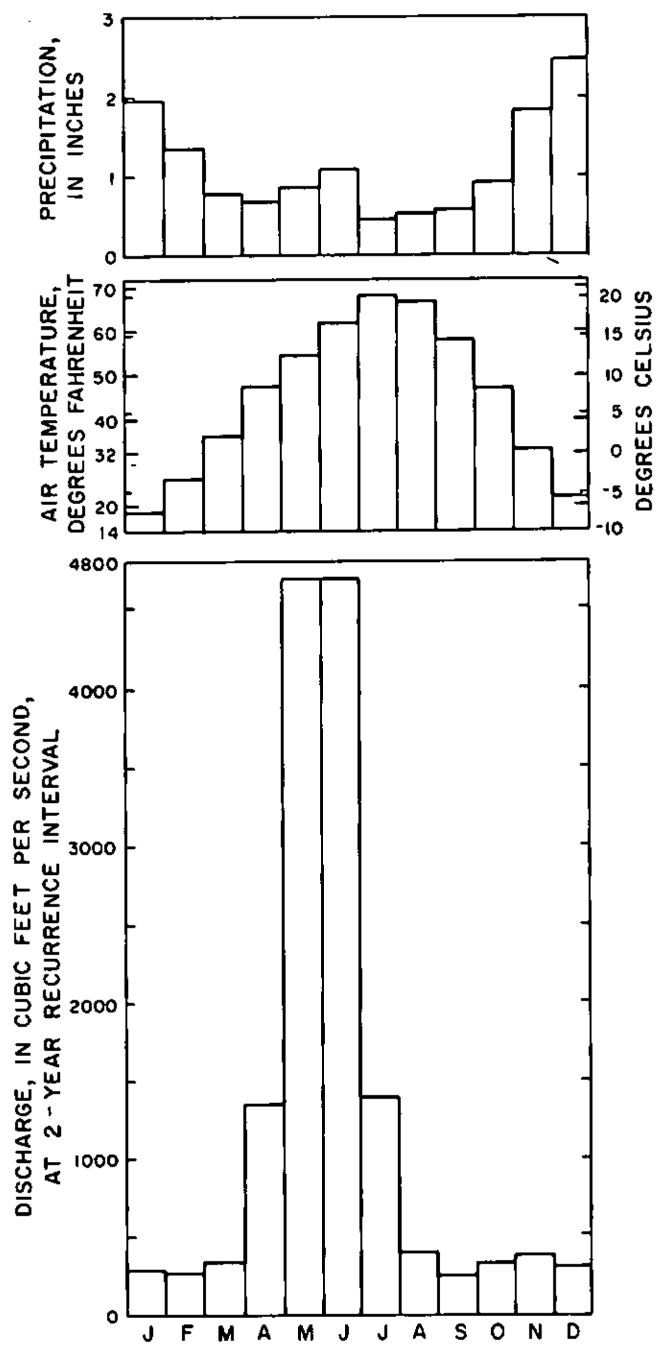


FIGURE B1. Frequency distribution of monthly mean discharge of Methow River at Twisp (12449500) for the period June 1919-September 1962, compared with the monthly average air temperature and precipitation at Winthrop for the period 1921-71. Climatological data from U.S. Weather Service.

TABLE B1.--Mean, maximum, and minimum monthly and annual stream discharges at four gaging stations in the Methow River basin

Gaging station: Official number and number on figure A1 (in parentheses)	Gaging station: Name and period of record	Characteristic	Discharge (cfs): October	November	December	January	February	March	April	May	June	July	August	September	Annual
12449500 (61)	Methow River at Twisp June 1919-Sept. 1962	Mean	416	466	394	311	317	416	1,594	4,850	4,818	1,641	459	305	1,327
		Maximum	1,383	1,183	923	578	958	1,773	7,692	9,515	11,030	4,392	1,205	727	2,231
		Minimum	189	233	208	178	183	204	180	1,550	846	289	162	148	467
12449600 (66)	Beaver Creek below South Fork, near Twisp Apr. 1960-Sept. 1970	Mean	7.74	6.94	6.23	6.25	6.50	6.91	14.1	62.9	49.8	16.3	8.18	6.30	16.2
		Maximum	15.3	9.49	8.85	9.15	8.09	11.2	27.3	145	136	33.0	11.6	8.09	25.5
		Minimum	4.75	4.87	4.84	4.68	5.00	5.00	6.99	22.3	18.0	7.42	4.89	4.60	10.1
12449950 (86)	Methow River near Pateros Apr. 1959-Sept. 1970	Mean	564	574	498	429	438	569	1,361	4,557	6,516	1,897	604	435	1,498
		Maximum	1,458	1,246	1,097	688	803	1,407	2,294	7,929	11,520	3,241	866	872	1,939
		Minimum	379	363	314	278	297	341	495	2,413	3,300	885	315	270	1,037
12450500 (89)	Methow River at Pateros July 1903-Sept. 1920	Mean	527	539	456	396	382	545	1,903	4,938	6,237	2,700	784	515	1,655
		Maximum	1,000	961	816	606	595	1,420	4,590	9,320	9,260	5,520	1,490	854	2,380
		Minimum	392	396	336	305	302	318	343	1,740	2,790	1,150	471	310	873

The frequency distribution of monthly mean discharge, depicted in figure B2 for Beaver Creek below South Fork near Twisp (12449600) and in figure B3 for the Methow River near Pateros (12449950), is similar to the flow pattern described for the Methow River at Twisp (12449500). (See figure B1.) However, the relative magnitudes of discharges for May and June are outstanding differences. For Beaver Creek, the monthly average discharge for May is larger than that for June probably because its 62-square-mile basin is at a lower altitude than the 1,301-square-mile basin of the Methow River upstream from Twisp, and the average depth of snow is less. Also, temperatures increase earlier and the snowpack melts in less time. At the station on the Methow River near Pateros (12449950), average discharges in May are less than those in June because between Twisp and Pateros some of the initial flood runoff is held temporarily in storage in the channel and flood plains, and some recharges the groundwater reservoir.

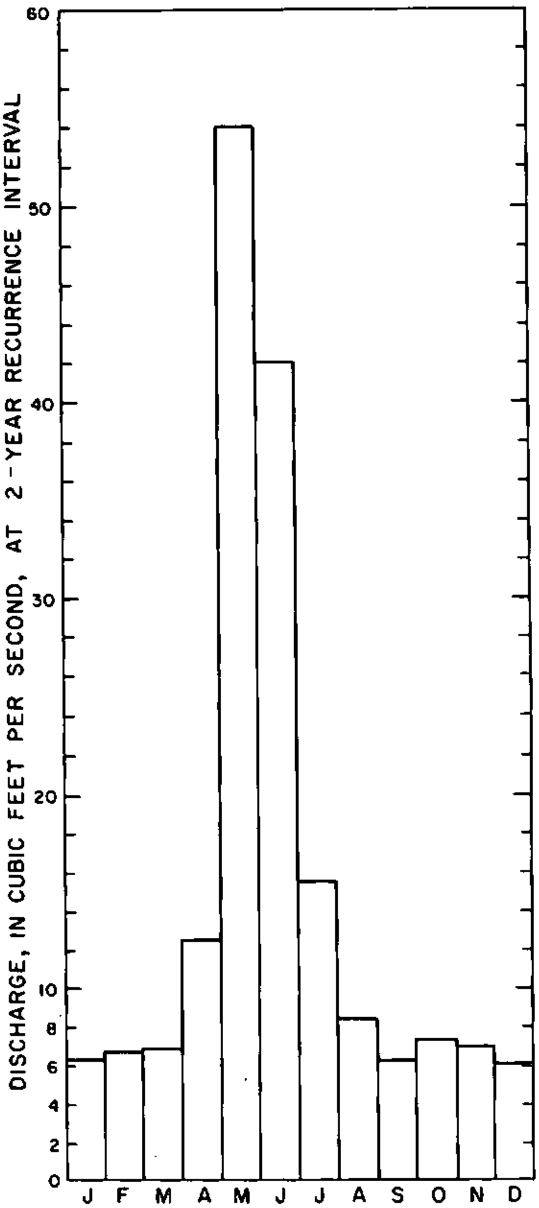


FIGURE B2. Frequency distribution of monthly mean discharge of Beaver Creek below South Fork, near Twisp (12449600), for the period Oct. 1, 1959-Sept. 30, 1970.

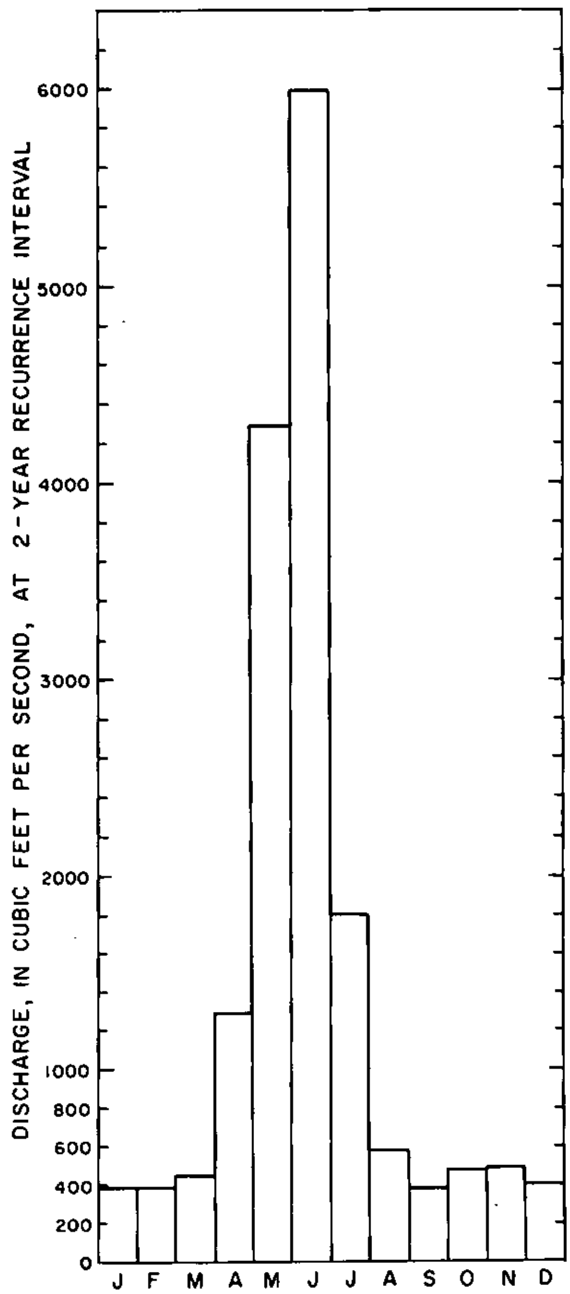


FIGURE B3. Frequency distribution of monthly mean discharge of Methow River near Pateros (12449650), for the period Oct. 1, 1958-Sept. 30, 1970.

Floods

Information on the magnitude and frequency of floods for streams in various parts of the Methow River basin is essential to flood-plain zoning and to the design for flood-control projects, bridge openings, channel modifications, and roadbed elevations. In this study, floods were analyzed only for the magnitude and frequency of maximum peak discharges in each year. Only three continuous-gaging stations and six crest-stage gages, located on eight streams, have adequate records to establish flood-frequency curves. The method of computation of magnitude and frequency of occurrence of floods is described by Riggs (1966) and by D. M. Thomas (written commun., 1968).

Flood-frequency curves included in this report were constructed by use of a computer program based on evaluation of the mean, standard deviation, and skew coefficient. An example of this, the flood-frequency curve for the Methow River at Twisp, is presented in figure B4. The curve for the station on the Methow River near Pateros, was adjusted at its upper end by comparing it with that for the Methow River at Twisp to compensate for the exclusion of the 1948 peak flow which falls outside the period of record for the station near Pateros.

Flood-frequency data, including those for the station on the Methow River at Twisp, appear in table B2. These data can be used to construct flood-frequency curves if graphical representation is desired.

To provide means of evaluating flood frequencies for ungaged streams, Bodhaine and Thomas (1964) developed regional relations and formulas for the upper Columbia River basin, including the Methow River basin. The relations and formulas are applicable mostly to streams with drainage areas larger than 20 square miles and should be used with caution for those with smaller drainage areas. The relations and formulas for streams in Washington are currently being updated by the Geological Survey.

Low Flows

Knowledge of the magnitude, frequency, and duration of minimum flows is important in hydrologic studies, and the low-flow-frequency curve based on gaging-station records is the best tool in use to acquire this knowledge. Construction of the 7-, 30-, 90-, 183- and 274-day low-flow-frequency curves for four gaging stations in the study area was done in accordance with Geological Survey standards (Riggs, 1968). Figure B5 shows a typical family of such curves for the Methow River at Twisp (12449500).

Low-flow-frequency data for the four stations presented in table B3 have been compiled from low-flow-frequency curves such as those in figure B5. The data are presented in a form convenient for use in studies of water availability during periods of low flows where storage facilities are not contemplated. However, if there is a need for within-year storage and if economic factors govern the design of a proposed storage facility, the data may be used to construct a frequency-flow mass curve that represents the total discharge available for a low-flow period of specified recurrence interval. In this case, the flow-mass-curve method (Rippl method) may then be applied to determine the storage required to maintain a constant draft rate (Ven Te Chow, 1964, p. 14-44 to 14-46). An example of the application of this method is shown in figure B6. The flow-mass curve in the figure, corresponding to 2-year recurrence interval (50-percent probability), is drawn smoothly through points obtained by plotting the volume of discharge for various durations of average minimum flow against the duration periods of 7, 30, 90, 183, and 274 days.

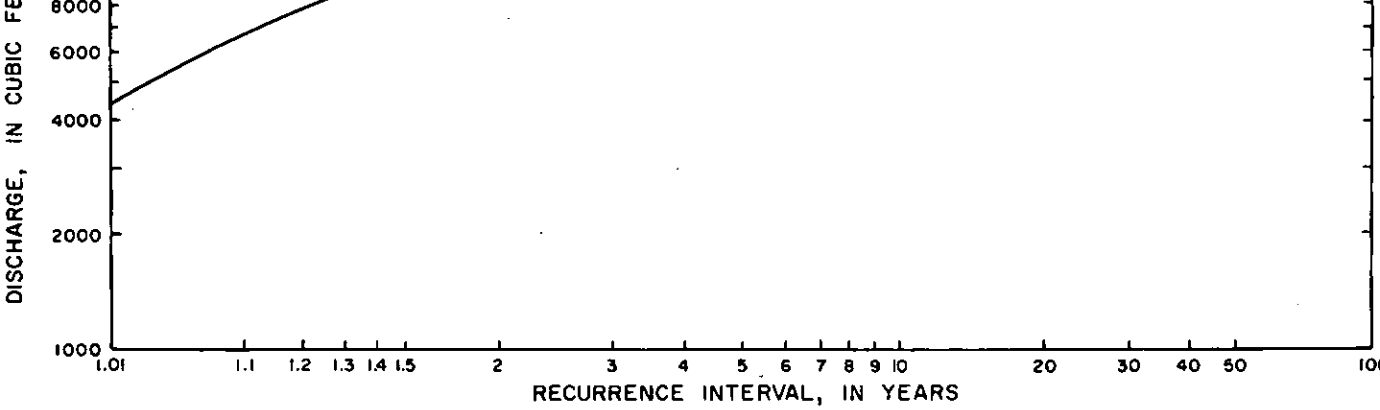


FIGURE B4. Flood-frequency curve for the Methow River at Twisp (1244950), for the period 1919-62.

TABLE B2.--Flood-frequency data for selected streams in the Methow River basin

Station number (table C1)		Station name	Ordinate of flood-frequency curve, in cubic feet per second, for indicated recurrence interval, in years									
			1.05	1.25	2.0	5.0	10	15	20	25	50	100
12447380	(6)	Pine Creek near Mazama	162	173	191	220	240	250				
12447400	(29)	Doe Creek near Winthrop	6.3	12	22	37	46	50	54	57		
12447430	(31)	Ortell Creek near Winthrop	20	35	56	78	88	93				
12448700	(49)	Williams Creek near Twisp	39	45	53	64	72	76				
12448900	(55)	Little Bridge Creek near Twisp	61	87	126	181	219	240				
12449500	(61)	Methow River at Twisp	5,830	8,310	12,100	17,800	21,800	24,100	25,900	27,200	31,300	35,700
12449600	(66)	Beaver Creek below South Fork, near Twisp	28	82	150	206	236	258	266			
12449790	(79)	Rainy Creek near Methow	45	55	72	96	115	126				
12449950	(86)	Methow River near Pateros	6,590	9,520	13,200	19,500	24,000	27,000	29,000	30,000		

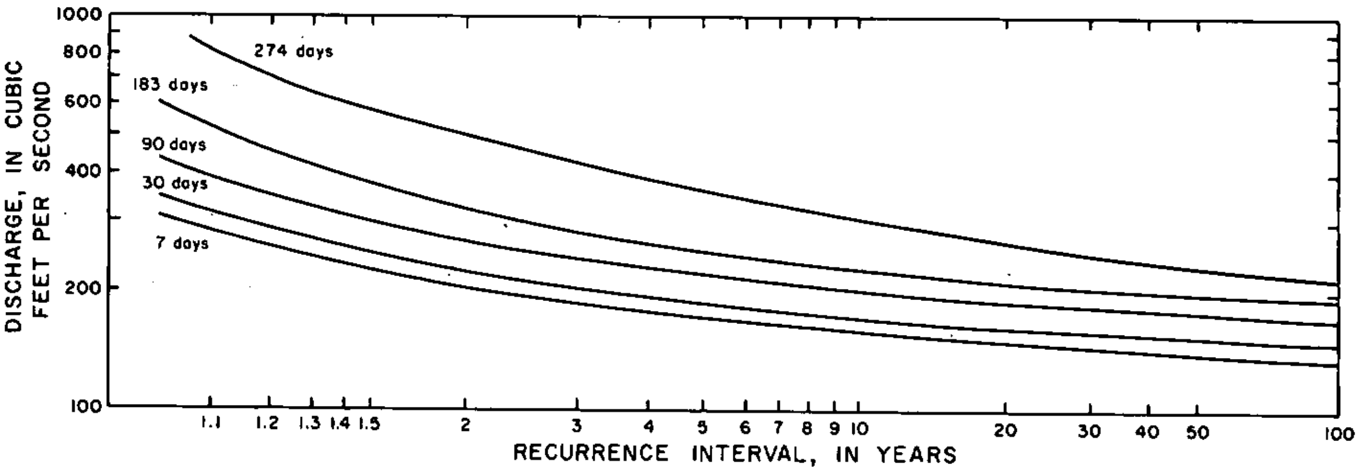


FIGURE B5. Magnitude and frequency of annual low flows of the Methow River at Twisp (12449500), for the period June 1919-September 1962.

TABLE B3.--Low-flow-frequency data for four gaging stations in the Methow River basin

Station number (fig.A1)	Station name	Number of consecutive days	Ordinate of low-flow frequency curve, in cubic feet per second, for indicated recurrence interval, in years									
			1.05	1.25	2.0	5.0	10	15	20	25	50	100
12449500 (61)	Methow River at Twisp	7	310	251	205	175	160	154	150	147	139	133
		30	345	278	226	189	172	165	161	159	153	149
		90	435	337	270	220	200	192	188	185	177	171
		183	600	435	325	253	230	219	212	208	199	194
		274	980	660	500	360	304	280	265	256	230	218
12449600 (66)	Beaver Creek below South Fork, near Twisp	7	6.8	5.4	4.3	3.5	3.1	3.0	2.9	--	--	--
		30	7.6	6.2	5.2	4.3	3.9	3.7	3.5	--	--	--
		90	8.6	7.0	6.0	5.0	4.6	4.5	4.4	--	--	--
		183	9.2	7.7	6.5	5.5	5.0	4.9	4.8	--	--	--
		274	11.5	9.3	8.0	6.5	6.0	5.7	5.5	--	--	--
12449950 (86)	Methow River near Pateros	7	410	350	300	260	245	243	240	239	--	--
		30	465	380	335	300	285	277	275	272	--	--
		90	630	465	360	320	305	300	300	299	--	--
		183	950	580	405	345	335	330	330	328	--	--
		274	1,250	850	630	540	465	443	430	420	--	--
12450500 (89)	Methow River at Pateros	7	420	365	310	260	240	229	220	218	--	--
		30	435	380	345	310	300	297	295	292	--	--
		90	550	450	380	335	320	312	310	309	--	--
		183	620	515	440	380	360	355	350	347	--	--
		274	1,250	900	740	600	540	515	500	490	--	--

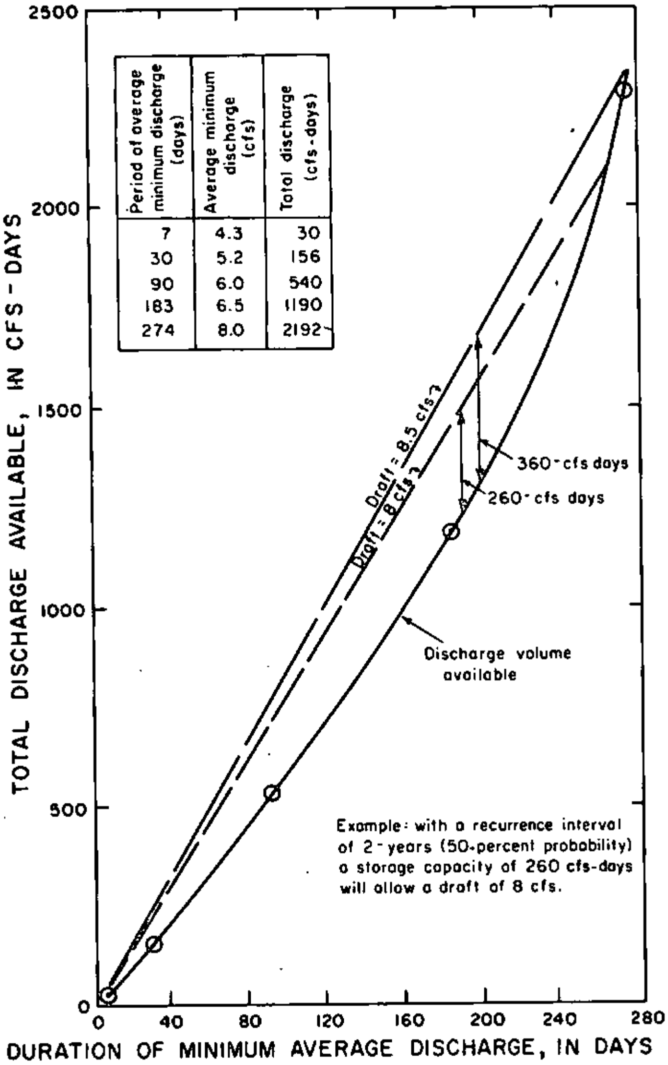


FIGURE B6.—Frequency flow-mass curve, at 2-year recurrence interval, and storage draft line for Beaver Creek below South Fork near Twisp (12449600). Average minimum discharges are from table B3.

The minimun-flow potentials of streams in the region are defined by four indexes which are based on the 7- and 183-day low-flow-frequency curves and mean annual discharge. These include the (1) low-flow-yield index, (2) slope index, (3) spacing index, and (4) base-flow index (Nassar, 1973, p. 22-26). These indexes reflect, in that reach of stream above each gaging station, the hydraulic relations between the stream and the adjacent reservoir of ground water, and (or) of water stored as snow.

Table B4 lists the four indexes for each of the four gaging stations in the project area, and includes the period of record, mean annual discharge, and drainage area for each of the four stations. The four indexes are briefly defined below table B4.

The low-flow-yield index is an excellent measure of average dry-weather flows of streams which depend largely on ground-water contribution. The slope index is a good indicator of variability of low flows over the years; the quantities of ground- and surface-water storage available in a basin influence the year-to-year variability of low flows, whereby large quantities of storage decrease the variations, and small quantities increase them. Stations on streams characterized by large amounts of storage produce frequency curves with flat slopes, and stations on streams having small quantities of storage will have frequency curves with steep slopes. The spacing index is influenced by the seasonal storage in the geologic materials underlying the basin above a gaging station. Stations whose basins are underlain by relatively impermeable materials and (or) small ground-water reservoirs will have widely spaced frequency curves and large spacing indexes, whereas those in basins underlain by permeable materials or large ground-water reservoirs will have small spacing indexes, as their frequency curves are closely spaced. The base-flow index is a measure of the contribution to total streamflow of ground water and (or) water resulting from melting of ice or snow; a high base-flow index indicates a relatively large contribution whereas a low index indicates a small contribution.

Streamflows recorded at the three stations along the main stem of the Methow River are affected by significant diversions for irrigation of 14,000 acres in the area. Therefore, the indexes for those stations, as they appear in table B4, do not always reflect the natural hydraulic relation between the Methow River and the adjacent ground-water reservoir. Undoubtedly the indexes for the Methow River at Twisp (12449500) would improve appreciably if the water diverted upstream was added to the flow past the station. For example, assume that the amount of water diverted from the Methow and Twisp Rivers upstream from station 12449500 and carried downstream from the station in canals is 87 cfs, which is the sum of (1) the average discharge of 54.0 cfs in the irrigation canal opposite the gaging station (number 42-A in table C2), and (2) the average discharge of 33.0 cfs in the Twisp-Methow Valley Irrigation District Canal half a mile west of Twisp (number 58-A in table C2). From this assumption, then, by adding the 87 cfs to the yield value of 205 cfs at 2-year recurrence interval in the 7-day low-flow-frequency curve, the yield index for station 12449500 would be 0.23 cfs per square mile instead of the calculated 0.16 cfs—an increase of about 44 percent. The effect from diversion should be of a lesser magnitude on the stations near Pateros (12449950) and at Pateros (12450500) because a large amount of the irrigation water diverted in the upper reaches of the basin seeps back into the river above the stations.

For the station on Beaver Creek (12449600)—whose flow is not affected by any regulation or diversion—the indexes in table B4 indicate that, although the capacity of the ground-water reservoir is small (yield index of 0.07 cfs per sq mi), the reservoir is characterized by high permeability, as indicated by the spacing index of 1.51 and the base-flow index of 0.25. Also, the slope index of 1.48 indicates small fluctuations in low-flow patterns from year to year.

In designing a water-supply project dependent on the low flows of a stream, the project planner must know the largest number of consecutive days a year that a predetermined given flow could be maintained. Any time the

TABLE B4.--Low-flow indexes at four gaging stations in the Methow River basin

Station number (fig.A1)	Station name	Period of record (water year)	Mean annual discharge (cfs)	Drainage area (sq mi)	Low-flow index[1/]			
					Yield	Slope	Spacing	Base-flow
12449500 (61)	Methow River at Twisp	1920-62	1,327	1,301	0.16	1.37	1.59	0.15
12449600 (66)	Beaver Creek below South Fork, near Twisp	1960-70	17.2	62.0	.07	1.48	1.51	.25
12449950 (86)	Methow River near Pateros	1959-70	1,540	1,772	.17	1.25	1.35	.19
12450500 (89)	Methow River at Pateros	1904-20	1,655	1,794	.17	1.41	1.42	.19

1/ The yield index is the ordinate of the annual 7-day minimum low-flow-frequency curve at a 2-year recurrence interval. It is expressed in cfs (cubic feet per second) per square mile to compare streams whose drainage areas differ in size.

The slope index is the ratio of the ordinates of the annual 7-day minimum low-flow-frequency curve at the 2- and 20-year recurrence intervals.

The spacing index is the ratio of the ordinates, at the 2-year recurrence interval, of the 183- and 7-day low-flow-frequency curves.

The base-flow index is the ratio between the yield index, in cfs, and the mean annual discharge.

flow in the stream falls below that predetermined value it will be considered deficient. Such information is depicted in figure B7, which contains frequency curves for maximum periods of deficient discharge for the Methow River at Twisp (12449500). Data in the following table—for the four stations for which adequate records have been maintained—were derived from curves similar to those in figure B7.

Magnitude and frequency of deficient discharge at selected stations

Gaging Station: Official Number and Number on Figure A1 (in parentheses)	Gaging Station: Name and Period of Record	Recurrence Interval (years)	Discharge, in cubic feet per second, below which flow remained continuous for length of minimum period indicated:			
			7-day	30-day	60-day	90-day
12449500 (61)	Methow River at Twisp June 1919-Sept. 1962	1.25	254	280	310	340
		2	207	225	250	272
		5	176	190	205	222
		20	152	168	180	190
		100	135	155	165	173
12449600 (66)	Beaver Creek below South Fork, near Twisp Apr. 1960-Sept. 1970	1.25	5.5	6.3	6.6	7.1
		2	4.3	5.2	5.6	6.0
		5	3.6	4.4	4.7	5.1
		10	3.2	3.9	4.3	4.6
		20	2.9	3.6	4.0	4.3
12449950 (86)	Methow River near Pateros Apr. 1959-Sept. 1970	1.25	355	385	430	465
		2	300	330	350	360
		5	265	300	312	325
		10	250	285	300	312
		20	240	275	290	305
12450500 (89)	Methow River at Pateros July 1903-Sept. 1920	1.25	360	385	420	450
		2	310	345	370	390
		5	262	305	325	340
		10	240	280	305	325
		20	225	265	290	310

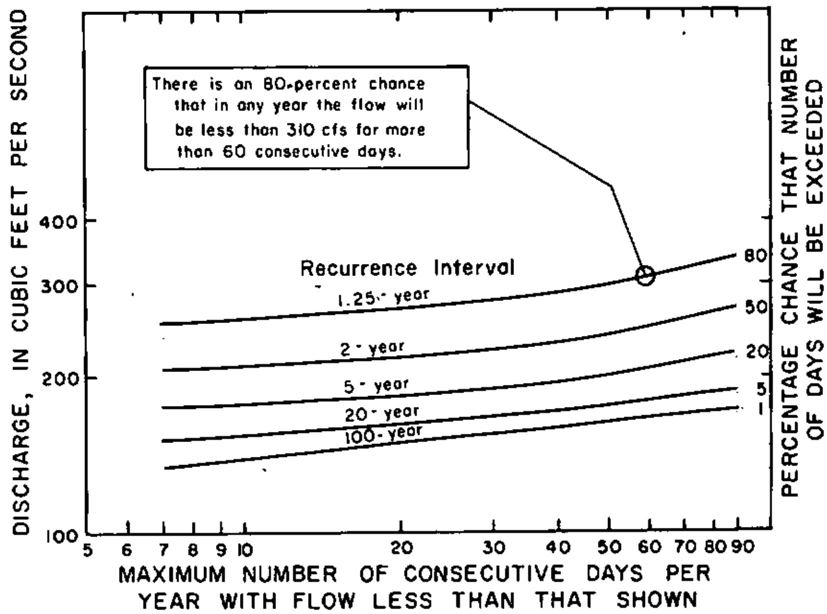


FIGURE B7.—Number of consecutive days of deficient discharge, Methow River at Twisp, for the period June 1919–Sept. 1962.

Flow Duration

Another way of showing graphically the streamflow variability at a gaging station is by the flow-duration curve which depicts the percentage of the total time of record that any discharge was equaled or exceeded. The flow-duration curve for a gaging station is constructed by (1) arraying, in order of magnitude, the daily discharges for a specific period of record, and (2) grouping daily discharges into classes or rates, and (3) computing the percentages of time that the various rates of discharges were equaled or exceeded. The discharges are then plotted against the corresponding percentages as shown in figure B8. The flow-duration curve in figure B8 indicates that the daily discharge past the gaging station on the Methow River at Twisp was equal to or exceeded 425 cfs 50 percent of the time during the period of record—June 1919 to September 1962—and that for 99 percent of that period the discharge was 165 cfs or more. Thus calculated, flow-duration data for three stations in the Methow River basin are presented in the following table.

The slope of the lower end of the flow-duration curve is a measure of the availability of streamflow during the low-flow period. A flat slope, as the one for the station on the Methow River at Twisp (fig. B8), indicates a dependable supply of water during dry-weather periods. It also indicates that a good hydraulic connection exists between the stream and the ground-water reservoir, and that ground water is the primary contributor to streamflow during the low-flow periods.

Percentage of time discharge equaled or exceeded that shown	Daily discharge, in cubic feet per second, at indicated gaging station and periods of record		
	Methow River at Twisp (June 1919-Sept. 1962)	Beaver Cr. below South Fork, near Twisp (Apr. 1960-Sept. 1970)	Methow River near Pateros (Apr. 1959-Sept. 1970)
1	10,400	150	12,400
2	8,500	118	10,400
5	6,600	74	7,400
10	3,900	40	4,200
20	1,870	17	1,750
30	890	10.7	880
40	570	8.6	620
50	425	7.7	505
60	347	7.0	440
70	297	6.4	395
80	258	5.7	355
90	221	4.9	320
95	198	4.4	295
98	177	3.9	274
99	165	3.6	258
99.5	157	3.4	245
99.9	155	2.9	220

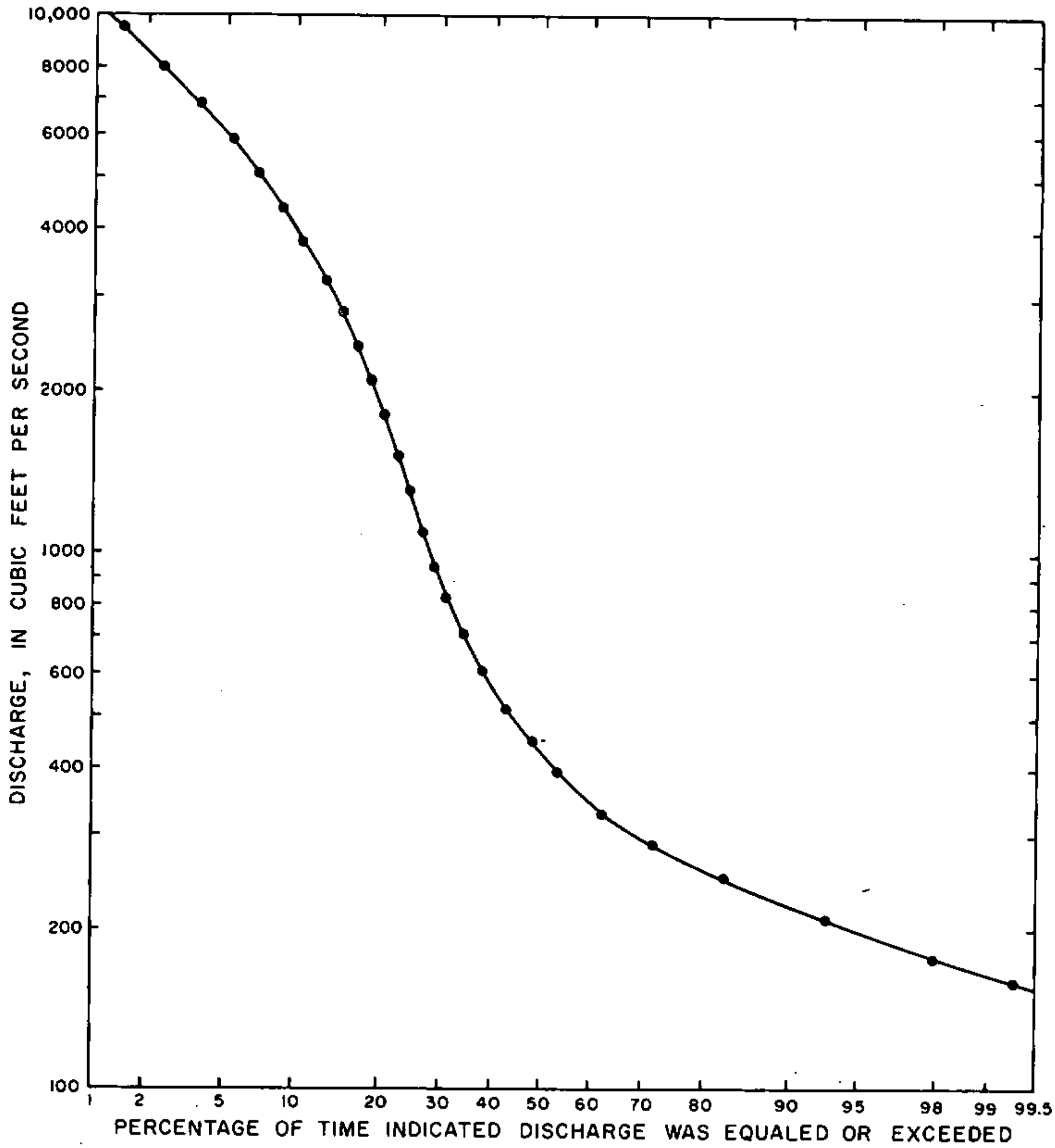


FIGURE B8. Flow-duration curve for the Methow River at Twisp (12449500), for the period June 1919-September 1962.

Ground Water

General Availability

The bedrock underlying the Methow River basin includes a variety of rock types, and its characteristics vary greatly from place to place. Although some bedrock is capable of yielding water to wells, yields generally are too low for bedrock to be considered an important source of water. In the types of bedrock common in the basin, water occurs only in random cracks or joints, and such occurrence is extremely unpredictable. Furthermore, the likelihood of encountering water-bearing cracks or joints in bedrock decreases with depth of penetration. Except in those cases where ground water is in such great demand that a very small supply justifies considerable expense and financial risk, the bedrock surface should be regarded as the floor of the ground-water reservoir.

Unconsolidated glacial and alluvial deposits are the principal water-bearing materials of the basin (fig. B9). Glacial till and remnants of glacial outwash occur as a thin and discontinuous mantle over much of the basin at intermediate altitudes—the higher peaks and ridges are bare bedrock, whereas the valley floors and adjacent river terraces are underlain by thick deposits of glacial and alluvial materials. The glacial deposits at intermediate altitudes comprise the soils of most of the commercially important forest areas of the basin, and are hydrologically important because they retard runoff during periods of heavy precipitation and contribute to the base flow of streams during dry periods. However, in many places they are too thin or too fine grained to yield appreciable amounts of water to wells.

Thick glacial deposits and alluvium—both in association with modern streams and as older alluvium in terraces along the major valley flood plains—are the principal sources of ground water in the Methow River basin. Although these water-bearing deposits underlie only about 4 percent of the total area of the basin (fig. B9), they are of great economic importance because they occur beneath the populated parts of the basin where ground water is most needed for domestic and irrigation use. Because ground water in appreciable quantities is known to occur only in or on the edge of stream valleys, the following discussion of the occurrence of ground water does not apply to upland parts of the basin except where they are specifically mentioned.

Areal Distribution

Southern part.—The lower reach of the Methow River valley—downstream from Carlton—is narrow, the terraces that flank it are discontinuous, and bedrock is exposed at many places both on the valley floor and in the valley walls. Ditches to supply irrigation water have not been constructed here and, although much land is irrigated by direct pumpage from the river, many irrigation wells are in use. Wells in this reach of the valley range in depth from about 20 feet to more than 80 feet and average about 50 feet. Where the bedrock is overlain by 50 feet or more of saturated unconsolidated deposits, properly constructed wells generally yield from 200 to 500 gpm (gallons per minute; table C4). Specific capacities of wells in this reach of the valley may be as great as 200 gpm per foot of drawdown. However, specific capacities of 80 to 100 gpm per foot of drawdown are much more common. The acreages irrigated from individual wells range from less than 10 to about 50.

Many shallow dug wells are used for domestic supplies. Water levels fluctuate with river stage and some of the shallow wells go dry during late summer. Numerous springs discharge at the line of contact between the bedrock and the overlying unconsolidated materials and are an important source of water for domestic use.

In the valleys of streams tributary to the lower reaches of the Methow River, alluvial deposits are thin and domestic water supplies are obtained from shallow dug wells and springs. However, ground water is not available in quantities sufficient for irrigation.

Central part.—The development of ground water in the central part of the Methow River basin—between Winthrop and Carlton—is about the same as in the southern part of the basin (fig. B9). Ground water is used to a considerable extent to supplement surface water for irrigation and for domestic use. In this area the valley of the Methow River is wider than in the areas to the north or south, and unconsolidated deposits are thicker. Also, two major tributaries—Twisp River and Beaver Creek—whose valleys contain appreciable ground water, enter the Methow River in this area.

Wells in the central part of the basin for which data are available range in depth from a few feet to more than 200 feet, and average about 55 feet (table C4). Wells constructed primarily for irrigation or public supplies have yields that range from about 100 to 1,300 gpm and average about 550 gpm. The specific capacities of wells in this area are about the same as those in the southern part of the valley—commonly about 100 gpm per foot of drawdown.

An area of several square miles in the Methow River valley just below the mouth of Beaver Creek is underlain by clay and fine sand locally more than 100 feet thick. Moderate yields of ground water can be obtained, but test drilling may be necessary to locate coarse sand and gravel beds that fill depressions or channels in the bedrock surface. Dug wells about 20 to 30 feet deep in the lower few miles of the Beaver Creek valley penetrate mostly gravel and produce enough water for limited irrigation. Data on ground-water availability in the Twisp River valley are limited to shallow wells. However, the yield of some of these shallow wells is great enough to indicate that properly located wells designed for maximum production would have substantial yields.

Northern part.—Ground-water development in the northern part of the Methow River basin—north and west of Winthrop—is chiefly along the floor of the Methow River valley, although a few wells have been drilled in the Chewack River valley and in the Early Winters Creek valley. Wells in this part of the basin range in depth from about 10 feet to about 200 feet and average about 60 feet. Most wells here were designed merely as sources of domestic supply and therefore meaningful data on the maximum yields obtainable are not available. However, drillers' logs of wells in this part of the basin (table C5) indicate that permeable materials in considerable thickness underlie the

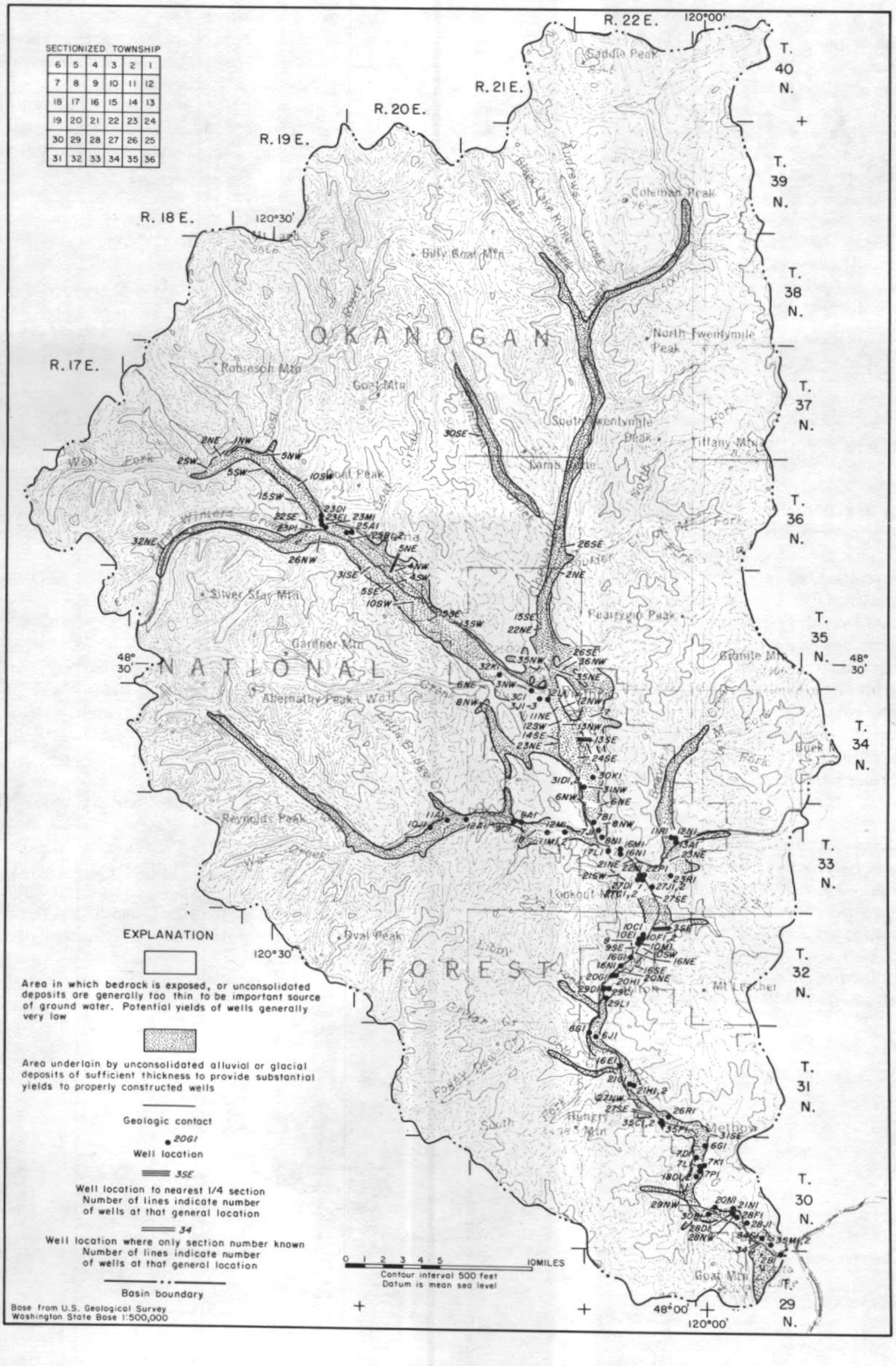


FIGURE B9. Location of wells and distribution of unconsolidated deposits in the Methow River basin.

valley floors, and properly constructed wells should have yields comparable to those in the central and southern parts of the basin.

Easier access to the northern part of the basin by opening of the North Cross-State Highway in September 1972, may lead to an increase in population and accompanying increase in water use. Building sites for some homes and resorts will undoubtedly be chosen on the basis of scenic views and access to recreational facilities and will result in increased demand for water supplies in areas where streams and accompanying alluvial deposits do not exist. Attempts to develop water supplies from bedrock aquifers may become more common.

Water-Management Considerations and Constraints

Supplies of fresh surface and ground water will continue to be adequate for presently projected use in the Methow River basin for many years to come. The basin contains many perennial streams that empty into the Methow River, and the broader, more populated parts of the valley floors are underlain in most places by unconsolidated sand and gravel which contain ground water in quantity sufficient for domestic and supplemental or standby irrigation use.

By far, irrigation is the principal water use in the Methow valley. About 95 percent of the irrigation water comes from streams and the remaining 5 percent comes from ground water. About 45 percent of the surface water diverted for irrigation is lost by leakage because the irrigation canals and ditches presently in use are unlined. In certain areas irrigators are turning to ground water irrigation because of the inadequacy of the surface-water conveyance system. In some areas, such as the Beaver Creek basin, most of the streamflow during the period June-September is being diverted for irrigation. This undoubtedly has greatly altered the low-flow characteristics of the streams below the points of diversions. Effective water management and rehabilitation of irrigation conveyance systems are needed to overcome problems of inadequate irrigation supplies and decreased streamflows.

The Methow River valley is adversely effected by extreme flooding and by the prevalence of subfreezing temperatures in winter. The flood of May-June 1948 resulted in severe damage along the Methow River; the towns of Winthrop, Twisp, and Methow were isolated, and six main highway bridges were destroyed or rendered useless. Parts of the highway were washed out, and hundreds of acres of orchards and many houses were destroyed. During the winter of 1968, temperatures reached to below -50°C (-58°F) and hundreds of acres of orchards were rendered useless.

Construction of flood-control projects along the Methow River or its two major tributaries, Chewack and Twisp Rivers, might achieve economical feasibility if the projects included power generation as a byproduct. Their value as purely flood-control projects might be doubtful because the recurrence interval of damage-causing floods appears to be greater then 50 years—the 1948 flood was the greatest since the historic flood of 1894.

With the opening of North Cross-State Highway—in September 1972—population in the Methow River valley probably will increase, primarily as a result of tourism and recreation, with a corresponding increase in water use.

To achieve an orderly development of the water resources of the area, additional surface- and ground-water data are needed to properly manage the resource, both on basinwide and local bases. While the total surface-water yield of the basin is fairly well defined, the individual yields of tributaries, except Beaver Creek, is not known. Discharge data are needed for Early Winters Creek, Chewack River, Twisp River and several of its tributaries, Libby Creek, and other tributaries in the southern part of the basin to determine surface- and ground-water yield from these subbasins. Major irrigation diversions should also be monitored to obtain a valid representation of the water resources available and their use in each basin.

Records of the chemical character of water in the Methow River basin are rather limited, but available data indicate that water generally is suitable for most common uses including drinking, according to standards recommended by the U. S. Public Health Service (1962). However, at least a reconnaissance study of water quality is needed, especially in the upper part of the basin where no data exist and where development is very likely to increase in the near future.

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Part C

BASIC DATA

TABLE C1.--Record of streamflow at data-collection sites in the Methow River basin

[Records for continuous discharge sites appear in table C3]

Number in fig. A1	Stream	Tributary to:	Location	Drainage area (sq mi)	Type of record 1/	Date	Discharge (cfs)
1	Methow River	Columbia River	Lat 48°39'32", long 120°32'27", in NW¼NE¼ sec.1, T.36 N., R.18 E., Okanogan County, at Ballard Campground, ¼ mile above Robinson Creek.	63.3	M	5-28-48 8-25-71	+4,130 49.6
2	Robinson Creek	Methow River	Lat 48°39'42", long 120°32'22", in SE¼SE¼ sec.36, T.37 N., R.18 E., Okanogan County, 20 feet above bridge and 0.2 mile above mouth.	19.7	M	8-25-71	9.88
3	Lost River	do.	Lat 48°39'19", long 120°30'18", in SE¼NW¼ sec.5, T.36 N., R.19 E., Okanogan County, 100 feet below highway bridge and ½ mile above mouth.	146	M	9-29-26 9-15-70 8-25-71	28.7 44.1 95.2
4	Gate Creek	do.	Lat 48°37'54", long 120°27'51", in SW¼SW¼ sec.10, T.36 N., R.19 E., Okanogan County, 220 feet above mouth at road crossing, 3.9 miles northwest of Mazama.	6.21	M	8-26-71	e1.0
5	Goat Wall Creek	do.	Lat 48°37'28", long 120°27'23", in SW¼NE¼ sec.15, T.36 N., R.19 E., Okanogan County, at road crossing 3.3 miles northwest of Mazama.	3.64	M	8-26-71	dry
6	Pine Creek	Early Winters Creek	Lat 48°34'48", long 120°37'33", in SE¼NE¼ sec.32, T.36 N., R.18 E., Okanogan County, at State Highway 20, 10 miles west of Mazama. (station no. 12447380).	4.63	C1	5- 6-66 6- 2-67 6-18-67 6-21-67 7-25-67 5-20-68 6- 5-68 5-23-69 6- 3-70 5-13-71 8-24-71	+180 110 134 +254 6.87 +187 75.4 +212 +191 +166 1.43
7	Silver Star Creek	do.	Lat 48°35'56", long 120°35'03", in NW¼NE¼ sec.27, T.36 N., R.18 E., Okanogan County, at State Highway 20, 400 feet above mouth.	2.60	M	8-24-71	4.32
8	Pekin Creek	do.	Lat 48°35'22", long 120°29'49", in SE¼ sec.29, T.36 N., R.19 E., Okanogan County, at State Highway 20.	1.51	M	8-24-71	.41
9	Cedar Creek	do.	Lat 48°35'17", long 120°28'13", in SE¼SE¼ sec.28, T.36 N., R.19 E., Okanogan County, ½ mile east of bridge on State Highway 20, and 500 ft above mouth.	30.7	M	8-24-71	28.2
10	Methow River	Columbia River	Lat 48°36'04", long 120°26'09", in SW¼SE¼ sec.23, T.36 N., R.19 E., Okanogan County, below Early Winters Creek, 1 mile northwest of Mazama.	335	M	1- 8-44	7.43
11	Methow River	Columbia River	Lat 48°35'24", long 120°24'19", in NE¼SE¼ sec.25, T.36 N., R.19 E., Okanogan County, 100-650 ft below highway bridge, ¼ mile southwest of Mazama.	342	M	8-21-42 9-25 9-10-67 9-15-70 8-26-71	76.8 15.4 51.0 24.4 145
12	Goat Creek	Methow River	Lat 48°34'53", long 120°22'42", in SW¼NW¼ sec.32, T.36 N., R.20 E., Okanogan County, 0.55 mile above mouth and 1.4 miles southeast of Mazama.	35.8	M	8-26-71	4.14

13	Methow River	Columbia River	Lat 48°34'19", long 120°22'55", east line SE¼ sec.31, T.36 N., R.20 E., Okanogan County, 1½ miles southeast of Mazama, and 0.2 mile above Little Boulder Creek.	346	M	9-25-42	Dry
14	do.	do.	Lat 48°34'12", long 120°21'55", NE¼NE¼ sec.5, T.36 N., R.20 E., Okanogan County, 750 ft above diversion dam for Dixon Pitt Ditch, 3 miles above Weeman Bridge (Fender Mill Bridge), and 2 miles southeast of Mazama.	391	M	1- 9-44	11.1
15	do.	do.	Lat 48°32'47", long 120°19'30", in NW¼SE¼ sec.10, T.35 N., R.20 E., Okanogan County, 850 ft above Weeman Bridge (Fenders Mill), and 5 miles southwest of Mazama.	403	M	1- 8-44	23.6
16	Hancock Creek	Methow River	Lat 48°31'59", long 120°19'31", in NW¼SE¼ sec.15, T.35 N., R.20 E., Okanogan County, 0.4 mile above mouth, just below culvert on dirt road.	1.79	M	8-26-71	20.3
17	Methow River	Columbia River	Lat 48°30'00", long 120°14'55", SW¼SW¼ sec.29, T.35 N., R.21 E., Okanogan County, 3½ miles above Winthrop.	424	M	9-30-26	112
18	Wolf Creek	Methow River	Lat 48°28'58", long 120°15'30", in NW¼NE¼ sec.6, T.34 N., R.21 E., Okanogan County, 1½ miles above mouth.	38.4	M	9-13-12	11.9
19	do.	do.	Lat 48°29'18", long 120°14'52", in NE¼SW¼ sec.32, T.35 N., R.21 E., Okanogan County, 3 miles northwest of Winthrop, at E.H. Perrow's home.	38.8	M	8-26-71 8-31	9.77 4.99
20	Methow River	Columbia River	Lat 48°28'33", long 120°11'01", in E½ sec.2, T.35 N., R.21 E., Okanogan County, just above Chewack River at Winthrop.	480	M	10- 2-13 8-13-15 8-13-19 10- 2	152 279 403 169
21	Chewack River	Methow River	Lat 48°47'37", long 120°03'37", in SE¼NW¼ sec.15, T.38 N., R.22 E., Okanogan County, 2½ miles above Andrews Creek and 23 miles north of Winthrop.	126	M	9-24-71	7.19
22	do.	do.	Lat 48°46'57", long 120°06'25", in NE¼NE¼ sec.20, T.38 N., R.22 E., Okanogan County, 75 ft above Andrews Creek, and 21.5 miles north of Winthrop.	135	M	9-15-70 8-31-71	3.28 17.6
23	Andrews Creek	Chewack River	Lat 48°49'23", long 120°08'42", in NE¼ sec.1, T.38 N., R.21 E., Okanogan County, on left bank 50 ft upstream from Blizzard Creek, 3.5 miles upstream from mouth, and 20 miles northeast of Mazama (station no. 12447390).	22.1	Gl	9-28-67 June 1, 1968-Sept.30,1970	3.48 Table C3
24	Blizzard Creek	Andrews Creek	Lat 48°49'22", long 120°08'40", in SE¼NE¼ sec. 1, T.38 N., R.21 E., Okanogan County, at mouth, 23 miles north of Winthrop.	.81	M	9-28-67	dry
25	Andrews Creek	Chewack River	Lat 48°46'59", long 120°06'31", in NW¼NE¼ sec.20, T.38 N., R.22 E., Okanogan County, 500 ft above mouth, and 22 miles north of Winthrop.	34.0	M	9-10-67 9-24-71	6.80 7.93

TABLE C1.--Record of streamflow at data-collection sites in the Methow River basin--Continued

Number in fig. A1	Stream	Tributary to:	Location	Drainage area (sq mi)	Type of record 1/	Date	Discharge (cfs)
26	Lake Creek	do.	Lat 48°45'18", long 120°08 07", in SW¼SE¼ sec.30, T.38 N., R.22 E., Okanogan County, 20 miles north of Winthrop, 0.35 mile above mouth.	53.5	M	8-31-71	17.2
						9-25	11.1
27	Buck Creek	do.	Lat 48°43'56", long 120°08'15", in NE¼SW¼ sec.6, T.37 N., R.22 E., Okanogan County, near mouth, and 18 miles north of Winthrop.	2.25	M	9-24-71	e.5
28	Twentymile Creek	do.	Lat 48°41'53", long 120°07'56", in SE¼SE¼ sec.18, T.37 N., R.22 E., Okanogan County, 50 ft above mouth, and 16 miles north of Winthrop.	41.5	M	9-24-71	1.06
29	Doe Creek	do.	Lat 48°40'41", long 120°08'01", in SW¼NE¼ sec.30, T.37 N., R.22 E., Okanogan County, 0.3 mile above mouth, and 14 miles north of Winthrop (station no. 12447400).	3.80	C1	12-10-56	+60.8
						5-26-58	+22.9
						5-28-58	9.46
						5- -59	18
						12-15-59	+44
						1961	+12
						1962	+5
						5-23-63	+22
						6- 8-64	+25
						5-19-65	+15
						5- 6-66	+7
						6-22-66	0.48
						4-11-67	.80
						6- 2-67	18.7
						6- 8-67	+26
						6-18-67	6.0
						5-20-68	+40
						5-22-68	17.5
						5- 9-69	+23
						3-29-70	+19
						5-13-71	+35
						8-31-71	.07
30	Falls Creek	Chewack River	Lat 48°38'04", long 120°09'21", in NE¼SW¼ sec.12, T.36 N., R.21 E., Okanogan County, 200-400 ft above mouth, and 11½ miles north of Winthrop.	27.1	M	9-22-20	7.49
						10-15-20	16.8
						8-31-71	9.39
						9-25-31	7.09
31	Ortell Creek	Eightmile Creek	Lat 48°39'50", long 120°15'13", in NE¼SE¼ sec.31, T.37 N., R.21 E., Okanogan County, 0.7 mile above mouth, and 14 miles northwest of Winthrop (station no. 12447430).	4.05	C1	4-19-65	+57
						5- 6-66	+36
						5-14-66	9.16
						6-22-66	1.00
						5-22-67	+64
						6-18-67	6.38
						10- 3-67	.56
						5-17-68	24.0
						5-20-68	+65
						5- 9-69	+55
						5-27-69	11.0
						5-22-70	+20
						6- 4-70	7.55
						5-13-71	+94
						8-31-71	.28

32	Eightmile Creek	Chewack River	Lat 48°36'15", long 120°09'17", in NW¼SW¼ sec.24, T.36 N., R.21 E., Okanogan County, 3-400 ft above mouth, and 9½ miles north of Winthrop.	46.2	M	9-22-20	13.8
						10-15-20	23.4
						9-25-71	20.1
33	Chewack River	Methow River	Lat 48°36'13", long 120°19'44", in NW¼SW¼ sec.24, T.36 N., R.21 E., Okanogan County, just below Eightmile Creek, and 9½ miles north of Winthrop.	381	M	9-29-48	+19,100
34	do.	do.	Lat 48°34'42", long 120°10'25", in SW¼NE¼ sec.35, T.36 N., R.21 E., Okanogan County, 800 ft above Boulder Creek, and 7.8 miles north of Winthrop.	384	M	9-29-26	45.4
35	Boulder Creek	Chewack River	Lat 48°34'43", long 120°09'49", in SW¼NW¼ sec.36, T.36 N., R.21 E., Okanogan County, about ½ mile above mouth and 7.8 miles north of Winthrop.	81.0	M	6-17-20	35.3
						6-30-20	26.2
						9-24-20	6.7
						10-15-20	6.57
						7-23-21	11.8
						9-29-26	7.18
						9-24-71	7.30
36	Chewack River	Methow River	Lat 48°34'41", long 120°10'26", in SW¼NE¼ sec.35, T.36 N., R.21 E., Okanogan County, 400 ft below Boulder Creek, and 7½ miles north of Winthrop (station no. 12447500).	465	G2	Apr. 1920-Sept.1921	Table C3
						10-13-21	72.5
						9-16-70	[b]16.0
37	do.	do.	Lat 48°33'54", long 120°10'37", in SW¼NE¼ sec.2, T.35 N., R.21 E., Okanogan County, 300 ft above highway bridge, 6.7 miles north of Winthrop.	466	M	8-20-42	58.9
						9-25-42	22.6
38	Cub Creek	Chewack River	Lat 48°33'09", long 120°11'35", in NW¼NE¼ sec.10, T.35 N., R.21 E., Okanogan County, 6 miles north of Winthrop, about 0.4 mile above mouth.	23.9	M	9-25-71	1.35
39	Pearrygin Lake outlet	do.	Lat 48°29'33", long 120°09'48", in SW¼NW¼ sec.36, T.35 N., R.21 E., Okanogan County, 40 ft below lake outlet,and about 1.3 miles northeast of Winthrop.	11.2	M	8- 4-44	8.57
40	Chewack River	Methow River	Lat 48°28'38", long 120°11'08", in SW¼NW¼ sec.2, T.34 N., R.21 E., Okanogan County, just above highway bridge at Winthrop (station no. 12448000).	525	G2	11-20-11	99.0
						9-11-12	170
						Oct. 1912-Sept. 1913	Table C3
						10- 2-13	76.5
						8-13-15	165
						8-13-19	127
						10- 2-19	72.5
						5-29-48	18,100
						9-10-67	34.3
						9-15-70	28.7
						9-25-71	53.8
41	Methow River	Columbia River	Lat 48°28'04", long 120°10'28", in SE¼SW¼ sec.2, T.34 N., R.21 E., Okanogan County, on left bank 0.4 mile downstream from Chewack Creek at Winthrop (station no. 12448500).	1,007	G1	11-20-11	276
						Jan.-Oct.1912	Table C3
						5-31-12	2,840
						9-10-12	388
						5-20-48	+35,000
						9-25-71	[a]239

TABLE C1.--Record of streamflow at data-collection sites in the Methow River basin--Continued

Number in fig. A1	Stream	Tributary to:	Location	Drainage area (sq mi)	Type of record1/	Date	Discharge (cfs)
42	Bear Creek	Methow River	Lat 48°27'05", long 120°08'53", in NE¼NE¼ sec.13, T.34 N., R.21 E., Okanogan County, 2½ miles southeast of Winthrop, and 0.6 mile above mouth.	18.4	C2	5-13-54	6.0
						6-12-55	16.0
						5-21-56	21.8
43	Twisp River	do.	Lat 48°27'25", long 120°34'10", in SE¼SW¼ sec.11, T.34 N., R.18 E., Okanogan County, ½ mile above North Creek, 22 miles northwest of Twisp.	12.6	M	10- 2-18	5.6
44	North Creek	Twisp River	Lat 48°27'16", long 120°33'20", in NE¼SE¼ sec.11, T.34 N., R.18 E., Okanogan County, ½ mile above mouth, and 22 miles northwest of Twisp.	6.72	M	9-23-71	4.80
45	Twisp River	Methow River	Lat 48°26'07", long 120°31'25", in NW¼NW¼ sec.19, T.34 N., R.19 E., Okanogan County, 75 ft above South Creek, and 19½ miles northwest of Twisp.	23.9	M	9-23-71	12.9
46	South Creek	Twisp River	Lat 48°26'05", long 120°31'25", in NW¼NW¼ sec.19, T.34 N., R.19 E., Okanogan County, at the mouth at South Creek campground, 19½ miles northwest of Twisp.	15.7	M	9-23-71	7.22
47	Scatter Creek	do.	Lat 48°25'58", long 120°31'35", in SW¼NE¼ sec.19, T.34 N., R.19 E., Okanogan County, 0.15 mile above mouth, and 19 miles northwest of Twisp.	3.05	M	9-23-71	[e].55
48	Reynolds Creek	do.	Lat 48°24'18", long 120°28'50", in SE¼NW¼ sec.33, T.34 N., R.19 E., Okanogan County, 800 ft above mouth, and 18 miles northwest of Twisp.	8.30	M	9-23-71	1.47
49	Willams Creek	do.	Lat 48°23'48", long 120°27'46", in NE¼NW¼ sec.3, T.33 N., R.19 E., Okanogan County, 17 miles west of Twisp and 750 ft above mouth (station no. 12448700).	3.15	C1	5-28-65	+52
						5- 3-66	+42
						5-13-66	15.4
						6-22-66	9.38
						6- 8-67	51.6
						6-18-67	52.1
						6-21-67	+78
						10- 3-67	.62
						5-17-68	16.8
						5-20-68	+54
						6- 5-68	28.8
						5-13-69	28.0
						5-23-69	+58
						6- 3-70	+42
						6- 4-70	39.6
						5-13-71	+61
						9-23-71	.48
50	Little Slate Creek	Twisp River	Lat 48°23'44", long 120°26'57", in NE¼NE¼ sec.3, T.33 N., R.19 E., Okanogan County, 1/3 mile above mouth, and 15 miles west of Twisp.	4.16	M	9-23-71	0.89
51	War Creek	do.	Lat 48°21'53", long 120°24'14", in NE¼NE¼ sec.13, T. 33 N., R.19 E., Okanogan County, 14 miles west of Twisp, and about 0.2 mile above mouth.	27.0	M	9-23-71	6.68

52	Eagle Creek	do.	Lat 48°21'29", long 120°23'35", in NE¼SW¼ sec.18, T. 33 N., R.20 E., Okanogan County, 1,000 ft above mouth, and 13 miles west of Twisp.	13.8	M	9-23-71	2.43
53	Buttermilk Creek	do.	Lat 48°21'43", long 120°20'12", in SW¼NW¼ sec.15, T.33 N., R.20 E., Okanogan County, 500 ft above mouth and 10 miles west of Twisp.	36.9	M	9-24-71	5.24
54	Canyon Creek	do.	Lat 48°21'55", long 120°20'21", in NE¼NE¼ sec.16, T.33 N., R.20 E., Okanogan County, 200 ft above mouth, and 10 miles west of Twisp.	8.89	M	9-23-71	.84
55	Little Bridge Creek	do.	Lat 48°24'23", long 120°19'39", near center of N½ sec. 34, T. 34 N., R.20 E, at road crossing 10 miles northwest of Twisp (station no. 12448900).	16.6	C1	4-19-65 5- 6-66 5-13-66 6-22-66 5-22-67 6- 8-67 10- 3-67 5-17-68 5-20-68 6- 5-68 5- 9-69 5-13-69 6- 3-70 6- 4-70 5-13-71	+91 +90 41.6 14.5 +199 93.8 2.92 55.0 +137 45.3 +147 91.8 +69 64.9 +220
56	do.	do.	Lat 48°22'45", long 120°17'05", in SE¼NW¼ sec.12, T.33 N., R.20 E., Okanogan County, 10 ft above mouth and 8 miles west of Twisp.	24.3	M	9-23-71	1.57
57	Twisp River	Methow River	Lat 48°22'45", long 120°15'04", in NW¼NW¼ sec. 8, T.33 N., R.21 E., Okanogan County, 6 miles above mouth, and just below Myer Creek.	216	M	8-11-19	187
58	Poorman Creek	Twisp River	Lat 48°22'03", long 120°11'58", in SE¼SW¼ sec.10, T.33 N., R.21 E., Okanogan County, 900 ft above mouth, and 4 miles west of Twisp.	12.2	M	9-24-71	1.04
59	Twisp River	Methow River	Lat 48°22'07", long 120°08'18", in SW¼SW¼ sec.7, T.33 N., R.22 E., Okanogan County, 1 mile above mouth, and 0.6 mile west of Twisp, below all diversions.	245	M	8-15-15	11.5
60	Twisp River	do.	Lat 48°22'06", long 120°07'13", in SW¼SW¼ sec.8, T.33 N., R.22 E., Okanogan County, 1,000 ft above mouth at Twisp.	247	M	11-21-11 6- 1-12 9-13-12 10- 3-13 8-11-19 5-29-48 9-22-71	75.6 76.2 50.0 50.1 113 9,440 23.8
61	Methow River	Columbia River	Lat 48°21'40", long 120°06'50", in NW¼ sec.17, T.33 N., R.22 E., Okanogan County, on left bank ¼ mile downstream from Twisp River, and 0.3 mile east of center of Twisp (station no. 12449500).	1,301	G2	10- 1-18 June 1919- Sept. 1962	249 Table C3
62	Volstead Creek	Beaver Creek	Lat 48°26'32", long 120°01'04", in SE¼SE¼ sec.13, T.34 N., R.22 E., Okanogan County, 300 ft above mouth, and 8 miles southeast of Winthrop.	4.91	M	5-19-56	19.4

TABLE C1.--Record of streamflow at data-collection sites in the Methow River basin--Continued

Number in fig. A1	Stream	Tributary to:	Location	Drainage area (sq mi)	Type of record[1/]	Date	Discharge (cfs)
63	South Fork Beaver Creek	do.	Lat 48°26'20", long 119°58'55", near N¼ corner sec.20, T.34 N., R.23 E., Okanogan County, 30 ft above Middle Fork and 8 miles northeast of Twisp.	13.7	M	8- 2-61	4.49
						9-30-61	1.66
64	Middle Fork Beaver Creek	South Fork Beaver Creek	Lat 48°26'22", long 119°58'54", near N½ corner sec.20, T. 34 N., R.23 E., 30 ft above mouth and 8 miles northeast of Twisp.	11.8	M	8- 2-61	3.61
						9-30-61	1.82
65	South Fork Beaver Creek	Beaver Creek	Lat 48°26'07", long 120°01'06", in NE¼NE¼ sec.24, T.34 N., R.22 E., Okanogan County, 100 ft above mouth and 7 miles northeast of Twisp.	27.1	M	5-19-56	109
						8- 4-56	8.73
						9-12-56	5.56
						11-27-56	5.61
						4-24-57	9.74
						5-16-57	55.2
						6-21-57	25.5
						7-22-57	9.56
						8-22-57	6.59
						9-30-57	4.40
						11-13-57	5.19
						5-28-58	60.9
						6-26-58	15.8
						7-29-58	8.28
						8-23-58	4.12
						9-28-58	3.90
						10-24-58	3.45
						9-29-59	5.90
						8- 2-61	5.27
						9-30-61	5.21
						9-11-67	4.18
						9-16-70	0
66	Beaver Creek	Methow River	Lat 48°26'01", long 120°01'25", in SW¼NE¼ sec.24, T.34 N., R.22 E., Okanogan County, 300 ft downstream from South Fork Beaver Creek and 7 miles northeast of Twisp (station no. 12449600).	62.0	G1	4-24-57	17.4
						5-16-57	186
						6-21-57	50.0
						7-22-57	22.9
						8-24-57	13.1
						9-30-57	8.99
						11-13-57	10.0
						12-14-57	10.3
						5-28-58	207
						6-26-58	44.5
						7-29-58	21.2
						8-23-58	9.93
						9-28-58	8.81
						10-24-58	9.32
						9-29-59	11.6
						Apr. 1960-Sept. 1970	Table C3

67	do.	do.	Lat 48°25'22", long 120°02'13", in NE¼NE¼ sec.26, T.34 N., R.22 E., Okanogan County, at private bridge, 5½ miles northeast of Twisp.	64.1	M	8-16-15	6.18
						5- 4-41	124
						5-21-41	55.5
						6- 5-41	48.2
						8-15-41	14.8
						9-24-41	13.4
						10-20-41	12.9
68	do.	do.	Lat 48°23'52", long 120°02'37", in SW¼SE¼ sec.35, T.34 N., R.22 E., Okanogan County, 2.8 miles north of State Highway 20, on left bank 3 miles downstream from South Fork (station no. 12449700).	68.1	G2	June 1956-Sept. 1960	Table C3
69	Frazer Creek	Beaver Creek	Lat 48°21'54", long 120°00'46", in NE¼NE¼ sec.13, T.33 N., R.22 E., Okanogan County, above small wooden bridge 50 ft south of State Highway 20, and 0.9 mile above Beaver Creek road.	19.6	M	9- 3-71	2.19
70	do.	do.	Lat 48°23'36", long 120°02'43", in SW¼NW¼ sec.13, T.33 N., R.22 E., Okanogan County, at road bridge, about ¼ mile above mouth.	21.1	M	5-14-56	7.04
						7-17-56	3.32
						8- 4-56	5.22
						9-12-56	2.28
						4-24-57	5.04
						5-16-57	9.54
						6-21-57	5.01
						7-22-57	4.25
						8-22-57	1.74
						9-30-57	3.81
						11-13-57	3.23
						5-28-58	9.30
						6-26-58	4.16
						7-30-58	5.48
						8-25-58	1.76
						9-28-58	3.52
71	Beaver Creek	Methow River	Lat 48°21'20", long 120°02'15", in SE¼SE¼, sec.14, T.33 N., R.22 E., Okanogan County, at private farm bridge below Frazer Creek.	106	M	7-17-56	13.9
						9-12-56	11.0
						4-24-57	27.6
						5-16-57	181
						7-22-57	13.6
						9-30-57	4.91
						11-13-57	16.7
						5-27-58	159
						6-27-58	41.0
						7-30-58	13.5
						8-25-58	2.55
						9-28-58	13.9
72	do.	do.	Lat 48°20'53", long 120°02'34", in SW¼NE¼ sec.23, T.33 N., R.22 E., Okanogan County, at Loup Loup road 3½ miles east of Twisp.	108	M	8- 4-56	1.31
73	do.	do.	Lat 48°19'43", long 120°03'36", in NE¼SE¼ sec.27, T.33 N., R.22 E., Okanogan County, near mouth at State Highway 16, 4 miles southeast of Twisp.	111	M	2-15-56	15.1
						3-15-56	11.2
						4-26-56	102
						5-19-56	320
						7-17-56	4.86
						8- 4-56	.38
						9-12-56	7.03

TABLE C1.--Record of streamflow at data-collection sites in the Methow River basin--Continued

Number in fig. A1	Stream	Tributary to:	Location	Drainage area (sq mi)	Type of record[1]	Date	Discharge (cfs)
73 (continued)						4-25-57	21.8
						5-16-57	180
						6-21-57	42.5
						6-27-58	30.7
						9-28-58	14.7
74	Texas Creek	Methow River	Lat 48°14'53", long 120°05'57", on line between secs. 28 and 29, T.32 N., R.22 E., Okanogan County, ¾ mile above mouth, and about ½ mile east of Carlton.	10.9	M	9-22-71	[e].1
75	Libby Creek	do.	Lat 48°15'07", long 120°09'28", in NE¼NW¼ sec.25, T.32 N., R.21 E., Okanogan County, 2.7 miles above mouth, and 2.5 miles west of Carlton.	38.0	M	9-22-71	7.03
76	Middle Fork Gold Creek	Gold Creek	Lat 48°10'57", long 120°10'34", in SE¼SW¼ sec.12, T.31 N., R.21 E., Okanogan County, at road crossing about 1 mile above mouth, 5.5 miles southwest of Carlton.	8.16	M	9-11-67	6.45
						9-16-70	3.47
77	Gold Creek	Methow River	Lat 48°11'03", long 120°07'03", in NW¼SW¼ sec.17, T.31 N., R.22 E., Okanogan County, 30 ft below concrete bridge and 700 ft east of South Fork Gold Creek road, 4.7 miles south of Carlton.	60.6	M	9-22-71	6.76
78	Rainy Creek	South Fork Gold Creek	Lat 48°08'47", long 120°10'30", in SE¼NW¼ sec.35, T.31 N., R.21 E., Okanogan County, ½ mile above mouth and 8 miles west of Methow.	7.87	M	5-29-48	+20,000
79	do.	do.	Lat 48°08'50", long 120°10'00", in NE¼NE¼ sec.35, T.31 N., R.21 E., Okanogan County, 200 ft upstream from South Fork Gold Creek and 7.5 miles west of Methow (station no. 12449790).	8.51	Cl	5-29-48	+20,000
						5-28-65	+62
						5- 6-66	+48
						5-17-66	12.0
						6-21-66	12.2
						6- 9-67	51.1
						6-21-67	+128
						10- 3-67	3.05
						5-17-68	23.0
						5-20-68	+97
						5-23-69	+83
						5-22-70	+64
						6- 3-70	34.9
						5-13-71	+61
						5-13-71	44.4
80	South Fork Gold Creek	Gold Creek	Lat 48°10'50", long 120°07'07", in SW¼SW¼ sec.17, T.31 N., R.22 E., Okanogan County, 2,000 ft above mouth, and 4.8 miles south of Carlton.	27.8	M	9-22-71	3.80
81	McFarland Creek	Methow River	Lat 48°08'33", long 120°05'14", in NE¼SE¼ sec.32, T.31 N., R.22 E., Okanogan County, 2.4 miles above mouth and 11 miles northwest of Pateros.	10.6	M	9-21-71	1.77
82	Squaw Creek	do.	Lat 48°05'21", long 120°01'32", in NE¼NW¼ sec.24, T.30 N., R.22 E., Okanogan County, ½ mile above mouth, and 6 miles northwest of Pateros.	15.7	M	9-21-71	.83

83	Black Canyon Creek	do.	Lat 48°04'11", long 120°01'11", in NW¼SE¼ sec.25, T.30 N., R.22 E., Okanogan County, ¾ mile above mouth and 5.25 miles northwest of Pateros.	24.3	M	9-21-71	1.15
84	Methow River tributary no. 1	do.	Lat 48°04'10", long 120°00'00", in NW¼ sec.30, T.30 N., R.23 E., Okanogan County, at State Highway 153, 3.7 miles south of Methow, 4.8 miles west of Pateros (station no. 12449900).	.77	C2	1954 10-26-55 3-18-57 1958 1959 1960-69	No evidence of flow +18.5 +15.9 No evidence of flow Less than 1.0 cfs No evidence of flow
85	Methow River tributary no. 2	do.	Lat 48°04'24", long 119°59'43", in SE¼NE¼ sec.30, T.30 N., R.23 E., Okanogan County, at State Highway 153, 4.2 miles south of Methow, 4.6 miles west of Pateros (station no. 12449910).	1.00	C1	1970 1971	Less than 1.0 cfs No evidence of flow
86	Methow River	Columbia River	Lat 48°04'39", long 119°59'02", in SE¼SW¼ sec.20, T.30 N., R.23 E., Okanogan County, on right bank 1.4 miles downstream from Black Canyon Creek, and 4.3 miles northwest of Pateros (station no. 12449950).	1,772	G1	Apr. 1959-Sept. 1970	Table C3
87	do.	do.	Lat 48°04'29", long 119°57'20", in NW¼NE¼ sec.28, T.30 N., R.23 E., Okanogan County, at State Highway 153, 3 miles northwest of Pateros	1,777	M	5-29-48 3-16-56 4-26-56 5-23-56 7-24-56 8- 5-56 9-13-56 10-17-56 4-23-57 6-22-57 7-20-57	+46,700 400 7,090 15,700 2,200 1,100 634 675 1,790 2,450 949

TABLE C1.--Record of streamflow at data-collection sites in the Methow River basin--Continued

Number in fig.A1	Stream	Tributary to:	Location	Drainage area (sq mi)	Type of record[1]	Date	Discharge (cfs)
87 (continued)						8-23-57	513
						9-24-57	401
						11-12-57	431
						2-25-58	720
						5- 4-58	3,170
						6-25-58	2,790
						7-30-58	844
						9-29-58	425
						10-26-58	531
88	Alta Lake	Methow River	Lat 48°01'15", long 119°56'33", in SW¼SW¼ sec.10, T.29 N., R.23 E., Okanogan County, on west shore 0.3 mile south of Alta Lake State Park, and 2.5 miles northwest of Pateros (12450000).	5.01	L	Nov. 1954-Sept. 1970	Table C3
89	Methow River	Columbia River	Lat 48°02'50", long 119°54'40", in NE¼ sec.2, T.29 N., R.23 E., Okanogan County, on left bank at Pateros, ¼ mile upstream from highway bridge, and 1 mile above mouth (station no. 12450500).	1,792	G2	July 1903-Sept. 1920	Table C3
90	do.	do.	Lat 48°03'00", long 119°54'06", in SW¼ sec.36, T. 30 N., R.23 E., Okanogan County, 500 ft below highway bridge on U.S. Highway 97 at Pateros.	1,794	M	3-11-55	377
						2-14-56	370
						12-13-57	410
						1-24-58	379
						8-22-58	362

Note: e, discharge estimated; +, peak discharge; a, mean daily discharge; b, measurement of base flow.

[1] Type of record: M, miscellaneous discharge measurements; C1, active crest-stage gage, C2, discontinued crest-stage gage; G1, active continuous discharge record gage; G2, discontinued continuous discharge record gage; L, lake-stage gage.

TABLE C2.--Record of discharge measurements made on irrigation ditches and canals in the Methow River basin

Number in fig.A1	Name of ditch or canal	Source of diversion	Location of measurement site	Date	Discharge (cfs)	Remarks
5-A	Kagle Ditch	Left bank Methow River	Lat 48°36'05", long 120°25'50", in SW¼SE¼ sec.22, T.36 N., R.19 E., Okanogan County, 50 ft below intake and 1.3 miles northwest of Mazama.	8-29-42 7-13-44	2.37 5.96	Not in operation at present.
9-A	Early Winters Ditch	Right bank Early Winters Creek	Lat 48°35'45", long 120°26'43", in SW¼NW¼ sec.26, T.36 N., R.19 E., Okanogan County, 2 miles west of Mazama.	8-29-42 8-25-71	22.9 22.6	
14-A	Kumm-Holaway Ditch	Right bank Methow River	Lat 48°33'51", long 120°21'42", in SE¼NE¼ sec.5, T.35 N., R.20 E., Okanogan County, 0.65 mile above Fawn Creek.	8-25-71	2.77	
14-B	McKinney Mountain Ditch	do.	Lat 48°33'44", long 120°21'20", in NW¼SW¼ sec.4, T.35 N., R.20 E., Okanogan County, 0.35 mile northwest of Fawn Creek.	8-25-71	23.1	
15-A	Unnamed ditch	Left bank Methow River	Lat 48°32'37", long 120°19'18", in SE¼SE¼ sec.10, T.35 N., R.20 E., Okanogan County, 300 ft below Weeman Bridge (Fenders Mill), on State Highway 20.	8-24-71	24.6	
17-A	do.	Right bank Little Wolf Creek	Lat 48°28'23", long 120°17'00", in NW¼SE¼ sec.1, T.34 N., R.20 E., Okanogan County, 800 ft southeast of downstream end of siphon which carries water from Wolf Creek.	8-31-71	.18	No water in siphon.
31-A	Eightmile Ditch	Right bank Eightmile Creek	Lat 48°36'16", long 120°10'03", in NE¼SE¼ sec.23, T.36 N., R.21 E., Okanogan County, about 1/3 mile above mouth of Eightmile Creek and 9½ miles north of Winthrop.	8-20-42 8-31-71	5.91 2.91	
36-A	Skyline Ditch	Right bank Chewack River	Lat 48°34'32", long 120°10'25", in NW¼SE¼ sec.35, T.36 N., R.21 E., Okanogan County, 0.2 mile below Boulder Creek, about 7½ miles north of Winthrop.	9- 1-71	18.7	
36-B	Jones-Boulder Ditch	Left bank Chewack River	Lat 48°34'25", long 120°10'18", in SW¼SE¼ sec.35, T.36 N., R.21 E., Okanogan County, 7.2 miles north of Winthrop at Game Dept. Camp.	9- 1-71	16.2	
36-C	Chewack Canal	Left bank Chewack River	Lat 48°33'56", long 120°10'31", in SE¼NW¼ sec.2, T.35 N., R.21 E., Okanogan County, 6.7 miles north of Winthrop.	9-11-12 10- 2-13 8-12-15 8-13-19 8-20-42 9-25-42 9- 1-71	5.23 10.7 11.5 43.0 57.1 24.2 36.0	

TABLE C2.--Record of discharge measurements made on irrigation ditches and canals in the Methow River basin--Continued

Number in fig. A1	Name of ditch or canal	Source of diversion	Location of measurement site	Date	Discharge (cfs)	Remarks
39-A	Fulton Ditch	Right bank Chewack River	Lat 48°28'55", long 120°10'46", in NE¼NW¼ sec.2, T.34 N., R.21 E., Okanogan County, ¼ mile north of Winthrop.	9-11-12	16.7	Above spillway.
				10-12-13	14.9	Do.
				8-13-15	15.8	Do.
				8-20-42	19.3	Do.
				9-26-42	23.6	Do.
				9-11-12	3.01	Below spillway.
				10-12-13	5.53	Do.
				9- 1-71	13.3	Do.
41-A	Foghorn Ditch	Left bank Methow River	Lat 48°28'16", long 120°10'54", in SW¼SW¼ sec.2, T.34 N., R.21 E., Okanogan County, 200 ft below bridge over ditch (southeast of hatchery), and ¼ mile southwest of bridge over Methow River at Winthrop.	8-27-71	20.7	
42-A	Methow Valley Irrigation District Canal	do.	Lat 48°25'03", long 120°08'23", in SW¼NW¼ sec.30, T.34 N., R.22 E., Okanogan County, 4 miles southeast of Winthrop at southeast end of landing strip.	8-21-42	83.0	
				9-28-42	73.9	
				8- 4-44	110	
				9- 1-71	51.9	
	do.	do.	Sec. 31, T.34 N., R.22 E., 2.8 miles northwest of Twisp.	5-29-37	49.1	
				7- 7-37	42.4	
	do.	do.	NW¼ sec.8, T.33 N., R.22 E., 1 mile above Methow River at Twisp, old gage.	5-28-37	69.2	
	do.	do.	SW¼ sec.8, T.33 N., R.22 E., ¼ mile above old gage on Methow River at Twisp.	6-14-22	8.8	
				9-28-22	12	
				9-28-22	7.0	
				9-28-22	2.5	
				9-28-22	22	
				9-28-22	21	
				6-26-23	34.5	
				6-27-23	39.1	
				6-27-23	39.1	
				9-26-23	42.7	
				6- 4-24	51.9	
				8-28-24	51.7	
				9-26-24	50.2	
				7- 3-25	61.3	
				8-26-25	57.4	
				5- 6-26	56.4	
				6-25-26	66.2	
				9-28-26	24.8	
				5-31-27	53.4	
				9-28-27	33.7	
				5- 3-28	33.8	
				6- 6-28	75.0	
				11-21-28	15.7	
				7- 1-29	60.8	
				9- 3-29	69.0	
				10-27-37	32.8	
				5-13-38	71.4	
				6- 9-38	76.9	

	Methow Valley Irrigation District Canal	Left bank Methow River	NW¼ sec.17, T.33 N., R.22 E., just above point opposite old gage on Methow River at Twisp.	10-10-34	44.1	
				10-16-35	25.4	
				6-14-36	55.3	
				10-27-36	49.0	
				6- 9-38	76.9	
				8-15-39	77.1	
				5- 1-40	23.1	
				6- 8-40	71.8	
				6-24-40	75.4	
				8- 2-40	67.8	
				9- 3-40	70.1	
				9-24-40	52.9	
				10-17-40	21.6	
				4- 7-41	0	
				5- 3-41	54.2	
				5-20-41	58.8	
				6- 4-41	64.4	
				8-15-41	72.9	
				9-24-41	36.1	
				10-21-41	5.93	
				5- 6-42	18.2	
				6- 8-42	58.2	
				7-25-42	78.9	
				9-28-42	66.8	
				9-28-42	73.9	
				5-21-43	23.6	
				7-15-43	60.1	
42-A	Methow Valley Irrigation District Canal	Left bank Methow River	Sec.17, T.33 N., R.22 E., ¼ mile below old gage on Methow River at Twisp.	7- 7-37	65.9	
	do.	do.	Sec.17, T.33 N., R.22 E., ½ mile below old gage on Methow River at Twisp.	6-15-35	69.9	
				6-14-36	55.3	
				10-27-36	49.0	
54-A	Elmer Johnson Ditch	Left bank Twisp River	Lat 48°22'15", long 120°19'26", in SW¼SE¼ sec.10, T.33 N., R.20 E., Okanogan County, 10 miles west of Twisp.	9- 2-71	2.10	
57-A	Twisp Power Ditch	do.	Lat 48°22'48", long 120°14'17", in NW¼NE¼ sec.8, T.33 N., R.21 E., Okanogan County, 5½ miles west of Twisp.	9- 2-71	22.7	
57-B	Unnamed diversion at Poorman Bridge	do.	Lat 48°22'27", long 120°12'05", in NE¼SW¼ sec.10, T.33 N., R.21 E., Okanogan County, 3½ miles west of Twisp.	9- 2-71	3.80	
58-A	Twisp-Methow Valley Irrigation District Canal	Right bank Twisp River	Lat 48°22'09", long 120°11'20", in SE¼SE¼ sec.10, T.33 N., R.21 E., Okanogan County, 3.2 miles west of Twisp.	9- 2-71	42.0	Above fish screen.
				9- 2-71	32.9	Below fish screen.
	do.	do.	SE¼ sec.11, T.33 N., R.21 E., at headgate, 3 miles west of Twisp.	9-10-36	29.1	
				10-27-37	12.9	
				8-26-42	36.8	
	do.	do.	SE¼ sec.11, T.33 N., R.21 E., below sluiceway at headworks.	5-13-38	13.6	

TABLE C2.--Record of discharge measurements made on irrigation ditches and canals in the Methow River basin--Continued

Number in fig.A1	Name of ditch or canal	Source of diversion	Location of measurement site	Date	Discharge (cfs)	Remarks
58-A (continued)		do.	SE¼ sec.11, T.33 N., R.21 E., above waterworks, near Twisp.	6- 9-38	49.6	
	do.	do.	S½ sec.12, T.33 N., R.21 E., at road crossing 2 miles above Twisp.	6-15-35	47.8	
				6-14-36	39.5	
				8-15-39	37.6	
	do.	do.	SE¼ sec.12, T.33 N., R.21 E., 1 mile west of Twisp and above all diversions.	8-14-15	42.2	
				7-24-21	53.3	
				10-14-21	18.9	
				6-15-22	50	
				6-26-23	37.3	
				9-25-23	18.0	
				6- 4-24	33.9	
				8-29-24	27.7	
				9-26-24	22.1	
				7- 3-25	37.2	
				8-26-25	36.7	
				5- 6-26	40.3	
				6-25-26	39.1	
				9-29-26	11.8	
				10-16-35	22.9	
	Twisp-Methow Valley Irrigation District Canal	Right bank Twisp River	Sec.18, T.33 N., R.22 E., at head of wooden flume ½ mile west of Twisp.	6-13-20	46.4	
				6-15-20	48.3	
				6-29-20	50.0	
				8-24-20	41.2	
				8-28-20	31.5	
				8-28-20	13.5	
				9-21-20	33.2	
				9-24-20	34.1	
				7-24-21	53.3	
				10-14-21	18.9	
				6-15-22	50.0	
				9-28-22	29.0	
				6-26-23	37.3	
				9-25-23	18.0	
	do.	do.	Sec.18, T.33 N., R.22 E., at road crossing about ¼ mile west of Twisp.	5-31-27	32.4	
				9-28-27	11.7	
				5- 3-28	22.2	
				6- 6-28	41.1	
				7- 2-29	42.8	
				9- 3-29	12.9	
				5- 1-40	0	
				6- 7-40	53.8	
				6-24-40	56.8	
				8- 3-40	50.2	
				9- 3-40	15.9	
				9-24-40	13.4	
				10-16-40	17.6	
				4- 7-41	0	
				5- 3-41	46.4	
				5-30-41	46.8	
				8-15-41	35.2	
				9-24-41	8.00	

				10-21-41	11.4
				5- 6-42	0
				6- 8-42	35.5
				7-25-42	47.6
				9-28-42	17.4
				5-21-43	41.0
				7-15-43	22.7
59-A	Risley Ditch	Right bank Twisp River	Lat 48°22'01", long 120°07'25", in NE¼NE¼ sec.18, T.33 N., R.22 E., Okanogan County, at Twisp just below intake.	8-14-15	8.95
				5-29-37	10.9
				8-15-39	14.6
	do.	do.	NE¼ sec.18, T.33 N., R.22 E., above all diversions at bridge on State Highway 18, at Twisp.	6-15-20	6.24
				6-18-20	5.05
				6-29-20	6.35
				8-24-20	8.17
				8-29-20	9.70
				9-21-20	12.0
				9-25-20	9.22
				10-14-21	2.0
				6-14-22	11.1
				9-22-22	9.7
				6-26-23	2.62
				9-26-23	3.98
				6- 4-24	9.19
				8-29-24	7.19
				9-26-24	2.88
				7- 3-25	16.3
				8-26-25	10.1
				5- 6-26	9.59
				6-25-26	11.9
				9-29-26	2.48
				5-31-27	6.62
				5- 3-28	7.18
				6- 6-28	11.1
				7- 1-29	7.58
				9- 3-29	7.34
				10-16-35	2.85
				7- 7-37	8.44
				10-27-37	2.36
				6- 9-38	11.5
				11-20-38	2.08
				4-30-40	7.55
				6- 7-40	21.2
				6-24-40	18.9
				8- 3-40	16.5
				9- 3-40	10.0
				9-24-40	11.1
				10-16-40	27.0
				4- 7-41	5.18
				5- 4-41	11.8
				5-20-41	7.45
				6- 4-41	11.5

TABLE C2.--Record of discharge measurements made on irrigation ditches and canals in the Methow River basin--Continued

Number in fig.A1	Name of ditch or canal	Source of diversion	Location of measurement site	Date	Discharge (cfs)	Remarks
59-A (continued)				8-15-41	14.6	
				9-24-41	31.4	
				10-21-41	8.86	
				5- 6-42	0	
				6- 8-42	0	
				7-25-42	13.7	
				8-25-42	13.5	
				9-28-42	7.37	
				5-21-43	11.9	
				7-15-43	11.9	
67-A	Unnamed ditch	Left bank Beaver Creek	Lat 48°23'53", long 120°02'34", in NW¼SE¼ sec.35, T.34 N., R.22 E., Okanogan County, at end of culvert on east side of road 2.8 miles north of State Highway 20.	9- 2-71	2.25	
75-A	Unnamed ditch	Right bank Libby Creek	Lat 48°14'52", long 120°08'58", in SW¼NE¼ sec.25, T.32 N., R.21 E., Okanogan County, 2.25 miles above mouth, and 1.5 miles west of Carlton.	9-22-71	2.02	
75-B	do.	do.	Lat 48°14'36", long 120°08'35", in NE¼SE¼ sec.25, T.32 N., R.21 E., Okanogan County, 1.8 miles above mouth, and 1.2 miles west of Carlton.	9-22-71	1.55	
75-C	do.	do.	Lat 48°13'57", long 120°07'18", in SE¼NE¼ sec.31, T.32 N., R.22 E., Okanogan County, 0.5 mile above mouth and 1 mile southwest of Carlton.	9-22-71	0	Flow destructed by beaver dam.
75-D	do.	Left bank Gold Creek	Lat 48°12'02", long 120°10'37", in NE¼SW¼ sec.11, T.31 N., R.21 E., Okanogan County, 1.15 miles southeast of Foggy Dew Junction, and 5 miles southwest of Carlton.	9-22-71	2.21	

TABLE C3.--Monthly and yearly mean discharges, in cubic feet per second, of streams, and first-of-the-month mean gage heights of Alta Lake in the Methow River basin, for the years indicated

[Number before station name is that in figure A1 and in table C1, that after station name is assigned by U.S. Geological Survey]

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
23. Andrews Creek near Mazama (12447390)													
1968	--	--	--	--	--	--	--	--	158	40.3	12.7	7.00	--
69	4.59	3.63	3.15	2.23	2.18	2.22	11.4	150	123	19.9	5.65	4.47	27.8
70	5.81	5.19	3.76	3.30	2.98	2.95	3.20	80.2	144	18.0	5.75	3.28	23.2
71	2.58	2.72	2.17	1.69	4.65	3.17	4.61	170	226	69.1	13.5	5.53	42.3
36. Chewack River below Boulder Creek, near Winthrop (12447500)													
1920	--	--	--	--	--	--	52	320	615	309	81.0	79.9	--
21	240	152	98.3	61.5	52.8	84.5	210	1,990	2,380	443	136	70	495
40. Chewack River at Winthrop (12448000)													
1912	--	--	--	--	--	--	--	1,080	931	286	131	126	--
13	94.1	--	--	--	--	--	230	986	1,620	430	137	111	--
41. Methow River at(near) Winthrop (12448500)													
1912	--	--	--	204	173	177	922	4,250	3,050	941	459	364	--
13	285	--	--	--	--	--	--	--	--	--	--	--	--
61. Methow River at Twisp (12449500)													
1919	--	--	--	--	--	--	--	--	5,270	2,670	646	403	--
20	287	304	222	227	209	240	246	1,550	2,990	1,750	392	351	731
21	886	569	375	325	319	490	1,280	6,120	7,410	2,150	617	323	1,740
22	436	596	643	406	305	259	727	3,760	6,000	1,210	469	341	1,260
23	357	316	281	250	239	245	1,590	4,480	5,320	2,280	563	311	1,360
24	320	307	264	227	238	312	737	4,950	2,180	723	267	192	897
25	262	291	371	309	286	384	1,900	5,910	3,700	1,110	321	210	1,260
26	242	247	222	190	193	238	1,230	1,580	846	289	162	168	467
27	345	342	303	257	229	222	571	2,520	5,480	1,310	469	692	1,060
28	909	710	693	537	395	570	1,030	6,110	2,810	1,270	316	214	1,300
29	268	274	253	199	183	205	180	2,020	2,790	588	185	148	609
30	209	233	208	183	238	280	2,270	3,100	3,440	1,060	314	228	980
31	245	301	234	229	249	279	772	3,540	2,080	588	223	236	752
32	236	319	247	226	356	990	1,550	4,540	3,670	1,010	329	222	1,140
33	289	676	507	345	257	313	1,090	3,650	6,590	3,020	633	321	1,480

TABLE C3.--Monthly and yearly mean discharges, in cubic feet per second, of streams, and first-of-the-month mean gage heights of Alta Lake in the Methow River basin, for the years indicated--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
							61. Methow River at Twisp (12449500)--Continued						
1934	732	1,183	876	552	611	1,773	7,692	5,974	3,544	968	323	212	2,036
35	258	708	613	578	958	730	1,278	5,312	6,257	2,188	561	302	1,645
36	262	304	251	230	209	204	1,372	3,481	3,368	532	195	196	883
37	189	244	223	178	185	212	310	3,110	6,851	1,674	338	270	1,148
38	392	574	415	361	322	498	2,052	6,655	5,772	1,379	297	230	1,583
39	283	311	280	275	248	311	1,405	2,955	1,981	853	221	198	779
40	704	234	261	209	230	331	1,353	4,506	2,540	468	205	176	895
41	330	406	314	281	270	619	2,765	3,180	2,777	726	318	669	1,054
42	845	666	577	335	356	355	1,883	5,876	4,648	1,528	422	210	1,480
43	233	300	261	228	275	311	2,265	3,405	5,496	3,051	594	220	1,388
44	280	312	267	243	231	248	631	2,979	3,321	765	257	164	808
45	258	292	264	261	254	269	495	4,035	5,198	1,199	271	194	1,084
46	282	453	308	287	287	341	1,645	7,695	5,003	1,926	482	363	1,597
47	380	351	292	248	280	733	2,229	5,190	3,300	965	340	236	1,216
48	439	523	438	310	298	282	876	6,052	7,985	1,971	1,185	565	1,743
49	634	434	343	269	240	344	2,208	7,491	3,683	1,288	430	299	1,480
50	355	636	748	399	358	357	947	4,761	11,030	3,943	865	257	2,056
51	525	612	553	491	762	616	3,632	9,385	6,538	2,426	668	493	2,231
52	566	504	356	324	297	363	1,991	5,770	3,434	1,441	464	255	1,317
53	301	285	247	257	261	378	1,052	5,621	6,503	3,181	673	276	1,592
54	456	456	371	302	318	349	855	5,880	6,063	4,392	1,205	694	1,788
55	572	702	627	416	336	316	637	2,501	7,721	2,937	721	323	1,484
56	548	989	526	377	274	321	2,910	9,256	7,006	2,461	697	394	2,149
57	536	521	459	322	338	363	1,124	9,515	3,825	942	362	195	1,553
58	342	349	292	268	299	404	1,144	8,202	3,793	981	282	235	1,392
59	380	439	526	435	367	452	2,030	4,892	7,285	2,913	644	727	1,759
60	1,383	1,115	923	511	390	644	2,011	3,659	5,489	1,767	464	282	1,552
61	321	329	259	260	281	386	1,247	5,133	7,329	1,139	302	209	1,433
62	320	300	240	250	398	333	1,379	2,263	3,697	1,160	510	197	920
							66. Beaver Creek below South Fork, near Twisp (12449600)						
1960	--	--	--	--	--	--	23.7	74.1	61.0	21.8	11.6	8.09	--
61	8.38	7.88	8.85	9.15	8.09	8.95	15.3	94.0	70.7	18.0	9.74	6.79	22.2
62	15.2	6.23	6.51	5.92	6.76	7.00	16.1	22.3	18.0	7.42	6.49	5.01	10.3
63	8.67	9.49	7.50	5.79	7.38	6.79	14.3	75.6	46.4	18.8	8.97	7.10	18.1
64	7.44	7.80	5.47	5.50	5.50	6.14	9.78	26.7	36.5	14.9	7.79	6.14	11.6
65	6.33	6.73	4.84	4.68	5.00	5.00	10.7	40.0	34.5	12.2	8.79	5.97	12.1
66	4.95	6.44	5.68	6.32	7.29	7.19	11.9	32.0	18.1	11.3	4.51	5.58	10.1
67	4.75	4.87	5.44	5.25	5.00	5.57	6.99	74.6	136	33.0	10.1	6.08	24.8
68	7.20	6.42	5.69	6.28	7.43	8.82	10.8	58.4	37.1	14.5	9.50	6.45	14.9
69	6.81	6.25	5.85	7.02	6.00	6.97	27.3	145	58.7	19.2	7.63	7.52	25.5
70	7.58	7.25	6.50	6.60	6.60	6.68	7.70	48.9	30.8	8.12	4.89	4.60	12.2
71	5.38	6.75	4.62	4.25	8.59	5.22	12.3	119	97.9	27.8	8.65	9.07	25.9

68. Beaver Creek near Twisp (12449700)

1956	--	--	--	--	--	--	--	--	55.7	25.7	15.0	14.0	--
57	13.7	11.0	10.7	9.48	11.1	10.3	18.4	258	67.7	26.2	12.8	9.01	38.5
58	11.0	9.42	10.4	10.7	13.1	14.5	21.2	161	68.1	24.0	11.2	8.70	30.5
59	8.45	9.95	12.7	10.7	9.21	9.25	27.5	90.6	100	32.0	11.0	16.5	28.2
60	14.6	10.6	10.9	8.84	8.72	12.3	25.9	80.7	63.7	19.0	11.1	7.92	22.9
61	8.87	8.40	9.20	8.92	7.80	8.22	15.8	98.5	82.7	18.1	7.48	7.70	23.6

86. Methow River near Pateros (12449950)

1959	--	--	--	--	--	--	2,082	5,246	8,200	3,241	866	872	--
60	1,458	1,246	1,097	652	479	812	2,294	4,029	6,516	2,185	643	435	1,819
61	429	412	324	339	368	487	1,489	5,677	8,534	1,400	448	326	1,686
62	379	363	314	335	501	426	1,480	2,413	4,149	1,415	670	359	1,066
63	478	771	798	517	634	718	1,059	5,056	5,268	1,930	732	525	1,544
64	623	608	565	496	393	425	1,015	3,057	8,079	2,515	670	404	1,567
65	529	416	333	398	329	492	1,223	3,658	5,732	1,651	751	509	1,336
66	436	396	345	323	314	341	1,331	3,895	3,300	1,541	478	371	1,093
67	427	450	425	372	356	418	661	5,031	11,520	2,668	598	350	1,939
68	549	861	580	688	803	1,407	1,224	5,422	6,058	2,265	641	466	1,748
69	426	392	345	319	343	383	1,974	7,929	5,756	1,072	437	329	1,648
70	470	400	347	278	297	349	495	3,266	5,074	885	315	270	1,037
71	346	318	302	317	688	514	1,278	8,488	7,789	3,216	873	434	2,054

88. Alta Lake near Pateros (12450000)

1955	--	--	7.84	7.08	7.84	--	--	7.90	7.84	7.53	7.18	--	--
56	--	6.22	6.26	--	--	--	--	8.27	8.73	8.64	8.29	8.01	--
57	7.74	7.82	7.77	7.91	--	--	8.81	--	10.19	--	--	--	--
58	--	9.03	9.04	9.17	--	10.09	--	--	11.97	11.82	11.45	10.96	--
59	--	10.71	10.88	--	--	11.44	--	--	--	--	--	11.58	--
60	--	11.52	11.54	--	--	--	--	12.44	12.71	12.49	12.01	11.52	--
61	11.30	--	11.15	11.20	11.39	--	11.92	12.28	--	12.22	11.74	11.26	--
62	--	--	--	--	--	--	--	--	10.92	10.54	9.99	--	--
63	--	--	9.29	9.30	--	9.39	9.39	--	9.64	9.24	8.76	8.30	--
64	8.04	7.80	7.87	7.89	8.02	7.96	8.04	8.06	7.88	7.62	7.10	6.65	--
65	--	6.19	--	--	--	--	6.38	6.50	--	--	--	--	--
66	--	4.50	4.52	4.53	4.60	4.49	4.70	4.73	4.59	4.32	3.93	3.38	
67	3.19	2.95	3.08	3.15	--	--	--	3.56	3.80	3.77	3.28	2.84	--
68	--	2.46	2.36	2.38	2.59	2.87	3.12	3.20	3.06	2.71	2.24	--	--
69	1.64	--	--	--	--	--	1.99	2.89	3.19	3.21	2.85	2.42	--
70	2.29	2.15	2.06	2.31	2.49	2.50	2.67	2.76	2.70	2.34	1.82	1.42	--
71	--	--	--	--	--	--	--	2.54	2.93	2.94	--	2.23	--

Note: Add 1,175 ft to obtain mean sea level elevation.

TABLE C3.--Monthly and yearly mean discharges, in cubic feet per second, of streams, and first-of-the-month mean gage heights of Alta Lake in the Methow River basin, for the years indicated--Continued

89. Methow River at Pateros (12450500)

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1903	--	--	--	--	--	--	--	--	--	3,150	1,140	854	--
04	1,000	961	816	606	595	485	3,980	6,830	7,060	3,610	832	509	2,270
05	479	476	451	421	347	1,210	2,500	4,210	8,250	2,830	847	498	1,880
06	719	614	454	424	370	398	1,920	5,250	4,940	1,970	592	453	1,510
07	461	722	528	343	430	558	1,560	7,190	6,720	2,760	882	602	1,900
08	531	468	448	395	411	434	1,140	4,520	7,250	3,250	763	478	1,670
09	392	444	404	317	327	405	871	3,250	7,520	3,210	798	432	1,530
10	428	485	516	360	361	1,420	4,590	9,320	6,360	3,090	889	520	2,370
11	827	704	519	389	398	583	1,440	3,660	7,320	2,210	728	654	1,620
12	439	396	338	318	309	318	960	4,780	4,980	1,590	675	526	1,300
13	424	420	363	305	324	350	1,100	4,260	7,400	2,480	764	505	1,560
14	425	419	364	353	378	419	2,360	6,230	5,690	2,470	559	492	1,680
15	671	828	492	403	394	503	2,550	3,580	2,790	1,150	621	416	1,200
16	406	450	439	394	422	636	2,770	6,120	9,260	5,520	1,490	686	2,380
17	512	495	453	399	379	387	454	3,580	6,560	3,050	723	432	1,460
18	399	422	426	578	383	437	1,610	4,360	5,320	1,510	576	310	1,360
19	398	415	410	361	302	356	2,190	5,060	5,470	2,680	756	492	1,580
20	414	443	336	370	366	361	348	1,740	3,140	2,070	471	404	873

TABLE C4.--Records of representative wells in the Methow River basin

Explanation of Well-Numbering System

In this report most wells are designated by symbols that indicate their locations according to the official rectangular public-land survey. For example, in the symbol 30/23-34G1, the part preceding the hyphen indicates successively the township and range (T. 30 N., R. 23 E.) north and east of the Willamette base line and meridian. Because the report area lies entirely north and east of the base line and meridian, the letters indicating the directions north and east are omitted. The first number following the hyphen indicates the section (sec.34), and the letter "G" gives the 40-acre subdivision of the section, as shown in the figure below. The numeral "1" indicates that this well is the first one listed within the subdivision.

Those wells for which the exact 40-acre subdivisions in a section could not be determined, owing to their locations being more generalized, are given numers that include the standard description of the 160-acre subdivision, such as 31/22-27NW¼.

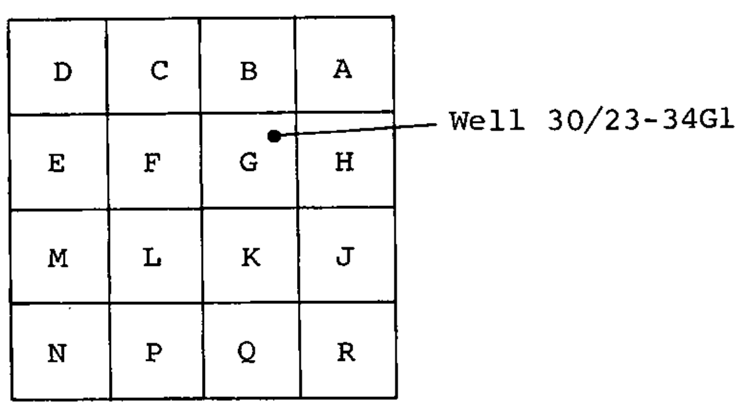

Table C4 in part C of the report contains a list of representative wells in the Methow River basin, and table C5 presents drillers' logs of 23 of the wells.

TABLE C4.--Records of representative wells in the Methow River basin

Well number	Well depth (feet)	Water level (feet below lsd)	Reported yield (gpm)	Drawdown (feet)	Use a/	Remarks b/
29/23-2B1	75	23	4	--	D	
30/23-6G1	40	16	400	2	--	Penetrates coarse gravel 14-40 ft.
7D1	40	15	--	--	D, Irr	Penetrates mixture of sand and gravel.
7K1	60	--	--	--	Irr	Does not enter bedrock.
7L1	30	23	--	--	Irr	Irrigates 10 acres.
7P1	42	--	200	--	D, Irr	Irrigates 15 acres.
18D1	50	--	300	--	Irr	Irrigates 22 acres.
18D2	25	--	--	--	D, Irr	Located near river, operates 225 sprinklers.
20N1	22	10	180	3	Irr	Penetrates gravel 10-22 ft. Irrigates 20 acres.
21N1	62	38	200+	--	Irr	Penetrates mostly gravel.
28D1	50	--	350	2	Irr	L.
28F1	62	--	--	--	Irr	Irrigates 52 acres in conjunction with well above.
28J1	79	--	400	--	D, Irr	Irrigates about 35 acres.
28NW¼	50	26	220	22	Irr	Penetrates mostly gravel.
29NW¼	60	58	--	--	D	Inadequate for domestic supply at low river stage.
30B1	22	16	125	2	Irr	Irrigates 10 acres.
34G1	18	--	180	--	Irr	Irrigates 7 acres.
34	40	--	300	--	Irr	Penetrates mostly sand and gravel.
34	28	--	--	--	D	Supplies 2 homes. Inadequate at low river stage.
35M1	50	25	500	23	Irr	L.
35M2	50	25	50	23	D	L.
31/22-6G1	35	33	--	--	D	Very adequate for domestic use.
6J1	40	16	--	--	D	
16E1	50	28	20+	--	--	Penetrated boulders and clay 0-45 ft, gravel 45-50 ft.
21G1	30	20	100+	--	D, Irr	Penetrates gravel 20-30 ft. Yield varies with river stage.
21H1	80	15	600	--	Irr	Penetrates only sand.
21H2	40	15	--	--	D, Irr	Penetrates mostly sand.
26R1	41	18	147	1	D, Irr	L.
27NW¼	51	17	120	--	Irr	
27SE¼	50	47	--	--	D	Inadequate for domestic.
27SE¼	30	--	--	--	D	Do.

TABLE C4.--Records of representative wells in the Methow River basin--Continued

Well number	Well depth (feet)	Water level (feet below lsd)	Reported yield (gpm)	Drawdown (feet)	Use[a]	Remarks [b]
31/22-35C1	82	40	440	8	Irr	Penetrates sand and gravel 27-82 ft.
35C2	78	--	--	--	D	Penetrates gravel 60-78 ft.
35F1	25	--	450	--	Irr	Irrigates 45 acres.
31/23-31SE¼	50	48	>10	--	D	Penetrates sand and gravel.
32/22-3SE¼	100	50	--	--	D	Penetrates mostly fine sand and clay, coarse sand at bottom.
3SE¼	85	83	--	--	D	Inadequate for domestic use. Penetrates clay.
3SE¼	75	55	--	--	D	Encounter coarse sand at bottom.
9SE¼	65	15	600	--	Irr	Irrigates 35 acres. Penetrates sand and gravel 28-65 ft.
9	86	69	--	--	D	Penetrates sand and gravel.
10C1	71	--	--	--	D	
10E1	105	58	350	--	D	Water reported very hard. L.
10F1	88	38	1,000	--	Irr	L.
10F2	105	58	1,000	--	Irr	Irrigates 50 acres.
10M1	80	30	--	--	D	
10SW¼	105	42	--	--	Irr	Irrigates 35 acres. L.
16G1	88	44	10+	--	D	L.
16N1	20	--	150	--	Irr	
16NE¼	55	46	--	--	Irr	One horsepower pump will not pump well dry.
16SE¼	118	43	--	--	Irr	Irrigates 35 acres. L.
20G1	60	--	--	--	--	Penetrates gravel.
20H1	80	78	100	--	--	
20NE¼	80	28	400	--	Irr	Irrigates 45 acres. L.
29C1	80	38	>10	--	D	L.
29D1	41	17	400	4	D, Irr	Irrigates 18 acres. L.
29L1	72	25	10+	--	D	L.
33/20-10J1	10	--	--	--	D	
11A1	13	--	--	--	D	Water level fluctuates about 6 ft with the seasons.
12A1	44	26	--	--	D	Penetrates boulders, sand, and gravel.
33/21-9A1	--	11	--	--	D	Adequate for domestic use.
9C1	37	16	±10	1	D	
10	20	--	--	--	D	Water level fluctuates with river stage.

TABLE C4.--Records of representative wells in the Methow River basin--Continued

Well number	Well depth (feet)	Water level (feet below lsd)	Reported yield (gpm)	Drawdown (feet)	Use a/	Remarks b/
33/21-11M1	25	13	500	4	D	Penetrates gravel 5-25 ft.
11M2	30	--	--	--	D	Supplies five homes.
12M1	12	9	20	3	D, Irr	
33/22-6NE¼	28	25	--	--	D	Water level fluctuates with river stage.
6NW¼	11	8	--	--	D	Supplies trailer court.
7B1	12	--	--	--	D	Do.
7J1	15	10	--	--	Irr	Penetrates only gravel.
8N1	52	--	450	--	PS	
8NW¼	35	22	--	--	D	Adequate for domestic use.
11R1	15	--	45	--	D, Irr	Irrigates 3 acres.
12N1	33	--	--	--	D	Water level rises and yield increases with increased irrigation.
13A1	30	11	--	--	D	Well was drilled to 70 ft, but backfilled to 30 ft.
16M1	64	54	10	--	S	
16N1	23	--	--	--	D	Penetrates only sand and gravel. Water level fluctuates with river stage.
17L1	83	16	1,300	10	PS	L.
21NE¼	34	16	--	--	D	Adequate for domestic use.
21SW¼	34	16	--	--	D	Penetrates only gravel.
22N1	20	12	184	4	D, Irr	Irrigates about 7 acres.
22P1	43	17	550	--	D	L.
23R1	100	--	500	--	D, Irr	
23NE¼	21	15	330	5	Irr	
27C1	222	12	--	--	--	L.
27C2	18	--	650	2	D, Irr	Water level fluctuates between 6 and 12 ft.
27D1	26	11	300	6	Irr	Penetrates only gravel.
27J1	210	46	325	4	D, Irr	Penetrates clay from 10 to 100 ft.
27J2	123	67	150	--	Irr	Irrigates about 5 acres.
27SE¼	36	29	300	3	--	Adequate for irrigation.
34/21-2L1	98	31	800 1,000	20 54	PS	L.
3C1	10	--	180	--	D, Irr	Irrigates 17 acres.
3J1	100	8	90	--	F	Sanded up, now only 65 ft deep.
3J2	145	--	--	--	--	Encountered bedrock at 98 ft. Abandoned.
3J3	13	--	2,300	--	F	Infiltration trench.
3NW¼	90	57	--	--	D	
6NE¼	1,800	--	--	--	--	Penetrates only bedrock. Abandoned, small yield.

TABLE C4.--Records of representative wells in the Methow River basin--Continued

Well number	Well depth (feet)	Water level (feet below lsd)	Reported yield (gpm)	Drawdown (feet)	Use[a/]	Remarks[b/]
34/21-8NW¼	15	--	--	--	D	Dug well near Patterson Lake, water level fluctuates with lake level.
11NE¼	40	--	--	--	D	Water level and yield fluctuate with river stage.
12NW¼	28	--	--	--	D	Adequate for domestic supply only.
12SW¼	40	--	--	--	D	Penetrates only gravel. Reported adequate to irrigate 5 acres.
13NW¼	12	--	--	--	D	Water level fluctuates with river stage.
13SE¼	25	20	--	--	D	Drilled on side of low ridge east of river.
13SE¼	16	--	--	--	D	Dug in low area to east of ridge. Inadequate in winter.
13SE¼	35	--	--	--	D	Drilled in low area to east of ridge. Adequate for domestic supply.
14SE¼	87	65	--	15	PS	Supplies school.
23NE¼	88	48	--	--	D	Penetrates glacial deposits, bottoms at bedrock. Yield reported "very good."
24SE¼	40	18	15	1	D	Penetrates sand and boulders.
34/22-7	12	--	--	--	D	Barely adequate for domestic use.
30K1	100	--	50	--	D	
31D1	33	--	150	--	D, Irr	
31D2	25	--	100	--	D, Irr	Irrigates about 6 acres.
31NW¼	200	--	--	--	D	Located on bluff overlooking river. Very limited supply from bedrock.
35/20-4NW¼	13	7	--	--	D	Very rapid recovery.
4SW¼	30	--	--	--	D	Adequate for domestic use.
5NE¼	70	50	--	--	D	Yield reported "very good."
5NE¼	105	--	--	--	D	Do.
5SE¼	73	36	--	--	D	Penetrates clayey gravel 0-48 ft, clean gravel 48-73 ft.
10SW¼	12	9	--	--	D	Yield fluctuates with river stage.
13SW¼	34	18	--	--	D	Reported "good" yield.
15SE¼	24	16	--	--	D	Supplies two homes.
35/21-2NE¼	21	2	--	--	D	Water level rose from 20 ft to 2 ft during drilling.
15SE¼	198	65	--	--	D	Very adequate for domestic use.
22NE¼	65	47	--	--	D	Yield reportedly low.

TABLE C4.--Records of representative wells in the Methow River basin--Continued

Well number	Well depth (feet)	Water level (feet below lsd)	Reported yield (gpm)	Drawdown (feet)	Use[a]	Remarks[b]
35/21-26SE½	14	--	--	--	D	Encountered bedrock at 12 ft. Goes dry in summer.
32K1	103	40	60	--	D, Irr	Irrigates 12 acres. L.
35NE½	80	45	3	--	D	Penetrates gravel and boulders 0-73 ft, bedrock 73-86 ft.
35NW½	145	45	8	--	D	Encountered bedrock at 20 ft, water at 90 and 130 ft.
36NW½	12	4	--	--	D	Supplies campground and store.
36/18-1NW½	71	56	10	--	D	Penetrates sand and gravel.
2NE½	40	--	10	--	D	
2SW½	85	40	7	--	D	Goes dry in fall.
32NE½	40	25	18	10	D	Supplies campground. Bottoms in bedrock.
36/19-5NW½	93	46	60	--	D	Penetrates only gravel and boulders.
5SW½	97	--	450	--	D	
10SW½	62	30	10	--	D	Penetrates sand and gravel.
15SW½	25	10	--	--	D	
22SE½	60	23	30	--	D	Penetrates sand 0-23 ft, gravel 23-60 ft.
23D1	55	25	--	--	D	L.
23E1	60	25	--	--	D	L.
23M1	58	23	40	--	D	L.
23P1	50	28	50	--	D	Penetrates rock and clay 0-25 ft, gravel and sand 25-50 ft.
25A1	27	14	--	--	D	Penetrates clay 0-14 ft, sand and cobbles 14-27 ft.
25B1	57	19	15	--	D	L.
25B2	76	--	--	--	D	
26NW½	50	21	550	1	D	L.
36/20-31SE½	30	--	--	--	D	Water level and yield fluctuates with river level.
36/21-26SE½	43	12	--	--	D	Penetrates only sand and boulders, pumps dry.
37/21-30SE½	100	--	--	--	--	Abandoned, no water.

[a] Use: D, domestic; F, fish propagation; Irr, irrigation; PS, public supply; S, livestock.

[b] Remarks: L, log in table C5.

TABLE C5.--Drillers' logs of wells

Well number and material penetrated	Thick-ness (feet)	Depth (feet)
30/23-28D1		
Silt, sandy, and boulders	3	3
Sand, gravel, and cobbles	17	20
Sand and gravel	5	25
Sand, gravel, and clay	5	30
Sand and gravel, water-bearing	20	50
30/23-35M1		
Topsil and boulders	6	6
Sand, fine, and fine gravel	34	40
Sand, coarse, and coarse gravel	10	50
30/23-35M2		
Topsoil and boulders	6	6
Sand, fine, and fine gravel	34	40
Sand, medium, and fine gravel	10	50
31/22-26R1		
Boulders, gravel, and silt	10	10
Gravel	5	15
Sand, gravel, and clay	15	30
Rocks	2	32
Gravel	3	35
Gravel, water-bearing	6	41

TABLE C5.--Drillers' logs of wells--Continued

Well number and material penetrated	Thickness (feet)	Depth (feet)
32/22-10E1		
Topsoil and clay	11	11
Sand, gravel, and boulders	59	70
Sand and gravel, dirty, some water	15	85
Sand and gravel, water-bearing	20	105
"Quicksand"	at	105
32/22-10F1		
Gravel, boulders, and sand	42	42
Sand and gravel, water-bearing	44	86
Sand, fine	2	88
32/22-10SW¼		
Boulders and gravel	45	45
Clay, silty	31	76
Sand, fine	9	85
Sand and gravel, water-bearing	20	105
32/22-16G1		
Topsoil	2	2
Sand, gravel, and boulders	28	30
Sand and gravel, dirty	30	60
Sand and gravel, water-bearing	28	88

TABLE C5.--Drillers' logs of wells--Continued

Well number and material penetrated	Thickness (feet)	Depth (feet)
32/22-16SE¼		
Sand, gravel, and boulders	47	47
Sand, fine, water-bearing	8	55
Silt, blue	43	98
Sand, muddy, water-bearing	20	118
32/22-20NE¼		
Sand, gravel, and boulders	42	42
Sand, dirty, water-bearing	26	68
Sand and gravel, water-bearing	12	80
32/22-29C1		
Sand, boulders, and gravel	52	52
Sand and gravel, water-bearing	28	80
32/22-29D1		
Silt and gravel	10	10
Sand, and coarse gravel	10	20
Gravel, coarse	21	41
32/22-29L1		
Topsoil	8	8
Gravel, and boulders	12	20
Sand, and gravel, bedded in clay	20	40
Sand, and gravel, some water	23	63
Sand, and gravel, water-bearing	9	72

TABLE C5.--Drillers' logs of wells --Continued

Well number and material penetrated	Thickness (feet)	Depth (feet)
33/22-17L1		
Gravel, and sand	5	5
Sand	10	15
Sand, and gravel	68	83
33/22-22P1		
Boulders, and clay	12	12
Sand, and clay	15	27
Sand, and clay, water-bearing	16	43
33/22-27C1		
Sand, gravel, and boulders	22	22
Sand, fine, silty	133	155
Clay, brown	12	167
Sand, fine, silty	40	207
Clay, brown	15	222
Sand	at	222
34/21-2L1		
Sand and boulders, brown	20	20
Sand, boulder, and brown clay	17	37
Sand and gravel, water-bearing	8	45
Sand, coarse to medium	5	50
Sand, fine, silty	18	68
Sand, medium	17	85
Sand and gravel	13	98
Bedrock	at	98

TABLE C5.--Drillers' logs of wells--Continued

Well number and material penetrated	Thickness (feet)	Depth (feet)
35/21-32K1		
Boulders, and gravel	15	15
Sand, fine	50	65
Sand, fine, some gravel, water-bearing	38	103
36/19-23D1		
Boulders, and gravel	25	25
Gravel and boulders, cemented	23	48
Sand and gravel, water-bearing	7	55
36/19-23E1		
Boulders and gravel	24	24
Sand and gravel, water-bearing	36	60
36/19-23M1		
Boulders and gravel	10	10
Clay, sandy	13	23
Sand and gravel, water-bearing	35	58
36/19-25B1		
Gravel and silt	6	6
Boulders, and coarse gravel	24	30
Sand	5	35
Gravel	22	57
36/19-26NW¼		
Clay and boulders	25	25
Boulders, clay, and gravel	5	30
Gravel, and sand	20	50

TABLE C6.--Chemical quality of water, Methow River near Pateros, station 12449950

Date of collection	Mean discharge (cfs)	Milligrams per liter																				Coliform		
		Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos per cm at 25°C)	pH (units)	Color (platinum-cobalt units)	Dissolved oxygen (mg/l)	MPN (most probable number groups per 100 ml)	Colonies per 100 ml	Temperature (°C)
7-29-59	1,800	11	--	20	1.8	2.6	0.6	71	--	6.1	0.2	0.2	0.9	0.20	79	58	0	131	7.1	--	--	--	--	--
8-28	610	13	--	27	5.1	3.8	1.2	107	--	9.4	.2	.2	1.4	.00	115	89	2	187	7.8	--	--	--	--	--
10- 1	1,180	12	--	21	4.2	3.0	1.1	83	--	6.6	.2	.2	.7	.01	89	70	2	147	8.1	--	--	--	--	--
11- 6	1,280	12	--	20	2.7	2.8	.4	75	--	6.4	.5	.2	.3	.00	81	61	0	134	7.9	--	--	--	--	--
12- 3	1,370	11	--	19	3.0	2.5	.6	72	--	5.8	.0	.4	.0	.01	82	60	0	128	6.9	--	--	--	--	--
12-29	807	12	--	23	3.5	3.4	.8	88	--	7.7	.2	.2	.6	.00	92	72	0	159	7.9	--	--	--	--	--
1-25-60	672	12	--	24	4.7	3.7	.7	94	--	8.2	.0	.2	.7	.01	101	79	2	170	7.7	--	--	--	--	--
2-24	451	12	--	29	3.3	4.4	.9	105	--	9.3	.5	.1	.7	.03	109	86	0	188	7.9	--	--	--	--	--
3-28	1,840	12	--	21	2.8	2.9	.6	81	--	6.7	.0	.2	.3	.02	87	64	0	144	7.9	--	--	--	--	--
4-25	1,840	12	--	21	3.1	3.0	.7	80	--	5.0	.0	.2	.3	.00	88	65	0	141	8.0	--	--	--	--	--
5-31	4,240	11	--	14	1.7	2.2	.5	54	--	3.6	.0	.1	.1	.01	67	42	0	93	7.7	--	--	--	--	--
6-27	4,210	8.9	--	12	2.2	1.9	.5	49	--	3.2	.2	.1	.1	.04	52	39	0	84	7.6	--	--	--	--	--
7-20	1,650	9.8	--	18	3.3	2.6	.5	70	--	5.2	.2	.1	.4	.01	80	58	1	120	8.1	--	--	--	--	--
8-17	560	12	--	27	5.1	4.1	.8	a/106	--	8.6	.5	.2	.8	.01	114	88	2	179	8.3	--	--	--	--	--
9-20	370	12	--	31	5.2	4.8	.9	118	--	11	.8	.2	.1	.00	128	99	2	209	8.0	--	--	--	--	--
10-18	435	11	--	29	5.3	4.6	.6	109	3	11	.5	.2	.6	.00	119	94	0	198	8.4	--	--	--	--	--
11-16	422	12	--	29	4.8	4.0	.6	110	0	10	.2	.2	.7	.02	120	92	2	190	8.1	--	--	--	--	--
12-19	300	13	--	28	5.1	4.0	.7	110	0	9.8	.8	.2	1.0	.02	118	91	1	194	8.2	--	--	--	--	--
1-17-61	360	12	--	29	4.9	4.4	.9	112	0	8.8	.8	.1	.8	.00	120	93	1	196	8.0	--	--	--	--	--
2-16	368	13	--	28	5.7	4.5	.8	112	0	9.8	.5	.2	.7	.00	117	93	1	192	8.1	--	--	--	--	--
3-13	380	11	--	28	4.8	4.5	.8	107	1	9.4	.5	.3	.7	.00	118	90	0	188	8.3	--	--	--	--	--
4-21	1,380	12	--	23	3.1	3.3	.5	86	0	7.0	.2	.2	.4	.01	96	70	0	151	8.1	--	--	--	--	--
5- 9	2,460	10	--	18	2.6	3.2	.6	68	0	4.8	.0	.2	.3	.01	74	56	0	120	7.8	--	--	--	--	--
6-13	8,680	8.1	--	9.5	1.1	1.6	.5	36	0	2.8	.0	.1	.2	.01	46	28	0	67	7.4	--	--	--	--	--
7-12	1,520	11	--	20	2.3	3.1	.7	74	0	5.6	.0	.2	.4	.07	83	60	0	131	7.9	--	--	--	--	--
8-21	387	11	--	29	5.9	4.6	1.1	114	0	11	.2	.2	1.3	.00	123	97	4	199	8.2	--	--	--	--	--
9-20	320	13	--	32	6.0	5.0	1.1	123	0	12	.5	.2	1.3	.00	137	105	4	211	8.2	--	--	--	--	--
10-31	380	12	.00	28	5.7	5.2	.8	112	--	10	.5	.2	1.0	.01	123	93	1	197	7.7	--	--	--	--	--
11-20	356	13	.02	28	5.8	4.6	.8	112	--	12	.2	.2	.8	.00	120	94	2	201	7.8	--	--	--	--	--
12-20	290	14	.02	28	5.6	4.4	.9	110	--	11	.5	.2	1.0	.00	120	93	3	197	7.9	--	--	--	--	--

TABLE C6.--Chemical quality of water, Methow River near Pateros, station 12449950--Continued

Date of collection	Mean discharge (cfs)	Milligrams per liter														Hardness as $CaCO_3$		Specific conductance (micromhos per cm at 25°C)	pH (units)	Color (platinum-cobalt units)	Dissolved oxygen (mg/l)	Coliform		Temperature (°C)
		Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Dissolved solids (residue at 180°C)	Calcium, magnesium	Noncarbonate					MPN (most probable number groups per 100 ml)	Colonies per 100 ml	
1-24-62	350	14	0.02	30	5.4	4.6	1.2	116	--	11	1.0	0.2	1.2	0.00	126	97	2	209	8.0	--	--	--	--	--
2-19	549	11	.05	26	3.8	4.0	.8	96	--	8.8	.5	.2	.7	.01	113	80	2	174	7.7	--	--	--	--	--
3-21	420	12	.00	28	4.0	4.5	.9	106	--	10	.8	.2	.6	.00	113	86	0	184	7.7	--	--	--	--	--
4-23	2,240	9.5	--	16	1.7	3.0	.8	58	--	5.4	.0	.1	.1	.01	66	47	0	108	7.9	--	--	--	--	--
5-21	1,760	9.0	.07	16	2.8	2.6	.8	64	--	5.2	.5	.3	.5	.01	73	52	0	115	7.4	--	--	--	--	--
6-27	3,710	8.0	.07	12	1.3	2.2	.6	44	--	4.0	.0	.1	.3	.00	55	35	0	79	7.7	--	--	--	--	--
7- 1	2,770	10	.01	20	3.4	3.2	.7	78	--	6.8	.2	.2	.4	.01	85	64	0	141	7.7	--	--	--	--	--
8-23	456	12	--	28	4.3	4.3	1.0	106	--	8.6	.5	.2	.9	.02	116	88	0	190	8.1	--	--	--	--	--
9-24	341	13	.01	32	5.1	4.8	1.1	121	--	11	.5	.1	.7	.03	130	101	2	216	8.1	--	--	--	--	--
12-18	804	11	.04	22	3.6	3.7	.6	84	--	7.2	.2	.2	.5	.01	90	70	0	148	8.0	5	13.4	36	--	--
3-28-63	812	12	.07	23	3.5	3.2	.6	88	--	8.6	.2	.2	.3	.01	101	72	0	151	7.7	5	11.6	91	--	--
6-27	2,780	9.0	.09	14	2.5	2.1	.5	54	--	4.2	.2	.2	.3	.01	61	45	0	93	7.7	5	10.0	23	--	--
9-23	518	13	.01	28	5.1	4.2	1.0	108	--	10	.0	.2	1.0	.01	124	91	2	189	8.0	0	9.5	430	--	--
11-19	626	14	.03	24	3.7	3.8	.7	92	--	7.2	.2	.2	.5	.00	100	75	0	160	7.8	0	--	--	--	--
1-29-64	451	12	.01	24	4.6	3.8	.7	94	--	8.4	.2	.2	.6	.00	104	79	2	169	7.7	0	12.9	23	--	--
4- 3	708	14	--	24	4.2	3.5	.7	93	--	8.4	.5	.2	.6	.01	101	77	1	163	7.3	5	11.9	36	--	--
5-19	4,820	9.1	--	13	2.2	2.0	.3	51	--	4.2	.0	.1	.5	.01	59	42	0	91	7.2	5	10.4	430	--	--
7-28	1,100	9.5	.03	20	3.1	3.0	.8	76	--	6.4	.0	.2	.6	.00	b/81	62	0	134	7.6	0	9.3	36	--	--
10-14	624	11	.02	24	4.1	3.6	.7	91	0	10	.0	.2	.6	.01	102	77	2	166	7.4	0	--	--	--	--
11-23	394	11	.01	26	4.6	4.1	.8	102	0	8.4	.5	.2	.8	.01	105	84	0	180	7.9	0	12.9	36	--	--
1- 9-65	400	12	.08	26	5.6	4.3	1.1	107	0	9.8	.2	.3	1.0	.00	114	88	0	188	7.9	0	13.8	23	--	--
3- 6	316	12	.03	26	5.3	4.3	1.0	103	0	9.4	.2	.2	.7	.01	115	87	2	184	8.1	0	12.7	430	--	--
5-15	3,990	8.5	.12	12	2.0	2.3	.5	47	0	3.6	.0	.2	.2	.18	b/52	38	0	83	7.2	5	10.5	230	--	--
7-10	2,020	8.4	.04	14	2.8	2.4	.5	57	0	4.6	.0	.1	.4	.00	61	46	0	101	7.6	5	9.9	0	--	--
9-11	492	12	.03	26	5.2	4.3	1.2	102	0	9.0	.5	.2	1.0	.01	117	86	3	182	7.9	0	10.2	0	--	--
11-13	389	12	--	26	4.9	4.2	.8	102	0	8.8	.2	.3	.7	--	b/108	85	2	179	8.1	0	12.5	0	--	--
1- 8-66	420	11	--	24	5.8	4.0	.8	98	0	8.8	.2	.2	.8	--	b/104	84	4	176	7.6	5	14.2	0	--	--
3-23	316	11	--	27	5.3	4.4	1.0	108	0	9.6	.5	.2	.8	--	112	90	1	190	7.6	0	11.9	0	--	--
5-10	6,670	7.7	--	9.2	1.3	1.6	.4	35	0	3.2	.2	.2	.3	--	45	28	0	64	7.0	10	10.6	430	--	--
7-13	1,660	8.6	--	16	2.5	2.6	.6	62	0	5.2	.0	.2	.4	--	68	50	0	111	7.2	0	9.8	0	--	--
9-15-66	443	13	--	28	5.1	4.3	1.1	110	0	10	0.0	0.2	0.9	--	b/117	91	1	196	7.4	5	11.1	91	--	--
11-17	452	11	--	25	4.4	4.0	.7	98	0	8.4	.0	.3	.8	--	106	80	0	174	7.4	0	12.4	360	--	--
2-23-67	352	12	--	26	5.0	4.0	.9	102	0	8.4	.0	.2	.8	--	b/107	86	2	180	8.0	5	12.8	36	--	--
5-24	9,330	8.9	--	10	1.6	1.6	.6	40	0	2.8	.0	.1	.4	--	b/46	32	0	72	7.2	5	13.2	73	--	--
8-16	550	12	--	25	4.5	3.7	1.0	100	0	8.0	.0	.2	.5	--	106	81	0	173	8.2	5	11.4	91	--	--

11-15	824	11	--	21	3.3	3.2	.7	84	0	6.6	.0	.2	.3	--	89	66	0	146	8.1	5	11.4	73	--	8
2- 7-68	816	9.4	--	20	3.3	3.1	.6	78	0	7.0	.2	.2	.3	--	89	64	0	137	7.7	5	14.0	94	--	0
5- 8	2,450	9.6	--	17	2.6	2.6	.6	66	0	5.0	.1	.2	.3	--	74	53	0	114	7.6	5	13.2	--	170	9
8- 7	715	11	--	23	3.8	3.3	.7	90	0	7.6	.6	.2	.6	--	95	73	0	156	8.0	5	9.9	--	140	18
11-20	377	12	--	25	5.9	4.1	.6	105	0	8.8	.3	.2	.8	--	110	87	1	181	7.9	5	11.8	--	89	5
2-13-69	350	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.7	--	11	1
5-14-69	11,100	8.5	--	9.6	1.4	1.6	.6	38	0	3.5	.4	.1	.2	--	50	30	0	68	7.7	10	11.0	--	260	10
8-13	461	13	--	28	5.0	4.6	1.0	109	0	9.6	.7	.2	1.4	--	118	91	1	197	7.8	0	9.9	--	320	18
11-13	410	13	--	27	4.8	4.1	.9	108	0	8.8	.4	.2	.9	--	132	87	0	189	8.1	0	12.8	--	190	4.4
2-11-70	292	12	--	28	5.0	4.2	.9	109	0	9.8	.5	.2	1.1	--	106	91	1	194	7.8	0	13.2	--	95	2.7
5-13	1,470	9.6	--	19	2.8	2.8	.8	71	0	5.8	.4	.1	.4	--	78	59	1	127	7.7	5	11.6	--	150	11.0
8-12	320	13	--	29	5.0	4.6	.9	109	0	9.6	.4	.2	1.7	--	114	93	4	197	7.9	0	9.8	--	55	18.9

a/ Included equivalent of 2 mg/l of carbonate.

b/ Calculated from determined constituents.

TABLE C7.--Chemical quality of ground water from two wells in Methow River basin

Well number	Well owner	Well depth (feet)	Date sample collected	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$	Specific conductance (micromhos per cm at 25 °C)	pH (units)	Color (platinum-cobalt units)	Temperature (°C)
				Milligrams per liter																	
33/22-8N1	Town of Twisp	52	10-20-59	13	0.02	33	4.1	4.3	1.2	111	0	14	0.8	0.0	2.1	127	100	215	7.2	0	11
			5-18-60	--	--	--	--	--	--	109	0	--	--	--	--	--	98	190	7.2	--	7
36/19-32	U.S. Forest Service	50	9-16-59	9.0	.02	18	1.0	1.9	.5	62	0	3.7	.0	.0	.5	65	49	111	7.1	5	--

TABLE C8.--Temperature of water, in degrees Celsius, in Methow River near Pateros, station 12449950

Day	1968 October Max	Oct Min	Nov Max	Nov Min	Dec Max	Dec Min	1969 January Max	Jan Min	Feb Max	Feb Min	Mar Max	Mar Min	Apr Max	Apr Min	May Max	May Min	June Max	June Min	July Max	July Min	Aug Max	Aug Min	Sept Max	Sept Min	Oct Max	Oct Min
1	--	--	6	4	3	2	0	0	0	0	6	3	9	7	9	8	12	10	17	13	21	17	19	15	12.0	10.5
2	--	--	6	5	2	1	0	0	0	0	6	4	8	7	9	7	12	11	17	15	21	17	19	16	11.0	9.0
3	--	--	7	5	3	2	0	0	0	0	7	4	8	6	10	7	12	10	17	13	21	17	20	14	11.5	8.5
4	--	--	7	5	3	2	0	0	1	0	6	4	8	7	11	8	12	10	16	14	19	17	16	13	11.5	8.5
5	--	--	6	4	3	1	0	0	1	1	6	4	9	6	12	9	12	10	16	13	18	14	16	11	11.5	9.5
6	--	--	6	4	1	0	0	0	1	0	6	4	9	7	12	10	12	10	17	13	19	14	17	12	12.0	9.5
7	--	--	6	5	1	0	0	0	1	0	7	5	10	7	12	10	11	10	18	14	21	16	18	13	11.0	9.5
8	--	--	6	5	2	1	0	0	0	0	6	3	12	8	11	10	13	10	19	15	20	16	18	14	11.5	10.0
9	--	--	6	5	3	1	0	0	1	0	6	2	11	8	11	9	13	11	20	16	21	16	18	16	11.0	9.5
10	--	--	6	4	2	2	0	0	1	0	5	2	11	9	10	8	--	11	19	16	21	17	20	16	10.5	8.0
11	--	--	5	4	3	2	1	0	1	0	5	2	11	9	9	7	--	--	18	14	21	17	19	17	10.5	8.0
12	--	--	6	4	2	0	0	0	1	0	4	1	11	8	9	7	--	--	17	14	20	16	20	16	10.5	8.5
13	--	--	5	3	0	0	0	0	1	0	5	2	9	8	9	7	--	--	17	13	21	16	18	16	9.0	6.5
14	--	--	4	3	1	0	0	0	1	0	4	2	8	7	9	8	13	12	17	13	22	17	16	13	8.0	5.5
15	--	--	4	2	2	1	0	0	1	0	7	3	10	7	9	7	13	12	18	14	21	17	15	11	8.0	5.5
16	--	--	2	1	2	1	0	0	1	1	8	5	9	8	9	7	14	12	18	14	19	16	14	12	8.0	5.0
17	--	--	3	2	1	0	0	0	1	1	9	6	9	7	9	7	15	13	19	15	19	14	14	13	8.0	5.5
18	--	--	4	3	1	0	0	0	1	1	9	6	9	6	10	8	16	13	20	16	19	16	15	13	8.0	5.0
19	--	--	5	3	2	1	0	0	1	1	9	6	11	8	11	9	16	14	21	17	19	16	15	12	7.0	5.0
20	--	--	6	4	1	0	0	0	1	0	9	6	9	7	11	8	16	14	21	17	21	16	16	12	8.0	6.0

21	--	--	6	5	0	0	0	0	0	0	8	6	10	8	10	8	15	14	21	17	21	16	15	12	9.0	6.0
22	--	--	6	5	0	0	0	0	0	0	8	6	11	8	11	8	15	13	22	17	20	16	14	13	9.5	7.0
23	--	--	5	4	0	0	0	0	1	0	9	5	11	9	10	8	14	13	22	18	21	16	15	13	9.5	8.5
24	--	--	4	3	0	0	0	0	1	0	9	5	9	7	10	8	14	12	22	18	21	17	14	12	8.5	6.5
25	--	--	3	3	0	0	0	0	3	1	9	6	9	6	9	7	14	12	20	18	20	16	16	12	6.5	5.5
26	--	--	4	3	0	0	0	0	4	3	10	6	9	7	9	8	13	11	19	16	19	15	14	12	7.0	5.5
27	--	--	3	2	0	0	0	0	5	3	11	7	10	8	9	8	13	11	20	16	18	14	13	11	7.0	6.5
28	--	--	3	2	0	0	0	0	5	3	11	7	9	8	9	8	13	11	21	17	17	14	14	11	8.5	6.0
29	--	--	4	3	0	0	0	0	--	--	10	7	8	6	10	8	13	12	21	17	17	13	13	12	8.0	6.5
30	7	--	3	2	0	0	0	0	--	--	11	7	8	6	11	8	15	12	21	17	19	14	13	11	9.0	7.0
31	7	4	--	--	0	0	0	0	--	--	10	8	--	--	11	8	--	--	22	17	19	14	--	--	9.0	7.0
Average	--	--	4.9	3.5	1.2	0.5	0	0	1.2	0.5	7.6	4.6	9.5	7.3	10.0	8.0	13.5	11.6	19.1	15.3	19.8	15.7	16.1	13.1	9.5	7.5

TABLE C8.--Temperature of water, in degrees Celsius, in Methow River near Pateros, station 12449950--Continued

Day	1969				1970																			
	November		December		January		February		March		April		May		June		July		August		September		October	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	8.5	6.5	1.0	0.5	0	0	0	0	4.0	2.0	11.0	8.0	16.0	11.0	13.0	11.0	16.0	13.5	18.5	16.5	19.5	15.5	15.0	11.5
2	8.0	6.5	1.0	1.0	0	0	0	0	4.0	1.5	11.0	8.0	16.5	13.0	12.0	11.0	18.5	14.5	18.5	16.0	18.5	15.5	15.0	11.5
3	8.0	6.5	1.0	0	0	0	0	0	5.0	3.0	10.0	7.0	17.0	13.5	12.0	10.5	20.0	16.0	21.0	15.5	18.0	16.0	15.0	11.5
4	8.0	7.0	1.0	.5	0	0	0	0	4.5	1.0	11.5	8.0	16.0	13.5	12.0	10.5	21.5	18.0	23.0	18.0	18.5	14.0	14.5	11.5
5	8.0	7.0	.5	0	0	0	0	0	3.5	.5	12.0	10.0	14.5	12.0	11.5	9.5	20.5	17.0	23.5	19.0	17.0	14.5	13.5	11.5
6	7.0	6.0	.5	0	0	0	1.0	0	3.5	3.0	11.5	9.5	14.0	11.0	12.0	10.0	20.5	16.5	23.0	18.5	18.5	14.5	12.0	10.0
7	7.0	5.5	.5	0	0	0	3.0	.5	5.5	3.0	10.5	7.0	14.0	11.0	12.0	10.5	21.0	17.0	21.5	17.0	17.0	15.0	10.0	7.0
8	6.5	5.5	1.5	.5	0	0	4.5	3.0	7.0	3.5	11.0	7.0	12.0	10.5	11.5	10.0	22.0	18.0	20.5	16.0	18.0	14.0	9.5	8.0
9	6.0	5.0	2.0	1.5	0	0	4.5	3.0	7.0	3.5	11.5	9.5	11.0	9.0	11.5	10.0	21.5	18.0	21.0	16.0	16.5	13.0	10.5	8.5
10	6.0	4.5	2.0	1.5	0	0	4.5	3.0	7.0	3.5	11.0	9.0	10.5	8.5	11.5	9.5	21.5	18.0	22.0	17.0	17.0	12.0	10.5	8.5
11	5.5	5.0	1.5	0	0	0	4.0	3.0	6.5	3.5	10.5	7.0	11.0	9.0	11.5	10.0	21.0	18.0	23.5	18.0	16.0	12.0	12.0	9.0
12	5.5	4.0	1.0	0	0	0	4.0	3.0	5.5	4.0	10.5	6.5	11.0	9.0	13.0	10.0	20.5	18.0	23.0	18.5	14.5	11.5	11.5	9.0
13	5.0	4.0	1.5	1.0	0	0	5.5	3.0	7.0	4.5	11.0	8.0	11.5	8.5	13.0	10.5	21.0	16.5	23.0	18.5	14.0	9.5	11.0	8.5
14	5.0	3.5	3.0	1.5	0	0	5.5	4.0	8.0	6.5	11.5	8.0	13.0	10.0	11.0	10.0	21.5	17.0	21.5	17.0	14.0	10.5	10.5	8.0
15	6.0	4.5	2.0	1.0	0	0	5.0	4.5	8.0	6.0	11.5	9.0	15.0	10.5	13.5	10.5	22.0	18.0	21.5	16.5	15.0	11.0	9.5	6.5
16	4.5	3.0	1.5	1.0	0	0	5.0	4.5	9.5	6.0	12.0	8.5	16.5	13.0	13.5	11.0	23.0	19.0	22.0	17.0	15.0	11.5	9.0	6.0
17	3.0	1.0	2.0	1.0	0	0	6.5	4.5	9.5	5.5	12.0	8.5	15.0	11.5	14.5	12.0	21.5	19.0	20.5	16.5	15.5	13.0	--	--
18	3.5	1.5	3.5	2.0	0	0	5.5	3.5	9.0	5.5	11.5	9.0	11.5	10.0	15.0	13.5	22.0	18.5	21.0	16.5	16.0	13.5	--	--
19	3.5	3.0	3.5	3.0	0	0	5.0	3.0	9.0	5.5	12.0	9.5	12.0	10.0	15.5	13.5	23.0	19.0	21.0	16.0	15.5	13.0	--	--
20	3.0	1.5	4.5	3.5	0	0	5.0	2.0	8.5	6.0	11.0	10.0	12.0	10.5	16.0	14.5	20.5	18.0	22.0	17.0	15.0	12.0	--	--
21	3.0	1.5	4.0	3.0	0	0	4.5	1.5	9.0	6.0	11.5	9.5	11.5	10.5	15.5	14.5	20.5	17.0	22.0	18.0	14.0	11.0	--	--
22	2.0	1.0	3.5	3.0	0	0	4.5	1.5	9.0	6.0	10.5	9.0	11.0	10.5	16.0	13.5	20.5	16.5	23.0	18.0	14.5	12.0	9.0	7.0
23	3.5	2.0	3.0	2.0	0	0	5.0	2.0	10.0	6.5	11.0	9.5	11.5	9.5	16.5	14.5	20.5	17.0	23.5	18.5	13.5	10.5	9.5	8.0
24	3.0	1.5	2.0	1.5	0	0	5.0	2.0	10.0	6.0	11.0	10.0	12.0	9.0	16.5	15.0	20.0	17.0	23.5	19.0	13.0	9.5	9.5	8.0
25	2.0	1.0	1.5	1.0	.5	0	5.0	2.0	9.5	6.5	11.0	9.0	13.0	9.0	17.0	14.5	18.5	16.5	20.5	16.5	13.0	9.0	8.5	6.0
26	1.5	.5	1.5	0	.5	0	5.0	2.0	10.5	6.5	9.5	8.0	11.5	9.0	16.5	15.5	18.5	16.0	18.5	16.0	14.0	9.5	6.5	5.0
27	1.0	0	0	0	.5	0	4.5	2.0	9.5	7.0	13.5	8.5	10.0	9.0	16.5	14.5	20.0	16.0	17.0	15.0	15.0	10.5	6.0	4.0
28	.5	0	0	0	0	0	5.0	2.0	10.5	7.0	14.5	10.0	10.0	8.5	16.0	14.5	20.0	16.0	19.5	15.5	15.5	11.5	--	--
29	1.0	.5	0	0	0	0	--	--	10.0	8.5	13.0	10.0	9.0	8.5	14.5	13.0	19.0	15.0	19.5	15.5	15.5	12.0	--	--
30	1.0	0	0	0	0	0	--	--	11.0	8.0	15.0	10.0	11.0	8.5	15.5	12.0	19.5	15.0	19.0	15.5	15.0	12.0	--	--
31	--	--	0	0	0	0	--	--	10.5	7.0	--	--	12.0	10.0	--	--	20.5	15.5	18.5	15.5	--	--	--	--
Average	4.5	3.5	1.5	1.0	0	0	4.0	2.0	8.0	5.0	11.5	8.5	12.5	10.0	14.0	12.0	20.5	17.0	21.0	17.0	15.5	12.5	--	--

TABLE C9.--Air and water temperatures at streamflow-gaging stations

Date	Time	Temperature (°C)		Date	Time	Temperature (°C)		Date	Time	Temperature (°C)	
		Air	Water			Air	Water			Air	Water
23. Andrews Creek near Mazama (12447390)											
9-28-67	1250	21.1	7.8	7-17-69	1030	20	6.7	10-20-70	1440	0.6	2.8
6-27-68	1150	16.7	7.8	7-28-69	1055	12.2	6.1	11-19-70	1000	-.6	2.2
7- 3-68	1150	28.3	7.8	10-10-69	1210	3.9	4.4	1-20-70	1300	2.2	.6
8- 8-68	1445	24.4	10	10-21-69	1200	0	1.1	3-16-71	1150	2.2	.6
10- 2-68	1235	6.7	3.3	2-12-70	1245	1.7	1.1	5- 7-71	0920	16.7	3.9
10-31-68	1415	-1.1	1.7	4-14-70	1210	7.2	1.7				
2-18-69	1530	-1.1	1.1	5-15-70	1135	8.9	2.2				
5-14-69	1300	18.9	3.3	6- 3-70	1625	25.6	5.6				
5-27-69	1355	7.2	2.8	7-24-70	1205	26.1	8.3				
6-13-69	1045	21.1	7.2	8-26-70	1230	25	12.2				
61. Methow River at Twisp (12449500)											
11- 8-45	1240	-8.9	--	6-13-50	1045	22.2	7.8	8-11-54	1530	31.1	--
3-13-46	1445	8.3	5.6	6-20-50	1730	26.1	9.4	9-22-54	1400	23.9	14.4
5- 1-46	1650	16.1	6.7	7-24-50	1715	27.2	8.3	10- 1-54	1105	14.4	8.3
5- 8-46	1005	20	7.8	9- 4-50	1830	26.7	16.1	10-20-54	1115	4.4	4.4
5-22-46	1510	16.7	6.7	9- 5-50	1035	22.2	13.9	1- 5-55	1115	-2.2	0
7-31-46	1915	15	13.9	10-23-50	1215	8.3	10	2- 3-55	0900	-6.7	.6
9-13-46	0950	16.1	12.2	11-25-50	1425	3.3	2.8	2-27-55	1330	-2.2	.6
12-19-46	1100	-13.3	0	1-16-51	1610	-5.6	2.2	3-19-55	1720	5	3.9
1-28-47	1240	-7.2	0	1-17-51	1100	-3.3	2.2	4-20-55	1710	4.4	4.4
2-30-47	1250	16.7	5.6	2-23-51	1605	-1.1	2.2	5-18-55	1745	23.9	--
5-19-47	1515	21.1	6.7	4-12-51	1505	15.6	8.3	6- 2-55	1150	18.3	6.1
6-29-47	1430	25.6	13.3	5-17-51	1015	16.7	6.1	6- 6-55	1555	24.4	6.7
8-11-47	1150	21.1	14.4	5-20-51	1645	27.8	8.3	6-11-55	2040	33.3	9.4
9-24-47	1150	28.3	13.9	5-28-51	1300	17.2	7.2	6-12-55	1120	30.6	9.4
12-14-47	1438	1.1	2.8	6-20-51	0915	21.1	9.4	6-13-55	1340	22.2	7.8
1-22-48	1145	1.1	.6	8-15-51	1030	23.3	20.6	6-23-55	1215	20	7.8
3- 2-48	1225	3.9	2.2	9-15-51	1935	20.6	11.7	8-10-55	0800	18.3	--
4- 9-48	1250	16.7	10.6	10-24-51	1025	4.4	--	9-15-55	1230	14.4	--
5-25-48	1640	23.3	8.9	12-14-51	1205	-6.7	0	11- 3-55	1415	3.9	5
8- 3-48	1000	21.7	12.8	1-18-52	1200	--	.6	1-17-56	1210	-1.1	1.1
8-24-48	1205	22.8	12.2	3- 6-52	1045	3.3	.6	2-15-56	1405	-15	.6
10- 6-48	1200	2.8	8.9	4-17-52	1100	19.4	7.8	2-29-56	1125	4.4	1.1
11-12-48	1700	6.7	5.6	5- 9-52	1110	22.2	9.4	3-15-56	1605	13.3	6.7
1-19-49	1120	-12.8	0	5-22-52	1025	20	8.3	4-26-56	1440	18.9	--
3-11-49	0830	-.6	1.7	5-27-52	1450	25	8.9	5-22-56	1250	--	6.7
4-15-49	1135	18.3	7.2	6- 9-52	1545	27.8	11.1	6- 2-56	1630	21.7	9.4
5- 4-49	1230	20.6	7.2	6-12-52	0945	12.8	9.4	7-11-56	1730	29.4	14.4
5-11-49	1830	28.9	9.4	7-19-52	1340	30	14.4	8- 3-56	1400	--	14.4
5-15-49	1755	26.1	9.4	9- 5-52	1905	--	17.8	9-12-56	1200	17.8	13.3
5-18-49	2000	18.3	9.4	11-22-52	1330	17.8	8.9	10- 1-56	1230	13.9	11.1
5-20-49	2000	12.8	7.8	12-10-52	1300	-.6	1.7	10- 1-56	1435	17.2	11.7
5-23-49	1800	20.6	8.9	1-20-53	1135	1.7	2.8	10-18-56	1355	14.4	8.9
5-25-49	1435	27.8	8.9	2-19-53	1125	-9.4	.6	11-26-56	1545	-3.9	2.2
6- 3-49	1005	18.3	7.8	3- 3-53	1550	10.6	2.2	5-17-57	1025	16.1	--
6-10-49	0950	22.2	9.4	4-30-53	1630	8.3	6.7	6-22-57	1110	--	10
8- 1-49	1330	29.4	16.1	5- 8-53	1830	11.1	6.7	11-12-57	1645	4.4	7.8
9-20-49	1100	11.1	9.4	5-18-53	1435	17.2	7.8	12-14-57	1050	-3.9	2.2
11-31-49	1700	11.7	7.2	7- 7-53	1500	27.8	10.6	1-25-58	1115	-4.4	2.2
12- 3-49	1220	-1.7	1.7	11- 6-53	1200	10	5.6	2-24-58	1720	6.1	5.6
1-24-50	0950	-17.2	0	12- 3-53	1300	2.2	2.2	12- 2-58	1030	.6	--
3- 3-50	1150	5.6	5	1-21-54	1330	-11.1	0	1- 9-59	1100	3.3	--
5-10-50	1320	25	10	2- 2-54	1600	-1.1	0	2-28-59	1150	-.6	2.2
5-25-50	1720	28.9	10	4- 1-54	1035	2.8	3.3	3-30-59	1500	5.6	7.8
5-30-50	1910	30.6	9.4	5-18-54	1400	25.6	9.4	4-29-59	1435	18.3	8.3
6- 6-50	1015	21.1	9.4	6- 1-54	1445	20	9.4	5- 9-59	1350	14.4	8.9

TABLE C9.--Air and water temperatures at streamflow-gaging stations--Continued

61. Methow River at Twisp (12449500)--Continued

Date	Time	Temperature (°C)		Date	Time	Temperature (°C)		Date	Time	Temperature (°C)	
		Air	Water			Air	Water			Air	Water
5-31-59	0910	20	7.8	7- 7-60	1315	31.7	14.4	11-29-61	0935	5	--
6- 4-59	1315	20.6	6.7	8-10-60	0900	25.6	13.3	12- 5-61	1400	7.2	2.8
6-20-59	1545	25.6	9.4	9-30-60	1520	21.1	13.9	1- 7-62	1300	3.9	5.6
6-23-59	1535	27.8	10.6	9-19-60	1525	26.7	13.3	2-13-62	1400	2.2	--
7-26-59	0850	25.6	12.2	10-18-60	1315	18.3	4.4	3-29-62	0745	1.7	5
8-29-59	1140	20	15	11-20-60	0920	3.9	4.4	4-12-62	1610	21.1	11.7
9-28-59	1520	17.8	11.1	12- 2-60	1050	-5	.6	5- 1-62	1015	11.1	7.8
11- 8-59	1205	.6	2.8	1-28-61	0900	-9.4	.6	5-15-62	1055	16.1	9.4
12- 4-59	1550	2.8	1.7	2-27-61	1330	5	1.1	6-29-62	1200	27.2	5
1- 9-60	1450	-3.9	.6	3-31-61	1430	8.9	2.2	7- 8-62	1310	23.3	22.8
2-18-60	1255	4.4	2.8	5- 1-61	1215	14.4	6.7	8-14-62	1025	25.6	13.3
4- 1-60	1415	10	2.2	5-19-61	1235	25	10	9-18-62	1205	21.7	13.3
4-20-60	0820	10	5.6	5-20-61	0810	21.1	10				
5-13-60	0745	--	4.4	9-30-61	0945	--	13.9				
5-17-60	0920	12.8	5.6	11- 3-61	0900	-1.1	1.1				

66. Beaver Creek below South Fork, near Twisp (12449600)

Date	Time	Air	Water	Date	Time	Air	Water	Date	Time	Air	Water
4-20-60	1530	8.3	3.3	1-21-64	1310	-1.7	0	4- 4-68	1420	12.8	3.3
5-12-60	1615	12.8	3.9	3- 3-64	0900	-2.2	0	5-16-68	1640	20.6	7.8
5-17-60	1015	15.6	3.3	4- 8-64	0750	6.7	1.1	5-21-68	1530	--	3.3
6- 7-60	0800	10	2.8	5-13-64	1655	8.3	5	6-27-68	1605	16.1	11.1
7- 7-60	0845	24.4	10.6	6- 2-64	0820	13.3	6.7	8- 9-68	0905	--	10
8-10-60	1615	31.7	15	6- 7-64	1345	17.8	8.9	10- 1-68	1710	17.8	6.7
8-23-60	1710	16.1	8.9	6-13-64	1645	18.9	10	10-31-68	0920	-1.1	.6
9-19-60	1710	25	6.7	7-23-64	1330	20.6	10.6	12-17-68	1625	-3.9	.6
10-19-60	0755	8.3	3.3	8-27-64	1650	12.8	10	2- 6-69	1600	-3.9	0
11-20-60	1400	4.4	1.1	9-24-64	1550	18.3	8.9	5-28-69	0955	3.3	.6
12-22-60	1200	-3.3	0	10-29-64	1520	6.1	1.7	5- 8-69	1430	23.9	6.1
1-27-61	1525	-5.6	0	12-12-64	0840	-8.3	0	5-13-69	1210	10.6	3.3
2-28-61	1355	-1.1	.6	1-26-65	1635	-7.2	0	5-28-69	1305	16.7	5
5-19-61	1700	23.3	7.2	2-24-65	1000	-3.3	0	6-12-69	1755	--	12.2
5-20-61	0915	15	3.9	4- 6-65	1100	1.1	1.1	7-18-69	0915	18.3	8.9
6-25-61	1840	--	16.7	5-17-65	1845	15.6	3.3	8-28-69	1525	--	10.6
9-29-61	1810	--	8.9	6- 5-65	1610	25.6	10	10- 6-69	1530	12.2	5.6
10- 2-61	1030	-2.2	0	12- 9-65	1250	7.8	0	11-20-69	1540	1.1	0
12- 5-61	0925	3.3	1.7	1-20-66	1050	-11.1	.6	1- 9-70	0920	-5.6	0
2-13-62	1155	2.2	1.1	4- 7-66	1452	21.1	4.4	2-27-70	1150	2.2	.6
3-28-62	1830	1.7	1.1	5-13-66	1340	11.7	5	4- 2-70	1345	--	2.2
4-12-62	1725	15	--	6-22-66	1320	18.9	4.4	4-13-70	1425	7.2	2.2
5- 1-62	1145	13.9	4.4	7-20-66	1017	18.3	10	5-14-70	1635	16.7	6.1
6-29-62	1000	20	4.4	9- 1-66	1450	20.6	11.7	6- 4-70	1710	26.7	11.1
8-14-62	1250	26.7	12.8	10- 4-66	1230	16.7	7.2	7-23-70	1200	30	11.1
9-18-62	0745	7.2	6.7	11- 3-66	1440	8.9	2.2	8-26-70	1623	28.9	13.3
10-16-62	1200	10	3.3	12-19-66	1635	3.3	0	10-21-70	0930	5.6	2.2
11-14-62	0835	1.1	1.1	1-21-67	1058	6.1	0	12- 8-70	0710	-8.9	.6
12-20-62	1000	-1.7	0	3- 2-67	1600	4.4	0	1-21-71	1400	0	.6
1-21-63	1645	-6.7	0	4-11-67	1405	14.4	7.8	3-16-71	1725	3.3	0
3- 1-63	0845	-.6	0	5-20-67	1655	25.6	4.4	5- 6-71	1525	21.7	8.9
4- 2-63	0950	5.6	0	5-23-67	1330	27.8	5	5-13-71	1115	11.7	3.3
4-30-63	1020	8.9	2.8	6- 9-67	1150	27.2	6.7	6-15-71	1750	21.7	8.9
5-29-63	0855	19.4	5	7-25-67	1215	27.2	12.2				
6- 7-63	0930	20.6	9.4	8-31-67	1410	32.8	13.9				
6-15-63	1045	26.7	9.4	10- 7-67	1015	10.6	6.7				
6-16-63	0755	14.4	8.3	11- 6-67	1520	1.1	.6				
10- 8-63	1025	15.6	5.6	12-10-67	1415	1.1	0				
11-18-63	1640	3.3	1.7	1-19-68	1055	2.2	.6				
12-20-63	0905	-3.3	0	3- 1-68	1105	--	.6				

TABLE C9.--Air and water temperatures at streamflow-gaging stations--Continued

Date	Time	Temperature (°C)		Date	Time	Temperature (°C)		Date	Time	Temperature (°C)	
		Air	Water			Air	Water			Air	Water
68. Beaver Creek near Twisp (12449700)											
5-16-56	1500	24.4	5.6	1- 9-59	1400	2.2	0	3-31-60	1600	17.2	2.8
5-19-56	1435	--	8.9	2-28-59	1355	5.6	2.2	4-20-60	1210	8.3	5.6
7-17-56	1135	32.8	13.3	3-30-59	1620	6.1	4.4	5-12-60	1230	10	3.9
8- 4-56	1015	--	10	5- 8-59	1600	19.4	8.9	5-17-60	1010	15.6	3.3
9-12-56	1535	22.2	12.8	5-31-59	1245	23.3	8.9	6- 7-60	1225	17.2	6.7
11-27-56	0950	21.1	0	6- 4-59	0945	--	6.1	8-10-60	1415	36.1	17.2
1-28-57	1655	-12.2	0	6-20-59	1130	28.9	10	9-19-60	1730	23.3	6.7
4-24-57	1435	12.2	3.9	7-25-59	1500	28.9	17.8	10-19-60	1000	10	3.3
5-16-57	1400	--	5	8-28-59	1525	25.6	12.2	11-20-60	1635	1.7	1.1
6-21-57	1645	--	8.9	8-29-59	1620	22.2	12.8	12-21-60	1530	-6.1	.6
11-13-57	1150	4.4	3.3	9-29-59	0955	8.9	6.1	1-27-61	1030	-11.1	0
12-14-57	1420	-2.2	0	11- 8-59	1445	8.3	2.2	2-28-61	1120	-1.1	.6
1-25-58	1455	0	.6	12- 5-59	1015	-5.6	0	5-19-61	1800	23.3	8.3
2-24-58	1520	6.1	1.7	1- 9-60	0930	-15.6	0	5-20-61	1140	30	6.7
12- 2-58	1420	1.7	.6	2-18-60	1610	.6	6.7	9-29-61	1705	--	8.3
								11-26-61	1200	0	1.1
86. Methow River near Pateros (12449950)											
3-11-55	--	6.1	4.4	5-30-61	1710	21.7	10	12-12-64	1055	-12.2	0
2-14-56	--	-4.4	0	6-25-61	1030	35.6	20.6	1-27-65	1250	5.6	.6
3-16-56	1010	9.4	--	9-30-61	1615	--	8.3	2-23-65	1510	5.6	2.8
5-23-56	0930	27.8	8.3	12- 4-61	1350	2.2	2.8	3-30-65	1325	18.3	6.7
6-24-56	1245	40	17.8	1- 8-62	1115	3.3	3.3	5-17-65	1530	23.9	8.9
10-17-56	1525	7.8	10.6	2-14-62	1030	5	4.4	6-19-65	1240	30.6	14.4
11-12-57	1355	7.8	--	3-29-62	1055	10.6	7.2	10-28-65	1325	20	10.6
9-24-57	1130	--	15	4-12-62	1205	16.7	10	11-18-65	1600	6.1	--
12-13-57	1530	-.6	2.2	4-30-62	1615	16.1	8.9	12- 9-65	1525	6.1	1.7
1-24-58	1630	1.7	.6	5-15-62	0930	18.9	--	1- 6-66	1215	-2.2	0
2-25-58	0945	5.6	--	6-14-62	1015	18.9	9.4	1-21-66	1235	-5	0
4-29-59	1115	18.9	8.3	6-29-62	1500	--	5.6	3- 3-66	0845	0	1.1
5- 8-59	1240	22.2	10	7- 9-62	1030	27.8	15	3-21-66	1605	7.8	8.3
6- 1-59	1110	25.6	10	8-13-62	1500	28.3	18.3	4- 8-66	1600	22.2	10
6- 5-59	1000	--	6.7	9-17-62	1535	25.6	14.4	4-28-66	1540	16.1	8.9
6-21-59	1045	27.8	10	10-15-62	1730	13.9	9.4	5-12-66	1145	22.2	8.9
6-24-59	1145	31.1	11.1	11-14-62	1300	7.8	6.1	5-17-66	1620	17.8	10
7-26-59	1700	33.3	17.8	12-20-62	1400	3.9	3.3	5-27-66	1220	24.4	9.4
8-30-59	1500	25.6	14.4	1-21-63	1440	-1.7	0	6-21-66	1510	20	10.6
9-28-59	1120	11.1	9.4	3- 1-63	1030	8.3	3.9	7- 7-66	1300	26.7	14.4
11- 9-59	1215	.6	2.8	4- 1-63	1440	14.4	8.3	7-19-66	2010	21.1	16.7
12- 5-59	1415	.6	0	4-29-63	1535	14.4	11.1	9- 2-66	0850	25.6	15
1-10-60	1230	-3.9	0	5-23-63	1730	26.7	10	9-28-66	1055	25.6	13.9
2-17-60	1415	3.3	2.2	5-26-63	1415	26.1	8.9	11- 4-66	1540	3.3	2.8
4-18-60	1320	12.2	5.6	6-14-63	1140	30	11.1	12-19-66	1500	5	3.3
5-13-60	1400	15.6	5.6	7-16-63	1345	31.1	15	1-20-67	1600	2.2	--
5-17-60	0845	14.4	5.6	10- 7-63	1445	17.2	12.2	2-27-67	1502	8.3	5
6- 6-60	1300	17.8	7.8	11-18-63	1540	2.8	4.4	4-10-67	1345	8.9	--
7- 6-60	1435	38.9	14.4	12-20-63	1240	2.2	1.7	5-15-67	1325	17.8	10
8- 9-60	1415	32.8	21.1	1-22-64	1125	5.6	0	5-22-67	1600	25.6	8.9
9-20-60	1810	19.4	15.6	3- 2-64	1330	2.2	3.3	6- 3-67	1910	20	7.8
9-30-60	1605	20	14.4	4- 7-64	1600	18.3	5.6	6-22-67	1515	21.1	11.1
10-19-60	1500	18.3	9.4	5-14-64	0815	17.2	6.7	6-29-67	1240	27.8	11.7
11-19-60	1530	--	5	5-23-64	1540	20.6	8.9	9- 1-67	1515	35.6	14.4
12- 8-60	1030	-1.7	1.7	6- 1-64	1745	23.3	8.9	9-28-67	0830	14.4	12.2
12-14-60	1550	-3.3	0	6- 7-64	1830	20.6	10.6	10-25-67	1025	5.6	7.8
1-29-61	1020	-1.7	0	7-24-64	0725	17.8	12.8	11-10-67	1615	8.9	5.6
3- 6-61	1100	4.4	1.1	8-28-64	0930	15	12.8	12-11-67	1210	-.6	.6
5-19-61	1050	17.8	10	9-25-64	0815	13.3	11.7	1-19-68	1300	4.4	2.2
5-20-61	1625	29.4	10	11- 4-64	1120	4.4	3.9	2-21-68	1455	6.1	2.2

TABLE C9.--Air and water temperatures at streamflow-gaging stations--Continued

Date	Time	Temperature (°C)		Date	Time	Temperature (°C)		Date	Time	Temperature (°C)	
		Air	Water			Air	Water			Air	Water
86. Methow River near Pateros (12449950)--Continued											
4-11-68	1250	7.2	5.6	5-27-69	1115	15.6	7.8	1-19-71	0900	2.2	0.6
5-22-68	1600	24.4	8.3	7- 9-69	1630	37.7	19.4	3-17-71	1300	5	1.1
7-15-68	1510	28.9	12.2	8-13-69	1200	28.3	17.8	5- 6-71	1200	16.7	8.3
8-22-68	1150	26.7	13.9	9-25-69	1030	14.4	12.2	5-14-71	1415	15.6	6.1
9-25-68	1625	21.1	15.6	11- 7-69	0925	3.9	5.6	6-15-71	1458	20	8.3
10-28-68	1520	8.3	6.1	12- 9-69	1033	3.3	1.7				
10-30-68	1300	--	6.7	1-21-70	1530	2.2	0				
12-11-68	1430	2.8	2.8	2-25-70	1015	4.4	2.8				
1-10-69	1305	0	0	6- 3-70	1130	30	10.6				
1-24-69	1248	-17.8	0	7-15-70	1600	35	21.1				
2-18-69	1500	0	0	8-26-70	0845	18.3	16.1				
3- 7-69	1040	6.7	5.6	10-21-70	1150	6.7	7.8				
3-27-69	1720	14.4	10.6	11-19-70	1245	10.6	2.2				
4-14-69	1525	13.9	8.3	12- 8-70	0900	--	1.1				
4-24-69	1420	15.6	7.8	12-30-70	1700	-.6	0				
88. Alta Lake near Pateros (12450000)											
3-11-55	1520	2.2	0	11-19-60	1545	4.4	6.1	1-16-68	1620	4.4	--
9-15-55	1510	15.6	18.9	12-14-60	1620	-3.3	.6	8-22-68	1313	25.6	21.7
11- 3-55	1830	1.1	8.9	1-28-61	1735	-3.3	0	2-18-69	1600	0	0
2-15-56	0950	-17.8	--	3- 6-61	0830	2.8	0	7- 9-69	1840	32.2	21.1
7-16-56	1355	34.4	24.4	4- 7-61	0845	6.1	3.9	11- 7-69	1015	17.2	10.6
11-26-56	1200	-1.7	3.9	6-25-61	0905	22.8	26.7	1-21-70	1545	1.7	0
1- 7-57	1405	0	0	9-30-61	1630	--	10	2-25-70	1220	5.6	0
3- 7-57	1230	7.2	--	8-13-62	1300	23.9	22.8	4-13-70	1725	12.8	7.8
9-24-57	1440	30	23.3	9-17-62	1200	26.1	13.9	6- 3-70	1340	32.8	--
11-13-57	1535	7.2	9.4	10-15-62	1330	13.3	12.8	11-12-70	1530	18.9	14.4
12- 1-58	1540	1.1	1.1	11-13-62	1635	5	4.4	1-21-71	1030	--	0
1- 9-59	1530	2.8	--	11-14-62	1630	5.6	5.6	3-17-71	1055	--	0
2-28-59	1500	5.6	--	10- 7-63	1435	17.2	18.3	8-10-71	1300	36.7	28.3
3-30-59	1725	6.7	12.8	11-18-63	1330	3.3	4.4				
11- 9-59	1250	--	9.4	12-20-63	1430	1.1	0				
12- 5-59	1435	.6	3.9	3- 2-64	1700	-.6	--				
1- 9-60	1600	-4.4	--	5-14-64	1110	17.8	16.7				
4-18-60	1705	8.9	6.7	6-14-64	0930	21.1	21.1				
5-17-60	0835	14.4	13.3	12-12-64	1315	--	3.9				
6- 6-60	1600	17.8	17.8	2-23-65	1650	1.1	--				
7- 6-60	1630	38.9	25.6	3-30-65	1530	18.3	0				
7-19-60	1800	33.9	27.2	5-17-65	1220	16.7	--				
8- 9-60	1730	31.1	27.2	1-21-66	1020	-4.4	--				
9-19-60	1100	26.1	21.7	9- 2-66	0915	26.7	--				
10-18-60	1315	18.3	12.8	7-29-67	1108	32.2	24.4				