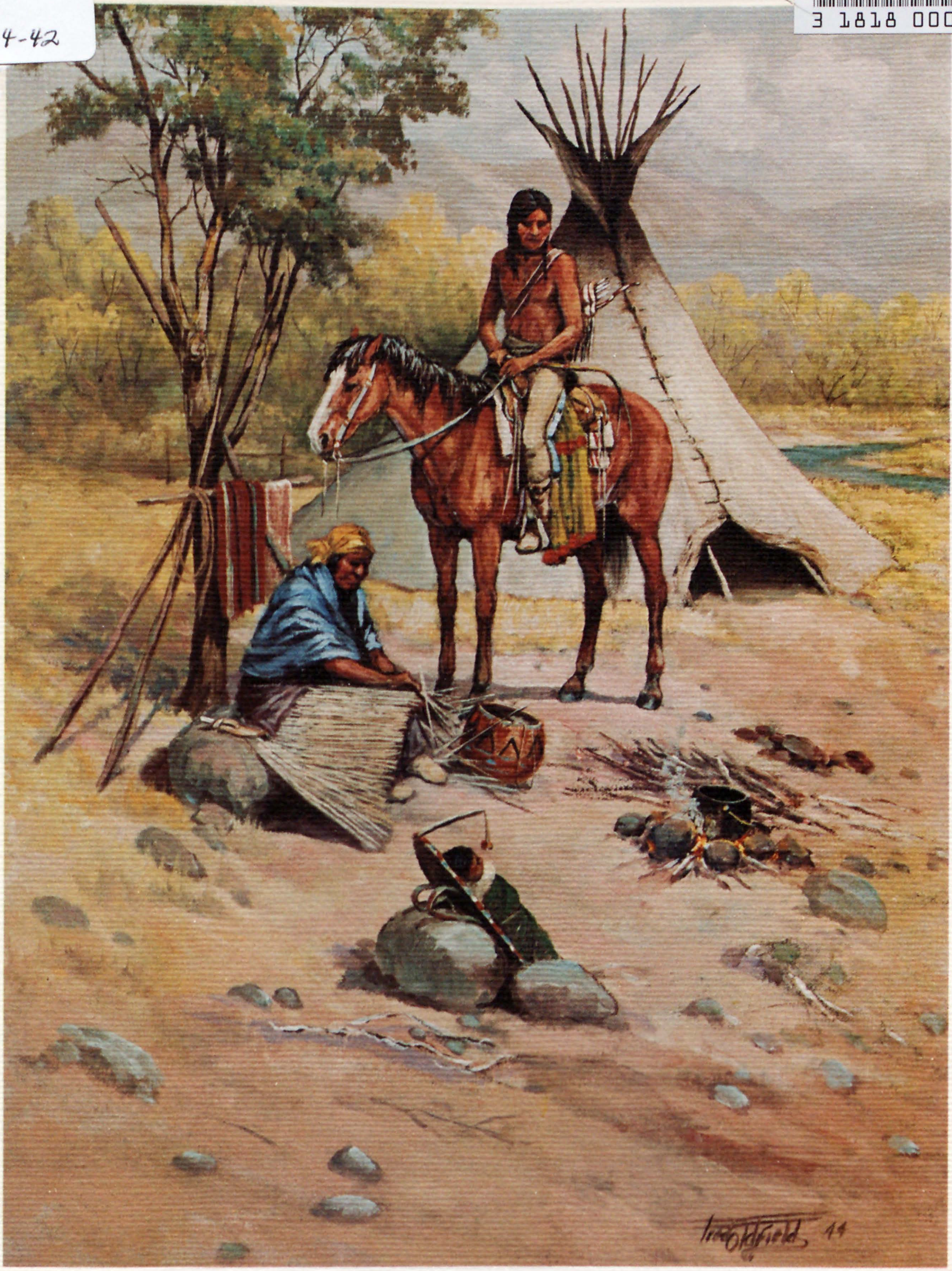

WATER RESOURCES OF THE TOPPENISH CREEK BASIN YAKIMA INDIAN RESERVATION, WASHINGTON

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations 42-74

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Prepared in cooperation with the
Yakima Tribal Council

January 1975

UNITED STATES DEPARTMENT OF THE INTERIOR

Rogers C. B. Morton, Secretary

GEOLOGICAL SURVEY

V. E. McKelvey, Director

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Geological Survey
Water Resources Division
1305 Tacoma Avenue
Tacoma, Washington 98402

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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 obtain
Inches	25.4	millimetres (mm)
	2.54	centimetres (cm)
	0.0254	metres (m)
Feet (ft)	0.3048	metres (m)
Miles (mi)	1.609	kilometres (km)
Square miles (mi^2)	2.590	square kilometres (km^2)
Acres	4047.	square metres (m^2)
Acre-feet (acre-ft)	1233.	cubic metres (m^3)
Cubic feet per second (ft^3/s)	28.32	litres per second (l/s)
	0.02832	cubic metres per second (m^3/s)
Gallons per minute (gal/min)	0.06309	litres per second (l/s)
Gallons per minute per foot [(gal/min)/ft]	0.2070	litres per second per metre [(l/s)/m]
Feet per second (ft/s)	0.3048	metres per second (m/s)
Feet squared per day (ft^2/d)	0.0929	metres squared per day (m^2/d)
Feet per second per square foot [$(ft/s)/ft^2$]	0.3048	metres per second per square metre [$(m/s)/m^2$]
Pounds per square inch (lbs/in^2)	0.07031	kilograms per square centimetres (kg/cm^2)

WATER RESOURCES OF THE TOPPENISH CREEK BASIN,

YAKIMA INDIAN RESERVATION, WASHINGTON

ABSTRACT

The Yakima River, which flows along the eastern margin of the Yakima Indian Reservation, provides about 93 percent of the irrigation water for the eastern part of the Toppenish Creek basin--the major agricultural area in the basin. During 1972, the total surface water diverted from all streams and from ground-water irrigation was nearly 700,000 acre-feet (863 million cubic metres); the quantities contributed from each source are as follows:

Source	Thousands of acre-feet	Percent of total
Surface water:		
Yakima River:		
(a) Main Canal-------------	647.2	92.5
(b) Wanity Slough----------	8.4	1.2
Toppenish Creek via Toppenish Feeder Canal-------	19.8	2.8
Simcoe Creek via Simcoe Creek flume------------------	3.5	.5
Ground water:		
(a) from wells in the basalt---	17.5	2.5
(b) from wells in the valley fill--------------------	3.5	.5
Total (rounded)---	700.0	100.0

The streams in the uplands of the basin have greatly variable flows throughout the year. Flow-duration curves for gaging stations on Toppenish Creek near Fort Simcoe and Simcoe Creek below Spring Creek, near Fort Simcoe, show that at the Toppenish Creek station streamflow was equal to or greater than 16 cubic feet per second (0.45 cubic metres per second) 90 percent of the time during 1944-72, and the flow of Simcoe Creek was 1.3 cubic feet per second (0.037 cubic metres per second) or greater 90 percent of the time for the same period. Present diversions from the Yakima River and from Toppenish Creek and its tributaries provide an excess of about 465,000 acre-feet (573 million cubic metres) of water that leave the basin each year.

The Toppenish Creek basin has three major aquifers: the basalt aquifers, which overlies the entire basin; the old valley fill, which overlies the basalt in the lower parts of the basin; and the young valley fill, which overlies the old valley fill in the eastern parts of the basin. Each aquifer is capable of yielding more than 1,000 gallons per minute (63 litres per second) to individual wells that are open to significant thicknesses of saturated aquifer material. Specific capacities of wells in the young valley fill range from about 2 to 58 gallons per minute per foot (0.4 to 12 litres per second per metre) of drawdown and average about 10 gallons per minute per foot (2.1 litres per second per metre) of drawdown.

During the period 1910-31 about 1.3 million acre-feet (1.6 billion cubic metres) of water entered into storage in the young valley fill. Although the annual-high water levels in the young valley fill have not changed significantly in recent years, there are considerable areal variations in the amplitude of annual water levels. Present (1974) pumpage from this aquifer is about 6,000 acre-feet (7.4 million cubic metres) per year, but as much as 120,000 acre-feet (150 million cubic metres) per year could be pumped. Properly constructed wells could pump about 1,350 gallons per minute (85 litres per second) with about 30 feet (9.1 metres) of drawdown. With minimum spacing of about 0.5 mile (0.8 kilometre) they should have minimal interference.

The old valley fill is composed primarily of sedimentary deposits of the Ellensburg Formation. The distribution of the components of this unit differs widely both vertically and horizontally. Where the aquifer is within 50 feet

(15 metres) of the land surface the upper part of the aquifer is under water-table conditions, whereas water in deeper zones is under artesian pressure. Specific capacities range from about 3 to 300 gallons per minute per foot (0.6 to 60 litres per second) of drawdown. There have been some declines in the heads in the artesian zones of this aquifer within the last 15 years, most likely due to the pumping from the underlying basalt aquifer. The old valley fill yields approximately 6,500 acre-feet (8 million cubic metres) per year to wells in the basin. Currently, an estimated 10,000 acre-feet (12 million cubic metres) of water per year is discharged from this aquifer as underflow beneath the southeastern corner of the basin; a large part of this discharge could be developed by wells.

Yields of wells tapping the basalt range from about 45 to 2,200 gallons per minute (2.8 to 140 litres per second), with specific capacities ranging from less than 1 to 400 gallons per minute per foot (0.2 to 83 litres per second per metre) of drawdown and averaging about 16 gallons per minute per foot (3.3 litres per second per metre) of drawdown. Water levels have declined substantially since the mid-1950's because of increased development of irrigation water from wells tapping the aquifer. About 1,400 acre-feet (1.7 million cubic metres) has been lost from storage; this is less than 1 percent of the total water pumped from the basalt. As much as 118,000 acre-feet (145 million cubic metres) of water may enter the basalt aquifer each year from recharge in the mountainous western highlands and from the overlying old valley fill. Present (1974) ground-water pumpage from the basalt aquifer totals about 16,000 acre-feet (20 million cubic metres) per year. However, this pumpage is inequitably distributed, and water-level declines in excess of 100 feet (30 metres) have occurred in some of the more heavily pumped areas. The potential for increased future pumpage from the aquifer and the probable impact of that pumpage on the heads in the basalt is presented in this report. Near Ahtanum and Toppenish Ridges the development of large withdrawals will result in large drawdowns. In Medicine Valley and in the remainder of the western lowland, expanded development will not result in drawdowns as great as near the ridges. In the eastern part of the lowlands the basalt aquifer has not been tapped. In the southeastern part of the valley, where the potentiometric surface may be as much as 150 feet (46 metres) above land surface, the basalt aquifer offers a potential for additional large supplies of water.

An annual water budget of the basin shows an input of about 683,000 acre-feet (842 million cubic metres) to the basin from precipitation and about 651,000 acre-feet (802 million cubic metres) from diversions from the Yakima River. About 719,000 acre-feet (887 million cubic metres) of the total is consumed by evapotranspiration, and the remainder drains back into the Yakima River, except for a small quantity of ground water that flows eastward beneath the river. Changes in management of the hydrologic system in the basin would allow capture of some or even most of the ground-water outflow.

INTRODUCTION

The Toppenish Creek basin of the Yakima Indian Reservation is on the eastern slope of the Cascade Range. The mountains form a partial barrier to the eastward movement of moisture-laden air from the Pacific Ocean, and, as a result, most of the basin has a semiarid climate. Owing to the dry climate, agricultural development of the abundant arable soils in the basin relies heavily on irrigation for crop production. Sufficient water is available for present needs, with about 651,000 acre-feet (802 million cubic metres) being diverted annually from the Yakima River, about 22,000 acre-feet (27 million cubic metres) from Toppenish Creek and its tributaries, and about 27,000 acre-feet (33 million cubic metres) from ground-water sources. Although sufficient water is generally available for the basin there are problems of distribution and supply within the basin; overpumping of basalt aquifers has produced a marked decline in the hydraulic heads in some areas and has also produced interference between large irrigation wells. Increasing demands for water supplies, plans for irrigating new lands, ground-water problems, and proposals to divert from the Yakima River by water users downstream from the reservation have made an accounting of water availability very important for present-day water management in the basin. The Tribal Council of the Yakima Indian Nation entered into a cooperative study with the U.S. Geological Survey to determine the general amount of water available and to provide information to aid the Tribe in the regulation, management, and protection of this resource.

This report summarizes the results of the study and presents technical information on the water resources of the basin for hydrologists, engineers, planners, and water managers who need this knowledge to guide their endeavors. A brief lay-reader report describing this study is also in preparation for those who may be interested in the general findings and highlights of the investigation without the detail and data compilations contained in this report.

Similar studies are also being conducted on the water resources of the Satus Creek and Klickitat River basins, the two other major drainages of the Yakima Indian Reservation.

Location and Extent of the Basin

The Toppenish Creek basin is the northernmost of three major river basins in the Yakima Indian Reservation. The basin has a drainage area of 627 mi^2 (1,620 km^2) in Yakima County of south-central Washington (fig. 1). With its western one-third forming an upland plateau along the eastern flanks of the Cascade Range. The Toppenish Creek basin descends to the east, from about 5,000 ft (1,520 m) above mean sea level to about 1,000 ft (300 m) in the first 15 mi (24 km). In the remaining 21 mi (34 km) to its eastern border at the Yakima River, the basin descends another 270 ft (82 m) eastward, between Ahtanum Ridge on the north and Toppenish Ridge on the south.

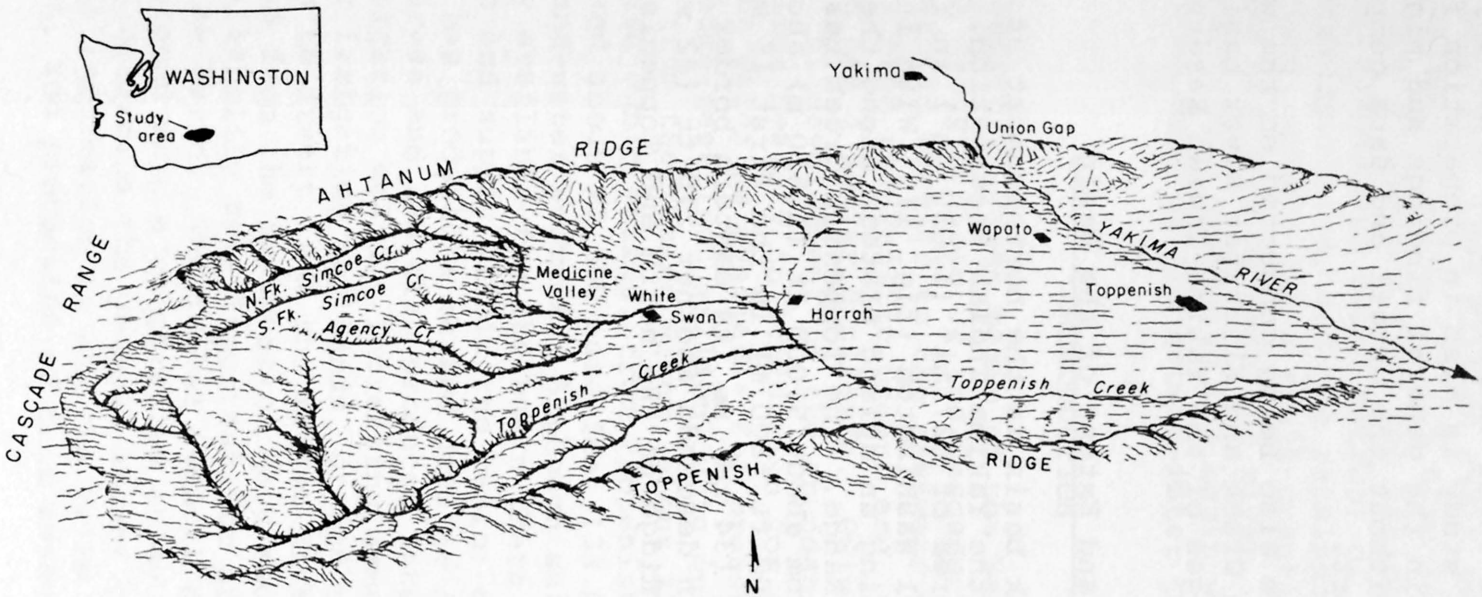


FIGURE 1.--Oblique-view sketch of major topographic features in Toppenish Creek basin.

Purpose and Scope

Toppenish Creek basin is an agricultural area whose productivity is dependent on irrigation. To develop plans for the regulation and management of the basin's water resources, the Yakima Indian Nation needs basic information on the following aspects of the hydrology of the basin:

1. The seasonal and areal distribution of natural streamflow.
2. The location and extent of geologic units relative to their capacity to store and yield water.
3. The degree to which the surface- and ground-water systems are interrelated.
4. The effects of the present and potential development on the hydrologic system.

This report compiles available data on surface and ground water in the Toppenish Creek basin and provides interpretations to satisfy the foregoing objectives.

Previous Studies

Many geologic studies have been made in and adjacent to the Yakima Indian Reservation since the earliest report by Russell (1893). Other early geologic reports covering central Washington are by Smith (1901, 1903) and Waring (1913). These reports discussed the general occurrence of ground water and described some of the earliest wells in the region.

More recent studies that include the reservation lands deal almost exclusively with the geology, and the resulting reports differ considerably in emphasis. Few intensive studies concerned principally with the water resources, such as that of the Ahtanum Valley by Foxworthy (1962), have been made in areas on or adjacent to the reservation. Kinnison and Sceva (1963) utilized limited gaging-station records of tributary streams in the Yakima Reservation in their study of streamflow records of the Yakima River. Numerous unpublished reports and administrative letters concerned with well-site appraisals, damsite proposals, drainage problems, and incomplete well inventories have been made since the late 1950's. Data and results of these earlier studies have been used where applicable in this study.

Acknowledgments

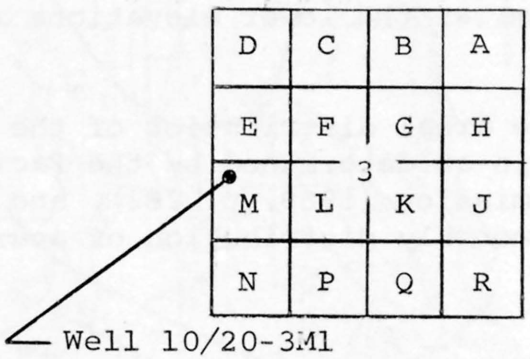
The U.S. Geological Survey is indebted to present and former personnel of the U.S. Bureau of Indian Affairs (BIA) for their considerable help in coding well forms, measuring water levels in wells, servicing water-stage recorders, and many other services. Appreciation is gratefully extended to Dick Anderson of the Yakima Agency Staff of BIA for the data and assistance provided and to Judd Allsop, Project Engineer, and J. B. Caruthers of the Wapato Irrigation Project Office of BIA, for providing data on the project's surface-water diversions. The cooperation of G. D. Black and H. L. Sexton of the Fort Simcoe Job Corps Center in installing gaging stations and servicing the Agency Creek gaging station is acknowledged. Special thanks are due the many well owners, including the cities of Wapato and Toppenish, for permitting their wells to be measured or tested. Without their cooperation this study would have been much more limited in scope.

D. O. Gregg and R. J. Burt collected the ground-water and geologic data and prepared the water-level-contour maps for this report, E. G. Nassar collected the surface-water data and performed most of the analyses of these data, and R. D. Mac Nish and G. G. Parker, Jr., prepared the report. Technical review of the manuscript by B. L. Foxworthy and H. H. Tanaka of the U.S. Geological Survey enhanced the final report.

WELL- AND SPRING-NUMBERING SYSTEM

In this report wells and springs are designated by symbols that indicate their locations according to the official rectangular public land survey. For example, in the well symbol 10/20-3M1, the part preceding the hyphen indicates successively the township and range (T.10 N., R.20 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, except in the computer printout of well records (appendix III, end of report). The first number following the hyphen indicates the section (sec.3), and the letter "M" gives the 40-acre (162,000 m^2) subdivision of the section, as shown in the diagram below. The numeral "1" indicates that this well is the first one listed within subdivision "M."

T.10 N., R.20 E., sec.3



As listed in appendix III, which is a computer printout of selected wells in the study area, this well is designated by the number 10N20E03M01. In the table, the wells are also given numbers designating their latitude and longitude locations.

THE HYDROLOGIC ENVIRONMENT

The hydrologic environment is controlled naturally mainly by climate, slope and shape of the land surface, and the types of rock materials that occur beneath the land. Below are discussed these various characteristics--and the activities of man--as they apply to the water resources of the Toppenish Creek basin.

Climate and Precipitation

Hot, dry summers and cold, dry winters characterize the climate in the Toppenish Creek basin. Daytime temperatures generally range from 25° to 40°F (-4.0° to 4.5°C) in winter to 75° to 95°F (24° to 35°C) in summer. Because the basin lies in the rain shadow of the Cascade Range, the annual precipitation ranges from more than 50 inches (1,270 mm) at the higher elevations in the western part of the basin to about 7 inches (178 mm) at the lower elevations in the eastern part.

Figure 2 shows the areal distribution of the annual precipitation in the basin as determined by the Pacific Northwest River Basins Commission (1969, p. 282), and figure 3 shows the percentage monthly distribution of average annual precipitation.

Geology and Physiography

The Toppenish Creek basin is the western half of an east-west oval-shaped geologic trough formed by folded basaltic rocks and is partially filled with unconsolidated sediments ranging from clay to coarse gravel. The major physiographic features of the basin are shown in figure 1.

The geologic origin of the basin can be traced back about 20 million years to the Miocene Epoch. At that time, what is now central Washington was a large plain extending from the present position of the Cascade Range eastward into Idaho and southward into Oregon. The plain resulted from millions of years of fissure-type eruptions of basaltic lavas that today make up the Yakima Basalt of the Columbia River Group. Near the end of the volcanic activity, the area was deformed by compression and the basalt flows were folded into ridges

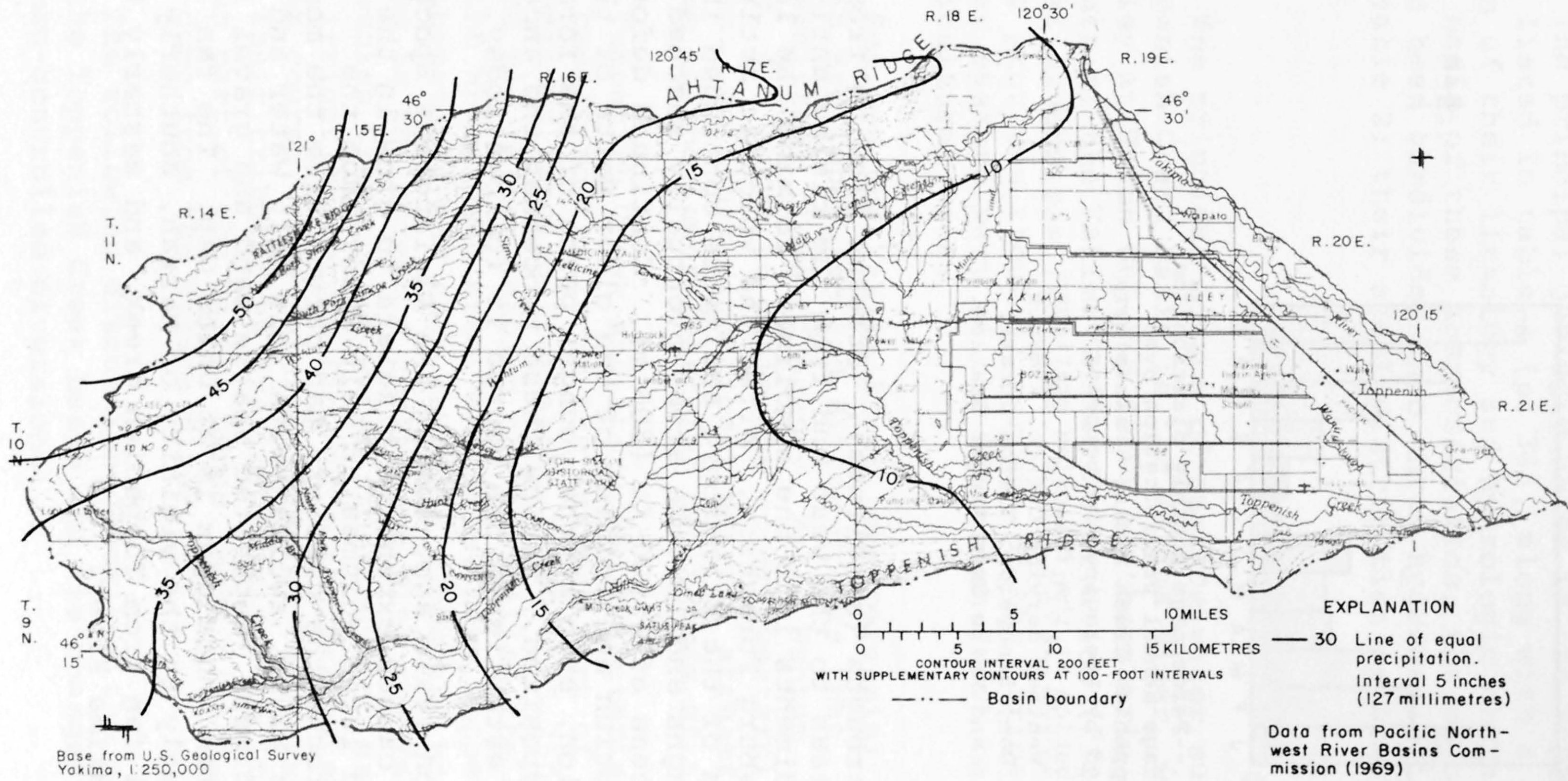


FIGURE 2.--Average annual precipitation in the Toppenish Creek basin.

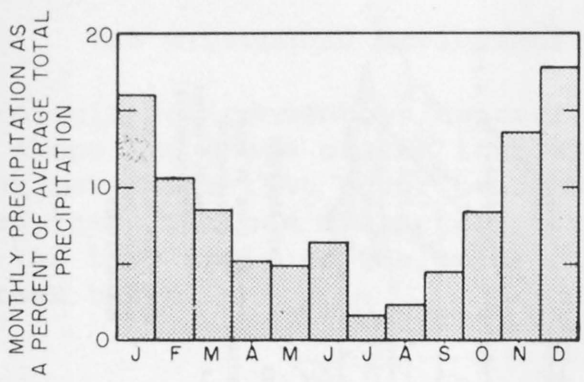


FIGURE 3.--Percentage monthly distribution of average annual precipitation over the Toppenish Creek basin. Values were obtained by averaging the percentage distribution at the following stations: Yakima Weather Service Office, Rimrock Tieton Dam, Sunnyside, Tieton Intake, Wapato, and White Swan Ranger Station.

(anticlines) and troughs (synclines). Streams flowing from the mountainous areas to the west and from the rising anticlines carried sediments into the synclines, forming the lower part of the Ellensburg Formation. After the volcanic activity ceased, deposition of the Ellensburg sediments continued in the deepening troughs and in some areas eventually reached thicknesses in excess of 1,000 ft (300 m). Continued deformation caused disruption and folding of the older parts of the Ellensburg Formation, even as the younger parts of the formation were being deposited. During these processes the ancestral Yakima River established the course it follows today.

About 1 million years ago, during the Pleistocene Epoch, a cooling climate caused extensive glaciers to grow in the Cascade Range, and large volumes of melt water from the glaciers carried rocks the glaciers had carved from the mountains. The Yakima River, swollen with this melt water and overladen with sediment, deposited coarse sand and gravel in a broad alluvial fan whose apex is at Union Gap. The fan extends southwesterly to the vicinity of Harrah, southerly to a similar alluvial fan from Toppenish Creek, and easterly to the present-day Yakima River.

The principal geologic units in the Toppenish Creek basin are listed in table 2 (p. 36), along with a general summarization of their lithology and hydrologic characteristics. On the basis of these characteristics, the major geologic units have been subdivided into three hydrogeologic units as listed in table 2; their areal distribution is shown in figure 15.

SURFACE-WATER RESOURCES

The principal source of surface water supplying the Toppenish Creek basin is the Yakima River, which enters the valley at Union Gap and flows southeasterly along the eastern margin of the Yakima Indian Reservation (fig. 1). Gravity-canal diversions from the Yakima River supply a ditch system that provides about 93 percent of the irrigation water for the lower eastern part of the Toppenish Creek basin--its major agricultural area.

Besides the Yakima River, the perennial streams in the basin are Toppenish and Simcoe Creeks that, combined with the intermittent flows of Agency, Mill, Wahtum, and Hunt Creeks (fig. 4), serve to drain the upper (western) one-third of the basin. No other significant natural streamflow enters Toppenish Creek in the lower (eastern) two-thirds of the basin.

Toppenish Creek and its upper tributaries originate in the basalt foothills in the western part of the basin, at elevations ranging from about 3,500 to 5,250 ft (1,070 to 1,600 m). After leaving the foothills, the streams converge in the White Swan area, and from there Toppenish Creek flows southeasterly and then easterly along the base of Toppenish Ridge to the stream's confluence with the Yakima River. Toppenish Creek gains water from abundant ground-water seepage and irrigation return flow from the irrigated areas along its lower course. The natural flows of Toppenish and Simcoe Creeks and their tributaries are insufficient to irrigate most of the lower part of the basin; hence, most of the irrigation water has come from the Yakima River.

The following discussion describes the natural streamflow in the Toppenish Creek basin and the changes in flow caused by man-controlled diversions.

Available Surface-Water Data

Basic data of varying lengths of record and quality are available for streamflow gaging sites in the Toppenish Creek basin. Figure 4 shows the locations of some of the sites and indicates the type of data collected. Table 1 lists the sites by downstream order number, and the periods of record for each site are shown by bars. For those sites to which no downstream order number has been assigned, the sites are alphabetically coded. Appendix II (end of report) lists monthly and annual discharge data for many of the sites for entire periods of record.

By use of a computer statistical-analysis program the long-term gaging-station record for the Toppenish Creek site (12506000) was used to extend the shorter term record for the gaging station on Simcoe Creek (12506500). These two stations provide the nucleus for evaluating the natural streamflow characteristics of the basin. For supplemental streamflow data on smaller tributary streams flowing directly from the uplands, four gaging stations were operated at the following numbered sites (shown in fig. 4):

12506300. North Fork Simcoe Creek near Fort Simcoe
12506330. South Fork Simcoe Creek near Fort Simcoe
12506600. Agency Creek near Fort Simcoe
12507100. Mill Creek near White Swan

As shown in figure 4, three crest-stage gages also were operated in the basin to record peak flood stages in small drainage areas.

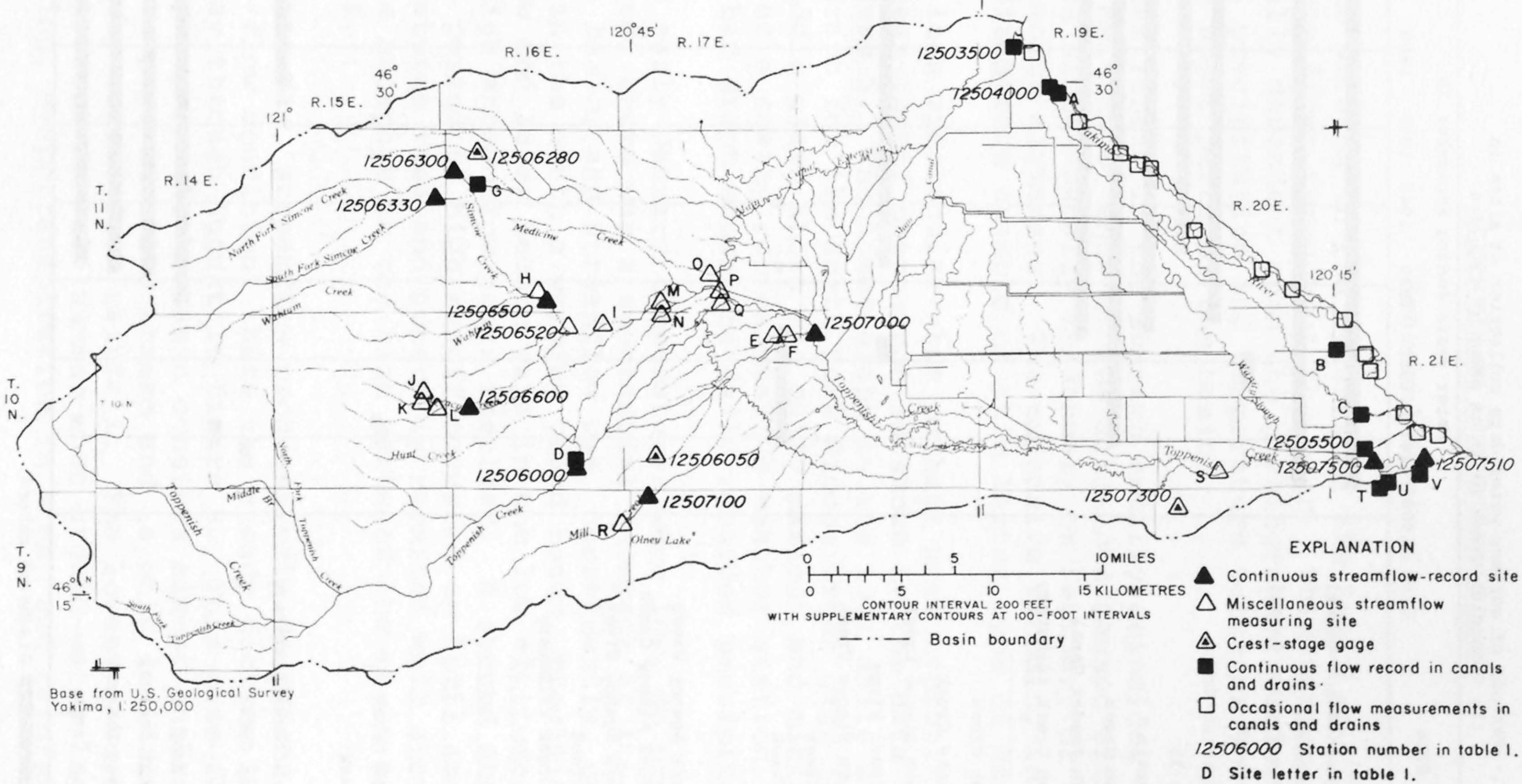
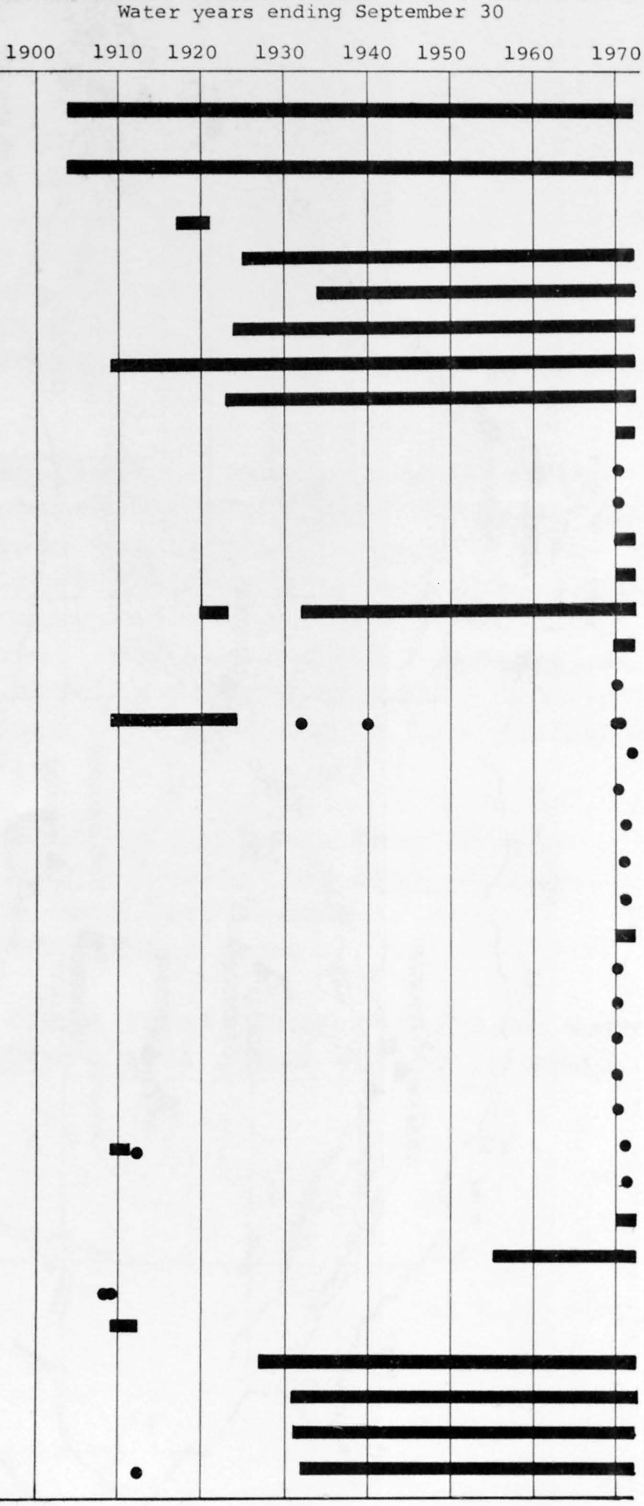


FIGURE 4.--Locations of surface-water data-collection sites in the Toppenish Creek basin.

TABLE 1.--Periods of surface-water data collection at sites in the Toppenish Creek basin as shown in figure 4

Number in fig.4	Site
12503500.	Main Canal (New Reservation Canal)
12504000.	Wanity Slough (Old Reservation Canal)
A.	Wanity Slough
B.	East Toppenish drain
C.	Subdrain 35
12505500.	Marion Drain
12506000.	Toppenish Creek
D.	Toppenish Feeder Canal
12506050.	Toppenish Creek tributary
E.	---do--------------
F.	Toppenish Creek
12506280.	Rattlesnake Creek
12506300.	North Fork Simcoe Creek
G.	Simcoe Creek Flume
12506330.	South Fork Simcoe Creek
H.	Spring Creek
12506500.	Simcoe Creek
12506520.	---do----
I.	---do----
J.	North Fork Agency Creek
K.	Middle Fork Agency Creek
L.	South Fork Agency Creek
12506600.	Agency Creek
M.	Simcoe Creek tributary
N.	---do-------------
O.	---do-------------
P.	---do-------------
Q.	---do-------------
12507000.	Toppenish Creek
R.	Mill Creek
12507100.	---do---
12507300.	Toppenish Creek tributary
S.	Toppenish Creek
12507500.	---do-------
T.	Satus 2 pump
U.	Satus West Lateral
V.	Satus East Lateral
12507510.	Toppenish Creek



Explanation: ▬ Discharge record.

● Discharge measurements.

Note: Occasional flow measurements were made at some sites not listed--discharge measured was direct return flow to the Yakima River.

Streamflow Characteristics

Seasonal Variations

The streams in the uplands of the basin may have highly variable flows throughout the year. This variability is generally dependent upon the physiography, geology, and the annual precipitation and temperature patterns that prevail in the upper parts of the basin.

Peak runoff in the streams usually coincides with the rapid melting of snow at low altitudes caused either by warm Chinook winds--usually in January or February or by inflow of warm, moist airmasses. The extensive flooding in January 1974 is a disastrous example of this latter type of snowmelt.

A less spectacular--but perhaps more typical--example of this peak-runoff phenomenon is shown by the data presented in figure 5. The lower graph is the 1971 daily streamflow hydrograph for the North Fork Simcoe Creek gage (12506300). The middle graph shows the daily maximum and minimum temperatures at a nearby representative weather station, and the upper bar graph shows the daily recorded precipitation.

In early January temperatures were low, no precipitation occurred, there was a substantial snowpack at low elevations in the basin, and streamflow was, consequently, quite low. Later in the month a warming trend began, precipitation began as snow and later became rain in the low altitudes, and two very high streamflow peaks resulted. A second and more prolonged period of high runoff occurred in April and May when temperatures rose and generally remained well above freezing, and the snowpack in the high parts of the basin melted and ran off.

After May, streamflow progressively decreases, and approaches a base-flow condition. Note the steady decline in streamflow from May through August in figure 5. This base flow in the upper part of the basin consists almost entirely of ground-water seepage into the stream and is only incidentally supplemented by runoff from rainfall. The lowest natural streamflows usually occur in late summer when ground-water levels are declining, evapotranspiration is high, and rainfall is sparse.

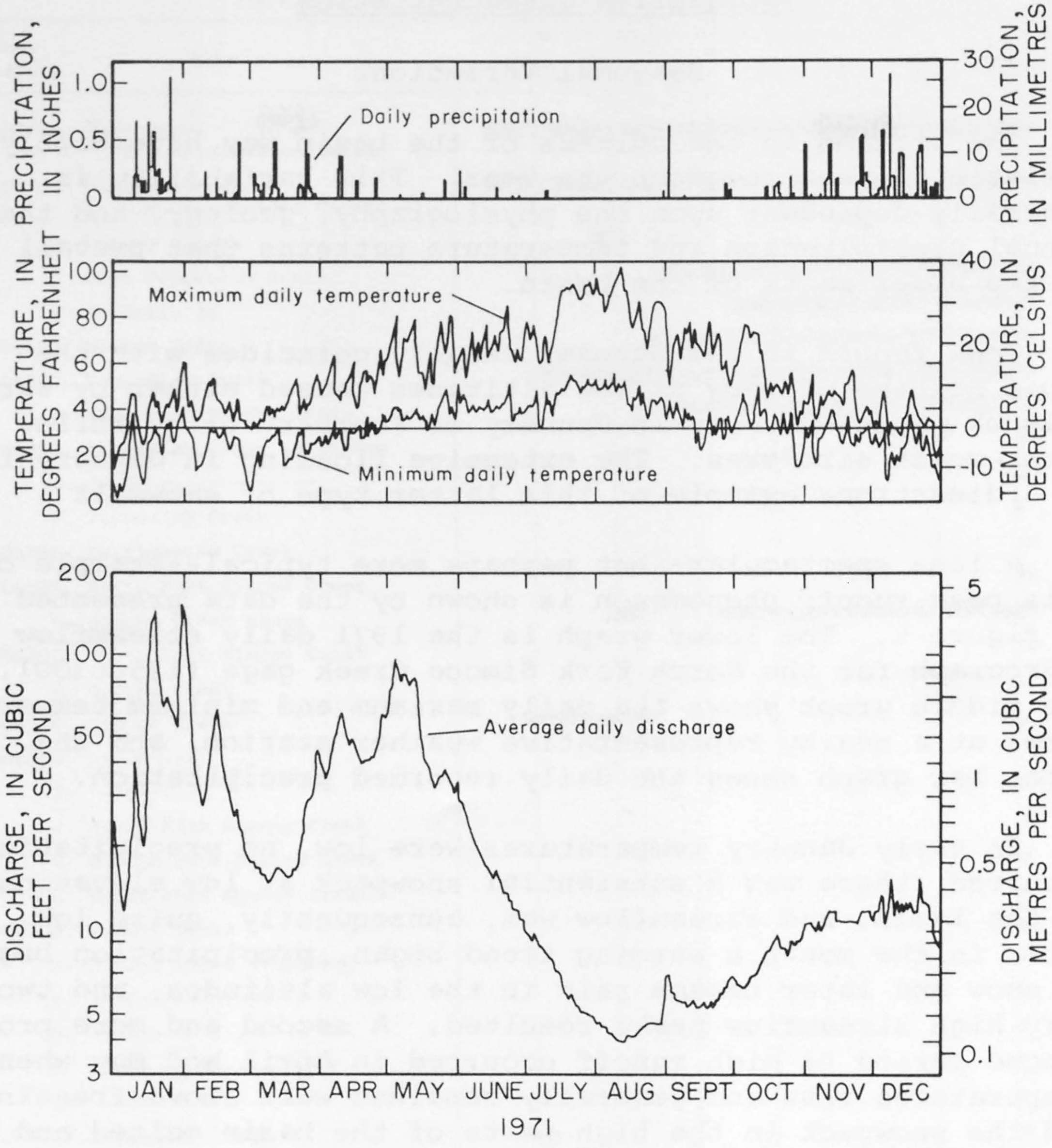


FIGURE 5.--Daily flows of North Fork Simcoe Creek near Fort Simcoe (12506300), and maximum and minimum daily temperatures and daily precipitation at Rimrock Tieton Dam.

In the fall, as temperatures begin to drop, evapotranspiration also declines owing to plant maturity or killing frosts, and precipitation begins to increase. Thus, the long streamflow recession is checked, and the streams again begin to rise. This general trend toward increasing discharge from September into the fall is demonstrated by the hydrograph in figure 5.

Areal Variations

Natural streams in adjacent basins generally have similar but not identical flow patterns throughout the year. This occurs because those factors which most affect streamflow characteristics--physiography, geology and climate--are similar.

Figure 6 illustrates this concept by comparing a 2-year average monthly runoff per square mile of drainage area from Toppenish Creek (station 12506000, which includes diversions into Toppenish Feeder Canal) to that from the combined drainage areas for the two gaged sites on the North and South Forks of Simcoe Creek (stations 12506300 and 12506330). The bar graphs show that the runoff per square mile of drainage area from the Simcoe Creek basin consistently equals or exceeds that of the Toppenish basin, because the mean annual precipitation over the Toppenish Creek basin is only about 30 inches (760 mm) as compared to about 43 inches (1,090 mm) over the Simcoe Creek basin. However, the monthly streamflow pattern for both basins is similar. (Note that for both basins the highest monthly averages shown in figure 6 occur in May and the second highest are in March.) Although the average streamflow at the Toppenish Creek station during the 2-year period used for preparation of figure 6 exceeded the long-term average at that station, the relative distribution of runoff by months is demonstrated and is considered representative.

For comparison, figure 6 includes data for the 2-year average monthly precipitation at the White Swan ranger station (elevation 970 ft or 296 m) and at Tieton Dam (elevation 2,730 ft or 832 m) near Rimrock. The precipitation differences due to elevation are evident. The Tieton Dam data were used because no high-elevation precipitation data were available from the Toppenish Creek basin for that period, and, by virtue of similarities in altitude and terrain, the Tieton Dam values should be generally representative of the precipitation in the

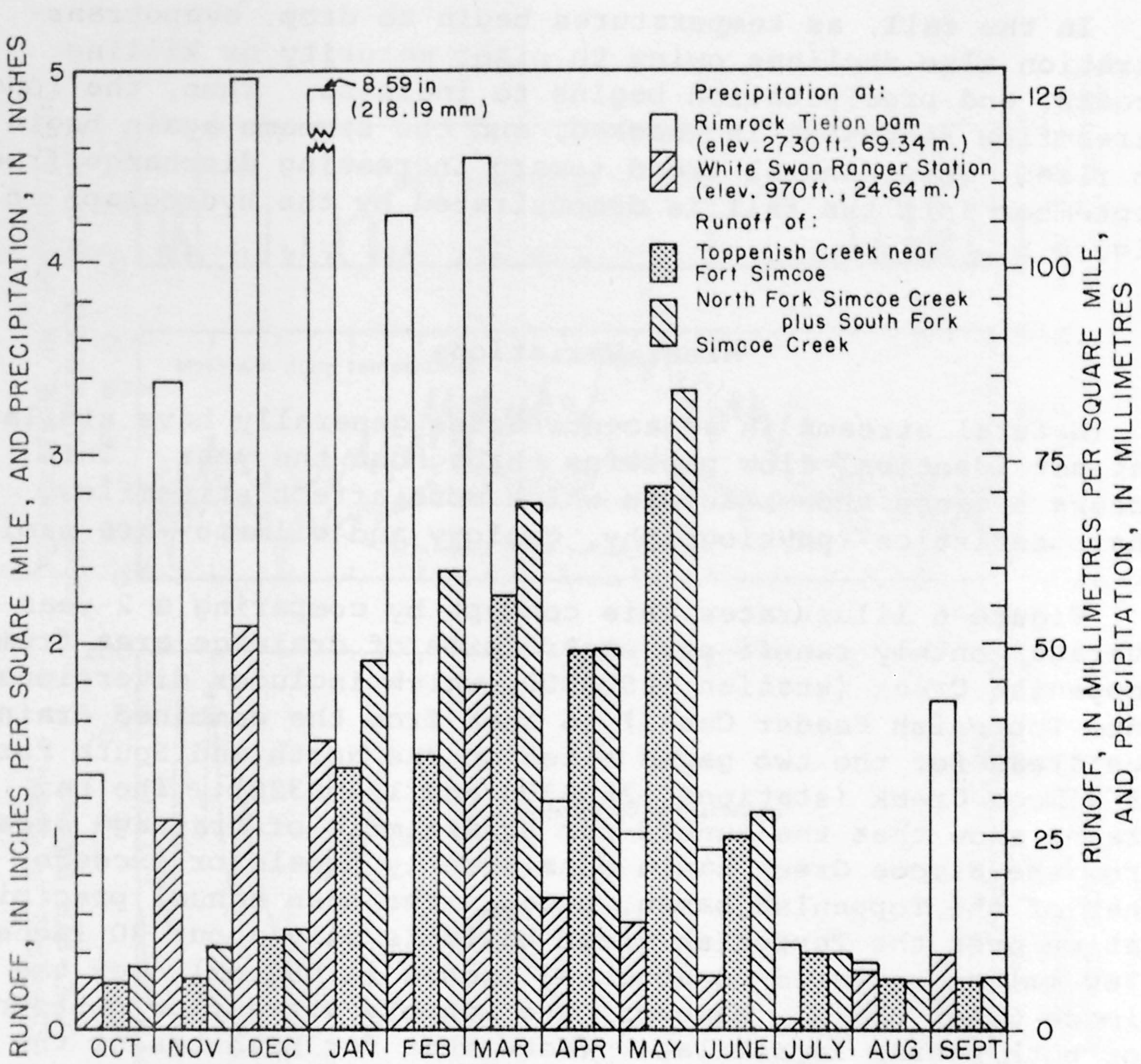


FIGURE 6.--Average monthly precipitation and runoff at selected stations during Oct. 1, 1970-Sept. 30, 1972.

upper Toppenish and Simcoe Creek basins. Note that five consecutive months (November through March) had the highest precipitation, but the highest monthly streamflows did not occur until May--after the high-elevation snowpack melted.

The average precipitation at Tieton Dam for the 2-year period ending September 30, 1972, was about 125 percent of normal. If the normal 30 inches (760 mm) of precipitation in the upper Toppenish Creek basin above the gaging station is increased by 25 percent to about 38 inches (965 mm), then the basin runoff for the 2-year period was about 33.4 percent of total precipitation compared to about 29.6 percent expected during years of "normal" precipitation. In that 2-year period, about 104,000 acre-ft (128 million m^3) of precipitation in excess of the average fell in the basin upstream from the gage site and about 49,000 acre-ft (60 million m^3) of this excess water left the basin as surface-water runoff. Apparently because of the time of year when most of the precipitation occurred, much of the above-average precipitation could not be used by vegetation as evapotranspiration nor did it enter the ground-water reservoir.

Flow Duration

A streamflow-duration curve graphically portrays flow variability at a stream site for a specific period of past time. For that period, it shows the percentage of time that various flows were equaled or exceeded. The lower part of the flow-duration curve is a significant indicator of the quantity of water available in unregulated streams. Also, the slope of the lower part of the curve is a good index of basin storage, including ground-water storage--the flatter the slope, the more abundant the storage in the basin.

Flow-duration curves for the stations on Toppenish Creek near Fort Simcoe (12506000) and Simcoe Creek below Spring Creek, near Fort Simcoe (12506500), are shown in figure 7. These curves show, for example, that at the Toppenish Creek station streamflow was equal to or greater than 16 ft^3/s (0.45 m^3/s) 90 percent of the time during the period 1944-72. Conversely, the flow was less than 16 ft^3/s (0.45 m^3/s) 10 percent of the time during the same period.

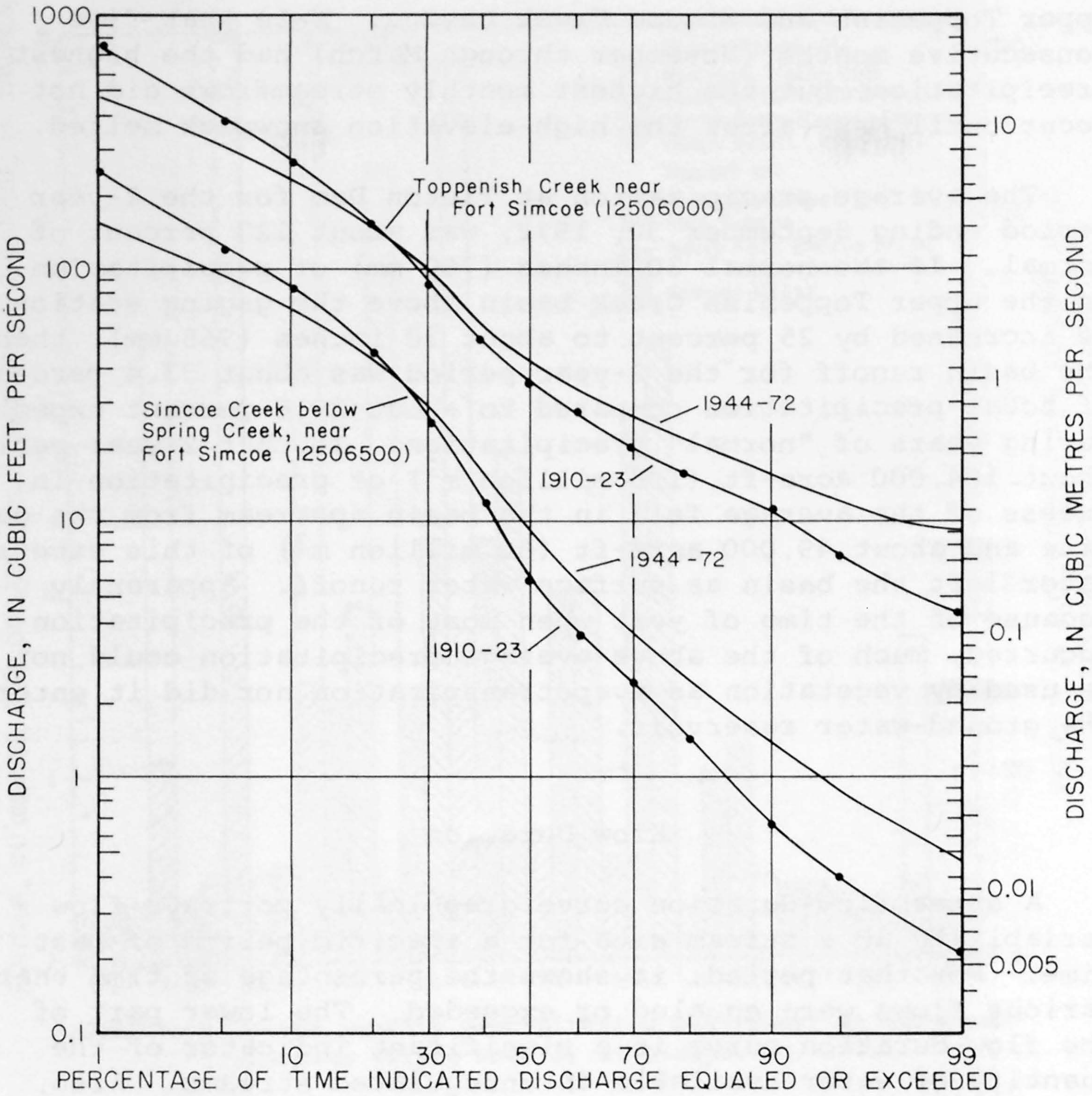


FIGURE 7.--Flow-duration curves for Toppenish Creek near Fort Simcoe (12506000) and Simcoe Creek below Spring Creek, near Fort Simcoe (12506500), for periods indicated.

The figure contains two curves for each stream--one labeled 1910-23, and the other 1944-72. As mentioned on page 14, the long-term record for the Toppenish Creek gaging station was used to synthetically extend the Simcoe Creek record period to 1944-72. Also, the streamflow data for Simcoe Creek included water diverted through the Simcoe Creek flume.

The flow-duration curve for 1944-72 for the Simcoe Creek station indicates that about 90 percent of the time the flow was equal to or greater than 1.3 ft^3/s (0.037 m^3/s) or, conversely, was less than 1.3 ft^3/s (0.037 m^3/s) about 10 percent of the time. The relatively steep slopes of the lower parts of the flow-duration curves for both streams indicate that there is relatively little ground-water contribution to flow in this part of the basin.

Frequency of Low Flows

The flow-duration curve, useful as it is for water-availability studies, does not indicate the sequence or frequency of flows. This deficiency is overcome by flow-frequency curves that show the average frequency, in years, at which specific average discharges may be expected to occur. Thus, the low-flow-frequency curve for a particular stream site shows how often the average discharge for specific time increments may be expected to be less than a selected discharge.

Families of low-flow-frequency curves for Toppenish Creek near Fort Simcoe (fig. 8) and Simcoe Creek below Spring Creek, near Fort Simcoe (fig. 9), were developed for five selected time increments ranging from 7 to 183 days. In figure 8 for Toppenish Creek, the 2-year recurrence interval intersects the 7-day low-flow curve at 14.5 ft^3/s (0.411 m^3/s). This means that the average natural stream discharge may be expected to be less than 14.5 ft^3/s (0.411 m^3/s) during any 7-day period at intervals averaging 2 years. The probability of such an event occurring in any future year is 0.5 (one chance in two) which is the reciprocal of the recurrence interval.

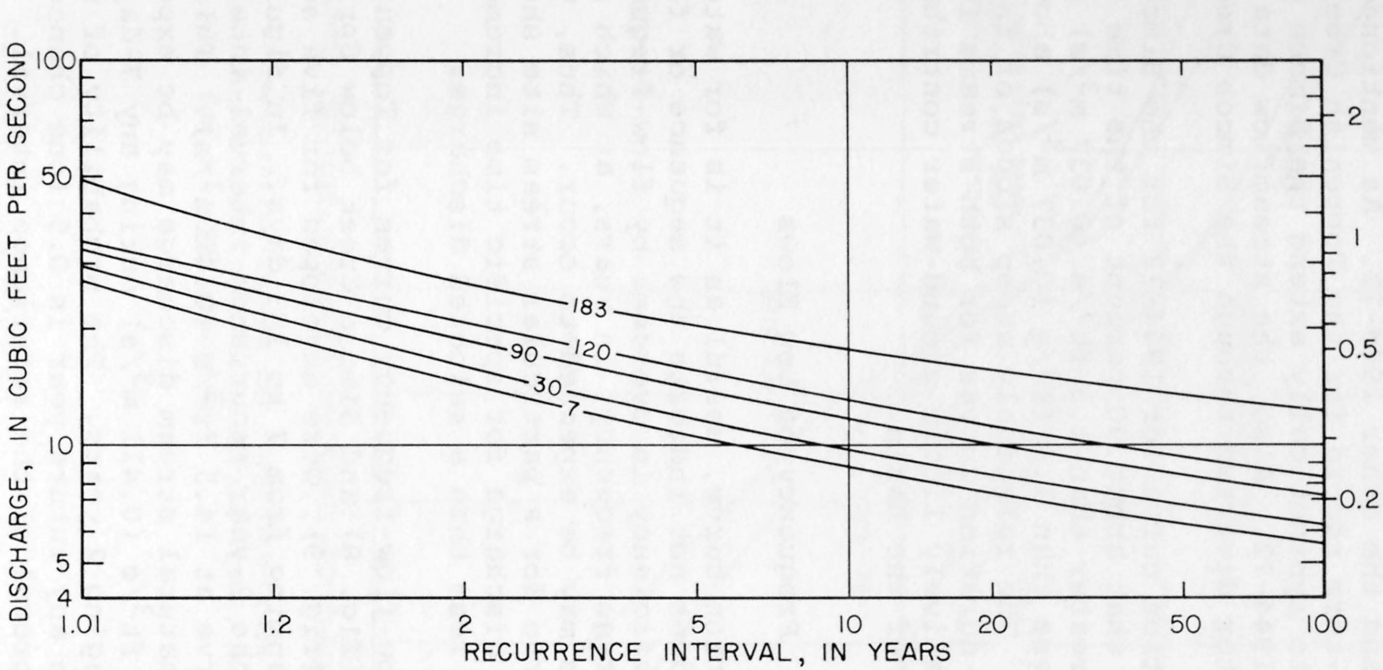


FIGURE 8.--Low-flow-frequency curves of annual lowest mean discharges for indicated numbers of consecutive days, Toppenish Creek near Fort Simcoe (12506000).

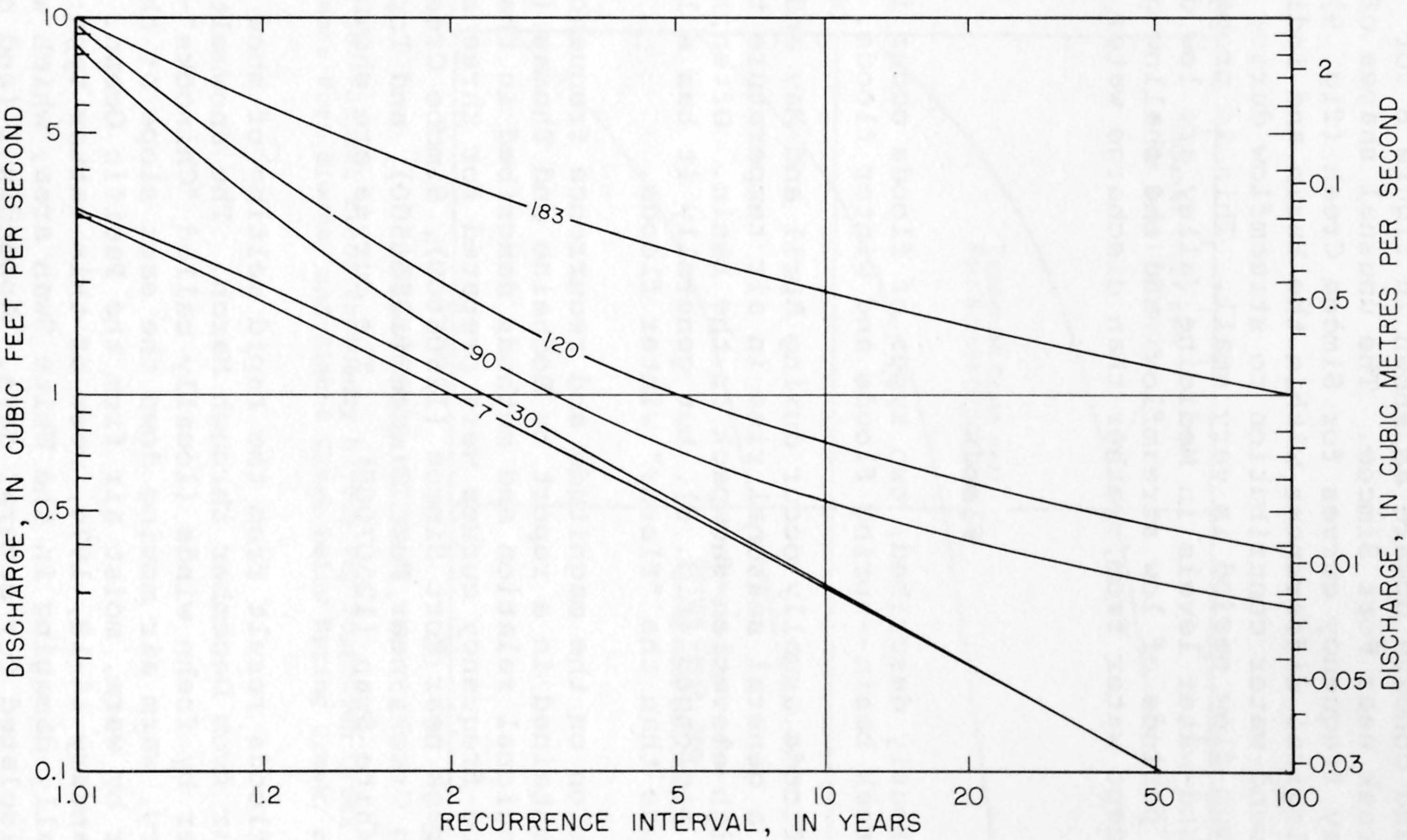


FIGURE 9.--Low-flow-frequency curves of annual lowest mean discharges for indicated numbers of consecutive days, Simcoe Creek below Spring Creek, near Fort Simcoe (12506500).

Usually, low-flow-frequency curves for perennial streams are smooth and concave upward as shown in figure 8 for Toppenish Creek near Fort Simcoe. The unusual shapes of the 7- and 30-day frequency curves for Simcoe Creek (fig. 9) reflect geological differences within the basin and indicate that the ground-water contribution to streamflow during the annual minimum-flow period is very small. This is probably because ground-water levels in Medicine Valley are low during late-summer periods of low streamflow, and the shallow gravels probably accept water from, rather than discharge water to, the stream.

Floods

As previously described, two types of floods occur in the Toppenish Creek basin--spring floods and winter floods.

Spring floods usually occur during April and May and are a result of a general seasonal rise in air temperature that melts the high-elevation snowpack in the basin. Often, this flooding is prolonged (fig. 5), but generally it has a lower peak magnitude than the "flashy" winter floods.

Information on the magnitude and recurrence frequency of floods is contained in a report by Bodhaine and Thomas (1964). Using the regional relation and methods described in that report, flood-frequency curves were prepared for three sites: Toppenish Creek near Fort Simcoe (12506000), Simcoe Creek below Spring Creek, near Fort Simcoe (12506500), and Toppenish Creek near White Swan (12507000). The curves are shown in figure 10.

Winter floods result from the rapid melting of snow and usually occur from December through March. The snowmelt is caused either by foehn winds (locally called "Chinooks"--formed of dry, warm air moving down the east slope of the Cascades) or by warm, moist air from the Pacific Ocean. The floods of January 14-18, 1974, were of this latter type; they were especially damaging in the White Swan area, which was completely isolated for several days. Appendix I (end of report) contains small-scale maps on which the maximum extent of the 1974 flooding in the basin has been approximately delineated. Because the flooding was so extensive, the exact area of inundation and the maximum discharge are unknown. However, based on the maximum discharge of about 33,900 ft^3/s (960 m^3/s) determined for Satus Creek near Toppenish (12508500), the Toppenish Creek flood peak may have exceeded 28,300 ft^3/s (793 m^3/s).

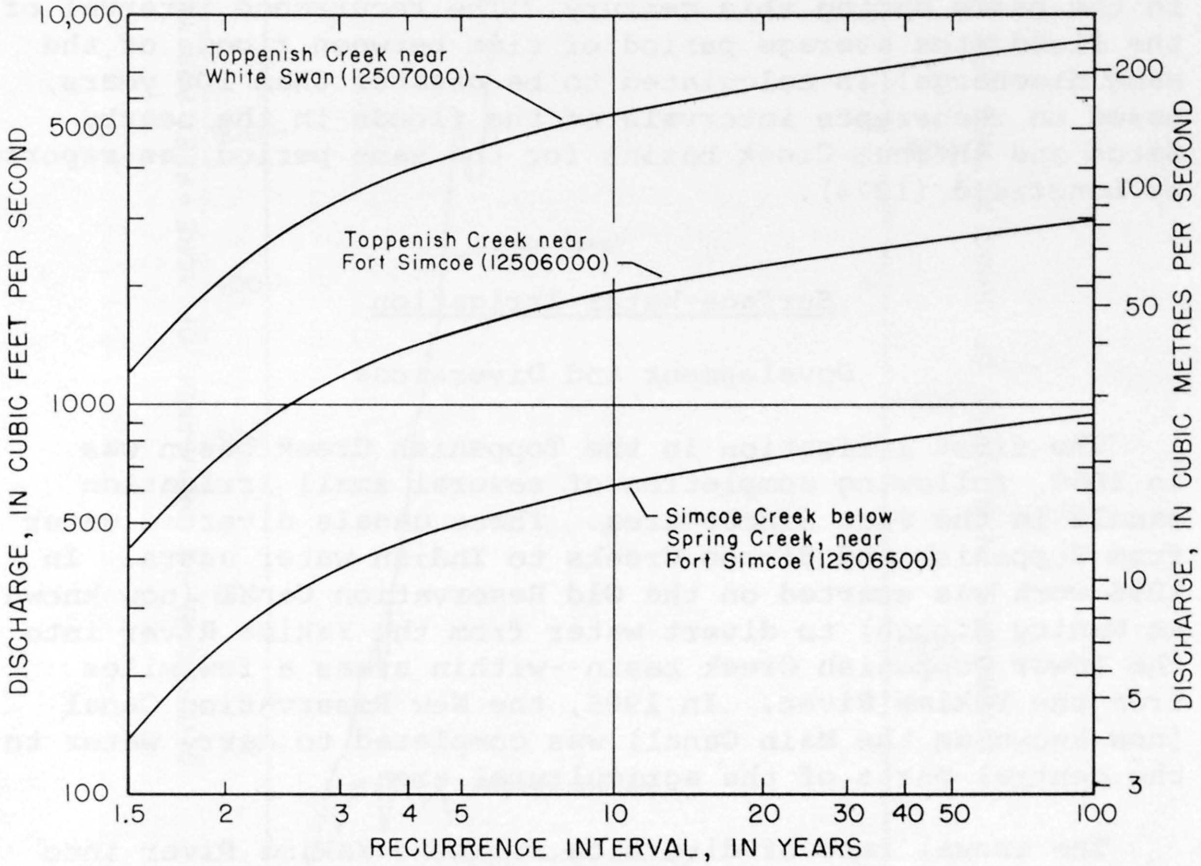


FIGURE 10.--Annual flood-frequency curves for Toppenish Creek near White Swan and near Fort Simcoe, and Simcoe Creek below Spring Creek, near Fort Simcoe.

Note on figure 10 that a flood on Toppenish Creek at White Swan with an average recurrence interval of 100 years would have a peak discharge of about 8,400 ft^3/s (238 m^3/s)--a discharge much less than that of January 1974. Undoubtedly, the magnitude of that flood was much greater than any other flood in the basin during this century. The recurrence interval of the flood (the average period of time between floods of the same discharge) is calculated to be greater than 100 years, based on recurrence intervals of the floods in the nearby Satus and Ahtanum Creek basins for the same period, as reported by Longfield (1974).

Surface-Water Irrigation

Development and Diversions

The first irrigation in the Toppenish Creek basin was in 1859, following completion of several small irrigation canals in the Fort Simcoe area. These canals diverted water from Toppenish and Simcoe Creeks to Indian water users. In 1896 work was started on the Old Reservation Canal (now known as Wanity Slough) to divert water from the Yakima River into the lower Toppenish Creek basin--within areas a few miles from the Yakima River. In 1905, the New Reservation Canal (now known as the Main Canal) was completed to carry water to the central parts of the agricultural area.

The annual rate of diversion from the Yakima River into the Toppenish basin increased rapidly in the early 1900's. As shown in figure 11, diversion into the Main Canal increased from about 25,000 acre-ft (30.8 million m^3) in 1905 to about 647,000 acre-ft (798 million m^3) in 1935. Thereafter until 1972, the diversion averaged about 633,000 acre-ft (780 million m^3), but fluctuated between extremes of 687,200 acre-ft (847 million m^3) in 1947 and 588,100 acre-ft (725 million m^3) in 1963.

The average annual diversion through Wanity Slough prior to 1924 was 67,100 acre-ft (82.7 million m^3). However, the yearly average was only 17,900 acre-ft (22.1 million m^3) from 1925-72 and only 9,860 acre-ft (12.2 million m^3) from 1960-72. In recent years, Wanity Slough has been used mainly during the post-irrigation season as a carrier of water from irrigation drains. During the irrigation season, this water is used to irrigate land, both north and south of the city of Toppenish, and the excess is allowed to flow into Marion Drain.

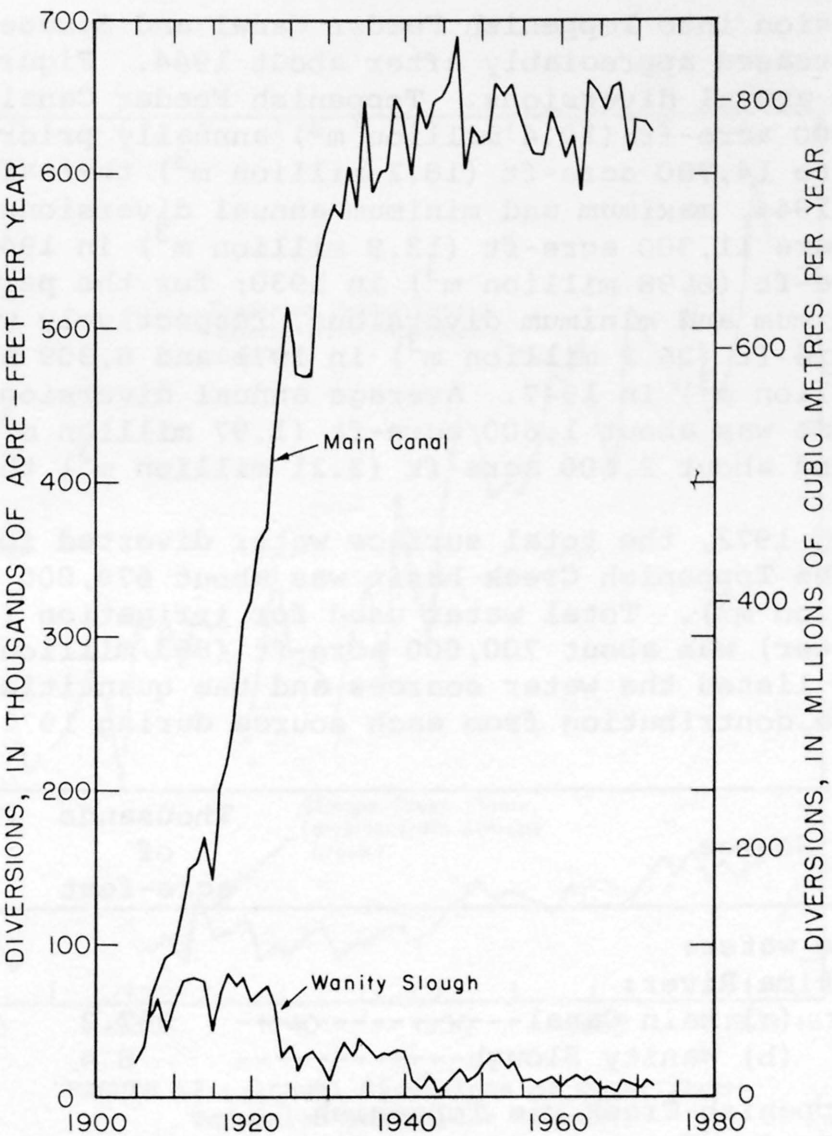


FIGURE 11.--Annual diversion of water from the Yakima River for irrigation in the Toppenish Creek basin.

Diversion into Toppenish Feeder Canal and Simcoe Creek flume increased appreciably after about 1944. Figure 12 shows the annual diversions. Toppenish Feeder Canal averaged about 8,400 acre-ft (10.4 million m^3) annually prior to 1944 compared to 14,780 acre-ft (18.2 million m^3) thereafter. Prior to 1944, maximum and minimum annual diversions, respectively, were 11,300 acre-ft (13.9 million m^3) in 1940 and 5,660 acre-ft (6.98 million m^3) in 1930; for the period after 1944, maximum and minimum diversions, respectively were 21,210 acre-ft (26.2 million m^3) in 1971 and 8,309 acre-ft (10.2 million m^3) in 1947. Average annual diversion in Simcoe Creek flume was about 1,600 acre-ft (1.97 million m^3) prior to 1944 and about 2,600 acre-ft (3.21 million m^3) thereafter.

During 1972, the total surface water diverted for irrigation in the Toppenish Creek basin was about 679,000 acre-ft (837 million m^3). Total water used for irrigation (including ground water) was about 700,000 acre-ft (863 million m^3). Below are listed the water sources and the quantities and percentage contribution from each source during 1972:

Source	Thousands of acre-feet	Percent of total
Surface water:		
Yakima River:		
(a) Main Canal----------------	647.2	92.5
(b) Wanity Slough-------------	8.4	1.2
Toppenish Creek via Toppenish Feeder Canal--------------------	19.8	2.8
Simcoe Creek via Simcoe Creek flume---------------------------	3.5	.5
Ground water:		
(a) from wells in the basalt-----	17.5	2.5
(b) from wells in the valley fill-----------------------	3.5	.5
Total (rounded)--	700.0	100.0

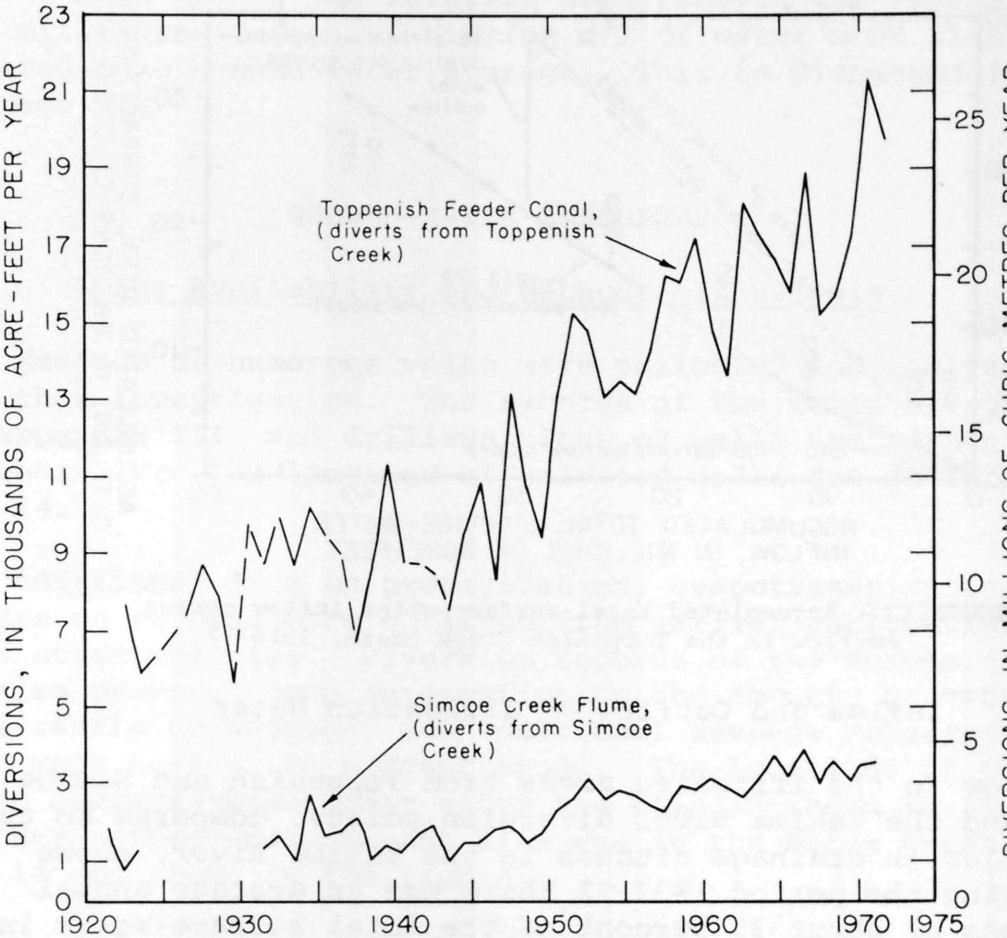


FIGURE 12.--Annual diversions of water from Toppenish and Simcoe Creeks.

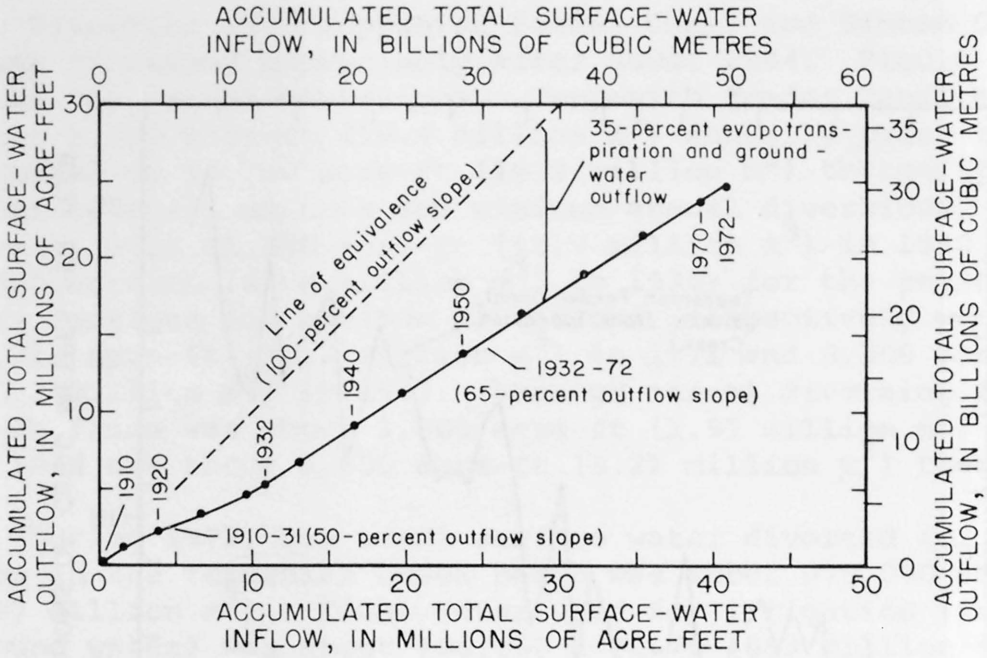


FIGURE 13.--Accumulated total surface-water inflow versus outflow in the Toppenish Creek basin, 1910-72.

Inflow and Outflow of Irrigation Water

Inflow to the irrigated areas from Toppenish and Simcoe Creeks and the Yakima River diversion points, compared to the return flow in drainage ditches to the Yakima River, shows that during the period 1932-72 there was an average annual water loss of about 35 percent of the total surface-water inflow. Figure 13 shows the relation between the cumulative basin inflow and the basin-drain outflows for 1910-72. (Data for 1913-24 were incomplete, and outflow values for this period were estimated.) Figure 13 shows that for 1910-31 the average annual loss was considerably greater--about 50 percent. The difference in annual water-loss rates for the two periods may be partly attributed to ground-water recharge in the early years when excess water went into ground-water storage, raising ground-water levels to new, shallower positions.

From 1910 to 1931 about 10.3 million acre-ft (12.7 billion m^3) of water flowed into the basin, and about 5.2 million acre-ft (6.4 billion m^3) returned to the Yakima River. Of the 5.1 million acre-ft (6.3 billion m^3) remainder, about 3.8 million acre-ft (4.7 billion m^3) is estimated to have been lost to evapotranspiration and ground-water seepage to the Yakima River. Rainfall for

1920-31 was nearly 1 ft (0.3 m) deficient, and the estimated evapotranspiration includes 0.2 million acre-ft (0.2 billion m^3) to make up for the rainfall deficiency. The remaining 1.3 million acre-ft (1.6 billion m^3) of water most likely entered into ground-water storage. This is discussed further on page 40.

GROUND-WATER RESOURCES

Data Availability and Methods of Analysis

Records of numerous wells were collected and analyzed during this investigation. The records of the wells are given in appendix III, and drillers' logs of wells are presented in appendix IV. The location of selected wells are shown in figure 14.

Additional data on precipitation, evapotranspiration, and diversion records were obtained from earlier publications and from other agencies. Diversion records of the Bureau of Indian Affairs provided some information on the amounts of water lost from canals by seepage, and additional seepage measurements were made during the present study. The locations of two of these seepage-measurement sites are also included in figure 14. Another seepage-measurement site was in the Satus Creek basin and is not shown in the figure.

In order to evaluate the water resources of the basin, which contains several distinct water-bearing rock units, a general understanding was needed of how the entire aquifer system functions and the quantities of water moving through the system. As an aid to understanding the flow system, a detailed water budget was developed. The development of this water budget involved using measured and calculated or estimated values of water movement to construct a flow-system model that was internally consistent and reasonable in terms of established hydrologic principles and hydraulic characteristics of the types of rocks present.

In the following pages the individual water-bearing rock units are described in terms of their areal distribution (shown in fig. 15), their hydraulic characteristics, water levels, the movement of water they contain, and their present state of development. For a summary of these characteristics see table 2.

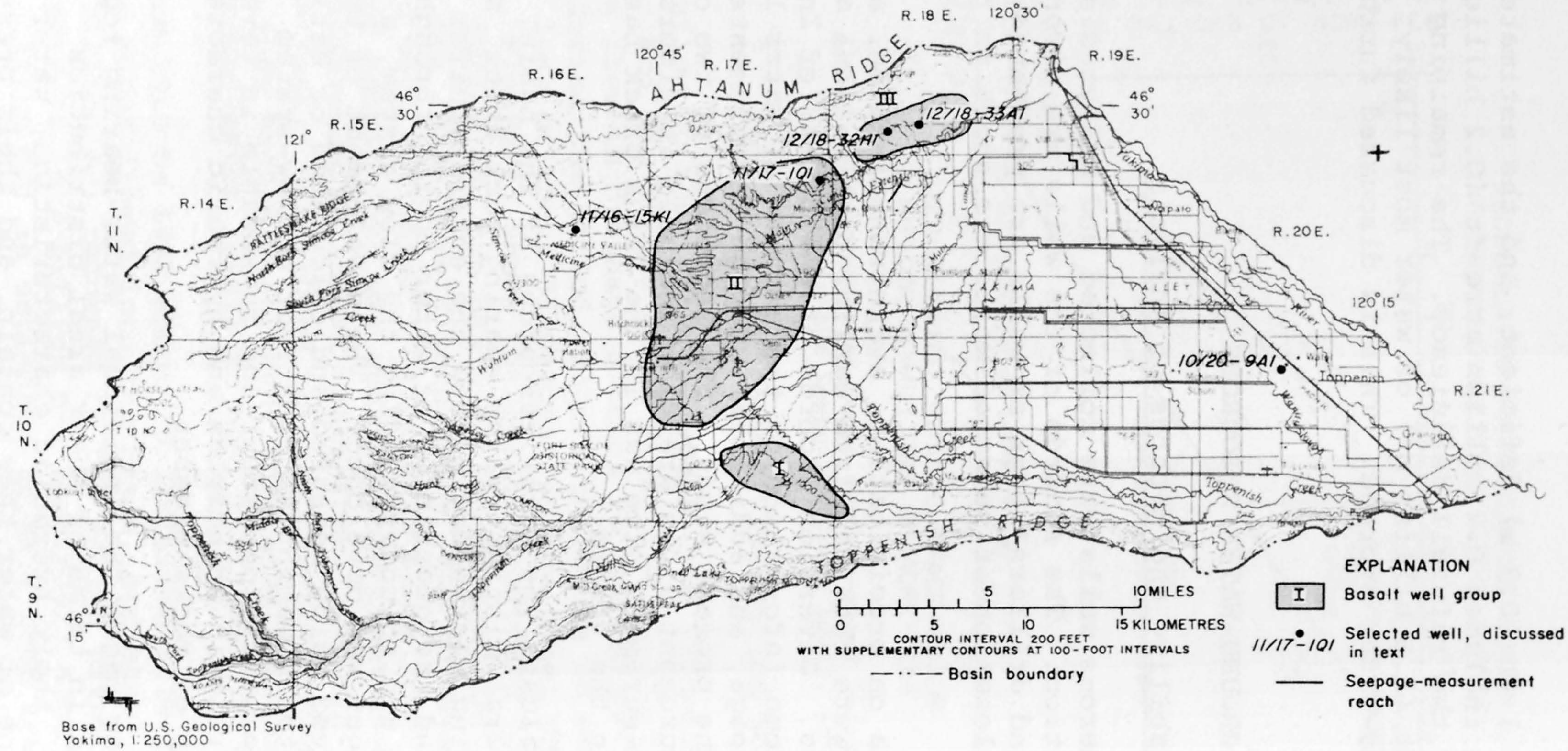


FIGURE 14.--Toppenish Creek basin showing locations of selected wells, seepage-data sites, and areas of various groups of wells tapping the basalt aquifer.

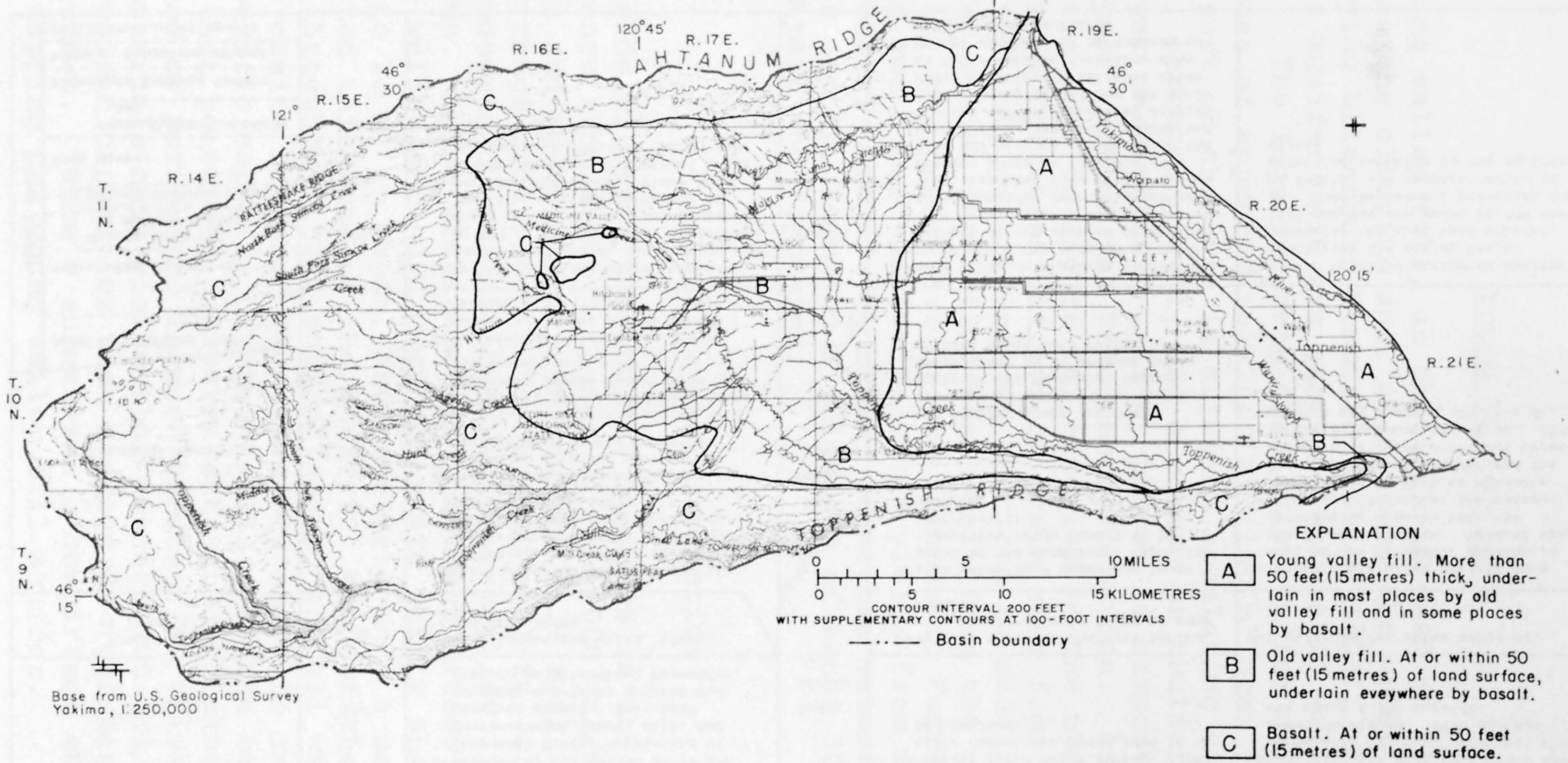


FIGURE 15.--Areal distribution of hydrogeologic units in the Toppenish Creek basin.

TABLE 2.--Stratigraphic relationships and hydrologic characteristics of the geologic units in the Toppenish Creek basin

Geologic units	Maximum thickness (ft)	Origin and lithology	Hydro-geologic units	Hydrologic characteristics	Remarks
Alluvium	150	Deposited by the Yakima River and Toppenish Creek, consisting of coarse gravel, sand, silt, and cemented gravel. Near base deposits are finer grained and similar to Ellensburg Formation.	Young valley fill	Generally yield water freely. Specific capacities range from 14 to 58 (gal/min)/ft.	Potentially the most productive and manageable aquifer, presently the least developed. 1970 pumpage was about 5,900 acre-ft.
Touchet Beds of Flint (1938)	35	Varied lacustrine silts, clays, and fine sands.		Very poor drainage characteristics, acts as a confining layer in some areas.	Not suitable for water supplies.
Ellensburg Formation	1,000	Partially consolidated fluviatile-lacustrine deposits. Conglomerate interbedded with sandstone, siltstone, and gravel in upper parts of formation. Partially consolidated thick silt and silty clay and clay in the central part of the formation. Partially consolidated coarse sand and gravel interbedded with finer sediments in the lower parts of the formation. Base interbedded with the Saddle Mountains Member of the Yakima Basalt.	Old valley fill	Yields water from upper and lower parts of the formation. Specific capacities range from 3 to 28 (gal/min)/ft. Lower aquifer zones are under artesian pressure in the lower parts of the Toppenish basin, heads range up to several tens of feet above land surface.	An important aquifer present over most of the irrigable acreage in the Toppenish basin. Present use is slightly greater than the alluvium. Potential for management is not as high as alluvium due to depths of aquifer and the presence of thick confining layers in the Ellensburg Formation. 1970 pumpage was about 6,500 acre-ft.
Yakima Basalt: Saddle Mountains Member					
Yakima Basalt: Priest Rapids Member Mabton Interbed of Mackin (1961) Quincy Diatomite Bed Roza Member Squaw Creek Diatomite Bed Frenchman Springs Member Vantage Sandstone Member Undifferentiated basalt	over 1,200	Lava flows. Hard, dense basaltic rocks. Individual flows range up to 100 ft in thickness. Interflow zones may be rubbly, and several have fine-grained sediments of variable thickness. Flows have varying degrees of vertical jointing, usually columnar though some are more irregular.	Basalt	Yields water mainly from interflow zones which may compose 20 to 30 percent of the section penetrated by a well. Yields are highly variable, specific capacities range from less than 1 to over 400, but average about 16 (gal/min)/ft. Near the margins of the basin the basalt flows have been folded and faulted. This structural deformation frequently reduces the aquifers' capacity to transmit water as the permeable interflow zone become pinched off by folding or displaced by faulting.	The most widely distributed aquifer, underlying the entire basin. Presently the most used aquifer, 1970 pumpage was about 16,000 acre-ft. Poor management potential due to depths, and impracticality of effecting recharge to the aquifer system.

Young Valley Fill

Young valley fill, as the term is used in this report, includes the alluvium and, at places, the upper part of the underlying Ellensburg Formation (Smith 1903). Typical sections of this aquifer unit are shown by schematic well logs in figure 16. The logs indicate that this aquifer unit reaches a thickness of approximately 500 ft (150 m) near Wapato. The upper part of the unit is alluvium consisting of silt, sand, gravel, cemented gravel, and a coarse or bouldery basal gravel. The lower part of this unit at places is composed of the permeable upper part of the Ellensburg Formation. As shown by the schematic logs in figure 16, material in the upper part of the Ellensburg Formation differs in grain size from place to place; about the only generalization that can be made is that in areas near the border separating the basalt from the old valley fill (fig. 15) the upper part of the Ellensburg Formation is fine grained and not conducive to large yields from wells. In the east-central part of the basin, permeable materials extend to greater depths, reaching a thickness of about 300 ft (90 m) near Wapato and Toppenish.

Aquifer Characteristics

Yields of wells tapping the aquifers in the young valley fill range from about 5 to more than 1,000 gal/min (0.3 to 63 l/s) and average about 30 gal/min (1.9 l/s). Specific capacities range from about 2 to 58 (gal/min)/ft [0.4 to 12 (l/s)/m] of drawdown and average about 10 (gal/min)/ft [2 (l/s)/m] of drawdown. These statistics are somewhat biased due to the nature of the wells sampled. Most wells are fairly shallow, 20 to 60 ft (6 to 18 m) in depth, and penetrate only a small part of the saturated thickness of the aquifer. Many of these wells are cased throughout their entire length, and all water has to enter at the casing bottom. These factors serve to reduce the yield and specific capacity of these wells. On the other hand, several wells that penetrate a greater saturated thickness and are screened or perforated through substantial thicknesses of permeable materials have yields that average 700 gal/min (44 l/s) and specific capacities that average 39 (gal/min)/ft [8 (l/s)/m] of drawdown. Table 3 summarizes a comparison of the types of wells tapping the young valley fill aquifer.

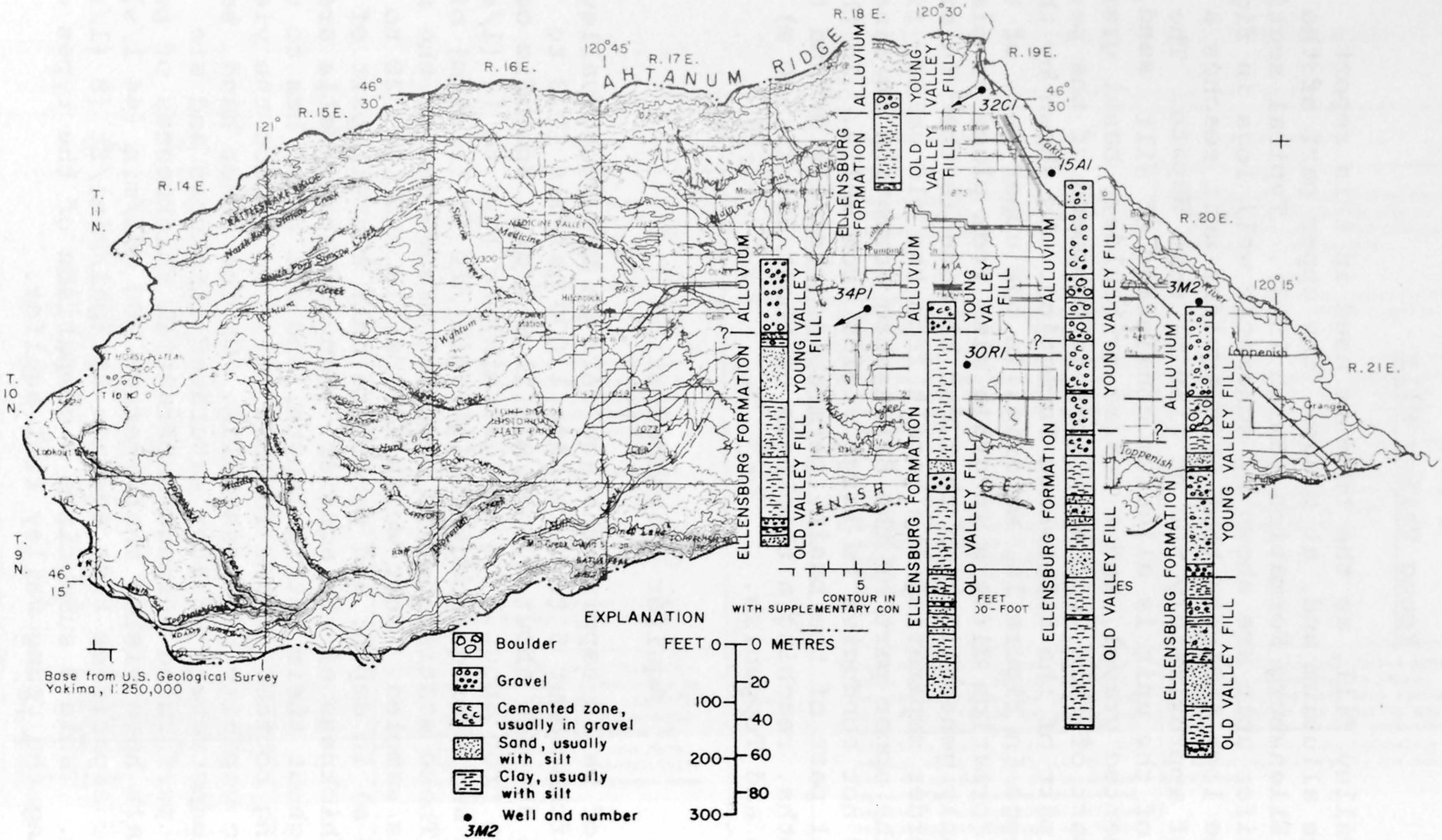


FIGURE 16.--Schematic logs of wells penetrating the young valley fill and partially penetrating the old valley fill.

TABLE 3.--A comparison of types of wells constructed in the young valley fill

Well type	Common use	Method of construction	Typical specific capacities [(gal/min)/ft of drawdown]	Remarks
Concrete ring well (dug)	Sumps, irrigation, and fire protection	Concrete rings 36 to 60 inches in diameter form the well casing, usually the wells are dug by a "clam shell" to an average depth of 22 feet.	58	Low cost of construction. Depth is limited, usually wells do not penetrate any cemented materials. Since cemented zones commonly occur at 20- to 30-foot depths in this aquifer this restricts the areas in which this type of well construction is feasible to those in which the water table is fairly close to land surface during the periods the well is in use. High potential for contamination from surface water.
Screened or perforated-casing wells (drilled)	Municipal and industrial supplies	A steel casing 6 to 24 inches in diameter lines the well bore. Adjacent to permeable water-bearing materials, the casing may be perforated or slotted so that water may enter the well, or a screen whose openings are sized to match the grain size of the water-bearing material may be installed.	34	Expensive construction. May obtain water from many zones at greater depths. Generally safe from contamination by surface water if the casing is not perforated or screened in the first 50 to 60 feet, and the surface casing is grouted.
Open-end casing wells (drilled)	Domestic	A steel casing, usually 6 to 8 inches in diameter lines the entire well bore. The well obtains water only through the open bottom of the casing. Usually less than 100 feet deep, but may be drilled to considerably greater depths.	2	Low to moderate cost of construction depending on depth. Can obtain water from only one water-bearing zone. Generally safe from contamination from surface water if greater than 50 or 60 feet deep, and the surface casing is grouted.

Water Levels

The upper surface of the ground water in the young valley fill in late July and early August in recent years is shown by the water-table contours in figure 17. Hydrographs in figure 18 indicate that water levels annually return to approximately the same upper limit at this time of the year. This occurs when the water tables reaches the level of the drains. Although the annual-high water levels in the young valley fill have not changed significantly in recent years, there is considerable areal variation in the amplitude of annual-high water levels. Figure 19 shows the areal distribution of annual water-level fluctuations in the aquifer.

One significance of the annual fluctuation is that it can be used to estimate the amount of water that annually enters and leaves this aquifer under present conditions. Aquifers composed of sand and gravel commonly have about 20 percent of their volume occupied by water. Calculations made using this typical value (storage coefficient of 0.2) indicate that 120,000 acre-ft (148 million m^3) of water annually enters and leaves the aquifer.

Data were insufficient to permit determining the water levels in wells tapping the aquifer prior to irrigation in the early 1900's. Some evidence exists for a substantial rise in water levels resulting from irrigation, but this evidence is highly subjective. When the Toppenish city well (10/20-3M1) was originally drilled in 1922 to a depth of 167 ft (50.9 m), water-bearing material was reported first at the 67-ft (20.4 m) depth; now, summer water levels are within 16 ft (4.9 m) of land surface. More convincing evidence is that shown by the historic relations of inflow to outflow in the diversion and drains during the development of the present irrigation system. During the period 1910-31, about 1.3 million acre-ft (1.6 billion m^3) of water (p.33) apparently entered into storage in the young valley fill, though some of this total probably entered irrigated areas underlain by the old valley fill. If a storage coefficient of 0.2 is assumed, this quantity of water would be equivalent to an average water-level rise of approximately 50 ft (15.2 m) over about 130,000 acres (526 million m^2)--the approximate area presently irrigated. Although these calculations are not precise, they nevertheless account for a substantial rise in water levels that apparently took place during this time.

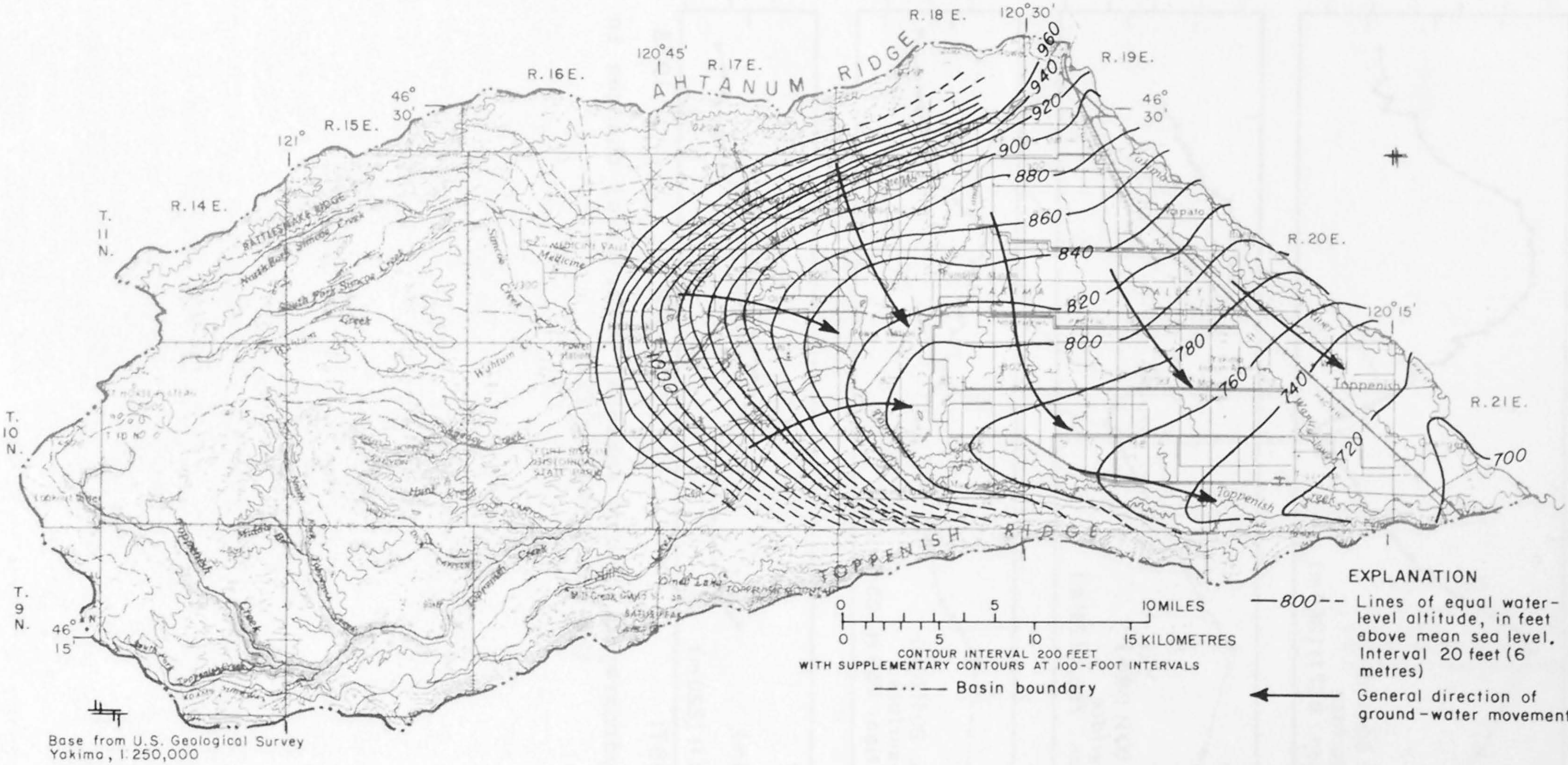


FIGURE 17.--Average July and August water-table altitudes in wells that tap the unconfined aquifers in the young and old valley fills.

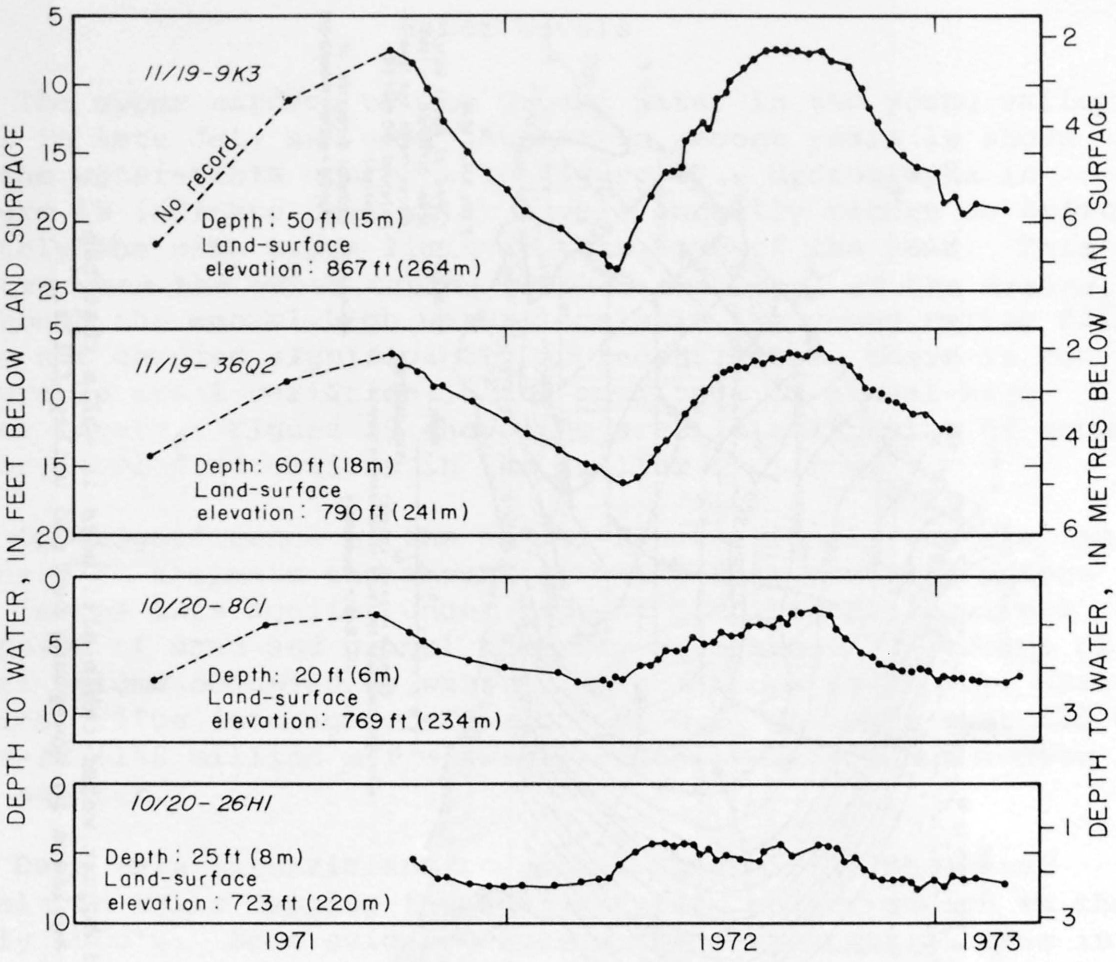


FIGURE 18.--Hydrographs showing seasonal water-level changes in the young valley fill.

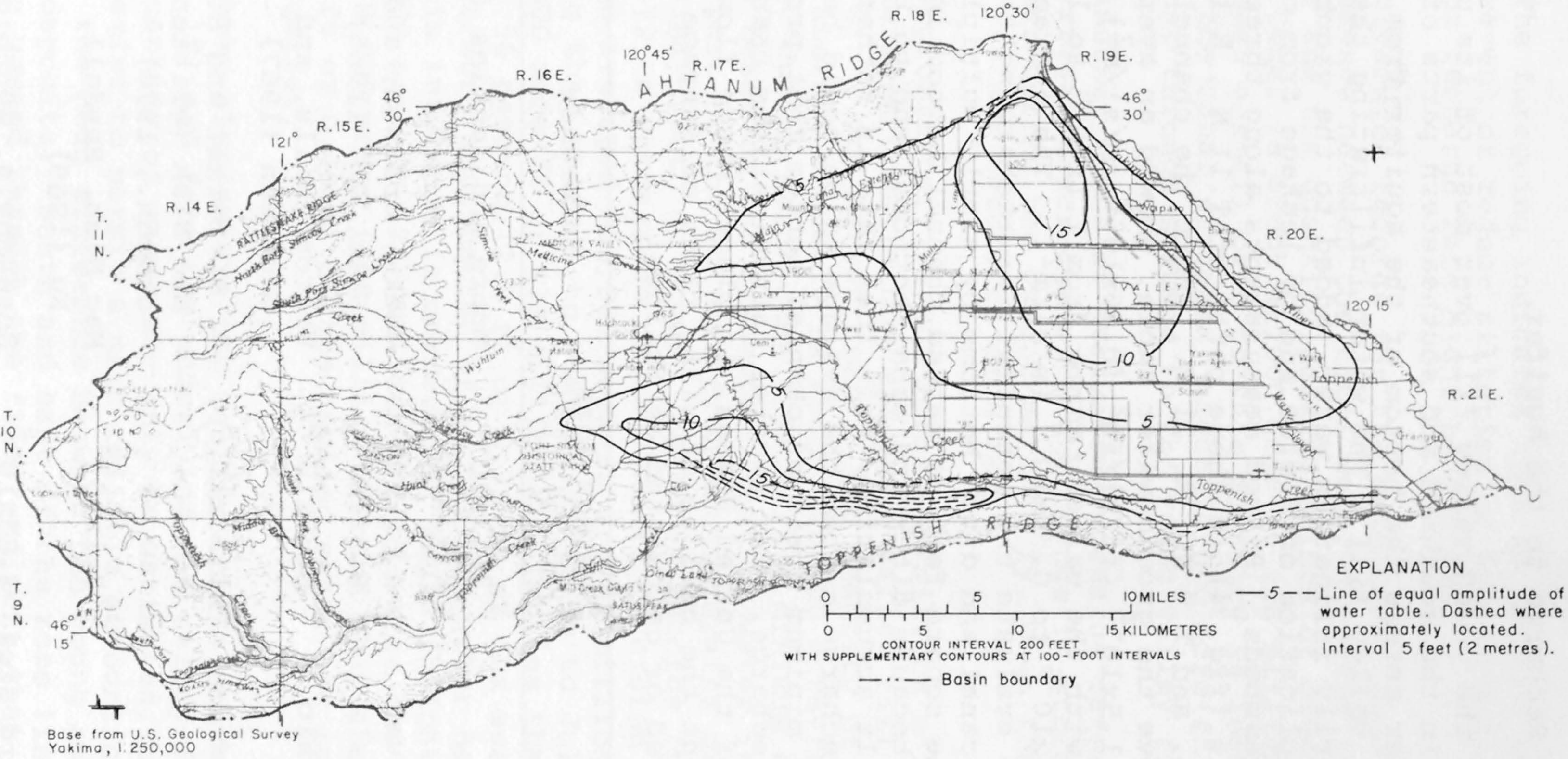


FIGURE 19.--Annual range in water-table fluctuations in the young valley fill and in the unconfined zone of the old valley fill.

Recharge to the Aquifer

Water enters the young valley fill over most of its upper surface, except in the southern and southeastern parts of the basin, where water enters the bottom of the aquifer from the underlying older valley fill. The water infiltrating the surface is primarily irrigation water, added to the ground water through application on fields and by leakage from canals, ditches, and streambeds. Paired measurements along three reaches of canals (fig. 4) in those parts of T.11 N., R.18 E., T.11 N., R.19 E., and T.9 N., R. 21 E., where the channel bottoms were above the ground-water table, showed an average rate of loss of $1.5x10^{-5}$ (ft/s)/ft^2 [$0.46x10^{-5}$ (m/s)/m^2] of channel bottom, with the values ranging from $1.1x10^{-5}$ to $1.7x10^{-5}$ (ft/s)/ft^2 [$0.34x10^{-5}$ to $0.52x10^{-5}$ (m/s)/m^2]. The average value might be used to evaluate the potential for recharging the aquifer through canal and ditch bottoms by simply multiplying the number by the square feet of wetted channel bottom in an area. However, because ditch and canal bottoms tend to become sealed due to silt accumulation, this loss rate is rather low. In designing a recharge system the average value could be used to determine the minimum areas of channel bottom that provide given rates of recharge. For several natural stream channels in other parts of the United States, in places where flow variations prevent the buildup of silt, rates of seepage loss have been measured or calculated as follows:

River	Seepage loss [(ft/s)/ft^2]	Reference
Arkansas River in Colorado	$2.17x10^{-5}$ $2.635x10^{-5}$	Moore and Jenkins (1966)
Little Plover River in Wisconsin	$4.55x10^{-5}$ $6.2x10^{-5}$	Weeks, Ericson, and Holt, Jr. (1965)
Miami River in Ohio	$6.38x10^{-6}$	Walton, Hills, and Grundeen (1967)
Walla Walla River in Washington	$1.55x10^{-5}$	R. A. Barker and R. D. Mac Nish (written commun., 1974)
Chemung River in New York	$3.1x10^{-5}$	Mac Nish, Randall, and Ku (1969)
Potowamut-Wickford area in Rhode Island	$2.63x10^{-5}$	Rosenshein, Gonthier, and Allen (1968)

The foregoing indicates that if methods were employed to prevent or reduce siltation of the channel beds the seepage or recharge rate might be doubled.

Diversion records for the Main Canal show that the difference between the total water diverted from the Yakima River and the quantity passing points of diversion from the Main Canal is about 21,000 acre-ft (26 million m^3) a year. Although a small part of this quantity is lost to evaporation from the canal surfaces, about 20,000 acre-ft (25 million m^3) is lost through seepage to the young valley fill aquifer.

Another means of evaluating recharge rates is to compare the irrigated acreage with the change in storage in this aquifer during the period March-July, when the young valley fill becomes saturated each year.

Approximately 78,000 acres (316 million m^2) are irrigated in the area underlain by the young valley fill east of the Main Canal and Harrah Drain. The quantity of water going into storage annually is about 120,000 acre-ft (148 million m^3), mostly during March-June. This is a minimum estimate because it is based on the assumption that no water is discharged from this part of the aquifer from either drains or subsurface flow; certainly, both do occur. Based on records for the period 1969-72, a comparison of the annual diversion of the Main Canal (which averaged 633,000 acre-ft or 780 million m^3 per year during that period) to that diverted up to July 15 (average 356,000 acre-ft or 439 million m^3) implies that by mid-July about 56 percent (2.5 ft or 0.76 m) of the average annual 4.5 ft/acre application of irrigation water had been made. If this inference is correct, it would indicate that about 200,000 acre-ft (247 million m^3) of water had been applied to the 78,000 acres (316 million m^2) and that about 60 percent (1.5 ft or 0.46 m) of the applied water had infiltrated into the aquifer.

Water also enters the aquifer in its southeastern part (fig. 15) and from the underlying old valley fill aquifer. The quantity of water may only be estimated, however, as no data exist to permit a more reliable accounting. Figure 20 shows the head difference between the young and old valley fill deposits. South and east of the zero line, water is moving upward through the finer sediment that separate the water-bearing zones of the young and old valley fill deposits.

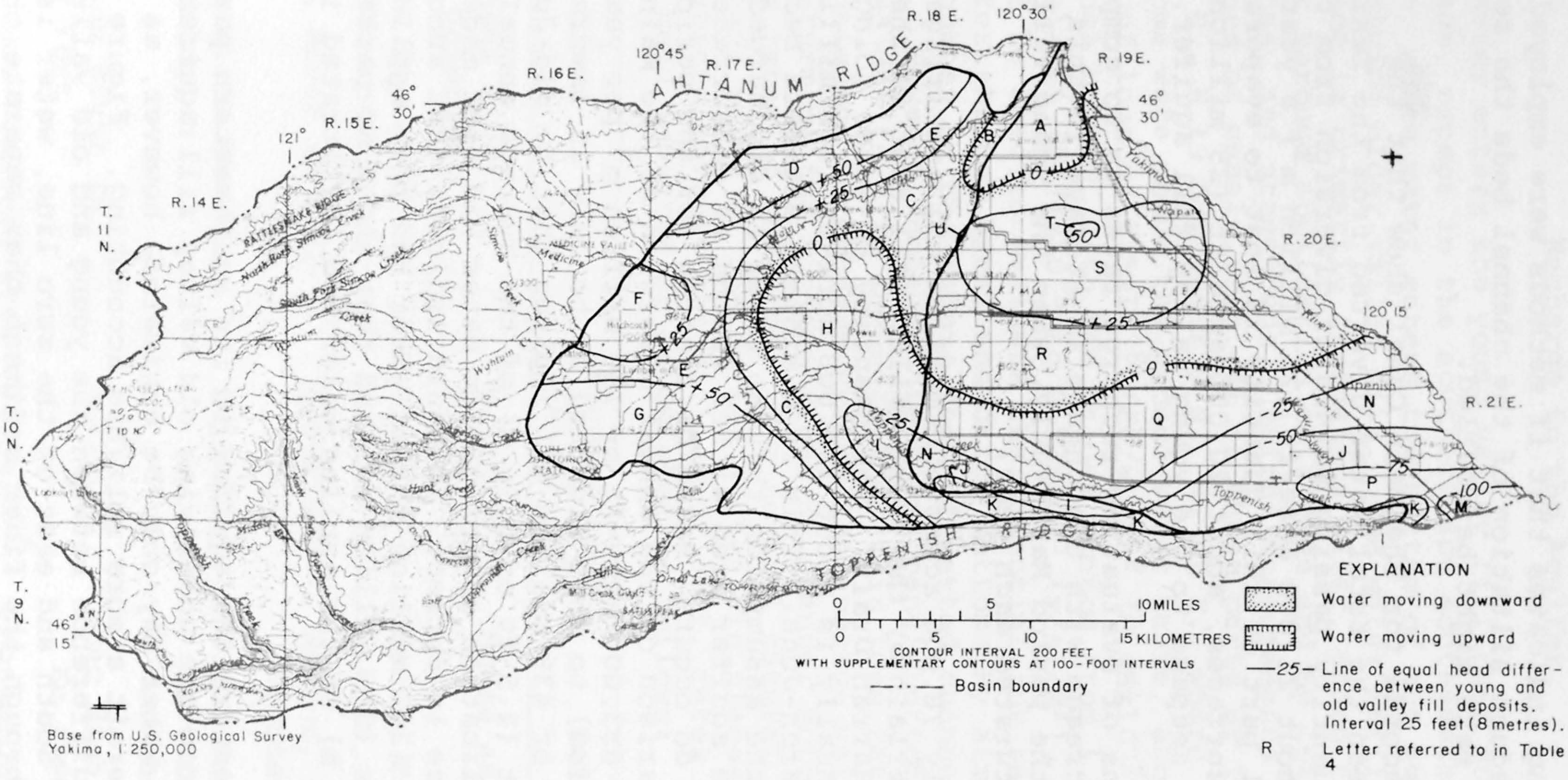


FIGURE 20.--Generalized differences between hydraulic heads in artesian zones of the old valley fill and the average water table shown in figure 17.

Driller's logs of the deeper wells in the area of the young valley fill indicate that the combined thickness of clay or clayey sediment averages about 75 ft (23 m) being as much as 100 ft (30 m) in the northern part of the area and as little as 50 ft (15 m) in the southeastern corner of the area. Assuming that the vertical conductivity of these clay beds is $0.1x10^{-6}$ (ft/s)/ft^2 [$0.03x10^{-6}$ (m/s)/m^2]--near the lower limit of conductivity described by Johnson (1964) as characterizing mixtures of silt and clay--an estimate can be made of the quantity of water moving between the young and old valley fill units.

Table 4 summarizes the volume of water moving vertically between these two aquifers, and shows that the water entering the young valley fill vertically from the old valley fill totals about 84,000 acre-ft (104 million m^3) per year, with almost all of this water entering the aquifer south of State Highway 220 (Fort Road). An additional 11,000 acre-ft (135 million m^3) enters the young valley fill from the old valley fill via lateral seepage along their western boundary.

Discharge From the Aquifer

Once having entered the young valley fill the water moves downgradient until it reaches a point or area of discharge from the aquifer. The configuration of the water-level contours in figure 17 indicate that the general direction of water movement is to the south and southeast, with the primary discharge area from the aquifer being along Toppenish Creek at the foot of Toppenish Ridge. In 1911, the measured discharges of Toppenish Creek near White Swan and at Alfalfa showed a gain of more than 77,000 acre-ft (95 million m^3) between the two sites. Although some of this was undoubtedly return flow from surface drains, most of that gain represented a discharge from the aquifer. In the area along Toppenish Creek, the proximity of water levels to land surface allows plant roots to tap water directly from the shallow aquifer. Thus, water is removed from the aquifer both by direct discharge to stream channels and by transpiration by vegetation in the area.

TABLE 4.--Ground-water flow between water-table zones in the young and old valley fill aquifers and artesian zones in the old valley fill aquifer, by areas

Area shown in figure 22	Area (mi^2)	Average head difference (ft)	Thickness of clay layer (ft)	Flow (acre-ft/yr)
Areas where water moves upward to water-table zones:				
In young valley fill:				
A. At Parker	10.1	12.5	100	2,550
Q. At Toppenish	34.7	12.5	50	17,500
N. South and west of Toppenish	17.1	37.5	50	25,900
J. At Granger	18.2	62.5	50	46,000
P. South of Granger	7.1	87.5	50	25,100
M. South of Granger	.8	100	50	3,230
Total (rounded)				120,000
In old valley fill:				
B. West of Parker	2.0	12.5	200	252
H. At Brownstown	29.4	12.5	200	3,710
I. South and southeast of Brownstown	8.1	37.5	200	3,070
K. South of Toppenish Creek	3.1	62.5	200	1,960
Total (rounded)				9,000
Areas where water moves downward from water-table zones:				
In young valley fill:				
R. South and East of Harrah	57.4	12.5	100	14,500
S. At Wapato	27.7	37.5	100	20,900
T. West of Wapato	.6	50	100	590
Total (rounded)				36,000
In old valley fill:				
U. North of Harrah	.2	37.5	200	76
C. North and west of Brownstown	27.3	12.5	200	3,440
D. North of the unit #1 pump canal	16.2	50	100	16,400
E. At White Swan	25.6	37.5	100	19,400
F. West of White Swan	8.5	12.5	100	2,150
G. South of White Swan	25.4	50	100	25,600
Total (rounded)				67,000

Note: Formula for calculation.

$$\text{Flow (acre-ft)} = \text{area (in ft}^2\text{)} \times \text{average head difference (in ft)} \times \frac{0.1\times10^{-6}\ \text{ft/s}}{\text{clay thickness (in ft)}} \times 724.$$

Perhaps the most significant method of discharge at the present time is that which occurs from the artificial drains that web the aquifer surface. When the aquifer becomes saturated by mid-July, any water from irrigation or rainfall in excess of that required for plant growth seeps into these drains. In recent years, the quantity of water leaving these drains averaged about 344,000 acre-ft (424 million m^3). No determination can be made at this time of the ratio of the quantity that moved through the aquifer to that leaving the area as surface runoff.

As a result of the difference in heads between the old and young valley fills (fig. 20), some water discharges from the young valley fill in its north-central part to the old valley fill. Table 4 shows this quantity is estimated to be about 36,000 acre-ft (44 million m^3) per year.

Another method of discharge from the young valley fill is through pumping from wells; in 1974 about 5,900 acre-ft (7.3 million m^3) was pumped annually. Although this pumpage represents a withdrawal from the aquifer, some pumped water percolates from the land surface back to this aquifer. Of the total pumpage, only that amount used consumptively (evapotranspiration) or exported from the aquifer surface by drains or by the shipment of crops is actually lost from the system.

Another method of discharge from the aquifer is ground-water seepage to the Yakima River. The amount of direct discharge to the Yakima River is much smaller than the discharge to Toppenish Creek, as can be inferred from figure 17. When the aquifer is saturated, the arrows indicating the direction of water movement in the aquifer closely parallel the Yakima River itself, implying there is very little net exchange between the aquifer and the river except in the southeastern corner of the basin where converging arrows imply significant discharge. During the part of the year when the aquifer is less than full, the water in the Yakima River channel moves into the young valley fill, at least in the northernmost two-thirds of its reach along the reservation. The net, yearly exchange of water between the aquifer and the Yakima River is included with the estimated flow from miscellaneous surface drains and totals 97,000 acre-ft (120 million m^3).

An additional 3,000 acre-ft (4 million m^3) a year is estimated to leave the young valley fill as underflow (beneath the Yakima River) in the southeast corner of the Toppenish Creek basin.

Present Ground-Water Development

The present (1974) pumpage from this aquifer is about 5,900 acre-ft (7.3 million m^3) annually (table 2). For an aquifer with such a high degree of hydraulic connection with surface-water bodies, high-specific-capacity wells, and a water level so close to land surface, this represents a very low level of development.

A variety of well types withdraw water from this aquifer. Table 3 summarizes the nature of construction and efficiency in terms of specific capacities of the various types of wells. Although the total pumpage from this aquifer is small, the points of withdrawal are numerous. Many domestic water supplies are obtained from this unit. Figure 14 includes information on the aquifers tapped by selected wells.

Potential for Further Development

Although the water-yielding characteristics of the young valley fill aquifer would permit extensive ground-water development anywhere the aquifer is present, the geometry of the aquifer suggests it would be best utilized by development in the central and southern parts of the aquifer. Stream water presently diverted to areas underlain by the young valley fill is adequate to irrigate its entire surface, although some augmentation by ground water may be necessary due to problems of surface-water distribution. If the present diversion of surface water to this aquifer surface were reduced in order to provide water elsewhere, the reduction could be made up by ground water pumped from the aquifer.

Present irrigation practices satisfy plant needs and prior to mid-July each year there is a surplus of 120,000 acre-ft (148 million m^3) of water in the northern and central parts of the aquifer. This excess irrigation water goes into storage in the young valley fill.

Although a digital computer model would be required for a more detailed evaluation of the interaction of surface-water drains and the aquifer, it is reasonable to assume that as much as 120,000 acre-ft (148 million m^3) could be diverted from the Main Canal to other areas, and this amount of diversion could be replaced by ground-water pumpage to laterals 2, 3, and 4. Properly constructed wells in the young valley fill could pump about 1,350 gal/min (3 ft^3/s) or 85 l/s with about 30 ft (9 m) of drawdown, and, with a minimum well spacing of one-half mile (0.8 km) along the laterals, there should be minimal interference problems. As the water levels in this aquifer are currently below the water levels in the laterals, lowering the water levels in the aquifer probably will not significantly increase leakage from the laterals. During the irrigation season water-level declines probably will not exceed 100 ft (30 m), as under current irrigation practice 60 percent of the applied water in the north-central parts of the young valley fill area seeps into the aquifer. The effect of this management scheme would be to reduce the ground-water outflow to drains. The amount of reduction in drain flow could approach the amount of pumpage.

The good hydraulic connection between the surface water and this aquifer system calls for some caution in water-use planning. Preliminary data from a study of ground-water quality (M. O. Fretwell, oral commun., 1974) shows that concentrations of dissolved nitrogen compounds in this aquifer are higher than in other aquifers in this area, and higher than in similar aquifer units in areas that are less agriculturally developed. Although concentrations of dissolved solids are presently well within the accepted limits of desirable water quality, the potential exists for persistent pesticide and fertilizer compounds to enter the aquifer and locally exceed standards set for these compounds by the Environmental Protection Agency (1972). As this aquifer has great potential for supplying large yields suitable for irrigation use, and because of the presence of suitable soils, the emphasis on development in this part of the area will likely be toward agriculture. Domestic and public supplies could be designed to tap deeper aquifers for their supplies to avoid any future contamination resulting from agricultural practices.

Old Valley Fill

As shown by the diagrammatic well logs in figure 15, old valley fill (largely comprised of the Ellensburg Formation) is within 50 ft (15 m) of land surface in the western part of the lowland and overlain by the young valley fill in the eastern part. To the west, it thins abruptly where the basalt forming the uplands rises toward the land surface. Near the center of the lowland of the basin the thickness of the old valley fill may be as much as 1,000 ft (305 m). This deposit yields water to wells over the entire lowland of the Toppenish Creek basin.

Aquifer Characteristics

The old valley fill is composed primarily of semiconsolidated silt, sand, gravel and clay of the Ellensburg Formation. The proportions of the various lithologic components of this unit vary widely both vertically and horizontally, as indicated by selected well logs in appendix IV. In the part of the area where the fill is within 50 ft (15 m) of land surface (fig. 15), the upper part of the aquifer is under water-table (unconfined) conditions. Water in deeper zones in this area and in the area farther to the east--under the young valley fill--is under artesian pressure.

Yields of efficiently constructed wells tapping old valley fill are as much as 1,500 gal/min (95 l/s), and specific capacities range from 3 to 300 (gal/min)/ft [0.6 to 60 (l/s)/m] of drawdown for wells that in most cases only partly penetrate the aquifer. An average specific-capacity value for this unit would be misleading as very few wells are open to all the productive zones. Specific capacities of wells open to most of the gravel and sand units in the aquifer probably average about 30 (gal/min)/ft [6 (l/s)/m] of drawdown.

Water Levels

The old valley fill has both water-table and artesian zones with differing water levels. Figure 17 shows average water levels in July and August in the water-table zones where the aquifer is within 50 ft (15 m) of land surface, and figure 21 shows the water levels in March 1972 in the artesian zones of the aquifer.

There has been some decline in heads in the artesian zones of this aquifer, as observed in well 11/17-1Q1, which had a measured water level of 30 ft (9.1 m) below land surface in 1961 and almost 89 ft (27.1 m) below land surface in 1972. The moderate amount of pumpage from this aquifer is not sufficient to explain the large water-level declines of more than 50 ft (15 m) in some wells tapping this artesian zone. The declines are most likely due to the pumping from the aquifer in the underlying basalt; this has changed the relation of the original heads in these two aquifers and caused water to move into the underlying basalt. This is discussed further on page 65.

Recharge to the Aquifer

The old valley fill receives recharge primarily in its western part, where the water-table zones receive infiltrating water from precipitation and irrigation water applied to the land surface. Of the 298,000 acre-ft (370 million m^3) of water applied to the aquifer surface in this area each year--from precipitation and from surface- and ground-water irrigation--about 193,000 acre-ft (238 million m^3) is estimated to be consumed by plants or evaporated from the surface. The remaining water enters the aquifer or runs directly off into surface drains. The water entering the aquifer contributes an estimated 58,000 acre-ft (72 million m^3) per year to recharge entering the lower artesian zones of the aquifer and the remainder is discharged to streams and drains on the surface of the aquifer. Although the quantity of water circulating through the shallow zones of the aquifer to discharge to streams and the quantity of direct surface runoff are not differentiated here, the combined total of the two components is currently about 47,000 acre-ft (58 million m^3) per year.

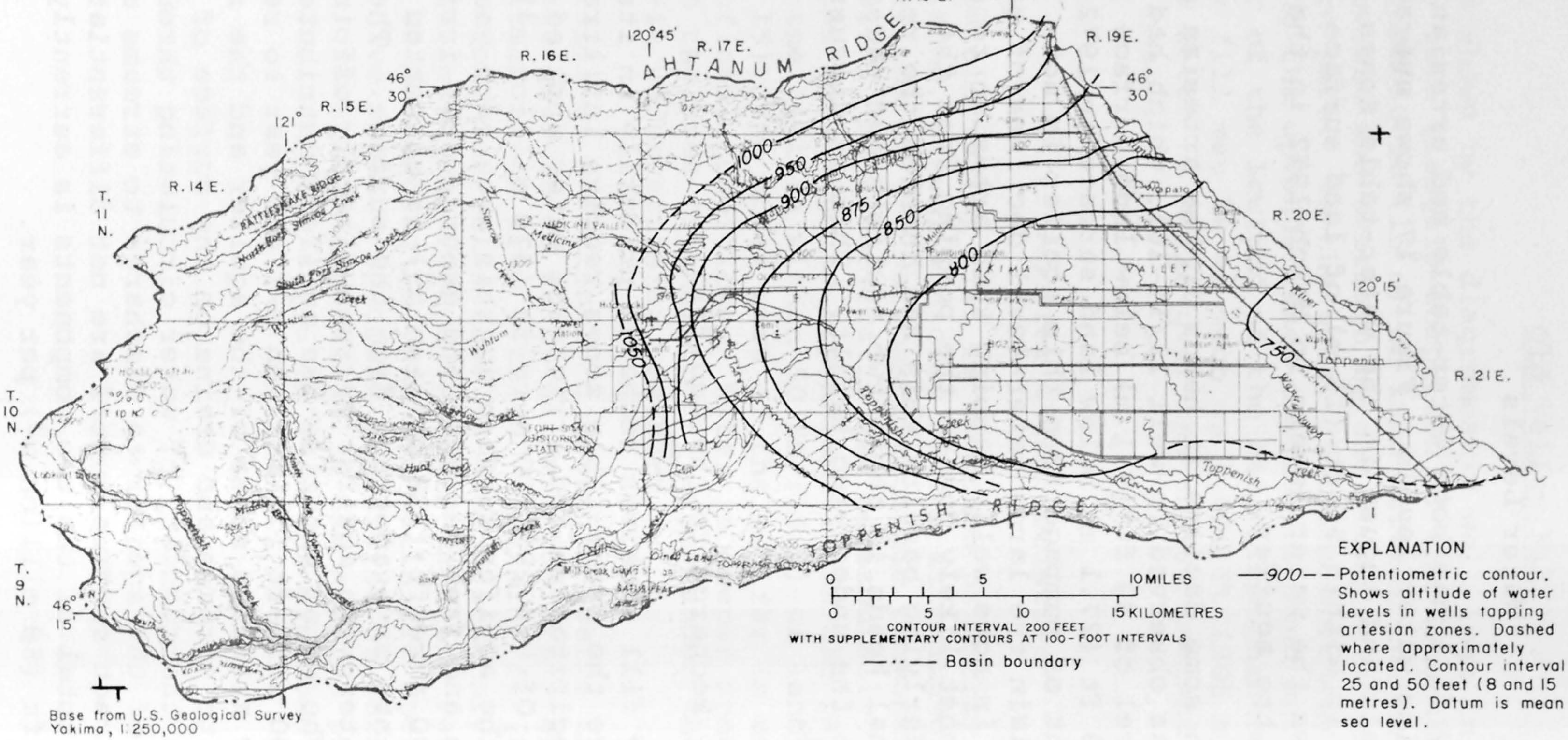


FIGURE 21.--Contours showing water levels in wells tapping artesian zones in the old valley fill, March 1972.

In the southeastern part of the area the water-level relation between the aquifers in the old valley fill and in the underlying basalt (fig. 22) indicates that recharge enters the old valley fill from the basalt in the area within positive contours. The thickness of the confining layer separating the basalt and old valley fill aquifers ranges from more than 300 ft (91 m) in Medicine Valley to an estimated 50 ft (15 m) in the southeastern part of the basin. The thickness of the layer in Medicine Valley is inferred from the records of water levels and flow in the Medicine Valley test well (11/16-15K1). As the test well was being drilled, water levels remained very near land surface (1,285-ft or 391-m elevation), but the yield of the well steadily increased with depth to 355 ft (108 m). From that depth to 687 ft (209 m) the water level remained the same and the yield of the well did not change significantly. When the well was at the 687-ft (209-m) depth the water level dropped to 437 ft (133 m) below land surface, or to an elevation of 848 ft (258 m)--a level compatible with the heads in the main basalt aquifer east of Medicine Valley. The predominance of fine materials in the old valley fill in the western part of the basin decreases and coarser materials occur toward the east, and the thickness of the confining layer is, thus, estimated to be as little as 50 ft (15 m) in the southeastern part of the basin. However, no wells penetrate to the basalt in this area at present (1974), hence the thickness of the confining layer can only be estimated.

The hydraulic conductivity of the confining layer can only be estimated as no means of measuring this value are available. Owing to the presence of some dense basalt zones in this confining layer its conductivity was assumed to be one-half that of the confining layer separating the old and young valley fill. Based on these assumptions, table 5 lists the distribution of flow between the old valley fill and the basalt aquifer. The table shows that about 94,000 acre-ft (116 million m^3) per year of recharge enters the old valley fill from the basalt in the southeastern part of the basin.

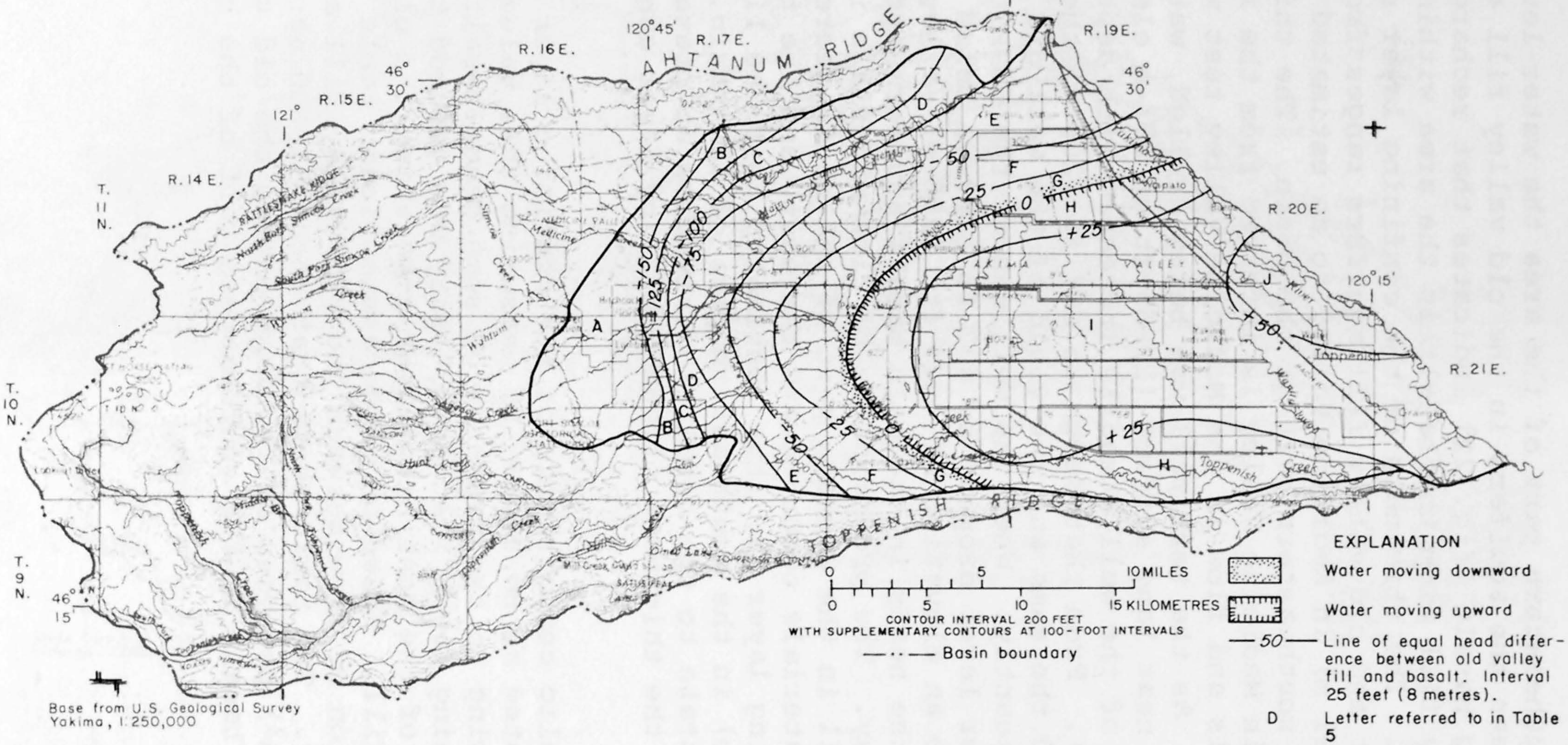


FIGURE 22.--Head differences between aquifers in the basalt and in the old valley fill, March 1972.

TABLE 5.--Ground-water flow between the old valley fill and basalt aquifers, by areas

Area shown in figure 22	Area (mi^2)	Average head differ-ence (ft)	Confin-ing bed thick-ness (ft)	Flow (acre-ft/yr)
Areas where water is moving downward:				
A. West of White Swan---------	23.9	150	300	12,100
B. -----do--------------------	7.9	137.5	300	3,650
C. -----do--------------------	13.3	112.5	300	5,040
D. -----do--------------------	16.6	87.5	300	4,880
E. At White Swan--------------	37.0	62.5	300	7,770
F. At Olney Flat--------------	32.2	37.5	200	6,100
G. At Brownstown--------------	25.1	12.5	150	2,110
Total (rounded)-----------------------------				42,000
Areas where water is moving upward:				
H. West of Harrah-------------	48.5	12.5	100	6,110
I. Harrah-Granger-Toppenish area--------------------	99.5	37.5	50	75,500
J. North of Toppenish---------	11.5	55	50	12,800
Total (rounded)-----------------------------				94,000

Note: Formula for calculation.

$$\text{Flow to old valley fill (acre-ft)} = \text{area (ft}^2) \times \text{average head difference (in ft)} \times \frac{0.5\text{x}10^{-7}\ \text{ft/s}}{\text{confining bed thickness (in ft)}} \times 724.$$

Discharge from the Aquifer

In the western part of the basin the old valley fill is being recharged at its upper surface at the same time water is being discharged to the underlying basalt. As a result of lower heads in the basalt in this part of the basin, about 42,000 acre-ft (52 million m^3) per year is discharged from the old valley fill to the basalt. In the eastern part of the basin, where the old valley fill underlies the young valley fill, about 84,000 acre-ft (104 million m^3) per year discharges vertically from the former to the latter (table 4). An additional 11,000 acre-ft (14 million m^3) is estimated to flow laterally into the young valley fill from the old valley fill where they abut along their common boundary. Also, as indicated by the contours in figure 21, water is discharged from the old valley fill as underflow (beneath the Yakima River). About 10,000 acre-ft (12 million m^3) per year leaves the Toppenish Creek basin in this manner.

Present Ground-Water Development

The old valley fill yields approximately 6,500 acre-ft (8 million m^3) per year to wells in the basin. About 5,000 acre-ft (6 million m^3) of this pumpage is in the area where this aquifer is overlain by the young valley fill. However, as many of the wells tapping this unit also obtain water from the young valley fill or the basalt, this pumpage must be considered a rough approximation.

Potential for Further Development

Additional development of the old valley fill aquifer is possible in most of the lowland parts of the basin. Wells which now (1974) yield as much as 1,000 gal/min (63 l/s) with less than 50 ft (15 m) of drawdown indicate continued potential for further development. Pumping levels would depend on the area of the aquifer being tapped (fig. 21). Because of its remoteness from surficial sources of contamination this aquifer can provide good-quality water[1] that is unlikely to be affected by agricultural or other practices that introduce surficial contaminants. Currently (1974) an estimated 10,000 acre-ft (12 million m^3) of water per year leaves the basin through this aquifer as underflow eastward beneath and beyond the Yakima River. Pumping in the eastern part of the aquifer could capture part of this discharge and reduce the discharge upward to the young valley fill. In view of the large expected yields and good-water quality, this aquifer represents a desirable water source for municipal and industrial, as well as irrigation, supplies.

Basalt

Basalt underlies the entire Toppenish Creek basin, being at the surface in the upland parts of the basin and within 50 ft (15 m) of land surface in the western part of the lowland. The maximum thickness of the basalt is unknown, but the minimum is about 2,000 ft (610 m) in this area (Foxworthy, 1962).

[1]The chemical quality of ground water in the Toppenish Creek basin is presently (1974) being evaluated. According to data collected in 1959 by Van Denburgh and Santos (1965, p. 90) the chemical analysis of a city of Toppenish municipal-supply well (10/20-9A1), which taps the artesian zone at the 792-863-ft (241-263-m) depth interval in the old valley fill in this area, indicates water of good quality, with a hardness of 42 mg/l (milligrams per litre), an iron concentration of 0.08 mg/l, and a dissolved-solids concentration of 158 mg/l.

Aquifer Characteristics

Yields of wells tapping the basalt range from 45 to 2,200 gal/min (2.8 to 139 l/s), with specific capacities ranging from less than 1 to 400 (gal/min)/ft [0.2 to 83 (l/s)/m] of drawdown and averaging about 16 (gal/min)/ft [3.3 (l/s)/m] of drawdown. Water moves through the basalt in fractures and through rubbly interflow zones that occur between successive flow units. The lateral variations in interflow-zone distribution, coupled with the dominance of these zones in terms of water-yielding ability, make it nearly impossible to predict the effect of any single well on adjacent wells. However, the interflow zones are mutually interconnected to such a degree that long-term effects of any stress will be felt over a fairly large area. Long-term pumping from this aquifer has caused declines over a 400 mi^2 (1,036 km^2) area in the Toppenish Creek basin.

The bowl-shaped structure of the basalt in the Toppenish Creek basin is shown by the basalt-surface contours in figure 23, which were developed from a gravity survey by Robbins, Burt, and Gregg (1975).

The northern and southern sides of the basalt structural basin are much steeper than the western side, which slopes upward in the Cascade foothills. The basalt is sharply folded along the Ahtanum and Toppenish Ridges which, with the associated faulting often found in such structures, act as effective barriers to ground-water movement.

A smaller flexure which trends northeastward across the western part of the basin and separates Medicine Valley from the eastern lowlands was the subject of a more detailed study by drilling of the Medicine Valley test well (11/16-15K1). This structure is apparently shallow, and although it acts as a barrier to ground-water movement in the upper zones of the basalt, it shows no effect on ground-water movement at depth. The test well showed that the damming effect of the structure does not extend to the deeper zones, and water levels on both sides of the Medicine Valley structures are in close agreement.

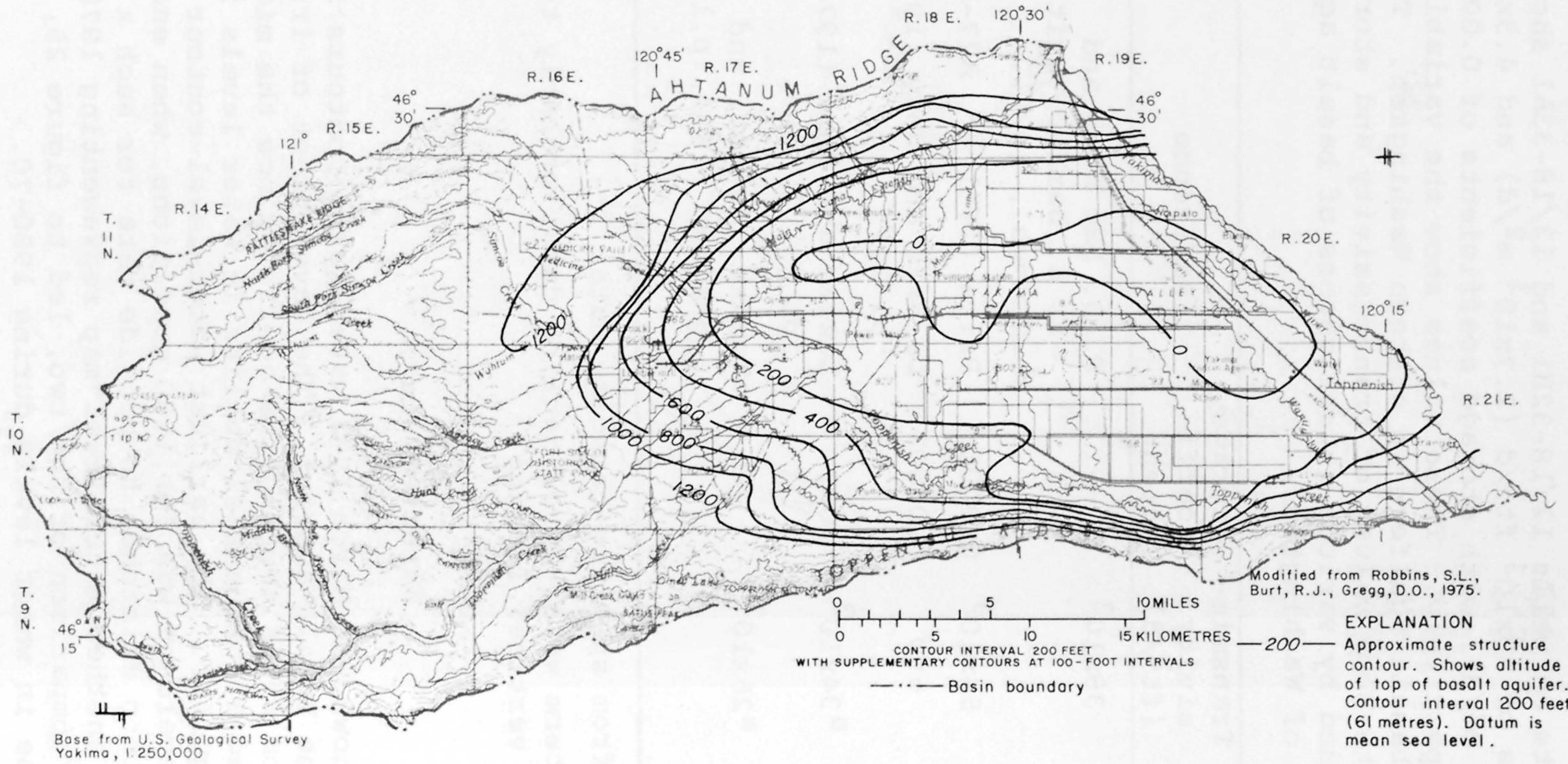


FIGURE 23.--Contours showing the generalized altitude of the upper surface of the basalt aquifer in the Toppenish Creek basin, as determined by gravity and aeromagnetic methods (Robbins and others, 1975).

Aquifer tests on wells 12/18-32H1 and 12/18-33A1 showed transmissivities of $29x10^3$ ft^2/d ($2.7x10^3$ m^2/d) and $4.3x10^3$ ft^2/d ($0.40x10^3$ m^2/d), with storage coefficients of 0.00006 and 0.0002, respectively. These values show the variability typical of the basalt aquifers in eastern Washington. The table below lists some values of transmissivity and storage coefficients found by various investigators of basalt aquifers in nearby areas of Washington.

Area	Transmissivity (ft^2/d)	Storage coefficient	Reference
Walla Walla----	$38x10^3$	--	R. D. Mac Nish and R. A. Barker (written commun., 1974).
Walla Walla----	$54x10^3$	0.0002	Price (1961, p. A27-A28).
Hanford--------	690	.00007	La Sala and Doty (1971, p. 39).
Odessa---------	[a]$34x10^3$	[b].002	Luzier and Burt (1974, p. 25).
Columbia Basin Irrigation Project.	[a]$26x10^3$	--	Tanaka, Hansen, and Škrivan (1974, p.11).

[a]Estimated from specific-capacity data.

[b]From long-term water-level decline data, probably too high because of vertical leakage.

Water Levels

Figure 24 shows the March 1972 water-level contours for wells tapping the basalt aquifer. The development of irrigation water from wells tapping the aquifer since the mid-1950's has caused a substantial decline in water levels in parts of this aquifer. The earliest water-level-contour map that could be developed was for 1960 conditions, when enough wells had come into existence to provide data for such a map. Construction of another water-level map representing 1970 conditions, and comparison of the two, led to figure 25, which shows the decline in water levels during 1960-70.

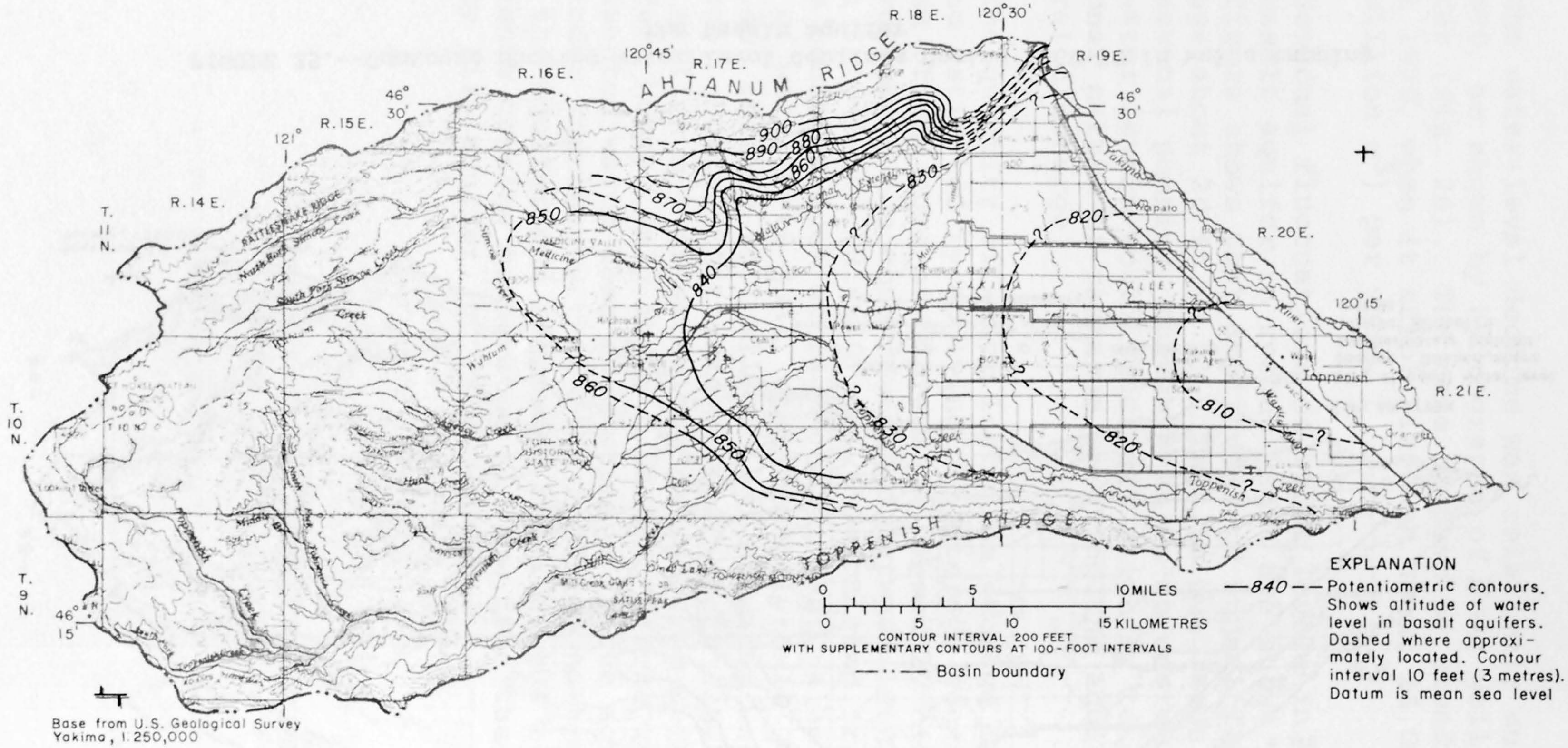


FIGURE 24.--Contours showing water levels in wells tapping basalt aquifers, March 1972.

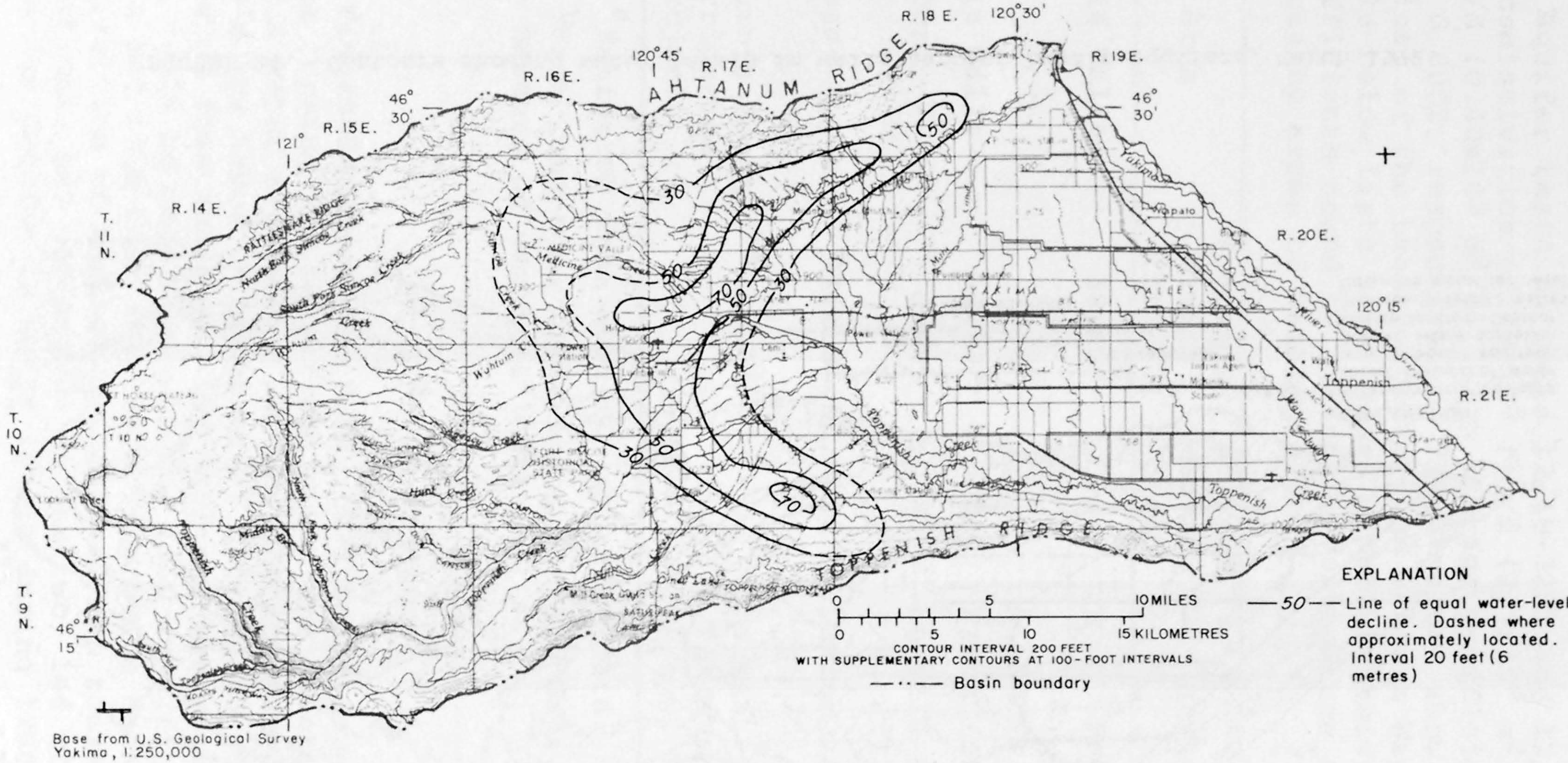


FIGURE 25.--Contours showing water-level declines during 1960-70 in wells tapping the basalt aquifer.

The water-level decline was relatively uniform from 1956 to 1970, as shown by hydrographs of four wells tapping this aquifer (fig. 26). The rate of pumping steadily increased until 1970, when it stablilized at about 16,000 acre-ft (20 million m^3) per year.

Seasonal fluctuations of water levels in wells tapping the basalt aquifer in recent years are shown in figure 27. The figure shows that amplitudes of annual fluctuation average about 20 ft (6 m). This is due largely to the effects of seasonal pumping, though even in an unstressed situation the water levels would fluctuate slightly to reflect the seasonal nature of recharge entering the aquifer and of natural discharge.

The quantity of water lost from storage in this aquifer may be estimated by applying the storage coefficient to the volume of the cone of depression caused by historic pumpage. The volume of the cone developed between 1960 and 1970 is about $3x10^{11}$ ft^3 ($8.4x10^9$ m^3). Calculated from the larger (more conservative) storage-coefficient value from the pumping test of well 12/18-33A1, approximately $6x10^7$ ft^3 ($17x10^5$ m^3) or 1,400 acre-ft (1.7 million m^3) of water was lost from storage. During that same period, about 128,000 acre-ft (158 million m^3) of water was pumped from wells tapping the aquifer; hence, only about 1 percent of the water pumped represented water lost from storage in the aquifer. The remainder represents that from captured natural discharge from the aquifer and increased recharge due to the increased gradients causing more water to flow from the overlying old valley fill aquifer.

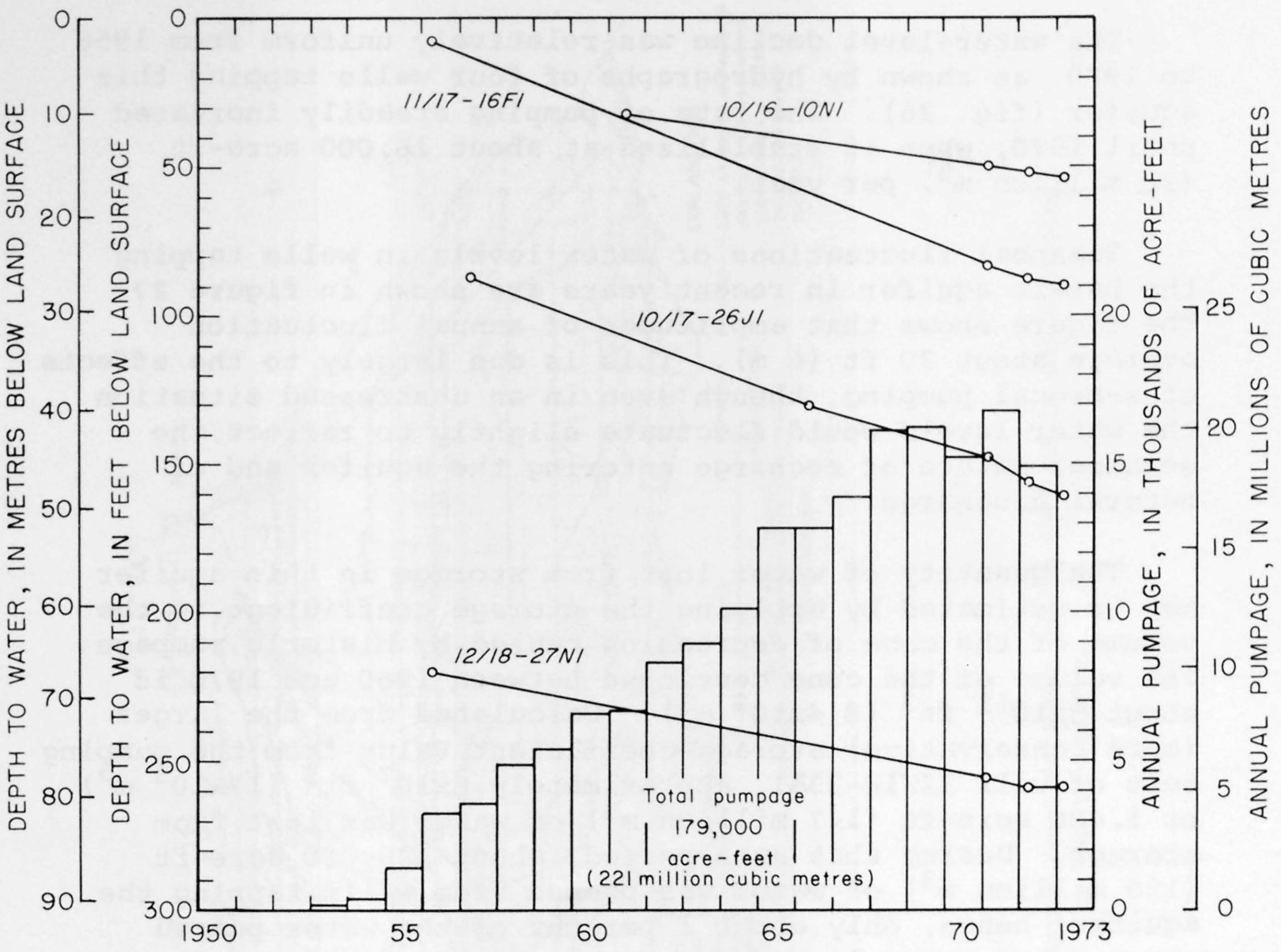


FIGURE 26.--Relationship of spring high-water levels in selected basalt-aquifer wells to annual pumpage, spring 1956 to spring 1973.

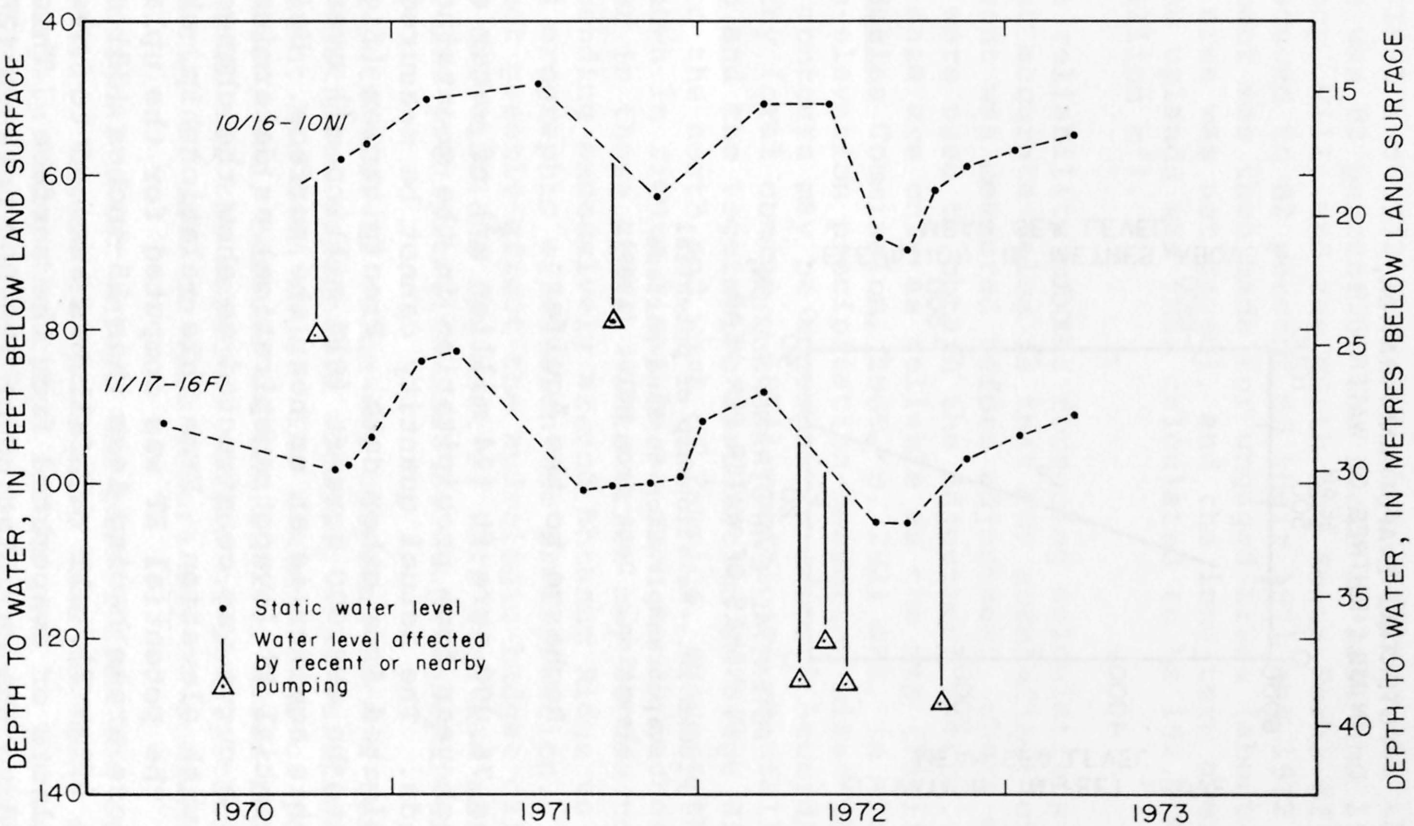


FIGURE 27.--Seasonal water-level fluctuations in basalt-aquifer wells.

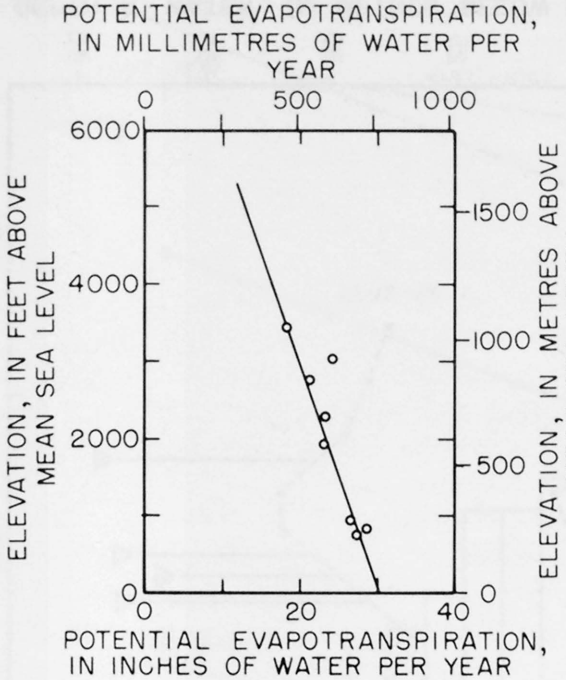


FIGURE 28.--Relationship of potential evapotranspiration to land-surface elevation. Data from Hulet (1969).

Recharge to the Aquifer

As much as 76,000 acre-ft (94 million m^3) of water enters the basalt each year from precipitation in the mountainous western uplands. The actual quantity cannot be measured but it may be estimated from other data. Precipitation (fig.2) was computed to be 498,000 acre-ft (614 million m^3) over the areas where this aquifer is at or near the surface. Using values of potential ET (evapotranspiration) as determined by Hulet (1969), a curve was constructed to show the change in potential ET with elevation. From this relationship, shown in figure 28, the potential ET was computed for the upland areas. In those areas having less than 15 inches (381 mm) of precipitation (fig. 2), all rainfall was assumed to have been captured by plants or evaporated from the surface. This assumption led to the calculation of 228,000 acre-ft (281 million m^3) as the excess of precipitation over ET. From streamflow gaging-station records and miscellaneous measurements of ungaged streams in the mountains, the annual discharge from the uplands was calculated to be 152,000 acre-ft (187 million m^3). This quantity was obtained by comparing the average flow of Toppenish Creek near Fort Simcoe for 1950-70 to the 1971 and 1972 flows at that station. As the long-term average was 82 percent of the flows in 1971 and 1972, the flows of Agency, Mill, and the North and South Forks of Simcoe Creek were reduced to 82 percent of their 1971 and 1972 values. An adjustment was then made for ungaged areas (about 17 percent of the area was not gaged), and the long-term average discharge from the uplands was thus calculated to be 152,000 acre-ft (187 million m^3).

The reliability of the foregoing calculations differs. The most accurate value is that for streamflow, of which 83 percent was measured before adjustment, where again measured values were used to obtain the adjustment factor. The precipitation data are only as reliable as the map (Pacific Northwest River Basins Commission, 1969, p. 282) and, in view of the lack of high-elevation precipitation-measuring sites the placement of the contours may be somewhat in error. According to B. L. Foxworthy (oral commun., 1974) unofficial rainfall records at Tampico and the vegetative association on Sedge Ridge, a few miles to the north and west of Tampico, suggest the precipitation shown in figure 2 may be as much as 20 inches (260 mm) in error in these areas. This error may be due to the isohyetal lines bending excessively around Ahtanum Ridge to account for assumed orographic effects on the precipitation. However, it would not greatly affect the hydrologic-budget calculations because calculations for most of this area had most, if not all, of its precipitation lost to evapotranspiration.

The potential-ET value was computed from a formula which has demonstrated reasonable accuracy when verification by measurement has been made. The maximum rate of potential ET was applied, and, because of the limited water-holding capacity of the soil and the seasonal nature of precipitation, the values of potential ET used in this report may be somewhat overestimated.

Additional water enters the basalt from the overlying old valley fill. Figure 22 shows that this movement of water takes place largely along the ridge flanks and in the western part of the lowland area where heads in the basalt aquifer are lower than those in the old valley fill. Table 5 summarizes this recharge by areas of head difference, and shows that the total combined recharge from individual areas of the old valley fill is about 42,000 acre-ft (52 million m^3) of water per year. Under natural conditions this recharge is probably smaller, as the declining heads in the basalt aquifer resulting from pumpage, especially in this area, have induced water to move more rapidly into the basalt.

The configuration of the water-level contours in figure 24 shows that water moves generally eastward in the Toppenish Creek basin. Because the ridge on the east side of Medicine Valley does not impede flow in the deeper zones, about 102,000 acre-ft (126 million m^3) of water per year is moving generally eastward into the lower part of the basin (fig. 24).

Discharge from the Aquifer

Water leaves the basalt in the Toppenish Creek basin by (1) moving upward into the old valley fill, (2) pumping from wells, and (3) underflow eastward beneath the Yakima River.

In the eastern part of the basin most of the water moves upward into the old valley fill. Figure 22 shows the areas of discharge having positive head difference, and table 5 lists the quantities of water moving in these areas. The total discharge from these areas to the old valley fill is about 94,000 acre-ft (116 million m^3) per year.

The second most important discharge from the basalt aquifer is through wells, which currently pump about 16,000 acre-ft (20 million m^3) per year from this aquifer.

A smaller amount leaves the Toppenish Creek basin as underflow to the east under the Yakima River, as indicated by the contours in figure 24. The quantity is probably about 8,000 acre-ft (9 million m^3) per year, as estimated from the water budget as the unaccounted outflow.

Present Ground-Water Development

In 1972 wells tapping the basalt aquifer were distributed in an arc around the western edge of the basin lowland (fig.14). Concentrations of wells along this arc occur in the southwestern part of T.12 N., R.18 E., in the northern half of T.11 N., R.17 E., and in the southeastern part of T.10 N., R.17 E. A small cluster of wells drawing water from both the old valley fill and the upper parts of the basalt is found in the central part of T.10 N., R.16 E. In all, 34 wells obtain all or most of their water from the basalt aquifer, and during the period 1970-72 the annual pumpage averaged about 16,000 acre-ft (20 million m^3).

Potential for Further Development

Presently the most heavily developed aquifer in the basin, the basalt has had water-level decline in excess of 100 ft (30 m) in the more heavily pumped areas.

The basalt is highly productive, yielding more than 2,000 gal/min (126 l/s) to some wells. However, the distribution of pumpage has not been equal over this aquifer, a factor that undoubtedly has contributed to the large local declines under what would be considered moderate pumpage.

An analysis was performed to project the effects of continued pumping from this aquifer and, thereby, to provide a basis for management decisions regarding the future development of this aquifer.

Because individual basalt wells display unique characteristics representing peculiarities in the aquifer in their immediate vicinity, this analysis was performed on three groups of wells, as shown in figure 14. By dealing with the well groups, a relation between time-drawdown and pumpage was developed to allow projection of declines in the basalt aquifer in response to future pumpage in these areas.

The analytic method used was to determine, for as many time periods as practical, the average rates of drawdown for each period in each group of wells. In some cases, the earliest water level for a well was adjusted to the measurement closest to March by estimating the earlier annual fluctuation from its present annual fluctuation.

For some well groups, where it was possible to calculate average drawdown rates for more than one period prior to 1971, the average drawdown rates of the wells drilled during the first period prior to 1971 was applied to the earlier wells before computing their annual drawdown rates during the earlier period. The resultant values of average drawdown rates over each time period were then divided by the average annual pumping rates for that group over the same time period. This value was then plotted as shown in figure 29, with some scatter (especially in the 1971-73 period for each group) being probably due to short-term variations. However, the points for all groups form a fairly straight line.

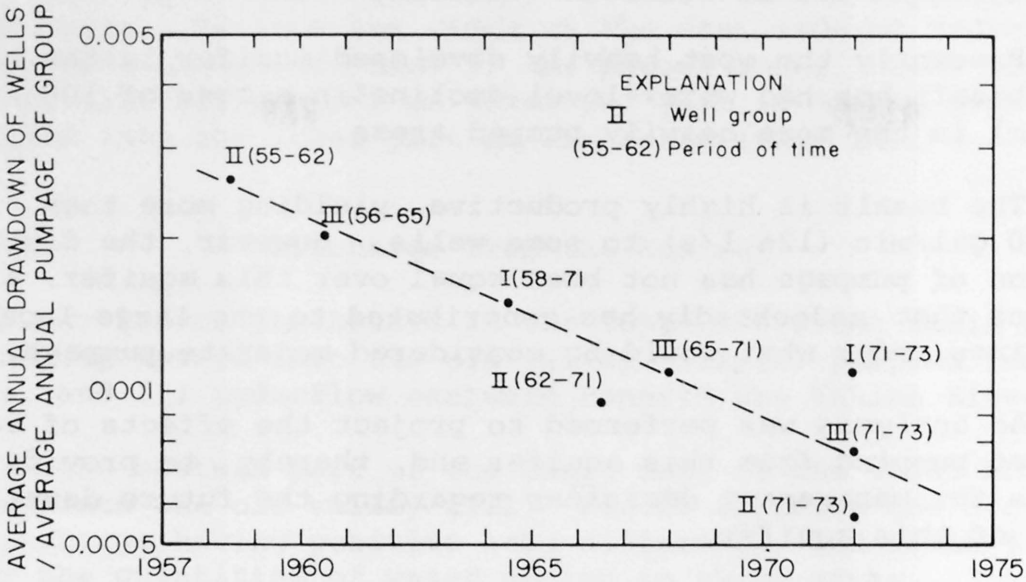


FIGURE 29.--Average annual drawdown per unit pumpage by groups of wells tapping the basalt aquifer in the Toppenish Creek basin.

From this analysis, a nomograph (fig. 30) was prepared that allows the drawdowns to be computed for any year for any chosen value of pumpage. Because the empirical nature of this analysis does not lend itself to accurate projections of extreme values of pumpage, values chosen for projection should be limited to 120 percent of current pumpage in the group, and drawdown projections of more than 5 years should be made with caution.

For the purposes of estimating the costs of pumping water from wells, an analysis of the cost per acre-foot of water was made using an average of the 1974 electrical-power costs of Rural Electrification Administration and Puget Power and Light Co. (These are the major electrical power suppliers to the area.) For the analysis the following assumptions were made:

1. Pumping rate was constant for 6 months.
2. Line pressure was 75 lbs/in^2 (5.3 kg/cm^2).
3. Pumping plant efficiency was 53 percent.

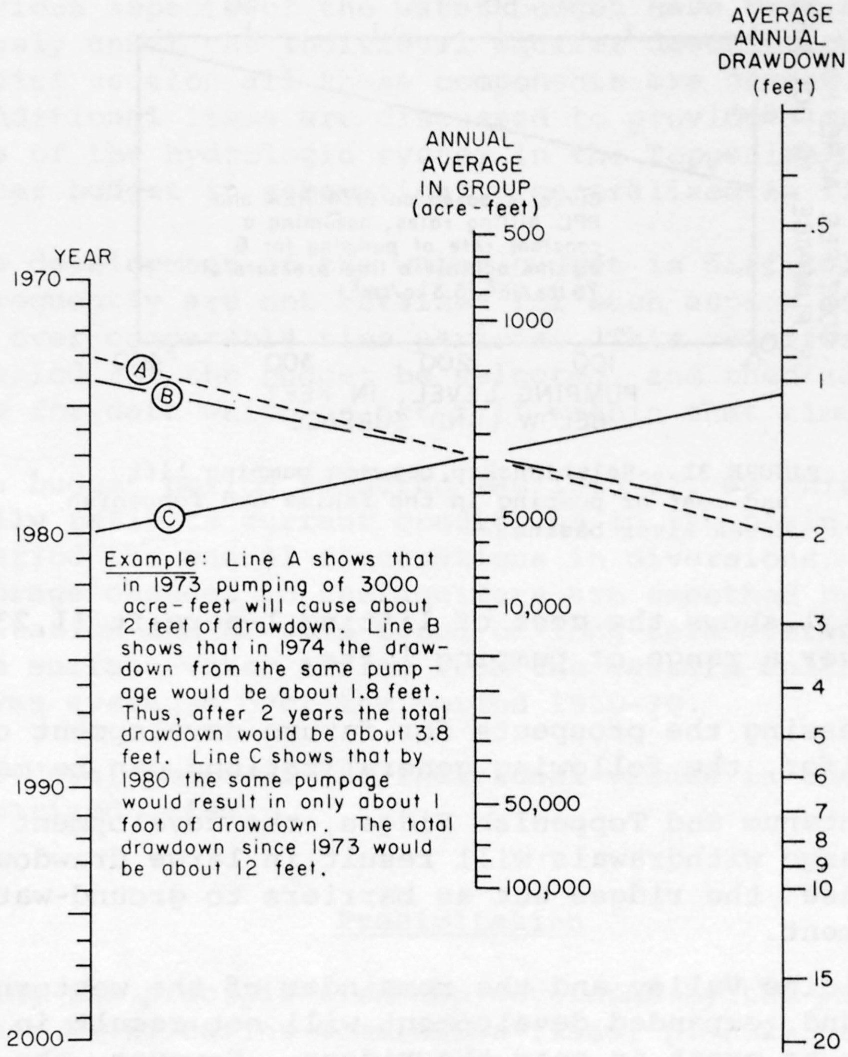


FIGURE 30.--Nomograph for projecting average annual decline of water levels in wells tapping the basalt aquifers.

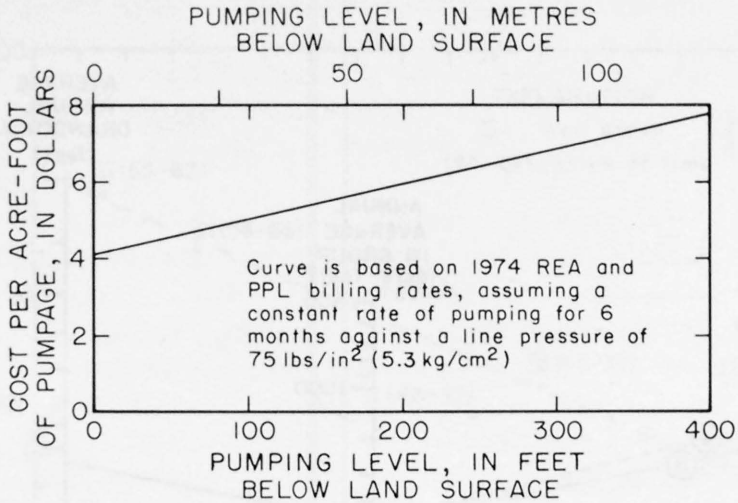


FIGURE 31.--Relationship between pumping lift and cost of pumping in the Yakima and Toppenish Creek River basins.

Figure 31 shows the cost of lifting 1 acre-ft (1,233 m^3) of water over a range of pumping lifts.

In assessing the prospects for future development of the basalt aquifer, the following generalizations can be made:

1. Near Ahtanum and Toppenish Ridges, the development of large withdrawals will result in large drawdowns because the ridges act as barriers to ground-water movement.

2. In Medicine Valley and the remainder of the western lowland, expanded development will not result in drawdowns as great as near the ridges. However, the high-yield zones in the aquifer are deep, and the water levels in wells tapping these zones are several tens or, at places, hundreds of feet below land surface.

3. In the eastern part of the lowland the basalt aquifer is not presently tapped. Evidence suggests that artesian-pressure heads may be significantly (as much as 150 ft or 46 m) above land surface in the southeastern part of the valley. Inasmuch as the basalt surface is generally within 1,000 ft (305 m) of the land surface, it is within the range of present technology to drill a well in this area that would be invaluable in evaluating this aquifer's potential for producing additional large supplies.

THE WATER BUDGET

Various aspects of the water budget have been discussed previously under the individual aquifer descriptions. In this brief section all these components are summarized and some additional items are discussed to provide a more complete picture of the hydrologic system in the Toppenish Creek basin. The water budget is schematically generalized in figure 32.

The development of the water budget is difficult because data frequently are not obtained for each aspect of the budget over comparable time periods. This requires that a time period for the budget be selected, and then adjustments be made for data which do not fall within that time period.

The budget period selected was 1965-72, as this period generally reflects current conditions in the basin. Over this period the annual fluctuations in diversions, drains, and storage changes in the aquifers are smoothed by averaging. Precipitation and ET were based on long-term average values, and the surface-water inflow from the western uplands (basalt area) was averaged over the period 1950-70.

The development of the individual values in the budget is summarized below.

Precipitation

Using the precipitation map developed by the Pacific Northwest River Basins Commission (1969, p. 282), the areas between contour lines were planimetered and the average precipitation in each area was calculated to be as follows:

Basalt area--------------	498,000 acre-ft
Old valley fill area-----	111,000 acre-ft
Young valley fill area---	74,000 acre-ft
Total----	683,000 acre-ft

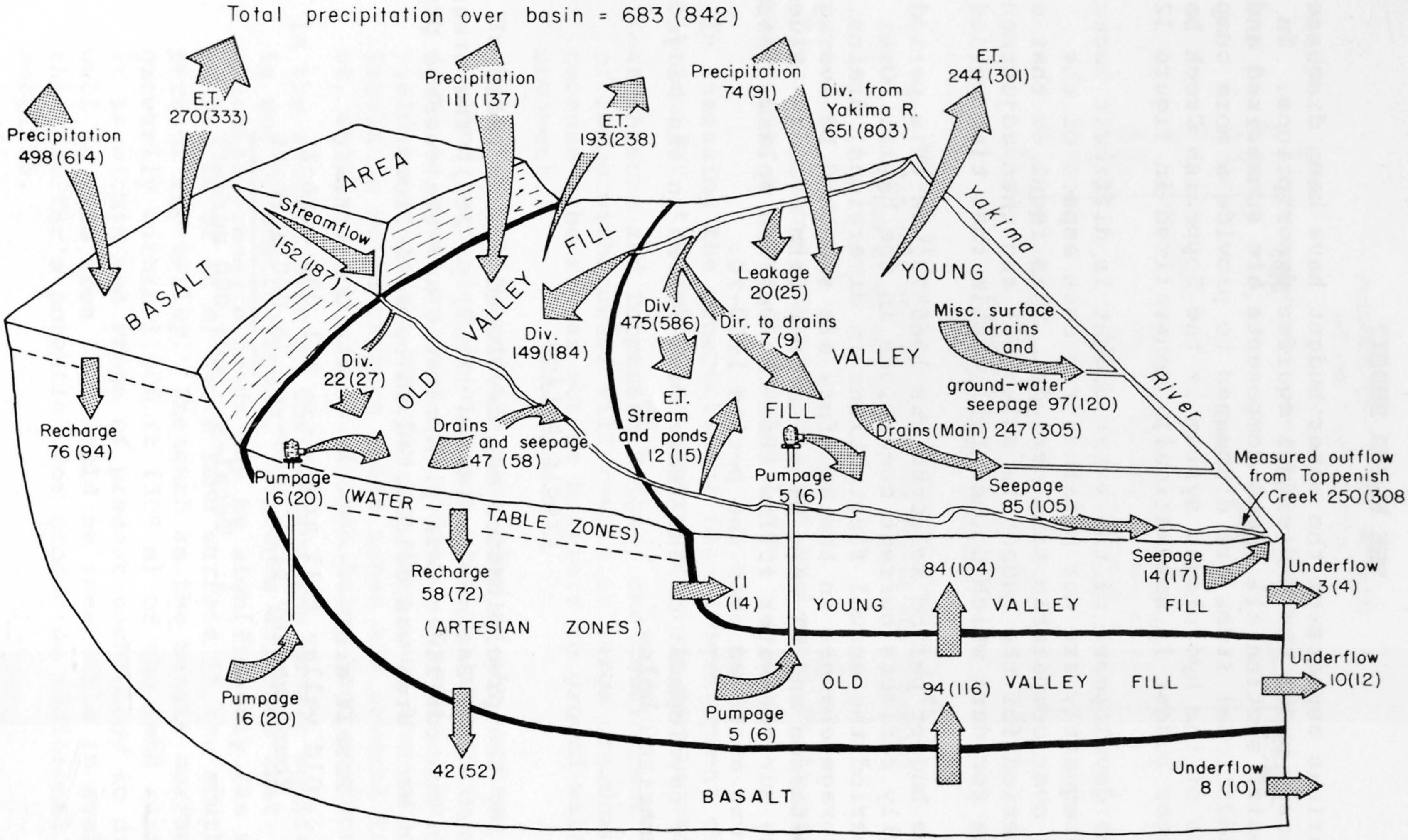


FIGURE 32.--Schematic budget of the hydrologic system in the Toppenish Creek basin. Values are in thousands of acre-feet per year. Values in parentheses are in millions of cubic metres per year.

Evapotranspiration

This was computed by the modified Blaney-Criddle formula (U.S. Dept. Agriculture, 1967) for irrigated areas, and for nonirrigated areas the estimate was based on ET figures computed by Hulet (1969).

Basalt area------------------------------	270,000 acre-ft
Old valley fill area------------------	193,000 acre-ft
	(133,000 from irrigated areas)
Young valley fill area----------------	244,000 acre-ft
	(222,000 from irrigated areas)
Lakes, ponds, and phreatophyte areas-	12,000 acre-ft
Total----	719,000 acre-ft

Streams

Flows from the basalt area (uplands) were computed from data for the 1950-70 average flow of Toppenish Creek, the 1971 and 1972 flows of Mill and Agency Creeks, and the flows of North and South Forks of Simcoe Creek as adjusted by comparison with Toppenish Creek for the same years. Ungaged-area contributions (17 percent of total) were computed by the extension of the smaller streams' flows on a per-square-mile basis. Thus, the total streamflow leaving the basalt area (uplands) was calculated to be 152,000 acre-ft (187 million m^3) per year.

The total surface water leaving the basin in Toppenish Creek during 1965-70, including water diverted to the adjacent Satus Creek basin, averaged 250,000 acre-ft (308 million m^3) per year.

Diversions

Based on 1965-72 records of diversion compiled by the BIA, the average annual diversion from the Yakima River into the Toppenish Creek basin during 1965-72 was 651,000 acre-ft (812 million m^3), of which 643,000 acre-ft (792 million m^3) was via the Main Canal and 8,000 acre-ft (10 million m^3) was via Wanity Slough. Distribution of the diversions from the Main Canal between old valley fill areas and young valley fill areas is based on diversion records provided by the BIA for the year 1971, and is as follows:

Old valley fill area--------	149,000 acre-ft
Young valley fill area------	475,000 acre-ft
[includes 8,000 acre-ft via Wanity Slough]	

The remainder of the 651,000 acre-ft (812 million m^3) diverted from the Yakima River includes 20,000 acre-ft (25 million m^3) lost as seepage to the young valley fill from the Main Canal and 7,000 acre-ft (9 million m^3) diverted from the Main Canal directly to Harrah Drain.

Drains

This is based on the 1965-72 BIA records of flow from the principal drains from the young valley fill areas. Miscellaneous drains were adjusted from the BIA estimates for 1970 by the proportional differences between the average value and the 1970 values for the main drains.

Main drains (Subdrain 35, Toppenish Drain, and Marion Drain)----------------	247,000 acre-ft
Miscellaneous drains (young valley fill areas, includes ground-water seepage to Yakima River-----------------	97,000 acre-ft
Total---	344,000 acre-ft

Pumpage

Values were obtained from records of municipal pumpage and by computing pumpage from individual wells from kilowatt-hour consumption, using a method described by Luzier and Burt (1974, p. 25,26).

Old valley fill pumpage (in young valley fill areas)---	5,000 acre-ft
Basalt pumpage (in old valley-fill areas)--------------------	16,000 acre-ft
Total--	21,000 acre-ft

Leakage from Main Canal System

Computed from 1971 records of the diversion to the Main Canal from the Yakima River, less all diversions from the Main Canal, the leakage was about 20,000 acre-ft (25 million m^3) per year.

Seepage

Return flow from seepage to the Toppenish Creek channel, computed by balancing the budgets of the old and young valley fill aquifers, was about 85,000 acre-ft (102 million m^3) per year.

Summary of Water Budget

A summary of the major components of the water budget follows. The summary omits all those items that involve inter-aquifer or inter-area flows, and only the inflow values--for precipitation and diversion from the Yakima River--and outflow values--for evapotranspiration and underflow from the basin--are included.

	Acre-ft/yr
Inflow:	
Precipitation on:	
Basalt area (uplands)-------------------	498,000
Old valley fill area--------------------	111,000
Young valley fill area------------------	74,000
	683,000
Diversions to:	
Old valley fill area, from:	
Main Canal------------------------------	149,000
Local streams---------------------------	22,000
Young valley fill area, from:	
Main Canal and Wanity Slough-----------	475,000
Main Canal seepage---------------------	20,000
Direct diversion to drain--------------	7,000
	673,000
Total inflow----	1,356,000
Outflow:	
Evapotranspiration from:	
Basalt area (uplands)-------------------	270,000
Old valley fill area--------------------	193,000
Young valley fill area------------------	244,000
	707,000
Streamflow and ditch drainage from:	
Basalt area (uplands)-------------------	152,000
Old valley fill area--------------------	47,000
Young valley fill area------------------	429,000
	[a]628,000
Underflow from basin, via:	
Basalt aquifer--------------------------	8,000
Old valley fill aquifer-----------------	10,000
Young valley fill aquifer---------------	3,000
	21,000
Total outflow---	1,356,000

[a]Includes 12,000 acre-ft evaporation from lakes, ponds, and streams.

SUMMARY AND CONCLUSIONS

The Toppenish Creek basin is underlain by three major aquifers, as follows:

1. Basalt, which underlies the entire basin.
2. Old valley fill, which overlies the basalt in the lower parts of the basin.
3. Young valley fill, which overlies the old valley fill in the eastern part of the basin.

All three aquifers are capable of yielding large quantities of water (more than 1,000 gal/min or 63 l/s) to individual wells whose construction is such that the well bore is open to significant thicknesses of saturated aquifer materials.

The basalt and old valley fill have limited potential for increased recharge by management, whereas the young valley fill presents excellent opportunities for management of recharge.

Each of the three aquifers is capable of producing water in sufficient quantity for irrigation or public use. However, the young valley fill is in such close hydraulic connection with the lakes and ponds that agricultural or other cultural practices may cause contamination by persistent chemical compounds and, therefore, this aquifer may not be desirable for public supplies.

Present diversions from the Yakima River and the natural flow of the streams rising in Toppenish Creek basin provide an excess of about 466,000 acre-ft (575 million m^3) of water that leaves the basin each year. Management of the hydrologic system in the basin could capture some or even most of this excess water. However, capturing most of the excess water and using it for irrigation would accelerate problems of salt buildup in the soils of irrigated acreage. Irrigating all irrigable acreage below the 1,500-ft (457-m^3) elevation in the basin would require less than 50,000 acre-ft (62 million m^3) of additional water per year to augment precipitation in the consumptive-use demand of crops on the 32,000 additional acres (130 million m^2). Depending on the irrigation method used, a considerably larger quantity of water would be diverted or applied to irrigate the additional acreage; however, the excess over 50,000 acre-ft (62 million m^3) would remain in the system and would eventually return to the drains.

Irrigation of additional lands on the south slope of Ahtanum Ridge and the north slope of Toppenish Ridge would most likely be from surface-water sources, as the proximity to ground-water-flow barriers in the ridges, and the remoteness of recharge areas in the basalt aquifer do not create a favorable environment for further development of this aquifer in those two areas.

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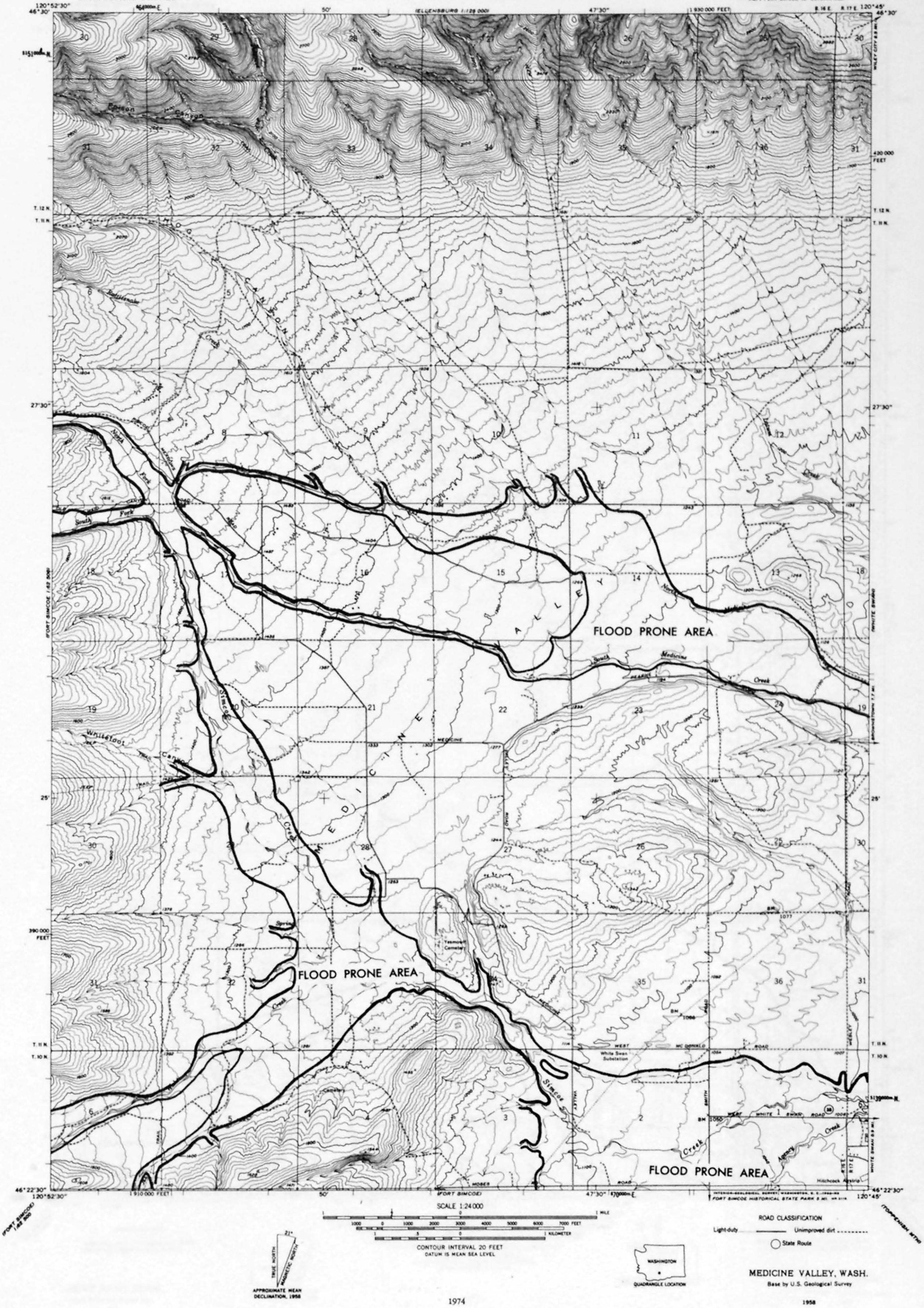
APPENDIX

APPENDIX I.--Reduced copies of U.S. Geological Survey 7.5-minute topographic quadrangles, showing areas largely inundated by the flood of January 1974 in the Toppenish Creek basin

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

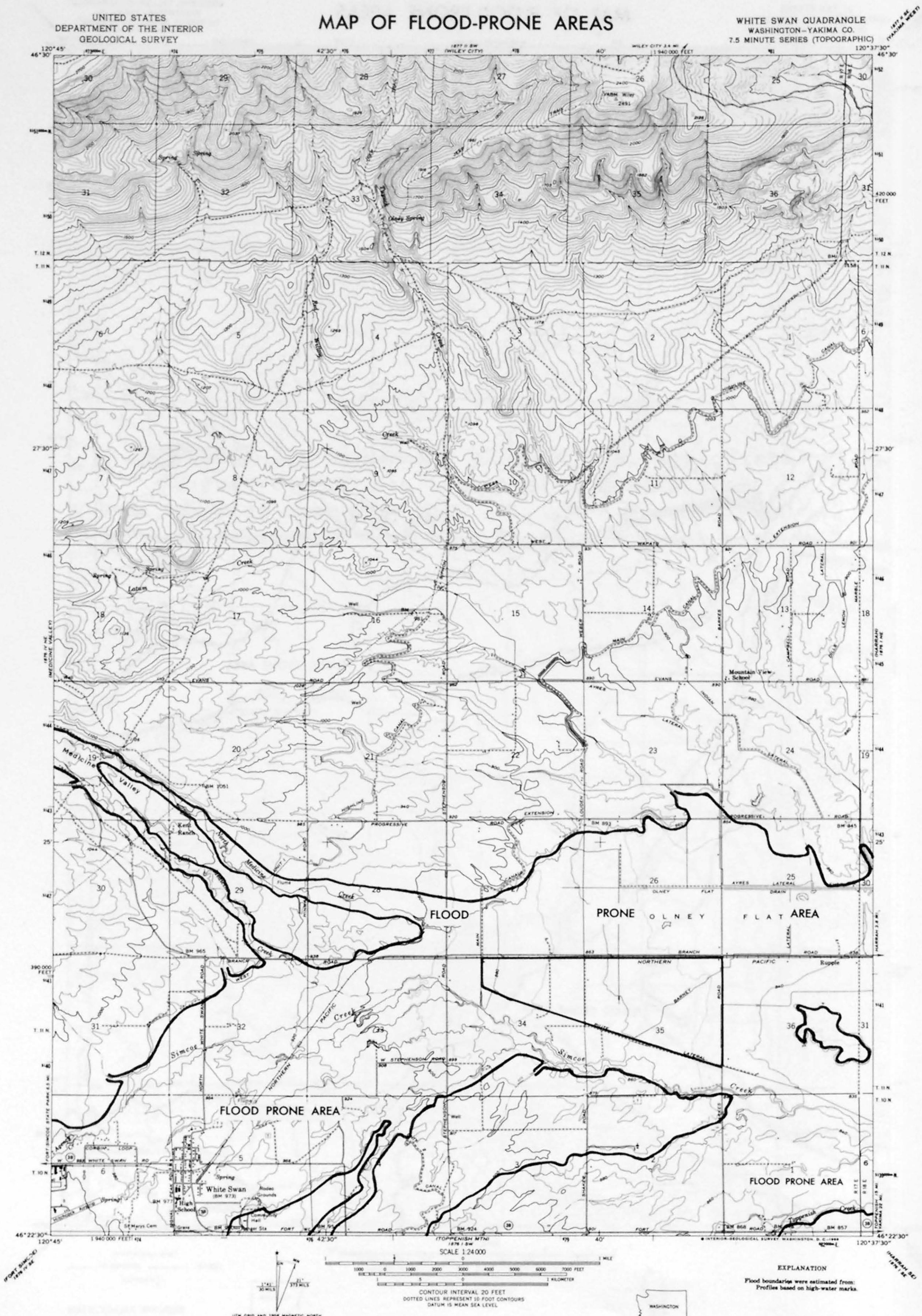
MAP OF FLOOD-PRONE AREAS

MEDICINE VALLEY QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



MEDICINE VALLEY, WASH.
Base by U.S. Geological Survey
1958

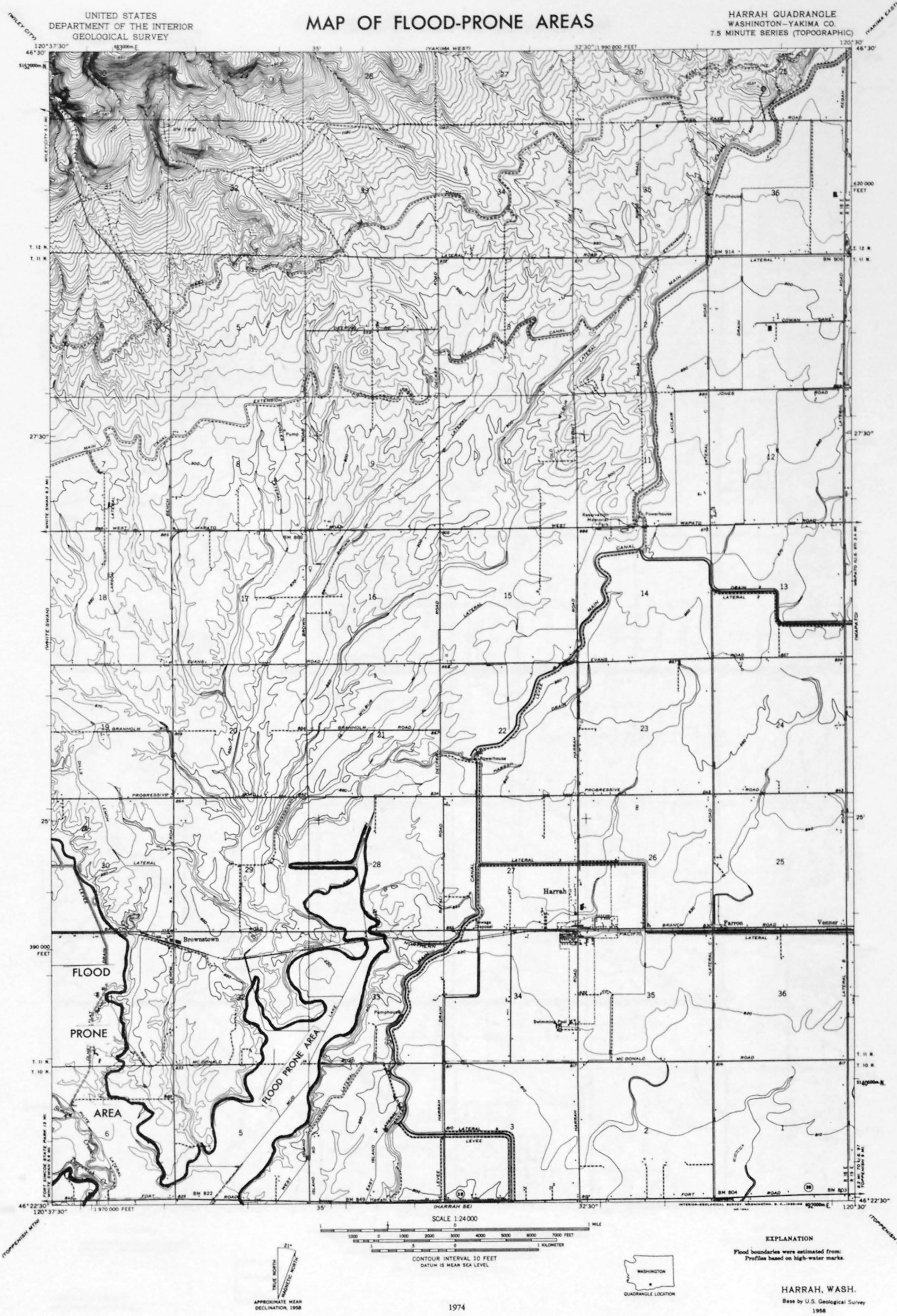
1974


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MAP OF FLOOD-PRONE AREAS
WHITE SWAN QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
FLOOD PRONE OLNEY FLAT AREA
FLOOD PRONE AREA
FLOOD PRONE AREA
White Swan
Medicine Valley
Simcoe Creek
Toppenish Creek
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
EXPLANATION
Flood boundaries were estimated from:
Profiles based on high-water marks.
WHITE SWAN, WASH.
Base by U.S. Geological Survey
1958
AMS 1876 I NW—SERIES V891
1974

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

HARRAH QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



EXPLANATION

Flood boundaries were estimated from Profiles based on high-water marks.

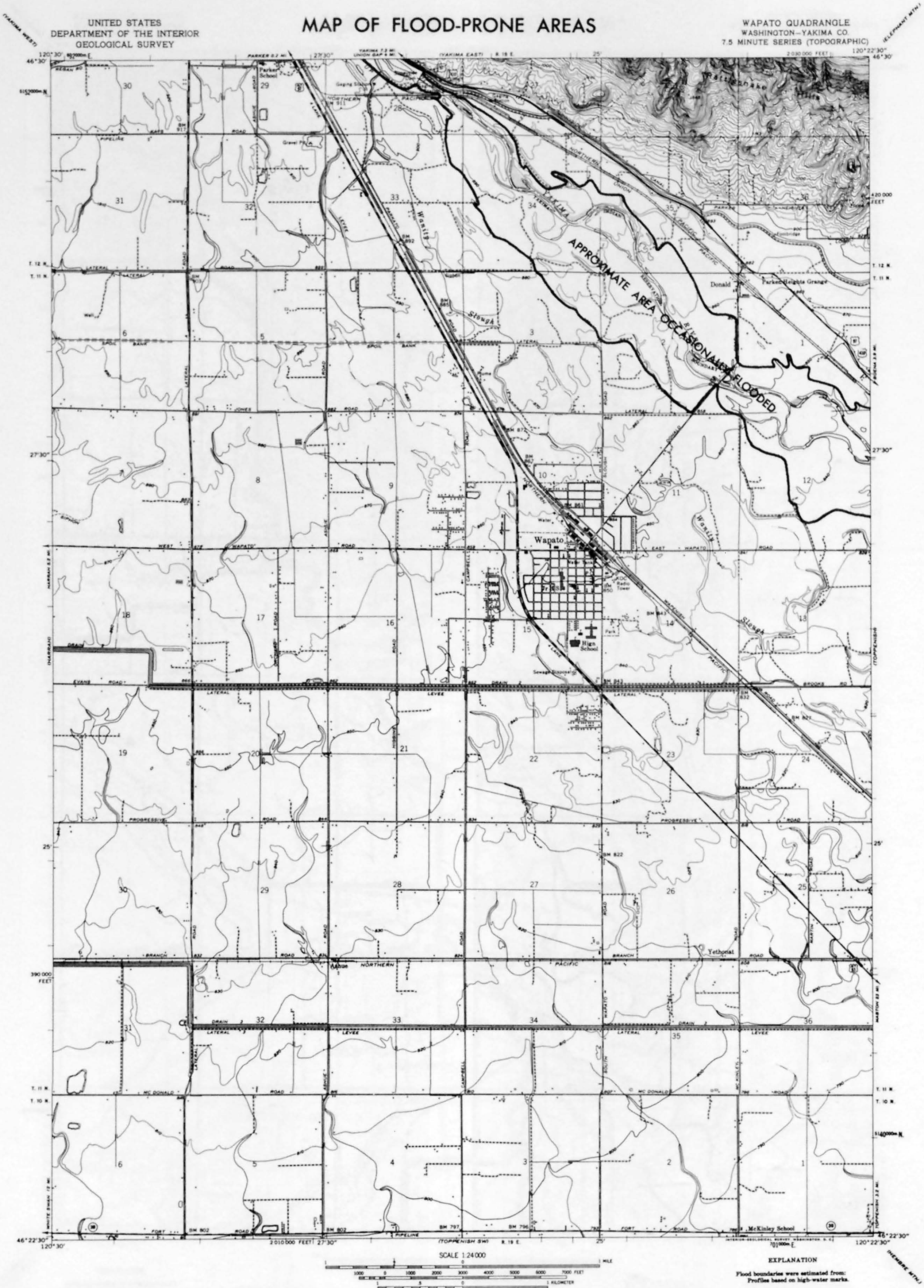
HARRAH, WASH.
Base by U.S. Geological Survey
1958

1974

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

WAPATO QUADRANGLE
WASHINGTON—YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

EXPLANATION

Flood boundaries were estimated from: Profiles based on high-water marks.

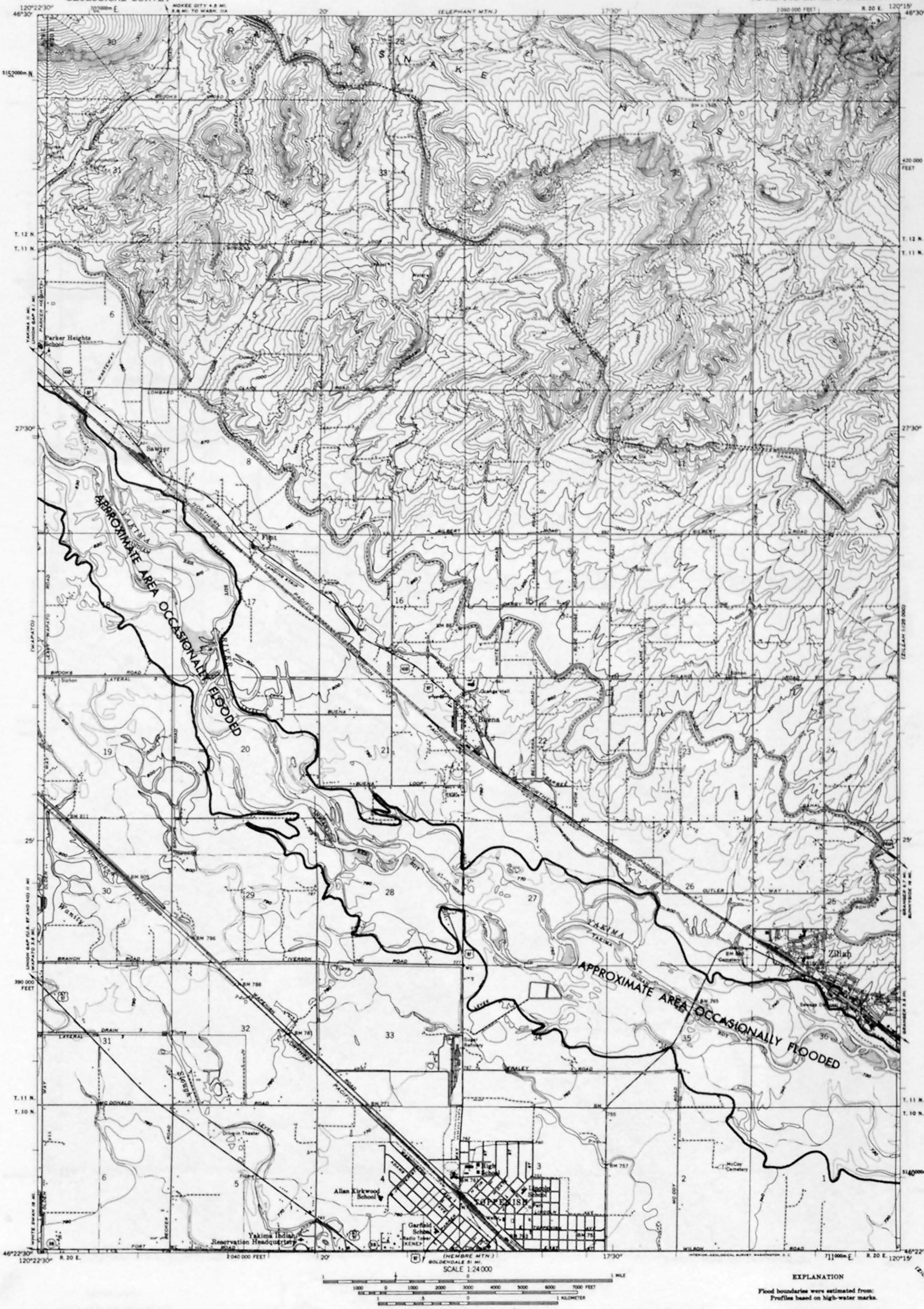
WAPATO, WASH.
Base by U.S. Geological Survey
1958

1969

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

TOPPENISH QUADRANGLE
WASHINGTON—YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



EXPLANATION

Flood boundaries were estimated from:
Profiles based on high-water marks.

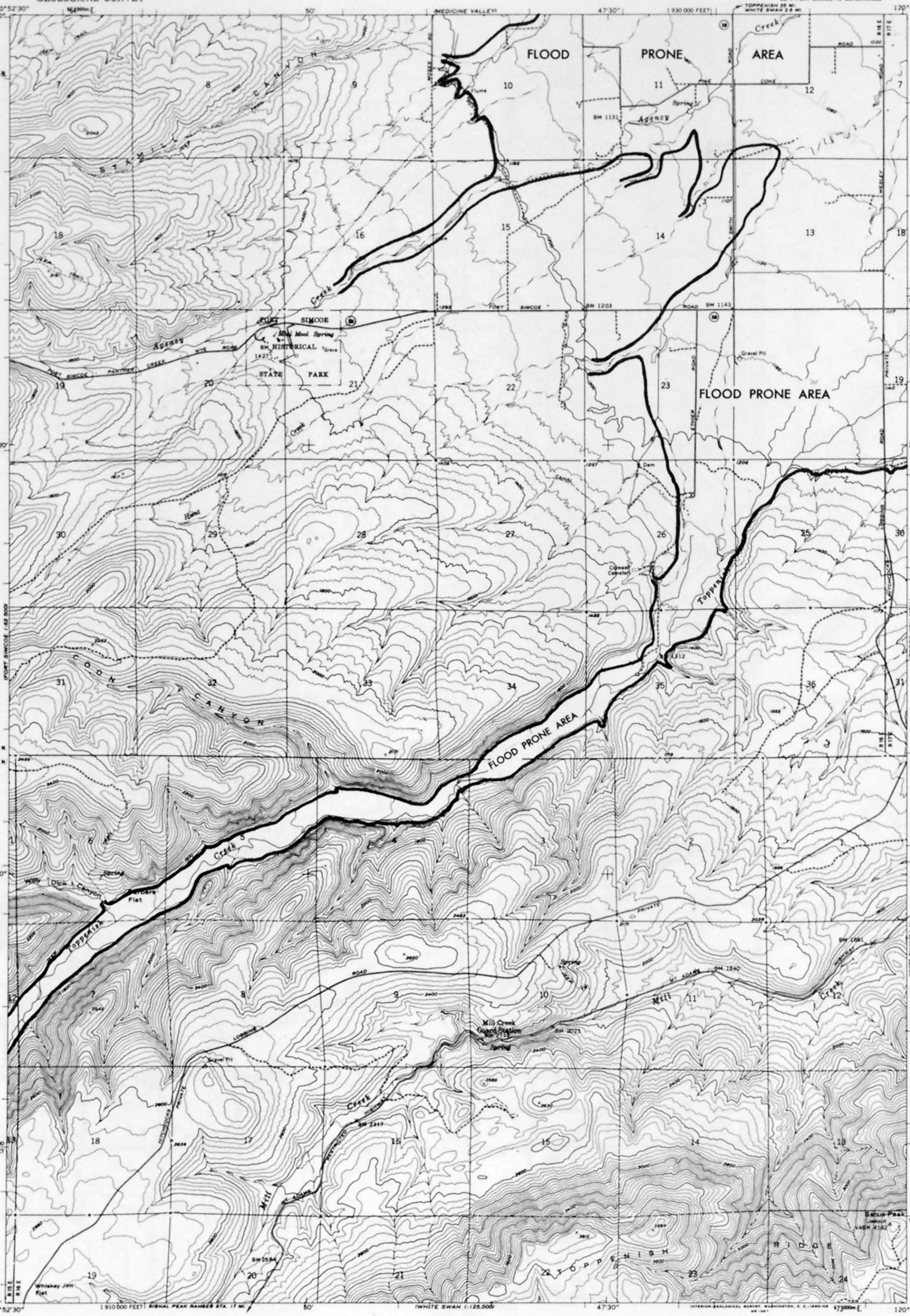
1969

TOPPENISH, WASH.
Base by U.S. Geological Survey
1958

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

FORT SIMCOE QUADRANGLE
WASHINGTON—YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1958

QUADRANGLE LOCATION

EXPLANATION

Flood boundaries were estimated from:
Profiles based on high-water marks.

FORT SIMCOE, WASH.

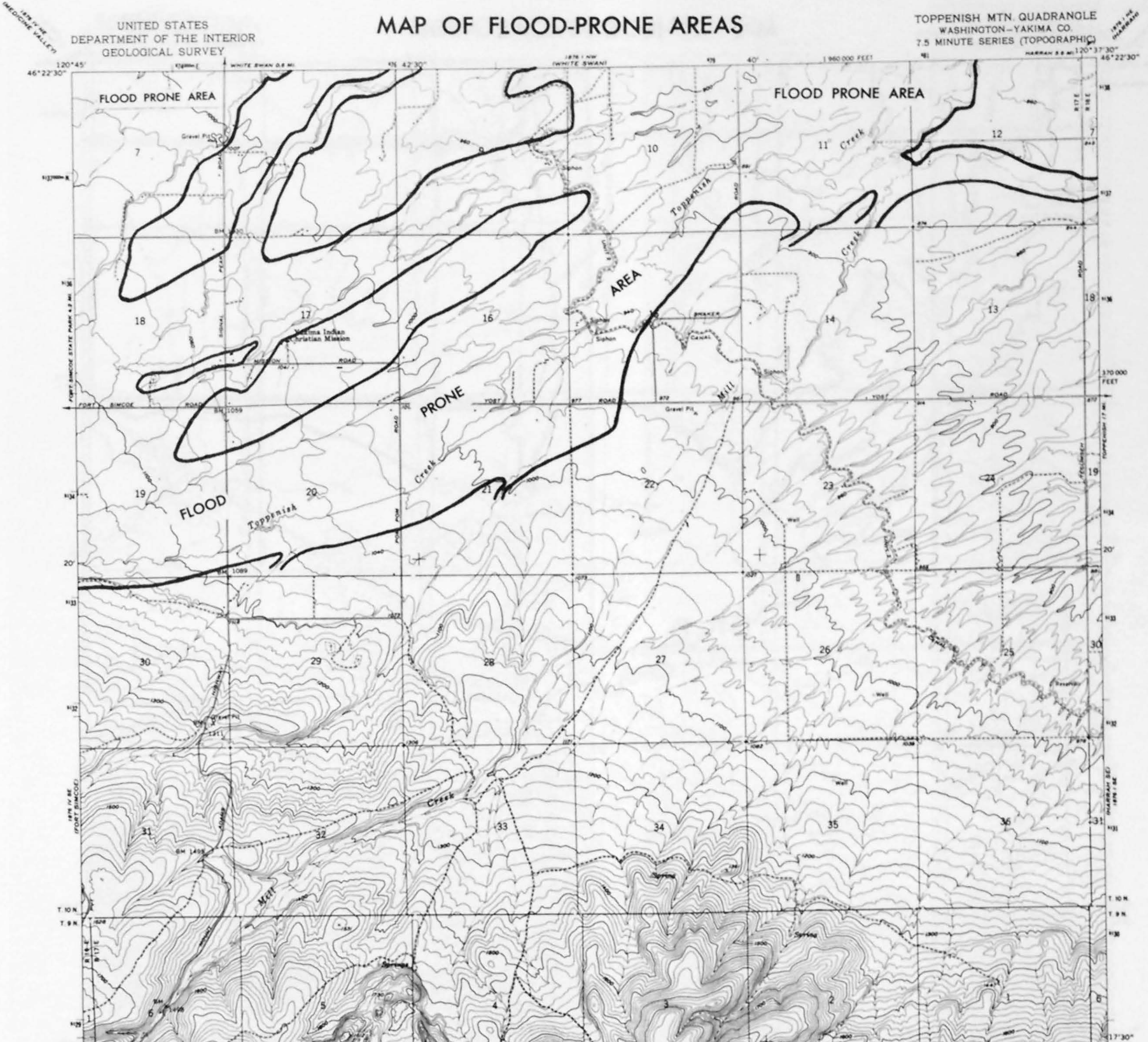
Base by U.S. Geological Survey
1958

1974

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

TOPPENISH MTN. QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



EXPLANATION

Flood boundaries were estimated from: Profiles based on high-water marks.

TOPPENISH MTN., WASH.
Base by U.S. Geological Survey
1958

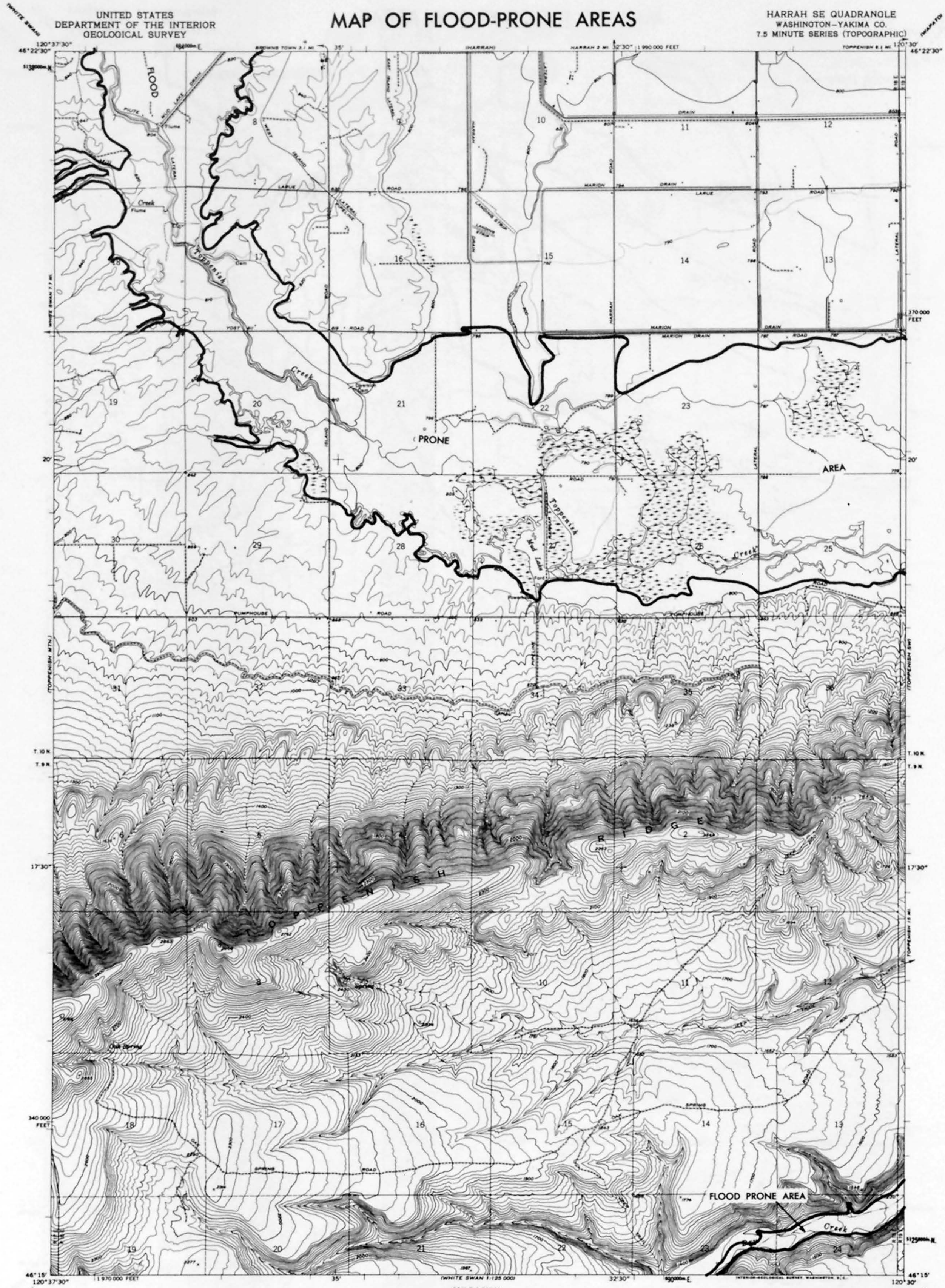
AMS 1876 I SW—SERIES V891

1974

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

HARRAH SE QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

WASHINGTON
QUADRANGLE LOCATION

This work was performed by the U.S. Geological Survey for and funded by the Federal Insurance Administration, Department of Housing and Urban Development, to meet provisions of the National Flood Insurance Act of 1968.

1974

EXPLANATION

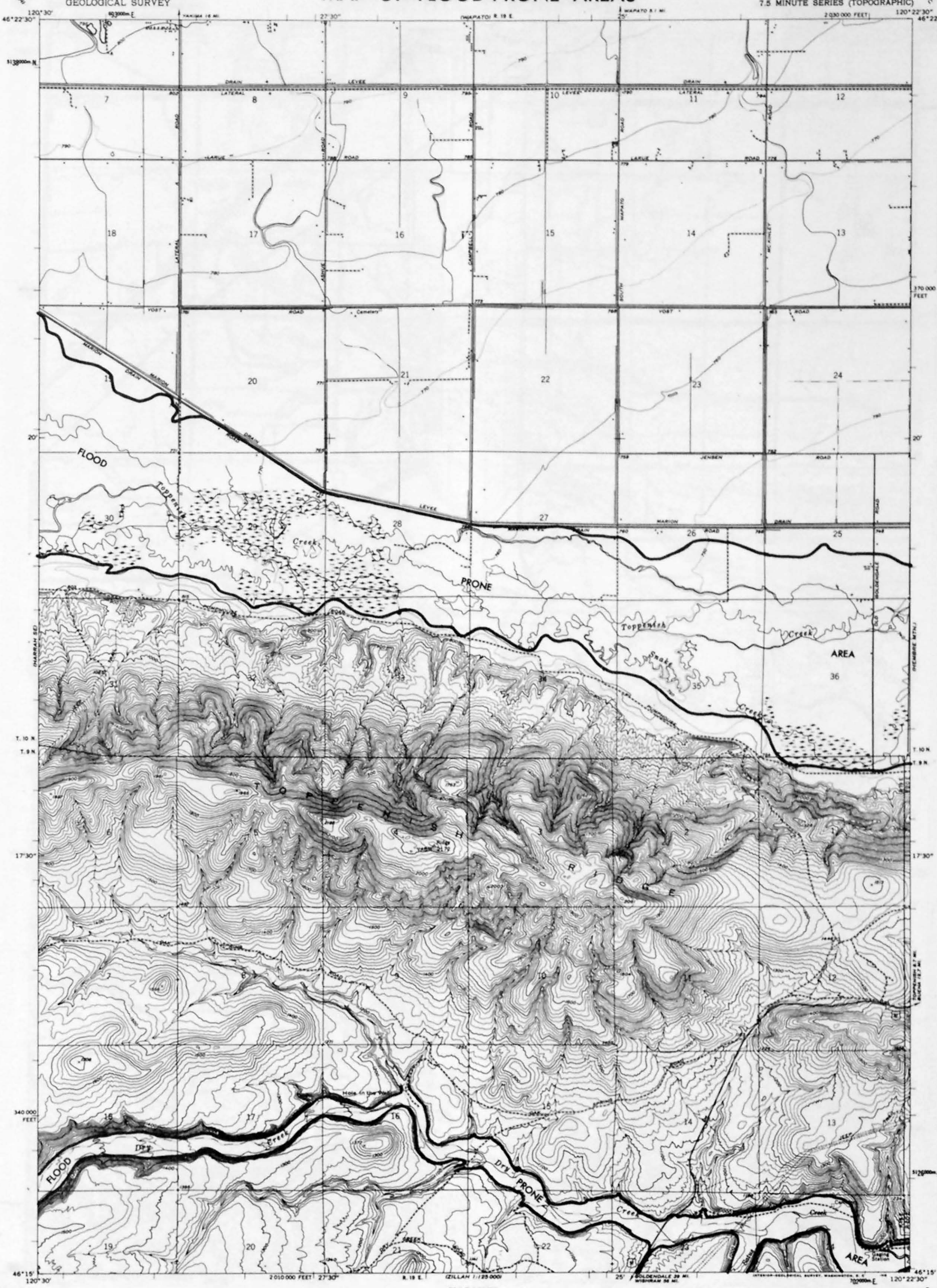
Flood boundaries were estimated from:
Photographs taken at time of flooding
Profiles based on high-water marks.

HARRAH SE, WASH.
Base by U.S. Geological Survey
1958

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

TOPPENISH SW QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

EXPLANATION

Flood boundaries were estimated from:
Photographs taken at time of flooding.
Profiles based on high-water marks.

This work was performed by the U.S. Geological Survey for and funded by the Federal Insurance Administration, Department of Housing and Urban Development, to meet provisions of the National Flood Insurance Act of 1968.

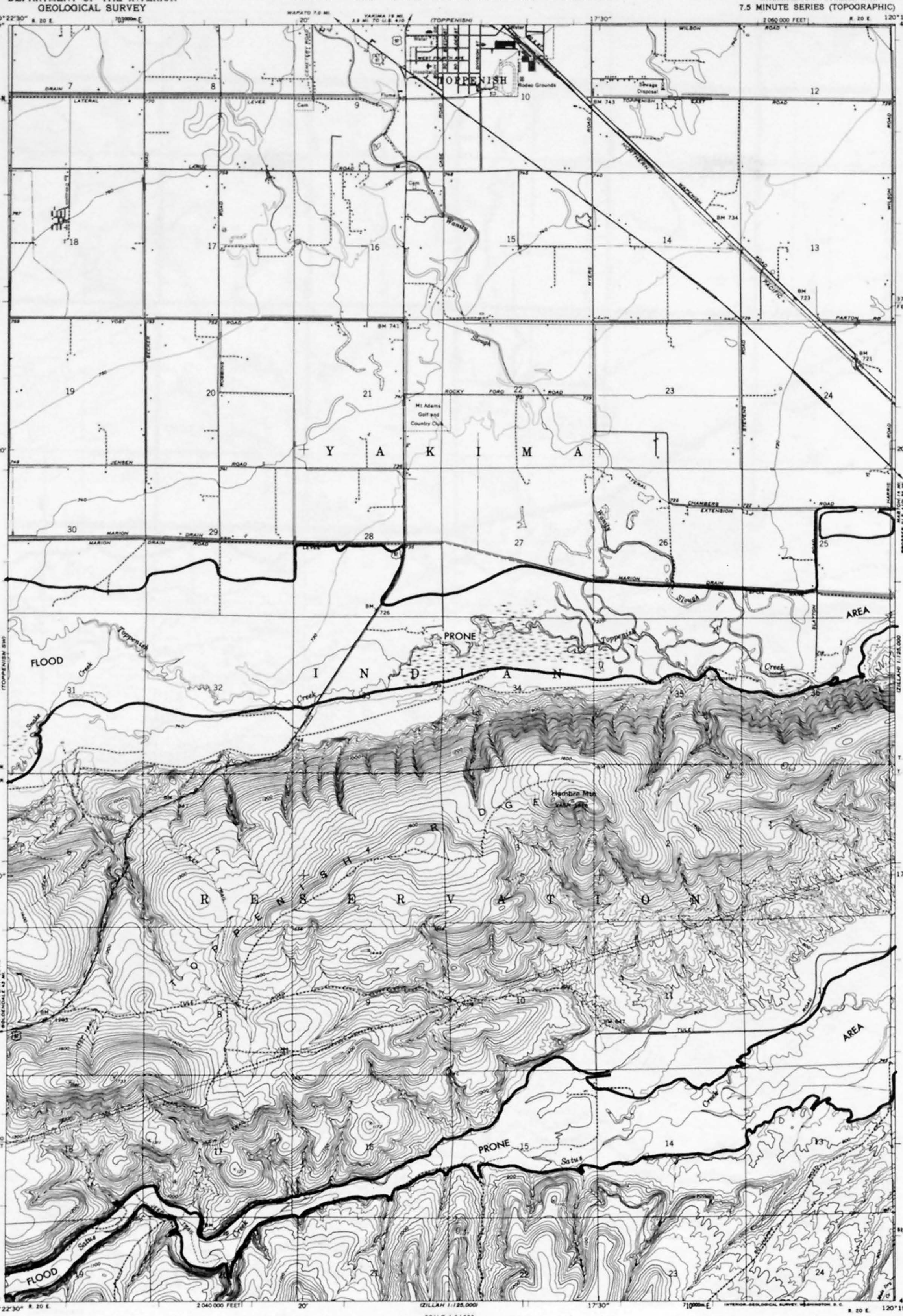
1974

TOPPENISH SW, WASH.
Base by U.S. Geological Survey
1958

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF FLOOD-PRONE AREAS

HEMBRE MTN. QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

1 MILE — 7000 FEET — 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

This work was performed by the U.S. Geological Survey for and funded by the Federal Insurance Administration, Department of Housing and Urban Development, to meet provisions of the National Flood Insurance Act of 1968.

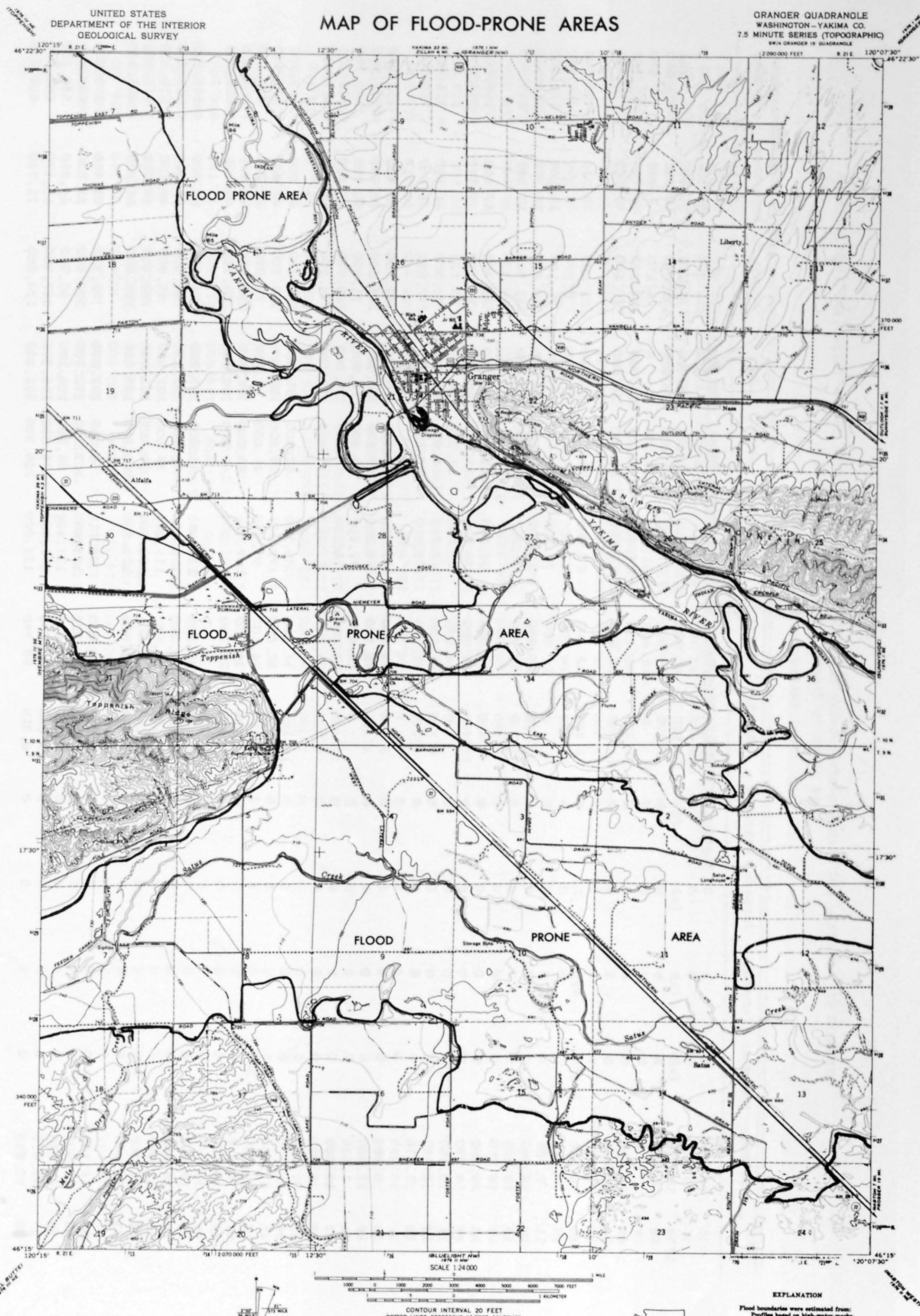
1974

QUADRANGLE LOCATION

EXPLANATION

Flood boundaries were estimated from:
Photographs taken at time of flooding.
Profiles based on high-water marks.

HEMBRE MTN., WASH.
Base by U.S. Geological Survey
1958


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MAP OF FLOOD-PRONE AREAS
GRANGER QUADRANGLE
WASHINGTON–YAKIMA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
FLOOD PRONE AREA
YAKIMA
RIVER
Granger
Liberty
Alfalfa
FLOOD
PRONE
AREA
Toppenish
Toppenish Ridge
SNIPES MOUNTAIN
YAKIMA RIVER
Satus Creek
FLOOD
PRONE
AREA
Satus
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
WASHINGTON
QUADRANGLE LOCATION
EXPLANATION
Flood boundaries were estimated from:
Profiles based on high-water marks.
GRANGER, WASH.
Base by U.S. Geological Survey
1965
AMS 1974 I SW—SERIES V891

1974

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1

[All values are in acre-feet]

Water Year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
						Station 12503500. Main Canal (New Reservation Canal) near Parker							
1904	(u)	(u)	(u)	(u)	(u)	(u)	595	1,660	2,920	5,310	4,110	4,380	(u)
05	1,490	0	0	0	0	0	0	0	5,810	8,420	7,990	0	23,710
06	0	0	0	0	0	0	2,450	11,800	10,300	0	4,170	4,940	33,660
07	5,440	0	0	0	0	0	0	14,400	16,100	15,700	14,100	0	65,740
08	0	0	0	0	0	0	7,870	18,200	15,200	16,000	12,400	9,040	78,710
09	6,460	1,550	1,480	0	0	0	12,200	17,500	14,300	17,700	11,400	8,330	90,920
10	9,780	0	0	0	0	0	14,900	21,300	17,600	17,000	7,870	6,130	94,580
11	9,780	0	0	0	0	0	17,900	22,500	23,400	21,700	15,100	10,100	120,500
12	9,390	0	0	0	0	0	23,800	33,100	26,100	26,400	14,400	15,100	148,300
13	10,900	0	0	0	0	0	10,800	33,800	26,900	30,600	21,400	17,100	151,500
14	9,780	0	0	0	0	0	25,000	35,200	31,700	30,200	26,700	10,900	169,500
15	4,330	0	0	0	0	0	16,000	36,600	32,200	28,800	19,400	7,130	144,500
16	10,400	4,570	0	0	0	0	20,600	43,000	37,200	31,000	33,200	19,600	199,600
17	7,250	0	0	0	0	0	11,400	43,900	44,500	45,300	40,900	21,500	214,800
18	5,830	0	0	0	0	0	14,600	49,400	55,900	50,000	42,600	31,800	250,100
19	6,660	0	0	0	0	0	23,700	67,300	59,200	57,400	60,700	36,000	311,000
20	13,500	0	0	0	0	0	15,700	69,200	59,600	65,900	59,500	39,100	322,500
21	5,630	0	0	0	0	0	28,400	72,600	69,400	71,900	71,900	40,900	360,700
22	10,900	0	0	0	0	0	11,600	76,200	79,100	79,900	69,500	41,100	368,300
23	6,390	0	0	0	0	0	33,800	93,200	79,900	75,100	74,000	55,200	417,000
24	0	0	0	0	0	16,300	77,400	89,100	82,900	81,800	74,300	44,000	465,800
25	23,400	0	0	0	0	21,900	57,000	99,600	86,500	92,000	83,700	47,300	511,400
26	14,700	1,340	0	0	0	12,200	74,100	97,500	83,600	91,000	69,000	27,700	471,100
27	0	0	0	0	0	3,830	39,600	104,000	83,600	97,300	88,600	49,700	466,600
28	9,100	0	0	0	0	1,540	25,400	102,000	102,000	90,900	89,700	45,600	466,200
29	27,200	0	0	0	0	0	52,800	115,000	95,000	97,800	94,300	60,500	542,600
30	24,400	11,700	0	0	0	6,020	83,100	112,000	96,000	98,100	85,900	47,000	564,200
31	19,000	0	0	0	1,600	35,400	85,600	115,000	84,900	102,000	88,900	46,100	578,500
32	27,400	7,290	0	0	0	7,110	63,600	118,000	97,400	103,000	93,300	54,200	571,300
33	31,100	0	0	0	0	4,400	59,800	122,000	106,000	109,000	105,000	66,900	604,200
34	24,900	0	0	0	0	17,060	84,600	96,710	96,960	101,600	92,710	63,460	578,000
35	16,600	0	0	0	0	10,670	95,210	124,900	103,100	111,700	103,400	81,030	646,600
36	26,020	0	0	0	0	7,070	71,430	122,400	95,960	106,100	95,940	64,250	589,200
37	45,670	0	0	0	0	3,880	49,730	131,000	79,880	119,300	107,300	65,170	601,900
38	20,850	0	0	0	0	6,010	58,990	123,800	105,300	111,000	104,600	71,730	602,300

1939	22,860	0	0	0	0	9,630	104,600	119,300	99,470	110,100	103,500	79,130	648,600
40	39,310	1,320	0	0	0	6,370	73,010	116,800	101,300	111,400	107,200	81,620	638,300
41	29,930	0	0	0	0	14,560	80,880	114,100	90,640	104,500	95,460	69,260	599,300
42	13,740	0	0	0	0	13,020	90,350	117,900	101,800	114,700	110,800	82,910	645,200
43	31,290	0	0	0	0	12,070	59,870	122,200	102,800	117,500	109,800	74,090	629,600
44	34,510	0	0	0	0	11,370	67,510	120,200	104,100	116,500	109,300	82,710	646,200
45	36,870	0	0	0	0	10,460	64,880	127,600	104,800	119,300	111,600	74,070	649,600
46	33,210	0	0	0	0	11,330	75,250	132,000	105,700	114,600	112,100	71,780	656,000
47	31,730	0	0	0	0	25,860	105,700	126,200	100,500	110,100	113,500	73,570	687,200
48	29,820	0	0	0	0	7,010	51,170	118,500	98,260	116,200	104,400	78,970	604,300
49	23,700	0	0	0	0	4,520	49,540	126,700	117,100	121,300	105,600	80,780	629,200
50	22,790	0	0	0	0	9,460	49,310	127,200	105,000	118,000	106,200	81,990	620,000
51	21,290	0	0	0	0	3,790	68,080	123,800	100,800	115,300	106,500	84,120	623,700
52	19,360	0	0	0	0	6,250	87,630	126,000	111,100	114,700	108,200	84,890	658,100
53	25,290	0	0	0	0	15,760	83,860	114,000	107,600	121,300	106,500	76,080	650,400
54	21,750	0	0	0	0	9,750	78,280	123,500	114,500	117,700	109,300	81,860	656,600
55	20,980	0	0	0	0	9,400	68,630	115,100	114,300	118,400	106,500	84,400	637,700
56	20,380	0	0	0	0	0	54,270	124,900	117,400	116,000	109,400	80,810	623,200
57	22,470	0	0	0	0	6,640	47,490	115,800	111,200	119,300	108,500	82,140	613,500
58	19,630	0	0	0	0	9,270	45,120	115,500	117,800	119,500	107,300	78,560	612,700
59	19,920	0	0	0	0	11,460	64,300	116,600	118,100	119,500	109,700	78,860	638,400
60	20,280	0	0	0	0	4,460	62,800	112,100	117,400	119,700	109,300	79,790	625,800
61	18,020	0	0	0	0	2,350	56,890	106,800	116,000	119,900	108,800	81,940	610,700
62	19,610	0	0	0	0	2,170	66,170	113,600	114,700	118,800	107,400	81,940	624,400
63	20,640	0	0	0	0	5,180	39,080	96,450	117,500	117,400	109,300	82,510	588,100
64	20,250	0	0	0	0	13,350	95,240	108,300	111,000	118,900	111,000	81,830	660,000
65	20,210	0	0	0	0	5,820	78,790	119,700	118,700	119,300	110,000	81,730	654,200
66	18,550	0	0	0	0	7,700	75,900	121,300	115,400	115,700	108,500	79,050	642,100
67	18,460	0	0	0	0	17,040	81,800	110,200	117,200	120,000	110,100	81,840	656,600
68	18,740	0	0	0	0	12,580	88,390	120,600	111,700	117,900	106,400	82,420	658,700
69	14,650	0	0	0	0	5,210	53,830	113,200	118,100	119,800	107,700	84,200	616,700
70	20,320	0	0	0	0	10,590	62,430	110,600	118,000	118,900	111,100	82,000	633,900
71	20,315	0	0	0	0	10,570	52,300	108,150	117,810	124,285	118,960	81,525	633,900
72	20,040	0	0	0	0	8,515	61,375	111,925	117,015	124,435	117,310	86,580	647,200

[u] Unknown.

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
					Station 12504000. Wanity Slough (Old Reservation Canal) near Parker								
1904	(u)	(u)	(u)	(u)	(u)	(u)	2,980	7,990	8,630	10,100	9,160	5,950	(u)
05	2,680	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)
06	(u)	(u)	(u)	(u)	(u)	(u)	(u)	9,780	6,600	8,180	2,800	3,470	(u)
07	2,210	0	0	0	0	0	0	16,200	14,700	13,300	6,460	3,240	56,100
08	0	0	0	0	0	0	8,030	15,700	12,300	12,500	8,730	6,430	63,690
09	3,720	2,500	1,740	0	0	0	0	0	13,100	12,900	6,520	3,620	44,100
10	5,570	0	0	0	0	0	9,640	15,200	12,600	9,220	4,980	3,730	60,940
11	5,960	0	0	0	0	0	13,800	17,500	14,100	11,300	6,520	5,950	75,130
12	4,970	2,340	0	0	0	0	13,200	15,700	14,600	10,900	8,180	7,440	77,330
13	5,470	0	0	0	0	0	6,950	17,800	14,500	16,500	8,360	7,910	77,490
14	6,460	0	0	0	0	0	12,900	16,300	15,300	11,200	8,210	5,320	75,690
15	2,230	0	0	0	0	0	7,730	14,500	9,060	8,250	2,660	305	44,740
16	0	0	0	0	0	0	9,250	17,500	16,400	10,200	12,200	5,080	70,630
17	1,920	0	0	0	0	0	6,830	18,600	17,700	17,100	12,000	7,220	81,370
18	2,200	0	0	0	0	0	8,000	16,400	17,200	10,700	10,300	6,720	71,520
19	2,700	0	0	0	0	0	8,690	20,200	17,000	12,400	11,500	5,690	78,180
20	1,010	0	0	0	0	0	9,160	15,500	13,000	10,200	8,790	5,930	63,590
21	1,730	0	0	0	0	0	10,900	13,700	15,600	11,900	9,350	5,500	68,680
22	0	0	0	0	0	0	5,350	17,600	16,200	14,400	11,700	7,860	73,110
23	0	0	0	0	0	0	8,520	15,500	8,000	9,980	9,320	6,960	58,280
24	151	0	0	0	0	208	5,290	9,400	4,600	2,460	2,310	1,350	25,770
25	167	0	0	0	0	1,870	6,660	9,900	7,980	4,160	1,680	1,240	33,660
26	311	0	0	0	0	1,400	6,330	6,880	3,500	363	0	0	18,780
27	0	0	0	0	0	0	5,540	9,230	6,880	5,390	0	0	27,040
28	0	0	0	0	0	0	8,020	12,300	7,220	1,280	0	0	28,820
29	0	0	0	0	0	0	4,620	9,010	4,140	4,350	0	0	22,120
30	111	0	0	0	0	1,020	8,490	2,560	0	0	0	0	12,180
31	0	0	0	0	728	3,920	6,610	8,780	4,100	3,380	0	0	27,520
32	0	0	0	0	0	1,910	5,450	8,960	7,470	7,790	4,800	0	36,380
33	0	0	0	0	0	415	6,590	8,330	2,870	3,270	4,060	1,050	26,580
34	184	89	0	0	71	1,490	10,620	11,940	4,670	4,320	3,310	1,500	38,190
35	200	0	0	0	0	3,210	9,470	5,810	2,940	3,730	4,220	3,170	32,750
36	325	0	0	0	0	1,400	8,690	10,640	3,110	1,490	922	244	26,820
37	160	0	0	0	81	1,950	3,320	9,090	3,330	5,570	4,480	1,220	29,200
38	431	653	417	246	160	269	2,310	9,410	4,140	5,090	3,090	1,480	27,700

1939	415	420	466	459	187	1,450	7,680	7,050	4,140	5,160	2,790	609	30,830
40	612	505	712	698	282	1,350	6,290	7,940	4,430	3,590	2,430	813	29,650
41	70	629	318	113	138	664	3,330	3,000	1,090	839	533	248	10,970
42	250	503	349	285	255	455	3,020	330	705	697	315	247	7,410
43	151	235	222	113	457	841	1,140	5,890	3,780	1,240	375	357	14,800
44	204	266	289	265	284	444	1,010	591	397	237	259	279	4,520
45	238	346	173	213	227	111	584	3,310	944	1,160	297	313	7,920
46	353	246	51	200	208	477	2,000	4,300	1,740	2,560	2,030	484	14,650
47	389	464	1,640	3,980	5,060	2,230	2,400	936	558	462	341	274	18,730
48	452	357	244	117	288	301	1,610	3,370	803	2,580	361	179	10,660
49	131	242	422	375	293	576	1,070	5,750	2,540	1,780	586	412	14,180
50	0	0	0	83	355	2,710	2,920	6,820	3,050	4,060	698	270	20,970
51	97	410	434	1,580	1,040	1,210	4,120	7,150	3,130	3,500	3,150	719	26,540
52	561	872	612	1,330	3,580	4,020	4,200	4,780	3,470	2,380	704	300	26,810
53	359	741	826	999	2,130	3,650	2,310	4,810	965	1,630	994	233	19,650
54	687	756	822	968	907	2,450	3,620	5,670	4,120	2,600	489	292	23,380
55	268	816	752	712	655	1,230	1,450	3,180	2,330	0	0	0	11,390
56	188	444	811	623	506	395	1,790	4,570	837	1,960	0	0	12,120
57	126	475	1,710	1,330	1,240	827	0	1,520	1,500	0	0	0	8,730
58	165	755	1,580	1,710	1,570	917	166	1,580	2,000	0	0	0	10,440
59	378	1,550	1,740	1,460	1,010	1,260	1,170	2,580	1,250	0	0	0	12,400
60	107	666	942	838	705	641	1,070	2,130	1,030	0	0	0	8,130
61	412	583	1,220	1,220	1,340	1,700	1,540	2,500	2,240	0	0	0	12,760
62	0	583	1,090	1,110	900	983	2,040	4,130	3,550	0	0	0	14,390
63	525	1,220	1,680	1,600	1,340	1,240	1,160	2,460	2,400	0	0	0	13,620
64	0	498	951	1,340	1,340	1,440	3,900	3,060	1,500	0	0	0	14,030
65	349	1,250	965	1,290	969	1,180	16	0	0	0	0	0	6,020
66	297	760	789	474	1,010	1,060	0	3,020	303	0	0	0	7,710
67	227	675	1,300	1,070	925	782	0	0	0	0	0	0	4,980
68	472	1,110	1,690	1,820	1,730	1,400	1,410	1,210	0	0	0	0	10,840
69	663	1,350	2,070	1,730	1,330	1,370	500	306	278	0	0	0	9,600
70	379	1,130	1,770	741	470	1,120	1,040	118	0	0	0	0	6,840
71	379	1,315	2,160	2,205	1,970	1,555	1,185	145	0	0	0	0	10,914
72	456	1,160	2,105	2,155	1,515	715	266	0	0	0	0	0	8,372

u Unknown.

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
						Station 12506000. Toppenish Creek near Fort Simcoe							
1909	(u)	(u)	(u)	(u)	(u)	12,000	21,600	16,200	3,800	1,320	842	1,250	(u)
10	1,360	11,800	12,100	11,300	8,660	47,400	22,000	6,640	2,150	1,530	935	1,030	126,900
11	1,480	2,350	3,600	2,530	2,170	12,100	13,400	13,300	4,770	1,360	953	1,040	59,050
12	1,010	1,260	1,430	5,340	5,870	3,780	14,600	11,300	2,000	1,080	818	780	49,270
13	1,020	2,420	3,800	5,290	5,440	5,660	19,500	19,400	3,880	1,290	916	1,090	69,710
14	1,290	1,550	1,730	15,900	8,440	20,600	27,500	16,700	4,900	1,780	812	1,020	102,200
15	1,720	2,330	1,940	787	3,900	11,400	10,700	4,190	2,040	787	489	514	40,800
16	953	1,470	6,640	5,090	14,000	32,500	44,200	32,500	10,200	4,780	1,640	1,180	155,200
17	1,430	1,830	1,830	2,180	1,870	2,600	9,580	21,700	6,310	1,510	947	946	52,730
18	904	1,250	9,650	7,500	6,940	8,120	9,760	6,700	1,910	1,020	793	762	55,310
19	1,010	1,240	1,440	11,300	3,220	5,710	18,300	8,790	1,590	922	781	833	55,140
20	953	1,110	1,790	3,550	2,650	5,600	5,410	4,460	994	526	361	499	27,900
21	984	2,340	4,700	8,240	13,400	20,500	19,700	16,500	3,090	563	505	519	91,040
22	935	1,740	5,340	1,540	1,750	4,060	12,600	15,900	2,110	293	290	284	46,840
23	536	756	2,370	15,200	3,000	6,640	15,400	6,760	1,200	605	331	266	53,060
24	793	934	2,770	2,320	10,400	4,380	4,390	1,850	528	343	360	359	29,430
25	742	2,920	3,550	4,000	16,000	8,850	17,600	7,810	1,500	286	305	577	64,140
26	(u)	(u)	(u)	(u)	(u)	6,030	4,830	530	276	198	175	206	(u)
27	601	2,010	222	766	956	990	1,250	1,220	597	420	462	662	10,160
28	1,070	1,840	2,520	4,530	2,080	7,270	9,900	5,760	208	202	301	329	36,010
29	428	593	2,000	2,190	1,790	6,850	5,250	5,280	395	395	311	351	25,830
30	428	510	2,040	2,110	8,650	6,320	5,540	440	311	305	254	278	27,190
31	205	(u)	(u)	(u)	(u)	1,650	5,190	1,090	319	282	228	305	(u)
32	613	1,010	2,000	5,110	8,610	13,500	13,800	7,800	428	306	303	263	53,740
33	442	1,230	1,530	2,670	2,540	7,890	18,400	19,200	6,110	282	224	327	60,850
34	532	744	26,400	24,300	8,430	8,490	3,950	660	256	173	226	286	74,450
35	910	3,280	5,940	9,130	6,890	5,660	10,700	9,220	573	131	184	171	52,790
36	405	460	1,140	3,360	1,720	5,310	12,000	5,140	520	248	190	266	30,760
37	274	500	912	591	1,580	6,670	19,300	9,400	536	182	175	226	40,350
38	218	1,040	8,800	11,800	4,330	13,600	26,300	16,700	2,150	454	466	274	86,130
39	500	456	1,540	1,910	2,110	4,240	3,610	286	97	188	151	194	15,280
40	274	264	1,490	1,180	8,890	13,600	9,560	2,590	294	256	236	244	38,880
41	325	538	1,800	3,540	3,890	7,870	5,340	581	163	172	210	192	24,620
42	357	563	7,140	3,490	5,160	6,920	11,200	2,650	186	186	149	119	38,120
43	222	1,890	4,640	5,340	5,470	9,860	23,500	9,280	2,280	311	186	141	63,120

1944	722	980	1,170	1,030	1,080	3,000	3,170	684	426	228	188	190	12,870
45	300	571	541	780	2,980	3,690	6,160	5,000	385	194	179	212	20,990
46	246	744	3,330	5,160	4,000	8,060	12,500	11,400	1,400	228	194	222	47,480
47	403	1,840	10,400	2,810	9,950	7,490	7,340	2,300	385	218	165	313	43,610
48	2,070	1,890	2,130	4,350	7,730	7,860	13,700	20,000	4,880	321	216	335	65,480
49	748	1,500	1,745	1,141	6,320	11,000	16,800	12,900	847	159	141	163	53,460
50	873	1,050	1,060	1,190	6,380	10,600	12,400	15,500	7,070	2,050	1,060	988	60,220
51	2,120	6,660	11,900	9,130	17,500	8,870	21,200	17,300	5,640	2,350	1,530	1,420	105,600
52	2,060	2,480	5,400	3,600	9,370	7,190	17,800	11,400	3,930	2,010	1,430	1,340	68,010
53	1,400	1,800	2,260	18,500	7,950	5,860	12,700	16,300	6,060	2,440	1,620	1,440	78,330
54	1,880	2,390	4,140	4,370	9,160	11,900	20,800	17,000	6,010	2,500	1,660	1,500	83,310
55	1,920	2,320	2,220	2,210	2,390	2,840	5,230	9,770	4,300	1,630	900	972	36,700
56	1,740	3,500	13,500	7,910	5,150	16,300	35,400	32,200	10,100	3,250	1,910	1,670	132,600
57	1,980	2,130	2,490	1,820	3,490	8,990	13,700	11,400	2,560	1,510	1,200	1,130	52,400
58	1,890	1,950	3,310	5,270	15,300	9,470	13,600	14,000	3,440	1,690	1,080	1,270	72,270
59	1,890	3,060	3,230	11,500	5,450	9,950	13,500	8,490	3,060	1,520	1,140	1,290	64,080
60	1,540	1,830	2,070	2,060	4,940	8,300	12,600	10,700	3,690	1,400	1,030	1,010	51,170
61	1,210	2,460	1,530	3,580	14,300	11,900	12,000	11,100	4,350	1,690	990	819	65,930
62	1,570	1,940	2,530	3,290	4,010	4,350	13,600	8,480	3,240	1,320	944	722	46,000
63	1,780	5,210	6,670	2,320	9,320	5,930	14,100	11,400	3,050	1,780	1,290	1,070	63,920
64	1,300	2,590	2,050	4,250	3,660	3,230	6,410	5,550	2,920	1,280	889	778	34,910
65	932	1,160	4,550	7,770	7,110	7,860	11,800	8,550	3,070	1,590	1,320	924	56,640
66	1,010	1,470	1,390	4,390	2,320	8,160	14,400	9,820	3,060	1,770	1,000	952	49,740
67	952	1,920	4,920	6,630	7,640	6,660	9,030	13,900	5,110	1,720	996	797	60,280
68	710	1,430	2,430	5,500	12,800	10,400	6,020	5,540	2,040	1,000	1,010	1,030	49,910
69	1,500	3,100	3,230	5,860	3,340	11,100	19,200	15,200	3,870	1,720	1,160	1,090	70,370
70	1,390	1,610	2,470	8,140	8,230	11,400	10,500	12,000	3,970	1,690	1,090	1,070	63,560
71	1,440	1,580	4,130	11,200	9,770	7,920	14,000	22,100	7,420	2,770	1,720	1,550	85,600
72	1,690	1,770	2,240	6,520	8,570	21,300	11,500	14,700	5,560	2,300	1,750	1,490	79,390

[u] Unknown.

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Site D. Toppenish Feeder Canal near Fort Simcoe

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1923	595	555	256	462	250	277	422	1,150	1,360	1,010	684	623	7,644
24	639	614	356	222	218	234	760	1,320	670	377	264	339	6,013
25	383	415	424	300	200	161	214	1,100	1,180	899	555	496	6,327
26	[e]400	[e]400	[e]270	[e]200	[e]175	254	1,018	1,650	740	272	274	371	[e]6,024
27	448	371	117	104	55	118	204	1,090	1,740	1,430	854	832	7,363
28	812	715	282	179	155	307	440	2,138	1,745	910	528	464	8,675
29	530	722	623	0	0	75	1,142	2,220	1,380	456	305	367	7,820
30	541	536	442	71	0	4	1,156	1,738	718	182	101	171	5,660
31	319	[e]300	[e]300	[e]70	[e]56	1,020	2,320	1,910	724	333	1,800	278	[e]9,430
32	375	111	113	[e]65	[e]56	[e]150	567	2,570	2,070	928	492	424	[e]7,921
33	555	714	547	61	56	101	278	1,540	2,850	1,680	843	700	9,925
34	865	813	458	0	56	222	1,420	1,980	1,040	659	551	623	8,687
35	446	583	548	0	0	167	706	2,840	2,520	1,170	619	557	10,160
36	621	883	738	391	0	129	938	2,360	1,930	638	395	414	9,437
37	[e]620	[e]750	[e]350	492	0	67	238	1,920	2,640	867	553	611	[e]9,108
38	615	637	0	0	0	0	8	2,130	2,730	1,180	672	627	8,599
39	692	839	105	0	0	0	2,550	2,390	853	470	292	426	8,617
40	494	710	811	952	456	67	1,670	2,840	1,390	734	538	633	11,300
41	791	879	341	0	0	240	1,770	2,390	1,020	526	397	422	8,776
42	504	772	516	0	0	[e]120	[e]1,000	[e]2,200	[e]1,600	[e]3,000	[e]500	[e]500	[e]10,712
43	[e]550	[e]600	[e]300	0	0	0	403	2,150	2,200	1,100	722	561	[e]8,316
44	583	442	85	339	533	504	1,260	2,030	781	405	254	329	7,545
45	395	476	492	492	458	799	1,070	2,500	1,800	538	280	298	9,598
46	446	573	639	377	327	307	1,330	2,480	2,180	1,130	551	528	10,870
47	553	536	377	184	167	184	1,390	2,280	1,180	575	466	417	8,309
48	419	672	1,080	1,000	230	0	621	1,780	2,800	2,450	1,150	954	13,160
49	780	726	779	330	56	61	115	2,360	2,560	1,420	940	599	10,730
50	615	595	50	0	0	0	105	1,550	2,960	1,910	924	698	9,407
51	960	900	0	0	0	0	1,260	2,940	2,570	2,050	1,300	1,160	13,140
52	1,100	1,010	885	430	0	0	1,460	3,420	3,010	1,790	1,160	966	15,230
53	1,060	720	492	274	0	462	2,360	2,590	2,420	2,070	1,310	1,010	14,770
54	944	724	413	807	52	0	1,460	2,800	2,460	2,030	1,360	1,080	14,130
55	833	670	589	563	520	601	1,520	3,010	2,700	1,220	662	593	13,480
56	619	595	345	0	0	0	52	3,120	2,860	2,670	1,610	1,320	13,190

1957	1,200	655	664	538	611	785	879	3,400	2,260	1,330	1,040	833	14,200
58	1,060	807	637	534	314	655	1,510	4,410	3,030	1,500	900	873	16,230
59	1,100	833	841	839	641	676	1,430	4,190	2,790	1,330	958	448	16,080
60	952	1,020	1,050	1,050	978	1,080	1,970	3,330	2,620	1,260	970	948	17,230
61	1,020	581	534	944	593	182	1,380	3,100	3,020	1,690	990	736	14,770
62	738	641	536	476	389	430	1,860	3,110	2,480	1,320	944	690	13,610
63	1,290	1,210	1,160	1,060	795	1,010	1,450	2,960	3,050	1,780	1,290	1,070	18,130
64	829	732	821	881	978	1,190	2,530	3,510	2,840	1,280	889	778	17,260
65	932	476	710	212	258	926	3,400	3,410	2,690	1,530	1,260	865	16,670
66	589	426	397	264	668	1,300	1,940	3,730	2,880	1,710	940	893	15,740
67	924	910	869	676	651	2,270	2,430	3,410	3,220	1,720	996	797	18,870
68	744	464	736	553	282	1,540	2,780	3,100	2,000	1,000	1,010	1,030	15,240
69	1,080	1,030	891	593	472	420	1,490	2,980	2,760	1,720	1,160	1,090	15,690
70	1,270	1,280	920	708	218	246	2,120	3,540	3,050	1,690	1,090	1,070	17,200
71	1,100	678	1,430	1,330	1,030	1,180	1,600	3,600	3,220	2,770	1,720	1,550	21,210
72	1,690	1,430	1,350	1,260	906	0	1,030	3,310	3,270	2,300	1,750	1,490	19,790

[e] Estimated.

<u>Site G. Simcoe Creek Flume near Fort Simcoe</u>

1920	(u)	(u)	(u)	(u)	(u)	(u)	(u)	123	208	92.2	30.7	23.8	(u)
21	0	0	61.5	184	278	246	179	492	246	61.5	61.5	59.5	1,869
22	6.2	17.9	0	0	0	0	11.9	307	357	92.2	43.0	29.8	865
23	24.6	6.0	0	0	0	0	357	307	268	184	92.2	29.8	1,269
32	0	0	0	0	0	0	432	518	280	95.2	21.8	0	1,347
33	0	0	0	0	0	67.4	395	571	438	127	53.6	39.7	1,692
34	37.7	0	0	0	0	133	524	210	73.4	61.5	21.8	0	1,061
35	639	0	0	0	0	121	694	799	296	97.2	61.5	27.8	2,736
36	0	0	0	0	0	0	381	712	379	91.2	61.5	59.5	1,684
37	0	0	0	0	0	0	309	825	371	182	75.4	59.5	1,822
38	61.5	59.5	0	61.5	0	0	113	799	666	222	87.3	25.8	2,096
39	0	0	0	0	0	15.9	494	264	143	75.4	61.5	49.6	1,103
40	0	0	0	0	15.9	37.7	490	494	216	99.2	61.5	0	1,414
41	0	0	61.5	0	71.4	0	476	300	141	65.5	61.5	23.8	1,201
42	0	59.5	61.5	0	0	0	409	538	284	186	95.2	39.7	1,673
43	0	59.5	61.5	61.5	55.5	61.5	69.4	609	393	341	169	75.4	1,956
44	61.5	59.5	0	0	0	0	254	270	202	115	61.5	11.9	1,035
45	0	0	0	0	0	0	159	659	395	171	69.4	33.7	1,487
46	0	0	0	0	0	0	73.4	613	464	222	83.3	59.5	1,515

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1947	61.5	59.5	61.5	61.5	55.5	61.5	315	545	411	151	37.7	0	1,821
48	0	0	0	0	0	0	176	657	399	363	204	119	1,918
49	0	119	0	0	0	0	103	633	450	147	83.3	35.7	1,571
50	0	59.5	0	0	0	0	0	639	472	361	186	59.5	1,777
51	33.7	0	0	0	0	61.5	329	791	579	357	135	69.4	2,356
52	123	75.4	0	0	0	19.8	643	996	458	214	81.3	0	2,611
53	0	0	0	0	0	428	732	863	422	347	196	121	3,109
54	61.5	59.5	0	0	0	0	252	936	662	381	188	119	2,659
55	115	59.5	0	0	0	0	343	849	734	363	184	179	2,827
56	91.2	0	0	0	0	0	357	805	655	407	234	119	2,668
57	123	0	0	0	0	0	288	980	520	284	147	89.3	2,431
58	61.5	59.5	0	0	0	41.6	341	960	545	226	91.2	59.5	2,385
59	61.5	59.5	0	0	0	430	1,140	746	307	163	89.3	0	2,996
60	0	0	0	0	0	0	543	1,100	718	294	153	89.3	2,897
61	61.5	0	0	0	0	0	422	1,260	855	202	224	89.3	3,114
62	61.5	0	0	0	0	0	486	1,100	722	311	173	89.3	2,943
63	61.5	0	0	0	0	0	89.3	1,380	756	319	135	89.3	2,830
64	61.5	0	0	0	0	105	611	680	783	381	363	179	3,164
65	101	0	0	0	0	107	833	1,290	690	349	290	97.2	3,757
66	61.5	0	0	0	0	0	833	1,310	599	260	91.2	59.5	3,214
67	0	0	0	0	0	341	855	1,220	891	387	169	59.5	3,923
68	0	0	0	0	0	210	831	918	611	282	91.2	69.4	3,013
69	0	0	0	0	0	0	528	1,430	966	369	179	119	3,591
70	81.3	0	0	0	0	0	571	1,210	746	262	101	59.5	3,031
71	0	0	0	0	0	0	508	1,250	1,050	415	182	59.5	3,465
72	0	0	0	0	0	0	238	1,470	1,190	405	177	85.3	3,565

u Unknown.

Station 12506500. Simcoe Creek below Spring Creek, near Fort Simcoe[a]

1909	(u)	(u)	(u)	(u)	(u)	3,810	3,780	3,620	750	98	6	2	(u)
10	29	1,300	2,210	7,440	3,330	23,500	6,430	2,870	470	277	51.0	23.8	47,900
11	86.7	208	338	246	383	1,650	2,580	2,720	1,680	203	98.4	59.5	10,300
12	67.6	119	123	2,050	4,160	2,220	4,820	3,930	375	123	117	59.5	18,200
13	117	190	283	1,030	1,850	1,320	6,430	5,910	869	222	115	85.7	18,400
14	419	270	291	8,180	5,260	7,010	7,680	2,050	220	31.4	34.4	48.8	31,500
15	101	361	231	292	2,950	5,260	4,870	1,380	428	136	32	24	16,100
16	33	57	1,830	1,030	9,030	14,200	8,630	6,000	2,450	904	288	155	44,600
17	132	225	349	437	410	527	1,090	3,810	1,430	277	100	33	8,820
18	15	35	4,860	4,960	2,710	2,470	2,770	1,540	487	194	64	16	20,100
19	22	80.9	186	2,940	1,970	3,110	3,840	1,910	467	211	76.9	30	14,800
20	21.5	53.6	127	387	542	941	1,110	947	189	58.4	9.2	8.3	4,390
21	6.1	16.7	588	3,510	5,510	6,270	4,530	3,810	940	199	116	39.3	25,500
22	41.2	92.8	2,240	806	733	1,660	3,360	3,870	542	189	67.6	9.5	13,600
23	12.3	54.1	129	4,460	1,230	2,830	4,020	2,490	334	211	55.3	30.3	15,900

[a]Diversion into Simcoe Creek Flume not included. [u] Unknown.

Station 12506300. North Fork Simcoe Creek near Fort Simcoe

1971	324	371	541	3,450	2,570	1,270	2,860	3,550	1,080	440	274	350	17,080
72	494	666	753	1,970	3,320	5,290	2,420	3,030	1,280	493	335	307	20,360

Station 12506330. South Fork Simcoe Creek near Fort Simcoe

1971	232	272	395	1,510	1,370	934	1,760	4,680	1,200	408	252	307	13,320
72	432	520	609	1,020	2,880	4,200	1,560	3,990	1,190	351	283	228	17,260

Station 12506600. Agency Creek near Fort Simcoe

1971	0	45.2	201	1,030	1,740	3,190	693	299	74.2	13.5	0	0	8,577
72	0	75.6	469	2,140	941	805	1,460	835	141	42.4	1.6	0	6,911

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
					Station 12507100. Mill Creek near White Swan								
1971	0	9.1	205	1,590	362	698	607	204	79.1	24.4	0	0	3,779
72	0	9.5	66.8	587	900	1,210	212	92.6	23.4	1.0	0	0	3,102
					Site V. Satus East Lateral (diverts from Toppenish Creek)								
1931	[e]2,000	0	0	0	0	845	4,370	7,141	6,393	6,232	8,487	3,497	[e]38,970
32	2,088	0	0	0	0	0	3,461	7,186	5,939	6,853	7,966	4,233	37,730
33	2,011	0	0	0	0	0	3,150	5,361	5,790	6,716	8,716	3,713	35,460
34	545	0	0	0	0	333	6,082	8,075	9,959	8,352	8,924	4,824	47,090
35	936	0	0	0	0	0	4,985	9,112	6,391	7,240	8,680	4,171	41,520
36	1,861	0	0	0	0	0	3,550	8,961	4,048	7,688	9,303	4,645	40,060
37	2,515	0	0	0	0	0	1,906	10,096	3,396	8,509	8,317	4,514	39,250
38	3,172	0	0	0	0	0	2,061	9,707	6,194	8,529	7,781	6,609	44,050
39	1,236	0	0	0	0	0	6,629	7,849	7,589	7,857	7,962	7,216	46,340
40	2,033	0	0	0	0	0	4,167	7,577	7,629	7,494	8,745	5,867	43,510
41	1,597	0	0	0	0	0	4,505	9,317	6,621	6,680	7,093	6,542	42,360
42	1,898	0	0	0	0	0	5,524	8,206	6,914	7,912	7,488	7,803	45,740
43	3,090	0	0	0	0	0	2,973	7,912	5,611	6,827	7,099	7,761	41,270
44	2,723	0	0	0	0	0	3,564	9,555	5,812	7,508	8,121	7,468	44,750
45	3,560	0	0	0	0	0	3,677	8,487	5,601	6,788	7,260	7,361	42,730
46	3,886	0	0	0	0	0	1,795	9,906	5,921	6,960	7,277	5,439	41,180
47	2,832	0	0	0	0	0	7,172	7,143	7,831	7,111	7,150	6,780	46,020
48	2,543	0	0	0	0	0	2,321	8,059	4,479	7,839	9,392	5,724	40,360
49	3,152	0	0	0	0	0	3,463	10,354	7,273	7,537	7,462	7,158	46,400
50	2,547	0	0	0	0	0	3,154	9,207	4,514	8,797	8,811	5,217	42,250
51	1,968	0	0	0	0	0	3,862	8,573	5,252	6,938	9,892	5,068	41,550
52	1,646	0	0	0	0	0	5,395	9,691	5,726	7,389	8,676	6,710	45,230
53	3,705	0	0	0	0	0	4,798	7,113	4,245	7,361	9,553	5,246	42,020
54	4,058	0	0	0	0	0	3,868	8,289	4,334	7,742	9,211	4,235	41,740
55	2,122	0	0	0	0	387	4,893	5,851	5,300	6,776	9,919	2,918	38,170
56	1,682	0	0	0	0	0	2,638	7,107	4,056	7,494	9,959	3,485	36,420
57	1,684	0	0	0	0	0	250	6,266	7,140	8,608	7,309	4,245	35,500
58	809	0	0	0	0	0	153	6,627	6,768	8,049	7,686	3,777	33,870
59	1,751	0	0	0	0	0	2,876	6,323	6,300	7,494	7,813	3,836	36,390
60	[e]1,700	0	0	0	0	0	2,535	6,869	6,321	8,733	7,985	4,659	[e]38,800

1961	1,577	0	0	0	0	0	2,878	6,242	6,478	8,628	7,505	5,441	38,750
62	1,890	0	0	0	0	0	3,886	7,418	7,484	9,174	8,580	6,781	45,210
63	1,904	0	0	0	0	0	904	5,044	7,833	8,703	8,930	5,399	38,720
64	2,525	0	0	0	0	0	6,303	7,172	5,972	9,511	8,596	6,105	46,180
65	2,245	0	0	0	0	0	4,512	8,142	6,881	8,910	7,985	4,502	43,180
66	2,463	0	0	0	0	0	4,374	8,894	6,966	7,398	8,840	4,927	43,860
67	1,337	0	0	0	0	0	5,242	7,799	7,541	9,066	8,594	5,726	45,300
68	2,142	0	0	0	0	0	6,018	8,700	7,444	9,782	8,245	4,895	47,230
69	1,777	0	0	0	0	0	4,405	8,245	8,069	9,636	7,640	5,109	44,880
70	2,051	0	0	0	0	0	5,613	8,539	8,505	9,560	8,655	6,195	49,120
71	2,320	0	0	0	0	0	6,079	8,204	7,600	10,368	10,070	4,510	49,150
72	964	0	0	0	0	0	6,565	7,335	7,140	10,090	9,320	7,245	48,660

[e]Estimated.

Site C. Subdrain 35 near Toppenish

1934	492	417	369	369	333	401	458	871	1,214	1,236	1,265	1,148	8,573
35	833	637	597	541	486	538	585	1,133	1,156	970	900	883	9,259
36	734	549	524	424	415	492	536	986	871	926	946	1,045	8,448
37	799	547	490	438	367	369	486	758	3,398	3,322	4,481	4,411	19,866
38	3,671	2,140	1,751	1,529	1,333	1,579	2,384	4,620	4,187	3,902	3,469	3,537	34,100
39	2,688	1,480	1,289	1,428	1,079	1,107	2,463	4,552	3,469	4,167	3,771	4,116	31,610
40	2,943	1,605	1,450	1,438	1,341	1,468	1,876	3,898	3,836	3,971	3,217	3,606	30,650
41	2,420	1,613	1,418	1,535	1,285	1,319	1,793	2,858	2,821	2,824	3,207	3,066	26,160
42	2,313	1,460	1,317	1,291	1,111	1,230	2,493	4,042	3,308	3,334	3,459	3,410	28,770
43	2,848	1,700	1,533	1,519	1,317	1,228	1,799	3,656	3,342	3,076	3,358	3,082	28,460
44	2,235	1,571	1,428	1,166	1,049	1,111	1,964	3,437	3,489	3,437	3,251	3,626	27,760
45	2,886	1,670	1,476	1,190	1,055	1,160	1,250	3,310	3,041	3,338	3,332	3,261	26,970
46	2,896	1,476	1,331	1,174	1,018	1,144	1,714	3,802	2,196	3,136	3,523	2,654	26,060
47	2,503	1,454	1,194	1,103	974	1,234	2,368	4,570	4,090	3,596	3,919	3,219	30,220
48	2,291	1,583	1,388	1,291	1,092	1,117	1,168	2,297	3,396	3,862	3,259	3,243	25,990
49	2,442	1,228	1,081	1,345	930	1,049	1,200	3,322	3,443	3,261	3,128	3,221	25,650
50	2,436	1,279	1,115	1,071	966	1,315	1,654	2,823	2,902	3,364	3,378	2,945	25,250
51	2,335	1,535	1,511	1,486	1,285	1,353	1,591	3,362	2,571	2,761	2,977	2,475	25,240
52	2,485	1,379	1,095	1,238	1,150	1,127	2,225	3,209	2,581	2,793	3,552	2,739	25,570
53	2,486	1,313	1,174	1,117	1,077	1,190	1,855	3,275	2,402	2,684	2,579	2,210	23,360

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1954	2,035	1,359	1,180	1,168	1,049	1,107	2,017	3,356	3,252	3,201	2,783	3,584	26,090
55	2,977	1,716	1,281	1,201	1,055	1,188	2,118	3,566	3,227	2,852	3,519	3,273	27,970
56	2,398	1,587	1,692	1,983	1,793	1,337	1,682	2,723	3,556	3,489	4,445	3,053	29,740
57	2,438	1,369	1,319	1,234	1,087	1,260	1,337	3,527	3,648	4,167	4,284	3,308	28,980
58	2,249	1,297	1,265	1,254	1,222	1,382	1,634	3,140	3,648	4,161	4,066	3,449	28,770
59	1,740	1,329	1,353	1,353	1,275	1,573	2,547	3,465	3,596	3,892	4,705	3,743	30,570
60	2,039	1,466	1,440	1,236	1,267	1,353	1,906	2,642	3,053	3,745	3,739	3,293	27,180
61	1,946	1,416	1,313	1,242	1,129	1,230	2,206	3,251	3,497	3,784	3,679	3,580	28,270
62	2,606	1,492	1,283	1,047	889	984	2,152	3,495	3,963	4,383	4,134	3,729	30,160
63	2,267	1,585	1,549	1,214	1,020	1,097	1,609	2,803	3,564	4,233	3,856	3,721	28,520
64	2,632	1,347	1,256	1,215	1,062	1,234	3,128	3,447	3,122	3,816	4,201	3,344	29,800
65	2,678	1,527	1,283	1,303	1,579	1,271	2,374	3,660	3,572	4,552	4,389	4,080	32,270
66	2,547	1,331	1,133	1,174	1,048	1,150	2,634	3,771	3,542	4,409	4,225	3,913	30,880
67	2,358	1,488	1,380	1,246	1,027	1,277	3,239	3,652	3,878	4,385	4,011	3,663	31,600
68	2,144	1,273	1,168	1,215	1,139	1,341	2,571	4,143	3,431	3,201	3,925	2,975	28,530
69	2,202	1,635	1,540	1,375	1,295	1,571	2,481	3,320	3,455	4,253	4,322	3,096	30,540
70	2,041	1,559	1,484	1,807	1,815	1,928	2,130	3,735	3,115	4,211	4,330	3,947	32,100
71	2,533	1,644	1,515	1,367	1,202	1,563	2,461	2,979	3,360	3,925	3,614	3,600	29,760
72	2,460	1,645	1,550	1,330	1,145	1,222	2,017	3,546	3,140	4,530	3,965	4,096	30,650

Site B. East Toppenish Drain near Toppenish

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1925	(u)	(u)	(u)	760	696	599	1,662	2,420	2,321	2,142	2,021	2,424	(u)
26	1,547	849	672	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)
27	(u)	(u)	(u)	697	605	719	1,144	2,200	2,793	2,214	2,176	3,350	(u)
28	1,587	1,125	1,000	922	666	481	1,063	1,722	2,100	2,495	2,182	1,757	17,100
29	2,091	1,126	676	525	453	551	955	2,213	3,396	2,588	1,736	2,709	19,020
30	1,497	1,244	734	573	469	464	1,432	2,305	2,305	2,077	2,136	1,589	16,820
31	1,402	1,012	615	635	573	1,075	1,412	2,672	2,842	2,091	2,172	1,720	18,220
32	1,956	1,256	563	508	708	549	1,414	3,154	3,190	2,491	2,158	1,652	19,600
33	1,426	807	587	567	502	452	928	2,543	3,185	2,263	2,344	2,894	18,500
34	2,031	1,141	3,414	1,474	934	1,043	1,676	2,842	2,271	1,856	2,041	2,200	22,920
35	1,220	938	722	577	464	474	920	2,475	3,134	2,216	2,154	1,944	17,238
36	1,291	833	712	605	426	462	1,057	2,777	3,197	2,122	2,007	1,690	17,180
37	1,267	813	712	561	397	492	732	1,819	3,691	3,074	2,309	2,317	18,180
38	1,140	801	740	637	484	492	813	1,934	3,358	2,416	733	862	14,410
39	1,450	728	470	373	327	307	962	2,547	2,218	1,918	1,454	2,100	14,850

1940	1,567	831	522	387	375	553	1,093	2,493	3,110	2,759	2,231	1,974	17,900
41	1,023	619	698	756	651	676	1,515	2,916	1,835	2,116	1,771	1,537	16,110
42	748	785	690	524	426	524	1,182	2,156	2,648	2,059	1,966	1,863	15,570
43	1,345	603	419	611	444	391	756	1,724	2,920	2,386	2,819	2,430	16,850
44	1,470	830	484	502	363	307	898	2,045	3,277	2,420	2,527	2,126	17,250
45	1,974	1,029	649	526	389	369	407	2,065	2,961	2,884	2,832	1,993	18,080
46	1,242	678	319	478	333	385	516	2,900	1,634	2,575	2,932	2,604	16,600
47	1,537	819	581	415	327	294	534	2,930	4,211	3,719	2,656	2,045	20,070
48	1,543	817	676	553	416	492	305	885	1,077	1,740	2,281	2,315	13,100
49	1,353	825	571	422	333	373	470	1,890	3,009	2,465	2,166	1,839	15,720
50	1,176	793	480	282	419	492	797	2,122	3,638	2,283	2,408	2,077	16,970
51	1,601	1,055	982	563	389	541	1,331	2,981	4,324	3,172	2,269	2,178	21,390
52	1,511	752	415	444	403	430	1,577	2,713	3,191	2,828	2,237	2,043	18,540
53	1,349	843	621	609	666	706	1,388	3,164	3,852	3,338	2,553	2,146	21,240
54	1,252	825	633	538	448	541	2,112	2,999	4,413	3,499	2,527	3,507	23,290
55	1,837	619	383	381	458	553	1,553	3,828	3,850	3,604	2,620	2,961	22,650
56	2,035	734	662	861	750	837	1,595	3,931	5,758	2,878	3,271	4,241	27,550
57	2,162	746	627	506	410	559	1,137	3,822	3,406	3,207	3,592	4,463	24,640
58	2,356	813	603	508	593	595	1,428	2,463	2,955	2,799	3,794	4,264	23,170
59	2,414	702	555	553	571	736	1,839	3,820	4,116	3,086	3,671	5,460	27,520
60	2,277	885	690	454	736	815	1,872	3,412	3,842	3,340	3,414	3,973	25,710
61	2,089	1,039	879	369	369	676	1,981	3,092	3,273	2,906	4,209	3,431	24,310
62	2,069	938	615	553	526	615	1,787	3,566	3,832	3,336	4,060	3,717	25,610
63	2,043	885	738	674	512	819	1,704	2,527	3,092	3,842	3,614	3,435	23,880
64	1,930	957	658	526	440	493	1,559	3,263	3,743	3,158	3,308	3,445	23,480
65	1,777	757	552	657	895	779	2,501	3,717	4,136	3,943	4,130	3,923	27,770
66	2,027	720	506	539	527	692	2,059	3,035	3,638	3,412	3,467	3,556	24,180
67	1,563	1,137	702	605	485	736	2,481	3,259	3,753	3,291	3,483	2,951	24,450
68	2,416	756	555	619	484	615	1,849	2,709	3,382	2,902	3,709	3,873	23,870
69	1,567	803	545	528	505	674	1,107	3,124	3,574	3,479	3,465	4,062	23,430
70	1,872	686	573	643	696	776	1,718	2,390	3,162	2,289	2,404	3,745	20,950
71	1,335	910	781	458	444	553	1,567	2,594	3,306	2,817	3,011	3,705	21,480
72	1,470	636	384	426	396	2,418	2,896	3,985	3,947	3,243	3,521	3,269	26,590

[u] Unknown.

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
						Station 12505500. Main Drain near Alfalfa							
1924	22,930	14,700	13,240	11,790	10,810	12,010	17,060	25,820	29,450	27,540	31,030	28,280	244,700
25	23,170	19,810	16,380	13,610	13,680	13,930	16,090	30,410	32,610	33,260	32,690	29,940	275,600
26	24,110	16,450	15,050	13,210	11,610	13,500	17,810	23,890	28,070	28,600	28,550	23,370	244,200
27	19,250	17,630	17,880	16,340	15,650	14,880	14,710	26,520	33,340	33,840	32,460	32,710	275,200
28	23,500	16,310	14,460	13,460	12,100	11,240	12,190	18,530	30,170	34,060	29,970	27,340	243,300
29	24,650	20,370	17,880	13,860	10,680	14,820	18,500	25,420	34,660	30,340	29,470	29,860	270,500
30	25,130	21,050	15,780	13,400	12,100	15,330	20,710	29,580	31,510	30,720	28,630	27,890	271,800
31	25,120	19,810	16,310	13,940	12,830	17,130	23,960	35,160	25,850	30,610	29,660	28,680	289,100
32	22,870	19,690	16,090	15,410	12,290	13,610	18,070	32,530	26,560	28,550	24,300	24,110	254,080
33	25,960	18,690	14,920	13,170	10,453	11,274	12,500	33,090	37,360	34,290	32,320	36,520	280,500
34	26,960	18,470	23,520	29,920	19,480	18,220	18,720	28,180	23,190	28,040	26,540	32,100	293,300
35	27,690	18,240	15,100	13,160	10,890	13,480	21,160	37,410	37,920	31,980	27,970	37,360	292,400
36	32,790	21,430	16,810	14,490	11,070	10,640	17,330	33,100	36,480	27,200	21,570	26,880	269,800
37	26,050	21,520	14,090	10,840	9,586	12,440	21,390	31,920	43,490	24,860	27,820	36,370	280,400
38	26,250	17,570	16,720	16,340	12,620	15,510	24,960	36,420	37,310	23,420	27,590	21,600	276,300
39	30,500	17,710	15,860	12,450	9,683	11,530	10,590	28,960	33,180	33,060	23,980	24,480	252,000
40	30,000	23,370	17,700	15,000	13,910	17,650	15,690	34,180	34,730	27,600	28,400	31,210	289,400
41	37,160	23,770	18,640	16,440	13,820	18,920	15,550	18,460	21,080	23,140	22,580	28,140	257,700
42	25,630	17,890	14,590	12,620	11,820	13,950	15,200	28,840	33,360	27,080	28,280	24,630	253,900
43	30,300	20,720	16,520	14,820	13,930	16,280	25,770	36,960	41,830	28,470	31,360	21,380	298,300
44	31,000	21,360	14,490	12,690	10,680	12,830	9,450	8,704	29,090	21,060	27,080	24,890	223,300
45	29,740	20,820	15,890	13,430	11,870	13,840	14,760	19,760	31,110	21,460	29,450	21,320	243,400
46	32,950	21,450	15,690	40,840	31,580	46,900	46,740	63,320	66,520	53,800	47,500	52,090	519,400
47	47,560	32,560	44,890	13,196	10,820	16,950	17,150	29,820	31,820	26,500	22,840	25,530	319,600
48	33,040	19,280	14,630	14,190	12,310	13,700	19,010	37,260	49,510	27,160	26,550	25,310	292,000
49	27,470	19,530	16,560	12,820	11,070	14,450	17,240	27,670	34,680	30,120	30,250	28,900	270,800
50	28,470	18,400	15,150	8,140	11,900	17,600	19,940	31,600	50,560	25,600	27,040	26,860	281,300
51	31,370	19,490	18,060	15,880	17,120	13,650	24,680	46,660	52,050	24,940	23,760	35,860	323,500
52	31,070	18,720	15,670	13,110	16,190	16,750	21,980	38,110	37,790	26,540	21,670	22,110	279,700
53	24,430	18,710	15,870	18,090	14,140	20,340	14,560	32,840	45,900	18,970	19,980	17,850	261,700
54	28,620	20,440	15,550	13,850	13,390	17,960	27,350	39,640	38,240	20,030	19,950	17,980	273,000
55	24,840	18,410	15,780	13,060	10,420	11,710	5,173	19,010	21,930	16,230	10,810	12,790	180,200
56	31,730	18,720	24,770	22,320	16,330	20,790	37,740	59,500	53,750	14,950	13,140	25,590	339,300
57	30,760	17,690	15,480	13,480	11,010	15,610	31,200	21,310	9,852	1,890	5,453	18,630	192,400
58	30,200	17,480	14,720	13,300	14,750	19,950	32,390	24,270	11,870	4,720	7,490	19,900	211,000

1959	23,550	17,200	15,200	15,500	12,350	17,850	24,440	24,590	24,120	8,555	5,465	20,830	209,600
60	30,780	16,790	13,960	11,740	11,700	12,330	23,560	23,900	17,690	2,216	8,773	16,310	189,700
61	24,190	17,220	14,780	12,590	15,540	17,560	25,310	36,790	22,420	6,565	6,480	7,391	206,800
62	25,560	16,800	14,550	13,390	10,960	11,970	25,110	29,160	22,270	4,643	11,240	8,690	194,300
63	30,390	19,560	16,570	13,140	15,090	17,840	23,780	21,030	5,952	5,409	7,581	9,914	186,300
64	21,140	16,940	14,500	12,750	10,960	13,960	5,736	11,010	28,220	6,859	8,727	7,855	158,700
65	20,700	17,600	13,770	10,970	21,580	16,560	26,270	27,140	25,300	6,922	8,232	9,422	204,500
66	25,530	16,940	14,620	14,590	11,320	14,360	28,710	21,490	21,200	10,610	6,097	11,730	197,200
67	26,430	16,360	15,680	13,460	11,430	16,370	22,460	26,030	19,550	4,903	6,391	6,980	186,000
68	25,980	16,910	15,000	13,950	14,360	19,290	14,390	8,376	10,100	960	11,080	18,440	168,800
69	24,600	16,850	15,300	13,580	12,200	19,310	32,030	40,030	20,130	2,283	3,233	7,270	206,800
70	22,750	16,400	15,360	19,310	17,460	20,520	25,400	19,400	14,540	2,208	4,294	8,140	185,800
71	17,460	16,770	15,220	19,980	15,210	14,180	16,590	25,880	24,810	4,907	4,005	12,540	187,600
72	20,920	16,400	15,410	14,120	12,410	31,010	24,300	18,880	19,330	6,682	6,680	11,650	197,800

Site T. Satus 2 pump (diverts from Toppenish Creek)

1927	0	0	0	0	0	0	2,191	3,844	2,729	1,562	222	484	11,030
28	673	615	215	0	0	189	2,600	3,824	1,502	653	0	0	10,270
29	0	1,772	514	0	0	0	2,570	4,458	1,889	248	0	0	11,450
30	0	0	0	0	0	0	4,261	2,737	768	0	0	0	7,766
31	0	0	0	0	0	0	0	0	1,371	2,475	2,321	720	6,887
32	0	0	0	0	0	0	0	0	710	2,747	2,291	871	6,619
33	0	0	0	0	0	0	0	0	0	1,934	3,029	2,059	7,022
34	0	7,022	0	0	0	0	0	1,404	4,907	4,368	4,824	1,214	23,740
35	236	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)
36	0	0	0	0	0	0	0	619	3,733	4,312	4,883	1,553	15,100
37	464	0	0	0	0	0	0	0	0	3,745	4,499	1,864	10,570
38	0	0	0	0	0	0	0	0	1,890	4,147	4,064	4,040	14,140
39	0	0	0	0	0	0	726	3,564	3,590	4,249	4,582	3,701	20,410
40	657	0	0	0	0	0	0	1,698	3,638	3,904	4,540	3,854	18,290
41	0	0	0	0	0	0	712	3,356	3,683	3,923	3,412	3,035	18,120
42	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)
43	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)	(u)
44	0	0	0	0	0	0	1,763	4,261	3,693	3,951	3,750	4,370	21,790
45	0	0	0	0	0	0	0	3,126	2,747	4,356	3,769	4,090	18,090
46	0	0	0	0	0	0	0	0	1,238	3,404	3,693	3,033	11,370

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1947	44	0	0	0	0	0	1,186	2,775	3,699	3,675	3,667	3,201	18,250
48	0	0	0	0	0	0	0	0	0	3,420	3,525	3,029	9,974
49	0	0	0	0	0	0	0	0	1,551	3,382	4,612	3,473	13,020
50	0	0	0	0	0	0	0	0	0	3,084	4,612	4,013	11,710
51	0	0	0	0	0	0	0	0	797	4,550	4,612	4,225	14,180
52	0	0	0	0	0	0	0	0	5,157	6,381	8,604	8,390	28,530
53	0	0	0	0	0	0	6,294	8,608	8,331	11,950	16,050	0	51,230
54	0	0	0	0	0	0	0	1,843	8,331	16,550	16,440	12,690	55,850
55	954	0	0	0	0	0	8,003	7,851	10,840	16,620	16,870	16,170	77,310
56	0	0	0	0	0	0	0	4,050	8,150	16,730	17,070	16,360	62,360
57	0	0	0	0	0	0	0	8,713	17,270	23,430	23,670	19,550	92,630
58	0	0	0	0	0	0	0	8,747	17,320	22,160	22,390	18,810	89,430
59	0	0	0	0	0	0	3,987	13,390	17,870	22,410	22,320	19,200	99,180
60	0	0	0	0	0	0	4,504	11,910	16,920	22,040	22,340	21,790	99,500
61	0	0	0	0	0	0	3,255	8,102	16,300	22,690	22,510	21,720	94,580
62	0	0	0	0	0	0	2,676	10,220	14,740	21,660	21,910	21,010	92,220
63	0	0	0	0	0	0	0	7,710	18,200	21,810	22,140	21,300	91,160
64	0	0	0	0	0	0	12,670	14,880	14,740	20,860	21,510	20,590	105,200
65	0	0	0	0	0	0	6,982	14,470	15,530	21,830	21,890	20,950	101,700
66	0	0	0	0	0	0	1,450	14,050	14,920	22,040	22,140	21,120	95,720
67	0	0	0	0	0	0	7,174	14,930	18,090	22,750	22,140	21,210	106,300
68	0	0	0	0	0	0	10,270	16,600	17,350	22,540	22,570	21,510	110,800
69	0	0	0	0	0	0	438	8,362	14,550	22,430	22,440	21,430	89,650
70	0	0	0	0	0	0	5,976	8,485	13,870	22,120	22,120	18,960	91,530
71	0	0	0	0	0	0	0	5,360	8,340	19,070	22,140	16,640	71,550
72	0	0	0	0	0	0	3,740	13,735	14,710	20,185	23,365	18,985	94,720

[u] Unknown.

Site U. Satus West Lateral (diverts from Toppenish Creek)

1931	[e]400	0	0	0	0	459	602	993	1,619	1,394	1,919	1,337	[e]8,723
32	607	0	0	0	0	0	0	476	853	762	1,258	1,061	5,017
33	213	0	0	0	0	0	53	119	238	365	307	220	1,515
34	44	0	0	0	0	0	179	1,214	1,577	1,377	1,317	932	6,640
35	262	0	0	0	0	0	174	1,184	811	1,031	968	865	5,295
36	246	0	0	0	0	0	385	1,109	889	1,148	1,057	813	5,647
37	77	0	0	0	0	0	0	833	534	966	922	536	3,868
38	387	0	0	0	0	0	36	764	893	1,071	988	952	5,091
39	278	0	0	0	0	67	1,275	1,763	1,222	1,444	1,444	1,527	9,020
40	248	0	0	0	0	0	605	1,236	1,123	1,196	1,377	813	6,598
41	194	0	0	0	0	0	1,154	1,827	1,521	1,434	1,297	1,285	8,712
42	371	0	0	0	0	0	990	1,287	1,258	1,167	1,283	1,468	7,824
43	914	0	0	0	0	0	91	1,275	809	1,248	1,277	1,371	6,985
44	557	0	0	0	0	0	1,061	2,079	1,043	1,303	1,297	1,502	8,842
45	1,186	0	0	0	0	0	309	1,129	1,036	1,135	1,216	1,422	7,433
46	780	0	0	0	0	0	81	1,672	1,008	1,022	1,109	902	6,574
47	470	0	0	0	0	0	591	1,091	1,125	1,067	1,154	1,109	6,607
48	734	0	0	0	0	0	0	740	766	908	1,008	660	4,816
49	446	0	0	0	0	0	77	1,200	1,087	1,299	1,117	869	6,095
50	264	0	0	0	0	0	399	1,079	611	979	1,162	1,006	5,500
51	341	0	0	0	0	0	357	1,307	966	964	1,283	934	6,152
52	206	0	0	0	0	0	466	760	811	934	942	855	4,974
53	609	0	0	0	0	0	738	[e]1,500	841	1,135	1,325	1,020	[e]7,168
54	403	0	0	0	0	0	728	2,420	1,866	1,214	1,531	1,184	9,346
55	438	0	0	0	0	194	849	645	682	651	1,188	591	5,238
56	167	0	0	0	0	0	0	292	405	837	585	407	2,693
57	127	0	0	0	0	0	0	660	891	1,014	1,148	603	4,443
58	107	0	0	0	0	0	0	496	1,323	1,212	1,577	1,041	5,756
59	236	0	0	0	0	0	448	1,093	1,236	1,430	1,521	1,277	7,241
60	0	0	0	0	0	0	329	768	817	1,083	1,083	375	4,455
61	214	0	0	0	0	0	315	573	778	970	1,010	716	4,576
62	238	0	0	0	0	0	557	859	867	990	1,142	885	5,538
63	315	0	0	0	0	0	143	996	1,339	1,355	1,321	928	6,397
64	272	0	0	0	0	89	1,133	1,131	942	1,377	1,444	1,281	7,669
65	597	0	0	0	0	0	292	1,010	829	1,343	1,307	805	6,183

APPENDIX II.--Monthly and annual surface-water discharges at selected sites in the Toppenish Creek basin as shown in figure 4 and listed in table 1--Continued

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1966	298	0	0	0	0	0	365	875	990	1,468	1,938	1,000	6,934
67	335	0	0	0	0	0	575	1,198	950	1,129	1,490	942	6,619
68	361	0	0	0	0	0	942	1,434	1,246	1,517	1,480	1,085	8,065
69	295	0	0	0	0	0	476	1,093	1,291	1,452	1,311	1,031	6,949
70	347	0	0	0	0	0	1,236	1,630	2,125	2,186	2,095	1,426	11,050
71	502	0	0	0	0	0	1,763	1,980	2,335	2,281	2,458	1,335	12,650
72	234	0	0	0	0	0	1,405	1,589	2,285	2,366	1,855	1,265	11,000

[e] Estimated.

Station 12507510. Toppenish Creek near Alfalfa

Water year	October	November	December	January	February	March	April	May	June	July	August	September	Annual
1932	(u)	(u)	(u)	(u)	(u)	(u)	5,260	13,250	9,796	5,570	5,094	4,725	(u)
33	5,054	2,892	2,910	3,193	2,765	5,090	13,240	22,350	15,610	5,566	4,867	5,816	89,350
34	6,569	3,592	14,790	26,150	13,340	9,344	4,086	4,842	2,416	4,017	2,993	3,505	95,640
35	3,634	3,300	4,046	8,914	13,270	8,440	6,968	7,718	6,143	3,977	3,747	2,763	72,920
36	2,949	3,263	3,122	3,985	2,664	8,583	6,062	5,742	13,930	3,035	2,696	2,475	58,510
37	4,017	2,723	2,519	1,833	3,166	6,875	16,030	6,016	14,440	3,628	4,848	5,490	71,590
38	2,041	2,817	3,477	16,500	11,050	28,040	24,640	17,190	12,290	12,480	7,888	8,616	147,000
39	4,136	3,209	2,541	2,295	2,214	2,656	5,367	5,724	3,931	6,198	6,371	4,007	48,650
40	2,628	2,452	2,735	2,701	4,447	21,000	15,740	4,600	4,262	5,994	9,697	9,475	85,730
41	3,509	2,426	2,551	4,072	4,848	9,858	9,051	10,800	12,440	10,670	14,100	7,579	91,900
42	3,332	2,551	3,886	4,227	8,083	10,510	11,790	7,501	6,964	7,228	5,770	6,218	78,060
43	2,652	2,402	3,269	4,453	9,245	10,580	28,560	9,223	9,810	6,988	7,990	5,639	100,800
44	4,449	3,665	2,894	2,434	2,384	2,602	5,322	7,815	5,022	7,696	6,972	8,063	59,320
45	4,899	2,622	1,837	2,158	2,549	2,787	6,579	9,497	9,418	8,684	7,894	7,999	66,920
46	2,668	2,650	2,584	6,541	5,234	10,030	11,640	11,960	7,966	8,130	9,898	5,205	84,510
47	3,777	2,832	9,596	3,110	10,920	11,470	5,022	8,618	6,950	6,365	4,953	7,781	81,390
48	3,759	3,134	2,757	4,616	10,500	13,990	12,820	17,940	22,420	11,250	11,860	8,588	123,600
49	8,275	4,126	3,336	2,711	7,325	23,000	18,990	10,210	6,710	5,653	5,839	4,859	101,000
50	3,775	2,870	3,338	7,690	5,413	23,240	15,170	8,049	13,700	4,756	4,588	3,336	95,930
51	4,021	4,804	16,570	17,920	38,470	18,830	20,270	11,790	9,035	5,958	4,873	2,928	155,500
52	3,886	3,338	5,506	4,274	17,660	11,700	10,830	5,806	4,721	6,389	7,180	7,389	88,680
53	7,660	2,811	3,112	19,010	15,690	9,110	4,439	12,430	11,440	6,974	3,507	4,334	100,500
54	4,066	2,590	2,642	3,398	10,900	18,430	14,790	9,876	13,500	4,788	6,244	12,250	93,470
55	9,049	3,090	2,464	3,437	2,840	4,455	5,113	7,049	8,642	9,531	8,660	11,250	75,580
56	3,878	3,777	19,460	27,920	15,920	30,700	35,690	22,990	13,080	5,286	2,753	4,209	185,660

1957	3,836	3,197	3,312	2,715	3,009	15,800	18,530	13,980	4,905	2,051	3,779	3,658	78,770
58	9,549	3,689	3,156	4,463	16,780	21,130	19,480	7,319	1,777	974	942	1,079	90,340
59	5,090	3,449	3,376	12,470	11,130	15,210	9,849	2,216	2,593	1,095	752	2,557	69,790
60	4,875	2,374	2,253	2,053	4,939	6,117	10,210	5,576	2,031	500	1,137	3,223	45,290
61	10,700	3,201	3,644	4,592	21,150	22,440	13,630	5,852	4,566	916	2,188	3,219	96,100
62	6,022	2,991	3,751	4,423	5,734	7,825	8,000	2,912	2,081	1,188	2,176	1,783	48,890
63	8,710	5,663	11,880	6,823	20,930	11,240	22,540	7,887	1,734	1,873	1,855	2,837	103,970
64	9,866	3,453	4,056	4,752	4,475	3,979	2,932	6,038	5,187	1,771	2,694	3,364	52,570
65	10,140	2,959	2,642	6,131	25,660	15,460	6,744	3,594	1,873	1,523	2,355	4,870	83,950
66	4,915	3,695	3,406	10,070	6,599	11,080	16,020	4,195	2,589	3,114	1,238	2,349	69,270
67	4,201	4,376	5,956	5,633	12,050	7,141	4,134	3,747	4,066	1,886	1,964	1,607	56,760
68	4,324	2,440	2,471	7,424	18,810	19,260	3,824	4,961	5,992	1,061	2,934	5,439	78,940
69	5,383	2,971	4,695	10,140	9,489	23,440	25,750	6,127	1,914	1,404	2,793	9,267	103,400
70	9,923	2,876	4,923	16,010	23,030	19,780	7,202	10,510	6,789	609	641	5,929	108,200
71	14,090	3,035	4,135	21,710	19,410	14,890	30,040	28,420	14,320	2,608	1,496	11,990	166,100
72	11,020	3,440	4,790	8,930	14,770	34,420	13,570	20,830	13,800	2,707	1,878	3,943	134,100

[u] Unknown.

APPENDIX III.--Records of selected wells in the Toppenish Creek basin

EXPLANATION

Local well number: Numbered by township, range, section, and 40-acre subdivision, as described on page 9.

Lat-long: Number of well by latitude and longitude.

Owner: Name of owner or tenant.

Use of water: The purpose for which water from the well is used; C, commercial; F, fire protection; H, domestic; I, irrigation; N, industrial; P, public supply; S, stock supply; U, unused; Z, other.

Altitude of LSD (ft): The altitude of the land-surface datum, in feet, with reference to mean sea level.

Well depth (ft): The depth of the well, in feet below LSD, at the time of well inventory.

Major aquifer: The geologic unit that contributes the greatest quantity of water to the well; YA, Yakima Basalt; EL, Ellensburg Formation (lower part of old valley fill); OA, alluvium (young valley fill and upper part of old valley fill).

Water level (ft): The measured water level of the well, in feet above or below LSD; F, flows, with head unknown; +12, flows, head 12 ft.

Date water level measured: Month and (or) year of measurement, usually during well inventory.

Yield (gpm): The pumping discharge of the well, in gallons per minute.

Drawdown (ft): The distance, in feet, that the water level was lowered by pumping at the stated yield rate.

Log available: D, driller's log; 3Z, geophysical logs; blank, no log available.

Decline, 1971-73 (ft): The amount of lowering of the water level in feet, from spring 1971 to spring 1973.

2-yr pumpage, 1971-72 (acre-ft): The total quantity of ground water pumped, in acre-ft, during 1971 and 1972.

APPENDIX III.--Records of selected wells in the Toppenish Creek basin--Continued

LOCAL WELL NUMBER	LAT-LONG	OWNER	USE OF WATER	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	MAJOR AQUIFER	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	YIELD (GPM)	DRAW DOWN (FT)	LOG AVAIL-ABLE	Decline, 1971-73 (ft)	2-year pumpage, 1971-72 (acre-ft)
10N16E01C01	462322N1204556.1	INEZ LEWIS	H	1035	120	OA	7	5-72	15	54	--	--	--
10N16E01D01	462315N1204623.1	W BARNHART	H	1050	82	OA	--	--	8	--	--	--	--
10N16E01H01	462301N1204513.1	MATTHEW JAMES	H	1006	54	OA	16	-63	10	--	--	--	--
10N16E02N01	462240N1204728.1	ALBERT WATKINS	H	1103	16	OA	12	4-58	--	--	--	--	--
10N16E03N01	462234N1204840.1	CLYDE RAMSEY	H	1175	179	YA	7	9-52	5	--	--	--	--
10N16E05G01	462258N1205046.1	HOGAN	I	347	--	YA	28	6-70	--	--	--	3	101
10N16E09K01	462158N1204920.1	OSCAR THON	I	1245	367	YA	26	6-70	150	130	--	4	42
10N16E10E01	462207N1204858.1	WB PACE	H	1220	112	OA	10	4-58	--	--	--	--	--
10N16E10E02	462207N1204859.1	WB PACE	H	1220	80	OA	10	--	--	--	--	--	--
10N16E10J01	462157N1204744.1	RAY BRISBOIS	H	1140	98	OA	--	--	10	--	--	--	--
10N16E10N01	462142N1204858.1	WB PACE JR	I	1230	567	YA	33	1-53	1300	94	D	6	394
10N16E11C01	462230N1204707.1	JAMES BLODGETT	H	1080	--	OA	10	4-72	--	--	--	--	--
10N16E11K01	462157N1204706.1	PHILIP AMBROSE	H	1110	111	OA	100	-63	10	--	--	--	--
10N16E12H01	462214N1204513.1	A SHIPPENTOWER	H	1050	43	OA	--	--	10	--	--	--	--
10N16E12L01	462204N1204601.1	FRED COLFAX	H	1060	115	OA	--	--	10	--	--	--	--
10N16E15M01	462100N1204856.1	LEONARD KUNEKI	H	1290	125	YA	67	4-72	15	--	D	--	--
10N16E15N01	462053N1204857.1	LEROY MCLAVEY	I	1290	310	YA	65	2-55	240	119	--	--	72
10N16E19G01	462025N1205147.1	FORT SIMCOE JC	H	1550	425	YA	26	7-67	60	32	D	--	192
10N16E20F01	462026N1205107.1	FORT SIMCOE	P	1500	305	YA	36	6-70	--	80	D	--	--
10N16E21D01	462041N1205008.1	FT SIMCOE ST PK	I	1375	163	YA	--	--	340	--	--	+1	66
10N16E23D01	462036N1204725.1	CAROL LAWRENCE	H	1180	131	YA	--	--	10	--	D	--	--
10N16E24F01	462024N1204558.1	WA CONST TR CTR	H	1160	216	YA	48	10-72	60	--	D	--	--
10N17E02F01	462303N1203938.1	ROSEMARY MCKAY	H	880	120	OA	--	--	10	--	D	--	--
10N17E02M01	462256N1204004.1	LOUISE JACKSON	H	890	52	OA	--	--	10	--	--	--	--
10N17E03Q01	462232N1204029.1	AMOS GRAIG	H	900	--	OA	12	9-71	--	--	--	--	--
10N17E04L01	462258N1204212.1	JOAN FRENCH	H	940	65	OA	--	--	10	--	D	--	--
10N17E04N01	462234N1204223.1	UNKNOWN	H	950	55	OA	24	5-71	--	--	--	--	--
10N17E05E02	462301N1204343.1	YAKIMA FIRE DT	F	965	--	OA	--	--	--	--	--	--	--
10N17E05L01	462246N1204336.1	OLIVER PIMMS	H	980	142	OA	26	5-72	9	100	D	--	--
10N17E05L02	462247N1204336.1	ROY BRADEN	H	980	59	OA	18	5-72	10	19	D	--	--
10N17E05L03	462249N1204336.1	KEITH CASSADY	H	980	91	OA	18	9-72	25	19	D	--	--
10N17E05L04	462251N1204336.1	SALLIE LUCEI	H	980	56	OA	7	5-92	14	14	--	--	--
10N17E05M01	462249N1204350.1	W SWAN SCHOOL	F	977	18	OA	10	5-70	500	--	--	--	--
10N17E05M02	462248N1204349.1	W SWAN SCHOOL	F	977	18	OA	9	5-70	500	--	--	--	--
10N17E05M03	462243N1204337.1	N PACIFIC RWY	U	955	757	YA	15	--	--	--	D	--	--
10N17E05N01	462241N1204351.1	W SWAN SCHOOL	F	977	18	OA	8	5-70	500	--	--	--	--
10N17E05Q01	462235N1204313.1	YAKIMA TRIBE	H	973	84	OA	26	11-57	25	0	D	--	--
10N17E06B01	462313N1204426.1	LEONARD JAMES	H	990	43	OA	--	--	10	--	--	--	--
10N17E06D01	462316N1204506.1	BOISE CASCADE	H	1000	242	EL	32	7-70	80	--	D	--	--
10N17E06D02	462315N1204505.1	BOISE CASCADE	N	1000	12	OA	5	6-70	--	1	--	--	--
10N17E06F01	462258N1204455.1	HENRY FIANDER	H	995	42	OA	32	-63	10	--	--	--	--
10N17E06F01	462305N1204440.1	FRANCIS OLNEY	H	982	40	OA	--	--	10	--	D	--	--
10N17E06F02	462305N1204446.1	JOHN SWAN	H	983	60	OA	18	-63	10	--	D	--	--
10N17E06F03	462306N1204444.1	WM FIANDER	H	995	42	OA	19	-63	10	--	--	--	--
10N17E06F04	462304N1204430.1	RUSS WATLAMET	H	978	49	OA	30	-63	10	--	D	--	--
10N17E06G01	462259N1204428.1	JOHN ROOTS	H	980	--	OA	9	5-71	--	--	--	--	--
10N17E06G02	462300N1204430.1	MICHAEL LEWIS	H	980	42	OA	--	--	10	--	--	--	--
10N17E06G03	462304N1204427.1	CHARLES FIANDER	H	975	43	OA	12	-63	10	12	--	--	--
10N17E06G04	462304N1204423.1	GEORGE ADAMS	H	975	48	OA	18	-63	10	--	--	--	--
10N17E06H01	462258N1204414.1	ELMER OLNEY	H	980	94	OA	--	--	10	--	D	--	--
10N17E06H02	462258N1204357.1	CECELIA ASHUE	H	975	37	OA	--	--	10	--	D	--	--
10N17E07B01	462200N1204420.1	DELMAR DEAN	H	1010	41	OA	17	-63	10	--	--	--	--
10N17E07M01	462156N1204510.1	BILL ENEAS	H	1170	51	OA	--	--	10	--	--	--	--
10N17E07R01	462140N1204355.1	JOHN SMARTLOWIT	H	1030	65	OA	24	4-72	21	25	D	--	--
10N17E08L01	462159N1204455.1	AGNES COOTES	H	1000	42	OA	--	9-63	10	--	--	--	--

10N17E10D01	462230N1204118.1	RAMONA VALLO	H	955	--	0A	9	5-71	--	--	--	--	--
10N17E11B01	462229N1203919.1	JASPER ANDY	H	880	57	0A	--	9-63	10	--	--	--	--
10N17E11D01	462223N1204006.1	LARRY WHITE	H	890	57	0A	16	5-71	--	--	--	--	--
10N17E12C01	462230N1203829.1	BUD BALCH #2	H	845	420	YA	F	4-58	22	--	--	--	--
10N17E12C02	462231N1203819.1	BUD BALCH #1	H	845	80	0A	--	--	--	--	--	--	--
10N17E14D01	462122N1204005.1	IDA SHOWAWAY	H	910	75	0A	--	--	10	--	--	--	--
10N17E15M01	462111N1204118.1	AMOS ANDY	U	950	110	0A	--	9-71	10	--	D	--	--
10N17E15M02	462109N1204114.1	LEWIS NAPIER	U	950	48	0A	--	--	10	--	--	--	--
10N17E16M01	462101N1204236.1	CELIA TOTUS	H	1002	60	0A	--	--	--	--	--	--	--
10N17E16M02	462101N1204231.1	CELIA TOTUS	H	1000	150	0A	--	--	--	--	--	--	--
10N17E17L01	462107N1204326.1	SUNDOWN M RANCH	H	1040	537	YA	--	--	--	--	D	--	--
10N17E17L02	462107N1204323.1	YAK IND MISSION	I	1035	310	EL	123	6-70	325	--	D	--	--
10N17E17N01	462059N1204346.1	FRANK WHITEFOOT	H	1045	48	0A	--	--	10	--	--	--	--
10N17E18A01	462135N1204359.1	MARIE ALBERT	H	1035	48	0A	--	--	10	--	--	--	--
10N17E18F01	462116N1204448.1	COLIN JOHNSON	I	1078	80	0A	10	6-70	135	--	--	--	--
10N17E18F02	462113N1204448.1	COLIN JOHNSON	I	1074	480	YA	14	6-70	135	135	D	--	--
10N17E18H01	462125N1204356.1	TEX GEORGE	H	1035	54	0A	--	--	10	--	--	--	--
10N17E18N01	462058N1204510.1	EAGLE SEELATSEE	H	1100	53	0A	--	--	10	--	--	--	--
10N17E18N02	462057N1204508.1	E WILSON	H	1100	90	0A	--	--	10	--	--	--	--
10N17E20A01	462047N1204247.1	M WEASELTAIL	H	1010	43	0A	--	--	10	--	--	--	--
10N17E20N01	462002N1204350.1	DAVID SOHAPPY	H	1080	77	0A	--	--	10	--	--	--	--
10N17E20R01	461955N1204242.1	MARY DICK	H	1050	47	0A	--	--	10	--	--	--	--
10N17E23B01	462046N1203926.1	W JASWAY	U	950	110	0A	25	5-71	--	--	--	--	--
10N17E23L01	462009N1203949.2	BERT C DEKKER	I	980	700	YA	95	-62	1600	45	D	10	2260
10N17E24C01	462046N1203827.1	W JASWAY	H	900	--	0A	24	5-71	--	--	--	--	--
10N17E26B01	461955N1203926.1	BERT C DEKKER	I	980	450	EL	90	-51	900	40	D	--	--
10N17E26J01	461916N1203909.1	BERT C DEKKER	I	1015	1000	YA	91	7-62	1600	110	D	8	2030
10N17E27Q01	461904N1204028.1	BERT C DEKKER	I	1118	1510	YA	196	4-59	1500	43	D	12	1990
10N17E28B01	461954N1204142.1	BERT C DEKKER	I	1045	880	YA	105	1-58	1800	12	--	4	800
10N17E35B01	461850N1203928.1	N SHELLENBERGER	U	1110	705	YA	169	4-58	872	15	D	10	338
10N17E35B02	461850N1203928.2	N SHELLENBERGER	I	1109	803	YA	247	6-70	1700	4	D	--	--
10N17E36A01	461849N1203747.1	LOUIS ARQUETTE	I	1024	310	YA	108	12-60	300	142	D	--	--
10N18E01A01	462317N1203015.1	G SCHILPEROOT	I	815	28	0A	15	3-72	--	--	--	--	--
10N18E01B01	462323N1203032.1	LAWRENCE HOWARD	U	815	72	0A	8	5-67	10	--	--	--	--
10N18E01D01	462324N1203106.1	MAURICE PEUGH	I	815	110	0A	15	4-71	800	--	--	--	--
10N18E01P01	462233N1203058.1	E F TIMMONS	H	800	56	0A	13	4-71	--	--	--	--	--
10N18E02C01	462323N1203204.1	GAYLUND HIND	H	818	39	0A	20	5-72	--	--	--	--	--
10N18E02K01	462245N1203145.1	RHODA WILLIAMS	H	805	41	0A	--	--	12	--	--	--	--
10N18E02N01	462243N1203221.1	DORA TULEE	H	805	41	0A	--	--	15	--	--	--	--
10N18E03R01	462238N1203238.1	FRED PATIO	H	805	33	0A	8	4-58	--	--	--	--	--
10N18E04A01	462324N1203352.1	STOVER	H	809	18	0A	11	7-71	--	--	--	--	--
10N18E05Q01	462241N1203524.1	WILLIAM DARROW	H	840	600	YA	F	4-58	--	--	--	--	--
10N18E05Q02	462335N1203544.1	ANNE MILLER	H	790	62	0A	46	6-63	10	--	--	--	--
10N18E06A01	462315N1203624.1	USGS	U	832	57	0A	24	4-72	--	--	D	--	--
10N18E06H01	462302N1203623.1	TONEY BENSON	H	810	59	0A	13	1-67	15	057	--	--	--
10N18E06P01	462232N1203716.1	BRUCE MORRISON	H	845	53	0A	28	4-58	--	--	--	--	--
10N18E06P02	462233N1203659.1	ASHUE	H	825	--	0A	12	5-71	--	--	--	--	--
10N18E06R01	462233N1203621.1	BF CLARK	H	825	30	0A	--	--	--	--	--	--	--
10N18E06R02	462241N1203626.1	MINA LOGIE	H	825	50	0A	36	9-63	10	--	--	--	--
10N18E07K01	462153N1203651.1	JOHN SHOCK	H	821	59	0A	--	9-63	10	--	--	--	--
10N18E08D01	462231N1203620.1	ARLEN MOSES	H	824	46	0A	12	4-71	--	--	--	--	--
10N18E09M01	462152N1203651.1	TEOWASH BENSON	H	830	65	0A	--	--	10	--	--	--	--
10N18E10R02	462224N1203257.1	ROSS SWINNELL	F	805	28	0A	12	5-70	500	--	--	--	--
10N18E11B01	462230N1203141.1	INDIAN LAND CO	I	800	20	0A	--	--	1000	--	--	--	--
10N18E11D01	462231N1203219.1	WALTER HOLDER	U	802	--	0A	--	--	--	--	--	--	--

APPENDIX III.--Records of selected wells in the Toppenish Creek basin--Continued

LOCAL WELL NUMBER	LAT-LONG	OWNER	USE OF WATER	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	MAJOR AQUIFER	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	YIELD (GPM)	DRAW DOWN (FT)	LOG AVAIL-ABLE	Decline, 1971-73 (ft)	2-year pumpage, 1971-72 (acre-ft)
10N18E12A01	462229N1203016.1	WES MORFORD SR	H	803	--	0A	7	7-71	--	--	--	--	--
10N18E12A02	462232N1203007.1	WESLEY MORFORD	H	800	--	0A	--	--	--	--	--	--	--
10N18E12C01	462230N1203059.1	WILSON CHARLEY	H	800	67	0A	10	5-67	10	--	--	--	--
10N18E13B01	462138N1203039.1	VELMA PHILIPS	H	790	--	0A	1	--	--	--	--	--	--
10N18F14J01	462110N1203128.1	JACK RICE	H	785	--	0A	--	--	--	--	--	--	--
10N18E14J02	462102N1203128.1	JACK RICE	I	785	14	0A	--	--	--	--	--	--	--
10N18E15L01	462103N1203323.1	AL CARL	H	800	54	0A	--	--	15	--	--	--	--
10N18E18A01	462140N1203622.1	USGS	U	820	62	0A	5	4-72	--	--	D	--	--
10N18E19J01	462016N1203630.1	BUR SPORTS FISH	U	840	--	0A	--	--	--	--	--	--	--
10N18E21D01	462046N1203458.1	LW HEALY	H	820	63	0A	28	11-71	--	--	--	--	--
10N18E23A01	462046N1203136.1	OLNEY	H	790	41	0A	9	5-71	--	--	--	--	--
10N18E23F01	462032N1203214.1	O SOCKZEHIGH	H	788	42	0A	16	9-71	12	--	D	--	--
10N18E24A01	462045N1203012.1	MARIE WOLF	H	778	63	0A	8	2-67	10	17	D	--	--
10N18E25D01	461954N1203161.1	USGS	U	786	62	0A	8	4-72	--	--	D	--	--
10N18E26D01	461952N1203227.1	R GOLDSMITH	H	790	80	0A	1	5-71	--	--	--	--	--
10N18E26Q01	461904N1203138.1	UNKNOWN	H	825	--	0A	15	5-71	--	--	--	--	--
10N18E27N01	461906N1203311.1	WAPATO IRR DIST	H	820	180	0A	25	5-71	--	--	--	--	--
10N18E28R01	461904N1203350.1	UNKNOWN	U	845	--	0A	17	5-71	--	--	--	--	--
10N18F29M01	461927N1203609.1	UNKNOWN	H	855	--	0A	--	--	--	--	--	--	--
10N18E29N01	461904N1203608.1	FRANDSKEELS	H	902	65	0A	--	--	--	--	--	--	--
10N18E30Q01	461904N1203650.1	UNKNOWN	U	922	--	0A	--	--	--	--	--	--	--
10N18E31N01	461823N1203734.1	BERT C DEKKER	I	1138	1044	YA	233	8-63	388	53	--	7	107
10N18E32A01	461902N1203506.1	JIM COSNER	H	860	90	0A	16	5-71	--	--	--	--	--
10N18E32C01	461901N1203544.1	UNKNOWN	U	900	80	0A	33	5-71	--	--	--	--	--
10N18E34A01	461901N1203251.1	UNKNOWN	U	841	--	0A	34	6-71	--	--	--	--	--
10N18E34L01	461834N1203312.1	JOHN CARL	H	1090	--	0A	117	5-71	--	--	--	--	--
10N18E36D01	461902N1203107.1	F WEGMILLER	H	862	93	0A	68	6-67	10	--	--	--	--
10N19E01C01	462323N1202307.1	LOTTIE WHITE	H	790	64	0A	14	1-67	10	008	D	--	--
10N19E01E01	462258N1202342.1	ANDREW LILLIE	H	790	63	0A	13	1-67	10	--	D	--	--
10N19E01M01	462246N1202343.1	ANDREW LILY	H	788	58	0A	14	2-67	10	5	D	--	--
10N19E01N01	462232N1202343.1	MCKINLEY GRANGE	H	786	24	0A	13	1-59	500	--	--	--	--
10N19E01P01	462233N1202308.1	GOMACHE	H	781	--	0A	10	6-70	10	--	--	--	--
10N19E02P01	462233N1202427.1	ERNIE CHAMPEAUX	H	790	60	0A	--	--	--	--	--	--	--
10N19E02P02	462234N1202424.1	FIRE DISTRICT 5	F	790	22	0A	13	--	500	--	D	--	--
10N19E03E01	462308N1202613.1	TOSH UMEMOTO	H	805	60	0A	--	--	--	--	--	--	--
10N19E07B01	462230N1202908.1	LARRY COLE	H	801	60	0A	--	--	--	--	--	--	--
10N19E07C01	462231N1202942.1	JOE KING	H	801	60	0A	10	4-71	--	--	--	--	--
10N19E07R01	462140N1202858.1	RODRICK DAVIS	H	790	61	0A	15	3-67	10	--	--	--	--
10N19E08N01	462140N1202836.1	SHIRLEY MANZANO	H	790	62	0A	12	4-10	--	--	--	--	--
10N19E08N02	462140N1202846.1	HARVEY DAVIS	H	792	64	0A	14	5-67	10	--	--	--	--
10N19E11B01	462232N1202418.1	W T SAUVE	H	790	38	0A	--	--	--	--	--	--	--
10N19E11H01	462217N1202348.1	R COMENOUT	H	785	67	0A	7	6-67	10	--	D	--	--
10N19E11P01	462142N1202439.1	DAVID MILLER	H	775	69	0A	13	3-67	10	--	--	--	--
10N19E12M01	462204N1202342.1	TEO JOE	H	781	60	0A	13	1-67	10	6	--	--	--
10N19F12Q01	462142N1202304.1	MOSE WINNIER	H	775	64	0A	12	2-67	10	7	D	--	--
10N19E12R01	462141N1202231.1	K SMARTLOWIT	H	765	--	0A	--	--	--	--	--	--	--
10N19E12R02	462141N1202229.1	CHESTER WAHPAT	H	767	61	0A	10	2-67	10	16	--	--	--
10N19E14A01	462138N1202347.1	OTTO HALVERSON	H	776	--	0A	--	--	--	--	--	--	--
10N19E14C01	462137N1202424.1	ALEX WESLEY	H	777	71	0A	14	2-67	10	8	--	--	--
10N19F14K01	462107N1202406.1	TOM ELY	H	768	69	0A	9	4-71	--	--	--	--	--
10N19E16A01	462137N1202617.1	LAURA CORPUS	H	784	60	0A	16	4-67	10	15	--	--	--
10N19E16D01	462138N1202731.1	FELIX RABANAL	H	785	61	0A	--	--	10	--	D	--	--
10N19E16J01	462111N1202620.1	ROLAND BRULOTTE	F	780	34	0A	7	5-70	500	--	--	--	--
10N19E17H01	462114N1202734.1	MARIE OLNEY	H	783	75	0A	20	4-67	11	10	D	--	--
10N19E17M01	462105N1202834.1	MAURICE PEUGH	I	782	20	0A	--	--	420	--	--	--	--

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10N19E18A01	462138N1202951.1	JOSEPHI ANDREWS	H	790	65	OA	19	4-67	11	6	--	--	--
10N19E18M01	462113N1203001.1	G SCHILPEROOT	H	783	25	OA	9	4-72	--	--	--	--	--
10N19E18Q01	462048N1202923.1	JOE ZACK	H	780	67	OA	8	2-67	10	16	--	--	--
10N19E21H01	462032N1202618.1	VERA MESPLIE	H	775	59	OA	10	2-67	10	10	--	--	--
10N19E21K01	462020N1202651.1	GILBERT CARL	H	773	62	OA	9	2-67	10	13	D	--	--
10N19E22R01	462008N1202504.1	CARL HUBBARD	H	759	68	OA	7	2-67	10	33	--	--	--
10N19E23C01	462046N1202428.1	YAKIMA TRIBE	H	764	--	OA	6	6-71	--	--	--	--	--
10N19E25R01	461954N1202305.1	SHARON MERCK	U	749	60	OA	5	--	--	--	--	--	--
10N19E29A01	461950N1202734.1	VERNA MULLINEX	H	770	55	OA	12	4-67	11	13	--	--	--
10N19E30Q01	461904N1202910.1	VIOLA ONEIL	H	795	--	EL	--	--	--	--	--	--	--
10N19E30R01	461906N1202905.1	VIOLA ONEIL	H	788	715	EL	+6	4-72	440	--	D	--	--
10N19E36K01	461829N1202251.1	USGS	U	741	44	OA	3	7-72	--	--	D	--	--
10N20E01K01	462247N1201539.1	LOUIS JACK	H	735	50	OA	12	10-65	10	10	D	--	--
10N20E01P02	462231N1201543.1	WESLEY TAKHEAL	H	735	50	OA	12	10-65	10	12	D	--	--
10N20E02K01	462247N1201655.1	ROBERT ELDER	H	745	60	OA	--	--	--	--	--	--	--
10N20E02Q01	462243N1201654.1	WALTER HALL	I	746	20	OA	--	--	1000	--	--	--	--
10N20E02R01	462232N1201634.1	HALL WALTER	S	742	168	OA	10	3-71	--	--	--	--	--
10N20E03M01	462247N1201848.1	TOPPENISH CITY	P	760	167	OA	--	-22	425	--	D	--	--
10N20E03M02	462244N1201848.1	TOPPENISH CITY	P	760	800	EL	12	4-46	400	79	D	--	--
10N20E03P01	462241N1201829.1	TOPPENISH CITY	P	760	188	OA	8	7-37	750	050	D	--	--
10N20E04J01	462250N1201904.1	TOPPENISH CITY	P	764	291	OA	17	12-51	950	60	--	--	--
10N20E04L01	462245N1201943.1	TOPPENISH CITY	P	760	1025	EL	--	--	2350	282	--	--	--
10N20E05G01	462257N1202038.1	EULAH BARTLETT	U	772	20	OA	7	3-71	--	--	--	--	--
10N20E05M01	462248N1202120.1	H J SHIPMAN	H	780	21	OA	7	6-58	15	--	D	--	--
10N20E05R02	462232N1202014.1	FIRE DISTRICT 5	F	760	26	OA	--	--	--	--	--	--	--
10N20E05R03	462237N1202011.1	YAKIMA INDIAN	H	760	194	OA	16	10-66	80	27	--	--	--
10N20E05R04	462231N1202014.1	YAKIMA IND AGY	H	760	194	OA	16	9-66	80	27	--	--	--
10N20E07R01	462143N1202122.1	MCDOUGAL	H	761	12	OA	--	--	--	--	--	--	--
10N20E08C01	462226N1202058.1	UNKNOWN	U	769	20	OA	--	--	--	--	--	--	--
10N20E08C02	462229N1202045.1	ESTHER THON	H	765	60	OA	16	2-66	10	10	D	--	--
10N20E09A01	462226N1201856.1	TOPPENISH CITY	P	757	863	EL	+59	12-59	1575	44	D	--	--
10N20E10J01	462200N1201742.1	YAKIMA TRIBE	H	742	51	OA	11	11-65	10	14	D	--	--
10N20E11F01	462210N1201711.1	W A WHITE	I	740	30	OA	--	--	250	--	--	--	--
10N20E12C01	462228N1201551.1	CECIL STAGNER	H	736	48	OA	8	11-65	10	0	D	--	--
10N20E13E01	462115N1201616.1	JOHN BARNEY	H	730	50	OA	14	10-65	10	8	D	--	--
10N20E13Q01	462048N1201540.1	MARGARET WANTO	P	721	50	OA	10	11-65	10	16	D	--	--
10N20E14L01	462111N1201714.1	ABEL FRENCH	H	733	50	OA	12	10-65	10	8	D	--	--
10N20E15L01	462111N1201815.1	JOHN HAAS	I	740	20	OA	--	--	27	--	--	--	--
10N20E16P01	462049N1201941.1	LARRY JENSEN	H	745	59	OA	12	1-66	10	--	D	--	--
10N20E19J01	462007N1202124.1	EW SCHNEIDER	H	743	60	OA	11	2-66	10	13	D	--	--
10N20E19Q01	462007N1202144.1	EW SCHNEIDER	H	745	20	OA	--	--	--	--	--	--	--
10N20E20K01	462019N1202042.1	GEORGE JENSEN	H	745	60	OA	10	2-66	10	015	D	--	--
10N20E20L01	462007N1202051.1	FLORENCE GIBSON	H	744	60	OA	12	2-66	10	12	D	--	--
10N20E20M01	462014N1202118.1	KATHRYN HUYLAR	H	745	60	OA	11	2-66	10	10	D	--	--
10N20E21B01	462039N1201916.1	CLIFFORD CHENEY	H	743	60	OA	11	2-66	10	14	--	--	--
10N20E21G02	462021N1201912.1	EVERETT COOK	H	731	56	OA	12	1-66	10	009	D	--	--
10N20E21J01	462012N1201857.1	MT ADAMS GOLF C	I	733	22	OA	--	--	350	--	--	--	--
10N20E21P01	462038N1201916.1	PAT JENSEN	H	736	59	OA	13	2-66	10	12	D	--	--
10N20E22E01	462022N1201831.1	GAMBLE FRANK	S	735	90	OA	--	--	100	--	--	--	--
10N20E22M01	462014N1201832.1	MT ADAMS GOLF C	I	733	21	OA	7	--	360	06	--	--	--
10N20E23P01	462004N1201702.1	HACKNER FRED	H	727	--	OA	7	--	--	--	--	--	--
10N20E24E01	462022N1201602.1	ERNEST COOLEY	I	720	16	OA	--	--	400	--	--	--	--
10N20E25C01	461941N1201540.1	CELIA UMTUCH	H	717	50	OA	12	10-65	10	11	D	--	--
10N20E25P01	461912N1201542.1	ENICH GEORGE	H	718	60	OA	--	--	--	--	--	--	--
10N20E26F01	461938N1201702.1	ALLISON SHUSTER	H	725	40	OA	--	--	40	--	D	--	--

APPENDIX III.--Records of selected wells in the Toppenish Creek basin--Continued

LOCAL WELL NUMBER	LAT-LONG	OWNER	USE OF WATER	ALTI-TUDE-OF LSD (FT)	WELL DEPTH (FT)	MAJOR AQUIFER	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	YIELD (GPM)	DRAW DOWN (FT)	LOG AVAIL-ABLE	Decline, 1971-73 (ft)	2-year pumpage, 1971-72 (acre-ft)
10N20E26H01	461938N1201628.1	WILBUR BASEY	I	723	25	0A	--	--	300	--	--	--	--
10N20E27A01	461953N1201751.1	FRANK GAMBLE	I	730	75	0A	1	3-62	310	46	--	--	--
10N20E27B01	461945N1201803.1	FRANK GAMBLE	I	725	110	0A	2	7-52	600	10	--	--	--
10N20E28F01	461941N1201944.1	DELBERT CARL	I	734	36	0A	7	--	420	4	--	--	--
10N20E28R01	461905N1201850.1	USGS	U	725	43	0A	12	4-72	--	--	D	--	--
10N20E29G01	461930N1202037.1	STANLEY JENSEN	H	738	65	0A	10	2-66	10	8	--	--	--
10N20E29H01	461938N1202012.1	DELBERT CARL	H	736	65	0A	11	2-66	10	8	D	--	--
10N20E29N01	461911N1202120.1	CELIA TOTUS	I	736	35	0A	--	--	--	--	--	--	--
10N20E30L01	461926N1202211.1	JULIA DRURY	I	741	--	0A	--	4-68	400	--	--	--	--
10N20E32K01	461827N1202023.1	BUR SPORT FISH	H	740	80	0A	--	--	--	12	--	--	--
10N20E32K02	461825N1202033.1	INTERIOR F&WL S	I	740	110	0A	--	--	50	15	--	--	--
10N20E32M01	461825N1202104.1	ART GADLEY	I	739	18	0A	--	--	--	--	--	--	--
10N20E32Q01	461821N1202036.1	ARTHUR GADLEY	I	742	22	0A	--	--	--	--	--	--	--
10N20E33L01	461830N1201930.1	D E CLYDE	H	745	40	0A	--	--	--	--	--	--	--
10N20E34F01	461843N1201827.1	JOHNNY JIM	H	735	41	0A	11	9-63	40	009	D	--	--
10N20E35F01	461846N1201657.1	BENT BARREL GUN	H	718	120	0A	--	--	--	--	D	--	--
10N20E36B01	461848N1201530.1	MARY SETTLER	H	718	40	0A	--	--	--	--	--	--	--
10N20E36G01	461846N1201537.1	MARY UMTUCH	H	718	40	0A	3	--	--	--	D	--	--
10N20E36G02	461847N1201538.1	MARY UMTUCH	H	718	50	0A	--	--	--	--	--	--	--
10N21E07D01	462229N1201500.1	KELLEY GEORGE	H	728	50	0A	11	10-65	10	10	D	--	--
10N21E07K01	462203N1201423.1	VIRGINI SHIRLEY	H	723	61	0A	7	6-71	10	10	D	--	--
10N21E17D01	462142N1201346.1	YAKIMA IND NAT	U	715	21	0A	4	--	--	--	--	--	--
10N21E19P01	461954N1201436.1	ERNEST JAMES	H	710	48	0A	14	11-65	10	10	D	--	--
10N21E21J01	462019N1201118.1	CITY OF GRANGER	P	735	207	0A	28	3-71	400	--	--	--	--
10N21E28L01	461917N1201156.1	SILAS PETERS	H	704	42	0A	4	--	40	--	D	--	--
10N21E29B01	461944N1201310.1	SIMON JOHN	H	710	60	0A	12	2-65	10	10	D	--	--
10N21E29F01	461942N1201326.1	UNKNOWN	U	710	--	0A	--	--	--	--	--	--	--
10N21E32B01	461851N1201258.1	C BEAVERT	H	704	24	0A	--	--	--	--	--	--	--
10N21E33B01	461859N1201148.1	LENA PHILLIPS	H	701	41	0A	3	--	60	--	D	--	--
10N21E33C01	461855N1201155.1	LENA SOHAPPY	H	703	42	0A	5	--	--	--	D	--	--
10N21E34D01	461903N1201114.1	MOSE DICK	H	700	42	0A	--	--	10	--	D	--	--
10N21E34G01	461840N1201030.1	JAMES STRONG	H	691	--	0A	--	--	--	--	--	--	--
10N21E35C01	461855N1200936.1	B L WORNELL	U	682	16	0A	--	--	--	--	--	--	--
11N16E08K01	462709N1205046.1	UNKNOWN	U	1550	--	0A	12	4-71	--	--	--	--	--
11N16E09L01	462715N1204954.1	UNKNOWN	H	1510	76	0A	32	4-71	--	--	--	--	--
11N16E11P01	462702N1204726.1	UNKNOWN	H	1301	--	0A	41	4-71	--	--	--	--	--
11N16E14C01	462651N1204716.1	NORTHOVER	H	1280	100	0A	19	4-71	--	--	--	--	--
11N16E15A01	462651N1204804.1	FLORENCE OLNEY	H	1320	--	0A	32	4-71	--	--	--	--	--
11N16E15K01	462614N1204803.1	USGS	U	1285	--	EL	--	--	--	--	3Z	--	--
11N16E15K02	462614N1204803.2	USGS	U	1285	--	EL	--	--	--	--	3Z	--	--
11N16E15K03	462614N1204803.3	USGS	U	1285	--	EL	--	--	--	--	3Z	--	--
11N16E16P01	462608N1204950.1	UNKNOWN	H	1390	35	0A	13	4-71	--	--	--	--	--
11N16E17E01	462637N1205120.1	C DANIELS	H	1530	142	YA	--	--	--	--	D	--	--
11N16E17N01	462601N1205111.1	UNKNOWN	H	1478	45	0A	19	4-71	--	--	--	--	--
11N16E20F01	462546N1205101.1	UNKNOWN	H	1422	85	0A	9	4-71	--	--	--	--	--
11N16E20Q01	462518N1205040.1	UNKNOWN	H	1370	--	0A	--	--	--	--	--	--	--
11N16E21N01	462524N1205011.1	UNKNOWN	H	1360	--	0A	1 8	4-71	--	--	--	--	--
11N16E21Q01	462521N1204920.1	UNKNOWN	H	1318	--	0A	23	4-71	--	--	--	--	--
11N16E21Q02	462516N1204927.1	UNKNOWN	H	1318	--	0A	26	4-71	--	--	--	--	--
11N16E22R01	462548N1204808.1	UNKNOWN	H	1262	--	0A	--	--	--	--	--	--	--
11N16E22G01	462539N1204812.1	UNKNOWN	H	1270	--	0A	10	--	--	--	--	--	--
11N16E22M01	462534N1204858.1	LEONARD ARQUETT	H	1310	--	0A	27	4-71	--	--	--	--	--
11N16E23B01	462551N1204655.1	UNKNOWN	U	1180	--	0A	20	4-71	--	--	--	--	--
11N16E25G01	462446N1204532.1	BILL BLODGETT	I	1095	525	EL	180	4-71	550	149	D	--	--
11N16E25N01	462417N1204612.1	JIM HUBBARD	H	1100	72	0A	--	--	10	--	D	--	--

11N16E25P01	462418N1204611.1	JIM HUBBARD	H	1100	160	OA	49	4-71	--	--	--	--	--
11N16E25Q01	462430N1204550.1	WB PACE JR	I	1100	1100	YA	243	5-70	100	--	--	--	--
11N16E26R01	462418N1204644.1	HUBBARD	H	1170	159	OA	120	4-71	--	--	--	--	--
11N16E27B01	462507N1204817.1	JOS ADAMS	U	1260	135	OA	--	--	--	--	--	--	--
11N16E27B02	462508N1204818.1	JOS ADAMS	H	1260	168	OA	--	--	--	--	--	--	--
11N16E27C01	462502N1204828.1	UNKNOWN	U	1275	--	OA	75	4-71	--	--	--	--	--
11N16E28A01	462501N1204904.1	UNKNOWN	H	1285	--	OA	12	4-71	--	--	--	--	--
11N16E28F01	462445N1204940.1	UNKNOWN	U	1282	--	OA	4	4-71	--	--	--	--	--
11N16E28N01	462420N1205006.1	UNKNOWN	H	1262	41	OA	5	4-71	--	--	--	--	--
11N16E28P01	462419N1204948.1	UNKNOWN	H	1250	75	OA	9	4-71	--	--	--	--	--
11N16E28Q01	462425N1204906.1	A J CAREY	H	1255	--	OA	--	--	--	--	--	--	--
11N16E29K01	462434N1205049.1	UNKNOWN	H	1315	20	OA	7	4-71	--	--	--	--	--
11N16E34K01	462343N1204810.1	A A GOUDY JR	U	1190	85	OA	74	4-71	--	--	--	--	--
11N16E34K02	462338N1204803.1	ALBERT GOUDY	I	1190	457	YA	346	8-72	15	--	D	--	--
11N17E01A01	462829N1203757.1	ROBERT WILCOX	I	1137	1000	YA	209	3-61	1200	56	D	10	619
11N17E01F01	462811N1203822.1	MT ADAMS SEED	I	1138	1174	YA	112	5-62	695	81	D	7	1460
11N17E01Q01	462746N1203757.1	MARTIN WARVICK	H	983	180	EL	30	3-61	30	--	--	--	--
11N17E02L01	462800N1203931.1	BERT C DEKKER	I	1100	870	YA	147	4-64	1700	38	D	14	2600
11N17E03L01	462758N1204101.1	C&H STEPHENSON	I	1122	989	YA	194	2-62	1160	1	D	8	1770
11N17E09B01	462733N1204144.1	WALT GAUGL	I	1020	651	YA	87	3-56	1160	36	--	8	665
11N17E10C01	462644N1204337.1	C&H STEPHENSON	U	1020	380	EL	--	--	--	--	--	--	--
11N17E10Q01	462654N1204028.1	UNKNOWN	U	960	--	OA	38	10-71	--	--	--	--	--
11N17E14E01	462630N1204008.1	MAURICE DUFAULT	H	910	500	YA	7	--	--	--	--	--	--
11N17E14L01	462626N1203933.1	ARTHUR WINTERS	H	910	--	OA	--	--	--	--	--	--	--
11N17E16F01	462630N1204220.1	C&H STEPHENSON	I	960	1003	YA	16	12-54	1600	16	D	8	1120
11N17E16H01	462637N1204130.1	C&H STEPHENSON	I	923	765	YA	+13	4-70	20	63	D	8	--
11N17E17P01	462602N1204338.1	C&H STEPHENSON	I	1062	995	YA	162	12-63	3200	10	D	8	2400
11N17E18N01	462501N1204456.1	WILLIE PACE JR	I	1218	610	YA	275	5-58	650	24	D	--	--
11N17E19L01	462532N1204436.1	GARY LAWRENCE	H	1050	80	OA	27	4-71	--	--	--	--	--
11N17E20F01	462546N1204338.1	WILLIAM DYKE	I	1070	725	YA	195	3-67	1613	17	D	10	3020
11N17E21C01	462554N1204211.1	TIM ST HILAIRE	I	1009	670	YA	65	9-55	850	52	D	8	761
11N17E22L01	462534N1204104.1	UNKNOWN	H	922	160	OA	22	3-71	--	--	--	--	--
11N17E22R01	462511N1204023.1	VANCE KING	H	895	--	OA	--	--	--	--	--	--	--
11N17E23B01	462600N1203912.1	UNKNOWN	H	890	150	OA	18	3-71	--	--	--	--	--
11N17E23D01	462600N1203954.1	JIM HILL	U	898	--	OA	--	--	--	--	--	--	--
11N17E24A01	462558N1203747.1	WALTER LADD	H	885	65	OA	21	3-71	--	--	--	--	--
11N17E24D01	462600N1203953.1	CALIHAN	Z	878	--	OA	6	6-70	15	--	--	--	--
11N17E24P01	462510N1203820.1	HARRY KWAK	H	864	800	YA	3	--	--	--	--	--	--
11N17E26R01	462420N1203855.1	BILL BROWN	H	845	--	YA	F	3-71	--	--	--	--	--
11N17E27Q01	462424N1204029.1	NETTIE MOSES	H	871	110	OA	14	3-63	40	46	D	--	--
11N17E28D01	462506N1204223.1	ELWOOD HINMAN	I	970	700	YA	28	3-41	300	9	--	--	223
11N17E29K01	462434N1204312.1	PETE FUNK	H	980	--	OA	42	3-71	--	--	--	--	--
11N17E30Q01	462430N1204430.1	W B PACE JR	I	1020	903	YA	128	4-65	980	--	D	10	915
11N17E31L01	462335N1204434.1	MORRIS MILLER	H	990	75	OA	--	--	10	--	D	--	--
11N17E31M01	462339N1204509.1	BOISE CASCADE	N	1000	--	OA	6	6-70	--	--	--	--	--
11N17E31N01	462326N1204508.1	BOISE CASCADE	H	1001	60	OA	7	6-70	20	--	--	--	--
11N17E32L02	462339N1204323.1	MICHAEL LEWIS	H	942	215	EL	15	4-72	15	17	D	--	--
11N18E01B01	462838N1203041.1	AL HOPTOWIT	H	905	42	OA	--	--	30	--	D	--	--
11N18E02F01	462824N1203158.1	DON SAMPSON	H	928	93	OA	28	3-63	90	32	D	--	--
11N18E02F02	462824N1203200.1	DON SAMPSON	H	930	91	OA	28	9-63	90	32	D	--	--
11N18E03E01	462812N1203351.1	INEZ LUKE	H	930	75	OA	11	9-62	10	29	D	--	--
11N18E03K01	462800N1203312.1	HERB KING	S	915	600	EL	28	3-71	--	--	--	--	--
11N18E07N01	462654N1203728.1	DAN HOPTOWIT	H	902	75	OA	--	--	10	--	D	--	--
11N18E08J01	462712N1203508.1	MEL SAMPSON	H	900	--	OA	--	--	--	--	--	--	--
11N18E08P01	462655N1203546.1	REECE BROWN	H	910	--	OA	--	--	--	--	--	--	--

APPENDIX III.--Records of selected wells in the Toppenish Creek basin--Continued

LOCAL WELL NUMBER	LAT-LONG	OWNER	USE OF WATER	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	MAJOR AQUIFER	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	YIELD (GPM)	DRAW DOWN (FT)	LOG AVAIL-ABLE	Decline, 1971-73 (ft)	2-year pumpage, 1971-72 (acre-ft)
11N18E08R01	462655N1203512.1	NATIE CLEVELAND	H	880	83	OA	32	12-65	10	--	D	--	--
11N18E09N01	462656N1203455.1	MONTE SIEGNER	H	885	400	EL	--	--	--	--	--	--	--
11N18E09R01	462654N1203355.1	JOE SHIELDS	H	902	--	EL	--	--	--	--	--	--	--
11N18E10E01	462732N1203349.1	ESTHER SPEEDIS	H	900	75	OA	11	-62	10	18	D	--	--
11N18E11A01	462744N1203122.1	YAKIMA TRIBES	H	886	--	OA	--	--	--	--	--	--	--
11N18E12N01	462654N1203117.1	STANLEY BRULOTE	F	880	20	OA	13	5-70	500	--	--	--	--
11N18E12P01	462657N1203055.1	HENRY BEAVERT	H	875	44	OA	--	--	10	--	D	--	--
11N18E12P02	462656N1203059.1	WILLIAM MILLER	H	870	41	OA	--	--	10	--	D	--	--
11N18E13C01	462652N1203058.1	KEN GASSLING	I	835	28	OA	20	--	500	--	--	--	--
11N18E14E01	462736N1203351.1	ANNIE GUYETTE	H	883	52	OA	15	--	10	15	D	--	--
11N18E15N01	462602N1203347.1	ERVIN WEIJOHN	H	870	--	OA	--	--	--	--	--	--	--
11N18E16M01	462621N1203450.1	ROBERT BROWN	H	865	--	OA	--	--	--	--	--	--	--
11N18E17B01	462652N1203537.1	CONRAD HERT	H	880	625	EL	F	7-70	500	10	D	--	--
11N18E17D01	462651N1203604.1	VIRGINIA BUENO	H	885	68	OA	--	--	10	--	D	--	--
11N18E17D02	462651N1203621.1	USGS	U	880	84	OA	8	4-72	--	--	D	--	--
11N18E17H01	462637N1203508.1	RAY POIREIR	H	868	--	OA	--	--	--	--	--	--	--
11N18E17L01	462626N1203601.1	YAKIMA TRIBE	U	875	283	EL	F	5-70	--	--	--	--	--
11N18E18E02	462638N1203736.1	UNKNOWN	U	895	260	EL	11	8-71	--	--	--	--	--
11N18E19R01	462509N1203623.1	MARVIN LAWRENCE	H	865	580	EL	F	--	--	--	--	--	--
11N18E20D01	462554N1203621.1	W SCHILPEROORT	H	860	--	OA	--	--	--	--	--	--	--
11N18E20E01	462536N1203616.1	BETTY CHRISTEN	H	862	190	OA	--	--	--	--	--	--	--
11N18E20Q01	462510N1203529.1	ALBERT WEGGE	H	850	--	--	F	-63	--	--	--	--	--
11N18E21F01	462536N1203502.1	RALPH SAMPSON	H	851	65	OA	--	--	10	--	D	--	--
11N18E22R01	462510N1203236.1	BRONCHEAU	H	840	49	OA	14	--	15	16	D	--	--
11N18E24D01	462600N1203104.1	FIRE DISTRICT 5	F	860	22	OA	14	8-71	500	--	--	--	--
11N18E24J01	462534N1203010.1	BENNETT OLSEN	H	849	32	OA	--	--	--	--	--	--	--
11N18E26L01	462442N1203214.1	SARAH CARLSON	H	835	52	OA	12	-65	10	--	D	--	--
11N18E26N01	462426N1203234.1	HARRAH SCHOOL	F	830	24	OA	13	5-70	500	--	--	--	--
11N18E26N02	462426N1203228.1	HARRAH SCHOOL	F	830	24	OA	13	5-70	500	--	--	--	--
11N18E26N03	462421N1203234.1	HARRAH SCHOOL	F	830	20	OA	10	--	500	--	--	--	--
11N18E26Q01	462418N1203152.1	RICHARD FINLEY	H	828	50	OA	--	--	10	--	D	--	--
11N18E28H01	462444N1203351.1	TED PHILLIPS	H	831	51	OA	--	--	10	--	D	--	--
11N18E29D02	462507N1203603.1	MARVIN LAWRENCE	H	852	90	OA	7	3-71	--	--	--	--	--
11N18E29P01	462417N1203600.1	BENNY QUAEMPTS	H	852	70	OA	--	--	10	--	D	--	--
11N18E30H01	462447N1203637.1	DICK BOISSELLE	H	855	544	EL	F	5-71	--	--	--	--	--
11N18E30J01	462433N1203624.1	ELMER BOISSELLE	H	855	--	OA	--	--	--	--	--	--	--
11N18E30Q01	462421N1203641.1	MAURICE ROWE	H	850	--	EL	F	-63	300	--	--	--	--
11N18E32D01	462407N1203630.1	USGS	U	840	45	OA	--	--	8	--	--	--	--
11N18E33D01	462413N1203454.1	GEORGE HENRY	H	810	54	OA	25	-63	12	--	--	--	--
11N18E33N01	462325N1203456.1	UNKNOWN	H	830	56	OA	16	5-71	--	--	--	--	--
11N18E34B01	462415N1203254.1	UNKNOWN	I	825	17	OA	9	7-71	--	--	--	--	--
11N18E34J01	462342N1203238.1	RICK KNIGHT	H	823	--	OA	--	--	--	--	--	--	--
11N18E34P01	462328N1203314.1	CHAS ST MARX	I	812	512	EL	--	--	--	--	D	--	--
11N18E35D01	462411N1203235.1	FIRE DISTRICT 5	F	830	16	OA	15	5-70	500	--	--	--	--
11N18E35N01	462327N1203233.1	EVA HAWK	H	817	64	OA	17	4-67	10	--	--	--	--
11N18E36D01	462411N1203107.1	MAURICE PEUGH	I	825	--	OA	9	8-71	450	--	--	--	--
11N18E36E01	462358N1203107.1	MAURICE PEUGH	I	824	--	OA	--	--	450	--	--	--	--
11N18E36J01	462340N1203021.1	ED BACHMIER	H	820	19	OA	--	--	320	--	--	--	--
11N18E36M01	462347N1203107.1	MAURICE PEUGH	I	822	--	OA	--	--	600	--	--	--	--
11N18E36N01	462334N1203107.1	MAURICE PEUGH	I	819	--	OA	--	--	600	--	D	--	--
11N19E02L02	462758N1202438.1	CELIA U JOHNSON	H	861	43	OA	12	5-62	15	--	D	--	--
11N19E03J01	462803N1202507.1	JOHNSON	U	869	22	OA	8	7-71	--	--	--	--	--
11N19E04D01	462837N1202725.1	CASSIE COLWASH	H	895	43	OA	23	3-63	15	35	D	--	--
11N19E04H01	462823N1202620.1	NINA WOODS	H	878	42	OA	8	7-62	10	11	D	--	--
11N19E05G01	462822N1202751.1	HUDON	I	895	20	OA	9	8-71	--	--	--	--	--

11N19E05H01	462823N1202732.1	C K VILLNIANN	I	890	20	0A	--	--	200	--	--	--	--
11N19E05M02	462800N1202840.1	UNKNOWN	H	892	--	0A	11	8-71	--	--	--	--	--
11N19E06F01	462822N1202936.1	DICK COWIN	H	894	50	0A	--	--	--	--	--	--	--
11N19E07L01	462713N1202928.1	C L & FRANK	I	877	22	0A	8	7-71	450	--	--	--	--
11N19E07M01	462714N1202945.1	L C & FRANK	I	877	25	0A	--	--	450	--	D	--	--
11N19E07N01	462703N1202958.1	L C & FRANK	I	875	23	0A	4	--	400	--	--	--	--
11N19E08N01	462655N1202838.1	CLARENCE TAHKEL	H	874	51	0A	--	--	10	--	D	--	--
11N19E08R01	462655N1202733.1	CALHOUN	C	868	49	0A	--	--	--	--	D	--	--
11N19E09K03	462614N1202641.1	JOHN SMARTLOWIT	H	867	50	0A	--	--	10	--	--	--	--
11N19E09R01	462611N1202858.1	JOHN EYLE	H	864	49	0A	--	--	10	--	D	--	--
11N19E10A01	462737N1202502.1	YAKIMA TRIBE	P	860	700	EL	32	7-69	1520	105	D	--	--
11N19E10B01	462738N1202526.1	YAKIMA TRIBE	P	860	765	EL	57	9-69	1266	188	D	--	--
11N19E10H01	462731N1202459.1	ROBERT JIM	H	859	41	0A	--	--	10	--	--	--	--
11N19E10Q01	462703N1202523.1	WAPATO CITY	P	860	765	EL	30	1-65	650	72	D	--	--
11N19E10Q02	462705N1202524.1	WAPATO CITY	P	860	750	EL	30	1-65	1000	95	D	--	--
11N19E11F01	462721N1202424.1	WALLY SEELAM	H	853	42	0A	--	--	10	--	D	--	--
11N19E13B02	462651N1202244.1	WILLIAM MILLER	H	831	50	0A	6	7-71	--	--	--	--	--
11N19E13K01	462614N1202256.1	HOWARD WAHPAT	H	825	43	0A	14	--	10	--	D	--	--
11N19E14D01	462652N1202442.1	CAROLINE STRONG	H	852	43	0A	--	--	10	--	D	--	--
11N19E15A01	462648N1202502.1	WAPATO CITY	U	850	975	EL	--	--	300	--	D	--	--
11N19E15A02	462648N1202502.2	WAPATO CITY	U	850	--	EL	--	--	714	30	--	--	--
11N19E15E01	462634N1202603.1	BEAVERT	H	854	50	0A	--	--	10	--	D	--	--
11N19E16A02	462652N1202614.1	MINNIE ANDREWS	H	857	52	0A	--	--	10	--	D	--	--
11N19E16J01	462614N1202621.1	WILLIAM CLAYTON	I	850	52	0A	--	--	--	--	--	--	--
11N19E16R02	462604N1202614.1	CLYDE CALAHAN	I	852	15	0A	--	--	200	--	--	--	--
11N19E17R01	462614N1202736.1	WESLEY CALAHAN	I	860	--	0A	--	--	600	--	--	--	--
11N19E18P01	462607N1202854.1	JOHN GROSZHANS	I	856	19	0A	9	9-72	--	--	--	--	--
11N19E19R01	462510N1202857.1	SAM NISHI	H	840	26	0A	--	--	--	--	--	--	--
11N19E20Q01	462518N1202748.1	ROY HOWARD	H	843	50	0A	18	--	11	17	D	--	--
11N19E21Q02	462511N1202650.1	LORENE SOHAPPY	H	840	59	0A	17	2-66	10	18	D	--	--
11N19E22A04	462511N1202858.1	JAMES SHIKE	H	837	51	0A	--	--	10	--	D	--	--
11N19E22J01	462533N1202500.1	DORIS SIMPSON	H	832	48	0A	--	--	10	--	D	--	--
11N19E23Q01	462509N1202404.1	EDNA SCONAWAH	H	822	51	0A	--	--	10	--	--	--	--
11N19E24F01	462535N1202322.1	UNKNOWN	H	821	--	0A	--	--	--	--	--	--	--
11N19E24R01	462509N1202229.1	DUANE CLARK	H	808	41	0A	16	--	10	--	D	--	--
11N19E26A01	462507N1202347.1	BEN OUGH	H	818	46	0A	--	--	15	--	D	--	--
11N19E26C01	462506N1202436.1	SUSAN SMATTIE	H	826	50	0A	--	--	10	--	D	--	--
11N19E27D02	462508N1202556.1	CALVIN CHARLEY	H	833	50	0A	--	--	--	--	--	--	--
11N19E27H01	462447N1202505.1	ALLEN JAY	H	822	35	0A	--	--	--	--	--	--	--
11N19E28B01	462504N1202641.1	WILFRED YALLUP	H	838	51	0A	16	--	10	19	D	--	--
11N19E28B02	462507N1202636.1	JULIA SOHAPPY	H	838	51	0A	24	4-72	12	3	D	--	--
11N19E28J02	462442N1202616.1	BOB BEAM	H	828	22	0A	--	--	--	--	--	--	--
11N19E29Q01	462426N1202759.1	N HERNANDEZ	H	833	120	0A	--	--	--	--	--	--	--
11N19E30D01	462508N1202952.1	FAIRBANKS DOUG	I	840	8	0A	--	--	500	--	--	--	--
11N19E30J01	462437N1202848.1	EP GAILAN	H	835	32	0A	--	--	--	--	--	--	--
11N19E30N01	462419N1202945.1	INDIAN RANCHES	C	830	69	0A	9	11-69	850	32	--	--	--
11N19E30P01	462419N1202939.1	BF CLARK	H	828	38	0A	--	--	--	--	--	--	--
11N19E31M01	462348N1203001.1	JOHN WINTERS	H	820	40	0A	--	--	--	--	--	--	--
11N19E32M01	462345N1202834.1	L RIPLEY	H	822	62	0A	14	4-67	11	14	--	--	--
11N19E32R01	462334N1202732.1	JULIA SETTLER	H	815	60	0A	10	4-67	10	12	--	--	--
11N19E33D01	462416N1202724.1	LF ZWIESLER CO	H	830	27	0A	--	--	--	--	--	--	--
11N19E34D01	462413N1202600.1	CLARENCE KAHAMA	H	820	65	0A	10	5-67	10	--	D	--	--
11N19E34M01	462348N1202611.1	PEDRO BATIN	H	818	64	0A	16	4-67	11	31	--	--	--
11N19E34P01	462328N1202459.1	HENRY TAHKEAL	H	805	57	0A	18	4-67	10	13	D	--	--
11N19E35A01	462413N1202347.1	ELTON KRUEGER	H	810	12	0A	--	--	300	--	--	--	--

APPENDIX III.--Records of selected wells in the Toppenish Creek basin--Continued

LOCAL WELL NUMBER	LAT-LONG	OWNER	USE OF WATER	ALTI-TUDE- OF LSD (FT)	WELL DEPTH (FT)	MAJOR AQUIFER	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	YIELD (GPM)	DRAW DOWN (FT)	LOG AVAIL-ABLE	Decline, 1971-73 (ft)	2-year pumpage, 1971-72 (acre-ft)
11N19E35G01	462402N1202420.1	ALVIN PINKHAM	H	812	61	OA	19	3-67	10	--	D	--	--
11N19E35N01	462327N1202443.1	DAVE GREER	H	802	100	OA	--	--	--	--	--	--	--
11N19E36Q01	462326N1202304.1	EVERYBODY SAM	H	790	56	OA	13	1-67	10	1	D	--	--
11N19F36Q02	462326N1202256.1	IDA WHITE	H	790	60	OA	14	1-67	10	--	--	--	--
11N20E07H01	462719N1202133.1	SNO KIST	N	831	165	OA	9	3-71	--	--	--	--	--
11N20E19D01	462558N1202222.1	BILL ROOT	U	812	39	OA	11	--	10	--	D	--	--
11N20E19L01	462523N1202209.1	CELIA P JOHNSON	H	810	41	OA	12	--	10	--	D	--	--
11N20E27C01	462500N1201810.1	FRANK RICHES	H	775	125	OA	--	--	--	--	--	--	--
11N20E27D01	462506N1201839.1	WINKLER	I	775	582	EL	--	--	--	--	--	--	--
11N20E28R01	462417N1201902.1	MARY SCOTT	H	780	47	OA	--	--	15	--	D	--	--
11N20E31D01	462414N1202225.1	RAMONA JAMES	H	790	51	OA	13	12-65	10	7	D	--	--
11N20E31E01	462358N1202225.1	MELVIN MILLER	H	790	50	OA	14	12-65	10	4	D	--	--
11N20E32H01	462356N1202016.1	ROWE	H	780	--	OA	11	4-71	--	--	--	--	--
11N20E32N01	462335N1201949.1	SADIE LONG	H	780	49	OA	12	1-66	10	9	D	--	--
11N20E33J01	462339N1201853.1	U&I SUGAR CO	N	767	225	OA	--	--	1200	--	--	--	--
11N20E33J02	462348N1201856.1	U&I SUGAR CO	N	767	262	OA	--	--	1650	--	--	--	--
11N20E33N03	462325N1201949.1	VICTOR LADDROUT	H	770	50	OA	13	2-66	10	13	D	--	--
11N20E34E01	462349N1201845.1	U&I SUGAR CO	N	767	260	OA	--	--	2300	--	--	--	--
11N20E36B01	462412N1201529.1	TOWN OF ZILLAH	P	950	281	OA	113	3-71	--	--	--	--	--
12N18E25M01	462954N1203118.1	HELEN WINKELMAN	I	1030	303	EL	95	5-62	60	--	--	--	--
12N18E27G01	463007N1203311.1	HANSEN FRUIT	I	1145	1000	YA	--	--	--	--	D	6	2320
12N18E27H01	463008N1203237.1	HANSEN FRUIT	I	1120	1020	YA	230	3-68	2100	310	D	4	1220
12N18E27N01	462935N1203342.2	DENNIS CAFFREY	I	1135	600	YA	220	2-56	400	78	D	1	489
12N18E27P01	462933N1203238.1	HANSEN FRUIT	I	1052	1109	YA	157	10-57	850	66	D	--	--
12N18E31R01	462842N1203635.1	RAY ST CLAIR	I	1105	1573	YA	209	4-65	1100	244	D	6	1170
12N18E32H01	462907N1203511.1	MT ADAMS SEED	I	1130	1176	YA	216	2-65	695	81	D	12	1460
12N18E32L01	462854N1203554.1	RAY ST CLAIR	I	1058	1252	YA	158	4-64	220	119	D	8	--
12N18E33A01	462930N1203355.1	HERBERT NYBERG	I	1185	953	OA	210	4-69	1400	126	D	--	252
12N18F33B01	462929N1203411.1	MT ADAMS SEED	I	1143	1091	YA	264	1-68	1180	67	D	8	--
12N18E35H01	462909N1203120.1	DON PATTERSON	H	952	141	OA	--	--	--	--	--	--	--
12N19E29B01	463016N1202757.1	NO PAC RR	U	923	25	OA	--	--	--	--	--	--	--
12N19E29E01	462958N1202838.1	ALBA SHAWAWAY	H	920	73	OA	18	4-63	40	2	D	--	--
12N19E29K01	462955N1202749.1	MARLEY ORCHARDS	H	918	305	EL	18	3-71	--	--	--	--	--
12N19E32C01	462930N1202808.1	CECIL JAMES	H	912	160	EL	20	3-63	40	010	D	--	--
12N19E32C02	462929N1202823.1	JIMMY ANDERSON	H	912	160	EL	20	3-63	40	10	D	--	--
12N19E32M01	462901N1202842.1	FRED HOPTOWIT	H	907	42	OA	8	7-62	10	2	D	--	--
12N19E32N01	462841N1202844.1	RICHARD HOWARD	H	913	42	OA	--	--	30	--	D	--	--
12N19F33K01	462900N1202642.1	HELEN JIM	H	890	42	OA	8	5-62	10	9	D	--	--
12N19E35D01	462921N1202454.1	GLEN RASMUSSEN	I	880	141	OA	16	3-71	--	--	--	--	--

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin

Material	Thickness (feet)	Depth (feet)
10/16-10N1. W. B. Pace, Jr. Drilled by Bill Ludwig, 1953; deepened by Henry Bach, 1961.		
Soft drilling, water at 34 and 80 ft	242	242
Rock, water at 275 and 340 ft	100	342
Rock, honeycombed	23	365
Rock, hard	95	460
Rock, broken, water	15	475
Rock, hard	4	479
Basalt, solid, black	46	525
Rock, broken, black	5	530
Rock, solid, black	30	560
Crevice, large	7	567
10/16-19G1. Fort Simcoe Job Corps. Drilled by Ralph Cassell, 1966.		
Boulders	23	23
Gravel, cemented, some boulders (10 gal/min)	11	34
Basalt, broken	16	50
Clay, some rock	15	65
Basalt, black, water on top	10	75
Basalt, hard, black	5	80
Basalt, hard, gray	25	105
Basalt, gray	6	111
Basalt, hard, gray	14	125
Basalt, gray	7	132
Basalt, hard, gray	13	145
Basalt, gray	7	152
Basalt, black	7	159
Basalt, hard, black	3	162
Basalt, gray	18	180
No log	245	425

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
10/16-23D1. Carol Lawrence. Drilled by Henry Bach, 1963.		
Soil	1	1
Gravel and boulders	41	42
Rock, black	9	51
Rock, broken, and yellow clay	33	84
Basalt	47	131
10/17-6D1. Boise Cascade Co. Drilled by John Riebe, 1969.		
Soil, silty, swampy (brackish water)	18	18
Rock, decomposed, and boulders; some water	167	185
Gravel, cemented, and boulders	7	192
Clay, hard, brown, and boulders	31	223
Basalt, broken, with sand, gravel and clay (water)	6	229
Rock, decomposed, cemented gravel, clay and boulders	13	242
10/17-17L2. Yakima Indian Mission. Drilled by Ludwig and Oltman, 1961.		
Soil	15	15
Boulders	13	28
Clay,and loose rock	2	30
Boulders	5	35
Clay,and loose rock	10	45
Rock and clay	35	80
Clay, muddy	10	90
Rock, broken, some water	10	100
Clay, gravel, and boulders	35	135
Clay, and broken rock	45	180
Clay, soft, and rock	10	190
Boulders and gravel, water-bearing	10	200
Shale, soft	10	210
Shale, blue	30	240
Shale, hard, and broken rock	6	246
Clay, sticky, blue	12	258
Boulders and gravel	2	260

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thick- ness (feet)	Depth (feet)
10/17-17L2.--Continued		
Shale, gray	15	275
Boulders and gravel, and a little sand and water	7	282
Shale and rock, broken	5	287
Rock, soft	3	290
Rock, hard	7	297
Rock, water-bearing	10	307
Rock, hard	3	310
10/17-23L1. B. C. Dekker. Drilled in 1962.		
Dirt	13	13
Unrecorded material; water at 75 ft	--	75
Clay and rock	79	92
Clay, blue	32	124
Clay, brown, and gravel; water-bearing	21	145
Clay and rocks	30	175
Clay, hard	33	208
Clay, sticky, blue	116	324
Basalt	72	396
Sandstone, loose sand; water-bearing	60	456
No log	244	700
10/17-35B1. N. Shellenberger. Drilled by Ralph Cassell, 1958.		
Soil	4	4
Gravel, cemented, some water	76	80
Clay, sandy	13	93
Clay	32	125
Gravel cement	35	160
Clay	69	229
Shale, blue	11	240
Basalt	35	275
Shale, green	6	281
Basalt	204	485

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
10/17-35B1.--Continued		
Basalt, seamed, with clay	20	505
Basalt	135	640
Basalt, broken	35	675
Basalt, porous	18	693
Basalt, broken	12	705
10/18-25D1. U.S. Geological Survey. Drilled by U.S. Geological Survey, 1972.		
Loam, silty, clayey, brown	2	2
Clay, silty, grayish-brown	12	14
Cobbles in matrix of silty clay	3	17
Clay, silty, and cobbles	13	30
Cobbles, cemented in places	32	62
10/19-11H1. R. Comenout. Drilled by Henry Bach, 1967.		
Soil	2	2
Sand, gravel	33	35
Sand, packed, and yellow clay	30	65
Sand, and gravel	2	67
10/19-17H1. Marie Olney. Drilled by Henry Bach, 1967.		
Soil	4	4
Sand and gravel	35	39
Sand, hard-packed	15	54
Sand, silty, fine	17	71
Sand, coarse	4	75

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thick-ness (feet)	Depth (feet)
10/19-30R1. Viola O'Neil. Drilled by N. C. Jannesen Co,		
Soil	4	4
Hardpan	26	30
Gravel	25	55
Shale, soft	195	250
Soapstone, yellow	20	270
Clay, yellow	10	280
Sandstone, gray	25	305
Gravel	30	335
Shale, blue	60	395
Shale, soft	80	475
Sandstone	10	485
Shale, soft	20	505
Shale, gray	15	520
Sandstone	5	525
Gravel	10	535
Sand	20	555
Shale, brown	4	559
Shale, soft	16	575
Sandstone, dark	15	590
Shale, blue	12	602
Shale, brown	3	605
Shale, blue	35	640
Sandstone	25	665
Shale, and fine sand	20	685
Sandstone, lime sealer	30	715
10/20-3M2. City of Toppenish. Drilled by A. A. Durand, 1946.		
Soil	2	2
Gravel	40	42
Gravel and clay	5	47
Gravel, coarse	5	52
Gravel and clay	5	57
Gravel	7	64
Gravel and clay	27	91
Gravel, and sandy clay	20	111

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thick-ness (feet)	Depth (feet)
10/20-3M2.--Continued		
Gravel, coarse	5	116
Gravel, and sandy clay	21	137
Gravel and sand	7	144
Gravel, and sandy clay	9	153
Gravel, coarse	7	160
Boulders and clay	60	220
Clay, sandy	35	255
Clay	5	260
Sand, hard, and sandstone	25	285
Clay, pink	5	290
Clay, and small boulders	12	302
Gravel, cemented, and boulders	39	341
Sand, clay, and gravel	116	457
Gravel and clay	3	460
Gravel, and firm sand	5	465
Sand, firm	5	470
Clay, yellow	35	505
Sand and gravel	12	517
Gravel, cemented, hard, and sand	13	530
Gravel, and firm sand	15	545
Gravel, cemented, hard, and sand	5	550
Clay, yellow	13	563
Sand, firm, and some clay	24	587
Sand, hard, with gravel and clay	20	607
Sand and gravel	3	610
Clay, yellow	10	620
Clay, blue, with some rock	10	630
Sand, firm, and a little clay	80	710
Clay, blue	30	740
Sand, firm, and gravel	2	742
Clay, blue	3	745
Clay, blue, and gravel	30	775
Gravel, and fine sand	1	776
Sand, gray	6	782
Sand and gravel	18	800

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thick-ness (feet)	Depth (feet)
11/16-25G1. Bill Blodgett. Drilled by Henry Bach, 1971.		
Soil	5	5
Gravel, cemented	130	135
Clay, sticky, gray	43	178
Sand and rock, water-bearing	12	190
Clay, hard, and sand	70	260
Sand and rock, water-bearing	18	278
Clay, soft, yellow	24	302
Clay, brown	18	320
Clay, sticky, yellow	40	360
Clay, brown	40	400
Clay, hard, green	10	410
Sand, coarse, brown	5	415
Sand, coarse, green	103	518
Basalt	7	525
11/17-1F1. Mt. Adams Seed Ranch, Inc. Drilled by Henry Bach, 1962.		
Soil	14	14
Gravel, small	2	16
Rock, and sand	23	39
Clay, yellow	71	110
Rock, and sand	35	145
Rock, and gray sand	43	188
Rock, and blue sand	136	324
Clay, sticky, blue	8	332
Rock, and blue sand	125	457
Rock and sand, very hard	27	484
Clay, blue, and hard sand	5	489
Rock and sand, very hard	12	501
Sand and clay, blue	16	517
Clay, sandy, sticky, blue	10	527
Sand, heaving	28	555
Clay, blue	48	603
Basalt, gray	56	659
Basalt, black	100	759
Basalt, black (creviced)	5	764

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
11/17-1F1.--Continued		
Basalt, hard, black	107	871
Basalt, black (creviced)	4	875
Basalt, black	6	881
Basalt, black (creviced)	6	887
Rock, black	5	892
Rock, black (creviced)	10	902
Rock, black	84	986
Basalt, black	76	1,062
Basalt, broken, black	45	1,107
Shale, sandy, broken	8	1,115
Basalt, broken, black	29	1,144
Basalt, hard, black	1	1,145
Basalt, broken, black	29	1,174
11/17-17P1. C. and H. Stephenson. Drilled by Henry Bach, 1963.		
Topsoil and small gravel	18	18
Gravel	2	20
Clay, brown	28	48
Gravel, cemented	23	71
Clay and sandstone	43	114
Gravel, water-bearing	2	116
Clay and sandstone	43	159
Clay, brown	28	187
Clay, sandy	14	201
Clay, sticky, green	15	216
Clay, gray	8	224
Clay, brown	14	238
Clay, green	19	257
Clay, brown	8	265
Clay, gray	7	272
Clay, green	34	306
Clay, brown	3	309
Clay, sandy, green	18	327
Sand	4	331
Basalt, black	12	343
Basalt, broken, black	39	382
Basalt, brown	4	386

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
11/17-17P1.--Continued		
Basalt, black	16	402
Basalt, broken, black, water-bearing	32	434
Basalt, broken, caving, black	139	573
Basalt, black	91	664
Basalt, broken, black	26	690
Basalt, black	9	699
Basalt, caving, black	12	711
Clay, green and gray	84	795
Basalt, black	12	807
Basalt, honeycombed, black	188	995
11/17-32L2. Michael Lewis. Drilled by C. Bach, 1972.		
Soil	15	15
Hardpan	5	20
Clay, sandy	11	31
Hardpan, sandy, green	7	38
Hardpan, brown	7	45
Clay, and gravel	5	50
Hardpan, brown	22	72
Sand, coarse (4 gal/min)	2	74
Clay, sandy	6	80
Clay, brown	45	125
Clay, red (29 gal/min at 135 ft)	30	155
Clay, sandy	30	185
Clay, hard, sandy, water-bearing	10	195
Clay, red	20	215

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
11/18-17B1. Conrad Hert. Drilled in 1930.		
Dirt	30	30
Sand, dirty	30	60
Clay, rocky	25	85
Clay, sandy	80	165
Rock, broken, and clay	65	230
Clay, tough, gray	35	265
Soapstone, brown	8	273
Sandstone, brown	33	306
Clay, sandy, brown	30	336
Sandstone, gray	34	370
Clay, sticky, blue	25	395
Sandstone, blue	29	424
Sand, loose	5	429
Clay, sandy, and shale	96	525
Clay, sticky, brown	20	545
Sandstone, coarse	20	565
Shale, and clay with sand streaks	60	625
11/18-34P1. C. P. St. Marx.		
Soil	3	3
Gravel, coarse	123	126
Boulders	6	132
Clay	4	136
Sandstone	15	151
Boulders and clay	14	165
Sandstone	90	255
Sand	4	259
Clay	50	309
Clay and sand	43	352
Sand	5	357
Shale, soft, loose	50	407
Clay, yellow	15	422
Shale, blue	40	462
Sandstone, hard	6	468
Gravel	9	477
Shale	15	492
Sand, some water	5	497

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thick-ness (feet)	Depth (feet)
11/18-34P1.--Continued		
Sand and rock	6	503
Sand, more water	4	507
Sand and rock, heavy flow of water	5	512
11/19-10B1. Yakima Tribe. Drilled by Smith & Son, 1969.		
Sand, compact, and gravel with cobbles	5	5
Sand, cemented, and gravel with cobbles	10	15
Boulders	15	30
Sand, and gravel, with cemented layers	20	50
Gravel, cemented	45	95
Gravel, cemented, and silt	25	120
Sand, cemented, and gravel	40	160
Sand, compact, with gravel and clay	5	165
Silt binder	5	170
Sand, cemented, and gravel	70	240
Sand, and gravel, with clay binder	75	315
Sand, gravel, and clay	5	320
Sand, and gravel, with clay binder	90	410
Clay, sticky, brown	5	415
Sand and gravel	5	420
Sand, and gravel, with clay binder	65	485
Clay, sticky, brown, and sand and gravel	20	505
Clay, blue	43	548
Clay, brown, and gravel	7	555
Sand, coarse, brown, water-bearing	30	585
Sand, fine, and gravel	15	600
Gravel, cemented	10	610
Sand, fine, with bits of shale or clay	45	655
Sand, fine, and pea gravel and yellow clay, water-bearing	40	695
Clay, blue, and shale, with sand seams	10	705
Sand, and gravel, water-bearing	45	750
Shale, and clay	15	765

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
11/19-15A1. City of Wapato. Drilled by N. C. Jannesen Co., 1946.		
Gravel	36	36
Gravel, coarse	13	49
Gravel, cemented	16	65
Sand	2	67
Gravel, cemented	102	169
Gravel, and loose boulders, water-bearing	12	181
Gravel, boulders, and clay	28	209
Clay and boulders	36	245
Gravel, clay, and boulders	18	263
Clay and boulders	23	286
Gravel, cemented	86	372
Clay, yellow	5	377
Gravel, cemented	48	425
Clay and gravel	8	433
Gravel, cemented	13	446
Clay, sticky	6	452
Gravel, cemented	38	490
Clay, sticky	35	525
Clay, sticky, yellow	15	540
Clay, sandy	15	555
Clay, sticky	4	559
Sand, loose	15	574
Sand, brown, and gravel	20	594
Sand, brown	17	611
Clay, yellow	11	622
Clay, blue	34	656
Sand, blue, water-bearing	49	705
Shale, sandy, hard, blue	125	830
Shale, sticky, blue	137	967
Shale, hard, blue	6	973
Sand, loose, gray	2	975

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
11/19-21Q2. Lorene Sohappy. Drilled by Henry Bach, 1966.		
Gravel	20	20
Sand, fine	34	54
Sand, coarse, and gravel	5	59
12/18-27H1. Hansen Fruit Co. Drilled by Dilley Drilling Co., 1968.		
Soil	8	8
Gravel	10	18
Rock and sand	47	65
Clay, sandy, yellow	7	72
Rock and sand	43	115
Clay, sandy, brown	20	135
Rock and sand	20	155
Clay, sandy, brown	20	175
Rock and sand	15	190
Clay, brown	20	210
Clay, sandy, brown	10	220
Shale, blue and brown	13	233
Clay, sandy, brown	12	245
Rock and sand, brown, water-bearing	8	253
Clay, sandy, brown	21	274
Clay, blue, with shale	6	280
Clay, sandy, blue	15	295
Rock and sand, blue, water-bearing	27	322
Sand, heaving, blue	8	330
Clay, sandy, blue	24	354
Clay, blue	21	375
Basalt, black	189	564
Basalt, gray	11	575
Basalt, black	2	577
Basalt, black, and green shale; caving	5	582
Basalt, black	5	587
Basalt, porous, black	3	590
Basalt, black	34	624
Basalt, broken, black, with clay in cracks	16	640
Basalt, black	110	750

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thick-ness (feet)	Depth (feet)
12/18-27H1.--Continued		
Basalt, black, with cracks	3	753
Basalt, black	57	810
Basalt, black, with crack	3	813
Clay	13	826
Basalt, black	25	851
Clay, blue,and black basalt	5	856
Basalt, black	25	881
Basalt, black, water-bearing	14	895
Basalt, black	1	896
Basalt, black, few cuttings, water-bearing	9	905
Basalt, black	33	938
Basalt, gray	4	942
Basalt, black	5	947
Few cuttings, water clear	11	958
Basalt, black	25	983
Basalt, black, no cuttings	7	990
Basalt, black, with cracks	1	991
Basalt, black	10	1,001
No cuttings, water clear	17	1,018
Basalt, black	2	1,020
12/18-32L1. Ray St. Clair. Drilled by Ralph Cassel, 1964.		
Topsoil	20	20
Sand, clay, and yellow shale	65	85
Clay, blue	15	100
Sandstone, and gravel, cemented	60	160
Rock and gravel, cemented	30	190
Clay, blue, with gravel	15	205
Clay, blue	10	215
Clay, blue, with sand	10	225
Sand, compacted	15	240
Clay, blue	10	250
Shale, hard, with gravel	15	265
Clay, green, with shale	70	335
Shale, hard, with gravel	5	340
Clay, green, with shale	45	385

(continued)

APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
12/18-32L1.--Continued		
Shale, sticky, hard, green	25	410
Shale, blue, with gravel	20	430
Clay, blue, with gravel and shale streaks	40	470
Shale, sticky, hard, green	25	495
Clay, green, and sticky hard shale	15	510
Clay, sticky, green	2	512
Sand, runny	8	520
Clay, green	5	525
Sandstone and sand formation	31	556
Sand	19	575
Shale, green, and clay	25	600
Shale, sticky, hard, green	8	608
Sand, green	10	618
Clay, green, and sticky shale	22	640
Basalt, broken, with clay in cracks	2	642
Basalt	8	650
Basalt, gray	30	680
Basalt, broken, black, and clay	22	702
Basalt, broken	13	715
Shale, and basalt, deteriorated	15	730
Basalt, broken	11	741
Basalt, broken, deteriorated	19	760
Basalt, broken, deteriorated, and clay	22	782
Basalt	40	822
Basalt, gray	20	842
Basalt, gray, with crack	2	844
Basalt, solid, gray	14	858
Basalt, dark gray	10	868
Basalt, solid, gray	25	893
Basalt, gray	22	915
Basalt, black	20	935
Basalt, gray	75	1,010
Basalt, gray and black	8	1,018
Basalt, black	27	1,045
Basalt, broken, gray	45	1,090
Basalt, honeycombed, broken, black	12	1,102
Basalt, broken, black	20	1,122
Basalt, hard, gray	23	1,145
Basalt, black	2	1,147

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APPENDIX IV.--Logs of selected wells in the Toppenish Creek basin--Continued

Material	Thickness (feet)	Depth (feet)
12/18-32L1.--Continued		
Basalt, deteriorated, with clay in cracks----------	9	1,156
Basalt, deteriorated, and clay--------------------	2	1,158
Basalt, broken, blocky with clay in cracks---------	7	1,165
Basalt, gray---------------------------------------	9	1,174
Basalt, coarse, and gray---------------------------	12	1,186
Basalt, greenish-black, and green mud--------------	20	1,206
Basalt, gray, and green mud------------------------	8	1,214
Basalt, broken, black, and clay--------------------	26	1,240
Basalt, solid, black-------------------------------	12	1,252
12/19-32C1. Cecil James. Drilled by J. C. Riebe, 1963.		
Soil, rocky--	5	5
Sand, gravel, and boulders-------------------------	21	26
Hardpan, and boulders------------------------------	9	35
Clay, rotten, and yellow granular clay shale--------	93	128
Sand, brown--	2	130
Clay, granular, yellow-----------------------------	23	153
Clay, dark gray, and sand--------------------------	7	160