UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WATER SUPPLY FOR A FISH-HATCHERY SITE, CLEARWATER VALLEY, IDAHO

By

M. J. Mundorff and W. I. Travis

Prepared in cooperation with the
U.S. Bureau of Sport Fisheries and Wildlife

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ABSTRACT

A fish hatchery proposed for the lower Clearwater River basin would require a continuous water supply of 10 to 12 cubic feet per second. Limitations on maximum and minimum temperatures and on turbidity are such that a combination surface- and ground-water supply probably would be required.

Six prospective sites were examined with respect to their water supply. The sites were at the mouths of Orofino, Jim Fork, Lolo, Lawyer, Clear, and Cottonwood Creeks.

The geology and ground-water hydrology were studied to determine the potential ground-water supply at each of the sites. Spot measurements were made on the six tributary streams and comparative studies were made with records on nearby streams to determine probable minimum flows.

Of the six sites studies only one, at the mouth of Clear Creek, had a favorable potential for both surface- and ground-water supply. As an alternate to the Clear Creek site, a location along the South Fork Clearwater River near Kooskia might be considered.

INTRODUCTION

This report gives the results of a reconnaissance investigation of water supply at selected sites, requested and financed by the U.S. Bureau of Sport Fisheries and Wildlife, along a part of the lower reach of the Clearwater River.

The objective of the investigation was to make a preliminary appraisal of the possibility of obtaining an adequate water supply for a fish hatchery for anadromous fish in the reach of the Clearwater River between the mouth of the North Fork Clearwater River, up to and including the mouth of Cottonwood Creek (figure 1).

In a joint conference on October 23, 1961, with Mr. Bruce B. Cannady and Mr. J. T. Barnaby of the Bureau of Sport Fisheries and Wildlife, basic water requirements were outlined, and six prospective sites along the Clearwater River were selected for study of surface- and ground-water conditions. The sites included the areas near the mouths of the following streams tributary to the Clearwater River: (1) Orofino Creek, (2) Jim Ford Creek, (3) Lolo Creek, (4) Lawyer Creek, (5) Clear Creek, and (6) Cottonwood Creek.

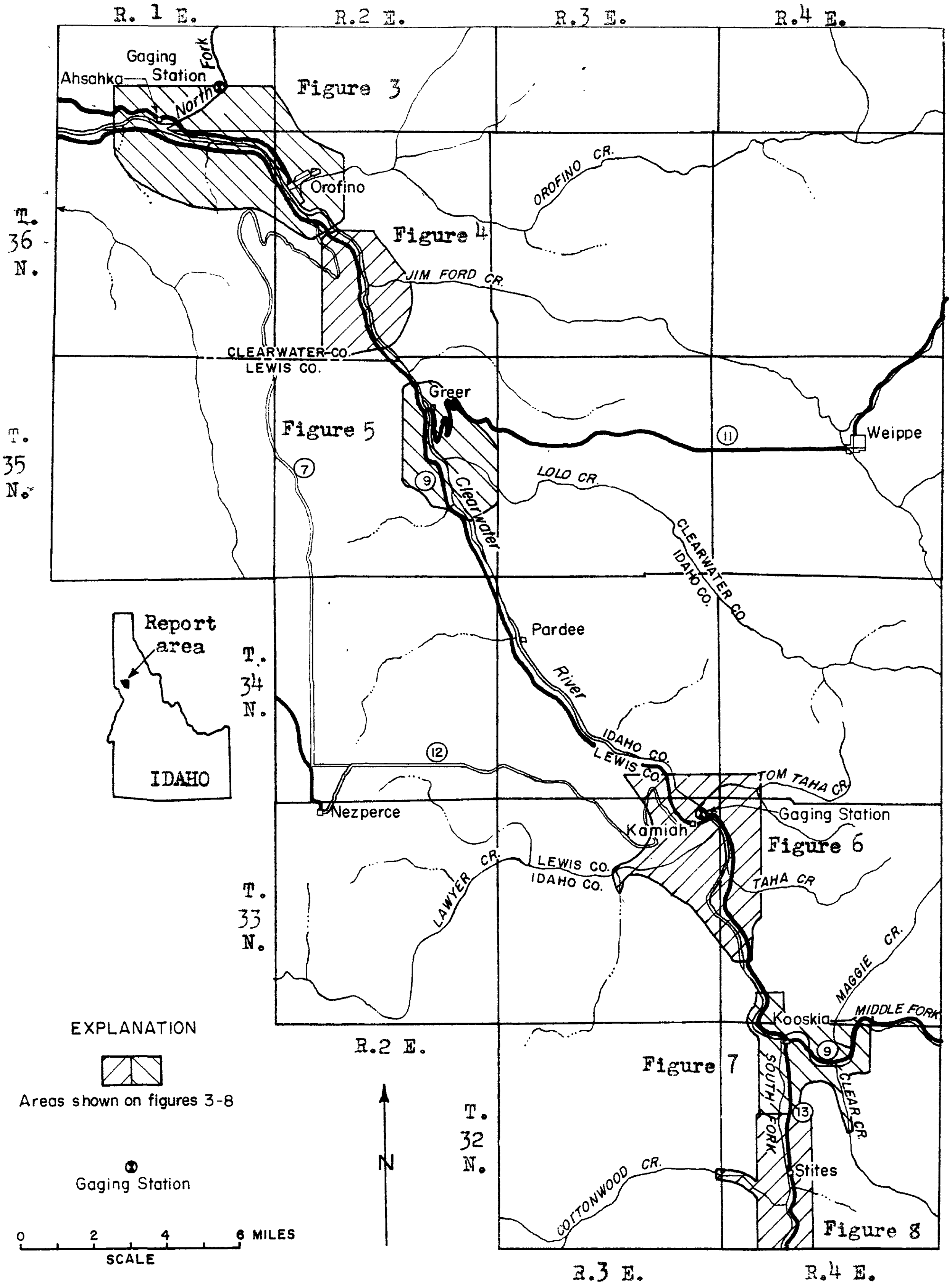

Figure 1.--Map showing location of area and the sites investigated.

Basic water requirement is a continuous supply of 10 to 12 cfs (cubic feet per second), at a preferred temperature of 46° to 52°F. Highly turbid water is not acceptable. Because there will be periods when surface water will be too warm, too cold, or too turbid, it was assumed that ground water would be required for at least a part of the time. A supply obtained entirely from ground water might be of satisfactory quality; however, unless the supply could be obtained from springs, cost of pumping from wells probably would make use of surface water desirable to the maximum possible extent. It was assumed at the outset that a combined surface- and ground-water supply would be most desirable.

The only topographic maps of the area are the series at a scale of 1:250,000 (about ¼ inch to the mile) and a contour interval of 200 feet. However, river survey maps and air photos were available and were used in the mapping.

Because the report was required early in 1962, field investigations could be made only in November and December, a period of the year not conducive to obtaining the most needed hydrologic data, particularly on stream flows.

The only previous areal investigation of water resources in the vicinity was a reconnaissance of a broad area by I. C. Russell (1901) during the summer of 1900. His report gives a good general description of the physiography and geology of the area but contains little specific information on the water resources.

PHYSICAL SETTING

The Clearwater River drains a rugged mountainous area in north-central Idaho, a considerable part of which has been designated as "Wilderness Area".

Most of the headwaters area is underlain by granite and related rocks of the Idaho batholith of Cretaceous age. The rocks in the headwaters of the North Fork Clearwater River are principally metamorphosed quartzitic and argillaceous rocks of the Belt Series of Precambrian age (Ross and Forrester, 1947). Overlying these older rocks in the western part of the basin are the relatively much younger basalts and associated sedimentary strata of the Columbia River Basalt (Miocene and Pliocene (?) in age). This formation was deposited over a very irregular erosion surface that had developed on the older igneous and metamorphic rocks.

The upper surface of the Columbia River Basalt originally formed a broad, relatively flat plain. However, subsequent faulting and warping of the lava flows has tilted the layers slightly to moderately. Downcutting by streams has separated the former broad plain into plateau segments. Two large segments are separated by the reach of the Clearwater River studied in this investigation.

The Clearwater River has cut a sharp canyon, averaging nearly 2,000 feet deep through the reach. The altitude of the river is about 1,000 feet at Orofino, and 1,200 feet near Kamiah, whereas the altitude of the plateau on either side is from 3,000 to 3,200 feet. The river has cut completely through the basalt sequence throughout most of the reach, and the rock in the canyon walls at the bottom of the canyon is chiefly granite and related rocks. However, from Kamiah upstream to beyond the end of the reach investigated, the wall rock at most places is Columbia River Basalt.

Where granite and related rocks form the wall rock at river level, the river has cut a canyon little wider than its immediate channel; flood plains or terraces are very narrow or nonexistent. Where basalt extends downward to river level the valley bottom generally is wider; terraces 100 to several hundred yards wide are common.

GROUND-WATER SUPPLY

Water-bearing character of geologic units

For the purposes of this brief report, the rocks in the area have been divided into three broad units as an aid in describing them and their water-bearing character. No attempt was made to study or describe the geology of the area in any detail. The description is based entirely on megascopic examination in outcrop and hand specimen.

Granite and related rocks

The granite of the Idaho batholith in this part of Idaho is typically a light- to medium-gray, equigranular, medium- to coarse-grained igneous rock warranting the field designation of granite, although in many places it actually is a quartz monzonite (Ross and Forrester, 1958). At a few places a finer-grained, dark-gray to greenish-gray rock was seen, probably a quartz diorite or diorite. At a number of places, particularly between Orofino and Lolo Creek, the rock has a pronounced gneissic or banded appearance, and is part of the border zone of the batholith as described by Ross and Forrester. At some places the minerals have been oriented parallel to the banding in such a way as to give the rock a moderate degree of schistosity. Generally the gneissic banding and planes of schistosity dip steeply or are nearly vertical.

The jointing in the granite varies considerably, but generally the more prominent joints are a few feet apart and are arranged in sets that give the granite a somewhat blocky appearance.

Granite is not normally a good water-bearing rock; even under the best circumstances, where it is greatly jointed and deeply weathered, yields of 100 gallons a minute per well would be considered exceptionally good. In this area where, because of steep slopes, the mantle is generally thin, and where jointing is not particularly prominent, yields probably would be much less, perhaps only a few to a few tens of gallons a minute. Gneissic rocks frequently yield somewhat larger quantities of water than their more massive counterparts, but it seems likely that individual well yields of more than 50 to 100 gallons a minute would be exceptional.

Columbia River Basalt

The Columbia River Basalt includes a very thick sequence of basaltic lava flows, associated pyroclastics, and interbedded sedimentary strata, and forms a wide basalt plateau province in central and eastern Oregon and Washington, and west-central Idaho. The area of this investigation is near the eastern margin of this basalt province, and for that reason may be somewhat different from typical areas.

Most of the flows are of olivine basalt which spread very widely from vents. Typically the base of the flow is dense and fine grained, sometimes glassy from sudden chilling. The centers of the flows are massive, moderately fine to medium grained, and commonly are crossed by intersecting joints which result in roughly hexagonal vertical columns. The flow surfaces are rough and broken, and the top few feet are usually vesicular. The most important aquifers are the roughly horizontal zones near and between successive lava flows. Pyroclastic material, cinders, scoria, and rubble between flows increase the permeability of the zone. Gravel and sand interbeds also are important aquifers, but fine-grained sedimentary deposits, such as fine sand, silt (mudstone), and clay (shale), yield little water. Sedimentary interbeds are much more common around the margins of the basalt province than in the interior.

The Columbia River Basalt yields moderate to large amounts of water to wells at favorable locations. Many wells yield 500 to 1,000 gpm (gallons per minute) each, and some have yields between 1,000 and 5,000 gpm. The average yield of a large number of municipal, industrial, and irrigation wells in Oregon and Washington is between 1 and 1½ gpm per foot of penetration below the water table. Thus, the average, larger diameter well (12- to 20-inch diameter) penetrating 500 feet below the water table in basalt could be expected to yield 500 to 750 gpm. Wells at unfavorable locations would yield much less, and those at favorable locations would yield more.

Ground water from the basalt usually is moderately hard, 100 to 200 parts per million, but otherwise is usually of good quality for most purposes. Chemical analyses from several sources are given in table 2. The water of shallow aquifers generally is the coolest; in this region water temperatures of shallow aquifers range from about 49° to 54°F. Generally water in deeper aquifers is warmer, the temperature rise averaging about 1 degree for each 50 to 75 feet of increased depth. Thus, basalt aquifers at depths of 500 feet could be expected to yield water having a temperature of about 55° to 60°F.

Alluvial deposits

The alluvial deposits are chiefly, if not entirely, stream deposited sand and gravel along the Clearwater River and its tributaries. Along the Clearwater River the deposits are chiefly coarse bouldery gravel. The deposits along the tributary streams from the east are nearly as coarse, but those along streams from the west are somewhat finer.

The alluvial deposits are believed to be very permeable and probably would yield large amounts of water where a moderate saturated thickness can be found. Yields probably would range between 10 and 50 gpm per foot of saturated thickness for deposits having 10 feet or more of saturated thickness. Because pumping dewaters the upper part of the aquifer in the vicinity of a pumped well, thick aquifers will yield more water per foot of saturated thickness than thinner ones of the same permeability.

Recharge to the alluvium is from precipitation on the alluvial terraces and runoff from the adjacent steep slopes. The air photos and available maps indicate that a steeply sloping strip, 1 to 1½ miles wide lying between the terraces and the plateau surface, probably contributes to recharge through short ephemeral streams that terminate at the margin of the terrace deposits. Precipitation at Orofino averages about 25 inches a year. Probably at least 60 percent, or 15 inches, of this precipitation is used by vegetation or is evaporated. If half of the remainder, or 5 inches, enters the alluvium, average underflow through a strip of alluvial deposits one mile long parallel to the river would be about 400 acre-feet a year, or a little more than 1 acre-foot a day. As the quantity of water needed for the fish hatchery is a continuous supply of about 20 acre-feet a day, it is obvious that the required quantity for any extended period could be obtained from alluvium only by inducing infiltration from the river. Because the Clearwater River is a swift flowing, clear stream with a sandy and gravelly bed, infiltration probably would be induced when the water table is drawn down below river level.

The amount of water stored in the alluvial deposits can be computed by assuming a value for the specific yield. The specific yield of these deposits is probably at least 20 to 30 percent. Assuming a value of 25 percent, each acre of aquifer would contain an acre-foot of recoverable water in each 4-foot depth interval below the water table. A deposit covering 1 square mile, having a saturated thickness of 40 feet, would contain 6,400 acre-feet of water. Obviously, recharge from the river would be induced after only a fraction of that amount had been withdrawn.

The time required for the water from the river to reach a well depends upon the coefficients of permeability and storage of the alluvium, the hydraulic gradient, and the distance of the well from the river. These factors are not known, but, based on experience in similar situations at other places, travel time probably would be a few weeks to a few months.

Ground-water potential of selected sites

The locations of the six sites investigated are shown in figure 1. The geology and well locations are shown on individual site maps, figure 3 to 8, and data on wells is given in table 1.

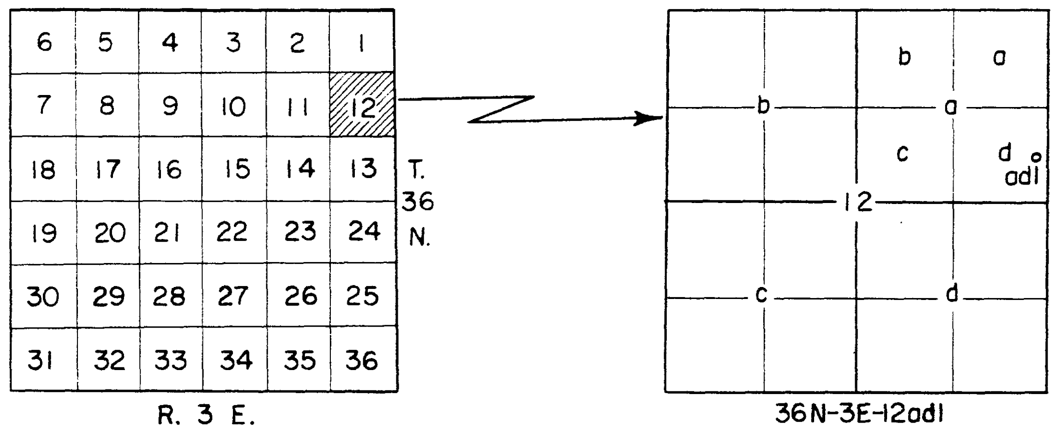

Figure 2.--Sketch showing well numbering system.

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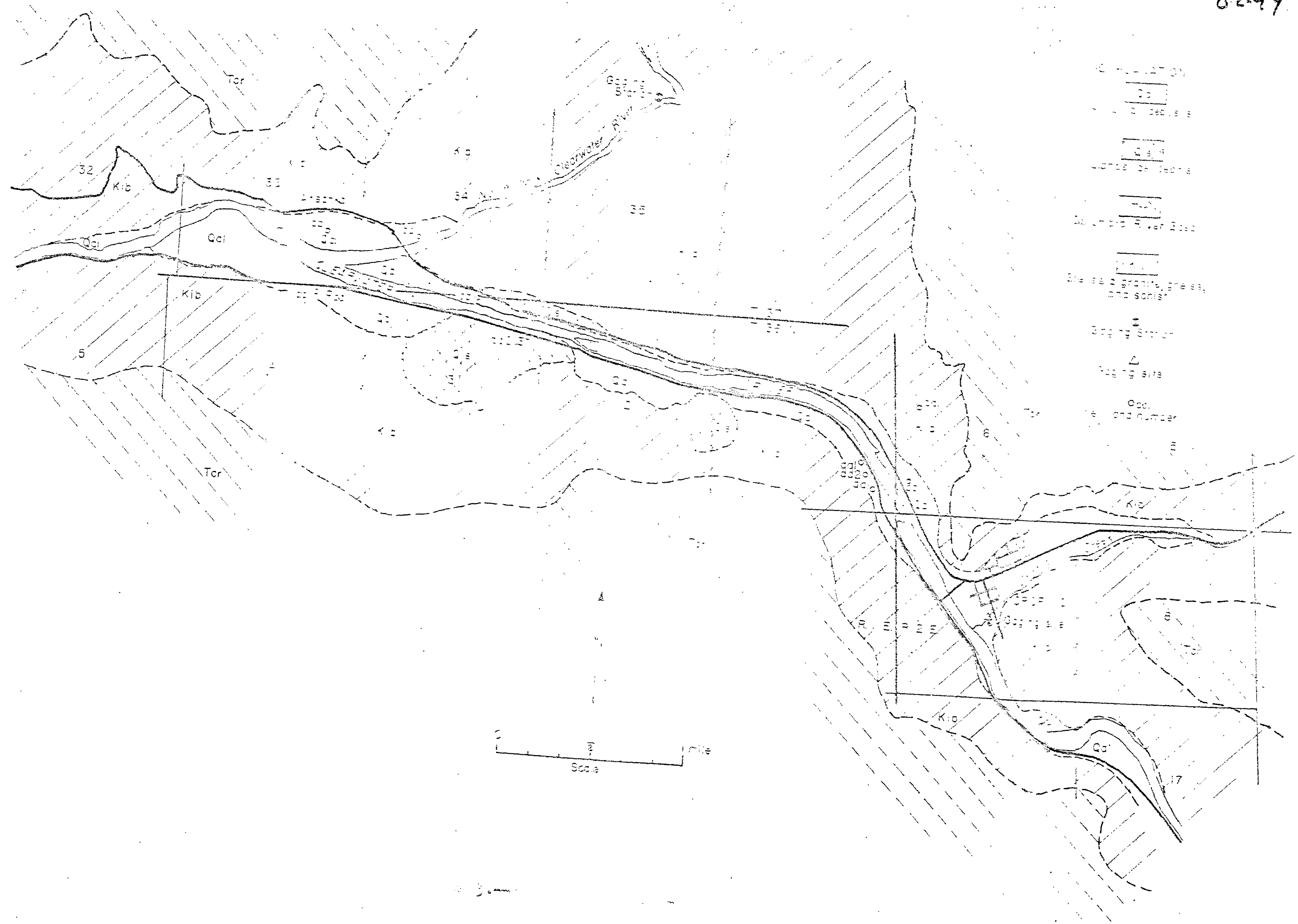


Well-numbering system

The well-numbering system used in Idaho by the Geological Survey indicates the locations of wells within the official rectangular subdivisions of the public lands, with reference to the Boise base line and meridian. The first two segments of a number designate the township and range. The third segment gives the section number, followed by two letters and a numeral, which indicate the quarter section, the 40-acre tract, and the serial number of the well within the tract. Quarter sections are lettered a, b, c, and d in counterclockwise order, from the northeast quarter of each section (figure 2). Within the quarter sections 40-acre tracts are lettered in the same manner. Well 36N-3E-12ad1 is in the SE¼NE¼ sec. 12, T. 36 N., R. 3 E. and is the well first visited in that tract.

Ahsahka-Orofino area

Orofino Creek enters the Clearwater River from the east at Orofino (figure 3). The valley of Clearwater River ranges from a little less than a quarter of a mile to about half a mile in width. For about one mile upstream from its mouth the valley of Orofino Creek is about the same width. There are alluvial terraces on both sides of the river; the most extensive is on the west side of Clearwater River opposite the mouth of the North Fork Clearwater River and is about a quarter of a mile wide by one and a half miles long.

The lower valley walls are chiefly granitic gneiss, with some schist and similar ancient metamorphosed rocks. Basalt crops out high on the walls, the base ranging from a few hundred to more than 1,000 feet above the valley floor.

Table 1.—Records of wells along a part of

Type of well: Dr., drilled.

Depth to water: Measured depths to water are given to the nearest tenth of a foot. Reported depths are given to the nearest foot.

Type of pump: B, bucket; C, centrifugal; J, jet; P, piston; T, turbine; Sub, submersible.

Well number	Owner	Type of well	Depth of well (feet below land surface)	CASING Dia. (inches)	CASING Depth (feet)	Character of aquifer
37N-1E						
-33da1	Ahsahka Lumber Co.	Dr.	24	6	22	Gravel
-34ca1	Unknown	Dug	-	28	-	-
36N-1E						
-1dd1	State of Idaho	Dr.	65	8	40	-
-1dd2	National Guard Armory	Dr.	50	10	38	
-1da1	Clearwater Timber Assoc.	Dr.	55	6	55	Sand & gravel
-3aa1	Elmer Crumb	Dug	14	52	14	Soil & loose rock
-3aa2	Dr. T. J. Peterson	Dr.	112	8	-	-
-3aa3	Deryl Fine	Dr.	89	8	-	-
-3ab1	B. J. Carney Co.	Dug	18.5	60		Soil & loose rock
-4aa1	C. C. Neglay	Dr.	35	6	-	-
-4ab1	R. W. Appleyard	Dr.	55	6	-	Granite
36N-3E						
-6bc1	Pentecostal Church	Dug	11.7	48	-	
-6cc1	State Hospital	Dr.	180	6	-	-
-28ab1	Fred Roy	Dug	10	24	-	Clay
-28ac1	Fred Roy-	Dr.	85	6	-	
-28ac2	Fred Roy	Dug	10	60	-	Clay
35N-2E						
-11ca1	N.P. RR Depot	Dr.	70	-	-	-
34N-3E						
-35da1	Potlatch Forest	Dr.	210	6	210	Basalt
33N-3E						
-1ab1	Dabco Inc.	Dr.	80	6		Rock & clay
-1ac1	Kamiah Gun Club	Dr.	220	10	-	Black silt

the Lower Clearwater River Valley, Idaho

Yield of well: All yields are reported by owner or user.

Use of water: Dom, domestic; Ind, industrial; Inst, institutional; Irr, irrigation; Pub, public supply; N, not used.

Remarks: All information is based on reports of owner or user. Dd, drawdown; gpm, gallons per minute.

WATER LEVEL Depth to water (feet)	WATER LEVEL Date	PUMP Type	PUMP H.P.	Yield of well (gpm)	Use of water	Remarks
12.9	12/5/61	J	1/3		Dom	
14.4	12/5/61	None			N	
20.9	12/5/61	J	1/3	20	Dom	Clay, basalt boulders, 0-22 ft.
15	8/ /61			40	Dom	Hit granite at 35'. Dd 23 ft at 40 gpm.
25	1961	T	1	50-55	Dom	
12	1960	J			Dom	
91.5	12/5/61	J		-	Dom	Reported inadequate.
82.6	12/7/61	J	½		Dom	
6.7	12/5/61	J			Dom	
8.4	12/5/61	J	1/3		Dom	
11.8	12/5/61	J	1/3		Dom	Hit granite at 35 ft. Water is hard, irony.
3.5	12/5/61	B			Dom	-
-	-	T	15	100	Inst.	
3.8	12/6/61	T	1/3		Dom	Will pump almost dry.
66.8	12/6/61	-	-	-	N	Water has sulphur taste.
3.0	12/6/61	-	-	40	Irr	Was pumped dry in summer.
-	-	T	3/4	-	Dom	Water very hard.
		T	5		Ind	Water at 194 ft. Could not bail down.
25-R	1956	J	½		Ind	
					N	Surface water to 30', no water below.

Table 1.—Records of wells along a part of the

Well number	Owner	Type of well	Depth of well (feet below land surface)	CASING Dia. (inches)	CASING Depth (feet)	Character of aquifer
33N-3E—(Continued)						
-1bd1	Grant Planing Mill	Dr.	70	6		Sand, slate
-1cb1	City of Kamiah	Dr.	285	10	-	-
-11ca1	City of Kamiah #2	Dr.	100	8		-
-12ad1	A. L. Benson	Dr.	180	6	180	Earth & clay
-12ad2	A. L. Benson	Du	35	36	10	Clay
-12ba1s	City of Kamiah	-		96		Gravel
-12bb1	City of Kamiah #1	Dr.	129	8	-	
-7ba1	Cedar Inn	Dr.	140	6	100	Sand
32N-4E						
-4bb1	Village of Kooskia	Dr.	108	12	50	Basalt
-4bb2	Village of Kooskia	Dug	35	9'x9'	-	Basalt
-10bb1	Potlatch Forest	Dr.	110	6	-	-
-17ad1	High School	Dr.	180			
-20db1	J. U. Dixon	Dug	20	5'x5'	-	Clay
-29ad1	Village of Stites	Dr.	58-60	6	12	
-30aa1	Joe Hartman	Dr.	55	8	8	Basalt
-32aa1	Leroy Swinehart	Du.	14			Clay & gravel

WATER LEVEL		PUMP		Yield of well (gpm)	Use of water	Remarks
Depth to water (feet)	Date	Type	H.P.			
20-R	1956	J	1/3		Ind	Temp. of water 58°.
159.3	12/8/61	Sub	40	250	Pub	Dd 100 ft. at 250 gpm. Sulfur odor.
16.4	12/6/61	J	10	Will pump dry	Pub	Petrified log at 100 ft.
60	1961	Sub	3	30	Dom	Water at 50 and 170 ft.
					-	Dry hole.
Flows	12/6/61			90	N	Spring. Temp. 56°..
59		T	15	70	Pub	Did not hit basalt; pumps dry in 4 hrs.
20	1961	J	½		Dom	
24.9	12/7/61	T	20	600	Pub	Alluvium 0-50 ft, basalt 50-100 ft, shale 100-108 ft.
-	-	T	-	-	-	Soil and sand to 12 ft, basalt 12 to 35 ft.
-	-	-	-	-	Dom	Used by 3 to 4 homes.
					Inst.	
1.1	12/7/61	P	1/3		Dom	Can be pumped dry in summer.
12.9	12/7/61	C	10	22	Pub	Hit basalt at 18 ft. Flows when not being pumped. Dd 13 ft at 22 gpm. Temp. 60°.
23.1	12/7/61	P	Hand		N	Hard water.
7.0	12/7/61	C	1/3		Dom	

The thickness of the alluvium underlying the terraces in not known, but based on sketchy information from well logs, it probably is 40 to 60 feet thick. As the terrace rises about 20 to 25 feet above river level, there is perhaps 20 to 40 feet of saturated alluvium in the valley.

The alluvial terrace along Orofino Creek averages about a quarter of a mile wide for a distance of about one mile upstream from the mouth of the creek. Upstream it narrows greatly and generally is less than 100 yards wide. The thickness of the alluvium is not known, but it may be relatively thin. The alluvial deposits along either the Clearwater River or Orofino Creek probably would not yield more than 10 percent of the required water without inducing recharge from the river, which might result in undesirable water temperatures.

Jim Ford Creek

Jim Ford Creek (figure 4) discharges from a narrow canyon on the east side of the Clearwater River. The largest alluvial deposits form a triangular area of about 40 acres at the mouth of the creek. No other terraces of consequence occur along the creek nor on the Clearwater River for several miles upstream or downstream.

Basaltic rock crops out on the north side of the creek near the mouth. At places the rock is a coarser grained, massive black rock much different in appearance from the usual basalt. It may be that this represents a feeder dike for the basalt lava flows. Basalt was seen on the west side of the river, opposite the mouth of the creek.

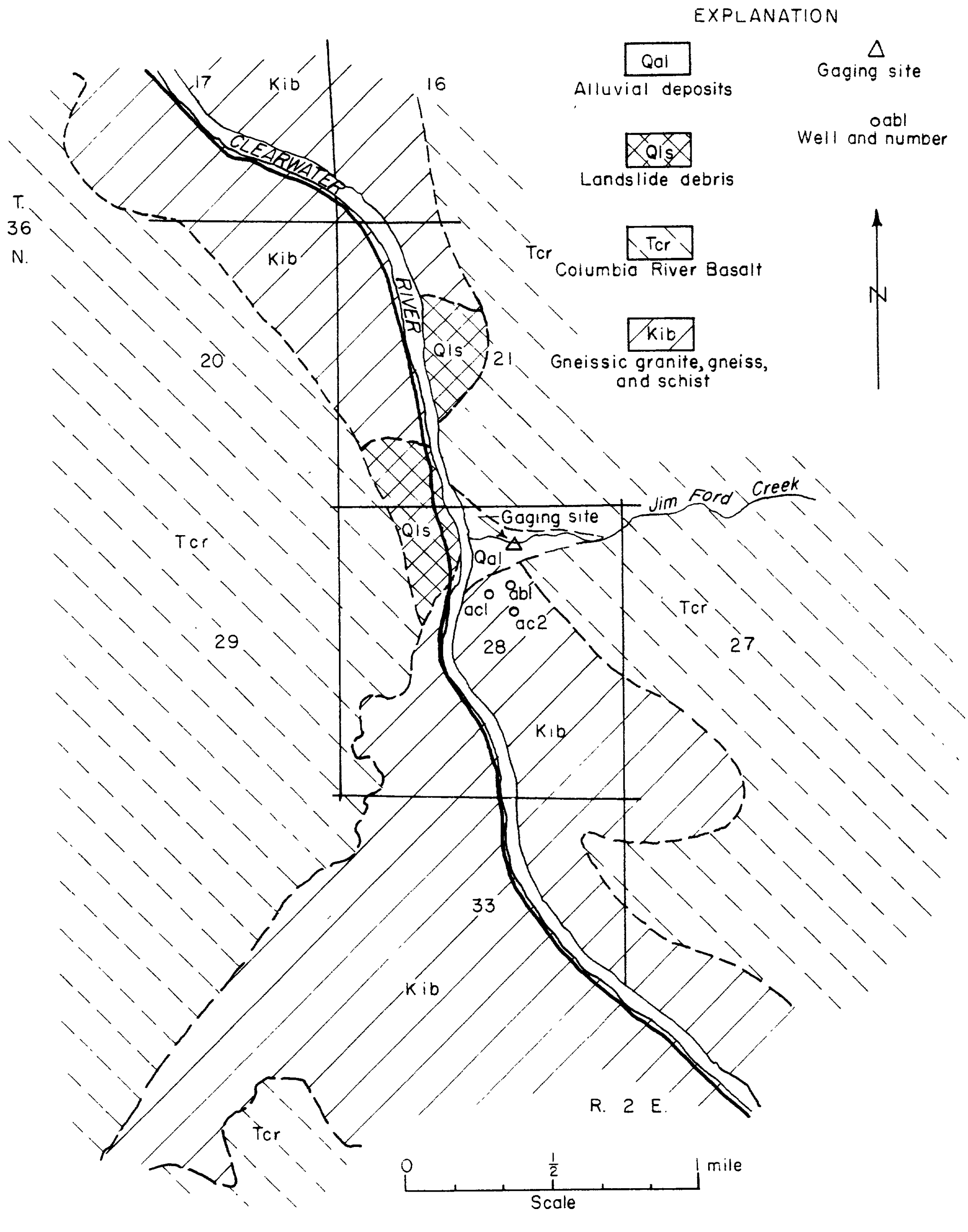


Figure 4.—Map of the Jim Ford Creek area.

However, the general appearance of the exposures, and pattern shown on air photos suggest a large landslide. A landslide block also is indicated on the east side of the river, a short distance downstream from the mouth of the creek. Elsewhere gneissic granite, schistose gneiss, and granite form the walls of the canyon.

The alluvial deposits are of too limited extent to be considered as a source of supply for the proposed hatchery. The basalt also is very limited in extent and does not appear to be very permeable. There does not seem to be any possibility of obtaining more than a few hundred gallons a minute at this site.

Lolo Creek

Lolo Creek enters the river from the east through a deep narrow canyon (figure 5, plate 1, A). Alluvial terrace deposits are very narrow, and of limited extent.

Granite crops out in the walls of the canyon of both the creek and the river, and rises to the top of the plateau on the west side of the Clearwater River. Basalt forms the rim of the plateau in this area only to the northeast of the junction of the creek and river.

There does not appear to be any possibility of obtaining a ground-water supply of more than few hundred gallons a minute in this area.

Lawyer Creek

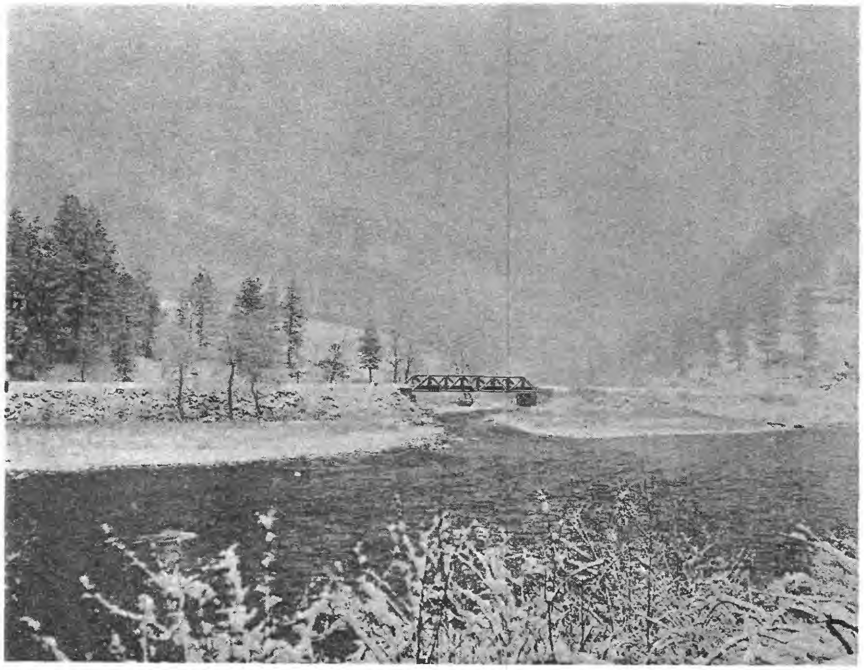
Lawyer Creek drains a large area of the plateau west of the Clearwater River and discharges into the river at Kamiah (figure 6, plate 2, B).

A broad alluvial terrace at the mouth of Lawyer Creek extends for more than two miles along the Clearwater River, and is more than a mile wide where Lawyer Creek enters the river. Alluvial deposits averaging about 300 yards in width extend several miles up Lawyer Creek.

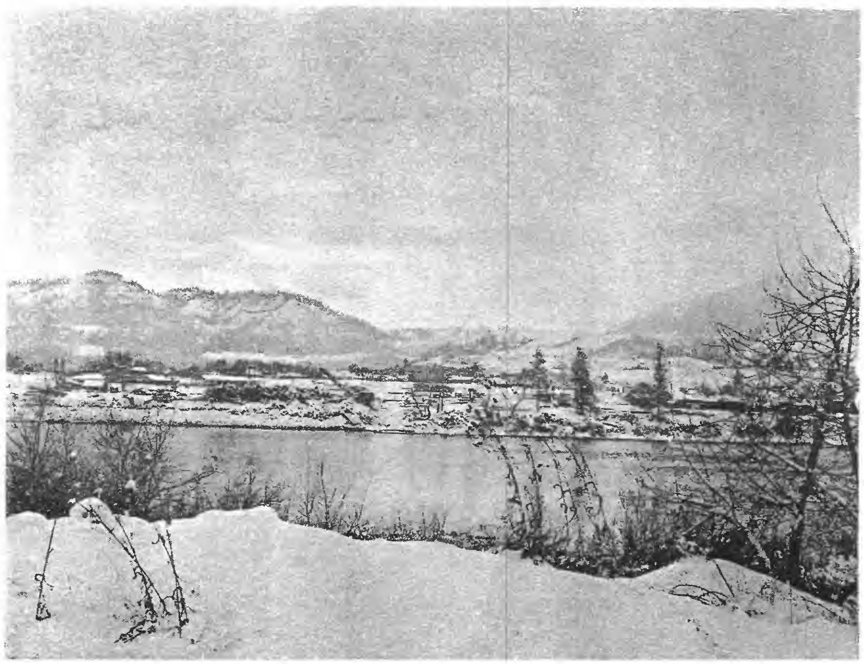
Granite crops out in the river bed and is exposed in both walls of the valley where the valley narrows about one mile northwest of the center of Kamiah. Granite also crops out at river level on both sides of the river about 1½ miles upstream from Kamiah. Basalt crops out on both sides of the river at Kamiah in a band 2 to 2½ miles wide at river level, but widening as it rises from the river up to the plateaus some 2,000 feet above the river.

The granite in this area is a light-colored, even-textured rock with very little of the gneissic and schistose structure that characterizes it downstream toward Orofino.

The outstanding feature of the basalt is the extent and thickness of sedimentary strata which are interbedded in and perhaps underlie it. Thick layers of tuffaceous shale, mudstone, sandstone, and similar strata are widespread in the lower several hundred feet of the basalt section at Kamiah. At several places sedimentary beds were observed in direct contact or in close proximity to the granite, and it appears that at places these beds were deposited in erosion channels cut in the granite.



A. Junction of Lolo Creek with the Clearwater River, showing limited terrace deposits and steep valley walls.



B. Terrace at Kamiah, looking into mouth of Lawyer Creek valley from east bank Clearwater River.

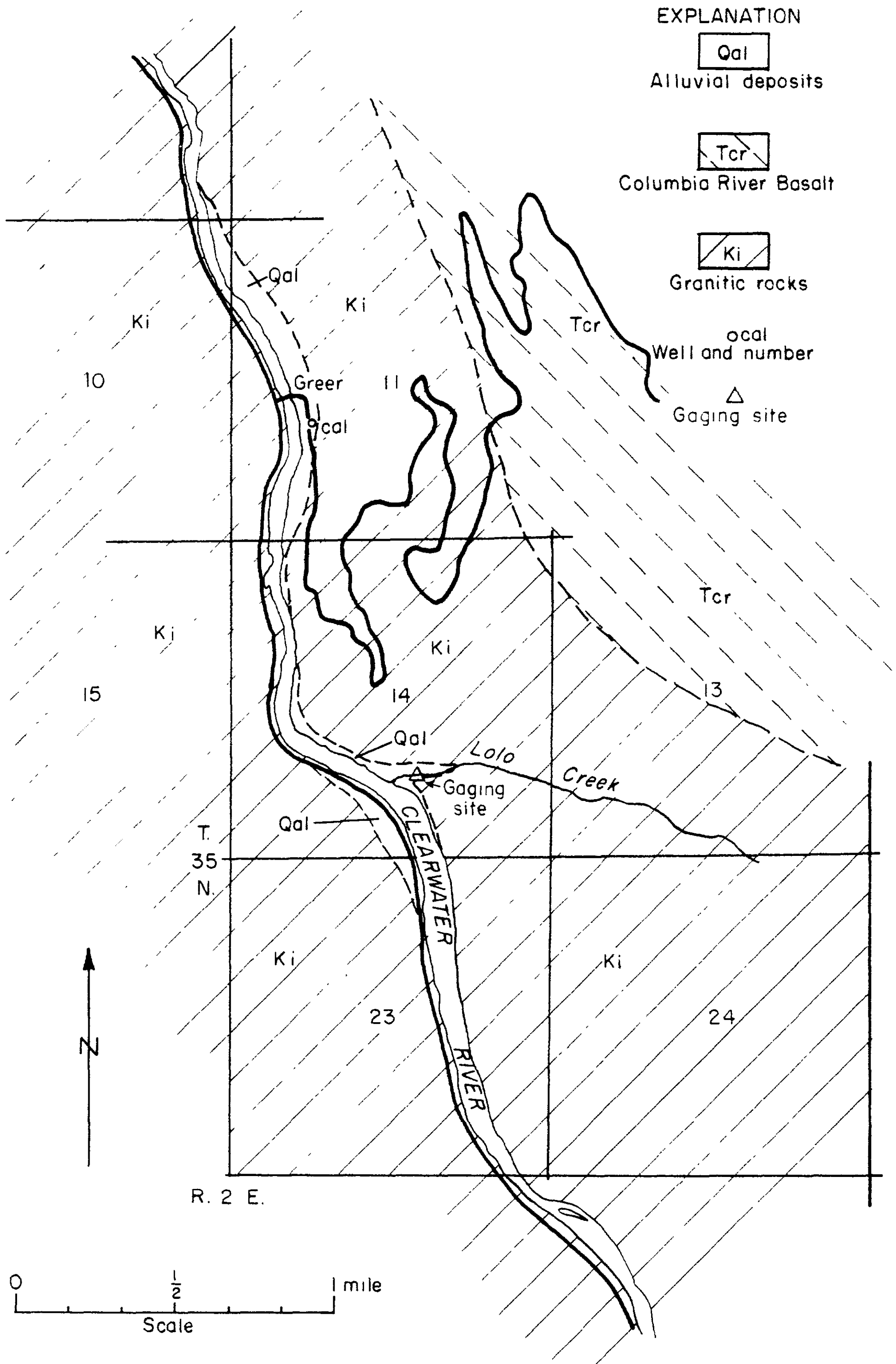


Figure 5.--Map of the Lolo Creek area.

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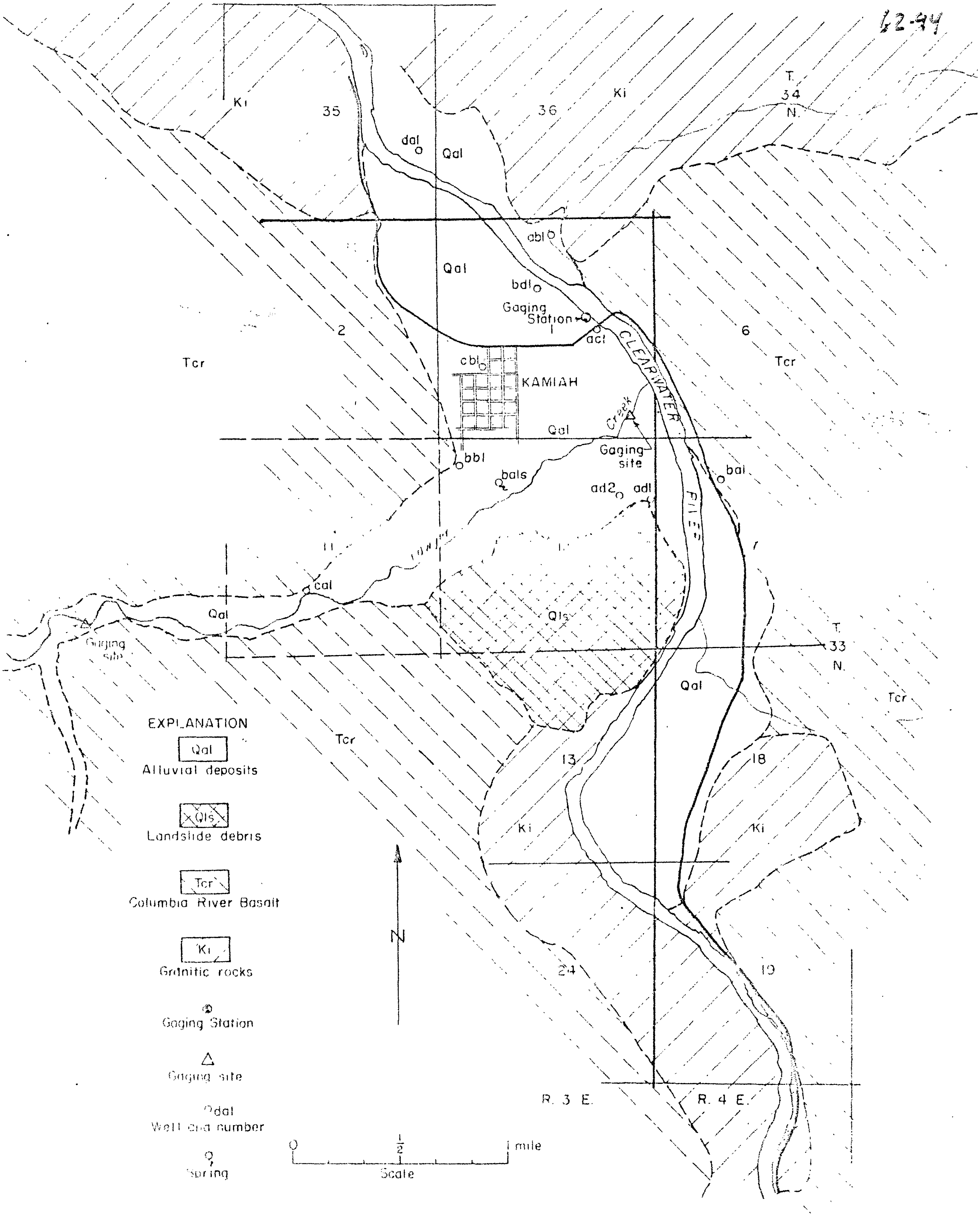
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Scale

The exact relations between the granite, basalt, and sedimentary strata are somewhat obscured by many faults, most of which may be minor, but they are closely spaced and at diverse angles so that the relations are difficult to decipher.

About half a mile south of Kamiah, a low-rolling bench apparently is underlain at places by shale and sandstone. At most places only clay and silt can be found. Basalt rubble is mixed with the clay at some places. It is thought that this bench probably is underlain by soft sedimentary strata and that the surface has been more or less covered by slope wash, landslide material, and other debris washed down from the hills to the west.

The alluvial deposits offer some possibility of furnishing a moderate supply of water. The surficial materials are coarse and permeable, but the scanty data from wells suggest that the underlying materials may be chiefly sand. The approximately two square miles of alluvium at Kamiah might contain as much as 10,000 acre-feet of water. Large production wells, if these could be obtained, located a quarter to a half mile from the river could be pumped for several months without drawing in enough river water to effect a large change in the water temperature.

The basalt is a potential aquifer, but the scanty well data available suggest that thick beds of fine-grained sandstone and shale also will be encountered. This also is indicated by the widespread distribution of sandstone and shale at the surface. Kamiah City wells 33N-3E-12bb1 and 33N-3E-11ca1 are 129 and 100 feet deep, respectively, and are reported not to have encountered basalt. It is reported that both wells can be pumped dry, well 33N-3E-11ca1, which has the larger pump, at a pumping rate of 70 gpm. The city's newest well, 33N-3E-1cb1, is reported to be 285 feet deep and to yield 250 gpm with 100 feet of drawdown. The yield is slightly better than 1 gpm per foot of penetration below the water table. The fact that sedimentary strata were found overlying granite at several places near Kamiah indicates that the exposed basalt is near the bottom of the formation. It is quite possible that deeper wells might encounter only a small thickness of basalt, and would be chiefly in sedimentary strata with granite beneath.

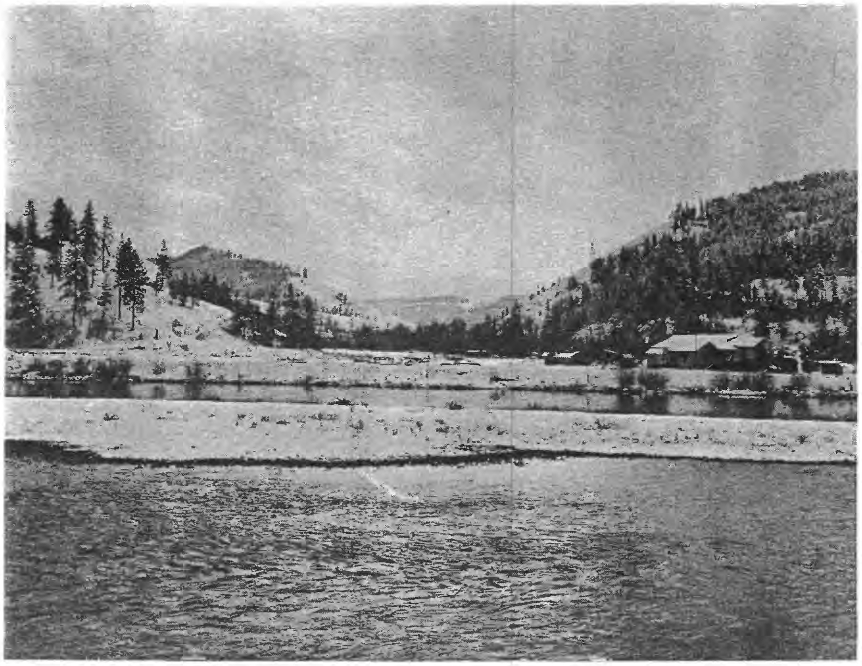
Clear Creek

Clear Creek enters the Middle Fork Clearwater River about 1½ miles southeast of Kooskia (figure 7, plate 2, A) which is at the junction of the South and Middle Forks of Clearwater River.

The alluvial valley floor is about one-third of a mile wide along the South Fork, but generally less than one-fourth mile wide along the Middle Fork. The valley bottom along Clear Creek generally is not more than 200 yards wide.

The alluvial deposits are of very limited extent; also basalt crops out in the bed of the Middle Fork at several places so the deposits probably are thin. Probably no large water supply could be obtained from the alluvium, except perhaps by inducing almost direct infiltration from the river.

Basalt and associated rocks form the valley walls. A few thin interbeds of ash and tuff were seen, but there are no thick sections of sedimentary strata, such as those cropping out near Kamiah.



A. Terrace deposits at mouth of Clear Creek valley, looking upvalley from north bank of Middle Fork Clearwater River.

B. Alluvial terrace on south side of Cottonwood Creek, looking up the Cottonwood Creek valley. (South Fork Clearwater River in foreground, mouth of Cottonwood Creek at extreme right side of picture)

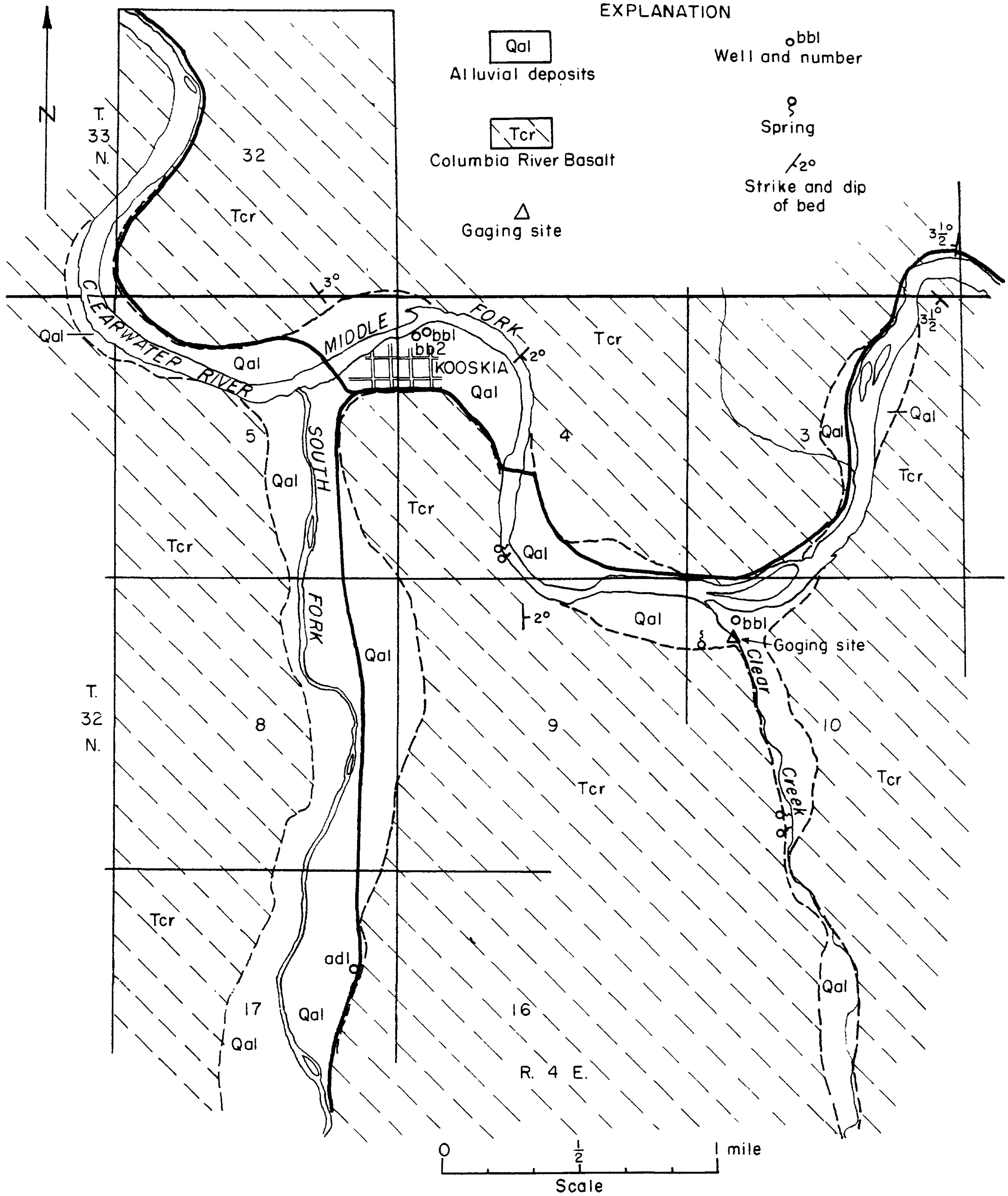


Figure 7.--Map of the Clear Creek area.

Much of the basalt cropping out near river level is very vesicular and scoriaceous, and even frothy. At places it appeared to be pillow lava formed by extrusion of basalt into water. Along the lower course of Clear Creek and the south wall of the canyon of the Middle Fork, downstream from Clear Creek, several small springs discharge from basalt above shaley interbeds. The temperature of the water was about 50°F.

The basalt cropping out near Clear Creek appears to be considerably more permeable than the average Columbia River Basalt. The relatively high permeability of the basalt also is indicated by the village of Kooskia well 33N-4E-4bb1, which is reported to be 108 feet deep and to have been tested at 600 gpm.

A few apparent dips were measured on basalt flows, and these indicate a slight synclinal sag in the basalt centering approximately on Clear Creek. This suggests that water in wells a few hundred feet deep might be under artesian pressure, and possibly might flow at the surface.

Cottonwood Creek

Cottonwood Creek enters the South Fork Clearwater River from the west 5 miles upstream from Kooskia (figure 8, plate 2, B). It drains a large area of the plateau segment west of the Clearwater River. The valley of Cottonwood Creek is 300 to 400 yards wide from its mouth to a point about 1 mile upstream, beyond which it is narrower. The valley of the South Fork averages about a quarter of a mile wide in the vicinity of the mouth of Cottonwood Creek.

Because the alluvial deposits are narrow and probably not very thick, continuous withdrawal of even a few hundred gallons a minute would induce recharge from the river or creek.

Basalt forms the valley walls and rises to the top of the plateau segments nearly 2,000 feet above the river. A few dips were measured on basalt layers, and apparent dips were slight but generally toward the valley of the South Fork. Artesian pressures in deeper aquifers might result in water levels above the land surface for wells drilled in the valley.

The basalt locally is very vesicular, scoriaceous, and rubbly, as at Clear Creek. At other places, however, the basalt is more massive and less open. In general, the basalt appears to have a somewhat better than average permeability.

Surface-water supply

As noted heretofore, this study is primarily concerned with determining the availability of water in certain surface tributaries of Clearwater River and in the adjacent valley alluvium and other formations which would be suitable in quantity, chemical and physical quality, and temperature for fish hatchery use. Main-stream flows may influence some aspects of the problem and general information on the availability of data is given herein.

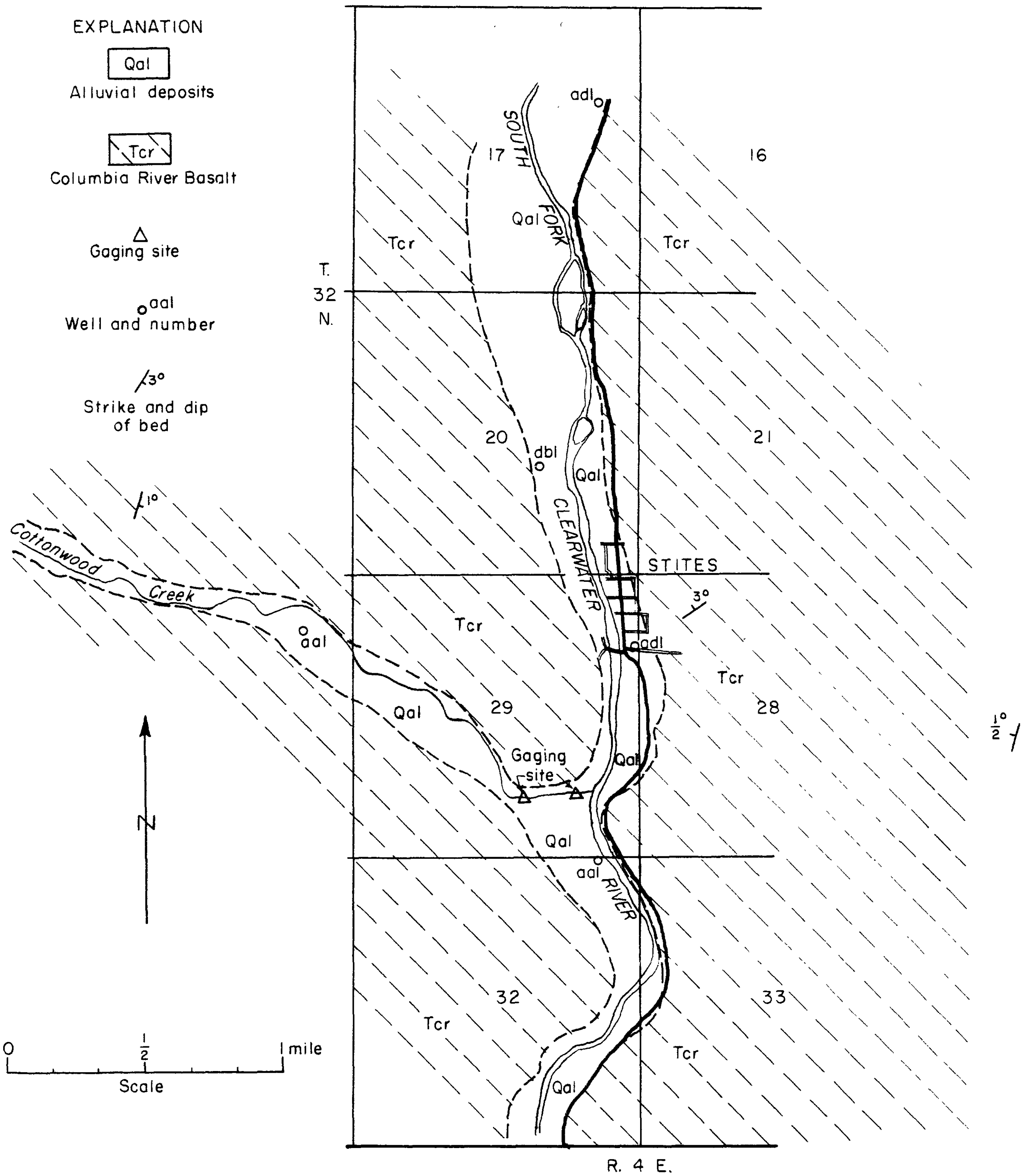


Figure 8.— [illegible] the Cottonwood Creek area.

Antecedent surface-water records

Records up to more than 50 years in length are available for the Clearwater River and principal tributaries. These records include daily discharge, maximum and minimum flows, flood heights, and short periods of water-temperature records. The periods of record for stations within or near the study area are given below.

Gaging station	Period of record	
	Discharge	Water temperature
Selway River near Lowell	Apr. 1911-Sept. 1912 Oct. 1929-date	Aug. 1958-July 1959
Lochsa River near Lowell	Oct. 1910-Sept. 1912 Oct. 1929-date	July 1956-July 1959
South Fork Clearwater River near Grangeville	Nov. 1910-Jan. 1911 Mar. 1911-July 1911 Oct. 1911-Sept. 1916 Apr. 1923-date	--
Clearwater River at Kamiah	Aug. 1910-date	June 1956-July 1959

The discharge records are published in the water-supply papers of the Geological Survey through September 30, 1960.

The antecedent record situation is entirely different for the six smaller tributaries being investigated as a source of supply. Except for about one year of daily record on Lolo Creek in 1911-12, only a few miscellaneous measurements are available for these streams.

Method of analysis

In the use of surface water for hatchery purposes the most critical periods are in late summer, when flows are low and temperatures high, and during periods of high turbidity. Brief periods of extremely low flows may occur in small streams following drastic drops in temperature below freezing. Because of the short time available and the timing of the study, it was not possible to obtain discharge or water-temperature data for the critical summer months directly for the streams under study. In lieu thereof, estimates of the probably minimum monthly flows have been made on the basis of spot measurements of streams in the study area and comparative records for nearby streams. The areas used for comparative studies are shown in figure 9. Water-temperature records for nearby streams are available from which general conclusions can be drawn regarding water temperatures in the streams under study. Chemical analyses of surface-water samples are given in table 2.

The average monthly flows, in cubic feet per second, for the period of record for the gaging station South Fork Clearwater River near Grangeville are listed below to show the general runoff pattern in the area.

October	263	February	301	June	2,192
November	322	March	567	July	660
December	324	April	1,951	August	219
January	280	May	3,234	September	192

Based on the relatively long record, it will be noted that September, August, October, and January, in that order, appear to be the most critical months from the standpoint of low flows.

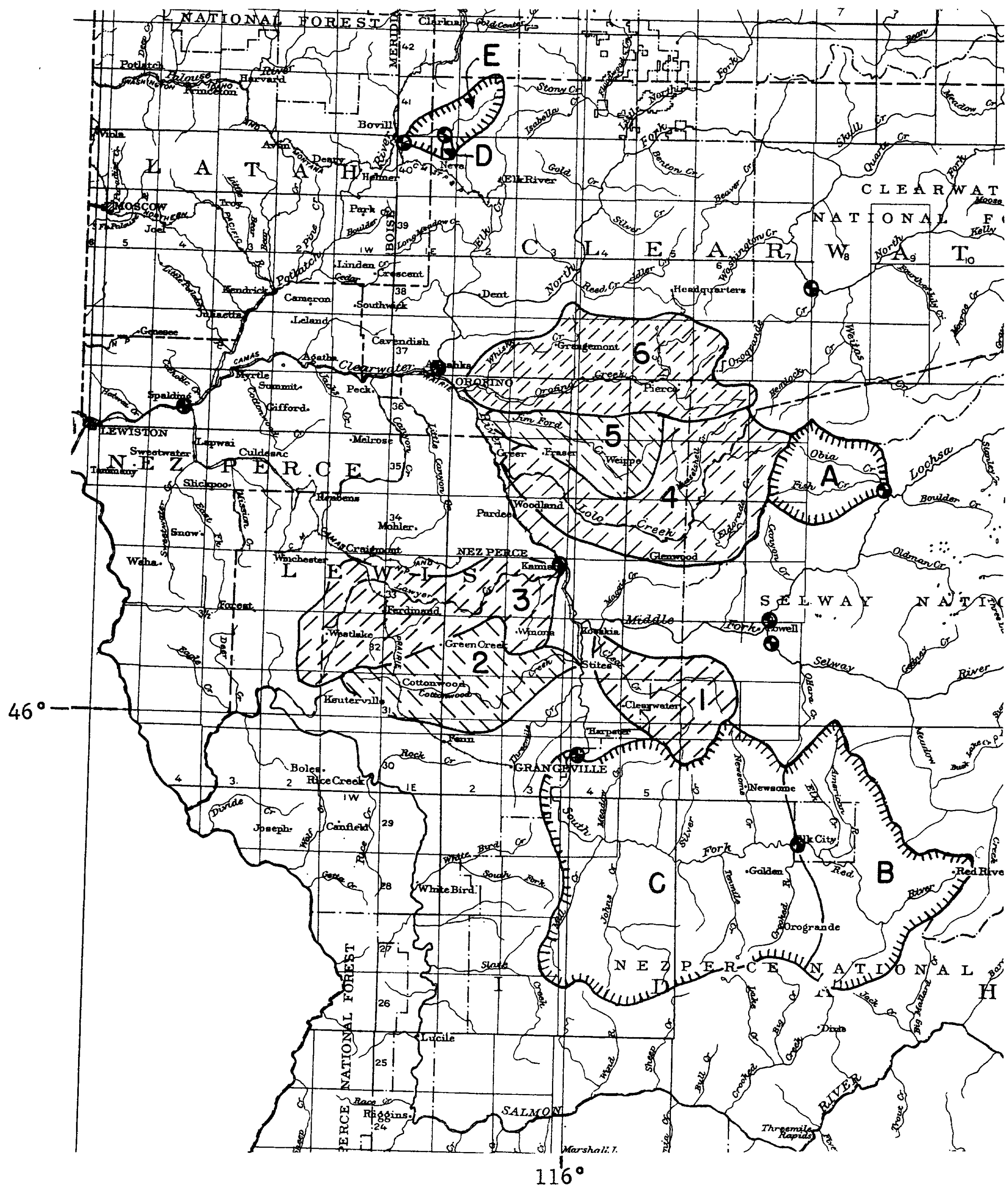


Figure 9.--Map showing drainage boundaries of study areas and outlying streams which were used for hydrologic comparison.

Study areas		Comparative areas
1. Clear Creek	4. Lolo Creek	A. Fish Creek
2. Cottonwood Creek	5. Jim Ford Creek	B,C. S. Fk. Clearwater River
3. Lawyer Creek	6. Orofino Creek	D. Bloom Creek
		E. E. Fk. Potlatch River

Table 2.--Chemical analyses of water from the Clearwater River basin, Idaho (Analyses by U.S. Geological Survey, except as noted; chemical constituents in parts per million)

Source		262-ft well in basalt Nr. Cottonwood	Shallow well, city of Kooskia[1]	Lochsa River, near Lowell	Selway River, near Lowell	South Fork Clearwater R., at Kooskia
Date of collection		12-1-61	-	4-19-60	4-19-60	4-19-60
Temperature	(°F)	-	55	44	44	47
Silica	(SiO_2)	24	-	12	12	19
Iron	(Fe)	.00	.17	-	-	-
Manganese	(Mn)	.1	-			
Calcium	(Ca)	39	12	3.0	3.0	3.5
Magnesium	(Mg)	11	6.2	.3	.2	1.2
Sodium	(Na)	9.4	24	1.5	1.6	3.0
Potassium	(K)	.3		.2	.4	.7
Bicarbonate	(HCO_3)	140	94	15	12	25
Carbonate	(CO_3)	0	0	0	0	0
Sulfate	(SO_4)	44	10	.0	.8	2.0
Chloride	(Cl)	1.5	2	.0	.0	.2
Fluoride	(F)	.2	.3	.1	.1	.1
Nitrate	(NO_3)	.0	-	.1	.0	.3
Dissolved solids		198	162	26	26	55
Total hardness as $CaCO_3$		142	55	9	8	14
Specific conductance (micromhos at 25°C)		309	-	26	26	48
pH,	field pH	-	-	7.4	7.6	7.5
	laboratory pH	7.6	7.7	7.7	7.1	7.1
Color		-	-	5	15	15

[1] Analysis by State Department of Public Health, Boise.

Estimates of low flows at selected sites

For the purposes of this study, miscellaneous measurements were made of Clear Creek, Cottonwood Creek, Lawyer Creek, Lolo Creek, Jim Ford Creek, and Orofino Creek during November and December 1961. The results of these measurements together with water temperatures and all previous measurements are given in table 3.

Hydrographs of daily flow during the period July to December 1961 are plotted in figure 10 for five gaging stations on streams nearby or adjoining the study area. Also plotted are the miscellaneous measurements referred to above. Flows measured in December and, to a lesser extent, those measured November 15 and 16 were affected by ice storage. Measurements made November 10 and 11 are believed to be more representative of base flow conditions and have been used almost exclusively in the correlation study.

Inspection of the hydrographs and other data reveals that August flows were lower than for any other month during 1961. Hence, as a first step in determining the minimum flows to be expected in the streams of the six study areas, their average discharges during August 1961 were estimated. This was accomplished by using the percentage correlation afforded by semilogarithmic plotting and estimating hydrographs for the six tributary streams. From these hydrographs the average monthly flows were computed.

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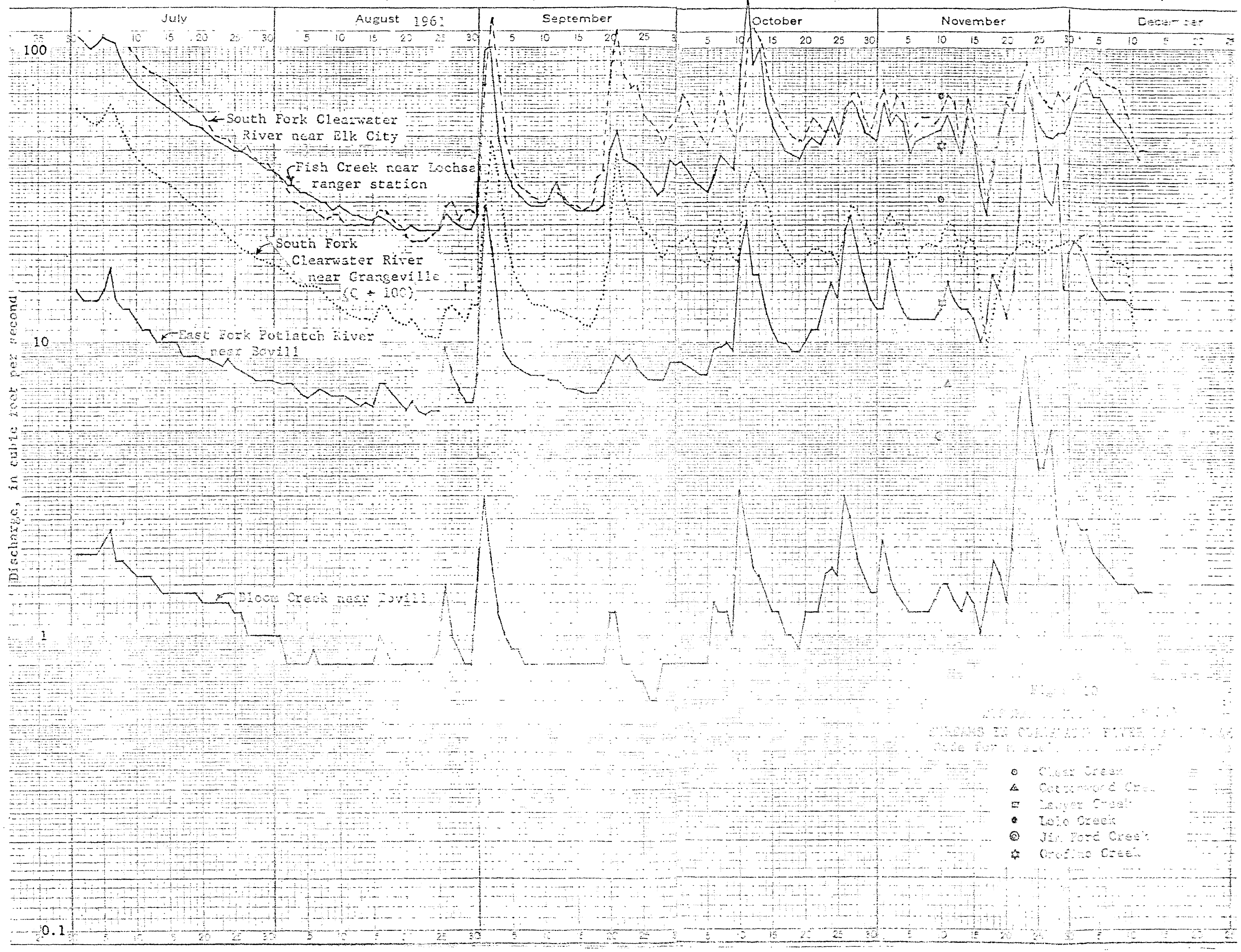

Table 3.--Discharge measurements and water temperatures for Clearwater River tributaries.

Stream	Location	Drainage area (sq mi)	Date	Water tempt. (°F)	Discharge (cfs)
Clear Creek	at mouth, near Kooskia	[a]107	June 9, 1924	--	56.3
do	do		Nov. 10, 1961	39	30.6
do	do		Dec. 10, 1961	32	16.1
Cottonwood Creek	at mouth, near Stites	[a]199	Nov. 11, 1961	45	7.19
do	do		Dec. 10, 1961	32	[b]10.0
Lawyer Creek	at mouth, at Kamiah	[a]209	Nov. 10, 1961	43	[c]13.8
do	do		Nov. 16, 1961	41	[c]6.42
do	Hwy. 62 crossing near Kamiah	[a]203	do	42	6.28
do	do		Dec. 10, 1961	37	12.9
Lolo Creek	at mouth, near Greer	243	Sept. 27, 1928	--	28.9
do	do		May 12, 1929	--	[d]500
do	do		Nov. 10, 1961	36	69.1
do	do		Dec. 9, 1961	32	84.8
Jim Ford Creek	at mouth, near Orofino	[a]103	Apr. 30, 1953	--	279
do	do		Nov. 10, 1961	34	4.79
do	do		Dec. 9, 1961	33	14.5
Orofino Creek	at dam, 1.6 mi upstream from Orofino	[a]226	May 29, 1948	--	3,600
do	above Whiskey Creek, 3½ mi east of Orofino	[a]174	Apr. 30, 1953	--	667
do	at mouth, at Orofino	[a]228	Nov. 10, 1961	35	46.6
do	do		Dec. 9, 1961	32	53.8

[a]Approximate.

[b]Measured 0.3 mile upstream from mouth.

[c]Includes 0.14 cfs estimated bypassing measuring section in pipe to sewer pond.

[d]Estimated.

The minimum monthly flows of record prior to 1961 for July, August, and September, and comparative flows for 1961 have been listed in table 4. for several streams in the area. In instances where a relatively short record was available, the August 1961 flow was less than the previous minimum. However, for the longer record at the station South Fork Clearwater River near Grangeville the ratio of the previous August minimum to the August 1961 flow is 0.66. Using this ratio, the August 1961 flows as determined above for the six tributary streams were adjusted to give flows which might reasonably be expected to be a minimum for the month of August over a long period of time. The results are given below.

Stream	Estimated August average discharge, in cfs	
	1961	long-term minimum
Clear Creek	16	11
Cottonwood Creek	3½	2½
Lawyer Creek	7	4½
Lolo Creek	36	24
Jim Ford Creek	3	2
Orofino Creek	25	16

Earlier in the report, it was pointed out that the ground-water potential along the lower reaches of the South Fork Clearwater River was favroable; hence, the possibility of using this source in combination with water from the South Fork should be considered. The quantity of surface water should be adequate as evidenced by the long-term minimums given in table 4.

Table 4.--Minimum monthly discharge.

Gaging station	Drainage area (sq mi)	Records available	Minimum monthly discharge[a]					
			July		August		September	
			(cfs)	(Cfsm)	(cfs)	(Cfsm)	(cfs)	(Cfsm)
Fish Creek near Lochsa ranger station	89.2	Sept. 1957-	82.4 (66.3)	0.924 (.743)	40.1 (27.5)	0.450 (.308)	32.5 (38.9	0.364 (.436)
South Fork Clearwater River near Elk City	261	Sept. 1944-	88.3 (77.7)	.338 (.298)	37.9 (26.7)	.145 (.102)	24.7 (51.7)	.095 (.198)
South Fork Clearwater River near Grangeville	865	[b]Apr. 1923-	175 (362)	.202 (.418)	87.5 (132)	.101 (.153)	93.0 (204)	.108 (.236)
Lolo Creek near Greer	243	Dec. 1911- Dec. 1912	174	.716	70.6	.291	93.4	.384
Bloom Creek near Bovill	3.66	Aug. 1959-	1.74 (1.48)	.475 (.405)	1.23 (.88)	.336 (.240)	.92 (.94)	.251 (.257)
East Fork Potlatch River near Bovill	42.5	Sept. 1959-	11.8 (10.6)	.278 (.249)	10.3 (6.65)	.242 (.156)	8.72 (9.04)	.205 (.213)
Potlatch River at Kendrick	425	Oct. 1945- Sept. 1960	13.1	.031	5.32	.013	8.56	.020
Mission Creek near Winchester	16 [c]	Dec. 1940- Sept. 1945	.489	.031	.075	.0047	.075	.0047

[a] First figure is minimum for period of record prior to 1961; figure in parenthesis is for 1961.

[b] Fragmentary earlier record.

[c] Approximate.

Temperature of surface water

Water temperatures for the six tributary streams were obtained when measurements were made in November and December 1961 and are shown in table 3. Temperatures during these months are not critical for fish culture and reliance must be placed on records at other sites and assumptions made regarding the comparability of observed temperature and those which are likely to occur in streams in the study area. Fortunately, several short records have been collected at nearby sites. Monthly average maximum and minimum data for these sites are presented in table 5.

Water-temperature readings at the time of discharge measurements only are available at the gaging station South Fork Clearwater River near Grangeville. However, comparison shows that the water temperature is reasonably consistent with temperatures at the station near Elk City. Comparative readings are given below.

Date	Water temperature, °F		
	Grangeville	Elk City	
		max	min
July 13, 1956	67	70	66
Aug. 19	70	67	59
Sept. 29	50	49	46
Nov. 10	38½	37	36
Jan. 12, 1957	32	32	32
Mar. 3	33½	33	33
Apr. 9	44	41	36
May 7	45	48	41
June 23	56½	58	51
July 13	65	68	63
Aug. 22	68	69	61

Diurnal temperature change of water in streams is often quite pronounced. Variations of 10 to 15 degrees are not uncommon; the larger differences generally occur in the smaller streams.

Table 5.—Monthly average range of water temperature (°F).

Water year	October Max	October Min	November Max	November Min	December Max	December Min	January Max	January Min	February Max	February Min	March Max	March Min	April Max	April Min	May Max	May Min	June Max	June Min	July Max	July Min	August Max	August Min	September Max	September Min
Fish Creek near Lochsa ranger station																								
1958	48	45	37	34	34	33	33	33	38	36	40	35	43	39	49	43	58	51	70	58	70	61	58	52
1959	47	43	37	36	39	37	34	33	35	33	39	36	43	39	46	41	55	48	69	57	65	56	56	52
1960	47	44	36	34	34	33	32	32	35	34	38	36	44	40	47	42	58	50	73	61	67	59	60	53
1961	48	44	38	36	—	—																		
Selway River near Lowell																								
1958																					—	—	62	56
1959	49	46	38	37	38	37	34	33	35	35	40	38	—	—	45	44	52	49	—	—				
Lochsa River near Lowell																								
1956																			—	—	72	65	63	58
1957	—	—	—	—			—	—	34	34	40	39	44	43	47	45	54	51	69	63	71	65	63	58
1958	50	48	38	37	35	34	33	32	38	37	42	39	45	43	48	45	58	55	71	65	73	66	62	57
1959	48	46	37	36	38	38	34	34	36	35	41	40	43	41	45	43	51	49	—	—				
South Fork Clearwater River near Elk City																								
1956																	—	—	68	61	65	59	55	51
1957	45	42	34	34	32	32	33	33	33	33	33	33	40	37	47	43	56	52	68	61	66	59	58	53
Clearwater River at Kamiah																								
1956																	—	—	—	—	—	—	64	59
1957	53	50	40	38	36	35	35	34	36	35	43	39	48	43	49	48	56	53	72	66	—	—	67	59
1958	54	50	42	40	39	37	37	36	43	40	46	41	50	45	50	49	61	57	74	67	75	68	65	58
1959	53	49	40	39	39	38	36	35	38	37	42	40	48	44	50	47	53	51	—	—				
Clearwater River near Ahsahka																								
1958	—	—	—	—	35	35	34	34	37	37	41	40	45	44	49	48	61	[illegible]	73	69	73	68	62	57
1959	50	48	—	—	38	37	35	34	36	36	40	39	44	42	47	45	54	[illegible]	68	64	69	65	59	57
1960	49	47	36	35	34	34	33	33	35	34	38	37	45	44	48	47	56	[illegible]	74	70	—	—	64	59
Bloom Creek near Bovill																								
1959																					—	—	53	47
1960	47	44	37	36	33	32	34	33	35	34	[illegible]	34	42	39	48	43	57	49	64	54	60	[illegible]	55	45
1961	47	43	36	35	—	—																		
East Fork Potlatch River near Bovill																								
1960	46	44	36	35	33	32	—	—	35	34	37	35	44	40	50	44	63	55	74	64	65	58	59	52

Turbidity of surface water

The plan of investigation specifically included collection of information on flows and water temperatures. During preliminary discussions, representatives of the Bureau of Sport Fisheries and Wildlife indicated that the turbidity factor, resulting from suspended sediment, also was an important consideration in fish hatchery operation.

So far as can be determined no sediment samples have been taken from any of the six small tributary streams included in the study. Slight turbidity was detected in Cottonwood Creek at the time of the discharge measurement on November 11; otherwise, the water was reported as clear at the time of observations in November and December.

In general, the sediment concentration in streams of the Clearwater River basin is relatively small. There are exceptions, such as the heavy concentration caused in the South Fork a number of years ago as a result of mining operations. Higher than normal concentrations for short periods in Lawyer Creek, Cottonwood Creek, and possibly other streams of the study area may result from farming operations on the watersheds.

A number of miscellaneous samples were taken during 1958-60 at the gaging stations Selway River near Lowell, Lochsa River near Lowell, Clearwater River at Kamiah, and North Fork Clearwater River near Ahsahka for the Idaho Department of Fish and Game. That agency analyzed the samples and report (personal communication) the highest observed sediment concentrations to have been 475 and 450 parts per million in samples taken from the Lochsa River (Oct. 11, 1960) and at Kamiah (Dec. 12, 1958), respectively.

CONCLUSIONS

There appears to be very little possibility of developing a ground-water supply capable of yielding more than a small percentage of the required hatchery water needs at the Orofino, Jim Ford, and Lolo Creek sites.

At Kamiah, at the mouth of Lawyer Creek, it is possible that a ground-water supply could be developed from alluvium or basalt or a combination of the two. However, the preliminary study suggests that neither of these units is a very good aquifer in this area.

At both the Clear Creek and Cottonwood Creek sites, the basalt appears to have a permeability above average and the chances of developing the required water supply from the basalt is believed to be reasonably good. Only relatively small amounts of ground water could be obtained from the alluvium at these sites.

Ground water from the basalt probably will have temperatures ranging from 55 to 60 degrees; the deeper wells would yield water with the higher temperatures, and wells more than 500 feet deep might yield water with temperatures exceeding 60 degrees. Water from the basalt generally is moderately hard; that from the alluvium usually is soft.

The foregoing conclusions are based on a few days of geologic and hydrologic reconnaissance, and sketchy records for 36 wells. Much more detailed information, including test holes and pumping tests will be needed for a firmer estimate of the ground-water potential of the several sites.

There appears to be sufficient surface flow in Clear Creek, South Fork Clearwater River, Lolo Creek, and Orofino Creek to meet requirements for hatchery purposes. The latter two areas are apparently unsuitable because of the ground-water situation. Clear Creek and South Fork Clearwater River appear to be the only two locations where both the ground-water and surface-water potential is favorable. There will be periods of at least two months in the summer when water temperatures of all of the streams will exceed the preferred maximum. Some modification of water temperatures during the winter also seems desirable.

It seems probable that the periods of excessive turbidity will be relatively short and that the worst conditions may occur in those streams draining from Camas Prairie on the west.

Much of the analysis of surface-water potential has been based on correlations rather than on data available at the sites. The findings, therefore, should be applied with appropriate consideration of the reliability.

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