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TEST-WELL DRILLING IN THE UPPER SATUS CREEK BASIN, YAKIMA INDIAN RESERVATION, WASHINGTON

By H. E. Pearson, 1935-

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METRIC CONVERSION TABLE

Multiply	By	To obtain
Inches	0.0254	meters (m)
	25.4	millimeters (mm)
Feet (ft)	30.48	centimeters (cm)
	.3048	meters (m)
Square feet (ft^2)	.09290	square meters (m^2)
Gallons per minute (gal/min)	.06309	liters per second (L/s)

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ABSTRACT

Two test wells were drilled in the upper Satus Creek basin of the Yakima Indian Reservation to provide geohydrologic information not otherwise available. The wells were drilled by the air-rotary method. At site 1 the well penetrated a young basalt and 175 feet of the Yakima Basalt Formation, and at site 2 the well penetrated the young basalt.

The well at site 1 was drilled to a depth of 350 feet. Testing for drawdown and yield indicated a specific capacity of about 11 gallons per minute per foot of drawdown. The potential yield of this well may be about 1,000 gallons per minute.

The well at site 2 was drilled to a depth of 500 feet. Only a small quantity of water was encountered and no test for yield was made.

Data from these wells, including chemical analysis of the water from the well at site 1, will provide information useful in the development and management of the ground-water resources in this part of the Yakima Indian Reservation.

INTRODUCTION

Purpose and Scope of the Study

The drilling of two test wells in the upper Satus Creek basin of the Yakima Indian Reservation was supervised by the U.S. Geological Survey in cooperation with the Yakima Tribal Council. The purpose of the test wells was to obtain information on ground-water conditions in this undeveloped upland part of the reservation. Mundorff and others (1977, p. 95) suggested that large yields might be obtained from wells drilled into the young basalt underlying the area, to augment the base flow of streams or to sprinkle irrigate arable upland tracts.

The test wells were drilled to depths of 350 and 500 ft. Test well 1 (350 ft) was test pumped, but test well 2 (500 ft) was not test pumped because of the lack of sufficient water. In addition to the information on ground-water availability at the two sites, a sample of the water from test well 1 was analyzed for chemical quality.

Previous Studies

The generalized geology of the upper Satus Creek basin was included in studies by Laval (1956) and Schmincke (1964). The geohydrology of the area is discussed in reports by Molenaar (1977) and Mundorff and others (1977).

Geologic Setting

The Satus Creek basin, in the Yakima Indian Reservation of south-central Washington (fig. 1), is underlain by several thousands of feet of the Yakima Basalt of the Columbia River Basalt Group of Miocene and early Pliocene age. The basalt flows are downwarped to form a structural and topographic basin that is open toward the Yakima River on the east; streams in the basin drain to the Yakima River. The axis of the structure is generally east-west and the lowest part lies approximately along the course of lower Satus Creek. Ground water occurs in fractures and interflow zones in the basalt, and the structure greatly influences the movement of ground water in the basin. Several wells in the lowland obtain water from the Yakima Basalt.

The upper Satus Creek basin, defined as that part rising west of the relatively flat lowland, is by far the largest part of the total basin. The highest point in the basin is 5,800 feet, at Potato Butte near the southwestern margin. The western part of the upland area is underlain by younger lava flows (olivine basalt) of late Pliocene and early Pleistocene age. Mapped by Sheppard (1967), these flows

extend south from Toppenish Ridge to the Simcoe Mountains area (outside the study area).

The upper Satus Creek basin is marked by rolling, partly forested topography cut in places by several streams that occupy deep gorges draining toward the east and northeast. The streamflow is provided by direct runoff from precipitation and snowmelt, and in some places--where the stream canyons have been cut below the base of the young basalt--by seepage of ground water percolating through the young basalt. The occurrence of ground water in the young basalt has been presumed from spring seepage to streams, particularly along Logy Creek which lies along the axis of a secondary downwarp in the upland area. The test well drilling was done primarily to determine the extent to which ground water occurs in the young basalt and to determine the potential for development of the ground water in the upland, from wells tapping the young basalt and the underlying Yakima Basalt.

DESCRIPTION OF THE TEST WELLS

Test well 1 is located in the NW¼SW¼ sec. 7, T.7 N., R.17 E. This site is in the drainage basin of the south fork of Logy Creek. Test well 2 is in the SW¼NW¼ sec. 28, T.8 N., R.16 E. This site is in the drainage basin of the middle fork of Dry Creek. Logy Creek and Dry Creek are major tributaries of Satus Creek.

The test wells were drilled between July 19 and August 16, 1976, by B and B Drilling Co.,[1] of Ahtanum, Wash. Using the air-rotary drilling method was used to achieve faster rock penetration, nonplugging of rock openings by drilling fluids, and a smooth, straight borehole. The drill rig was a Speedstar model SS-15-THH, top drive rotary with a casing hammer.[1]

tables 1 & 2

Tables 1 and 2 present the logs of the test wells, and figure 2 shows the construction features of the test wells.

fig. 2

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[1] The mention of brand names and commercial operators in this report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

Test well 1 has consisted of a 10-inch sanitary-seal pipe to a depth of 15 ft, an 8-inch cased hole from the surface to a depth of 63 ft, an 8-inch open hole from 63 to 250 ft, and a 6-inch open hole from 250 ft to the final depth of 350 ft. The well penetrated the young basalt (table 1) to a depth of 175 ft and then entered and remained in the Yakima Basalt where water was encountered in two zones of fractured or creviced rock.

Test well 2 has consisted of a 10-inch sanitary-seal pipe to a depth of 11 ft, an 8-inch cased hole from the surface to a depth of 21 ft, an 8-inch open hole from 21 to 240 ft, and a 6-inch open hole from 240 to 500 ft. The well was drilled entirely in young basalt (table 2).

According to geologic section B-B' on the map prepared by Sheppard (1967), the maximum thickness of the young basalt beneath the reservation may be as much as 1,500 ft, and at test well site 2 it may be about 750 ft; the test drilling there indicates it is at least 500 ft thick. Only a small quantity of water was encountered at a depth of about 428 ft, and therefore no aquifer test was possible.

AQUIFER TEST

On August 25, 1976, an aquifer test--test pumping of the well--was made using well 1. A turbine pump with a 6-inch column and six-stage bowl with a maximum rated capacity of 300 gal/min was used for the test.

The static water level--level before pumping started--was 115.8 ft below land surface. After 10 minutes of pumping at a rate of 220 gal/min, the water level was drawn down to 136.9 ft below land surface. The pumping rate was reduced slightly to 215 gal/min, and the water level became stabilized at 136.1 ft below land surface about 4 hours after pumping had started and remained constant at that level for the remaining 6 hours of the pumping test (total of 10 hrs.). Water-level measurements were made only in test well 1, as there were no nearby wells where lowering of the water level due to pumping of the test well could be observed. The pumping rate was monitored by a flow meter and remained at about ~~210-220~~ 215 gal/min during the period of pumping.

The rate at which the water level in the well recovered from the

effects of pumping was also measured. Within 5 minutes after pumping ceased, the water level recovered about 12 ft, after 20 minutes there was 14 ft of recovery, and after 1 hour there was 15 ft of recovery. Full recovery to the original static water level occurred about 4 hours after pumping stopped. Table 3 summarizes, and figure 3 graphically illustrates, the water-level drawdown and recovery during the pumping test.

The specific capacity of well 1 (the rate of discharge of water from the well divided by the drawdown of water level within the well) was about 11 gal/min per foot of drawdown. The transmissivity[1] of the basalt aquifer, determined by the method used by Mundorff and others (1977, p. 50; roughly equivalent to the specific capacity multiplied by 270) is approximately 3,000 ft^2 per day.

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[1]Transmissivity is the rate, usually expressed in square feet per day, at which water is transmitted through a 1 ft vertical strip of the water-bearing material (aquifer) under a hydraulic gradient of 100 percent.

The potential yield of test-well 1 was calculated to be about 1,000 ~~1,075~~ gal/min. This was determined from the aquifer pumping-test data and the assumption that the relationship between drawdown and pump yield is directly proportional. For example, if the drawdown were increased five times, to about 100 ft, the pump yield would also be increased five times, to about 1,000 ~~1,075~~ gal/min.

GROUND-WATER QUALITY

A water sample for chemical analysis was collected during the pumping of test well 1. The analysis (table 4) indicates that the water is soft and is suitable for all common uses.

CONCLUSIONS

The information resulting from the two test wells drilled in the upper Satus Creek basin indicates moderately favorable conditions for ground-water development from the Yakima Basalt but not from the young basalt where tested in the upper Logy Creek and upper Dry Creek drainages. In the upper Logy Creek basin, properly constructed wells could obtain 1,000 gal/min or more from the Yakima Basalt, with pumping levels about 100 ft below the static water level. At the test well site in the upper Dry Creek basin, there appears to be insufficient quantities of ground water available for most uses within depth zones that are economically feasible for pumping.

At some places in both the upper Logy Creek and upper Dry Creek basins, however, it may be possible to obtain large well yields from the young basalt. The lack of water in the young basalt at both sites 1 and 2 may be due to the unfortunate selection of a drilling site, or where the configuration of the Yakima Basalt surface results in local thinning of the young basalt. Also, water does not occur throughout the entire thickness of basalt, but rather in fractured zones between successive

flows or in sedimentary interbeds between flows. Numerous saturated zones in the young basalt may occur since water is discharged naturally into perennial streams,

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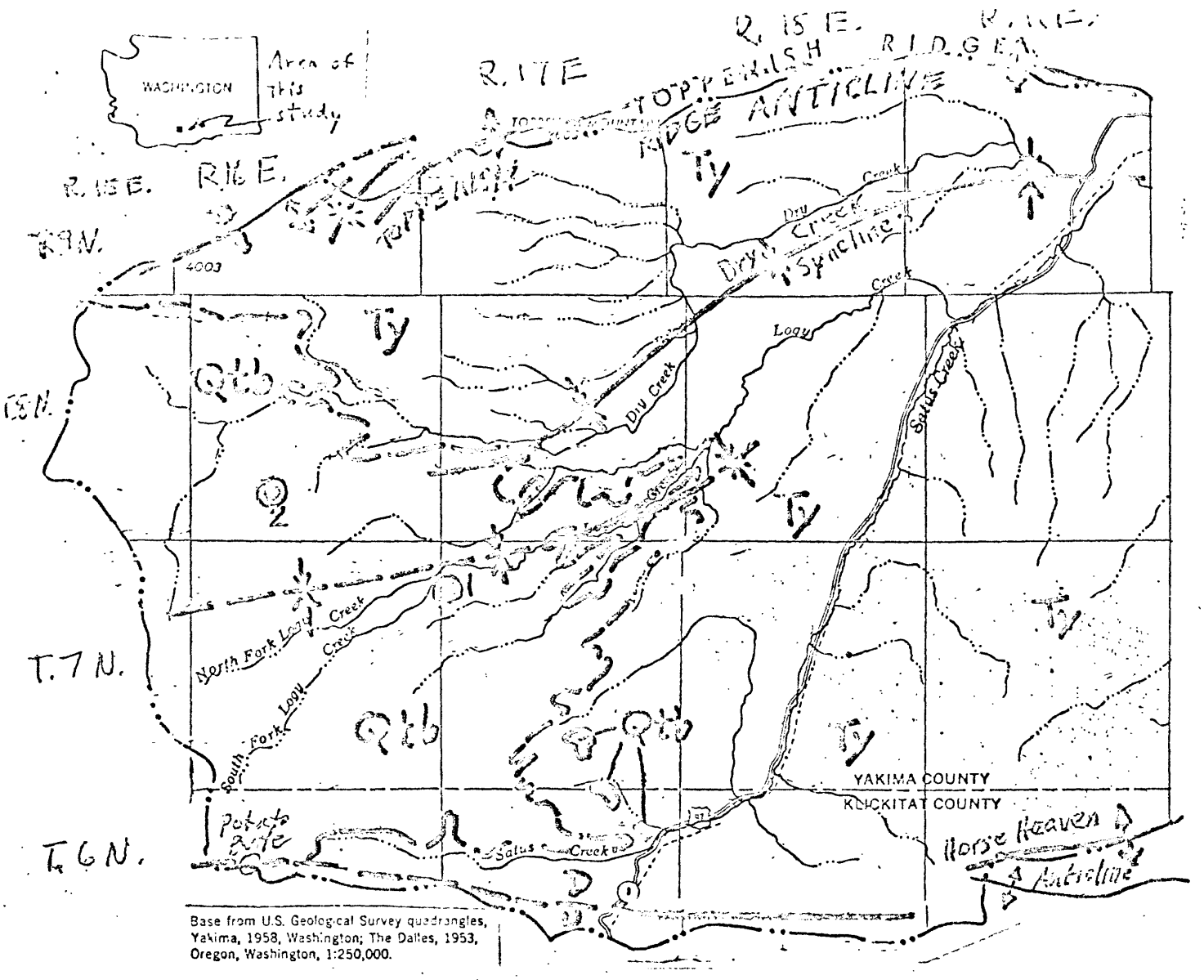

EXPLANATION

1 Test well 1
2 Test well 2

(Quaternary age)

Qtb Young basalt. Olivine basalt extruded from northwest-trending zone of shield volcanoes and local vents. Thin, black, porous, fresh-appearing lava flows, 3 to 40 feet thick. Some scoria cones, mainly red to dark gray. (Tertiary age)

Ty Yakima basalt. Dark gray to black, each sequence generally 20 to 150 feet thick. Bases of flows are generally dense and fine-grained; upper layers are often vesicular and(or) rubbly.

Anticline; dashed where inferred

Syncline; dashed where inferred

Fault: dashed where inferred; D, downthrown side; U, upthrown side

Geologic contact

Basin boundary

FIGURE 1.-- Locations of test wells and generalized geology and structural features in uplands of Satus Creek basin. Geologic units from Sheppard (1967) and Mundorff and others(1977), and structural features from Mundorff and others(1977).

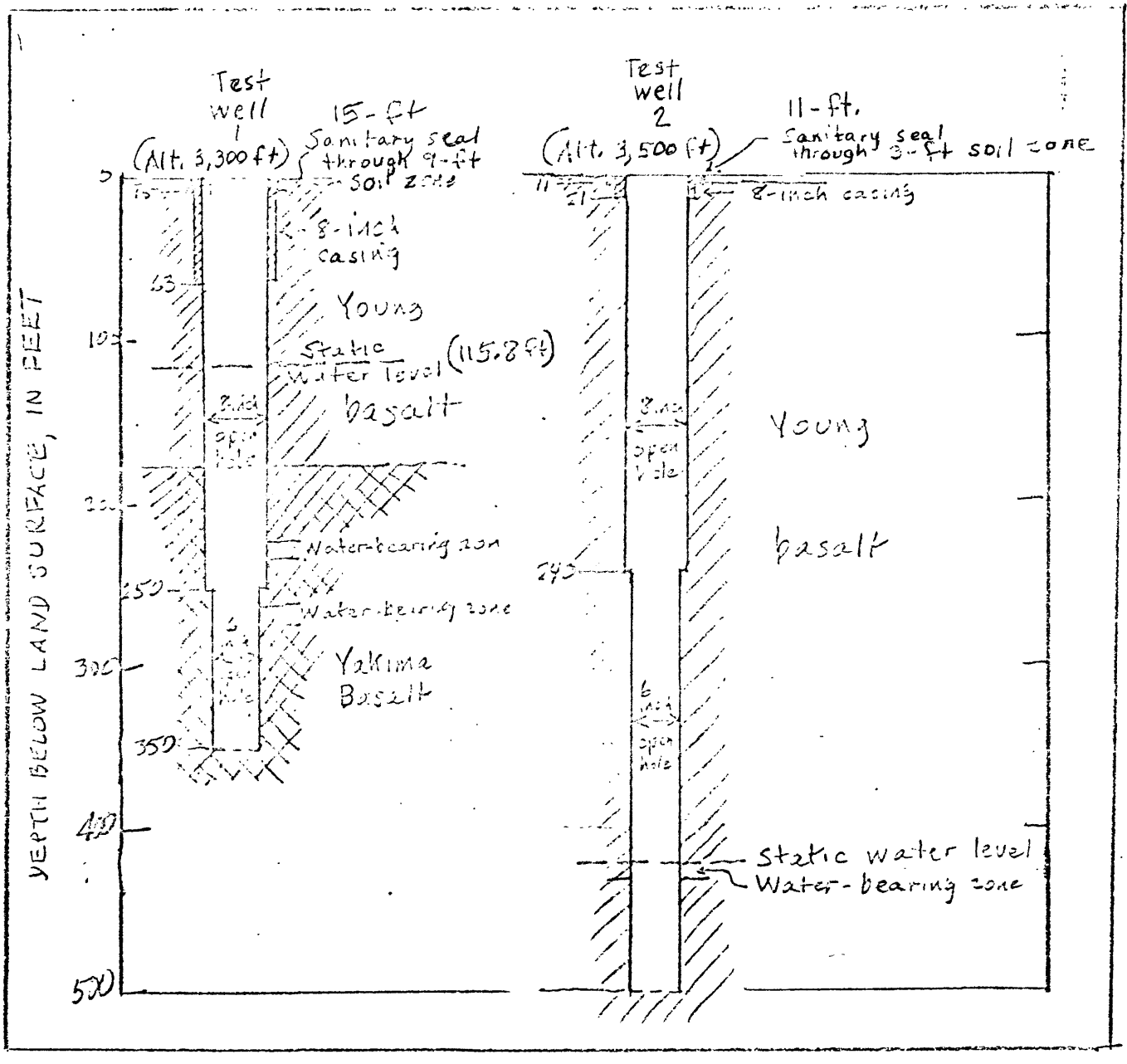

FIGURE 2.-- Diagrams show construction features of test wells.

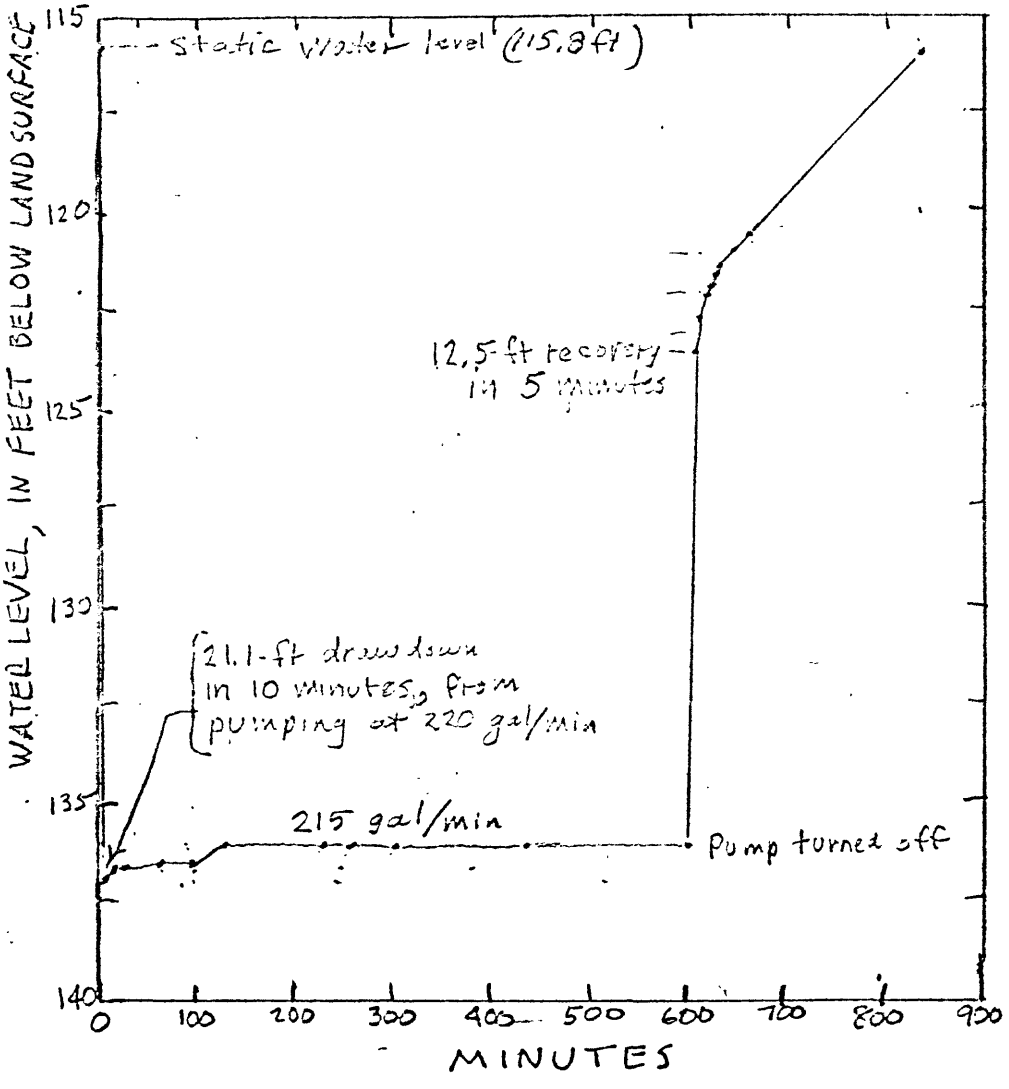

FIGURE 3.-- Drawdown and recovery of water level during pumping test of test well 1, August 25, 1976.

TABLE 1.--Log of test well 1

Located in the NW¼SW¼ sec. 7, T.7 N., R.17 E., allotment T-2971, about 30 ft south of dirt road. Altitude about 3,300 ft. Drilled by B and B Well Drilling Co., July 19-August 2, 1976.
Casing: 8-inch to 63 ft. Static water level about 116 ft below land surface.

Material	Thickness (ft)	Depth (ft)
Soil, soft, with some brown clay----------	9	9
Young basalt:		
Basalt, gray, hard----------	31	40
Basalt, brown, medium-hard----------	46	86
Basalt, red, soft (pillows?)----------	17	103
Basalt, brown, medium-hard----------	10	113
Cinders, brown, soft with clay----------	23	136
Basalt, brown, fractured, with some water---	19	155
Basalt, brown, fractured, with cinders------	20	175
Yakima Basalt:		
Basalt, gray, hard----------	45	220
Basalt, gray, fractured, with water--------- (estimated 20 gal/min discharge)	12	232
Basalt, gray, hard----------	30	262
Basalt, gray, hard, creviced and water-bearing---------- (estimated 150 gal/min discharge)	10	272
Basalt, gray, hard----------	28	300
Basalt, gray, fractured----------	10	310
Basalt, black, dense hard----------	40	350

TABLE 2.--Log of test well 2

Located in the SW¼NW¼ sec. 28, T.8 N., R.16 E., allotment T-4026, about 100 ft east of dirt road. Altitude about 3,500 ft. Drilled by B and B Well Drilling Co., August 11-16, 1976.
Casing: 8-inch to 21 ft. Static water level about 420 ft below land surface.

Material	Thickness (ft)	Depth (ft)
Soil	3	3
Young basalt:		
Basalt, gray, hard	27	30
Basalt, gray, with brown clay	5	35
Basalt, gray, hard	2	37
Basalt, gray, soft, with brown clay	7	44
Basalt with some cinders	6	50
Basalt, gray, medium hard	68	118
Clay, red, soft	22	140
Clay, brown, soft, with some blue siltstone	18	158
Basalt, gray, hard	2	160
Basalt, gray, soft, with some silt	20	180
Basalt, gray, soft, with brown clay	35	215
Basalt, black, hard	10	225
Sand, black, soft and coarse-grained	15	240
Basalt, black, hard	6	246
Basalt, black, fractured	86	332
Basalt, with red cinders	8	340
Basalt, black, hard	7	347
Cinders, red, soft, with some clay	53	400
Basalt, gray, hard	3	403
Basalt, gray, with red cinders	20	423
Basalt, gray, medium hard, with some water	5	428
Sand, black, coarse	3	431
Basalt, gray, with pockets of red cinders	69	500

TABLE 3.--Data from pumping test of well 1, August 25, 1976

Time (local)	Time after pumping started/or stopped (minutes)	Water level below land surface (ft)	Drawdown (ft)	Remarks
0800	5 (before)	115.8	0	Static water level
0805	0	---	-	Pump on
0815	10	136.9	21.1	Discharge = 220 gal/min rate
0823	18	136.7	20.9	215 gal/min
0831	26	136.7	20.9	215 gal/min
0907	62	136.5	20.7	215 gal/min
0940	95	136.5	20.7	215 gal/min
1015	130	136.4	20.6	215 gal/min
1155	230	136.1	20.3	215 gal/min
1225	260	136.1	20.3	215 gal/min
1310	305	136.2	20.4	215 gal/min
1520	435	136.1	20.3	215 gal/min
1805	600	136.1	20.3	215 gal/min
1815	0	136.1		Pump off
1820	5	123.6		(recovery)
1825	10	122.7		
1830	15	122.1		
1835	20	121.8		
1840	25	121.5		
1845	30	121.3		
1900	45	120.9		
1916	61	120.6		
2210	235	115.9		

TABLE 4--Chemical analysis of water from test well 1

Item	Values in milligrams per liter, unless otherwise indicated
Date and time of collection	August 25, 1976, at 11:30 a.m. (about 3½ hrs after pumping began)
Silica (SiO_2)	21
Iron (Fe)	40 micrograms per liter
Manganese (Mn)	0 micrograms per liter
Calcium (Ca)	18
Magnesium (Mg)	7.9
Sodium (Na)	7.9
Potassium (K)	1.3
Bicarbonate (HCO_3)	112
Alkalinity as $CaCO_3$	92
Sulfate (SO_4)	1.9
Chloride (Cl)	0.8
Fluoride (F)	0.1
Nitrite plus nitrate (as N)	0.08
Dissolved solids (calculated)	114
Hardness as CaCO	77
Noncarbonate hardness	0
Sodium adsorption ratio	0.4 Sodium Adsorption Ratio
Specific conductance	144 micromhos per cm at 25°C.
Water temperature	10.8 degrees Celsius
Color	3 platinum cobalt units