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GROUND-WATER RECONNAISSANCE OF THE SAILOR CREEK AREA, OWYHEE, ELMORE, AND TWIN FALLS COUNTIES, IDAHO

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ABSTRACT

This report evaluates the ground-water resources of about 1,000 square miles in the semiarid uplands south of the Snake River between the Bruneau River and Salmon Falls Creek.

The outcropping rocks are the Idavada Volcanics of Pliocene age, and the Idaho Group of Pliocene and Pleistocene age, consisting of the Banbury Basalt of middle Pliocene age and the overlying predominantly sedimentary deposits of middle Pliocene through middle Pleistocene age. These rocks dip gently northward. The volcanic rocks are the best aquifers, but the yield of water from the sedimentary deposits is adequate for domestic and stock use. About 6,000 acre-feet of water is withdrawn annually from the Idavada Volcanics by 9 irrigation wells to irrigate about 3,000 acres. Only a few tens of acre-feet of water is withdrawn from the other formations.

The regional dip of the rocks induces weak artesian conditions in the volcanic rocks and somewhat higher artesian head in the sedimentary rocks.

Estimated depth to water ranges from less than 250 feet to more than 750 feet, as shown in an accompanying map.

The eastern part of the area appears to be more favorable for the development of ground water for irrigation than the western part because of better aquifers at shallower depth.

INTRODUCTION

The Sailor Creek area includes those parts of Owyhee, Elmore, and Twin Falls Counties lying between the Bruneau River and Salmon Falls Creek, and from the Snake River to the south side of Township 10 South (fig. 1). The area is essentially identical to unit 1-1 of the U.S. Bureau of Land Management's division of the State into units of their master plan. A part of the area is public land under the administration of the Bureau of Land Management and a part is used as a gunnery range by the U.S. Air Force. This report is a reconnaissance evaluation of the occurrence and availability of ground water in the area, done during July and August 1962 at the request of the Bureau of Land Management to aid the Bureau in orderly planning of future development. Two weeks were spent collecting well logs and other well data and examining geologic formations. Altitudes of wells were interpolated from topographic maps.

Well owners, drillers, and pump companies supplied much of the basic data and their cooperation is gratefully acknowledged. Published data by H. E. Malde, H. A. Powers, and C. H. Marshall of the Geologic Division of the U.S. Geological Survey were extremely valuable in making hydrologic interpretations for this investigation and in the preparation of a generalized geologic map of the area.

Private individuals, companies, and the U.S. Bureau of Reclamation have considered using water from Snake River to irrigate parts of the upland area. The latest study by the Bureau of Reclamation (1961, vol. IV, pt. 1, p. 285-295) indicated that there is at least 133,000 acres of medium to high quality land suitable for irrigation in T. 6-9 S., R. 6-13 E. The irrigable land lies in scattered shoestring-shaped areas. The considered water supply would be from a dam and reservoir on the Snake River at Clear Lakes, about 7 miles upstream from the mouth of Salmon Falls Creek.

The provisions of the Desert Land Act of 1877 and subsequent amendments have given impetus to recent irrigation of desert lands in many parts of Idaho by pumping ground water. A strong demand for opening of public land to desert entry is anticipated with the return of $13\frac{1}{4}$ townships of the gunnery range to the administration of the Bureau of Land Management and with the ending of the moratorium on the filing of desert land entries.

Geography

The Sailor Creek area is a rolling upland of about 1,000 square miles dissected by broad valleys and narrow canyons. The altitude of the upland ranges from 3,000 to 4,100 feet above sea level. The Snake and Bruneau Rivers and Salmon Falls Creek flow in narrow valleys or canyons 300 to 800 feet below the upland.

All streams within the area are ephemeral. Sailor and Deadman Creeks are the principal streams and are tributary to the Snake River. Lesser drainage ways are Pot Hole Creek, which is a tributary of Sailor

Creek, and Tuana Gulch, Rosevear Gulch, and Browns Creek, which are tributary to the Snake River. The drainage basins of the smaller streams and most of the drainage basins of Sailor Creek and Deadman Creek are within the Sailor Creek area. There are many draws, gulches, and "creeks" of minor importance. About 80 percent of the area drains to the Snake River less than 5 percent to Salmon Falls Creek, and about 15 percent to the Bruneau River.

In the northern three-fourths of the area broad valleys with little relief have been eroded below relatively flat table lands. Steep slopes and small-scale "badland" topography separate the valleys from the table lands. The southern part of the area is broadly rolling and comparatively undissected.

Sage brush is the predominant native vegetation, but rabbit brush is common. Large areas in the northern part have been cleared and reseeded to range grasses. "Cheat" or "bronco" grass has invaded the area and is the predominant grass in the north-central part. These grasses and the sparse native grasses growing with the sage brush are foraged by sheep and cattle. Substantial stands of Russian thistle thrive on land cleared for reseeding.

All crops in the area depend on irrigation. The water supply in the Bruneau River Valley is from Bruneau River and flowing wells. Water pumped from Snake River is used to irrigate Indian Cove and a few small isolated tracts. Water from Malad Springs irrigates terraces south of the Snake River reaching from Bliss to Pasadena Valley, Kinghill, and Glenns Ferry.

The valley bottoms and low terraces along the Snake and Bruneau Rivers are not the concern of this report, because they are mostly in agricultural production and it is believed that most irrigable land has an adequate water supply. Some irrigable land in Indian Cove is undeveloped. The canyon of Salmon Falls Creek has no tillable land and very little for pasturage. Withdrawals from or recharge to the aquifers in the lowland areas probably do not greatly affect the water supply of the uplands, although withdrawal by the deep artesian wells in the Bruneau River Valley undoubtedly affects the water supply of the Sailor Creek area but data are too inadequate to permit estimation of the magnitude of the effect.

The uplands are now cultivated only along lower Salmon Falls Creek. About 4,200 acres is irrigated in the southeast part of T. 8 S., R. 13 E. and the northeast part of T. 9 S., R. 13 E. with water pumped from Salmon Falls Creek by the Magic Water Corporation and about 3,000 acres is irrigated with ground water in the northwest part of T. 10 S., R. 13 E. and the northeast part of T. 10 S., R. 12 E. About 300 of the 3,000 acres receives water pumped from Salmon Falls Creek.

Dry farming was tried in part of the area now irrigated with ground water and the valley of Deadman Creek south of Glenns Ferry was dry farmed many years ago, but dry farming is no longer practiced. The remaining upland is used for pasturage.

Bruneau village is the only settlement in the Sailor Creek area. The only permanently occupied houses on the upland are in the area irrigated with water from Salmon Falls Creek. The area is rimmed on the north and east by scattered villages and farms, but the interior has no permanent residents.

The U.S. Air Force has used 19¼ townships in the area for an aerial gunnery range. In September 1962 13¼ townships were eliminated from the range.

The developed areas around the edge of the upland have paved and graveled roads, but the upland has few graveled roads and no paved roads. Graded dirt roads and unimproved "wagon" roads provide access to the upland during most seasons of the year.

Climate

The climate of the area is semiarid with hot summers and cool to cold winters. Weather stations around the margin of the area and isohyetal maps indicate that most of the area receives about 8 inches of precipitation annually. A weather station was established at the Cheat Grass Experiment Area in sec. 21, T. 6 S., R. 9 E. in 1961 and a storage rain gage was installed in sec. 21, T. 10 S., R. 10 E. in July 1962.

The mean annual temperatures at stations around the area range from 47.7 to 54.1°F. The lower temperatures are probably representative of the area.

The following table shows the precipitation and temperature at stations near and on the border of the area.

Precipitation and temperature at stations near the Sailor Creek area

(From records of the U.S. Weather Bureau)

Station	Altitude (feet above sea level)	Average annual precipitation (inches)	Period of record	Mean annual temperature (°F)	Period of record
Bliss	3,269	7.60	1920-61	49.6	1932-61
Buhl	3,500	8.21	1919-61	50.1	1919-61
Glenns Ferry	2,580	8.55	1923-61	54.1	1930-61
Grasmere	5,126	7.95	1954-61	47.7	1954-61
Hot Spring	2,590	8.62	1906-18	52.5	1906-18
Three Creek	5,420	1/ 13.13	1940-59	-	-

1/ Partly estimated.

Precipitation in the Jarbidge Mountains and on Elk Mountain near the Nevada-Idaho boundary supplies most of the flow of the Bruneau River and its tributaries, the East Fork Bruneau River and the Jarbidge River, south of the East Fork Bruneau River. Precipitation also is the principal source of recharge to the Sailor Creek area. Data from snow courses in and near the Jarbidge and Elk Mountain suggest that precipitation probably averages more than 20 inches at the higher elevations on the mountains and locally exceeds 24 inches.

Evaporation is an important factor in determining the amount of effective precipitation available for other uses. Kohler and others (1959, pl. 2) estimate that annual evaporation from lake surfaces in the southern part of south Idaho is 38 inches. Any development which contemplates storage or transmission of water in surface structures would have to consider this loss. For example, the canal and distribution system of the Magic Water Corporation is relatively long, and evaporation is an important part of their losses.

Evapotranspiration is defined as the water used in plant growth and water evaporated from adjacent soil. According to Blaney and Criddle (1949, p. 9) evapotranspiration by sparse vegetation ranges from 6 to 9 inches annually. No data are available to estimate evapotranspiration by native vegetation in the Sailor Creek area, but a rate of 7½ inches is arbitrarily assumed.

Simons (1953, p. 64) and Jensen and Criddle (1952, p. 12) estimate that evapotranspiration by irrigated crops in southern Idaho ranges from 10.6 to 21.7 inches, depending on the crop. This value includes precipitation during the growing season. Considering the types of crops grown in the eastern part of the Sailor Creek area (grain, potatoes, and alfalfa) the evapotranspiration may average about 18 inches, or about 11,000 acre-feet from 7,200 acres.

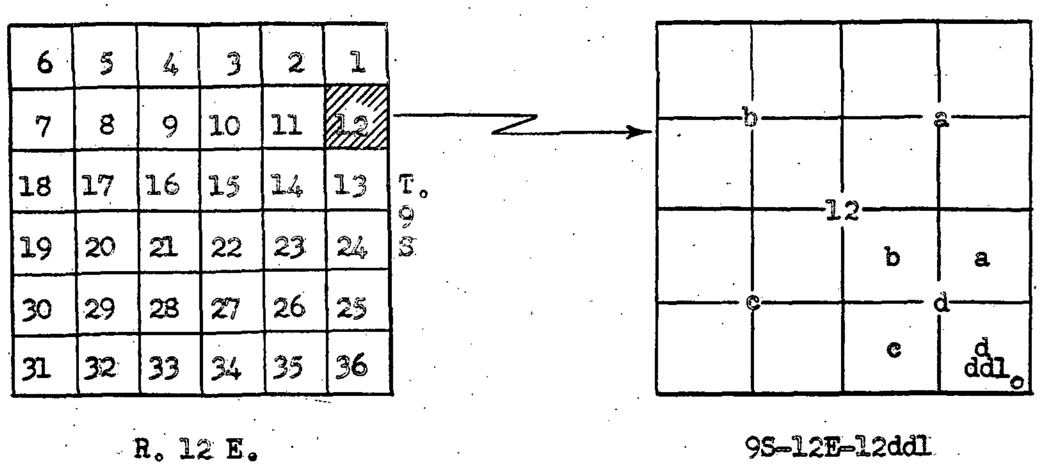
Previous investigations

Piper (1924) studied the water resources of the Bruneau River basin with particular emphasis on the area from Hot Springs to Bruneau and Little Valley southwest of Bruneau. Littleton and Crosthwaite (1957) restudied the same area and a part of the Snake River Valley to the west of the Sailor Creek area. Mundorff and others (1960) summarized ground-water conditions in the Snake River Valley including the Bruneau-Indian Cove-Glenns Ferry area and the Sailor Creek area. Hadley and Sumsion (1958, 1959) examined proposed well sites for stock water for the Bureau of Land Management.

Malde and Powers (1962) have made a detailed geologic study of the canyon lands from Buhl to Indian Cove. Malde, Powers, and Marshall (1963) have made a reconnaissance geologic map that includes the Sailor Creek area.

Well-numbering system

The well-numbering system used in Idaho by the Geological Survey indicate 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 (see diagram). Within the quarter sections 40-acre tracts are lettered in the same manner. Well 9S-12E-12dd1 is in the SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 12, T. 9 S., R. 12 E. and is the well first visited in that tract.



Sketch showing well-numbering system

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

Malde and Powers (1962) have mapped in detail the geology from the mouth of Sailor Creek east to Salmon Falls Creek and from the Snake River south to about 1 mile south of the south line of T. 7 S. Malde, Powers, and Marshall (1963) have mapped in reconnaissance all the Sailor Creek area. A modification of their map is reproduced as figure 1.

The rocks consist of rhyolitic and basaltic volcanic rocks and sedimentary deposits dominated by silt, sand, and clay. The sedimentary beds include some ash and diatomite. For the purpose of this report the rocks are divided into three units: a rhyolitic unit, the Idavada Volcanics (Pliocene); a basaltic unit, the Banbury Basalt (Pliocene) of the Idaho Group; and a sedimentary unit, principally the Glenns Ferry Formation (Pliocene and Pleistocene) of the Idaho Group but also including other Pleistocene sedimentary deposits of the Idaho Group. Deposits above the Idaho Group consisting of alluvium and terrace deposits of late Pleistocene and Recent age are largely ignored, because they either yield no water or are unrelated to the hydrology of the uplands in the Sailor Creek area. The approximate subsurface relations of the geologic units are shown on two cross sections (figs. 2 and 3).

Structure

In general all the formations dip gently northward toward the Snake River, but southward dips are found locally. At some places the sedimentary beds are nearly horizontal. Near centers of basaltic eruptions the flows slope away in all directions. The fine-grained sedimentary beds and dense nonpermeable volcanic rocks tend to confine ground water in permeable beds and in fractured, broken volcanic rocks, thus causing artesian conditions.

All the formations are broken by northwesterly trending faults, usually downthrown on the northern side. There are occasional narrow downthrown blocks bounded by faults on both sides. Almost all the identified faults are in the southern half of the area (figs. 1, 2, and 3). The basaltic and silicic volcanic rocks are displaced from a few to several hundred feet. The Idavada volcanics have been displaced more than the Banbury Basalt and the Banbury Basalt displaced more than the sedimentary deposits, indicating that there were several periods of faulting. The faulting doubtless influences the occurrence and movement of ground water, but many additional data would be required to determine the effect of the faulting. In the nearby Bruneau-Grand View area the zones of fracturing caused by faulting are believed to provide avenues for the downward movement of recharge and the upward movement of artesian water in areas of discharge (Littleton and Crosthwaite, 1957, p. 168). The same conditions may occur in the Sailor Creek area.

Idavada Volcanics

The oldest rocks exposed in the Sailor Creek area are a thick sequence of tuff, welded ash, and lava flows of silicic composition. The field term "rhyolite" is often applied to this unit. Malde, and Powers (1962) named the formation the Idavada Volcanics and believed it to be of early Pliocene age. The formation is exposed in the canyons of Salmon Falls Creek and the Bruneau River and at the surface in the central and southeast part of the area (fig. 1). Presumably the formation underlies all the Sailor Creek area at some unknown depth. Most of the formation consists of welded ash flows ranging in thickness from a few to several hundred feet, and black to dark gray, lavender, and brown in color. Much of the rock is massive with widely spaced vertical joints but a platy, more or less horizontal jointing is generally present. Thin banding is common. Tuffaceous sediments and ash beds occur between the flows in the mountains several miles south and southeast but they do not crop out in the Sailor Creek area. Logs from irrigation wells in the southeast part of the area suggest that tuffaceous sediments are present in the subsurface of at least a part of the area.

Joints and platy partings provide openings for the movement of ground water, and the wells in the southeast part of the area obtain water from these openings. Nonwelded tuff beds also yield water to wells where the beds are below the water table.

Idaho Group

Banbury Basalt.--The Banbury Basalt of middle Pliocene age overlies the Idavada Volcanics. It is exposed in the southern and central parts of the area from Salmon Falls Creek to the Bruneau River and crops out at several places in the valley of the Snake River from Salmon Falls Creek to Tuana Gulch (fig. 1). The Banbury Basalt is locally at least 1,000 feet thick. Malde and Powers (1962) divide the formation into 3 parts: A lower unit consisting of at least 400 feet of decomposed olivine basalt; a middle unit about 100 feet thick consisting of sand and gravel with some silt, clay, diatomite, and volcanic ash; and an upper unit 500 feet thick consisting of olivine basalt and porphyritic plagioclase-olivine basalt. Locally, thin discontinuous beds of silt and sand occur between the basalt flows. South and southwestward from the mouth of Salmon Falls Creek the formation becomes thinner and at some places only one or two flows of the Banbury Basalt lie on the Idavada Volcanics.

In the canyon of the Bruneau River 7 miles south of Hot Springs 800 feet of the formation is exposed above river level. A few miles to the south the underlying Idavada Volcanics rise above river level and at the junction of the East Fork Bruneau River and Bruneau River the Banbury Basalt is about 300 feet thick.

The Banbury Basalt probably underlies the northwestern part of the area but it is deeply buried at most places. Wells drilled for oil or gas and by the U.S. Army, Corps of Engineers (wells 6S-17E-16bbl, 6S-8E-19bbl, 6S-8E-28adl, and 7S-9E-16bcl) encountered basalt which may be Banbury Basalt at depths of 2,300 to 2,600 feet below land surface.

The basalt is vesicular, hard, dense, and fine textured. The predominant color is dark gray, tinged with brownish alteration products. Some deeply weathered basalt is brown and crumbly. Jointing is prominent and ranges from widely to closely spaced. At some places tuff, cinders, and pillow basalt occur. Contact zones between flows and between flows and intercalated sediments are often composed of vesicular, broken, rubbly basalt.

At most places the deeply weathered basalt yields little water to wells because most of the joints and other openings are filled with alteration products and secondary minerals that permit little circulation of ground water. Water is transmitted through joints in the less weathered basalt, rubbly interflow zones, and cinders. The interbedded sediment may yield small supplies of ground water.

Sedimentary deposits.--The central and northern parts of the Sailor Creek area are underlain by sedimentary beds with intercalated basalt flows, all within the Idaho Group. These sedimentary deposits overlap the Banbury Basalt and Idavada Volcanics across the central part of the area and extend into the southeast corner of the area (fig. 1). The sediments consist predominantly of tan, pale yellow, olive, brown, gray, and white silt, clay, and fine sand but include some pebble and cobble gravel. They also include some ash and dark colored basaltic sand beds. A few olivine basalt flows of somewhat limited areal extent are intercalated in the sediments. The sedimentary deposits and basalt flows in the northeast part of the area are in the Glenns Ferry Formation of late Pliocene and early Pleistocene age (Malde and Powers, 1962) and resemble the Banbury Basalt in degree of alteration and permeability to ground water. The beds also include parts of the Tuana Gravel (early Pleistocene), Bruneau Formation (middle Pleistocene), and other formations of the Idaho Group, described by the same authors. The basalt flows downstream from Deadman Canyon are in the Bruneau Formation. The sedimentary deposits were laid down in lakes and on flood plains of streams. Total thickness of the sedimentary deposits exceeds 3,000 feet. The thickness at Glenns Ferry exceeds 2,700 feet, according to well logs. The intercalated basalt flows are quite variable in thickness, from several hundred feet where they filled stream channels or valleys to 1 or 2 feet at the edge of flows.

Beds of permeable sand yield small amounts of water to wells and joints and other fractures in the intercalated basalt flows often yield somewhat larger supplies.

HYDROLOGIC SETTING

Ground water occurs under artesian, unconfined, and perched conditions in the Sailor Creek area. As mentioned previously there are flowing wells near Bruneau, Indian Cove, and Glenns Ferry where the ground surface is below an altitude of about 2,700, 2,600, and 2,500 feet respectively. Southward from the Snake River the water table or artesian-pressure surface rises to progressively higher altitudes, and near the south edge of the Sailor Creek area it is at an estimated altitude of 3,500 feet above sea level. Except for the irrigation wells in the southeast corner and the stock wells southwest of Glenns Ferry, wells are scarce in the Sailor Creek area. Thus, the position of the water table or artesian-pressure surface is poorly defined.

Drillers report that the water rises a few to several feet in almost every well drilled in the area indicating that the water is under slight artesian pressure. Only rarely does the water level fail to rise when water is encountered in the well. From the available data it appears that water in the volcanic rocks (basalt and rhyolite) is under slight artesian pressure and the water in the sedimentary deposits under a somewhat greater head.

The estimated depth-to-water level below the land surface is shown on figure 4. Well data are so sparse in much of the area that certain assumptions were made in order to construct the map. For example, it was assumed that the water table (or artesian pressure surface) was at the same elevation as the Bruneau River where the land surface is above an altitude of 2,700 feet. Data from wells drilled south of the Sailor

Creek area and from springs suggest that the water table may be near river level. Also, it was assumed that the form or shape of the water table is influenced by the different rock types. Thus, in the west-central part of the area the slope of the water table would be less steep than in the north or northeast part of the area because the basalt is more permeable than the sedimentary deposits and it requires less head to move the same volume of water through permeable rocks than through less permeable rock. Finally, the depth to water was computed by subtracting the inferred altitude of the water surface from the height of ground. The map showing depth-to-water level should be considered as only a general guide. Information obtained from wells drilled in the future will undoubtedly modify the map. Well data used in constructing the map are included at the end of this report.

Because of the paucity of data, there are only four divisions on the depth-to-water map (fig. 4). These are: less than 250 feet, 250 to 500 feet, 500 to 750 feet, and more than 750 feet.

Ground water occurs under water-table conditions at shallow depth in the valley of the Bruneau River, beneath the terrace south of King Hill, in Pasadena Valley, and along the Snake River. The aquifers are alluvial sand and gravel deposited by streams. These aquifers yield supplies adequate for domestic and stock water to the farms in the area.

Perched water occurs at a few places in the Sailor Creek area and some of the water has been developed for watering stock. Much of the perched water is in basalt flows intercalated in the sedimentary deposits. For example Yahoo, Tuana, and Pilgrim Springs issue from joints in basalt. Yahoo and Tuana Springs have been developed for stock water. Dove Spring issues from a well-cemented conglomeratic sandstone on Sailor Creek. Reportedly, there is some shallow water in Sailor Creek upstream from Dove Spring which is probably perched water. Dove Spring was dry when visited in July 1962.

Some water was reported at a depth of about 200 feet in wells 8S-7E-24dcl and 8S-8E-16dcl. The water was lost with further drilling. Detailed well logs are not available for these wells, but the water probably was perched on a sedimentary bed between two basalt flows.

Perched water constitutes an important source of stock water but the amount and availability is very limited and is not adequate for irrigation use.

The ultimate source of practically all ground water is precipitation. In the Sailor Creek area practically all precipitation is evaporated or transpired so that most of the ground water is derived from precipitation on the uplands and mountains south of the area. Precipitation on the mountains percolates into the ground and moves northward toward the Snake River.

An analysis of the amount of recharge which moves into the Sailor Creek area from the south is beyond the scope of this report, but certain features may be mentioned. Precipitation on the uplands and mountains on the Idaho-Nevada State line and in Nevada ranges from 12 to 30 inches annually (Mundorff and others, 1960, fig. 5) and probably averages more than 20 inches. Some of the mountains support a growth of timber but most of the area has only sparse vegetation and there are many areas of bare rock with no vegetation. Precipitation on the area is dissipated in three general ways: (1) by runoff in streams, (2) by evaporation from the ground surface and transpiration by vegetation, and (3) by infiltration into the ground. The annual runoff of streams is moderately well known, but the amount of water involved in the other two factors is largely unknown. Studies of similar areas in Idaho suggest that infiltration into the ground may be on the order of 1 to 3 inches or 100,000 to 250,000 acre-feet annually on an estimated area of 2,000 square miles. These figures suggest that present annual withdrawals of ground water do not approach the average annual recharge to the aquifers in the Sailor Creek area.

In the Sailor Creek area probably less than ½-inch of the annual 8 inches of precipitation infiltrates into the ground. One-half inch on 650,000 acres is equivalent to about 25,000 acre-feet. This moisture recharges the main water table in the outcrop area of the volcanic rocks and the perched water tables in all rock types. Direct precipitation on the area is the only source of recharge to the perched water tables, except in the area irrigated by the Magic Water Corporation. Locally, perched zones may develop in the area of ground-water irrigation.

AVAILABILITY OF GROUND WATER

Wells tapping the Idavada Volcanics yield as much as 300 miner's inches[1/] (2,700 gpm). There are 9 irrigation wells in the southeast part of the area producing from the Idavada Volcanics, the yields ranging from 125 to 300 inches. At least 7 wells drilled in the same general area were considered inadequate for irrigation (reported yields of 20 to

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1/ In Idaho one miner's inch equals 9 gpm.

30 inches). All or a major part of the wells were drilled in Idavada Volcanics below the water table.

At least one well near Hot Springs north of the Hot Springs fault obtains part of its water from the Idavada Volcanics. At this place the Idavada Volcanics are only a few hundred feet below the surface. This well yields an estimated 60 inches by artesian flow.

The Idavada Volcanics have not been explored for water in the central and western parts of the area because they generally are far beneath the surface and the area has been closed to development for several years for use as a gunnery range.

Flowing wells that penetrate the Banbury Basalt in the Bruneau River Valley and in Little Valley, a few miles south of Bruneau, yield as much as 100 inches by artesian flow from the formation (Littleton and Crosthwaite, 1957, p. 162). Elsewhere in the Sailor Creek area the Banbury Basalt has been little explored for ground water.

Numerous springs in the Bruneau River Canyon just upstream from Hot Spring discharge from the Banbury Basalt. The total flow is not known but streamflow records suggest that it may be 20 to 30 cubic feet per second (1,000 to 1,500 inches). The aggregate discharge of springs in Hot Creek in sec. 3, T. 8 S., R. 6 E. near Hot Spring was 245 inches in September 1954. (Littleton and Crosthwaite, p. 173, 1957).

Most stock wells in the Sailor Creek area obtain water from the sedimentary deposits and yields are adequate for that purpose. In the Bruneau River Valley below Hot Spring wells below an altitude of about 2,700 feet above sea level yield water by artesian flow. In the Indian Cove area wells below about 2,600 feet flow, and in the Glenn Ferry area flowing wells are obtained below about 2,500 feet. Yields of flowing wells range from less than 0.1 to about 7 miner's inches. Pumped wells will probably yield as much as 20 to 50 miner's inches.

In the lower reach and westerly from Sailor Creek the estimated depth to water is less than 250 feet. This area is underlain by a thick sequence of poorly permeable sedimentary deposits and the available data indicates that yields of more than 20 or 30 miner's inches cannot be expected. The rocks underlying the sedimentary deposits have been encountered in 4 wells. The deepest well, (6S-8E-28cd1) drilled by the U.S. Army, Corps of Engineers, is 4,000 feet deep. Basalt, assumed to be Banbury Basalt, was encountered at about 2,450 feet and Idavada Volcanics at 3,960 feet. The depth to water was 340 feet. The well was pumped at a rate of 14 miner's inches. Estimated drawdown was 260 feet, for a total pumping lift of 600 feet. Although this well did not yield a large supply of water, the yield obtained from one well does not either prove or disprove the ability of a formation to yield supplies adequate for irrigation. Practically nothing is known about the aquifers which may be deeply buried beneath the sedimentary deposits.

To the east and southeast of the lower reach of Sailor Creek the estimated depth to water is 250 to 500 feet. The sedimentary deposits underlie most of this region but to the southeast the Banbury Basalt and Idavada Volcanics rise to the surface. The Banbury Basalt has not been proved as an aquifer with large yields in this area but in the Bruneau-

Grand View area it is an important source of irrigation water (Littleton and Crosthwaite, 1957, p. 162)[1/].

All the irrigation wells in the upland of the Sailor Creek area produce from the Idavada Volcanics. In this part of the area the rhyolitic rocks are a good aquifer and yield as much as 40 miner's inches per foot of drawdown. However, at some places these rocks yield only small amounts of water to wells. Several wells in and near sec. 12, T. 9 S., R. 12 E. failed to find supplies adequate for irrigation in the Idavada Volcanics. These wells might yield more water if they were deepened several tens or hundreds of feet, but data are inadequate to determine if this would be true.

From the above discussion it can be seen that by using the geologic map (fig. 1) and the estimated depth-to-water map (fig. 4) a crude estimate can be made of what geologic formations may be encountered and where the water table will stand in exploring for a water supply. However, the estimated depth-to-water map should be used with caution because of the various assumptions used in its construction. Cross sections across the eastern and western parts of the area (figs. 2 and 3) show the parts of the geologic formations that are saturated with ground water.

Irrigation by the Magic Water Corporation in the eastern part of the area has built up a perched water table in the sedimentary deposits. Scanty data from wells suggest that the perched water is 50 to 100 feet

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1/ Littleton and Crosthwaite designated the aquifer as "basalt of Pliocene(?) age." Malde and Powers (in press) correlate this basalt with the Banbury Basalt.

above the main water table (or artesian pressure surface). Domestic wells in the irrigated area yield supplies which are adequate for domestic and stock use but are not adequate for irrigation.

GROUND WATER USE

There are 6 wells used for stock water in the area, all producing from the sedimentary deposits (table 1). As mentioned previously, Yahoo and Tuana Springs are used for watering stock. Total annual use by stock is estimated to be 10 to 15 acre-feet annually. Domestic and stock use in the area served by the Magic Water Corporation is estimated to be 5 to 10 acre-feet annually. The 9 irrigation wells in the southeast corner of the area probably withdraw about 6,000 acre-feet annually. Well owners report little change in the yield of wells indicating that the present state of development has not appreciably affected the water levels. Little water is allowed to run to waste because sump pumps are used to lift the water from the lower ends of the fields to the upper ends. The following table summarizes the performance of the irrigation wells.

Well number	Owner	Yield[1] (miner's inches)	Specific capacity[2] (miner's inches per foot of drawdown)
10S-12E-11dc1	Anton Potucek	155	10
12ad1	McClain Bros.	200	6
12ba1	do	165	6
12bb1	do	250	3
12cd1	Alfred Kramer	130	35
10S-13E- 5dd1	J. E. Keller	100	1/2
8bd1	Kenneth Marshall	200	5
8cd1	do	125	4
9cd1	do	165	8
		1,490	

1/ Yields are those reported by owners or computed from pump data.

2/ Specific capacity is yield per foot of drawdown. It is useful in comparing the performance of wells.

Depth to the water-bearing formations in the volcanic rocks usually is somewhat greater than the depth to water. Stock and domestic wells have to be drilled several feet below the water table in order to intersect enough openings to provide an adequate water supply. Irrigation wells must be drilled several tens to several hundred feet below the water table to obtain sufficient water and at some places wells might have to be several thousand feet deep. There are some exceptions. For example, well 10S-12E-11dcl was drilled 60 feet below the water table and reportedly produces 1,400 gpm (155 inches). Wells in the sedimentary deposits often have to be drilled several tens to several hundred feet below the artesian pressure surface to find a sand bed that will yield adequate stock and domestic supplies.

QUALITY OF THE WATER

The chemical quality of the water determines its suitability for irrigation or other uses. A single analysis from well 10S-12E-11dcl, which produces from the Idavada Volcanics, is a sodium bicarbonate type. Percent sodium is 40. It has a low sodium hazard and a medium salinity hazard and probably can be used on open, well-drained soils without any adverse effect to crops. This type of water is excellent for domestic purposes because it is soft and contains the optimum amount of fluoride (1.4 parts per million) for retarding the formation of dental caries in childrens' teeth.

Littleton and Crosthwaite (1957, p. 181) found that the ground water in the Bruneau-Grand View area west of the Sailor Creek area contained moderate to high percentages of sodium, high sodium adsorption ratios, and generally large amounts of residual sodium carbonate. All these properties present a sodium hazard to poorly drained irrigated soil. Generally, the water of poor quality occurs in the sedimentary deposits whereas the water in the volcanic rocks is of fair quality for irrigation use.

SUMMARY AND CONCLUSIONS

The depth-to-water level beneath the Sailor Creek upland ranges from less than 250 feet (depth to water in well 6S-8E-29ad1 reportedly is 80 feet, see table 1) to more than 750 feet (fig. 2). The water-bearing formations are sandy beds and intercalated basalt flows in the sedimentary deposits, and cinders, tuff, and jointed and fractured basalt, and silicic volcanic rocks. In general the depth to water is less in areas underlain by sedimentary deposits, but these formations yield small supplies to wells. The aquifers in basaltic and silicic volcanic rocks have a greater potential for large yields but the depth to water is 500 or more feet in much of the area where these rocks crop out. There are some exceptions. In the southeast corner of the area the Idavada Volcanics yield substantial supplies of water to irrigation wells from depths of less than 500 feet. North of the area of ground-water irrigation several wells have failed to find water adequate for irrigation in the Idavada Volcanics.

Present knowledge of the geologic and hydrologic condition suggest that the southeastern part of the area is more favorable for development of ground water for irrigation than the remainder of the area.

Wells adequate for stock watering probably can be drilled at almost any place in the area. However, wells drilled in the sedimentary deposits will have to be carefully constructed to prevent pumping of sand.

Any future study of the area should include drilling of wells in a few key locations in order to gain better data on the position of the water table and the ability of the aquifers to yield water. Only a very small part of the area has been tested by drilling and thus much remains to be learned of the hydrology of the area. Recharge to the Sailor Creek area is by underflow from the area to the south. An estimate should be made of the amount of recharge. This would require at least a reconnaissance of the geology and hydrology of the southern area; that is, the drainage basin of the Bruneau River and its eastern tributaries and part of the drainage basin of Salmon Falls Creek.

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Table 1.—Records of wells in the Sailor Creek area

Character of aquifer: S, sand in sedimentary deposits; Tb, Banbury Basalt; Tiv, Idavada Volcanics ("rhyolite").

Altitude of land surface: Approximate altitude determined from topographic maps.

Depth to water: Measured depths are given to nearest tenth of a foot. All others are reported depths to water.

Type of pump: J, jet; P, piston; T, turbine; C, centrifugal, N, none.

Use of water: Irr, irrigation; D, domestic; S, stock; U, unused.

Yield of well: In Idaho 1 miner's inch equals 9 gpm.

Remarks: Log, in table of well logs; all yields and well performance data are reported.

Well number	Owner	Depth of well (feet below land surface)	CASING Dia. (inches)	CASING Depth (feet)	Character of aquifer	Altitude of land surface (feet above mean sea level)	Depth to water (feet)	PUMP Type	PUMP H.P.	Yield of well (miner's inches)	Use of water	Remarks
5S-9E-												
26dc1	A. V. Capps	800	6	-	S	2,500	70	J	1	-	D	Inadequate.
34aa1	Ralph Thompson	-	6	-	S	2,490	11	C,J	3/4, 3/4	15	D,S	Two pumps.
5S-10E-												
27bc1	George Larsen	825	5	90	S	2,580	83	-	-	2	D	Log.
32ad1	Albert Eichholz	1,006	6	85	S	2,510	-	-	-	40	D,S	Log; flows 20 gpm.
32ba1	do	2,100	6	140	S	2,555	14	J	1/3	-	D	
6S-7E-												
16bb1	State of Idaho	2,660	10	330	-	2,775	-	-	-	-	U	Log; oil test well.
6S-8E-												
19bb1	-	3,808	13	215	-	2,633	-	-	-	-	U	Log; oil test well.
28cd1	U.S. Air Force	4,000	17-14-10 8-6	2,118	S,Tb, Tiv	3,100	340	-	-	14		Log; test well.

Table 1.—Records of wells in the Sailor Creek area—Continued

Well number	Owner	Depth of well (feet below land surface)	CASING		Character of aquifer	Altitude of land surface (feet above mean sea level)	Depth to water (feet)	PUMP		Yield of well (miner's inches)	Use of water	Remarks
			Dia. (inches)	Depth (feet)				Type	H.P.			
6S-8E-												
29adl	Wilbur Wilson	200	6	–	S	2,840	80	P	Windmill	–	S	
6S-9E-												
1bbl	Louis Solosobal	1,460	6	26	S	2,500	Flowing	–	–	–	D	Log.
1bb2	do	640	6	21	S	2,500	Flowing	–	–	–	D	
1bb3	do	1,235	6	40	S	2,500	Flowing	–	–	–	D	
2dbl	A. V. Capps	1,235	8	–	–	2,620	75.9	P	3/4	–		
25dal	Louis Solosobal	535	6	42	S	2,970	285	P	–	–	S	
27abl	U.S. Bureau of Land Management	787	6	400	S	3,060	325	P	–	1/2	S	Log.
35cbl	Louis Solosobal	640	5½-4	610	S	3,100	365	P	Windmill	–	S	
6S-10E-												
32bcl	Wilbur Wilson	290	–	–	S	2,995	280	N	–	–	U	
7S-9E-												
11dal	Louis Solosobal	225	6-5	225	S	2,890	165	P	Windmill	–	S	
16bcl	State of Idaho	2,068	10	132	–	2,975	–	–	–	–	–	Log; oil test well.
8S-7E-												
24dc	John Sanborn, et al	460	12	225	–	3,720	Dry	–	–	–	U	Log; abandoned, measured depth 316 ft.
8S-8E-												
16dcl	do	500±	12	–	–	–	Dry	–	–	–	U	Abandoned.
8S-11E-												
33cbl	U.S. Bureau of Land Management	290	6	290	S	3,190	171	T	–	17	S	Log.
8S-13E-												
27adl	Pete Rarick	134	8	58	–	–	90	–	–	–	D,S	Log.

Table 1.—Records of wells in the Sailor Creek area—Continued

Well number	Owner	Depth of well (feet below land surface)	CASING Dia. (inches)	CASING Depth (feet)	Character of aquifer	Altitude of land surface (feet above mean sea level)	Depth to water (feet)	PUMP Type	PUMP H.P.	Yield of well (miner's inches)	Use of water	Remarks
8S-13E-27dd1	Maurice Eckert	800	12	38	Tb, Tiv	3,420	136	N	-	-	U	Log; drilled for irrigation.
34aa1	do	283	8	26	S, Tb	3,435	135	P	-	-	D, S	Log.
8S-14E-7ad1	Doyle Sliger	960	8	272	Tb	2,900	Flowing	-	-	3½	D	Log; water used for swimming pool.
9S-12E-12ab1	W. A. Hansen	-	-	-	Tiv	3,780	-	N	-	-	U	Drilled for irrigation, inadequate.
12ac1	do	635	16	9	Tiv	3,760	455.4	N	-	-	U	Log;
12dd1	C. E. Quinton	600	-	-	Tiv	3,770	461.9	N	-	-	U	Log; drilled for irrigation, inadequate.
26da1	Holson	-	20	-	Tiv	3,650 ±	240±	N	-	-	U	Drilled for irrigation, inadequate.
9S-13E-33bb1	Fred Thieme	558	20	125	Tiv	3,810	-	N	-	-	U	Log; drilled for irrigation, inadequate.
10S-12E-2cb1	McClain Bros.	-	22	-	Tiv	3,730	310.2	N	-	-	U	Unused, drilled for irrigation.
11bd1	Anton Potucek	443	8	-	Tiv	3,740	311.3	N	-	-	U	Log; test well.

Table 1.—Records of wells in the Sailor Creek area—Continued

Well number	Owner	Depth of well (feet below land surface)	CASING Dia. (inches)	CASING Depth (feet)	Character of aquifer	Altitude of land surface (feet above mean sea level)	Depth to water (feet)	PUMP Type	PUMP H.P.	Yield of well (miner's inches)	Use of water	Remarks
10S-12E-												
11db1	Anton Potucek	700	20	-	Tiv	3,750	326.3	N	-	-	U	Inadequate.
11dc1	do	375	20	-	Tiv	3,740	315	T	150	155	Irr	
11dc2	do	485	20	13	Tiv	3,745	332.0	N	-	60	U	Log; drilled for irrigation, inadequate.
12ad1	McClain Bros.	-	20	-	Tiv	3,710	-	T	200	200	Irr	
12ba1	do	444	16	30	Tiv	3,690	260	-	200	165	Irr	Log.
12bb1	do	500	20	80	Tiv	3,720	343.3	T	250	250	Irr	Log.
12cd1	Alfred Kramer	450	-	-	Tiv	3,730	305.4	T	125	130	Irr	
10S-13E-												
5cd1	J. E. Keller	760	20	97	Tiv	3,840	420	N	-	225	U	Log; drilled for irrigation, inadequate.
5dd1	do	595	16	90	Tiv	3,818	409	T	150	100	Irr	
8bd1	Kenneth Marshall	510	20	-	Tiv	3,845	430	T	250	200	Irr	
8cd1	do	590	20	92	Tiv	3,840	445	T	250	125	Irr	Log.
9cd1	do	760	20	97	Tiv	3,825	445	T	250	165	Irr	

LOGS OF WELLS

The following well logs were obtained from drillers, well owners, and files of the Idaho Department of Reclamation. Where practical, the original-source terminology was modified for uniformity and clarity. The notation in parenthesis at the end of the log is the identification of the water-bearing formation.

5S-10E-27bcl. George Larson

Material	Thickness (feet)	Depth (feet)
Gravel	8	8
Clay, loose	67	75
Shale, blue	700	775
Sandstone	50	825

5S-10E-32adl. Albert Eichholz

Material	Thickness (feet)	Depth (feet)
Gravel	75	75
Shale, blue	425	500
Not recorded, probably clay, silt, and some sand	506	1,006

6S-7E-16bbl. State of Idaho

Material	Thickness (feet)	Depth (feet)
Shale and clay	71	71
Clay, sand, and shale	266	337
Shale and clay	541	878
Shale and sand	1,092	1,970

6S-7E-16bb1—Continued

Material	Thickness (feet)	Depth (feet)
Shale and rock	145	2,115
Shale	225	2,340
Shale and sand	213	2,553
Shale, sand, and lime	37	2,590
Shale	37	2,627
Shale, lime, and lava	26	2,653

6S-8E-19bb1.

Sand	85	85
Shale	10	95
Gravel, sand, and shale	30	125
Sand and shale	90	215
Shale, blue	30	245
Shale	170	415
Shale, blue	195	610
Shale	175	885
Shale and sand streaks	370	1,255
Sand, hard	59	1,314
Shale	60	1,374
Shale and sand streaks	106	1,480
Sand and shale	30	1,510
Shale	270	1,780

6S-8E-19bb1—Continued

Material	Thickness (feet)	Depth (feet)
Sand and shale	275	2,055
Shale	205	2,260
Shale, sand, and lime	205	2,465
Sand and shale	82	2,547
Sand, shale streaks, lava	78	2,625
Sand, lime streaks, lava	130	2,755
Sand, shale	44	2,799
Sand, shale, lime, and lava	86	2,885
Sand, lime, shale, and lava	82	2,967
Sand, lime, and shale	78	3,045
Shale and sand	48	3,093
Sand, lava, and shale	20	3,113
Lava and shale	69	3,182
Shale, black, hard, and lime	28	3,210
Not recorded	26	3,236
Shale, dark green, hard, mineralized (basalt?)	572	3,808

6S-8E-28cdl. U.S. Army, Corps of Engineers

Material	Thickness (feet)	Depth (feet)
Shale, grayish-white	10	10
Silt, pale brown, and shale, blue and gray	400	410
Sandstone with basalt boulders	20	430
Siltstone, fine sandstone, and shale	1,790	2,220
Basalt, black, cinders, black, and shale, gray	43	2,263
Siltstone and some white ash	67	2,330
Siltstone, gray, and basalt cinders	30	2,360
Siltstone, gray	30	2,390
Shale, gray, and basalt cinders	30	2,420
Siltstone, gray	30	2,450
Basalt cinders, black	10	2,460
Shale, gray, silty	27	2,487
Basalt cinders, black, some gray silty shale	196	2,683
Basalt, black	7	2,690
Siltstone, gray, shale, and basalt cinders, black	61	2,751
Basalt, black	6	2,757
Shale, gray, silty, some basalt cinders	187	2,944
Basalt, black, hard	20	2,964
Shale, gray, some ash	236	3,200
Siltstone and shale, gray	167	3,367
Basalt cinders, black	14	3,381
Siltstone, gray and sandstone, fine	52	3,433
Basalt, black	14	3,447

6S-8E-28cd1—Continued

Material	Thickness (feet)	Depth (feet)
Basalt, black, cinders, sandstone, shale and pebbles .	23	3,470
Shale, gray	165	3,635
Basalt, black	20	3,655
Shale with some cinders and pebbles	100	3,755
Basalt boulders	10	3,765
Basalt, black	10	3,775
Basalt cinders, black	105	3,880
Basalt, black	10	3,890
Sandstone	73	3,963
Rhyolite tuff and gray shale	41	4,004
(Sedimentary deposits, Banbury Basalt and Idavada Volcanics)		

6S-9E-1bb1. Louis Solosabal

Clay, sand, and gravel	7	7
Shale	1,453	1,460
Water comes in between 450 and 500'.		
(Sedimentary deposits)		

6S-9E-27abl. U.S. Bureau of Land Management

Material	Thickness (feet)	Depth (feet)
Blow sand	13	13
Sand and silt, light tan, trace of clay	32	45
Clay, light tan, trace of clay	36	81
Clay, light steel gray	22	103
Clay gradually turning to dense blue shale	15	118
Clay, tan, crumbly	3	121
Lava	22	143
Lava, porous	48	191
Lava, very hard, abrasive	12	203
Lava	20	223
Lava, yellow, soft	4	227
Sandstone, light	6	233
Sandstone, light, with light gravel	19	252
Clay, dark steel gray, some silt	46	298
Clay, dark steel gray	102	400
Clay, dark steel gray, occasional gravel	50	450
do , water	20	470
Clay, dark gray	170	640
Shale, firm	10	650
Medium weight clay, getting more dense with occasional light streaks of solidified shale	137	787
Static water level 324'. 390-400 - occasional trace of gravel. (Sedimentary deposits)		

7S-9E-16bcl. State of Idaho

Material	Thickness (feet)	Depth (feet)
Shale	41	41
Sand and clay	119	160
Clay and sand	31	191
Shale	30	221
Clay	39	260
Gravel, sandy lava	100	360
Clay and silt	210	570
Shale, slight sandy lava	90	660
Shale, sand, and rocks	460	1,120
Shale and sand streaks	510	1,630
Sand, hard, shale, and lime	125	1,755
Sand and rock	34	1,789
Sand, shale, and lava	61	1,850
Sand, shale, and lime	80	1,930
Sand, shale, and rock	61	1,991
Sand, shale, and lava	69	2,060
Diabase lava, black and green	8	2,068

8S-7E-24dcl. John Sanborn, et al

Lava	180	180
Sand, red	45	225
Rock, red, and crevices	235	460

8S-11E-33cb1. U.S. Bureau of Land Management

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Hardpan	17	20
Clay, gray, sandy	30	50
Clay, red, sandy	190	240
Clay, brown, sandy	10	250
Clay and gravel, big cobblestone	35	285
Clay, gray, sticky	5	290
(Sedimentary deposits)		

8S-13E-27ad1. Pete Rarick

Soil	10	10
Sand, hard, packed	35	45
Soil	4	49
Clay, gray	9	58
Rock, black, hard	45	103
Rock, red, soft	18	121
Rock, black, hard	13	134
(Banbury Basalt)		

8S-13E-27dd1. Maurice Eckert

Material	Thickness (feet)	Depth (feet)
Topsoil	5	5
Clay	33	38
Lava, gray, hard	9	47
Lava, gray	8	55
Lava, red	10	65
Lava, brown	15	80
Lava, gray	40	120
Clay and lava	5	125
Lava, gray	30	155
Lava, gray, sandy and clay, green	10	165
Lava, gray and red	20	185
Lava, dark gray	15	200
Lava, dark gray and mud, black	25	225
Lava, gray	25	250
Clay, green and lava, gray	15	265
Lava, brown, coarse	10	275
Lava, gray	25	300
Lava, gray and red	10	310
Lava, red and clay streaks	20	330
Basalt, dark gray, very hard	40	370
Lava, gray and red	35	405
Lava, gray and sticky mud	15	420
Basalt, gray, hard	95	515

8S-13E-27dd1—Continued

Material	Thickness (feet)	Depth (feet)
Sandstone, gray and mud streaks; sticky	26	541
Clay, blue, sticky, some boulders	13	554
Clay, blue and green, small gravel	25	579
Clay, brown and boulders	33	612
Lava, dark gray	48	660
Lava, dark gray, very hard	53	713
Clay, blue-green and gravel	3	716
Lava, dark gray, very hard	37	753
Lava, dark gray, some boulders with soft streaks of blue clay, caving some	7	760
Rhyolite, dark gray, hard	40	800
Hit water at 150'.		
(Banbury Basalt and Idavada Volcanics)		

8S-13E-34aa1. Maurice Eckert

Soil	8	8
Lava, loose	15	23
Lava, gray, hard	20	43
Lava, red, broken, caves	20	63
Lava, red, soft	23	86
Lava, black, hard	18	104
Lava, red, soft, small amount of water	9	113

8S-13E-34aa1--Continued

Material	Thickness (feet)	Depth (feet)
Lava, black, hard	13	126
Lava, red, soft, small amount of water	15	141
Lava, black, hard	11	152
Lava, black but softer	7	159
Lava, red, soft, small amount of water	28	187
Lava, black, hard	39	226
Clay, yellow, sandy, small amount of water	8	234
Lava, black, hard	9	243
Clay, green, small amount of water	6	249
Rock, red, rotten, small amount of water	14	263
Rock, black, soft, small amount of water	10	273
Lava, black, hard . . . . (Banbury Basalt)	10	283

8S-14E-7ad1. Doyle Sliger

Stream gravel	33	33
Sediments and lava	100	133
Banbury Basalt, hard. (Perhaps more than one flow) .	67	200
Clay, silt, and sand	70	270
Banbury Basalt (plagioclase porphyry)	110	380
Sandstone indurated - contact with overlying basalt uncertain	40	420

8S-14E-7ad1--Continued

Material	Thickness (feet)	Depth (feet)
Compact clay and silt	90	510
Sand, some slumping	5	515
Sediments, compact	40	555
Sandstone	5	560
Basalt with pillow base and good artesian flow from base	35	595
Sediments, compact	125	720
Basalt, iron stained pillows	30	750
Sandstone, tan	25	775
Sandstone, coarse, very green cement	15	790
Pebble conglomerate, much increase in flow	25	815
Clay and sand, green	30	860
Basalt pillows, much decomposed	100	960
Bottomed in decomposed basalt pillows. (Banbury Basalt)		

9S-12E-12ac1. W. A. Hansen

Topsoil	8	8
Clay, light yellow, and gravel	32	40
Lava, gray	2	42
Lost cuttings	5	47
Lava, dark gray, hard	13	60

9S-12E-12ac1—Continued

Material	Thickness (feet)	Depth (feet)
Lava, gray-red, broken	30	90
Lava, red and cinders	15	105
Lava, red and talc	20	125
Lava, gray and red	10	135
Lava, red	30	165
Lava, gray and red	20	185
Lava, red and cinders	15	200
Lava, gray and red, talc, and clay	28	228
Basalt, gray and black	52	280
Cinders, gray, lava, and green clay	10	290
Lava, gray and brown clay seams	10	300
Lava, dark gray, very hard	20	320
Lava, dark gray and cinders	30	350
Lava, gray, sand, and blue clay	175	525
Lava, dark gray, red rhyolite, and quartz	55	580
Sand rock, dark gray, fairly solid	10	590
Black sand, lava, and water talc, cuttings settling in bottom of hole, water	25	615
Lava, gray, light gray sand, water talc and quartz (Idavada Volcanics)	20	635

9S-12E-12ddl. C. E. Quinten

Material	Thickness (feet)	Depth (feet)
Topsoil	25	25
Gravel	10	35
Rock, brown	5	40
Rock, gray, broken	20	60
Rock, brown	30	90
Rock, red, crevices	40	130
Rock, brown	15	145
Rock, red	10	155
Rock, gray, broken	50	205
Rhyolite, red	30	235
Not recorded	10	245
Rhyolite, brown	30	275
Rhyolite, gray	25	300
Rhyolite, red	50	350
Clay, brown	50	400
Rhyolite, red, water	80	480
Rhyolite, red, talc	45	525
Rock and talc	75	600
(Idavada Volcanics)		

9S-13E-33bb1. Fred Thieme

Material	Thickness (feet)	Depth (feet)
Clay	30	30
Clay, brown, and gravel	65	95
Clay, brown, sand, and rock	28	123
Clay, brown, and sand rock	102	225
Lava, gray	10	235
Lava, gray, talc, and black sand	25	260
Talc, red	5	265
Lava, red and brown sandy clay	160	425
Rhyolite, red and gray lava	70	495
Gyp, talc, and gray lava (Idavada Volcanics)	63	558

10S-12E-11bd1. Anton Potucek

Clay	157	157
Sand and gravel, cemented	25	182
Sand and clay	25	207
Rhyolite, gray, rotten	40	247
Rhyolite, gray	10	257
Rhyolite, blue, hard	8	265
Rhyolite, gray, hard	22	287
Rhyolite, brown	8	295
Rhyolite, light red, hard, water stands at 302 feet	30	325
Rhyolite, reddish with white crystals, very hard (Idavada Volcanics)	118	443

10S-12E-11dc2. Anton Potucek

Material	Thickness (feet)	Depth (feet)
Topsoil, brown	3	3
Clay and boulders	7	10
Clay, reddish brown	66	76
Rhyolite, gray, firm	6	82
Rhyolite, gray, soft	17	99
Shells of rhyolite and talc	8	107
Rhyolite, gray, and red clay	15	122
Conglomerate	15	137
Rhyolite, gray, hard	21	158
Conglomerate, losing drilling water	6	164
Rhyolite, gray	71	235
Rhyolite, pink, very hard, abrasive	100	335
Rhyolite, pink, shells with talc	21	356
Rhyolite, solid, very hard	4	360
Hard rhyolite shells, some water talc	20	380
Rhyolite, pink, hard, solid	12	392
Rhyolite, pink, hard, shells, and some talc	54	446
Rhyolite, pink, solid	39	485
Water struck at 318.		
(Idavada Volcanics)		

10S-12E-12ba1. McClain Bros.

Material	Thickness (feet)	Depth (feet)
Topsoil	5	5
Gravel	33	38
Rock	5	43
Clay	7	50
Rock	17	67
Rock, gray	38	105
Rock	95	200
Clay	10	210
Rock	70	280
Clay	5	285
Sandstone	65	350
Rock, black	15	365
Rock, red	79	444
(Idavada Volcanics)		

10S-12E-12bb1. McClain Bros.

Topsoil	5	5
Gravel	20	25
Gravel, cemented	55	80
Lava, gray	20	100
Rock, loose	20	120
Lava, red	80	200

10S-12E-12bb1—Continued

Material	Thickness (feet)	Depth (feet)
Lava, gray	60	260
Clay	25	285
Lava, black	20	305
Lava, red	35	340
Lava, black	50	390
Rock, loose	40	430
Rock, gray, loose (Idavada Volcanics)	70	500

10S-13E-5cd1. J. E. Keller

Dirt	25	25
Sand and gravel, mostly sand	38	63
Clay	12	75
Sand and some gravel	20	95
Rock, gray	59	154
Rock, gray, broken and clay	16	170
Rock, gray	15	185
Rock, blue, hard	25	210
Clay, brown	120	330
Sand	10	340
Rock, gray	20	360
Rock, light gray, hard	25	385

10S-13E-5cd1—Continued

Material	Thickness (feet)	Depth (feet)
Rock, light brown	52	437
Rhyolite, gray, hard, hit water at 439'	55	492
Rhyolite, brown, and water talc, caving, broken	35	527
Rhyolite, gray	25	552
Rhyolite, loose and sand	18	570
Rhyolite, red and clay seam	15	585
Rhyolite, gray, sluffing	15	600
Water raised to 419'.		
Rhyolite, light brownish-red, hard	28	628
Rhyolite, loose, and water talc	3	631
Rhyolite, loose, light brown	17	648
Rock, gray, hard	4	652
Rock, loose and squeezy clay	5	657
Rock, light gray, extremely hard	13	670
Rock, gray, hard	62	732
Clay, white, squeezing	5	737
Rhyolite, light red	14	751
Clay, squeezing	9	760
(Idavada Volcanics)		

10S-13E-8cd1. Kenneth Marshall

Material	Thickness (feet)	Depth (feet)
Soil and dirt	30	30
Gravel, clean	30	60
Gravel and clay	32	92
Lava, gray	63	155
Clay and lava	5	160
Lava, gray	25	185
Clay and lava	35	220
Clay, brown, sandy	60	280
Sand rock, gray and clay	50	330
Clay, gray, sandy	30	360
Clay, brown and lava	35	395
Lava, black, sandy and cinders	15	410
Lava, gray and red, coarse	10	420
Lava, red	25	445
Lava, red, loose, caving	15	460
Lava, red, cinders, and boulders, cavey	20	480
Lava, red, talc, caving	10	490
Lava, red and gray, sticky, rough	20	510
Lava, red and gray, cavey	30	540
Lava, red	5	545
Lava, red and gray, sandy	10	555
Lava, red and brown, sand rock, and talc	30	585
Lava, red and gray	5	590
(Idavada Volcanics)		