Ground Water in the Sandpoint Region Bonner County, Idaho

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1779-I

Prepared in cooperation with the U.S. Bureau of Reclamation

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By EUGENE H. WALKER

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GROUND WATER IN THE SANDPOINT REGION, BONNER COUNTY, IDAHO

By EUGENE H. WALKER

ABSTRACT

The Sandpoint region is in the northern part of Idaho. Topographically, the area comprises north-trending valleys and mountain ranges. The valleys are occupied by many farms, and stock raising and dairying are the principal occupations. Supplies of ground water for supplemental irrigation would be valuable because summers are dry and supplies of surface water are limited.

The mountains are formed of sedimentary rocks of Precambrian age and granite of Mesozoic age. These rocks do not yield much water to wells. The valleys contain unconsolidated sedimentary deposits of Pleistocene and Recent age that include glacial till, fine-grained lacustrine materials, and sand and gravel spread by streams. Any of these materials can provide the small amount of water required for domestic needs, but only the sand and gravel yield supplies large enough for use in irrigation.

Thick water-bearing deposits of sand and gravel are restricted to the Hoodoo Valley and the valley south of Cocolalla Lake. Although they are not developed, these deposits will probably yield adequate supplies for supplemental irrigation.

The other lowlands—the Priest River valley; the Pend Oreille River valley; the Purcell Trench, which is the broad valley north and east of Sandpoint; and the lowlands north of Cocolalla Lake—are underlain mainly by lake beds composed of clay, silt, fine-grained sand, and some glacial till. Beds of sand and gravel are few and thin. Therefore, supplies of ground water adequate for irrigation are not expected in these areas. However, at places beneath the flood plain of the Pack River north and east of Sandpoint, a thin sheet of sand and gravel should yield irrigation supplies to shallow pits.

The ground water in general, is of good chemical quality. The average hardness is 84 parts per million.

INTRODUCTION

The Sandpoint region of northern Idaho is a region of extensive lowlands and north-trending mountain ranges. The lowlands are occupied by many farms, most of them small to medium-sized, on which the principal occupations are dairying and stock-raising. Although the precipitation averages about 30 inches per year, less than 2 inches of rain falls during July and August when the water needs of field crops, hay, and pasture are greatest. The amount of hay that can be grown for winter feeding of stock depends primarily on the amount of summer rainfall because only a small percentage of the farms have supplies of surface water adequate for irrigation. For this reason, supplies of ground water for supplemental irrigation would be very valuable.

This reconnaissance investigation was financed by the U.S. Bureau of Reclamation and was made by the U.S. Geological Survey. The purpose of the brief study was to obtain information on the character and distribution of the unconsolidated water-bearing deposits in the lowland areas of the Sandpoint region.

Ground-water conditions were investigated in the field in September 1961. Typical wells were inventoried, and additional information was gained through interviews with the several well drillers who operate in the area. Samples taken to determine the chemical character of representative ground water were analyzed by the Regional Laboratory of the U.S. Bureau of Reclamation in Boise, Idaho, and the results of these analyses are given in table 1.

The wells inventoried in this investigation (table 2) are referred to by the numbers which the U.S. Geological Survey uses in Idaho to show the location of wells within the official rectangular subdivisions of public lands. The first two segments of a number designate the township and range with reference to the Boise base line and meridian. The third segment gives the section number and is followed by two letters and a numeral which indicate, respectively, 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 (fig. 1). Thus well 57N-3W-25dd1 is in the SE¼SE¼ sec. 25, T. 57 N., R. 3 W., and was the first well visited in that tract. Only the last segment of the well number is used on the map (pl. 1) showing the location of wells.

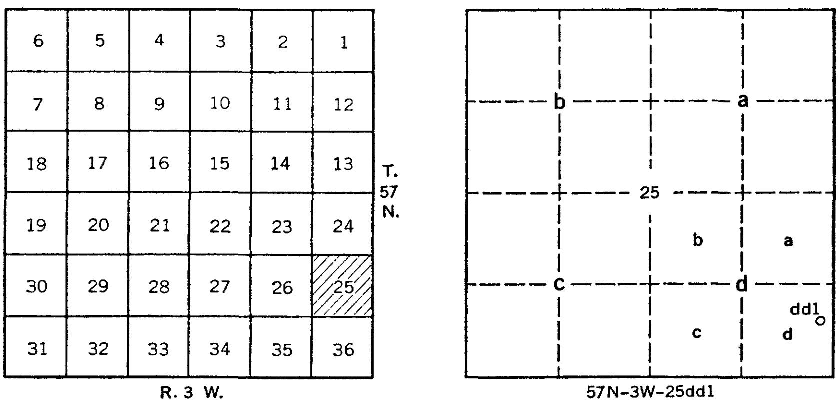

FIGURE 1.—*Sketch showing well-numbering system.*

GEOGRAPHY

TOPOGRAPHIC FEATURES

The area described in this report lies in Bonner County, Idaho, in the northern Rocky Mountains (fig. 2). Sandpoint, the largest town,

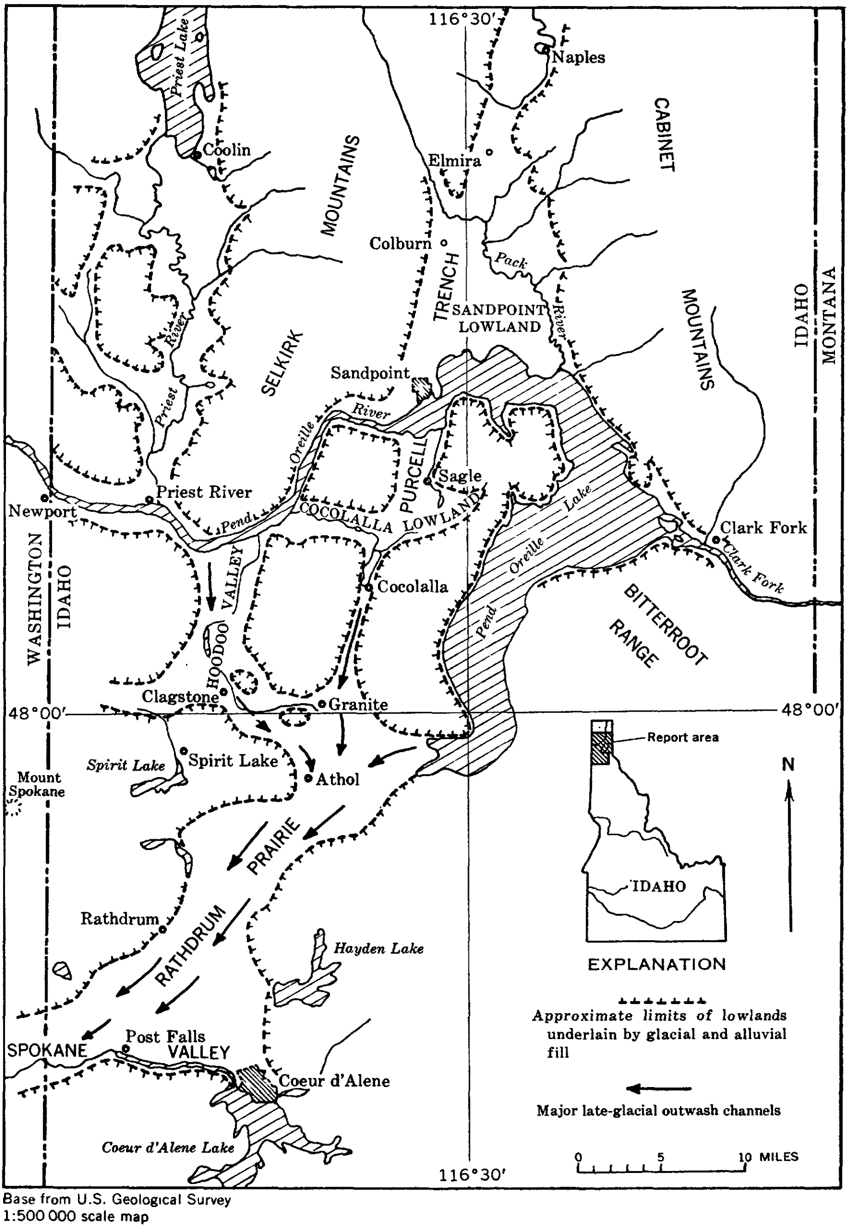

FIGURE 2.—Map of the Sandpoint region, Idaho.

is about 45 miles north of the city of Coeur d'Alene and about 50 miles south of the Canadian border. The principal mountain ranges and valleys trend northward. The mountains rise in many places to altitudes about 6,000 feet, but only a few peaks reach altitudes about 7,000 feet; valley floors are at altitudes between 2,000 and 2,500 feet. The entire area has been glaciated, so that the mountains are rounded and the valleys contain thick deposits of unconsolidated sediments. Clark Fork enters the area from Montana to the east and empties into Pend Oreille Lake. The lake is drained by the Pend Oreille River, which flows westward into Washington, then loops northward into Canada, and finally joins the Columbia River. This tortuous course reflects drainage changes caused by glaciation.

The principal depression is the Purcell Trench, which extends northward into Canada. The broad part of the Purcell Trench north of Pend Oreille Lake, bordered on the east by the Cabinet Mountains and on the west by the Selkirk Mountains, is referred to in this report as the Sandpoint lowland. West of the Selkirk Range, the Priest River drains southward from Priest Lake through a long valley. The Hoodoo Valley, the Cocolalla lowland, and the trough occupied by Pend Oreille Lake are separated by low mountains which terminate against the broad Rathdrum Prairie to the south.

CLIMATE

The area has a cool and temperate climate that includes long winters and a short growing season—averaging about 113 days, from about the middle of May to early September (fig. 3). The annual precipitation has averaged 30.5 inches during the period of record (1911–60) and has ranged from 17.9 inches to 41.1 inches. Precipitation is greatest in winter months (fig. 3) and least in summer months, averaging slightly more than 5 inches in December and less than 1 inch in July and in August. Over the period of record, the combined precipitation of July and August has averaged 1.65 inches; in half of the years the combined precipitation has been 1.36 inches or less; and in a quarter of the years, 0.9 inch or less.

POPULATION AND RESOURCES

The city of Sandpoint (population about 4,300) is the largest city in the area, and Priest River (population 1,600) is second largest. Sandpoint furnishes services to the surrounding area and is a major tourist and recreation center in summer. The other named settlements in the area are much smaller, ranging from Clark Fork which has about 400 inhabitants to communities consisting of only a few houses.

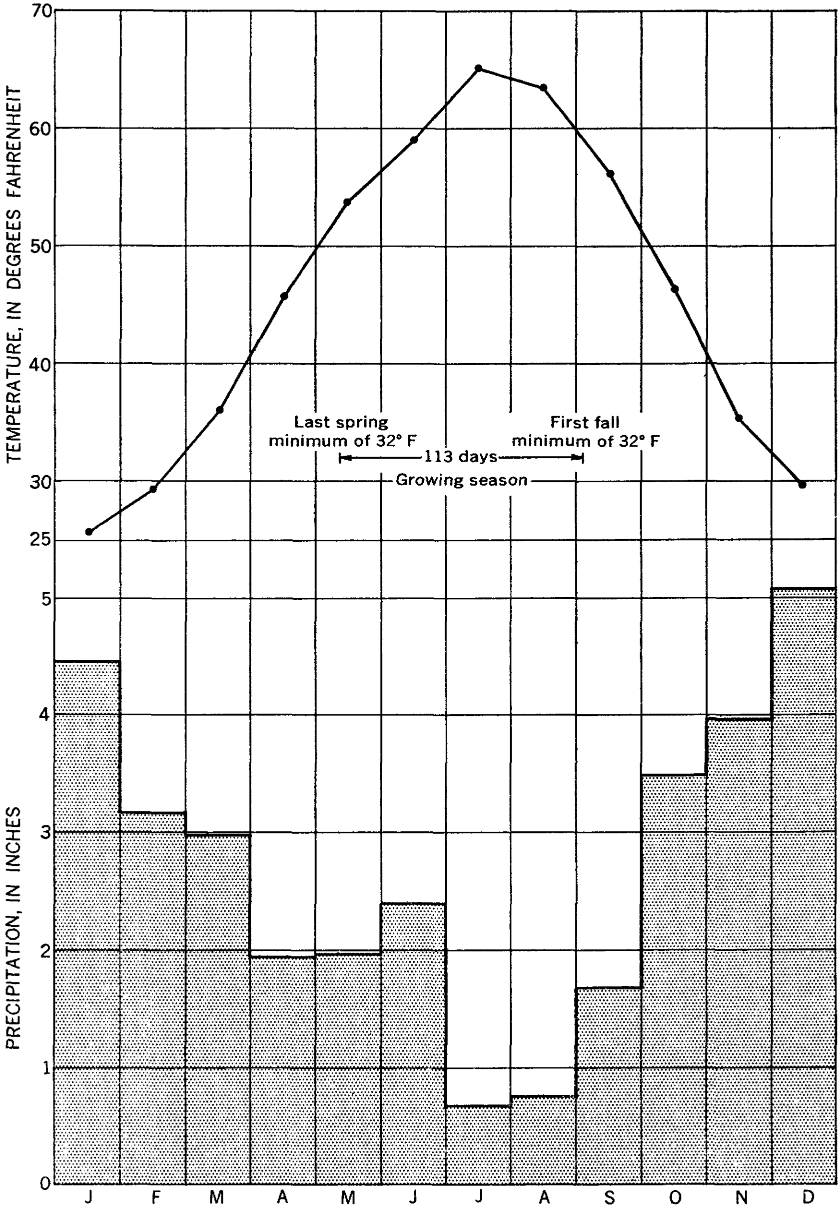

FIGURE 3.—Average monthly precipitation and temperature at Sandpoint Experimental Station, Idaho.

The rural population is fairly large because the farms are generally small and, therefore, numerous. On half of the farms in Bonner County, less than 25 acres of land is used for raising crops; and on only about 5 percent of the farms is 100 acres or more used for raising crops.

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Many people who live in the country raise crops for their own use only and earn their incomes from other sources.

The principal activity on most farms is dairying and stock raising and the attendant care of pasture and production of feed for winter. The main harvested crop is hay, mainly clover and timothy, but alfalfa is also grown. Small grains such as wheat and oats, potatoes, miscellaneous garden crops, and fruits such as apples and cherries are produced.

The lumber industry is second to agriculture in providing rural employment, as many men find seasonal work in the forests and sawmills. Mining is a minor activity, and probably employs only a few tens of workers.

GEOLOGIC SETTING

In general, the region comprises two main geologic elements: the older consolidated formations, which compose the bedrock that crops out in the mountains and underlies the valleys at depth, and the unconsolidated materials of Pleistocene and Recent age, which occur as valley fill. The contact separating these two elements is drawn on plate 1 as accurately as is possible without field detailed study. Some outcrops of waterlaid deposits occur in tributary valleys outside of the contact as drawn; and till deposited by ice, although it is not identified in figure 4, forms a discontinuous cover over the gentler slopes of the mountains and hills.

BEDROCK

A detailed description of the bedrock is given by Anderson (1930). The oldest rocks in the area, metasedimentary rocks of the Belt Series of Precambrian age, are well exposed along U.S. Highway 10 on the east side of Pend Oreille Lake from the mouth of the Pack River to Clark Fork. Several formations have been indentified by Anderson. They consist mainly of slate or argillite and quartzite, and include a few beds of limestone or dolomite; all are strongly folded. Quartz diorite sills were injected into the sedimentary rocks in Precambrian time.

The Sandpoint Conglomerate of Anderson (1930, p. 193), a consolidated bouldery formation that Anderson considered to be of late Paleozoic age, crops out at places on the east side of the Sandpoint lowland and in some of the hills.

Granite or granodiorite is the most widespread bedrock. Its intrusion occurred in late Mesozoic time and was probably related to the intrusion of the Idaho batholith of central Idaho.

Rocks intermediate in age between the Mesozoic granite and the deposits of Pleistocene and Recent age have not been found in this area. Some remnants of the Columbia River Basalt of Miocene and

Pliocene(?) age and associated Latah Formation of Miocene age may be present at depth in the valleys.

The consolidated bedrock contains some water in joints and fractures, but because the openings are small and few, these rocks generally will yield only small supplies to wells.

UNCONSOLIDATED VALLEY FILL

The unconsolidated deposits, which are the source of ground water in the lowlands and valleys, reflect a long history of events, mainly in the Pleistocene Epoch. Three kinds of material are found: sand and gravel deposited by streams; clay, silt, and fine-grained sand laid down in lakes; and glacial till deposited directly by the ice. These materials have very different water-yielding properties. Their distribution is best explained by describing briefly the glacial history of the area before describing their occurrence in the subareas.

Several authors have contributed to the understanding of the glacial history of the area; but the work of Alden (1953) is the most recent, and it summarizes older work. Field studies for this report brought to light certain features not noted previously. The history presented here is brief and explains only the main features.

During the first recognized stage of glaciation in this region—the Spokane advance—ice moved southward in the lowlands as far as the site of Coeur d'Alene (fig. 2). The valleys probably were deepened considerably during this stage. The ice probably was 5,000 feet thick above the bedrock floor of the trough of Pend Oreille Lake and overtopped all but a few of the higher mountains. The ice moved up the valley of Clark Fork for several miles and impounded Lake Missoula, whose surface rose to an altitude of about 4,200 feet. The lake was as much as 2,000 feet deep above the ice dam and had a total area of about 3,300 square miles (Alden, 1953, p. 155). The recognizable deposits of this ice are the moraines or accumulations of till, now much weathered and eroded, near Coeur d'Alene.

During the Wisconsin Glaciation, a lobe of ice extended a few miles south of the lower end of Pend Oreille Lake, and an offshoot of this lobe extended up the Clark Fork, recreating Lake Missoula. To the west, the ice front probably lay across the southern end of Cocolalla Lake and the northern end of the Hoodoo Valley (pl. 1).

The melt water from ice standing at this front spread great masses of gravel southward along the Hoodoo Valley, the valley south of Cocolalla Lake, and out onto the Rathdrum Prairie. When the ice melted back out of Clark Fork Valley, immense volumes of water released from Lake Missoula poured southward through Rathdrum Prairie.

A large lake formed in the lowlands of the Sandpoint region as the ice melted away, because the Pend Oreille River was still dammed somewhere along its course northward into Canada. Water no longer spilled southward through the Rathdrum Prairie, but through a lower gap south of Newport, Wash. The altitude of the gap and of the water surface of the lake was about 2,500 feet, and eventually the valleys became filled to about this level with clay, silt, and fine-grained sand.

When ice ceased to block the Pend Oreille River, the lake drained and streams began to cut down into the valley-fill deposits. At this time the drainage from Pend Oreille Lake probably spilled through the gap in the hills west of Granite and then ran northward along the now abandoned channel that runs past Harlem and down the Hoodoo Valley. Later, a tributary stream deepened its channel in the soft lake beds along the present valley of the Pend Oreille River toward Sandpoint, and the river assumed this course, abandoning the earlier course along the narrow channel through rock hills west of Granite.

After the main valley floors had been lowered to an altitude of about 2,200 feet, ice accumulated in the mountains and moved down the mountain valleys. Ice descended the valleys of Grouse Creek and Rapid Lightning Creek, on the east side of the Sandpoint lowland, to altitudes of about 2,200–2,300 feet; the moraines in the valley of Grouse Creek lie on eroded lake beds. A larger glacier filled the valley of the Priest River and formed a moraine about 2 miles north of the town of Priest River. This moraine overlies lake beds eroded to a level of about 2,200 feet.

Runoff from the ice masses of the latest interglaciation deposited sand and gravel on valley floors of that time. The broad terrace that extends for several miles south of Elmira (pl. 1) on the east side of the Sandpoint lowland is capped by several feet of cobbly gravel. The largest gravel pit in the Sandpoint lowland is opened in a fan of cobbly gravel at the mouth of Grouse Creek. The deposits of sand and gravel which occur along the valley of the Pend Oreille River about 40–50 feet above river level are presumably of the same age.

In post-glacial time, erosion has lowered valley floors to their present levels. The many low sand dunes, most of which are vegetated, in the upper part of the Sandpoint lowland and along the bottom lands of the Pack River indicate that there was less protective cover on the sandy lowlands during some period in the last few thousand years.

GROUND-WATER RESOURCES

OCCURRENCE AND MOVEMENT

Ground water occurs everywhere in the lowlands underlain by lake beds and the bodies of sand and gravel. The sand and gravel yield far more water to wells than do the fine-grained lake beds, which have low permeability, but the lake beds yields supplies adequate for domestic and stock use to properly constructed wells.

Most of the ground water in the area occurs under water-table conditions. Below certain depths, which depend on the local geology and topography, all the intergranular openings in the lake beds and in the sand and gravel are filled with water. The water level in most wells, particularly those in the larger bodies of sand and gravel, represent the surface of the saturated zone.

Bodies of perched water are common in the lake beds. The clayey layers impede the downward movement of water, and water accumulates in the sandy layers. Such perched bodies may occur many tens of feet above the water table, and they are a source of water to many shallow wells.

Artesian water occurs in some wells, and is most common in drilled wells that end in thin beds of sand and gravel which are confined beneath thick deposits of lake beds. Ordinarily the artesian pressure is insufficient to raise the water to the surface and cause a well to flow.

Recharge is provided directly from precipitation and by infiltration from stream channels. Melting snow and the rain that falls in autumn and early spring are sources of much recharge on the level lowlands. The small amount of rain that falls in summer produces little recharge. The many wet-weather rills that descend mountain slopes and the larger streams draining mountain valleys replenish ground-water supplies at the base of the mountains and along stream courses discharging from the mountains.

The ground water generally moves away from the margins of the valleys toward lines of drainage where it is discharged as seepage. Many areas of seepage are seen where streams have cut into the lake beds, but there are few distinct springs. As the gradient of the water table in the wide lowlands is low at most places, the rate of movement of ground water is probably very slow, especially through the lake beds.

DEVELOPMENT OF GROUND WATER

TYPES OF WELLS

Several different types of wells are used to develop ground-water supplies in this region. The variety reflects the different types of water-bearing materials and, to some extent, the quantities of water that owners may wish to develop.

Dug wells are the commonest type in places where the water level is within a few tens of feet of the surface in fine-grained lake beds. The older dug wells are lined with timber cribbing or with stone or brick, but in recent years the wells have been cased with concrete tile or culvert, three to four feet in diameter. Many individuals still dig their own wells. One well driller, who specializes in constructing such large-diameter wells, uses augers 3–4 feet in diameter to bore the holes. He improves the efficiency of his wells by underreaming opposite the first bed of fine-grained sand penetrated below water level and then filling the space outside the casing with gravel.

Dug wells of large diameter serve efficiently in two ways in developing ground water from a low-yielding aquifer. First, they provide a large area for seepage of water from the formation. Second, the large-diameter well provides a large storage space—53 gallons per foot of depth in a 3-foot-diameter well. Thus, a few hundred gallons could be pumped from such a dug well once a day, even though the formation might yield only a quart a minute or 360 gallons a day.

Driven wells develop satisfactory supplies for domestic and farm needs in bottomlands underlain by sand, such as in parts of the Sandpoint lowland and in Priest River valley.

Drilled wells are used to develop ground water (1) where the bedrock is probably at fairly shallow depth, as along the margins of the valleys; (2) where the depth to water is too great for a dug or augered well to be economical, as on the bench 120 feet above the valley bottom east of Elmira in the Sandpoint lowland; or (3) where sand and gravel are known to occur, such as the thick gravel in the Hoodoo Valley or the stray lenses of gravel amid the lake beds in the upper part of the Cocolalla lowland and in the valleys of the Pend Oreille and the Priest Rivers. Six-inch casing is generally used, and perforated or slotted sections are set in the water-bearing zones.

One landowner in the Sandpoint lowland has developed sufficient ground water for supplemental irrigation of hay and pasture by use of a pit excavated in the shallow sand and gravel along the bottomlands of the Pack River. His success is likely to stimulate other such developments.

Most of the wells throughout the area develop small amounts of water from depths of no more than a few tens of feet, and jet pumps having motors of less than 1 horsepower are commonly installed. In a few wells that either develop larger than average supplies or that are very deep, submersible or cylinder pumps and motors having a few horsepower are used.

MEASUREMENT OF YIELDS

The yield of wells is commonly given as so many gallons per hour (gph) or per minute (gpm), but many uncertainties are unmentioned in such figures. For example, one well may yield 10 gpm for only a short time before the water level is lowered below the level of the pump valves; another well may yield 10 gpm and have no failure of supply. In the first instance, water is being pumped from the well faster than it can be replenished by the water-bearing formation; in the second instance, the water-bearing formation yields at least 10 gpm to the well and may be capable of yielding at a greater rate.

The main factor that determines the yield of a well, neglecting poor construction of the well, is the ability of the water-bearing formation to yield water. This can be determined by measuring the amount and rate of lowering of the water level in the well while pumping at a constant rate, but such information is obtained only from tests specially designed to provide data for mathematical analysis.

Where such data are lacking, the potential yield of wells is best expressed in terms of the specific capacity, which is the yield, in gallons per minute per foot of drawdown. As an example, well 56N–2W–15bc1 had a specific capacity of 2 gpm per foot of drawdown during a completion test, as the water level was observed to draw down 9 feet when 18 gpm was being pumped. The well cited could probably yield 40 gpm—at which drawdown would be about 20 feet—but such predictions based on specific capacity are safe only within moderate limits.

GEOLOGY AND GROUND WATER IN THE SUBAREAS

SANDPOINT LOWLAND

The Sandpoint lowland is a broad part of the Purcell Trench. It is about 9 miles wide at its southern end where it terminates at the north end of Pend Oreille Lake and narrows to the north between the enclosing mountains to a width of less than 2 miles near Elmira. The numerous hills of bedrock that rise above the valley floor were well rounded by ice action and are now partly mantled by glacial till. A very low divide separates the northern part of the lowland from the southern part. The principal stream is the Pack River, which meanders across the southern part of the valley from northwest to southeast. Sandpoint Creek drains a strip less than 2 miles wide along the western side of the valley. The northern end of the valley is drained northward by Deep Creek, which joins the Kootenai River at Bonners Ferry. The present drainage pattern has been inherited from the first drainage that developed when the glacial lake was drained.

The valley has two topographic elements: bottomlands only slightly above present stream levels, and slightly higher benchlands. The principal bottomlands lie along the Pack River and extend north of Samuels; bottomlands along Sandpoint Creek, a small stream, are commonly less than 100 yards wide. The benchlands are remnants of the valley floor that existed before the last stage of down-cutting, and they are best illustrated by the 1½-mile-wide terrace east of

Elmira. This terrace, which is about 120 feet above the bottomlands at Elmira, narrows southward and finally tapers out at the mouth of Rapid Lightning Creek. Most of the valley floor southwest of the Pack River is this older surface, somewhat eroded along lines of ephemeral drainage.

Three types of deposits are recognized in the Sandpoint lowland; in order of decreasing age, these are: (1) lake bed deposits of clay, silt, and fine-grained sand; (2) late-glacial gravels; and (3) stream-deposited sand. Logs of water wells penetrating these materials are shown in figure 4.

Stream-deposited sand is restricted to the bottomlands along the Pack River and to the narrow part of the valley near Elmira. The sand is fine grained. The sand is probably not much thicker than 10–15 feet along the Pack River. The few available well logs show that the sand in the northern part of the valley may be somewhat thicker.

The late-glacial gravels form a capping on the terrace on the east side of the valley and a fan of outwash at the mouth of Grouse Creek. The few feet of gravel beneath about 10 feet of windblown sand in well 58N–1W–21ad2, on the bench a mile southwest of the Pack River, probably represent the same deposit, which has thinned out to the south.

Lake beds composed of clay, silt, and fine-grained sand occur at most places in the valley beneath soil or the local superficial deposits of sand or sand and gravel. The lake beds are recorded in almost all well logs and seen in many roadcuts and stream banks. A few wells close to hills or the mountains penetrate through stony rubble into bedrock. The stony rubble may be either slope debris or glacial till.

Exposures of the lake beds normally show alternate beds of silty sand and silty clay, each a few inches to a few feet thick. The clay-rich beds probably were deposited in periods when the lake was unstirred by currents, and fine-grained material settled from suspension; the sandy layers were probably deposited in periods when currents were active in spreading material on the floor of the lake.

The thickness of the fine-grained lake beds is unknown, but it is apparently great. A test well drilled at a compressor station of the Pacific Gas Transmission Co. about half a mile northeast of Samuels penetrated 330 feet of clay and sand before being abandoned. According to local inhabitants, the Northern Pacific Railroad Co. in about 1900 drilled a test well in Sandpoint to a depth of 950 feet and abandoned it because only fine sand and clay were penetrated. In two other wells, drilled in about 1908–10 and 1928–29 by private individuals in Sandpoint to depths of about 800 feet, the same materials were found. The lake beds may be much thicker in places,

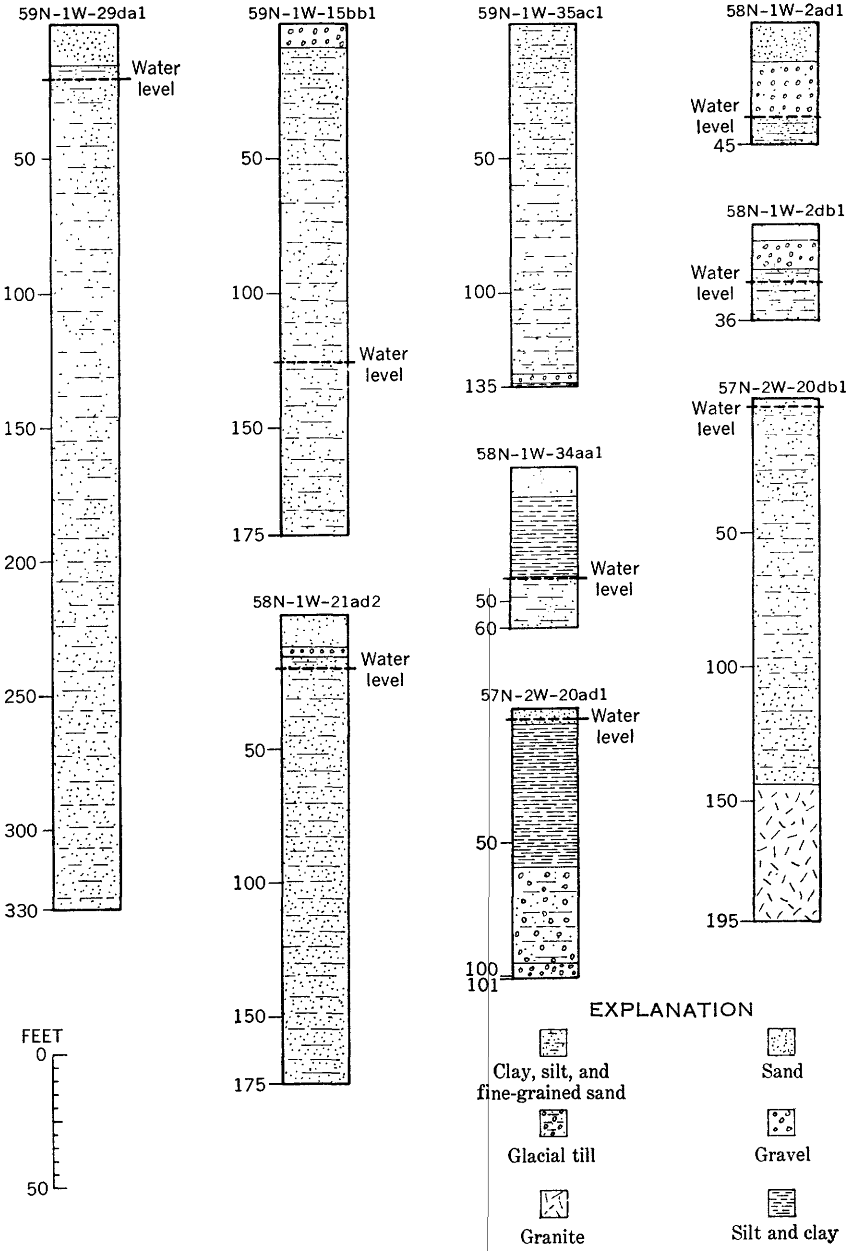

FIGURE 4.—Logs of wells in the Sandpoint lowland.

because Pend Oreille Lake is 1,140 feet deep, but bedrock hills may be buried at shallow depth anywhere in the lowland.

The two water-bearing formations in the Sandpoint valley are the lake beds and the shallow sand and gravel along bottomlands. The bedrock locally furnishes small supplies to a few wells on the valley margins.

Depth to water in wells in the lake beds depends upon the topography, but it is rarely as much as 30 feet and is more commonly 20 feet or less. The greatest depth to water reported was 125 feet in in well 59N–1W–15bb1 on the edge of the terrace on the east side of the valley. The generally shallow depth to water mainly reflects the low altitude of the valley above stream level, but at some places it is due to perched water in the sandy beds. For example, on the bench south of the Pack River, water stands about 20 feet below the surface in dug well 58N–1W–21ad1, which is 30 feet deep, and stands 74 feet below the surface in well 58N–1W–21ad2, a few tens of feet away, which was drilled and cased to a reported depth of 175 feet.

Wells in the lake beds have very low yields. Only the sandy layers yield a significant amount of water, and the sand is so fine grained that permeability and rates of movement are low. Many owners stated that their wells were only adequate for domestic purposes and, at that, inadequate for watering lawns or gardens. Most dug wells probably yield no more than 1 gpm, and occasional pumping of 10 gpm can be sustained only because of the water stored in the well.

The only way in which a greater yield could be obtained would be by penetrating deeper into the sedimentary deposits and using large diameter screened or gravel-packed wells that would draw from several of the sandy layers. Improved construction methods would increase yields, but the added expense would be a deterrent to most of the small-farm owners of the area.

The sand containing some gravel in the Pack River bottomlands and in the narrow part of the valley above Samuels is a much better aquifer than the lake beds. The water level in most places ranges from a few feet to 20 feet below land surface. Yields of well points and dug wells may be as much as 20 gallons per minute, though the average probably is less. High rates of pumping tend to draw the fine-grained sand into the wells.

Sufficient water for supplemental irrigation can be developed where gravel and sand occur in the bottomlands near a source of replenishment. The gravel does not occur everywhere under the bottomlands, and, at a number of places where it does occur, it probably is not more than 10 feet thick and does not store enough water to sustain heavy pumping for a period of weeks. Sustained yields, therefore, depend on infiltration of water from some nearby source, such as the Pack River or the sloughs. Because of these factors, tests by drilling and pumping are advisable before equipment for irrigation is purchased.

PRIEST RIVER VALLEY

The Priest River valley extends a distance of about 20 miles from Coolin at the south end of Priest Lake to the town of Priest River on the Pend Oreille River. The upper part of the valley is broad and flat; the lower portion is also broad but has a more undulating surface. The central part of the valley is narrow between foothills of the mountains.

In the southern and central parts of the valley, glacial till lies over lake beds. These formations are well exposed in the highway cuts about 2 miles north of the town of Priest River. A recessional moraine occurs about 3 miles farther north, and detailed mapping probably would show others farther north. Benches formed by gravelly outwash from the receding glacier occur at many places along the Priest River and a large pit is opened in the gravel just north of McAbee Falls.

The few exposures in the northern part of the valley, which is mostly forest-covered, show sandy lake-bed deposits that indicate deltaic type of deposition toward the head of the valley. Some beds of gravel are penetrated by well 59N–4W–10cb1 (fig. 5) in a terrace at Coolin; the log of this well shows 20 feet of sand, 30 feet of gravel, and then clay.

The Priest River is entrenched throughout the valley mainly into lake beds. The inner valley of the river is generally narrow except at a few localities, such as near McAbee Falls. McAbee Falls are merely shallow rapids over a ledge of granite; a much deeper valley probably is buried nearby, and the river in cutting down through valley fill has here become superimposed on a rock shoulder or buried hill.

Several exposures in the southern part of the valley give evidence of the conditions under which the lake beds accumulated. Beds of silt and fine-grained sand alternate with varved clay which shows annual couplets of dark winter layers and light-colored summer layers. The varved clay denotes a lake that was ice-covered in the winter and open in the summer—the dark layers are formed of clay, mud, and organic matter that settled from suspension in still water under ice; the light layers are of silt spread by currents in summer. Measurements show that the varved clay accumulated at a rate of about 1 foot every 16 years. The time required for deposition of the layers of sand and silt was probably much less than that required for deposition of comparable thicknesses of varved clay.

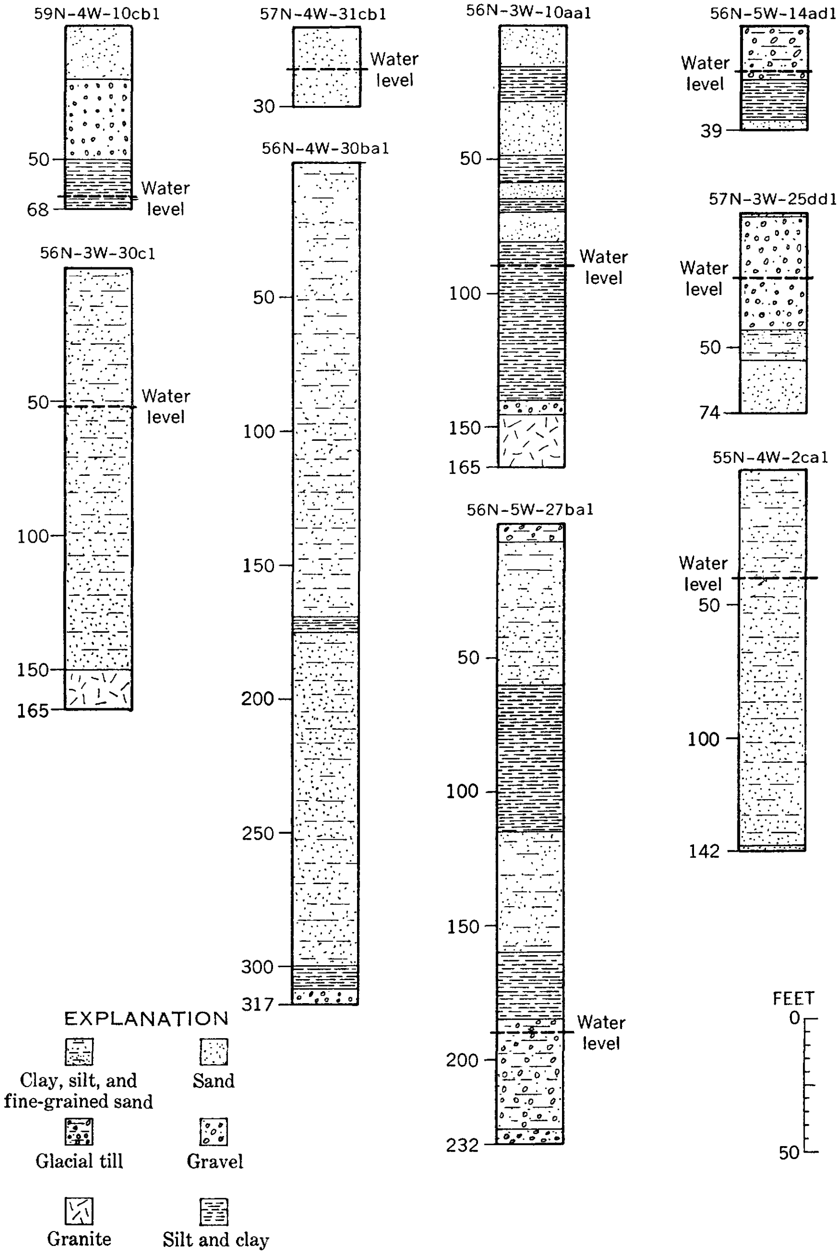

FIGURE 5.—Logs of wells in the Priest River and Pend Oreille valleys.

The water-bearing formations in the Priest River valley are the sandy layers in the lake beds, the occasional thin beds of sand or sand and gravel that are associated with glacial till, and the sand and gravel along the present course of the Priest River. The lake beds and glacial till may extend to the bedrock floor of the valley, which at the lower end of the valley probably is at a depth of hundreds of feet. For example, well 56N–4W–30ba1, on the east side of the town of Priest River, terminated in sedimentary deposits at a depth of 317 feet. The sand and gravel along the river and its flood plain are apparently a product of recent cut and fill during seasonal floods and, therefore, probably are not more than 10–20 feet thick.

The depth to water varies widely from place to place, and this variance suggests several different water-bearing zones. The water level is not deep even in the high parts of the valley; the greatest depth to water measured in this reconnaissance was about 60 feet. Water tapped in many dug wells is undoubtedly perched locally. Water in some of the thin beds of sand and gravel at depth is under sufficient pressure to flow at the surface.

Well yields are low but are adequate for domestic and stock supplies. Large diameter dug wells are used to develop water from the lake beds, and if one such well is inadequate, the combined yield from it and another similar well a hundred feet or more away almost always suffices for the domestic and stock needs of the average farm. Drilled wells that tap thin beds of sand or sand and gravel yield more than dug wells. Well 56N–5W–14ad1, in the lower part of the Priest River valley, had a drawdown of 20 feet when bailed at about 10 gpm; therefore, it has a specific capacity of 0.5 gpm per foot of drawdown. Other drilled wells are reported to have yields of about the same magnitude.

The possibility of getting sufficient ground water for irrigation in this valley is slight. The beds of sand and gravel found in drilled wells are thin and cannot be expected to yield large supplies; also, they are isolated or not in contact with any significant source of recharge such as streams. The largest bodies of sand and gravel in the valley are the remnants of outwash of the latest glacial stage, but they are not a source of water because they are above water level. Sand and gravel along the present stream might be explored as a possible source; although the deposits are probably thin, there may be some localities near the river where supplies could be developed.

PEND OREILLE RIVER VALLEY

The valley of the Pend Oreille River begins about 2 miles west of Sandpoint and extends down river to Newport (fig. 2). The valley is underlain by lake beds and occasional thin layers of sand and gravel. As described previously, the Pend Oreille River valley was not a spillway during the major periods when gravel outwash was being deposited because it was blocked to the west and north by ice.

The logs of wells 56N–3W–10aa1 and 30c1 (fig. 5) show about 150 feet of fine-grained material above bedrock along the valley between Laclede and Dover. Well 56N–4W–30ba1, on the east side of the town of Priest River, penetrated 312 feet of lake beds and bottomed in 5 feet of gravel. A mile west of Priest River, well 56N–5W–27ba1 also ended in about 6 feet of gravel at a depth of 231 feet. The 45 feet of clay and gravel reported beneath lake beds in this well may be glacial till.

Deposits of sand and some gravel a few tens of feet thick are banked against the walls of the valley at places. These deposits overlie the lake beds and are the remnants of a once extensive sheet that accumulated during the latest glacial substage.

The water-bearing formations in the Pend Oreille River Valley are lake beds and sporadic beds of sand or sand and gravel in the lake beds. The lake beds, as in the other subareas previously described, provide very small supplies to the common type of dug wells having concrete casings about 3 feet in diameter.

The beds of sand or sand and gravel penetrated at depth by drilled wells yield supplies adequate for domestic and stock needs. Well 56N–3W–10aa1 had a specific capacity of 2 gpm per foot of drawdown (pumping rate 20 gpm, drawdown 10 ft). Well 56N–5W–27ba1 had a specific capacity of 0.7 gpm (pumping rate 7 gpm, drawdown 10 ft).

The evidence suggests that supplies of ground water adequate for irrigation cannot be developed. Fine-grained lake beds containing few thin layers of coarser material extend to bedrock in wells 56N–3W–10aa1 and 30c1 and probably do so at other places where they have not been penetrated completely.

COCOLALLA LOWLAND

For the purposes of geologic description, two divisions of the Cocolalla lowland are distinguished: the lowland of irregular shape that extends northward from Cocolalla Lake to Pend Oreille Lake and westward to the Pend Oreille River, and the narrow valley south of Cocolalla Lake (pl. 1).

The valley fill in the northern lowlands consists of lake beds and glacial till. The materials shown in the logs of wells 56N–2W–9db1 and 15bc1 (fig. 6), both north of Algoma, are lake beds. However, the 100 feet of material in well 56N–2W–4bd1 that the driller called clay, hardpan, and gravel may be till or may include some till. The clay and boulders reported to a depth of 55 feet in well 56N–2W–32ab1 probably is till. In the lowland that runs westward to Pend Oreille River, only lake beds are exposed along Cocollala Creek, but glacial till forms some of the rolling terrain above the creek valley.

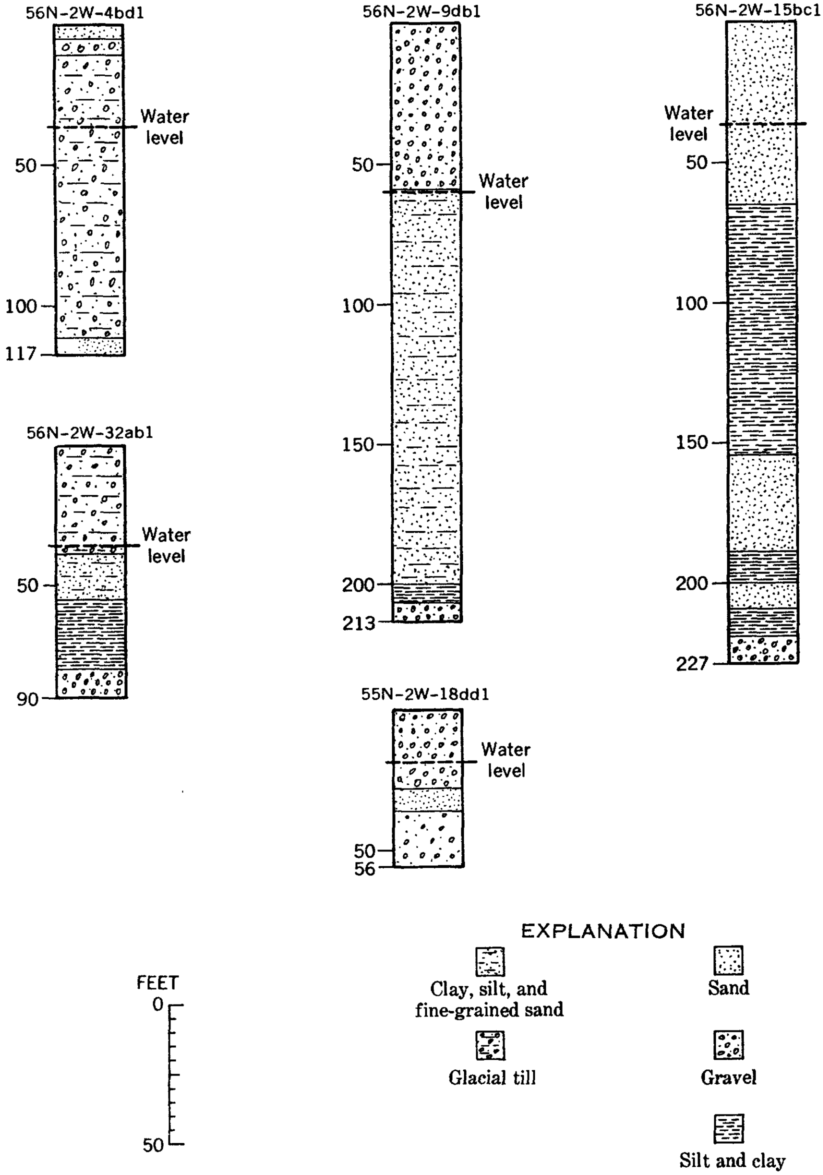

FIGURE 6.—Logs of wells in the Cocolalla lowland.

The narrow valley south of Cocolalla Lake was an outwash channel and is filled to an unknown depth by gravel as is shown in well 55N-2W-18dd1 (fig. 6), which is 56 feet deep, at the Cocollala station of the Northern Pacific Railroad. Similar gravel probably continues southward past Granite to the Rathdrum Prairie.

The log of well 56N–2W–9db1, 1½ miles north of Algoma, shows about 60 feet of gravel immediately below the surface (fig. 6). This gravel may be local, but it is possibly part of a channel deposit that continues southward to connect with the gravel in the valley south of Cocolalla Lake.

In the lowlands north of Cocolalla Lake, ground water is developed from the lake beds and from occasional beds of sand or sand and gravel at depth in the lake beds. The outwash gravel in the narrow valley south of Cocolalla Lake is an excellent aquifer.

Drilled wells in the lowlands north of Cocolalla Lake commonly penetrate some thin beds of coarse sand or sand and gravel in lake beds. These water-bearing beds are shown at depths ranging from 80 to 220 feet in four of the well logs on figure 7.

Water levels in dug wells normally are within 10–20 feet of the surface. Water levels in the drilled wells commonly stand at greater depths, usually 35–60 feet below the land surface. The difference in levels suggests perched water in the lake beds.

The yields of dug wells in the fine-grained lake beds north of Cocolalla are very low and are sufficient only for domestic purposes. Information on the yield of four drilled wells in the lowlands north of Cocolalla Lake is presented below. The specific capacity, the most

Well	*Pumping rate (gpm)*	*Drawdown (feet)*	*Specific capacity (gpm per foot)*	*Duration of test (hours)*
56N–2W–4bd1	12	62	0.2	2.8
9bd1	30	40	.75	6
15bc1	18	9	2.0	4.5
32ab1	5	10	.5	3.75

significant of the figures, ranges from 0.2 to 2.0 gpm per foot. Somewhat larger specific capacities probably would be obtained in larger-diameter wells that were carefully developed to attain maximum efficiency. It seems doubtful whether large yields, sufficient for irrigation of many acres, could be obtained. Because water-bearing beds are thin and because they are isolated at depth under thick deposits having low permeability, they are poorly connected with sources of recharge.

The gravel in the valley south of Cocolalla Lake provides large yields to wells. Well 55N–2W–18dd1 at the Cocolalla station of the Great Northern Railroad had a drawdown of 23.5 feet when pumped at 60 gpm for 24 hours; the indicated specific capacity is 2.6 gpm per foot of drawdown. This specific capacity, low for a well that penetrates about 30 feet of water-saturated gravel, probably indicates high entrance loss to the well, which is reported to have only 6 feet of screen. If the well were screened throughout the water-saturated zone, it probably would have a much higher specific capacity. The gravel in the valley south of Cocolalla probably would yield sufficient water for supplemental irrigation to properly constructed wells. However, tests would be required to verify this possibility.

The water level is close to the land surface between Careywood and Cocolalla; farther south it declines to the deep water level below the Rathdrum Prairie. A water-table divide probably occurs a short distance south of Careywood, and the ground water moves to the north and to the south from this divide.

HOODOO VALLEY

Most of Hoodoo Valley is underlain by clean gravel and sand that was deposited as outwash south of the ice when the ice front was near the north end of the valley. The gravel is exposed in large pits at the north end of the valley, and well 55N–4W–9aa1 (fig. 7) penetrated gravel throughout its entire depth of 147 feet. In the southernmost part of the valley, where it opens onto the Rathdrum Prairie, well 54N–4W–27cb1 penetrated gravel to a depth of 400 feet. The gravel probably is thick in much of the valley, but buried hills of bedrock may exist anywhere.

Some lake beds are reported in wells along the margins of the valley. The log of well 55N–4W–25cc1, about three-quarters of a mile from the east side of the valley, shows that the well penetrated 55 feet of gravel and sand, about 90 feet of clay and silt, and then 2 feet of gravel (fig. 7). Well 54N–4W–12d1 is in a reentrant on the side of the valley, away from the main outwash-bearing channel; this well penetrated 100 feet of silt and fine-grained sand.

Well 55N–4W–10ba1, on the northwest side of the low mountain at the north end of the valley, penetrated about 40 feet of silt and clay which were deposited on the gravel after it had been somewhat eroded in this locality.

The aquifer in the Hoodoo Valley is the sheet of gravel just described. It extends from one end of the valley to the other and occupies most of the width of the valley.

The water level is fairly deep at the northern end of the valley; the reported depth to water in well 55N–4W–9aa1 is 130 feet. Farther south the depth to water is less, and toward the southern end of the valley the water table is at the surface in lakes and sloughs along the abandoned glacial channel.

Water-level measurements and altitude data indicate that there is a water-table divide somewhere between Edgemere and Harlem. Ground water north of the divide moves northward to discharge into Hoodoo Creek and the Pend Oreille River. Ground water south of the divide moves southward toward Athol and joins the large ground-water body moving southwestward beneath the Rathdrum Prairie. The water level was 219 feet below the surface in well 54N–4W–27cb1,

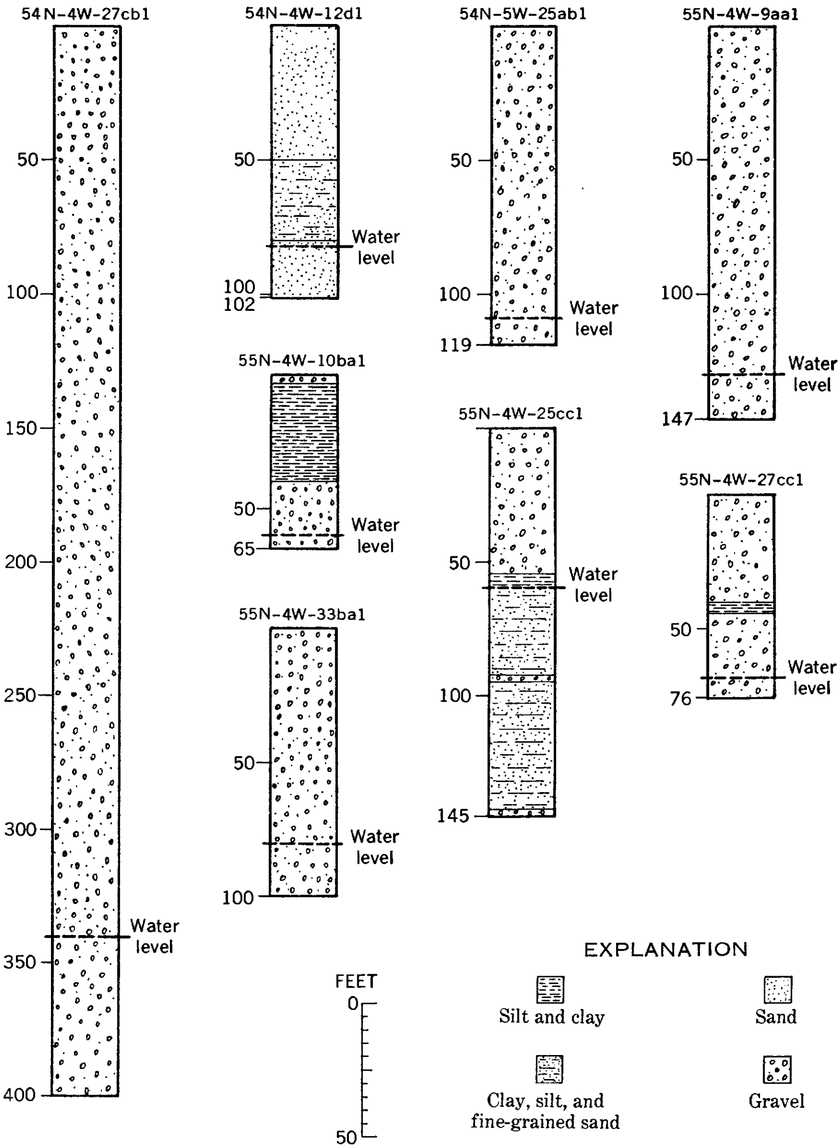

FIGURE 7.—Logs of wells in the Hoodoo Valley.

at the south end of the Hoodoo Valley, when measured in August 1948. Prior to 1939 the depth to water in this well was about 331 feet. The rise may have been caused by plugging the lower part of this well, and the higher water level is that of a perched body of water.

All the wells in the Hoodoo Valley were drilled for domestic and stock supplies and are adequate for these needs. Thus, there has been no incentive to make tests of yields and drawdowns, and little data are available on what wells could yield.

The aquifer can most likely yield far larger supplies than have been developed. The sand and gravel that fills most of the valley is very permeable. Well 55N–4W–13bd1, near the post office and store at Vay, is reported to have been used at one time to irrigate 18 acres, though it is a dug well only 22 feet deep and does not penetrate more than a few feet into the saturated zone below water level. Well 54N–5W–25ab1, when pumped at a rate of 120 gpm is reported to have a drawdown of 1.25 feet, and, therefore, a specific capacity of 96 gpm per foot of drawdown.

QUALITY OF GROUND WATER

The chemical character of the ground water is shown by the analyses of seven samples that represent waters from the various subareas (table 1). These analyses are also presented graphically in figure 8.

TABLE 1.—*Chemical analyses, in parts per million, of ground water from wells in the Sandpoint region, Idaho*

[Analyses by U.S. Bur. Reclamation, Boise, Idaho]

Well	59N–1W–15bb1	59N–4W–10cb1	58N–1W–16ca1	56N–2W–9db1	56N–4W–30ba1	55N–4W–13bd1	54N–5W–25ab1
Date of collection, September 1961	4	9	13	14	12	13	7
Temperature °F	45	[1] 63	[1] 54	45	46	[1] 50	44
Calcium Ca	34	10	47	13	29	20	12
Magnesium Mg	7	3	13	5	6	4	4
Sodium Na	2	3	2	3	5	2	2
Potassium K	2	1	1	1	1	1	1
Bicarbonate HCO_3	124	49	206	62	106	81	50
Sulfate SO_4	12	2	4	4	17	3	2
Chloride Cl	2	2	1	3	1	1	1
Nitrate NO_3	.00	.00	.00	.00	.00	.00	.00
Boron B	.00	.00	.00	.00	.00	.00	.00
Dissolved solids [2]	120	45	169	59	111	71	47
Hardness as $CaCO_3$	114	37	171	53	97	66	47
Residual Na_2CO_3 me per l	–.22	.06	.00	–.05	–.18	–.02	–.08
SAR	.08	.21	.06	.16	.23	.12	.13
Class	C1–S1	C1–S1	C2–S1	C1–S1	C1–S1	C1–S1	C1–S1
Specific conductance micromhos at 25°C	209	76	307	105	194	131	84
pH	8.00	6.90	7.42	7.60	8.02	7.42	7.22

[1] Not true ground-water temperature.
[2] Sum of constituents determined.

All the waters are of good to excellent quality for irrigation or domestic use. The sum of the constituents determined ranges from 45 to 169 ppm (parts per million); total dissolved solids would be 15–20 percent greater, owing to the presence of silica and other substances present in low concentrations. The hardness in most of these waters is low, averaging 84 ppm, and would not require softening; however, the water in well 58N–1W–16cc1 has a hardness of 171 ppm.

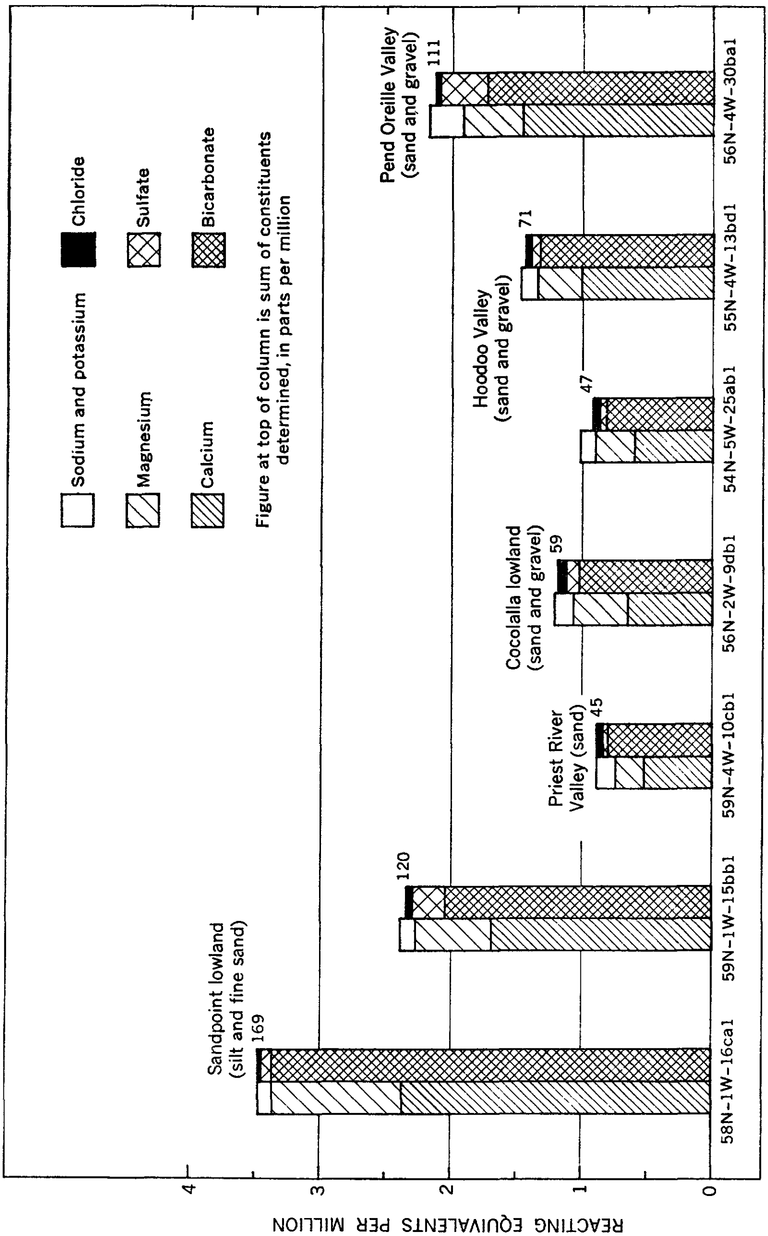

FIGURE 8.—Chemical character of ground water in the Sandpoint region, Idaho.

The analyses show no concentrations of chemical constituents that might be objectionable or harmful. The amount of iron in the waters was not determined, but probably it is not high because well owners who were interviewed did not complain about the iron content of the water.

All the sampled waters are of the calcium magnesium bicarbonate type that is common in temperate regions. As the bar graphs in figure 8 show, calcium, magnesium, and bicarbonate ordinarily make up about 90 percent of the constituents determined, and the remaining 10 percent comprises sodium, potassium, sulfate, and chloride. Sulfate composes 17 percent of the anions in the water from well 56N–4W–30ba1, which penetrates gravel deep in the Pend Oreille Valley.

The main difference among the sampled waters is in the concentration of dissolved substances, as shown by the specific conductance and the sum of constituents determined, rather than in the proportions of different substances. In general, the waters having the highest concentration of dissolved solids are from the fine-grained lake beds, and the waters having the lowest concentration of dissolved solids are from sand and gravel. The water that has a conductance of 307 micromhos is from a well (58N–1W–16ca1) in the lake beds; the water that has a conductance of 76 micromhos is from a dug well (59N–4W–10cb1) in sand and gravel. The concentration of dissolved solids is probably related to the length of time that water has been in contact with the rock materials; water circulates very slowly through the lake beds and thus has more prolonged contact with them than with the more permeable sand and gravel beds. The water that has a conductance of 194 micromhos—from well 56N–4W–30ba1—is from a bed of sand and gravel beneath 300 feet of lake beds; the rate of circulation in this deeply buried bed is doubtless slow compared to that in shallower bodies of sand and gravel.

SUMMARY

The small farms in the valley and lowlands of the Sandpoint area support a variety of crops, but most of the farmers' income is from dairying and stock raising; consequently, much of the acreage is used for growing hay and for pasture. Dry summers and small supplies of surface water for irrigation limit the number of stock that can be raised, hence the production of milk.

Supplies of water for domestic purposes can be obtained from wells anywhere in the lowlands. Larger supplies for supplemental irrigation can be obtained only in the Hoodoo Valley and in the part of the Cocolalla lowland south of Cocolalla Lake. Sand and gravel occur under these two areas because the areas were spillways for water tnat melted from glaciers in the valleys to the north. The rest of the lowlands were covered by lakes that formed after the ice melted and now contain a fill of lake beds consisting of clay, silt, and fine-grained sand, and sporadic thin beds of sand. Such strata yield only small supplies of ground water.

Granite and ancient quartzite and shale form the bedrock of the mountains. These formations yield very little water to wells.

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Anderson, A. L., 1930, Geology and ore deposits of the Clark Fork district, Idaho: Idaho Bur. Mines and Geol. Bull. 12, 132 p.

RECORDS OF WELLS

The following table (table 2) presents descriptive data for the wells inventoried during this investigation. Only a small fraction of all the wells in the area were inventoried, but a representative sample probably was obtained.

Information was derived by interviews with well owners and well drillers and from the records submitted by well drillers to the Idaho Department of Reclamation.

Few measurements of water level were obtained because the typical wells drilled for domestic and stock needs are usually sealed.

The reports of drawdown in wells during pumping are almost wholly derived from completion tests made by well drillers.

TABLE 2.—*Records of wells in the Sandpoint region, Idaho*

Type of well: D, dug; Dr, drilled; Dv, driven. Depths of wells are reported depths.
Character of aquifer: S, sand; G, gravel; Sl, silt; Gn, granite.
Depth to water: Measured depths to water are given to the nearest tenth of a foot. Reported depths to water are given to the nearest whole foot.
Type of pump: J, jet; P, piston; T, turbine; C, centrifugal; N, none.

Use: N, none; Obs, observation; Irr, irrigation; PS, public supply; Dom, domestic; St, stock; Ind, industrial; Inst, institution.
Remarks: Log, shown in figure; Analysis, in table; pumping rate and drawdown when known.

Well	Owner	Year drilled	Type of well	Depth of well (feet below land surface)	Casing		Character of aquifer	Water level		Pump		Yield of well (gpm)	Use of water	Remarks
					Diameter (inches)	Depth (feet)		Depth to water (feet)	Date	Type	H.P.			
59N-1W-3cc1	R. J. Minnich	1945	Dr	27		3	S	10	1945	J			Dom	Serves 6 family houses.
9da1	Ed Holbert	1948	Dv	20	2		S, G	5		J			Dom	
14bd1	R. F. Cullison		Dr	100	6		G	20		J	½		Dom, St	30 ft to bedrock.
15bb1	Carl Jenkins	1951	Dr	190	5		Sl	125		C	¾	5	Dom, St	Log. Analysis
16cd1	M. W. Wilson	1942	Dv	20	2		S	15		J			Dom, St	
29da1	Pacific Gas Trans. Co.	1961	Dr	330			S, Sl	20	1961				N	Log. Test hole.
29dc1	M. Jukich		Dv	17	2		S			J			Dom, St	
33aa1	Donald Lund	1953	Dv	25	2		S	10		J			Dom	
35ac1	McNall Brothers	1939	Dr	135	5		S, G			C	½		Dom	Log.
59N-4W-10cb1	J. M. Roberts	1948	D	68		4	S, G	63		J	¾		Dom	Log. Analysis
58N-1W-2ad1	Lenora Frazier	1945	D, Dr	45	5		G	34.8	9/5/61	J	½		Dom	Log.
2db1	W. B. Ogden		D	36		2	S	22		J	¾		Dom, St	Log.
7dc1	G. W. Finley	1960	D	30	60		Sl	28	1961	J			Dom	
9ad1	Claude Hopkins		D	21		3	S	16.6	9/6/61	J	½		Dom, St	
11bb1	Burton Ahola		D	16		3	S	12		J	¾		Dom, St	
11cc1	R. D. Reber		Dv	22	2		S			J	½		Dom, St	
16bd1	H. Thomason	1960	D	10			S, G	4		C	7½		Irr	Infiltration pit, 50 x 100 ft on flood plain.
16ca1	do	1958	Dr	28	36		S			J	1		Dom	Analysis.
20dc1	Robert Green	do	D	30	36		S	0–15		J	½		Dom, St	
21ad1	Darrell Brown		Dr	30	36		S	20		J	½		Dom, St	
21ad2	do	1961	Dr	175	6		Sl	73.7	9/5/61				N	Log.
22bd1	Henry Shadel	1928	D	30	36		S	28		P			Dom, St	
23bc1	Northside School		Dr	37	60		Sl	6		J	¾		Inst	
32ab1	C. G. Cox		D	12	36		S	2–8		J	½		Dom	
32ad1	Andrew Reppe	1936	D	38	36		S	22.8	9/6/61	J			Dom, St	
34aa1	John Macki		Dr	60	24		S	41		J	½		Dom, St	Log.
58N-2W-12db1	R. B. Pedersen	1951	Dr	42	30		S	22		N			N	
26aa1	R. M. Lyons												Dom, St	Spring.

TABLE 2.—*Records of wells in the Sandpoint region, Idaho*—Continued

Well	Owner	Year drilled	Type of well	Depth of well (feet below land surface)	Casing: Diameter (inches)	Casing: Depth	Character of aquifer	Water level: Depth to water (feet)	Water level: Date	Pump: Type	Pump: H.P.	Yield of well (gpm)	Use of water	Remarks
58N-4W-11c1	W. H. Howell	1956	D	60	36			58		J	½		Dom	
57N-2W-2ab1	Dave Blayne		D	16	36		G	10					Dom	16 ft silt, then gravel layer.
17dc1	Dwight Crowell	1961	Dr	65	6		Gn	32		J	½	2.5		Drawdown 29 ft while pumping 2.5 gpm.
20ad1	E. J. Messmore	do	Dr	101	6		S, G	4		J	½	5	Dom	Drawdown 95 ft while pumping 5 gpm. Log.
20db1	W. E. Brunsell	do	Dr	195	6		Gn	3		J	½	11	Dom	Drawdown 170 ft while pumping 11 gpm.
28bb1	James Breinich	do	Dr	110	6		Gn	21		J	½	5	Dom	Drawdown 105 ft while pumping 5 gpm.
57N-3W-25dd1	Earl Anderson	do	Dr	74	6		S	23	5/60	J	½	10	Dom	Drawdown 1 ft while pumping 10 gpm. Log. Water temperature 42° F.
57N-4W-19aa1	Robert Savage	1953	D	18	48		S	14		P	½		Dom, St	
20bb1	John Myrvang	1940	Dr	120	2		S?			N			N	Flowed at surface
31cb1	Hammond	1959	Dr	30	24		S	15		J	½		Dom	Log.
56N-1W-22bc1	Earl Gibson	1960	Dr	145	6		Gn	40				2	Dom	Drawdown 140 ft while pumping 2 gpm.
56N-2W-4bd1	Jerry Spade	1961	Dr	117	6		S	37				12	Dom	Drawdown 62 ft while pumping 12 gpm. Log.
9db1	Carl Frantz	1959	Dr	213	6		G	60				30	Dom, St	Drawdown 40 ft while pumping 30 gpm. Log. Analysis.
15bc1	Herbert Gordon	1960	Dr	227	6		S, G	37				18	Dom	Drawdown 9 ft while pumping 18 gpm. Log.
32ab1	C. C. Collins	1961	Dr	90	6		S, G	35		J	½	5	Dom	Drawdown 10 ft while pumping 5 gpm. Log.
56N-3W-10aa1	Orren Overland	1960	Dr	165	6		G	90				20	Dom, St	Drawdown 10 ft while pumping 20 gpm. Log.

26bc1	A. W. Fisher	1948	D	12	48		S, G	5		P	½		Dom	
26ca1	Dan Robinson											5	Dom, St, Irr	Spring. Water temperature 48° F.
30c1	Great Northern Railroad.	1954	Dr	165	8		S	52	2/17/54	N		3	N	Drawdown 28 ft while pumping 3 gpm. Log.
56N-4W-30ba1	Hedlund Lumber	1957	Dr	317	6		G	0		T	1		Ind	Flows at surface. Log. Analysis.
56N-5W-14ad1	Arthur Hailand	1960	Dr	39	6		S	17	6/17/60			10	Dom	Drawdown 20 ft while pumping 10 gpm. Log.
27ba1	Clark Foote	1961	Dr	231	6		S, G	190				7	Dom	Drawdown 10 ft while pumping 7 gpm. Log.
55N-2W-18dd1	North Pacific Railroad.	1945	Dr	56	8	51	S, G	18	3/5/45			60	Ind	Drawdown 23 ft while pumping 60 gpm. Log.
55N-4W-1ac1	George Robinson	1910	Dr		6		G	90		P	1½		Dom, St	
2ca1	Homer Smith	1952	Dr	142	4	142	S	40		J	⅓		Dom	Log.
9aa1	Henry Bergdorf	do	Dr	147	6	147	G	130		J	1		Dom	Log.
9aa2	do	1957	Dr	138	6	138	G	124		J	1		St	
10ba1	J. W. Baylor		Dr	65	6			60		J	½		Dom, St	Log.
12cd1	Richard Morse		D	14	36		S, G	9		J	½		Dom, St	
13bd1	Ann Casey	1953	D	22	36		S, G	18		J	¾		Dom	Reported to have been used for irrigation. Analysis.
13cc1	Frank Crook	1959	Dr	43			G	34					Dom	
15ac1	Frank Waters	do	Dr	42	4		G	35		J	½		Dom, St	
15ca1	Frank Lehman	1952	Dr	50	4		S, G	42		J	½		Dom, St	
21db1	Owen Brownfield	1959	Dr	40	4		G	32		J	½	12	Dom, St	
25cc1	Edgemere Grange	1950	Dr	145	6	145	S, G	60	6/50	P	0		Dom	Log.
27cc1	W. C. Gornick	do	Dr	76	4	76	G	68		J	½	7	Dom, St	Log.
33ba1	R. Larson	1956	Dr	100	6	100	G	80	1956	J	2	20	Dom, St	Log.
34bd1	E. C. Heinrichs		Dr	30	2		G	20		J	¾		Dom	
34db1			Dr		6		G	35.1	9/7/61	P	0		N	
35bc1	Edgemere School		Dr	35			G	27		J	0		Inst	
54N-4W-10db1	Arnold Blood	1950	Dr	30	4		G	20		J	½		Dom, St	
12c1	Bob Bandy	1954	Dr	76	4		G	66		J	¾		Dom, St	
12d1	do	1958	Dr	102	6		S	82		J				Log.
15ca1	Harold Stewart	1947	Dr	142	4		G	117		P	0		Dom	
23bb1	S. A. Manning		Dr	72			G	57		P			Dom	
23bb2	Harold Stewart	1909	D	32			G	21		J	½		Dom, St	
27cb1	Herb Finney		Dr	404	8		G	339.4	3/26/38	N			Obs	Log.
35da1	Cecil Rosenfeldt	1946	Dr	215	4	215	G	205	3/15/47	P			St	
54N-5W-20ad1	F. L. Poirier	1926	D	120	24		G	85.3	9/20/59	J			PS	Supplies 25 families.
25ab1	Archie Herrick	1930	D	119	36		G	108.4	9/7/61	T	15	120	Irr	Drawdown 1.3 ft while pumping 120 gpm. Log. Analysis.