Ground-Water Resources of Snohomish County Washington

By R. C. NEWCOMB

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GROUND-WATER RESOURCES OF SNOHOMISH COUNTY WASHINGTON

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ABSTRACT

Snohomish County comprises an east-west strip, six townships wide, extending 60 miles from the eastern shore of Puget Sound to the drainage divide of the Cascade Mountains. Topographically, the eastern two-thirds of the county varies from hills and low mountain spurs at the west to the continuous high, maturely carved mountains of the Cascade Range at the east. The western third of the county lies in the Puget Sound lowland section; it is made up largely of unconsolidated deposits, as contrasted with the hard rocks of the mountain section. High-level deposits of glacial debris in some places form a transitional ramp from the lowlands to the mountain topography; in other places the transition is abrupt. The principal rivers—the Snohomish, Skykomish, Stillaguamish, and Sauk—drain westward and northwestward to Puget Sound.

The Puget Sound lowland, with its extensions up the river valleys, is economically the important part of the county. Within that part, ground-water development is of particular importance. The climate is equable and dominantly oceanic, with an average of about 32 in. of rainfall annually, but with a pronounced dry season from June to September. A mean annual temperature of 52 F, a growing season of more than 200 days, and a variety of good soils form a setting in which supplemental irrigation can at least double the average crop production.

Within the coastal lowland, plateau segments 200 to 600 ft or more in altitude are separated by flat-bottomed, alluviated river gorges. The river flats in some cases represent the surface of as much as 500 to 600 ft of glacial and alluvial deposits backfilled into canyonlike arms of the ancestral drainage system. The plateau segments are formed of the till-smoothed remnants of bedrock or the tabular segments of Pleistocene deposits.

The Pleistocene deposits consist, above sea level, of about 200 ft of Admiralty clay and as much as 1,000 ft of deposits of the Vashon glaciation. The latter include as much as 300 ft of either clay or sand units of advance outwash, up to 150 ft of till, and variable thicknesses of outwash-terrace and train material. The Admiralty clay is composed largely of clayey materials without important quantities of ground water. Similar clayey sediments are known to continue downward for more than 1,000 ft below sea level. The sand unit and, to a lesser extent, the clay unit are largely advance outwash of the Vashon glaciation. They are water bearing, and the position of their ground-water reservoirs—in flat-shaped bodies perched on the Admiralty clay beneath the plateau surfaces and slopes—makes them particularly susceptible to useful development. The till is a persistent ground-moraine deposit that mantles most of the area of the plateau segments and passes beneath much of the outwash and alluvium of the valleys. The till is a great waster of precipitation; it sheds off to the creeks much water

that would otherwise recharge the ground-water reservoirs. A small amount of water percolates irregularly into and through the till or accumulates in the soil zones on top, where it is tapped by a great many "hardpan" wells of small yield. Outwash terraces of gravels and sands, where they lie below the local water table, carry large quantities of ground water. The alluvial materials of the river valleys are good aquifers, but the water is iron bearing in many places and is saline in places in the lower parts of the Snohomish and Stillaguamish Valleys.

At present, no good aquifers are known to exist in the bedrock formations. The metamorphic, granitic, and volcanic rocks of the mountainous parts of the county are largely nonpermeable. The Tertiary strata, which underlie the coastal lowland at depth and crop out about its inner margin, contain little or no water, and that which is present is usually of poor quality.

The chemical quality of the ground waters is in general excellent. The iron-bearing water of the alluvial valleys is the principal water of poor quality; the saline water of the lower river valleys is another.

Ground water is used principally for domestic and public supply in Snohomish County. It is expected, however, that in the future it will be much more widely used for irrigation, in industry, and for many other purposes.

INTRODUCTION

LOCATION AND EXTENT OF THE AREA

Snohomish County embraces an area of approximately 2,200 sq mi lying in an east-west strip that contains Tps. 26 to 32 N. of the Willamette base line. It reaches from the Puget Sound shore eastward 60 miles to the drainage divide of the Cascade Mountains. The western third, the Puget Sound lowland, is the part of the county for which ground-water information is most needed. (See fig. 1.)

HISTORY OF THE INVESTIGATION

It was desired to gather and summarize for public use all pertinent information on the nature and occurrence of ground water in the lowland part of the county. The investigation was made by the Ground Water Branch of the Geological Survey, United States Department of the Interior, in cooperation with Snohomish County Public Utility District No. 1. Continuing cooperation with the State Department of Conservation and Development made possible the undertaking and completion of this study, which included a well canvass begun in the fall of 1944 and completed in the summer of 1945; geologic mapping, during 1946, of the western third of the county; hydrologic studies; and the preparation of this report. The hydrologic studies and the report were finished by June 1947 but were subsequently revised.

The well canvass was made by Olaf Stromme in the northern part of the county and by J. W. Owen in the southern part. Those connected with the construction and operation of water wells were cooperative and helpful, special acknowledgment of generous help being due C. E. Miller, of Everett; C. D. Marks & Son, of Snohomish; J. J. Bell

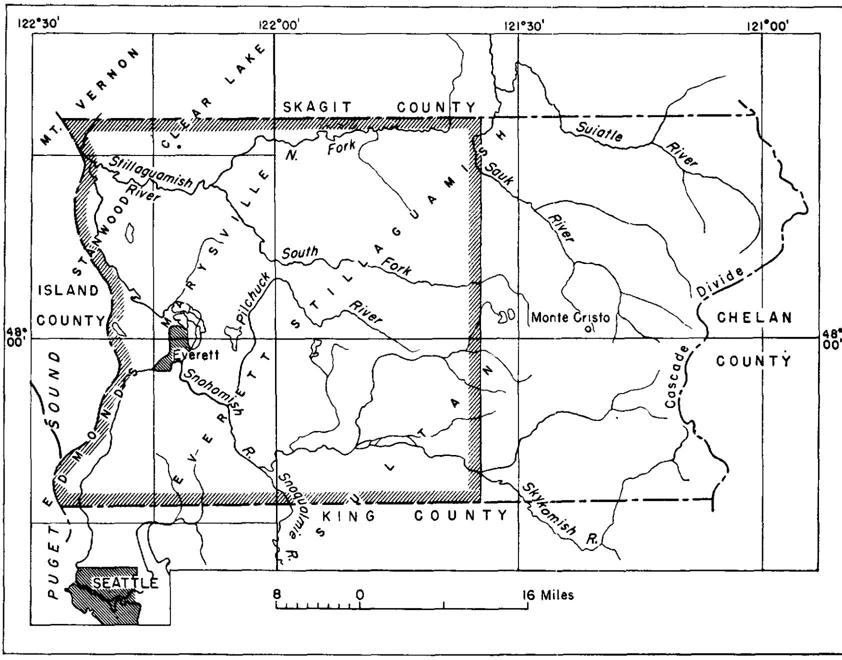

FIGURE 1.—Index map of Snohomish County, Wash.

& Son, of Seattle; and the N. C. Jannsen Drilling Co., also of Seattle. Essential information on most of the drilled wells and on representative dug wells was obtained, and all available records, such as drillers' logs, water-level data, and chemical analyses, were collected and incorporated. (See pl. 1 and pp. 87–129.)

The author did the geologic mapping (pl. 1) and prepared the report. The mapping was of a reconnaissance nature, with considerable detailed coverage along the sea cliffs and river bluffs in the areas affording good exposures. Outcropping exposures of all the different types of earth materials in the western part of the county were visited, and the rough, brushy areas in the interior of the Tulalip plateau block south of Lake Goodwin and in some of the hilly region north of Monroe and south of Roesiger Lake were hastily reconnoitered.

As the study progressed, it became increasingly apparent that several more or less distinct areas of particular ground-water conditions exist in the glacial drift of Snohomish County. The stratigraphy of the Pleistocene deposits, when studied in detail, was found to be relatively regular and definable. As a result, a reasonably reliable prediction of expected results can be made for a given type of water-well exploration in many parts of the county. It is entirely possible that, as the public collection and integration of such geologic and hydrologic information continue, the stratigraphical knowledge of the Quaternary deposits will permit the development of gound-water resources in a progressively more economical and businesslike manner.

LOCATION SYMBOLS USED FOR WELLS AND SPRINGS

In this report, wells and springs are designated by symbols that indicate their location according to the official rectangular survey of public lands. For example, in the symbol for well 31/5–22B2, the part that is written as a fraction and precedes the hyphen indicates township and range; because all parts of the county are in the northeast quadrant of the Willamette base line and meridian, this part of the symbol is specific and indicates T. 31 N., R 5 E. The number after the hyphen indicates the section (sec. 22); the letter denotes the 40-acre subdivision of the section, according to the following diagram; and the final digit is a serial number, wells and springs in each 40-acre tract having been numbered in sequence.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Thus well 31/5–22B2 is in the NW¼NE¼ sec. 22, T. 31 N., R. 5 E., and is the second well in that tract to be listed.

In table 4 these location symbols are not given in full for each well. Rather, the symbols are grouped by townships under appropriate subheads, and only that part of the symbol is tabulated which indicates the section, 40-acre tract, and serial number. All wells and springs listed in the tables are located on plate 1.

CLIMATE

Stretching from Puget Sound to the summit of the Cascade Mountains, Snohomish County has an equable climate dominated by normally heavy precipitation in the winter months and a dry period in the summer. The prevailing winds are westerly, and, although the area is partly in the rain shadow of the Olympic Mountains, the climate is predominantly oceanic.

The precipitation occurs largely as rain in the western, lowland part of Snohomish County and as rain and snow in the eastern, mountainous part, where snow depths of 5 to 10 ft are common in the higher regions by early spring. The average annual precipitation is progressively greater at higher altitudes eastward from the Puget Sound shore line (fig. 2). At Everett, on Puget Sound, an average annual precipitation of 32.65 in. was recorded by the United States Weather Bureau for the period 1916–46 (fig. 3). At Monte Cristo, in the eastern part of the county, measurements made by the Weather Bureau between 1895 and 1901 recorded a precipitation of about 120 in. per year.

The driest month is August, which at Everett has an average of about 1 in. of rain, whereas the wettest month, December, has about 11 in. The proportionately greater precipitation characteristic of the higher, eastern part of the county is most pronounced in the winter; during the dry period it is not so marked. For example, the average August rainfall at Darrington for some years was no more than that at Everett (fig. 2).

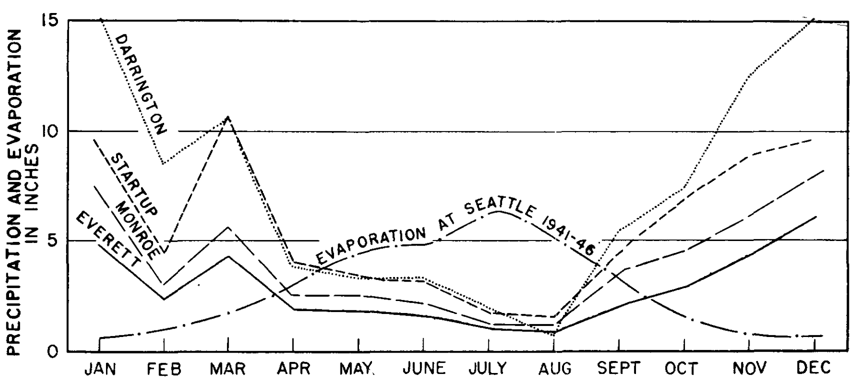

FIGURE 2.—Graph showing the average monthly precipitation for the years 1931–35, inclusive, at four Washington stations (Everett, Monroe, Startup, and Darrington), located at progressively greater distances from Puget Sound, and the average monthly evaporation at Seattle for the years 1941–46, inclusive.

The western, lowland part of the county has a mean annual temperature of about 52 F. The records show 51 F at Everett and 52 F at Monroe and Startup for the 7-yr period 1940–46, inclusive. The variations within the year during that period showed the highest average monthly temperature (usually in July) to be 63 F at Everett, 65 F at Monroe, and 64 F at Startup; the average monthly low temperature (usually in December) was 39 F at Everett and Monroe and 40 F at Startup. Only in an occasional year is there severely cold weather in the western, lowland part of the county—usually at

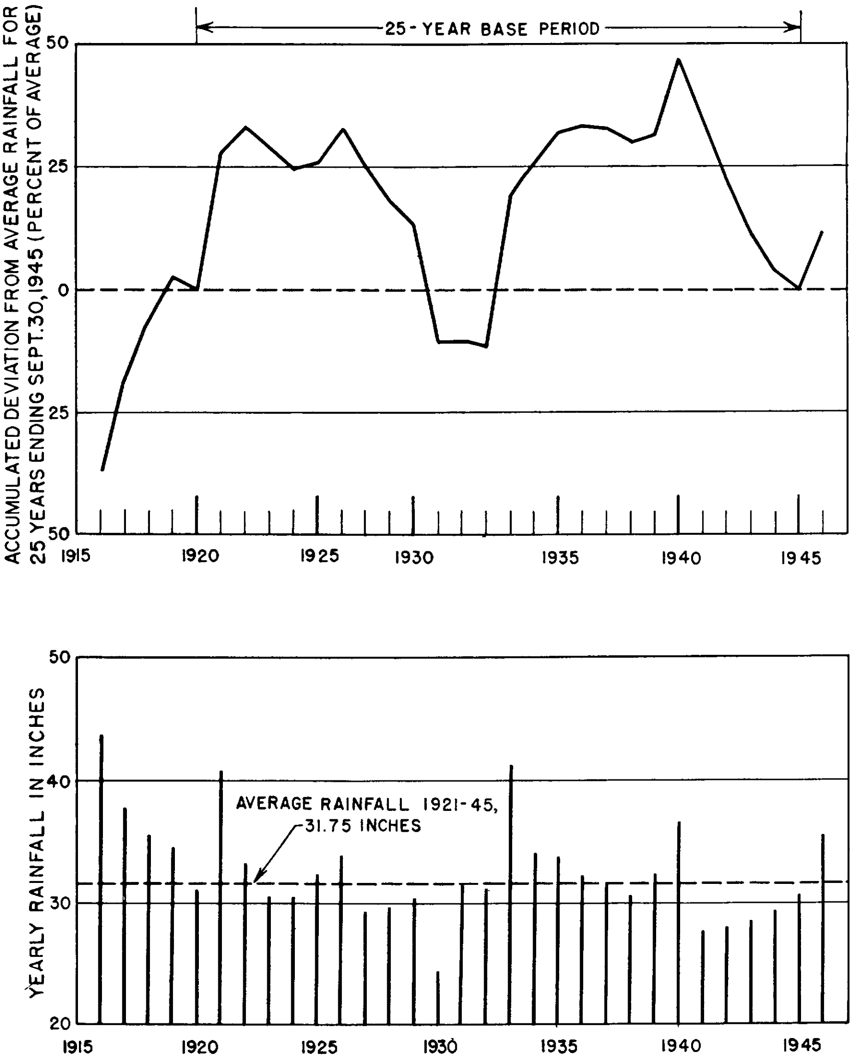

FIGURE 3.—Graph showing the rainfall at Everett, Wash., during the climatic years ending September 30 of each year, 1916–46.

times when a high-pressure cold front spills back westward over the mountains.

The growing season is relatively long; the average limiting dates of killing frosts during the years 1940–46 were March 19–November 6 (duration of season, 232 days) at Everett, April 9–October 20 (202 days) at Monroe, and May 1–November 4 (188 days) at Startup.

There is much cloudiness, especially in the winter. The average number of clear days per year for the period 1940–46 was only 109 at Everett, 110 at Monroe, and 120 at Startup.

GEOLOGIC SETTING

PHYSIOGRAPHY

The six-township tier that constitutes Snohomish County extends in an east-west direction across two major physiographic sections of the Pacific Northwest, the Puget Sound section of the Puget-Willamette lowland province and the Northern Cascade section of the Cascade-Sierra province. The commonly accepted boundary between the sections extends generally north-northwestward down the valley of the Snoqualmie River along the foot of the Cascade Mountains into the Skykomish Valley near Monroe, thence northward to the vicinity of Granite Falls. From there it extends down the South Fork Stillaguamish River and northwestward around the prominent mountain south of McMurray Lake to the edge of the Skagit River delta near Conway, in Skagit County (Fenneman, 1917, p. 95, pl. 1).

CASCADE MOUNTAIN AREA

The eastern two-thirds of the county is a rugged, mountainous terrain, consisting of hard rocks dissected to a mature stage of erosion. The drainage system is dendritic and even-textured, and the streams flow strongly. The main streams, the Skykomish, the South and North Forks of the Stillaguamish, and the Sauk, flow westward and northwestward to Puget Sound.

The interstream summits of the Cascade Mountain upland in the eastern part of the county form a relatively uniform summit level at an altitude of 6,000 to 7,000 ft. The steep mountain slopes, commonly 2,000 to 4,000 ft in height, bear marks of alpine glaciation—cirques, U-shaped valleys, rocky moraines, lakes, and residual "cliff" glaciers. To the west, the intervalley mountain ridges descend from their altitude of 7,000 ft to a general average altitude of 1,000 ft, where they end rather abruptly at the edge of the Sound lowland.

The western part of the Cascade Mountains has been subjected to continental or piedmont glaciation in which the overriding ice approached from the west and northwest. The main rivers have broad, terraced valleys that in places are partly blocked with high terrace deposits of morainal drift. The mountain slopes are smeared with glacial drift, and the normal drainage pattern is deranged generally up to an altitude of about 2,000 ft. In places along the mountain border the glacial deposits have accumulated in sufficient depth to form a transitional slope between the Sound lowland and the level of the rock foothills of the Cascade Mountains (pl. 2).

PUGET SOUND LOWLAND

The western third of Snohomish County is in the eastern part of the Puget Sound lowland. This area, with its mountain-valley extensions, includes most of the population, industry, and farming. The details of its main physiographic features—(1) broad-floored, alluviated river gorges separating (2) smooth plateau blocks 200 to 600 ft in altitude—largely control the environment and circumstances that govern the lives of the people of the county.

The gorges are followed (or were formerly followed) by the main rivers across the Sound lowland. These major streams, after their descent from the mountainous catchment area, follow trunk valleys lined with terrace deposits of glacial outwash and later alluvial materials. West of the mountain front, or west of the outlying bedrock exposures, the major valleys have fewer terraces and their character is mainly that of broad, alluviated flood plains. The gradient of the principal trunk streams decreases downstream from an average of 20 to 40 ft per mile in the bedrock areas of the mountains to 6 to 20 ft per mile in the terrace-bordered stretches along the mountain front and to only 2 to 6 ft per mile over the estuaries or deltas nearer the river mouths.

The alluviated stream gorges represent former extensions of the armlike reaches of Puget Sound. In their lower ends, near the Sound, they probably once extended downward to a depth at least equal to that of the present bed of Possession Sound, which in places is now about 600 ft deep. These large stream valleys differ materially in some details, but both the Skykomish and Stillaguamish Rivers follow broad flood plains across the lowland from the outwash-terraced segments that characterize their mountain valleys. The Stillaguamish delta fills the upper part of Port Susan and nearly ties Camano Island to the mainland. The Skykomish River leaves its former course at Monroe, where it flows off the south side of its own alluvial cone, to join the Snoqualmie River. Below their junction the short stretch named the Snohomish River passes over marshy peat lands to the deltaic shoal area in Possession Sound.

The low trough 3 miles wide that extends ramp-fashion northward from the Snohomish drainage at Marysville to the valley of the Stillaguamish River near Arlington represents an abandoned, partly filled valley segment of a much larger river of pre-Vashon age, probably the ancient Stillaguamish. It is among the more striking examples of the many glacial derangements of drainage in the area, as are the gorgelike valley followed by the Pilchuck River in its course southwestward from a point near the Stillaguamish River to the Snohomish River, the southward diversion of the Sultan River from the Sultan Basin, and the aberrant nature of the Sauk and Suiattle River passage northward from Darrington.

The separate mesalike plateaus of the Puget Sound lowland are more or less disconnected and altered segments of a former universal level. Their surfaces in general are smooth and gently rolling, but terracelike forms along the margins, lumpy morainal deposits, and marshy depressions all diversify the surface in detail. For the sake of convenience in reference the following names are used: "Intercity plateau," for the upland plain between Puget Sound and the Snohomish River; "Tulalip plateau," for the area extending westward from the Marysville trough to the sea; "Getchell Hill plateau," for the upland that extends south from Arlington to Snohomish; "Cedarhome plateau," for the mesa surface extending north from the Stillaguamish River to the mountains; and "Roesiger plateau," for the higher area north of the Skyhomish River and east of the Pilchuck River.

As the physical separation of these plateau segments antedated the latest (Vashon) glaciation, each segment now bears its own set of glacial alterations and additions. Extensive outwash terraces occur about the margins of some of the plateau blocks, and most of the surface area of all the blocks bears a thick mantle of till of the Vashon glaciation. The smooth marginal slopes of these mesalike areas, as along the west side of the Marysville trough, may carry a thick mantle of glacial till; elsewhere, as in the case of the sea cliffs near Edmonds, they are erosional slopes from which the till has been largely removed. The margins of the plateau blocks adjacent to the major streams in places are marked by terrace deposits of outwash and alluvial materials that partly fill the valleys.

The plateau segments are characterized by fairly even upland surfaces of two common types: the rolling, hilly, smoothed surface of the glacial till and the usually even, level surface of the glacial outwash. On level stretches the till surfaces are characterized by poor drainage, the outwash surfaces largely by well-drained bench lands. Both types were formerly covered by natural stands of luxuriant, heavy timber but are now cut-over brushlands or are cleared for domestic, agricultural, or industrial use.

In some places the surface descends evenly from the edges of the upland blocks to the level of the alluviated valleys, either over a succession of glacial-outwash or alluvial terraces, such as those of the Stillaguamish Valley, or over smooth till surfaces, such as those of the Tulalip plateau west of Marysville. However, where postglacial erosion has been active, as it has along the sea cliffs and reexcavated river bluffs, the descent to tidewater altitudes is commonly over steep cliffs.

The Intercity plateau is an undulating upland plain sloping southward from an arc-shaped drainage divide that follows closely about its north, east, and west edges. To the south the plateau surface descends toward the swales of the Sammamish River and Lake Union areas in King County, but on the east, north, and west sides its escarpments overlook steep descents to tidewater level. The undrained swales in the till plain are sites of impounded water such as Silver and Thomas Lakes. These lakes usually overflow slightly during the rainy season or during exceptionally wet years and are depleted considerably by evaporation each summer.

The Bald Hills "island" mass east of Cathcart is similar to the Intercity plateau in height, but its central structure is a rugged, glaciated rock eminence.

The Tulalip plateau is characterized by a smooth till slope that descends in all directions from its general summit altitude of about 500 ft to disappear beneath the Sound level on the south and west and beneath the fill of the Marysville trough on the east. This smooth till slope is dissected to a minor extent by the sea cliff on the west and by the Stillaguamish River bluffs on the north. Its upland surface contains many details commonly associated with the melting of stagnant ice, such as unintegrated local outwash pods, steep sand ridges of the ice-front type, and small areas of lumpy kamelike till deposits.

The Cedarhome and Roesiger plateau segments resemble each other in that they represent a diverse plateau surface that ascends from a low level (about 100 ft in altitude) to abut against the rock foothills of the Cascade Mountains (fig. 4). The till mantle is interrupted by many glacial-outwash terraces of diverse types.

FIGURE 4.—Till directly overlying metamorphic rock, Snohomish County, Wash. This relation is common along the western margin of the Cascade Mountains.

The Getchell Hill plateau is largely a smoothly rolling glacial-till upland separated from the mountain province by the steep gorge of the South Fork Stillaguamish River and from the Roesiger plateau by the smaller valley of the Pilchuck River. This plateau surface, like the higher parts of the Cedarhome plateau, carries a distinct northwest-southeast fluting or grooving, which seems to be most distinct where the glacial till is not far above the Tertiary bedrock.

These physiographic features of the Puget Sound lowland in Snohomish County are important as regards the occurrence of ground water. The differences in altitude from place to place are of significance in the downward seepage and accumulation of ground water, and the differences in the geological history of these plateau segments are in places the controlling factor that governs the occurrence of ground water in important quantities at one place and in negligible quantities at another. In projecting ground-water data laterally it is necessary to bear in mind, not only that these projections must be kept within the same or similar stratigraphic units, but also that among the glacial deposits, many stratigraphic units are limited to one physiographic element.

ROCK FORMATIONS

For the purposes of the present ground-water study the rock materials of Snohomish County can be divided into two principal groups, the consolidated "hard rocks" and the unconsolidated deposits. The mountain and foothill masses in the eastern part of the county are composed of consolidated rocks; in the western, lowland area and its extensions these consolidated rocks descend oceanward and are overlain by unconsolidated deposits that, in places, are known to extend many hundreds of feet below sea level.

CONSOLIDATED ROCKS

The consolidated rocks of Snohomish County are of three types: (1) the metamorphic and igneous rocks of pre-Tertiary age, (2) the volcanic rocks of possible early Tertiary age, and (3) the Tertiary sedimentary rocks.

PRE-TERTIARY ROCKS

The pre-Tertiary metamorphic and igneous complex forms most of the mass of the northern Cascade Mountains. It consists of greenstones, quartzites, schists, marbles, gneisses, and other rocks, into which granitic and some basic igneous rocks have been intruded. These massive rocks have little consistent structure other than the general north-south and northwest-southeast trends that mark the ridges of the northern Cascades.

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TERTIARY (?) VOLCANIC ROCKS

Along the west flank of the Cascade Mountains is a band of volcanic rocks of andesitic or basaltic composition that are for the most part unmetamorphosed. The volcanic rocks overlie the pre-Tertiary rocks and apparently pass beneath the Tertiary sedimentary rocks that lie to the west. As their physiographic habit is similar to that of the rocks of the pre-Tertiary complex, they were mapped with the metamorphic and igneous rocks in all places, except in the Bald Hills mass west of Monroe, where their boundaries could be accurately determined. These volcanic rocks may be early Tertiary (Eocene) in age.

TERTIARY SEDIMENTARY ROCKS

The Tertiary sedimentary rocks are overlain by unconsolidated deposits except where they crop out in a band 2 or 3 miles wide along the flank of the Cascade Mountains and the east edge of the Puget Sound lowland. These sedimentary rocks consist largely of medium-hard yellowish sandstone, dark conglomerates, and light-colored shale. The beds generally either are horizontal or dip gently to the west, but locally they seem to dip outward, away from the adjacent older, metamorphic or volcanic rocks. The strata were folded into broad arches, trending generally north and northwest, and were carved into strike ridges before their burial beneath the unconsolidated Pleistocene deposits.

Fossils from the Tertiary sedimentary rocks at three localities in Snohomish County have been assigned an Oligocene age (Weaver, 1937, pp. 225, 230, 234). The fossils from two of these localities were classed as "middle Oligocene." The writer assigned a probable Oligocene or Eocene age to fossils that he himself collected from two additional localities: a shale bed 1 ft thick exposed at the foot of a waterfall 200 ft east of the right bank of Jim Creek (NW¼NW¼ sec. 17, T. 31 N., R. 6 E.) and the north bank, at the crest of the terrace, of a road cut for State Highway 1A (NW¼SW¼ sec. 32, T. 28 N., R. 6 E.). On the basis of Foraminifera and shell fragments taken at a depth of 1,070 ft in the Standard-Alderwood Manor oil test (in SW¼SW¼ sec. 35, T. 28 N., R. 4 E.), according to a personal communication of November 1947 from W. S. W. Kew, that zone was correlated with the Blakely formation, which Weaver has termed upper Oligocene.

Coal beds up to 2 ft in thickness occur in these strata. Several hundred tons of coal was once mined from a shallow inclined shaft on the left bank of the South Fork Stillaguamish River, opposite the Jordan store, in the SW¼NE¼ sec. 28, T. 31 N., R. 6 E. Small coaly partings are common in the Tertiary sedimentary rocks along lower Jim Creek, where they occur at a horizon very close to that occupied by marine fossils.

The westward slope of the Tertiary strata carries them beneath the unconsolidated deposits of the western part of the county. Toward the northern end of the county, where they extend westward in the high mountain south of McMurray Lake, the Tertiary strata are encountered in wells that penetrate the glacial materials, and they are likewise encountered in the area along the eastern part of the Getchell Hill plateau. Elsewhere the dip of the Tertiary strata is sufficiently steep that they have not been reached except in the Lake Goodwin oil-test wells, where they were encountered at a depth of some 2,000 ft. A buried "high" of Tertiary sedimentary rock underlies the Intercity plateau surface north of Alderwood Manor. There Tertiary rocks were encountered at a depth of 360 ft in the Standard-Alderwood Manor oil test. They may have been reached, also, by the deep well (27/4–24Q1) of the Edmonds water department (pl. 2).

The total exposed thickness of the Tertiary strata probably is not great in Snohomish County. About 900 ft is exposed on the mountain slope south of McMurray Lake and about 500 ft in the railroad cuts north of Cathcart.

The consolidated rocks in Snohomish County are not water bearing, so far as appreciable well- or spring-water recovery is concerned. From a ground-water viewpoint they serve mainly as aquicludes, which restrict the supplies of economically recoverable ground water to the unconsolidated materials.

UNCONSOLIDATED DEPOSITS

Study of the stratigraphic sequence of the deposits that crop out in sea cliffs, river bluffs, quarries, ravines, and road cuts, as well as those recorded by well drillers, allows a general subdivision of the deposits into units that make the geologic succession understandable and useful in the prediction and interpretation of well-drilling results.

ADMIRALTY CLAY

A fine-bedded, horizontally stratified clay and silt sequence is exposed to a height of 100 ft or more in the sea cliff just north of Richmond Beach. Northward from this exposure the clay and silt beds can be followed along the cliff to Mukilteo Point and eastward to Everett, thence southeastward to a point near Marshland School. These clay and silt beds belong to those described as till by Willis (Willis and Smith, 1899) and later extended by Bretz (1913) as the Admiralty clay and till. The clays, silts, and fine interbedded sands continue upward to an altitude of about 200 ft; their depth below sea level is known only from drilling records. From its tabular position beneath the Intercity plateau, lateral extensions of the Admiralty are believed to be present on the other side of the Snohomish River trough, where a very similar clay and silt sequence crops out for some distance northward from Cavalero Corner. Similar material is exposed, also, in the bluffs of the Pilchuck River east of Snohomish and is penetrated by wells in the Lake Stevens area, indicating that the Admiralty probably extends at least that far east. Northward from Everett a similar hard, well-bedded silt crops out from place to place at a low altitude along the sea cliff as far north as the valley of the Stillaguamish River, where in places it forms the southern bluff up to an altitude of about 100 ft. A further extension of the Admiralty is made to include the exposures of lithologically similar clay and silt beds in the lowest part of the sea cliff on Gedney (Hat) Island.

In Snohomish County the characteristic deposits of the Admiralty clay make a series of hard, evenly bedded gray and blue silt and clay, sand and gravel beds, and thin, woody peat strata. The sand beds are generally thin—rarely over 15 ft thick. The gravels are usually thin and discontinuous but commonly have a rather widespread distribution. One gravel streak can be traced in the railroad bank, at an altitude of about 40 ft, from Pigeon Creek near Everett for a distance of about 8 miles westward and southwestward to Picnic Point. Fine sand and silt, in alternating beds as much as 12 in. thick, are common along the upper part of the section at Picnic Point. In several places clay or silt is exposed continuously to a thickness of 100 ft or more without a single sand or gravel layer. No animal fossil was seen in the many excellent exposures examined, and no marine fossils are known by the writer to have been found in the Admiralty clay in Snohomish County, either from outcrops or from well drillings. There are, however, many peat and lignitic beds, the greatest thickness observed being 3½ ft.

In some exposures it is difficult to distinguish the true Admiralty from younger backfill deposits that lie in depressions in the Admiralty. Many such younger backfill deposits contain glacial till of Vashon age, and at only a few localities can it be definitely ascertained that till forms a part of the Admiralty deposits. At those localities, in the sea cliff east and south of Mukilteo Point, small pods of unweathered till lie in the continuous gravel streak in the Admiralty already mentioned. Certain other occurrences of low-lying till that may be Admiralty or may be of Vashon age—for example, the till exposed in the road cut just east of Picnic Point—were designated "undifferentiated" till.

Since Willis (Willis and Smith, 1899) named certain till-carrying clays exposed in Admiralty Inlet as the "Admiralty till" and attributed it to the existence of an "Admiralty ice sheet," the idea that two invasions of northern ice extended into the Puget Sound trough has been rather commonly accepted (McLellan, 1927; Mackin, 1937, 1938; Hansen and Mackin, 1940). Bretz (1913) concurred in this general conclusion, although he observed (p. 177) that there was no true till sheet in the Admiralty sediments. "It is wholly a matter of inference," he stated, "to style it a till sheet."

In Snohomish County there is no evidence known to the writer that there was an ice sheet in the Puget Sound basin prior to the Vashon glacier of the piedmont ice invasion during Wisconsin (Bretz, 1913, p. 36), or Vashon, time. He questions the inference of glaciation by northern ice during Admiralty time. Perhaps local mountain or distant piedmont glaciers furnished ice tongues and bergs that could account for the deposition of till of Admiralty age in the Puget Sound basin and in the shallow (fresh?) water that lay over most of the basin floor. Such a theory would help to explain many of the puzzling features of the till in the Admiralty, such as its podlike shapes, spotty distribution, and numerous occurrences of water-laid, till-like materials (Willis, 1898; Bretz, 1913, p. 175). In addition, a local-ice theory of glaciation would fit more reasonably the conditions under which the considerable thicknesses of clay and silt that marked Admiralty time were deposited.

Some observed sections, exposed above sea level, that are considered representative of the Admiralty clay are here listed (measured by hand leveling):

1. Sea cliffs south of Edwards Point in sec. 26, T. 27 N., R. 3 E. Overlain by till of the Vashon glaciation. Altitude at top of section, 195 ft (interpolated).

	Altitude (feet)
Clay, gray	193–195
Sand, silty, yellow	163–193
Silt and clay, blue	88–163
Clay, blue	43–88
Silt and clay, blue, interbedded	0–43

2. Sea cliff near Mosher, NW¼SW¼ sec. 32, T. 28 N., R. 4 E. Overlain by the Esperance sand member; altitude at top of section 175 ft (interpolated).

	Altitude (feet)
Sand, fine, with clay and silt interbeds	154–175
Clay, blue, banded	150–154
Sand, fine	145–150
Silt	130–145
Gravel, red, with irregular base	120–130
Sand and gravel	110–120
Gravel	100–110
Glacial till, gravelly	90–100
Clay, silty, massive	70–90
Silt, blue and gray	0–70

3. Sea cliff north of Picnic Point, SW¼NW¼ sec. 20, T. 28 N., R. 4 E. Overlain by the Esperance sand member. Altitude at top of section, 190 ft.

	Altitude (feet)
Clays, silts, and fine sands, partly covered	120–190
Clay and silt	110–120
Gravel	107–110
Clay and silt	80–107
Silt, fine sand, and clay; gravel streak at 30 ft	10–80
Covered	0–10

4. Pigeon Creek ravine in sec. 36, T. 29 N., R. 4 E. Overlain by the Esperance sand member. Altitude of top of section, 209 ft (interpolated).

	Altitude (feet)
Clay, blue, with 1 in. of peat at base	204–209
Sand, poorly sized; top foot fine sand	195–204
Silt, gray, with 1 in. of peat at base	180–195
Sand, poorly sized	176–180
Silt and clay, blue, finely banded; 2-inch peat layer at 165 ft	161–176
Sand, yellow, coarse-to-medium-grained	141–161
Silt, blue, massive; top 4 ft clayey	116–141
Sand, fine, silty	112–116
Silt, blue	108–112
Silt, blue, and sand; reddish involuted striations	103–108
Sand, medium-grained, yellow	77–103
Sand and pebble gravel; red clay; silty	67–72
Sand and gravel, red	60–67
Pebble gravel, red	55–60
Sand, medium-grained, massive	30–55
Clay, blue, with fine sand interlaminae	15–30
Covered	0–15

5. River Bluff east of Pinehurst in sec. 8, T. 28 N., R. 5 E. Overlain by the Esperance sand member. Altitude at top of section, 170 ft (interpolated).

	Altitude (feet)
Clay, gray	167–170
Covered	156–167
Clay, gray	141–156
Sand, coarse, loose	130–141
Silt, blue, finely banded	125–130
Covered	115–125
Clay, gray	90–115
Covered	75–90
Clay, gray	55–75
Covered	0–55

6. Ravine banks north of Cavalero Corner in secs. 13 and 14, T. 29 N., R. 5 E. Overlain by till of the Vashon glaciation. Altitude at top of section, 230 ft (interpolated).

	Altitude (feet)
Clay and silt, yellow, firm, blocky, finely bedded	160–230
Sand, fine, with clay interbeds	130–160
Silt, clayey, blue-gray (Admiralty clay)	105–130
Covered	50–105
Silt and clay	25–50
Covered	0–25

7. Bluffs of Pilchuck River in NW¼SE¼ sec. 16, T. 29 N., R. 5 E. Overlain by Pilchuck clay member, which is overlain in turn by till. Altitude at top of section, 200 ft (hand-leveled from USGS bench mark).

	Altitude (feet)
Silt, blue, massive	191–200
Sand, dark, poorly sorted	175–191
Silt and clay	173–175
Silt, blue, with sand partings	163–173
Clay, finely banded	162–163
Sand, dark, fine	158–162
Covered	153–158
Silt, blue, clayey	143–153
Covered	138–143

8. River bluff and clay quarry on Reformatory Hill in NE¼SW¼ sec. 11, T. 27 N., R. 6 E. Overlain by later massive clays of the Pilchuck clay member. Altitude at top of section, 185 ft (interpolated).

	Altitude (feet)
Silts and clays containing numerous thin beds of fine sand	35–185

The Admiralty clay below sea level is known only from well drillers' records. The fact that material similar to the Admiralty clay continues to a depth of at least several hundred feet is established by reliable drilling records, such as those for wells 29/5–19K1, 32/4–19P1, 29/6–8F4, 30/4–7G1, and 28/4–22B1. Wells 27/3–24Q1 and 29/5–8R1, which reach some 800 and 1,500 ft below sea level, respectively, penetrated similar material at their greatest depths. According to the log (on file with the supervisor of the Division of Mines and Geology, Washington State Department of Conservation and Development, 1946), Lake Goodwin oil test 1 was in Tertiary (?) sandstone at a depth of 3,100 ft (2,700 ft below sea level). In connection with this Lake Goodwin oil test it was reported orally to C. E. Miller that no rock of "continuous nature" was penetrated above a depth of 2,200 ft (1,800 ft below sea level). The Florence oil test in SW¼SE¼ sec. 8, T. 31 N., R. 4 E., is reported to have penetrated only unconsolidated materials in its full depth of 1,200 ft (800 ft below sea level). Thus it may be concluded that there is a commonly known part of the Admiralty clay—the upper 100 or 200 ft of a predominantly clay and silt series—which at its inner margin (in the Marshland School area) lies upon folded and eroded Tertiary strata, and a lower, less well known part to the west, which extends downward to considerable depth and which may even continue downward to the Tertiary strata or other hard bedrock that is found at irregular depths up to 2,000 ft or more below sea level.

No consistent upper limit of the Admiralty clay has been identified. It is definite in some places and indefinite in others. Geologists believe that the sharpness of this separation depends largely on the lack of similarity between the silt of the Admiralty and the overlying deposits. Where the Admiralty is overlain by the glacial-outwash sand and gravel deposited from the advancing Vashon glacier the separation is sharp and distinct. In the Seattle Heights area that separation is reported by C. E. Crary to be further marked, where encountered in well drilling, by a 6-ft peat zone at the top of the silt. Along the Snohomish River such a sharp separation prevails between the Admiralty clay and the overlying sands and gravels of the advance outwash of the Vashon glacier. In other places the deposits overlying the Admiralty are silts and clays, which, though fine-grained, are slightly coarser than the materials typical of the Admiralty. Where such fine deposits overlie the coarser phases of the Admiralty, as they do in places along the sea cliffs on Tulalip Reservation and just north of Picnic Point, it is difficult or impossible to point out any distinguishable break. However, even in these cases the governing consideration of clay-silt predominance below and sand and gravel above is not lost even though the actual contact is difficult to define. The lithologic distinction of the Admiralty can suffice as a workable means of identification until, possibly, later work distinguishes it further.

VASHON DRIFT

ADVANCE OUTWASH AND ASSOCIATED DEPOSITS

In the plateau blocks of Snohomish County are several hundred feet of water-laid deposits that overlie the Admiralty clay and, in turn, are overlain by the later till and other deposits of the Vashon glaciation.

It is true that this interpretation differs from that of Bretz. He seemed to consider (1913, p. 198) all sediments up to the till of the Vashon glaciation as Admiralty in age. Also, (p. 178) he did not feel that subdivisions could be made in the glacial materials, as Willis had done in the Tacoma folio, for the entire basin of Puget Sound. Except for the till of the Vashon glacier and possibly for the Admiralty clay, that restriction is probably true for the entire basin, but local lithologic units can be distinguished and the writer believes that in many cases their definition and delineation is imperative to the proper concept of ground-water occurrence and development in Snohomish County.

The deposits in question are composed of current-laid sands and gravels, massive clays, silts, and peat. In this report they are referred to in part as the Pilchuck clay member and in part as the Esperance sand member. For the most part these deposits immediately preceded the Vashon ice and are of Vashon-advance age.

The clay and sand members of the Vashon glacial deposits commonly are separable from the sands of the Admiralty clay by the relatively coarser grain of the sediments. Where they are fine-grained, as they frequently are in the Pilchuck clay member, the separation from the Admiralty is more difficult. In some places near the mountains the less firm character, lighter hue, and more arkosic or kaolinitic nature help to distinguish the Pilchuck.

As regards the subdivisions of the advance outwash, the fundamental distinction of the Esperance sand member is its prevailing coarse-grained character as distinguished from the fine-grained character of the Pilchuck clay member, which consists largely of finer materials that seem to have accumulated in slack waters, probably impounded against the mountains along the inner margin of the advancing Vashon ice.

Pilchuck clay member.—The beds of the clay unit are varied in character. In the outcrops along the west escarpment of Getchell Hill they are largely clays and silts similar to those in the Admiralty clay. South of Rees Corner in the upper part of the Snohomish River bluffs, in the hill exposures near Roesiger Lake, and in the upper part of the Reformatory Hill bluff southwest of Monroe, the sediments are mainly yellow and nearly white massive clays. In the bluffs along the left bank of the Pilchuck River above Dubuque Creek the sediments are dirty sands and gravels with thick clay beds and peat streaks. Within the Skykomish Valley embayment of the coastal lowland beneath the till of the Vashon glaciation are mixed sedimentary materials, which may be Admiralty or the later Pilchuck clay deposits. Those penetrated by well drilling at the Monroe city well field are largely sand and gravel with interbedded clays.

Esperance sand member.—In the coastal section there is commonly a sand and gravel zone immediately beneath the till of the Vashon glaciation. In the Intercity and Tulalip plateau blocks, and to a lesser extent on the smaller Cedarhome plateau block to the north, this sub-till sand and gravel layer occupies most or all of the gap between the top of the underlying Admiralty clay and the overlying till, which once mantled it almost universally. The sand and gravel layer reaches a maximum thickness of about 300 ft.

The Esperance sand member (in its complete thickness) is made up of two types of material, which were deposited under different conditions during separate episodes in the geologic history of the area. In the reservoir-spillway ravine in southeast Everett about 100 ft of fine- and medium-grained yellow sand overlies the Admiralty clay and extends up into coarser outwash-type gravel exposed in the road cuts and quarries immediately to the south. In the sea cliffs just north of Picnic Point 100 ft or more of fine sand with some silt beds overlies the Admiralty and is overlain, in turn, by the outwash-type sands. The outwash-type sands are covered by till, which caps the cliffs. At many other exposures (such as the south bluff of the Stillaguamish River, the sea cliff north and south of Subeebeda, and the large quarries northwest of Beverly Park) the upper part, and a large proportion of the remainder, of the Esperance sand member consists of cross-bedded outwash-type material.

The earlier phase of the sand member appears to be a coarser continuation of the horizontal Admiralty clay, whereas the later outwash phase is undoubtedly the advance outwash of the Vashon glacier. A layer of red gravel lying between the lower sand and a small section of the upper, outwash-type sand and gravel is exposed in the left bank of the Pigeon Creek ravine above road level in the road cut of State Highway 1I. At other places little evidence could be seen of the time interval that separated the deposition of these two types of material in the Esperance sand member.

The lower beds of the Esperance are cut off abruptly by the bluffs of the gorges that form the present arms and the tributary alluviated river valleys of Puget Sound. The upper outwash beds of the Esperance are foreset gently to the south and southeast on the Intercity plateau. Near the plateau margins they display diverse, steep foreset bedding, which in many places slopes inward from the present arms of Puget Sound. The deposition of the Esperance sand member (and possibly the Pilchuck clay member) is believed to have bridged the period during which the great gorges of Puget Sound were carved.

Further study of the Esperance sand member may result in the separation of its two elements—the upper advance outwash of the Vashon glaciation and the lower, older sand strata—but, because of their evident hydrologic continuity and the difficulty in mapping a separation of these sands, the two are grouped together for this ground-water study.

The Esperance sand member is exposed from place to place in the ravines along the upper part of the slopes that descend from the Intercity plateau to Possession Sound. Many sand and gravel quarries operate in these exposures, the largest being the county-city quarries 1 mile northwest of Beverly Park (fig. 5). At that quarry about 200 ft of uniform gray sandy pebble gravel is exposed. From the vicinity of the quarries just west of the Seattle Heights crossroads (245th Street of Seattle) southward beyond Esperance School the sand and gravel unit forms the surface, only small remnants of till overlying it here and there. (Fig. 6 shows a thin till cap.) It crops out in exposures, in places aggregating 100 ft or more in thickness, nearly all the way along the Snohomish River bluffs of the Intercity plateau, but its exposures do not show its full sectional thickness about the margin of the plateau segments. A combination of factors—its own

FIGURE 5.—Pebbly and cobbly gravel of the outwash facies of the Esperance sand member. Face of about 90 ft exposed in the city-county quarry northwest of Beverly Park, Snohomish County, Wash.

FIGURE 6.—Till overlying the Esperance sand member in a quarry face in the NE¼ sec. 17, T. 27 N., R. 4 E., Snohomish County, Wash.

marginal thinning and the ramplike blanket of till—serves to diminish the marginal sections (fig. 7).

On the Tulalip plateau the sand beds are exposed here and there in the sea cliffs along the west side—in some places to their full thickness. Along the east and south sides there is only one known exposure, that at Edwards Springs (31/4–24N3), but there are good outcrops in the Stillaguamish bluffs at the northern end (fig. 8).

The Esperance sand member was penetrated for its full thickness by well 28/4–22B1 at Payne Field on the Intercity plateau block, by the Florence oil test well northwest of Lake Goodwin, and by well 30/4–7H1 on the Tulalip plateau.

FIGURE 7.—Sub-till sand and overlying till sloping down to the west along the sea cliff just south of Subeebeda, Snohomish County, Wash.

FIGURE 8.—Section exposed in the bluff of the Stillaguamish River south of Silvana, Snohomish County, Wash. Esperance sand member overlain by till and underlain by Admiralty (?) clay. Considerable ground water flows from the lower part of the Esperance sand member.

Though the Esperance is largely—and in places entirely—composed of sand and gravel, discontinuous silt beds are common in it. Moreover, in the region south of Alderwood Manor to the Sammamish River trough, slack-water deposits, fine sands and clays, predominate. A measured section in the sea cliff on the new road cut at Tulare subdivision, in the SW¼NE¼ sec. 7, T. 30 N., R. 4 E., traverses the Esperance between altitudes of about 100 to 400 ft. It is overlain by till of the Vashon glaciation.

	Altitude (feet)
Silt and fine sand, loose, horizontal	0–100
Fine- and medium-grained sand, loose	100–175
Coarse sand, with pea to cobble gravel, foreset up to 20° SE	175–350
Pea gravel, mostly foreset 20° SE	350–380
Silt, finely banded, horizontal	380–400

TILL AND ASSOCIATED DEPOSITS

The till of the Vashon glaciation (locally known as "the hardpan") mantles the surface of the coastal plateau blocks to an average depth of about 50 ft and is in places as much as 150 ft in thickness. It is largely ground moraine dropped in place by the melting of the Vashon glacier. In appearance it is a gray, heterogeneous mixture of rounded gravel and sand particles in a matrix of silt and clay. The material has formed a strong, durable mass similar in appearance to a "low-mix" concrete aggregate. Weathering is confined usually to the upper 10 or 15 ft, where the material may have a slight reddish stain. The till below the soil zone is largely impermeable, though inclusions of gravel and sand that lack the clay binder occur in places and permit the downward movement of small amounts of water (figs. 9, 10).

The till was not accumulated nor preserved so faithfully in the river valleys. In the low sea cliff at the northwest end of American Legion Memorial Park in Everett, the 30-ft section of till may be seen to pass laterally through a transitional phase in which the materials become progressively more water-sorted until, within 500 ft of the true till, the corresponding stratum is composed entirely of segregated layers of water-sorted materials—gravel, sand, and silt. Such loss of identity may affect the till materials in any of the valleys and, along with such factors as postglacial erosion and alluvial burial, may account for the absence of the till from some of the valley troughs. The till remains on many of the marginal slopes of the plateau blocks—in some places on such steep pitches as the 50° slope of the sea cliff just north of the beach settlement in sec. 9, T. 28 N., R. 4 E., and the gentler landward slope of the Tulalip plateau east of John Sams Lake. The till descends into some of the valleys and is known to pass beneath the later outwash and alluvial deposits. This relation is apparent in the terrace escarpments in the Arlington district, where much of the till was probably covered by outwash deposited in ponded waters before the erosive effect of the stream was reestablished.

FIGURE 9.—Till in a new road cut near the center sec. 13, T. 32 N., R. 6 E., Snohomish County, Wash. The photograph, taken in June, shows wet streaks that mark the sandy or gravelly zones through which water can percolate in some of the till.

FIGURE 10.—Till exposed in a road cut through the right bluff of the valley of Pilchuck Creek in sec. 31, T. 32 N., R. 5 E., Snohomish County, Wash. During the spring months the wet zones illustrate the differential water-absorption characteristics of the till.

The surface expression of the till left by the melting of the Vashon glacier is commonly that of a smooth rolling plain or slope. Drumlin-like topography similar to that northwest of Stevens Lake; small terminal moraine areas like those on the plateau north of Richmond Beach; and the hodgepodge features of the interdeposited till and outwash common to areas of ice stagnation, such as are found on the Tulalip plateau, vary the usual tabular mantle character of the till deposit. The till is a single sheet in nearly all places but is divided into two sand-separated layers in one place along the sea cliff (fig. 11) north of Picnic Point. In several places small pods of till beneath the Esperance sand member probably mark the site of early surges of the edge of the Vashon ice as it lay in the depressions of the Sound area.

FIGURE 11.—Till in a double sheet exposed in the sea cliff just north of the beach settlement 1½ miles south of Mukilteo, Snohomish County, Wash. The lower till sheet (20 ft thick) is separated from the upper till by 20 ft of sand and gravel.

Till is only a minor part of the great water-laid moraines, such as the one west of Robe in the valley of the South Fork Stillaguamish River, that mark the location of what once were the upper ends of the Vashon ice tongues.

RECESSIONAL OUTWASH AND ASSOCIATED DEPOSITS

The wasting of the Vashon glacier resulted in the deposition of water-sorted materials in bodies of impounded water and in current-laid trains along the changing avenues of escape. Some of these deposits remain in isolated remnants and some in massive deposits, such as the great water-laid drift moraines of the major mountain valleys, and cannot be specifically designated within the scope of this study. They are called undifferentiated outwash in distinction to those deposits that have been named.

Undifferentiated outwash.—The undifferentiated outwash comprises the many valley trains and local pockets of gravel and sand that spot the plateau surfaces and form some terraces along the valleys. The deposits have accumulated to thicknesses as great as 1,000 ft or more in places in the mountain valleys, but in other places they may be only a thin mantle of gravel or sand. Most of these deposits floor former gaps of meltwater escapement or comprise terraces whose surfaces grade to former col escapements or to higher levels of drainage, now largely effaced. Such materials as the broad fan of outwash debris that extends down across the end of Frailey Mountain into the valley of the North Fork Stillaguamish River, or the train of gravels that leads northwest from Lake Goodwin, are characteristic of this classification. Many of these deposits could be further classified as to manner of origin, relative order of deposition, and other characteristics. For instance, further work may establish much of the undifferentiated outwash on the terraces about Bryant as an extension of the Marysville sand member and Arlington gravel member. Such extension would, among other results, clarify the history of the late meltwater that flowed south from the McMurray Lake drainage and would further delineate the courses of ground-water percolation in and about these terrace lands.

The undifferentiated outwash is principally gravel and sand. The water-laid moraines of the mountain valleys contain much clay, silt, and almost unsorted deposits containing some till pods. A notable exception, where exclusively fine-grained deposits predominate, is the clay-capped terrace at an altitude of about 300 ft in Skykomish Valley west of Sultan.

Differential outwash.—The outwash differentiated within Snohomish County consists largely of the deposits that accumulated during late Vashon time in the impounded water of the South Fork Stillaguamish River and the subsequent terrace deposits and valley trains that were formed by integrated streams flowing across the Stillaguamish sand member and on down the Marysville trough (Arlington gravel member and Marysville sand member).

The Stillaguamish sand member is an outwash deposit which accumulated to a thickness of about 200 ft at a time when the melting ice temporarily blocked the river at the north end of Getchell Hill and caused the Stillaguamish drainage to pass southward through a spillway now followed by the Pilchuck River. Blocks sloughing from the ice dam were buried, later melting and forming the kettle holes that mark the outwash terrace north of Arlington. The deposits are largely fine sand and clay but contain much coarse material toward the top and especially around the margin opposite points of tributary-stream debouchment. In the Arlington Heights district the character of the material in the Stillaguamish sand member as interpreted from outcrops in the escarpments about sections 5 and 6 is as follows (from an altitude of 300 ft down):

	Altitude (feet)
Sand, fine, uniform, loose	225–300
Silt, blue, massive	195–225
Covered (sand?)	155–195
Till of the Vashon glaciation	135–155

The Arlington gravel member is an outwash deposit of sand and gravel forming a veneer of no great thickness, spread over a terrace cut mainly in the earlier Stillaguamish sand member. It differs from the earlier outwash (Stillaguamish) and later outwash (Marysville) in being only a terrace veneer. In large part it is underlain by the till of the Vashon glaciation, which crops out around much of the terrace margin and in many places has obviously defended the Stillaguamish and Arlington deposits from more complete destruction by the sweeping action of the rivers. The Arlington is not differentiated upstream above the terrace on which Trafton is located. Remnants of a terrace survive in places along the valley sides of both forks of the Stillaguamish and indicate that the outwash-terrace level of the Arlington gravel member may be represented upstream in the North Fork by the 300-ft terrace north and east of Oso. The levels of both the Arlington gravel and Marysville sand members may have continued up the valley of the North Fork to the 500-ft terrace northwest of Darrington.

The outwash deposit making up the Marysville sand member floors the Marysville trough. Possible extensions of this outwash train are found along the present flood plain of the Stillaguamish in the lower terraces west of Bryant. Low terraces along the sides of the valley of the Snohomish River south of Everett may be, in part, contemporaneous with the outwash of the Marysville trough.

About 100 ft of sand and gravel is exposed in the escarpment at the north end of the Marysville trough. A water well (31/5–15R2)

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penetrated 166 ft of sand and gravel northwest of Edgecomb. Only sand and gravel are exposed in quarries in the outwash of the Marysville trough; however, peat beds several feet thick occur near the surface in several places, and their subsidence has formed low boggy areas in some places. The outwash deposit buries the sloping till on the flanks of both the Getchell and Tulalip plateaus. The till is reported to be penetrated by wells east and north of Marysville and may possibly extend all the way across the lower end of the trough beneath the outwash. The outwash sediments are much finer grained in the lower end of the trough. Elsewhere the meager information available indicates that clay underlies the outwash of the Marysville trough at a level close to, or below, present sea level. Except for some of the lower outwash and alluvial terraces near East Stanwood, the Marysville sand member may be the youngest of the Vashon glacial deposits in Snohomish County.

RECENT DEPOSITS

The Recent sedimentary deposits, which have accumulated since the disappearance of the Vashon glacier, are divided readily into two categories: the older, which accumulated prior to the formation of the present river flood plains, and the younger, which has accumulated on the present stream and lake flood lands.

The older alluvium consists of silt, clay, sand, and gravel in rather thin tabular deposits, mostly forming terraces just above the present river flood plains, as distinguished from the alluvial deposits that still are accumulating. Alluvial debris accumulated over earlier materials along the foot of steep mountain slopes also has been included in this category. The principal features of these materials are an apparent alluvial character and a position above the present level of accumulation (fig. 12).

The younger alluvium occurs beneath the flood plains of the aggrading streams and impounded waters. The principal bodies are along the flood plains of the main rivers (fig. 13). The materials are sand, silt, clay, and peat. Some gravel occurs along the relatively steeply sloping mountain-valley portions of the streams. The thickness is not great—in the downgrading stretches it commonly is little more than the total range of river-level fluctuation, but it may be 100 ft or more in the lower parts of the main stream valleys. At this time it is not possible to estimate closely its thickness in the alluviated mouths of the major streams or to know the amount, in those places, of the unconsolidated material belonging to any one division of time since the Vashon glacial advance. The shoal materials off the mouths of the Snohomish and Stillaguamish Rivers are in this category of material of unknown thickness.

FIGURE 12.—Coarse outwash of glacial-alluvial origin in a road bank east of Goldbar, Snohomish County, Wash. This type of deposit forms the large fanglomerate terraces that slope downstream from the terminal-drift deposits east of Reiter in the valley of the Snohomish River.

FIGURE 13.—Till and pre-till beds in the valley of the South Fork Stillaguamish River 1 mile southwest of Riverside, Snohomish County, Wash.

STRUCTURE

CONSOLIDATED ROCKS

Pre-Tertiary igneous and metamorphic complex and Tertiary (?) volcanic rocks.—The pre-Tertiary metamorphic rocks of the mountain areas have diverse and complex structural characteristics. They have been deformed and have been intruded by igneous masses. The strike of the dominant structures ranges from north to northwest. The primary structure is complicated by fracturing and secondary folding. Because the rocks are largely impermeable and because of the complexity of the structure, the metamorphic rocks have little effect on the ground water except to restrict its movement. The structure of the Tertiary (?) volcanic rocks in the Bald Hills eminence, on the south side of the valley of the Sultan River, and in the small exposures north of Bryant is generally massive and indeterminate. These rocks likewise are largely impermeable.

Tertiary sedimentary rocks.—The sedimentary rocks of Tertiary age are exposed along the inner edge of the Puget Sound lowland and in the Cascade foothills. They dip mainly to the west and southwest, generally at an angle of less than 10°. The sandstones and shales exposed in the Cathcart area have a semicircular strike around what may be the western extension of the volcanic rock mass known as Bald Hills. From the vicinity of Roosevelt northward to Arlington the exposed Tertiary sedimentary rocks are largely horizontal or dip slightly to the west. The large mountain southwest of McMurray Lake and northwest of Arlington is composed of these strata, which there dip steeply to the southwest. They generally pass as strike ridges beneath the glacial materials of the Sound lowland.

For many miles beyond the western edge of Snohomish County the Tertiary sedimentary rocks are not known in the islands of Puget Sound. They crop out in the Skagit delta area to the north and in Bainbridge Island to the south, but to the west, if present, they must lie at a considerable depth beneath the center of the Puget Sound depression.

UNCONSOLIDATED DEPOSITS

The unconsolidated deposits, which form the bulk of the deep fill within the Puget Sound lowland, for the most part are horizontally stratified. The Admiralty clay about the edges of the Intercity, Getchell Hill, and Tulalip plateau blocks is uniformly well bedded and is very nearly horizontal. The Esperance sand member of the Vashon drift—that is, the upper outwash deposit of that unit—is irregularly bedded and preserves the original features of deltaic and current deposition, though the master bedding is not far from horizontal. The till of the Vashon glaciation has only rude banding and occasional intercalated sand or gravel beds, which show diverse inclinations near the horizontal. The recessional outwash of the Vashon glaciation and the postglacial alluvium have only a gentle down-gradient inclination except for the minor irregularities of dip common to such current-laid materials.

Only one major and one minor instance of postdepositional deformation were observed in the unconsolidated materials. The major deformation occurs on both sides of the Port Gardner embayment, which extends west from Everett. Along the sea cliff at the west side of Hermosa Point in secs. 21 and 28, T. 30 N., R. 4 E., the till-capped sand strata of the advance outwash can be observed dipping 5° due south. The dip is apparent for 700 or 800 ft, in which distance the top of the weak "sandstone" strata rises northward from below sea level to about 60 ft above and then levels off to a horizontal position in the sea cliff. A similar dip appears to be present at the north side of Tulalip Bay. These dips indicate the inclination of a considerable part of the north flank of Possession Sound.

On the south side of Possession Sound, in the face of the plateau escarpment in the southern part of Everett, severely deformed material lies in a zone at least 300 ft wide. It can be observed intermittently in outcrop for more than a mile. In excavations near the northeast corner of Forest Park in Everett, dips of 26° in a N. 65°–70° E. direction are present in the Admiralty clay (and in what may be the upper part of the Esperance sand member). This zone of deformation can be followed northwestward. The strata dip 70° NE. in the road bank a block east of the city water reservoir, and vertical shear zones can be seen in the borrow pit just north of the reservoir. Farther northwest a shear zone in clay may be followed for 500 ft to a point where it disappears beneath forest litter The covered prolongation of this shear zone lies in a sharp ravine that leads to Possession Sound at a point just east of the mouth of Little Pigeon Creek (in the NE¼SE¼ sec. 25, T. 29 N., R. 4 E.). The top of the Admiralty clay appears to be about 140 ft lower in the sea cliffs north of this ravine than it is in the gully forming the reservoir spillway to the south. Eastward from the Forest Park vicinity the zone of deformation is known only in the pits of the Everett Brick Co. near 41st Street and Rockefeller Avenue extended, where in March 1946 the quarry face displayed highly sheared beds of the Admiralty clay. It is believed that the evidence for a glacial ice-thrusting origin of this structure zone is outweighed by the evidence indicating large-scale earth movement. In either event the deformation probably occurred after the deposition of the Esperance sand member, as did that which formed the aforementioned southerly dips at Hermosa Point. The observed structures at Hermosa Point and in Everett may outline a synclinal sag, which may be responsible for the location of the harbor (Port Gardner) and the present mouth of the Snohomish River.

The other minor postdepositional deformation in the unconsolidated deposits is the tortuous involution of a clay layer within the Esperance sand member. The layer is exposed in the escarpments at the east and west sides of Everett—in the bluff below the west end of 19th Street and also in the east bluff near the end of 22d Street. This 1-ft bed of yellow clay is found penetrating the sand in a myriad of fantastic dikelets. The deformation is considered to be a compression phenomenon due to the load imposed by the weight of the Vashon ice. Bretz (1913, pl. 17) observed similar phenomena in the sea cliffs of Camano Island.

Certain well drillers ascribe the presence of steep-sided massive clay lenses ("shot clay") within the normal interval of the Esperance sand member in the Seattle Heights district to a bulging of the underlying Admiralty clay ahead of the Vashon ice front. No evidence of such an occurrence could be found in the exposures of the area, and it is believed that the clay humps may be either erosional ridges of the underlying Admiralty clay or local clay lenses in the Esperance. The latter are common southeastward from the Seattle Heights district.

GEOLOGIC HISTORY

The succession of geologic events in the area, as portrayed in the outcrops of its rock formations, explains many of the variations in water-bearing characteristics of the different types of earth materials and the consequent variations from place to place in the occurrence of ground water in usable quantities.

PRE-TERTIARY HISTORY

The metamorphic rocks now exposed in the ridges and foothills of the Cascade Mountains in Snohomish County indicate that, during parts of the Paleozoic and Mesozoic eras, marine sediments accumulated in that area. Subsequently consolidation, compression, and intrusion by igneous magmas have converted the sediments to hard rocks. These old sedimentary rocks and the later igneous intrusives have undoubtedly been subjected to several epochs of deformation, including at least one epoch of mountain building. Compaction of the rocks and recrystallization of their mineral grains have made the rocks largely nonporous. Water movement is restricted largely to the fracture openings in the rocks.

TERTIARY HISTORY

Consolidated sandstones, shales, and conglomerates of Eocene (?) and Oligocene age and an older, underlying volcanic series comprise the rocks of known or probable Tertiary age that crop out in the county. The series of sandstones and shales has a conglomeratic basal zone that rests on, and contains pebbles of, the Tertiary (?) volcanic series and the pre-Tertiary metamorphic and igneous rocks. The basal conglomerate is exposed along the river bluffs north of Cathcart. At least part of the Tertiary sediments apparently were laid down in broad estuaries in which marine and fresh-water conditions alternated.

The Tertiary sediments underwent consolidation and were involved in the tectonic movements of late Tertiary and Pleistocene time. During the major warping incident to the uplift of the ancestral Cascade region in late Tertiary time the sediments were folded into broad east-west swells and downwarps, which are believed to be represented in the Tertiary ridges that extend through the Seattle and Mount Vernon areas westward across Puget Sound (Weaver, 1945). The subsequent early Pliocene erosion reduced the older Cascade Mountains to a westward-sloping plain of low relief. Below the level of that plain the Tertiary sediments remained where they had been protected from erosion in the downfolded areas and in the lower western areas.

The major deformation that raised the present Cascade Mountain system near the close of the Tertiary period in effect elevated a north-south belt of this erosion surface. It produced the framework of the main present-day structural elements—the Puget lowland, the high Cascade block, and the Olympic and other uplands west of the Puget Basin.

The Tertiary sedimentary rocks in Snohomish County floored a westward-plunging, troughlike basin that extended to a considerable depth, possibly several thousand feet, in the central part of the Puget depression. As erosion progressed into the Cascade upland, this sedimentary belt was etched into strike ridges, which, during the ensuing Pleistocene time, became progressively buried by the thickening sedimentary fill and glacial deposits that accumulated in the Puget Basin.

PLEISTOCENE HISTORY

Much of the erosion that reduced the present Cascade Mountains to a mature state of dissection occurred during Pleistocene time. A part of the rock material so removed accumulated as fill in the Puget trough. The deposits that now underlie the lowland plateaus of the western third of Snohomish County, where the greater part of the population lives, accumulated largely during the Pleistocene epoch. They contain much of the important ground water of the county.

There is a considerable gap in the known geologic history of the Puget Sound region between the time of the uplift of the Cascade area in late Pliocene time (Willis, 1903, p. 70) and the deposition of the Vashon glacial deposits in late Pleistocene time. It is presumed that some of this intervening period is represented by the Admiralty clay and by other deposits at depth within the Puget Sound trough.

Little is known of the oldest and lowest sediments of the Pleistocene epoch in the Puget Basin. The oldest exposed Pleistocene deposit, the Admiralty clay, is visible in Snohomish County for about 200 ft above sea level (fig. 14). Its continuation for 1,000 ft or more below sea level is inferred from the continuation of silty clays similar to those of the Admiralty clay as known from deep drillings such as well 32/4–29P1 (table 5). The subsurface deposits represent a large part of the Pleistocene fill of the Puget Sound basin, and it is possible that some older Pleistocene, or very late Pliocene, sediments—so far unknown—underlie it in the deeper parts of the Puget trough.

FIGURE 14.—View looking east at the upper part of the sea cliff near the settlement 3 miles north of Picnic Point, Snohomish County, Wash. Till forms the escarpment at the upper right, and silts of Admiralty clay are exposed in the foreground. Landslide topography marks the bench between the two escarpments.

The Puget Basin, in which the Admiralty clay was deposited, was a large, rather shallow lake. It may have contained fresh water, and the water level may have stood higher than present sea level. As the Pleistocene sediments accumulated in this basin, the marginal peat swamps and driftwood piles were continuously being covered and interlayered with the clay. The fineness or coarseness of the sediments varied from place to place—probably according to their position with respect to the inlets of the main rivers. Throughout the Snohomish County area the deposits are largely silts, fine sands, and clays, except near the mountain-valley debouchment of the Skykomish River, where coarse sands and gravels are interbedded.

The fine-grained water-laid sediments had filled the basin to a level 100 or 200 ft above present sea level when a major change in sedimentary environment occurred. The prevailing deposition of clay was succeeded in the Snohomish County area by a predominance of current-laid sand and fine gravel, which accumulated to a depth of 100 ft or more before its deposition was interrupted by the succeeding erosional epoch. In the stratigraphic discussion, these sands and gravels have been separated from the Admiralty clay and placed with the later, coarser-grained sediments—the Esperance sand and Pilchuck clay members of the Vashon drift.

The beginning of the deposition of coarse-grained sediments was interrupted abruptly by a period of canyon cutting, during which a system of river gorges, as much as 1,000 ft in depth, was carved headward along the main drainage courses into the horizontally bedded Pleistocene clays and sands of the Admiralty clay and later Pleistocene accumulations.

The gorge system had scarcely been carved upstream to the rock ledges of the mountain coves when the Vashon glacial ice of late Pleistocene time advanced southward into the low parts of the present Snohomish County area. The ice moved south and southeast across the area, extending first into lowland areas and then gradually rising in height until it flowed over the intergorge plateaus. It reached a maximum thickness of about 3,000 ft in the Snohomish County area, and it thrust arms up the major streams to the limit of its gradient capacity, at which places these arms dammed the streams and caused the deposition of great ridges of water-laid drift.

As the Vashon ice advanced into the lowlands, it dammed the streams and caused many temporary drainage diversions. Probably the Skykomish and Snoqualmie Rivers were then diverted southward into the Sammamish Lake drainage of King County, and at least one of the forks of the Stillaguamish River may have reached the same southward outlet. Possibly the Skagit and certainly the present Sauk and Suiattle Rivers at one time flowed down the Stillaguamish, which may have discharged down the Marysville trough to the Snohomish drainage at Everett. The ice in time filled the lowlands, and the drainage, as well as the meltwater from the ice, passed across the intergorge plateau segments. As the base level of the waters over the plateaus was controlled by the marginal ice, the level continued to rise and the streams continued to build up their beds to keep pace—a procedure that resulted in the formation of extensive deposits as much as 200 or 300 ft thick on some of the intergorge plateaus, where the deposits were eventually covered by the advancing ice.

This gravel and sand deposit—here called the Esperance sand member—is the sub-till sand and gravel formation from which important quantities of ground water are now drawn. Even where great thicknesses of this advance outwash did not accumulate, there was usually a thin deposit such as that referred to in the text and tables as "unnamed sub-till sand."

When conditions were no longer favorable to the accumulation of glacial ice on the inland side of Vancouver Island and the seaward side of the opposite Coast Range of British Columbia, the great piedmont ice sheet was no longer sufficiently nurtured and the Vashon ice melted back from the Puget Basin, leaving the surface much as it is today. In wasting, the ice dropped an immense load of debris. This debris has been partly consolidated and now forms a persistent mantle known as the till of the Vashon glaciation, locally better known as "the hardpan." In some of the principal drainage courses the till materials were water-sorted.

Many significant deposits resulted from the flow of meltwater that accompanied the wasting of the ice sheet. The Stillaguamish River, freed of ice upstream, was dammed in the narrows at Arlington by unmelted or resurgent ice and the resulting lake was filled with sediments to an altitude of 300 ft. The spillway of the lake was through the present course of the Pilchuck River. The uppermost terrace formed by the lake sediments, the largest area of which is now known as Arlington Heights, and the later, lower, steplike terraces that line the Stillaguamish Valley above Arlington were left during the erosion of the lake sediments.

As is usual, many otherwise unusual topographic land forms were left by the melting glacier. Besides those previously mentioned, the crosscutting gorge of the Pilchuck River from Hartford to the Snohomish River might be noted. This course probably was formed by meltwaters flowing along the eastern margin when the ice front had melted back to that position. Lake Stevens, also, located in what was apparently the ice-deepened swale at the confluence of two small preglacial creeks, came into existence with the retreat of the ice cap and overflowed briefly through at least three different outlets before stabilizing in its present overflow to the Pilchuck River. (See pl. 1 for depths of water measured in Lake Stevens.)

In the last stages of the withdrawal of the Vashon ice from Snohomish County, the debris-laden meltwaters from the Bryant area and areas farther north joined the Stillaguamish west of Arlington and emptied to Puget Sound by way of the Marysville trough. As the ice cleared from the Stanwood area of Possession Sound the Stillaguamish, at that time alluviated to an altitude of about 125 ft above present sea level at Arlington, found a shorter outlet westward to the Sound and abandoned the Marysville trough.

RECENT HISTORY

When the glacial ice left the county area, the principal rivers were estuarine considerably farther inland than at present—the Snohomish River probably back as far as Snohomish and the Stillaguamish probably back as far as Florence. The subsequent Recent deposits of deltaic material have filled the lower courses of these rivers and have created large shoal areas reaching into Puget Sound. Wave action has carved seaward slopes into steep cliffs and at such places has removed much of the till of the Vashon glacier. The level to which the last outwash built its train is preserved in the lower part of the Marysville trough by the outwash terrace at a level of 50 to 60 ft above present sea level and in the Snohomish River gorge by a narrow terrace at that same level. Subsequent changes of sea level have apparently been solely in a downward direction, though evidence for any large temporary postglacial recessions of sea level is believed negative or inconclusive. The Recent deposits in the lower Stillaguamish and Snohomish Valleys have apparently accumulated in brackish or salt water since the melting away of the Vashon ice.

WATER-BEARING CHARACTERISTICS OF THE ROCK MATERIALS

CONSOLIDATED ROCKS

PRE-TERTIARY ROCKS

The sedimentary, metamorphic, and igneous rocks that comprise the mass of the Cascade Mountains and some of the outlying foothills are generally so tight and impervious that they carry little water. No wells are known to derive water from them at present. However, small openings—joint cracks, other fractures, and solution channels—exist at places in these rocks. The quartzitic schist that forms the rock knob rising above the Arlington Heights flat near the center of sec. 4, T. 31 N., R. 6 E., is highly fractured where exposed. If the rock is similarly fractured below the surface, it should transmit and yield water readily. In the terrace flat adjacent to the knob the water table occurs at a rather shallow depth. Vuggy limestones that are exposed northeast of Menzel Lake should yield water where they extend below the water table.

The abundant surface-water resources of the mountainous part of the county largely preclude the necessity of attempting to develop ground water from the consolidated rocks.

TERTIARY ROCKS

The Tertiary shales, shaly sandstones, and conglomerates are for the most part not water bearing. In outcrop the shales appear chalky or clayey, the sandstones dirty and of low permeability. The voids of both sandstones and conglomerates are generally filled with fine material or cement.

The records of wells that have penetrated these formations bear out the low permeability noted in the outcrops. Of the six or seven test holes reported to have been drilled some distance into the Tertiary rocks in Snohomish County none has obtained a yield of more than 10 gpm from 100 ft or more of open hole. In most wells the water obtained has been reported to be of inferior quality.

Though the formations of the Tertiary rocks serve as water sources in a few places elsewhere in the Puget Sound area (such as on Lummi Island), they are not worthy of further exploration in Snohomish County except as a last resort.

UNCONSOLIDATED DEPOSITS OF PLEISTOCENE AND RECENT AGE

ADMIRALTY CLAY

This name applies to a series of firm, fine-grained sediments that are known principally from outcrops between sea level and an altitude of 200 ft. They probably extend several hundred feet below sea level, as previously described. This sequence of sediments underlies much of the western lowland of Snohomish County; consequently, its occurrence and water-bearing characteristics are of importance to anyone attempting to develop deep water wells. The upper limit of the Admiralty is at a maximum altitude of about 200 ft beneath the plateau segments; its eroded forms carved from similar clays descend beneath the main river troughs to a depth of 600 ft or more below sea level.

Twenty-two properly constructed wells are known to have penetrated the Admiralty clay for substantial depths. These wells, as listed in table 4, are numbers 27/3–24Q1, 27/3–24Q2, 27/4–32M1, 27/5–32R1, 27/5–35E1, 28/4–22B1, 29/5–19K1, 29/5–29G1, 29/5–8R1, 29/6–7D3, 29/6–7J1, 29/6–8F4, 28/6–6Q1, 28/7–31H1, 28/7–31H2, 28/7–22E1, 28/7–22E2, 30/4–17K1, 30/4–19P1, and 30/4–19K3, as well as unnumbered test wells at the cheese plant (300 ft deep) and the former Carnation Milk plant (1,100 ft) at Stanwood. Of these, the Monroe city wells (29/7–31H1, 29/7–31H2, 29/7–32E1, and 29/7–32E2), the Lake Stevens PUD well 1 (29/6–8F4), plus small house wells 27/5–35E1, 28/6–6Q1, 29/6–7J1, and 30/4–17K1, yield small to fair supplies from what are apparently strata of the Admiralty. One well (27/5–32R1) is not used because of the inferior quality of the water, which is understood to contain hydrogen sulfide gas; another

(29/5–8R1) may obtain its water supply from materials overlying the Admiralty. To the remaining 11 wells, the sections of the Admiralty deposits penetrated by the drill were found to yield little or no water.

The predominant clayey or silty nature of the deposits, the compacted and silt-bearing character of the sands and gravels, the lack of horizontal continuity of the thicker sand and gravel beds, and the predominantly horizontal attitude of the beds (which restricts the opportunities for recharge) all militate against the Admiralty as an important source of ground-water supply in the county.

The unconsolidated strata beneath the till under the broad terraces about Monroe, from which strata the present Monroe city well installations now pump, may not belong to the Admiralty clay. It is possible that they are younger, that they belong to the Pilchuck clay member, and that they have refilled gorges cut in the Admiralty clay during the canyon-cutting epoch. However, these strata might be of Admiralty age, and their water-bearing character might be due to local deposition of coarser materials near the mountain debouchment of the Skykomish River in Admiralty time.

Judging from the character of the Admiralty clay, as exposed in outcrop and from its record as logged in drilling operations, in Snohomish County it may be considered an uncertain and expensive source for the development of more than small-capacity water wells.

VASHON DRIFT

ADVANCE OUTWASH AND ASSOCIATED DEPOSITS

PILCHUCK CLAY MEMBER

The miscellaneous sediments that extend upward from the top of the Admiralty clay to the mantle of till of the Vashon glaciation along the inland part of the western lowland are composed largely of clays with interbedded sands and gravels. At the contact with the overlying till there is, in many places, a layer of outwash gravel and sand as much as 10 or 15 ft in thickness.

The upper sub-till outwash gravel and sand is tapped by several wells (28/6–9P1, 28/6–29H1(?), and 28/7–16J1, for example), and the yields are generally satisfactory for domestic use. The yields obtained from the sand and gravel layers interbedded with the clay are not so satisfactory. These interbedded sands and gravels usually are dirty, compacted, or otherwise poor as water bearers, although an exception to this generalization appears to exist in the valley of the Skykomish River east of Monroe, where good yields are obtained from sands and gravels interbedded with clays.

The Pilchuck clay member occurs beneath the till most extensively in the higher foothill lands northeast of Snohomish. As a result they are largely unexplored by water-well drilling.

ESPERANCE SAND MEMBER

Beneath the till on the Intercity, Getchell Hill, and Tulalip plateau blocks—and to a less extent on other plateau blocks of the western lowland—wells enter a thick zone of sand and gravel, in this paper called the Esperance sand member (figs. 5–8, 11, 18). The lower part, and in some places the whole deposit, is saturated with water. It is probably the most widespread and most important single ground-water source in the county; certainly it is the most important ground-water body that occurs beneath the plateau lands.

The sand has been explored thoroughly beneath the Intercity plateau, where a large number of both drilled and dug wells tap it. It has been less thoroughly explored under the Tulalip plateau block, and its presence beneath the western part of the Getchell Hill and the Cedarhome plateau blocks has only been established.

The Esperance sand member ranges in thickness from 25 to as much as 300 ft. Though in general hydraulically continuous both horizontally and vertically, in many places it contains several clay layers near its base. In places, clay layers separate the water into zones having a slightly different hydrostatic head near the discharging part of the aquifer (as is evident in the Main Street well field at Edmonds), but they do not alter the general singleness of the ground-water body.

The gravels and sands are mostly loose, clean, and permeable. The sands, which predominate, are commonly coarse- or medium-grained, but thick sections of fine sand also are present in places. Southward from the vicinity of Alderwood Manor to the valley of the Sammamish River in King County, a thick sequence of silts and clays lies in the middle of the Esperance. Development of water from the sand member in that district has been largely restricted to the sand and gravel below and above the clay; consequently, successful well development from the Esperance in the district has been a relatively difficult undertaking.

The water in the Esperance sand member occurs in flat-bottomed, lens-shaped bodies beneath the plateau segments, perched on top of the Admiralty clay. Its surface, or water table, has a gentle slope except near the margins, where it slopes downward rather steeply to springs that discharge the water into creek valleys or from the bluff faces of the plateau segments. The writer estimated that water was discharging at the rate of 2,000 gpm per mile from the lower edge of the Esperance sand member (at an altitude of about 175 ft) in the 6-mile stretch between Everett and the Marshland School district during February 1946. The summer and fall flow of such streams as North, Bear, and Woods Creeks is largely composed of spring discharge from the Esperance. Along the east side of the Tulalip plateau, and possibly the southeast side of the Getchell Hill plateau, the thick, sloping mantle of till covers the beveled edge of the Esperance and confines the ground water. The Edwards Springs (31/4–24N3) discharge from a point where the confining till layer has been broken.

Water is added to this aquifer by downward percolation of the precipitation on the plateau surface. After it reaches the water table, the ground water moves slowly in a lateral direction toward the points of spring discharge. The till mantle sheds a great deal of water that otherwise would find its way to these ground-water reservoirs. In some places the till is so impermeable that little if any water can percolate through it, and recharge to this aquifer in those places must be by lateral percolation from the sides of stream or plateau slopes or from the few other places where the till is absent.

On the Tulalip plateau block the water table is at an altitude of about 350 ft in the wells just north of Lake Goodwin, whereas 4 miles to the west it is at or near sea level in wells such as 31/3–36A1 and 31/3–36B3, whose water levels fluctuate with the tides. It is possible that the hydraulic gradient may be evenly continuous between these two extremes, but the writer considers it more likely that between the two points the Esperance sand member drapes down over the edge of a buried escarpment on the Admiralty clay; thus the water in the Esperance near Lake Goodwin would be separated by a ground-water cascade from its westward equivalent, which is resting on a salt-water base at the Sound level south of Warm Springs (pl. 2).

The wells that tap the Esperance sand member generally obtain only moderate yields. A capacity of 100 gpm is about the average for a drilled well with a diameter of 8 or 10 in. Among the largest yields so far obtained are those of the Beverly Park and Pinehurst wells (28/6–7G2, 28/6–7G3, and 28/6–7H1), which have capacities of 300 to 450 gpm.

TILL

The mantle of ground moraine left by the melting of the Vashon ice is largely impermeable. However, the soil and subsoil, 1 to 10 ft thick along the surface of the till, form a slightly permeable zone, which fills with water each rainy season and each summer partly or entirely dries out (fig. 15). Shallow wells dug into that zone are the most commonly used source of water supply for rural homes in Snohomish County. Relatively abundant yields of water may be obtained in the rainy season, but only small yields, or none at all, in the dry season. A few hundred gallons a day is the maximum yield for most wells dug into the till. In a few places gravel streaks within the till serve to concentrate this shallow water and to lead it downward through the till (fig. 9). A shallow well that strikes one of these gravel streaks may obtain more than the average capacity for the till wells and may adequately supply a household.

The till of the Vashon glaciation, in addition to being a poor aquifer, sheds off a large part of the precipitation each year, resulting in the waste of water that might otherwise enter ground-water storage in the

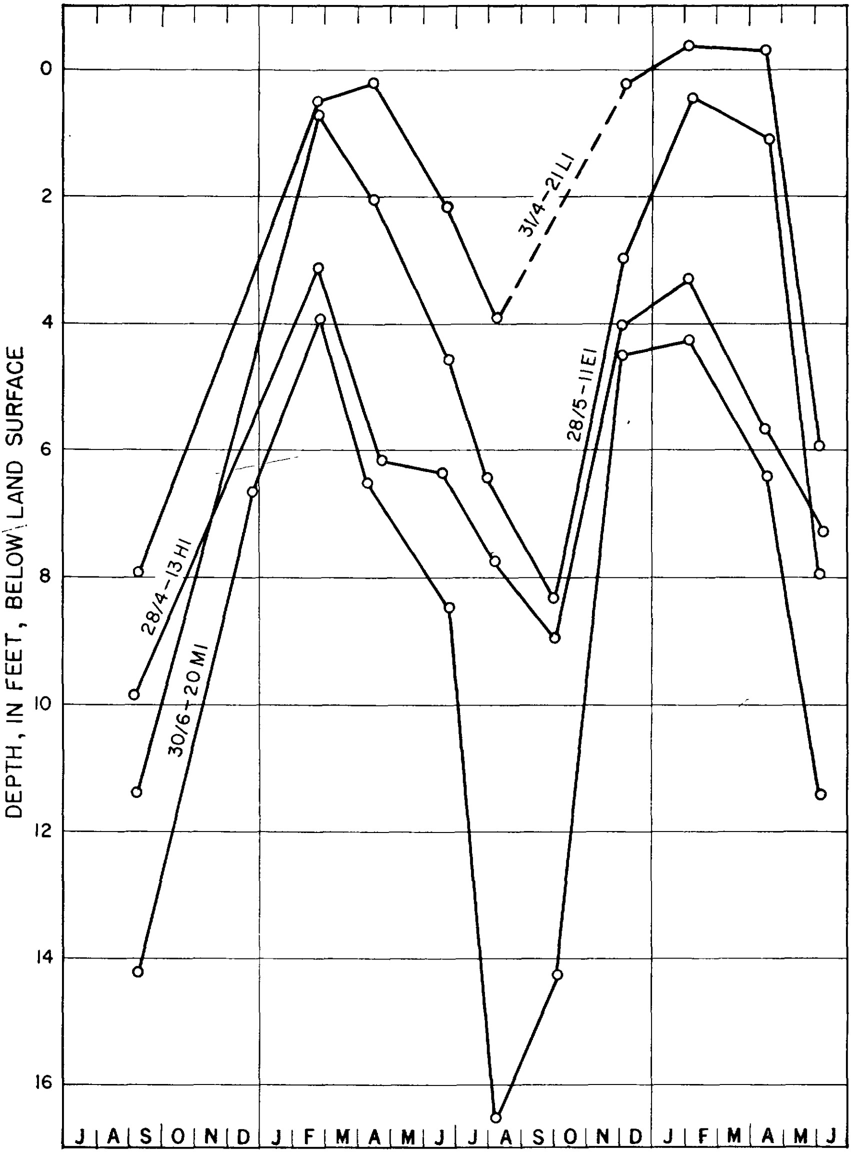

FIGURE 15.—Fluctuations of the water level in four wells in Snohomish County, Wash., tapping the perched ground water of the soil zone of the till.

underlying sands. This effect of the till can be shown by a table of comparative stream-gage readings taken on Little Pilchuck Creek and on the South Fork Quilceda Creek (table 1). The drainage area of Little Pilchuck Creek is almost entirely mantled by the till of the Vashon glaciation, whereas the South Fork Quilceda Creek, in addition to the direct surface runoff from the till mantle of its headwaters area, receives ground-water discharge from the sub-till sands throughout the year along part of its entrenched course at the edge of the Getchell Hill plateau. Consequently, the measured flow of the South Fork Quilceda Creek shows an annual fluctuation less than one-third as high as that in Little Pilchuck Creek. A further effect of this fundamental difference is shown by the similarity of the low-water flow of the two streams despite the fact that Little Pilchuck Creek has much the larger drainage area.

TABLE 1.—*Comparison of flow in South Fork Quilceda Creek and in Little Pilchuck Creek, Snohomish County, Wash.*

[Measurements by Surface Water Branch, U. S. Geological Survey]

Date	Little Pilchuck Creek, in sec. 22, T. 30 N., R. 6 E., at road crossing east of W¼ corner (area of basin, 13 sq mi)		South Fork Quilceda Creek at highway crossing east line of sec. 34, T. 31 N., R. 5 E. (area of basin, 4½ sq mi)	
	Discharge (cfs)	Ratio to low flow (pct)	Discharge (cfs)	Ratio to low flow (pct)
1946				
July 3			1.53	1
10			2.22	2.2
22	1.51	1.5	1.64	1.6
31	1.39	1.35		
Aug. 13	1.03	1.0	1.76	1.7
25			1.51	1
Sept. 12	1.32	1.30	1.52	1
24	1.02	1.0	1.62	1.6
Oct. 15			1.86	1.8
Dec. 12	109.0	107	32.5	32
1947				
Feb. 5	51.0	50	12.4	12
Mar. 13	30.9	30	8.53	8.4
Apr. 15	17.1	16.5	5.23	5.1
May 27	1.51	1.5	1.52	1

RECESSIONAL OUTWASH

Undifferentiated outwash.—Undifferentiated outwash, resulting from the wasting of the Vashon glacier, now remains largely as terrace-capped bodies along the main drainage channels. For the most part it is composed of sand and gravel. It is highly absorptive, and, being fairly permeable, it transmits ground water readily. Consequently, where it lies in a position to retain a ground-water body, it serves as an excellent aquifer—as it does, for example, on the terraces north of Sultan and on those south of Bryant. Where the infiltrated water is held up by an impervious base and is discharged at a considerable

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elevation above stream level, the resultant springs are often usable and valuable (28/8-8G1, 32/6-31M1). However, much of the ground water in the outwash deposits is in the more remote river valleys and, except for its contribution to stream flow in the summer months, is largely lost at present so far as beneficial use is concerned.

Differentiated outwash.—The outwash of the Stillaguamish sand and Arlington gravel members ranges from coarse gravel to fine sand. The larger part of the Stillaguamish sand member of the outwash, which forms the Arlington Heights terrace, is sand. Gravel commonly forms the upper part of the terrace deposits of the Arlington gravel member. Both materials absorb a large percentage of the rainfall and (except for some fine sand of the Stillaguamish sand member beneath the Arlington Heights terrace) will yield large quantities of water to adequately constructed wells. For the most part the ground water within these two units of differentiated outwash is largely undeveloped except for household use. There seems to be adequate ground water for irrigation from wells on the Arlington Heights flat. In the western part of the Arlington Heights area the sediments are more sandy than elsewhere, and wells of special construction may be necessary to obtain large yields.

The Marysville sand member is the sand and gravel deposit that floors the Marysville trough. It extends downward from the surface to an unknown depth that is estimated to be 100 to 200 ft in the northern part of the trough. It contains a large body of readily available ground water whose upper surface lies at shallow depth. The ground water moves down the steep gradient of the trough to discharge into the creeks tributary to Ebey Slough. Shallow wells have large yields; 190 to 200 gpm is commonly pumped for sprinkler irrigation from wells only 10 or 15 ft deep with no more than 2 or 3 ft of drawdown. The ground-water body has a divide, at an altitude of about 110 ft, close to the Edgecomb-Lakewood Station road near the northern end of the trough. Water north of the divide percolates north to discharge to the Recent alluvial terrace of the Stillaguamish River.

RECENT ALLUVIUM

These deposits have accumulated in ponded water and along stream valleys since the Vashon glacier melted. For the most part they are fine-grained materials—silts, clays, and sands—but along the major river valleys they contain numerous coarse sand and gravel layers. The ground-water body in these alluvial materials is commonly tributary to and in balance with nearby surface water. Large yields are obtained from the wells tapping clean gravel in these Recent deposits. Among these wells are the productive city well at Arlington and the dug wells at Monroe, whose capacities of 1,000 gpm are among the largest in the county. Unfortunately, the water in the alluvial bodies in some places is of inferior quality—iron bearing in many inland localities and saline in places in the lower reaches of the main river flood plains.

OCCURRENCE OF GROUND WATER

FORM, MOVEMENT, AND RECHARGE OF THE PRINCIPAL GROUND-WATER BODIES

The water-bearing beds in the Admiralty clay are thin horizontal members. Their lack of porosity, thickness, and continuity is shown in outcrop. These conditions are illustrated, also, by subsurface evidence—for instance, the fact that the thin sand bed tapped by wells 29/6–7J1 and 29/6–8F4 was not present in test hole 29/6–7D3 (pl. 2). Such discontinuity to the west could indicate an eastward thickening of the coarser-grained members in the Admiralty clay, and such a presumption would be in accord with the evident coarseness of the sub-till sediments (probably of Admiralty age in part) in the Skykomish Valley as noted from the Monroe city well logs. If the presumption is correct, recharge from permeable deposits in the mountain valleys may cause ground-water movement westward into the flat-lying coarser-grained layers in the Admiralty. That recharge and movement would probably affect only a small area outside the Skykomish Valley; elsewhere permeable beds and lenses in the Admiralty may lie isolated by the surrounding clay, and the small quantities of ground water available may be derived largely from storage and from the compaction of the sediments. Thus the aquifers in the Admiralty clay are believed to be largely horizontal sand beds in which recharge and movement of water are restricted by the low permeability of the surrounding clay.

The ground water in the Esperance sand member is, in essentially all places, water from precipitation that has percolated more or less directly to the regional water table. The ground-water bodies have a generally flat base and an upper surface that slopes radially outward at an average of perhaps 25 ft per mile toward the surface streams into which the water drains. The gradient near the outlets is much steeper, commonly over 50 ft to the mile, as it is in the Edmonds district. In a few places, such as the east side of the Tulalip plateau and here and there along the northwest and south slopes of the Getchell Hill plateau, the water is confined under artesian pressure by the overlapping till. On the southeast slope of Getchell Hill (near well 29/6–2F1) the gravel underlying the till is practically full of water, but the water is not under pressure. Elsewhere water-table conditions exist in most places, and the ground water lies unconfined in the lower part of the Esperance sand member.

The sand aquifer is covered so generally by the almost impenetrable till that in most places direct vertical recharge by precipitation is slight, has a considerable time lag, and occurs mostly in years having an especially wet period (fig. 16). From about 1920 to 1933 there was a gradual and progressive decline, totaling about 10 ft, in the water table of the Seattle Heights-Edmonds district, probably in response to the downward trend of average yearly precipitation during that time (fig. 3). The water table fluctuates from season to season and from year to year, and the amount of water available to wells or springs depends on long-term climatic differences as well as on the annual precipitation cycle.

It is reported that the water level in Beverly Park well 28/5–7G2 declined about 10 ft during the period 1936–42. The decline was probably due to the relatively heavy pumping in that vicinity. The pumping eventually must be restricted to an amount that will avoid a persistent decline in the water table. Within limits, however, the lowering of the water table to a stable pumping level is beneficial, because it increases the area influent to the wells and decreases the amount of water that would, in this place, otherwise percolate to Woods Creek and be wasted.

The ground-water bodies in the undifferentiated recessional outwash of the Vashon glaciation are recharged by downward percolation of precipitation. Commonly the outwash rests on an impervious base that stops the downward movement of the water and forces it to percolate laterally to the edge of the outwash, where it emerges at the surface drainage or enters adjacent earth materials. Though the recharge originates largely from direct precipitation and the movement is generally in a downstream direction, the shape of each individual body of ground water depends upon that of the containing outwash deposit.

The ground water beneath the outwash plains southwest of Bryant is in a thin sheet recharged by precipitation, and the water moves laterally to the edge of the deposit and discharges from the bluff face over the underlying till. There the discharge level is known locally as "the spring line." The ground water of the large gravel train along the Stillaguamish River downstream from Darrington Flat is a water-table body of complex shape, generally tributary to the creeks and swamps of the lower terraces. The gravel outwash in the stream ravine north of Roosevelt Corners passes beneath the clayey alluvium of the Snohomish-Monroe trough, where the water becomes confined under artesian pressure and supplies flowing wells in the river-flat area to the south (28/6–22J1, 28/6–27H1, and others). The great water-laid moraines northeast of Granite Falls, east of Lake Champlain, and east of Reiter contain large, complex bodies of ground water that at

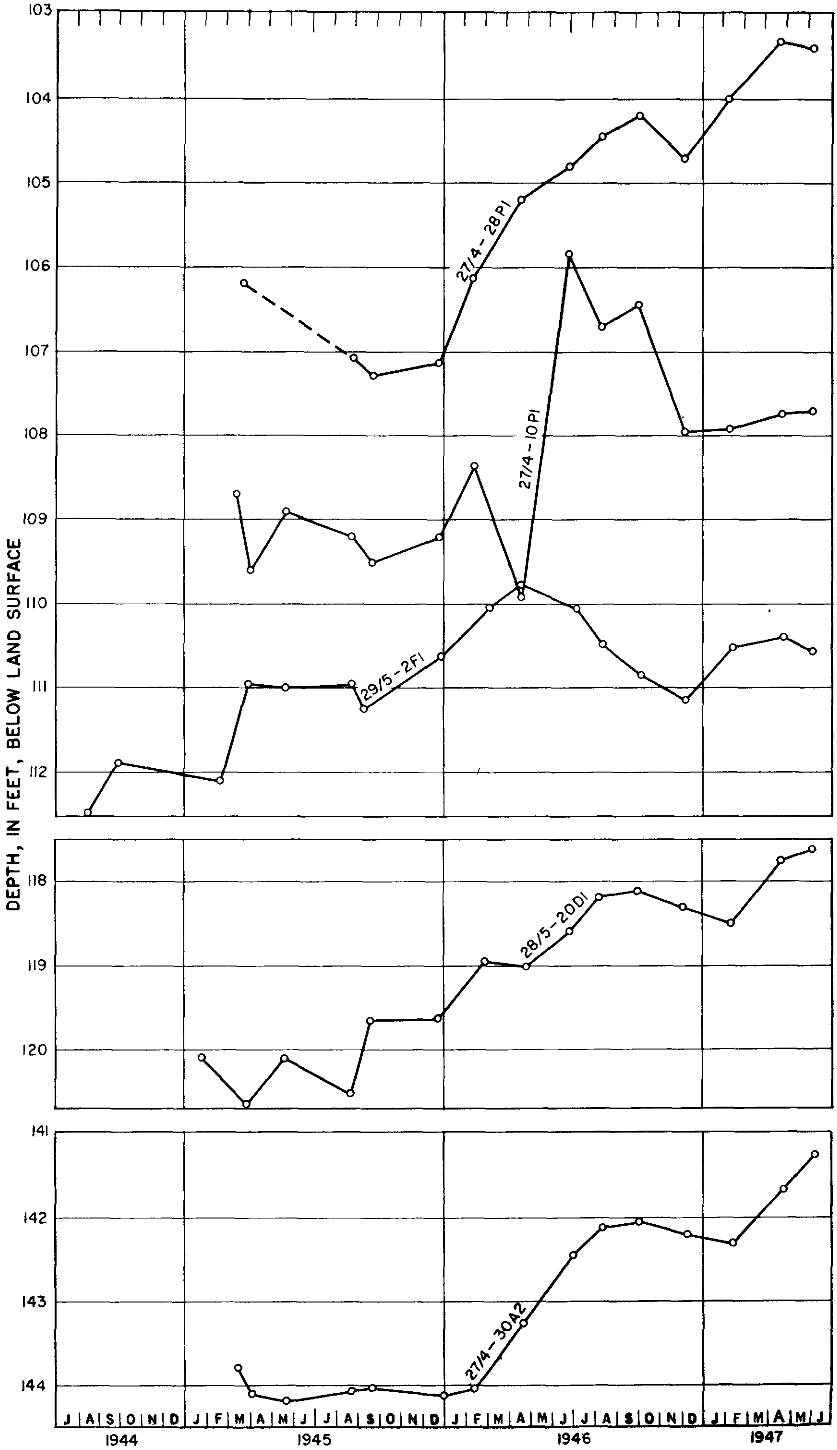

FIGURE 16.—Fluctuations of the water level in five wells in Snohomish County, Wash., tapping the Esperance sand member or other sub-till sand.

present serve usefully only by helping maintain stream flow during dry or prolonged cold weather.

The Stillaguamish sand member filled glacial Lake Stillaguamish. Its principal remnants are the sediments underlying the Arlington Heights terrace and the outwash train extending southward through the Pilchuck Valley to Hartford. The water table in the outwash beneath the Arlington Heights terrace is recharged from precipitation on the terrace surface and by runoff from Ebey Mountain. The ground water moves radially from an apex near the eastern edge of the terrace at an altitude of about 280 ft and discharges to springs at an altitude of about 200 ft around the periphery of the terrace escarpment. Decreasing permeability in the finer materials that underlie the terrace toward its western edge may have considerable influence in maintaining the high level of this water under the greater part of the Arlington Heights terrace.

A potentially productive ground-water body occupies the northern part of the Pilchuck Valley spillway of this old glacial lake. There is a divide in the water table northwest of Lochloy, the water north of it passing northward and discharging as large springs (30/6–11M1, 30/6–11P1, and others) into the South Fork Stillaguamish River and that south of it being tributary to the Pilchuck River. The water table rises and falls in an annual cycle in which there is a lag of about 6 months. This lag is so great that it suggests a principal source of water other than direct precipitation on the outwash train, possibly a source from the upper part of the Pilchuck River or from the adjacent ground-water body in the sub-till sand unit of the advance outwash below the till. The latter possibility is suggested by the reported similarity in water levels in well 30/6–10J1, tapping the Stillaguamish sand member, and a well a quarter of a mile southwest that taps water in sand below the till. At that place the till slopes eastward beneath the outwash-train deposit.

The Arlington gravel member, which in many places is simply a thin deposit on a terrace that was cut into the Stillaguamish sand member contains a continuation of its ground-water body. Recharge by vertical infiltration of rain water augments the water that moves down gradient to it. The springs from which South March Creek originates percolate from this outwash deposit.

The Marysville sand member contains a "strong" ground-water body with a water table of rather uniform slope. The water from precipitation that reaches the floor of the Marysville trough passes southward and northward from a divide near Edgecomb. To the north the water empties from the springs that feed Portage Creek, and to the south the water is tributary to all the surface drainage downstream from the vicinity of Stimson Crossing (pl. 1 and fig. 17).

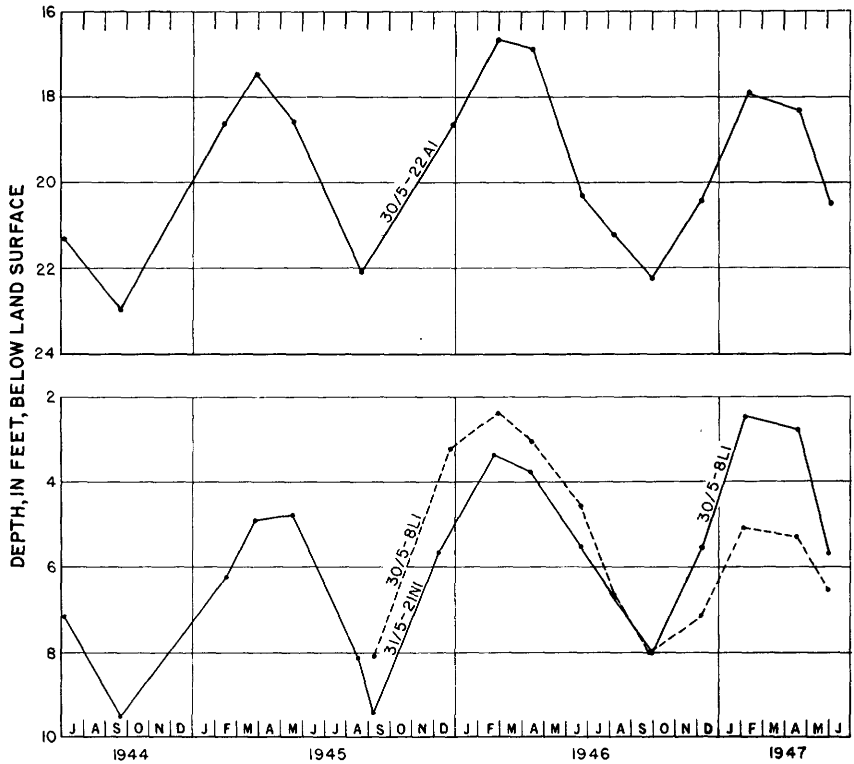

FIGURE 17.—Fluctuations of the water level in three wells in the Marysville sand member, Snohomish County, Wash.

The permeable material is known to be at least 150 ft thick in the Edgecomb district. Little is known as to the shape of the base of the water body. In the vicinity of Marysville the outwash may be underlain at rather shallow depths by the till of the Vashon glaciation, which may pass beneath the eastern half, at least, of the lower Marysville trough. A well in sec. 17, T. 30 N., R. 5 E., drilled for the U. S. Army ammunition dump, is reported to have penetrated successively 7 ft of brown sand, 10 ft of sandy clay, 13 ft of water-bearing sand, and 10 ft of sandy clay. Clayey sections are not common in the upper part of the Marysville trough and may indicate that a constriction of the water-bearing section of the valley is effected by the greater volume of clayey materials in the lower part of the trough. Such a constriction of the water-transmitting sediments appears to be indicated by the large ground-water discharge to Quilceda Creek and other streams in the southern part of the trough (pl. 1).

The Recent alluvium along the main stream valleys, particularly along the lower reaches of the larger streams, contains ground-water bodies in the permeable members. These waters are recharged by direct accumulation of water from precipitation, by infiltration of surface runoff from adjacent slopes, and—during periods of high river stage—by infiltration from the main streams and their tributaries (fig. 18). The slope of the water table is usually downstream or diagonally toward the stream channel. The ground-water bodies are largely tributary to, and in balance with, the river water. Thus the ground-water level commonly fluctuates with the river stages.

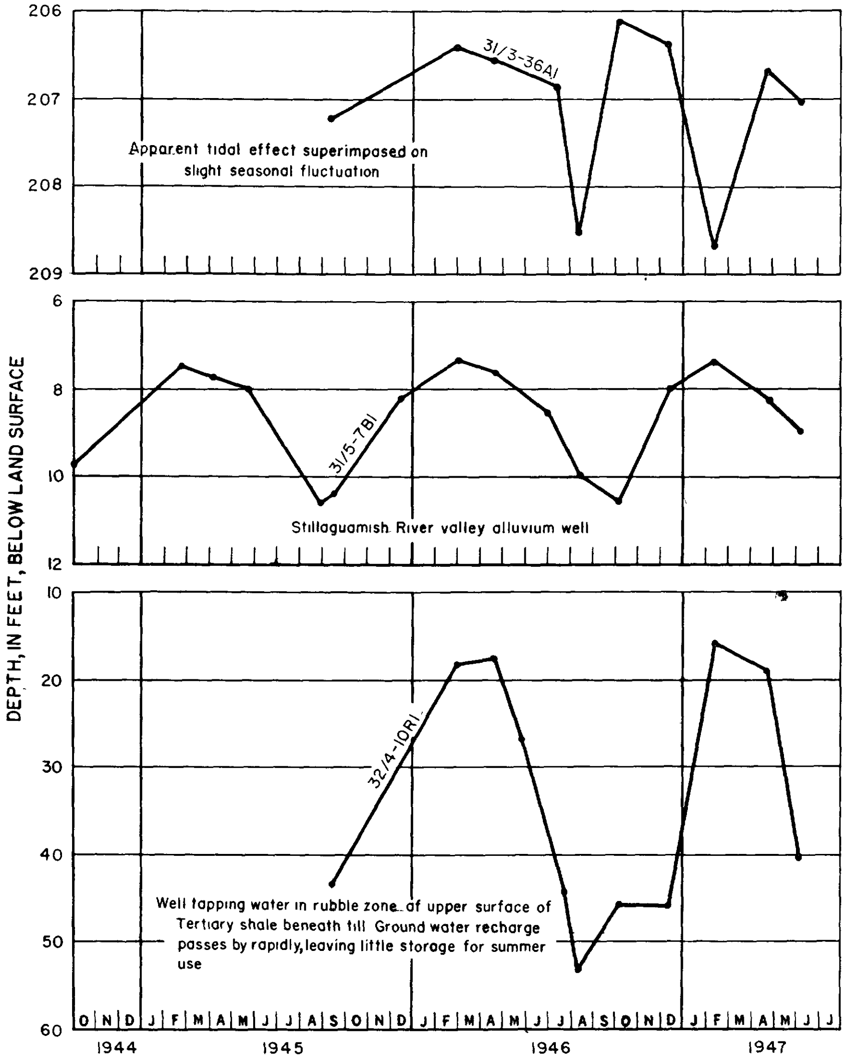

FIGURE 18.—Fluctuations of the water level in two wells in Snohomish County, Wash., that have special features of replenishment and response.

The lower estuarine courses of the Snohomish and Stillaguamish Rivers are deep troughs filled with sediments, of which at least the upper 100 ft is alluvial fill of postglacial age. In this and the lower fill are many sand and gravel strata carrying ground water in a more or less trapped or stagnant condition. Though their recharge must be by devious routes of percolation, or even from the adjacent fine-grained material, in most places these ground-water bodies show a dampened response to the fluctuations of river stage.

DISTRIBUTION OF AQUIFERS IN THE COUNTY

The Intercity and Tulalip plateau blocks and the northwestern part of the Getchell Hill block are largely underlain by the Esperance sand member. As has been pointed out, this is probably the most widespread and most important source of ground water in Snohomish County, at least under the plateaus. Below the till in the valley of the Skykomish River the Pilchuck clay member or relatively coarse-grained strata of the Admiralty clay are present. The Pilchuck clay member has been tapped by wells with generally satisfactory yields except where too much clay is interbedded with the sand and gravel layers, but it has not been explored by drilling in the area where it occurs most extensively. In general the Admiralty clay is an unlikely source of supply for wells of more than small capacity, but it is possible that certain coarse-grained strata now providing water for the city of Monroe may belong to the Admiralty. On the northwest slope of the Cedarhome plateau, in the Bryant area and the district north of Lake Stevens, and in many other places, unnamed sub-till sand and gravel strata yield ground water, usually in small amounts. In the river valleys ground water occurs in the alluvial deposits of the valley flood plains, in the outwash gravels that line the sides of many of the valleys, and in strata below the till where those strata pass beneath the valley-fill materials, as they do in the vicinity of well 30/6-10J1.

AREAS DEFICIENT IN GROUND WATER

In some districts little or no ground water has been found below the soil zones. Areas in which such deficiency is common include (1) the northeast part of the Cedarhome plateau northeast of U. S. Highway 99, where the till lies directly on Tertiary shales or on clays that in turn lie upon the Tertiary; (2) the Cathcart district and (3) the northeast part of the Getchell Hill plateau, where a similar subsurface succession exists in some areas; (4) the East Stanwood hill area, over most of which till of the Vashon glaciation lies directly on the Admiralty clay and fine-grained material of the Pilchuck clay member; (5) the north side of the Lake Stevens area, where the till lies on the

Admiralty clay and the Pilchuck clay member and only a thin sub-till sand is commonly present; and (6) the Alderwood Manor-Sammamish River district, where the normal sandy interval between the till mantle above and the Admiralty clay below is largely taken up by silt or fine sand.

In developing ground-water supplies in such water-deficient areas, all available surface and subsurface geologic and hydrologic information should be considered, and test drilling should be done where necessary to supplement the existing data. In many places where the till mantles the surface, only test holes can establish the presence or absence of an adequate water supply in the sands or gravels that customarily underlie the till. At Lake Stevens, for example, two wells obtained only meager yields from fine-grained sub-till sands before a third found a sufficient thickness of clean gravel. At least eight inadequate wells have been drilled on the East Stanwood hill; one beneath the terrace land east of Stanwood hill (32/4–20L1) found water in a sub-till gravel that may be the continuation of the gravel bed exposed beneath the westward-sloping till in the river bluffs three-quarters of a mile east of Woodland School.

ARTESIAN CONDITIONS

Both flowing and nonflowing artesian water occur at a few places in Snohomish County. Hydrologists in general, including those of the Geological Survey, use "artesian" to mean any confined ground water, although most dictionaries still use the old designation of ground water that flows to the surface. In the Elder Lake district of the North Creek valley, shallow wells tap water under slight pressure in the Esperance sand member either beneath a clayey alluvial cover or beneath remnants of the till, which slopes down into the valley.

In the vicinity of Roosevelt Corners, northwest of Monroe, wells that pass through the thick clay deposit of the older alluvium reach confined water in the glacial-outwash gravels beneath. Apparently these gravels are the continuation of the gravel train that occurs at the surface along the creek valley on the upland to the north. The gravels pass under the valley-clay blanket at an altitude of about 100 ft. Wells that tap this artesian aquifer (28/6–22J1, 28/6–27H1, and others) have static levels 45 to 55 ft above sea level and show an annual water-level fluctuation of 2 ft or more in close agreement with the rainfall cycle (fig. 19).

At the northwestern end of the Getchell Hill plateau a few wells (31/5–10J1, 31/5–10J2, 31/5–10J3, and others) tap confined water in sand beneath 60 ft or more of a hard confining layer, which has been variously reported as clay or hardpan and which may in fact be the till of the Vashon glaciation. Possibly the confining layer, if it is

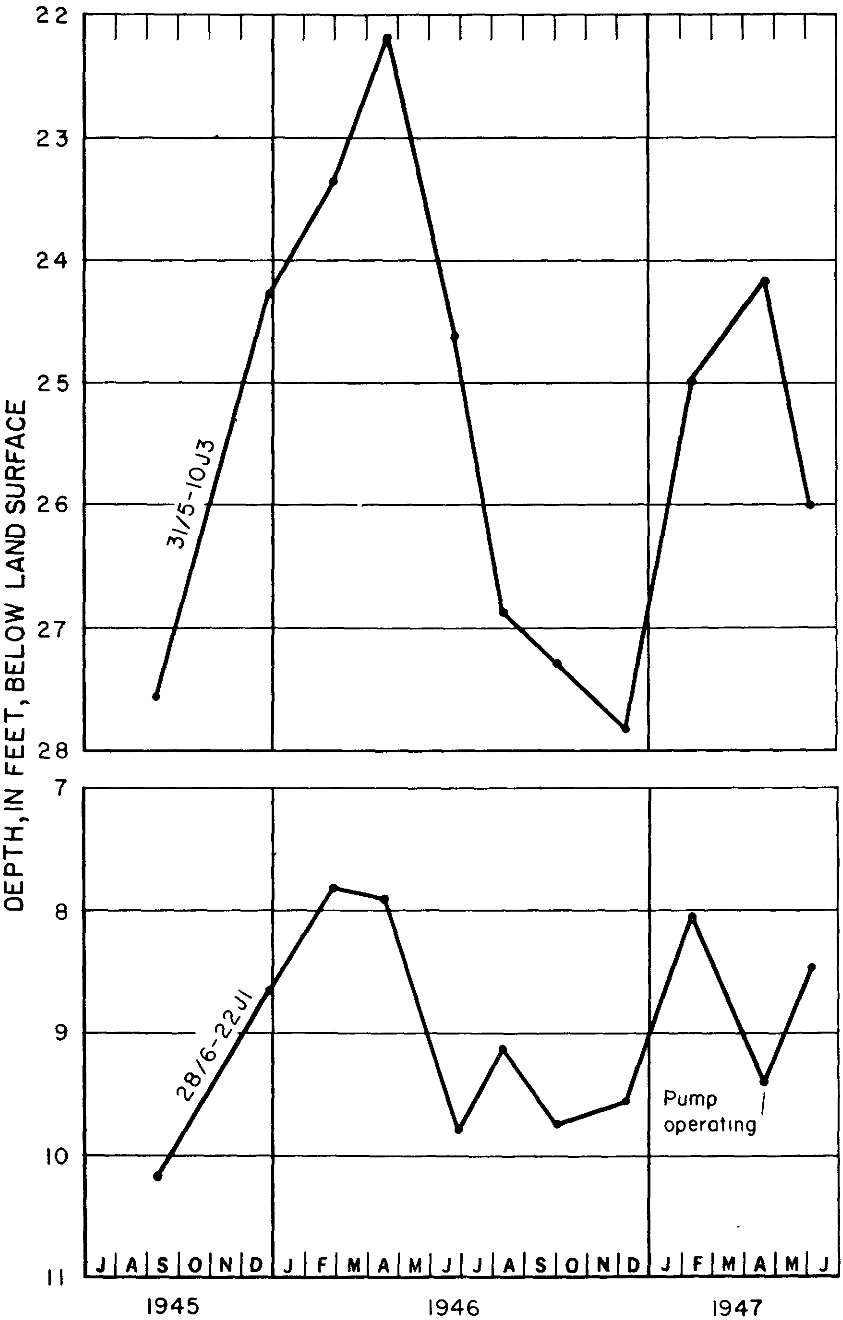

FIGURE 19.—Fluctuations of the water level in two wells in Snohomish County, Wash., tapping confined ground water.

the till, there slopes north in buried continuation of its slope from the Getchell Hill plateau.

The till of the Vashon glaciation slopes into the principal valleys and may function as a confining layer beneath the swales. The sloping till blanket at the northwest side of the Pilchuck Valley north of Lochloy may direct some confined water beneath the floor of the Pilchuck Valley. The thick till mantle along the steep western side of the Marysville trough may confine important supplies of ground water. Wells 29/6–7D2 and 29/6–7D3 tap nonflowing artesian water beneath the till in the swale north of Lake Stevens.

There is a common rumor that the Lake Goodwin oil test well in the SW¼ sec. 22, T. 31 N., R. 4 E., penetrated an artesian aquifer yielding flowing water at a depth of about 365 ft. In view of the generally horizontal nature of the Esperance sand member and the relative isolation of the shallower earth formations of the Tulalip plateau, it seems more probable that a good fresh-water gravel may have been encountered at that depth and that the evidence of water, as shown by the thinning of the circulating mud or by the possible loss of mud circulation, led mistakenly to the artesian-water rumor. At least one subsequent attempt has been made to drill for this "artesian" water, but the well found adequate water (unconfined) at a lesser depth in the Esperance sand member and was not continued.

CHEMICAL CHARACTER OF THE GROUND WATER

The ground waters of the county in general are low in dissolved mineral matter, soft to only moderately hard, and free from color or odor.

In studying the chemical character of the waters in the area, 10 relatively complete chemical analyses were available for representative ground-water samples (table 5). About 50 additional samples were analyzed for hardness by field methods, and about 18 more were analyzed for hardness and chloride content (table 4, column 14). Five samples were analyzed mainly for iron content (table 2).

HARDNESS

Based on field determinations, the hardest water encountered, with a hardness of 150 ppm, was from well 29/6–22J1, which taps artesian water in glacial-outwash gravels. The water from well 29/6–7J1, which draws water from a silty sand layer of the Admiralty clay, was the softest, having a hardness of 15 ppm. Though the composition varies from well to well, in general the water from the alluvial materials of the upland valleys has a hardness of about 40 to 50 ppm, that from alluvial flood-plain materials in the lower parts of the valleys and from the soil zone of the till an average of about 50 ppm, that from the Esperance sand member and unnamed sub-till sands an average of about 100 ppm, and that from the Admiralty clay an average of about 25 ppm. Waters in the recessional outwash gravels are not uniform in hardness but are generally the hardest of all.

SALINITY

All but two chloride (salinity) contents determined were relatively low. Water from the alluvial materials in the seaward part of the Snohomish and Stillaguamish River flood plains commonly carries high concentrations of salt (sodium chloride), and water from the Esperance sand member and other sands exposed at sea level near Everett and along the Tulalip shore north of Hermosa Point shows small amounts of saline contamination. In most well waters, however, the chloride content is only 5 to 10 ppm. Waters carrying more than 15 ppm of chloride may be suspected of having some extraneous source of salt. Though this amount still is far below the upper limit for potability, it exceeds the average chloride content of the waters in the area.

The Snohomish flood plain below Marshland School and the Stillaguamish flood plain and delta below Silvana have been generally considered to afford only brackish well water. However, some wells in those areas yield fresh water having a chloride content well within the desirable limits for a good household water supply. It is possible that peaty solutions and iron-bearing waters from this area have in past times been reported as "brackish" and that the extent of saline contamination has been exaggerated. Though it is established that some sand and gravel beds in the alluvial fill of these areas carry saline water, it is possible that careful test drilling and well construction may develop many supplies of fresh, potable water in the lower flood plains of these two principal rivers.

The small amounts of contamination in the ground-water bodies along the Tulalip shore are probably due to intermixing with sea water, with which these ground-water bodies are in hydraulic balance. Overpumping in these areas may draw sea water into the wells.

GASEOUS COMPOUNDS

Water from wells in the fine-grained Admiralty (?) clay beneath the valley of North Creek and Skykomish Valley contains undesirable amounts of gas, reportedly both methane and hydrogen sulfide. Also, wells in the Tertiary sedimentary rocks in some places have been abandoned because of the sulfurous odor in even the small amounts of water that could be developed. Such gases, however, can probably be removed by aeration. Generally wells need not be abandoned because they yield gaseous water that is otherwise of satisfactory quality.

IRON

Iron is the most common objectionable constituent in the ground waters of Snohomish County. Much of the alluvium of the stream valleys and the glacial outwash and some of the glacial till carry water containing excessive amounts of iron. This high iron content is especially prevalent where peaty or boggy soils are present. The Stillaguamish Valley below Arlington, the Marysville trough, and the Snohomish and Skykomish Valleys below Monroe—some of the richest lands in the county—are areas where the ground waters contain excessive amounts of iron.

IRON CONTENT

Generally the iron content in the ground water decreases progressively with depth, but it can be avoided in few places in the alluvial materials. The iron content of water differs from place to place within the iron-bearing areas, but the iron waters are almost universally present in areas underlain by peaty alluvial materials.

The iron probably occurs in the water principally as the bicarbonate. The waters are slightly acid generally, and some are reported to be strongly corrosive. The iron is oxidized and precipitates from solution on contact with the air, and usually only about 0.10 to 0.30 ppm remains in solution after a short contact with the air. The total dissolved iron content is as high as 9 ppm in many well waters. Aerobic bacteria (for example, *Crenothrix*) often take hold and thrive in these waters where air has access. The bacteria extract the iron in order to build their hairlike iron hydroxide sheaths; wells, cisterns, reservoirs, and water pipes may become the habitat of great masses of furry *Crenothrix* accumulations. The decay of these organisms may cause disagreeable tastes and odors in the water, especially during warm weather.

Water containing iron in excess of 0.10 ppm is considered undesirable for household use because it may stain clothes and utensils.

IRON-REMOVAL PRACTICES

People dependent upon ground water with a high iron content have sought to purify it in several ways. Among the cruder devices is the charcoal and gravel "filter barrel" that is in common use at many farms. Some commercial devices have been used and some elaborate filters have been built for the removal of iron. One of the most efficient of these devices seen during the present investigation is that built by Andrew J. Strotz to treat the water of well 31/5–7H1. It consists of a concrete cistern, 10 ft long, 6 ft wide, and about 6 ft deep, divided by a baffle, at the bottom of which pipes connect the two halves. One half of the cistern is a filter, the material grading upward from gravel to sand. Charcoal interlayers are bedded in the filter. The well water pumped onto the filter side drops nearly all its iron on the first filter layer, which is a changeable sand tray. From the other half of the reservoir, a second pump delivers the water to the house pressure system. The purified water has an iron content below the amount that normally stains cloth and utensils; however, it has a flattish taste that could be improved by aeration after filtration. It is probable that a layer of crushed marble or limestone in the filter or the addition of lime would reduce the acidity and improve the purified product, as iron generally precipitates more readily from the alkaline solution. Filters built in this manner should provide aeration by allowing the water to trickle through the filter in the presence of air. Mr. Strotz's filter undoubtedly loses some of its efficiency because it operates under water.

Table 2 shows the effect of iron-removal processes on waters reported to contain iron.

TABLE 2.—*Iron content and acidity of five samples of ground water, reported to contain iron, from Snohomish County, Wash., and the effect of iron-removal processes on three of the samples*

[All samples taken Dec. 9, 1946. Analyses by U. S. Geological Survey]

Well No.	Iron-removal process	Specific conductance (K x 10⁵ at 25° C.)		Fe (ppm)		pH	
		Raw	Treated	Raw	Treated	Raw	Treated
32/4-33F1	Commercial device	21.4	30.3	3.9	0.10	6.6	7.0
31/5-7E1	Charcoal barrel	28.7	26.4	.45	.15	7.0	7.0
31/5-7H1	Improvised filter	23.4	29.4	6.4	.12	6.9	6.5
31/5-27M1		16.0		.11		6.2	
31/5-32R1		16.3		.03		6.3	

IRON-BEARING WATER FOR IRRIGATION

Waters of high iron content are suitable for use in irrigation if the acidity of the water is not too great. The iron accumulation in the soil ordinarily will not be great enough to affect fertility. Acid waters, however, might aggravate any acid condition already existent in the soil. Acidity determinations of the water and soil should be made, and their combined effects on the crops to be grown should be appraised as a precaution before strongly acid iron-bearing waters are used for irrigation.

USE OF GROUND WATER

The utilization of ground water is largely confined to the western, lowland section of the county. Here it is used for domestic and municipal supply, irrigation, industry, commercial fish propagation, and other purposes.

DOMESTIC SUPPLY

The use of ground water for the home or farmstead is most common on the hill lands of the coastal plateaus. South of Everett most houses on the Intercity plateau are now connected with the Everett or Seattle water systems, but elsewhere ground water is used more than surface water for domestic purposes. In the areas of saline and iron-bearing ground waters in the lower valleys of the Snohomish and Stillaguamish Rivers, many farmsteads are served by spring or creek water brought by pipeline from the adjacent bluffs.

Shallow dug wells outnumber drilled wells by 10 or 20 to 1 as a source of ground-water supply for household use in most of western Snohomish County. In the Marysville trough, dug wells predominate nearly to the exclusion of drilled wells.

From a reconnaissance of the wells and springs of the county, it is estimated that 20,000 shallow wells and springs are in use for household or farmstead supply, at the estimated over-all average rate of 200 gal per day. Two hundred drilled wells furnish an average of 500 gal per day for similar purposes. Thus, outside the corporate limits of cities and towns, about 4 million gallons of ground water is used each day for domestic purposes.

MUNICIPAL SUPPLY

All the larger incorporated settlements in the county, except Everett and Snohomish, use ground water. Everett conducts surface water from the Sultan River, and Snohomish derives a surface-water supply from the Pilchuck River above Machias. The remaining communities draw about 5 million gallons of ground water per day.

Table 3 shows the water consumption of the principal communities using ground water.

TABLE 3.—*Water consumption of the principal communities in Snohomish County, Wash., using ground water*

Municipality	Source of supply	Average consumption (gallons per day) [1]		Number of customer connections	Remarks (as of 1946)
		Maximum	Minimum		
Arlington	Well	500,000	420,000	700	Supply adequate.
Beverly Park	Wells (3)	300,000	250,000	1,200	Do.
Edmonds	Wells (7), spring.	576,000	400,000	800	Do.
Granite Falls	Wells (2)	175,000	76,000	250	Do.
Lake Stevens Public Utilities District.	Wells (2)	[2] 500,000		[2] 500	Supply adequate. System under construction.
Marysville	Spring, well.	1,400,000	750,000	700	Supply adequate.
Monroe	Wells (4)	[2] 1,500,000	[2] 750,000	750	Supply adequate. Third of water goes to reformatory.
Pinehurst	Wells (2)		180,000	512	Supply adequate.
Silvana	Spring	15,000		30	Supply in excess of need. Conduit inadequate.
Stanwood	Springs (2)	720,000	360,000	535	Supply inadequate in summer; to be augmented by wells.
Sultan	Spring	500,000	240,000	344	Supply adequate, large excess.
Total		6,136,000	3,426,000	6,321	

[1] Reported (for 1946) by officials of the water departments concerned.
[2] Figure is approximate.

INDUSTRY

The industrial use of ground water is largely centered around the municipal areas. Pulp mills, canneries, creameries, ice plants, lumber mills, and food-processing plants are among the largest users. The Soundview pulp mill at Everett, pumping some 2 million gallons per day for its acid-solution make-up—for which the even-temperatured ground water is especially suitable—is the largest single industrial user. About 5 million gallons per day is the estimated average withdrawal of ground water for purely industrial uses within the county.

FISH PROPAGATION

Spring-water discharge is being used increasingly for food-fish propagation. The even temperature, the lack of fish-disease organisms, and the relative freedom from the legal restrictions that prevail on streams that have been used naturally by game fish all favor the use of ground water for this purpose.

IRRIGATION

A great potential use for ground water is in supplemental irrigation. The consensus among agriculturalists is that the proper addition of about a foot of water in irrigation will double the yield of summer and fall field crops and will increase pasturage crops by a considerably larger amount.

At present the use of ground water for the irrigation of other than small garden plots is estimated to be about 2,000 acre-ft of water per year for about 2,000 acres of land. Much of the irrigated land is in the Snohomish-Monroe area and in the Marysville trough. There is some irrigation of pasturage on the till-mantled plateau lands. A large increase in the use of ground water for this purpose can be expected in the future.

In many areas in which an economical supply of surface water is lacking, any supply for irrigation must be derived from ground water. In this respect the Marysville trough and the central valleys of the main rivers are fortunate in having a plentiful supply of ground water at relatively shallow depths. On the higher lands the supply is not so plentiful, but in many places adequate water is known to be available for use. Such areas as the outwash terraces east of Arlington and those west of Bryant, the till uplands of the Intercity plateau block north of Alderwood Manor, and the Tulalip plateau block in the Lake Goodwin vicinity all have ground-water supplies available for use in irrigation. Probably the cost of deep wells large enough to develop the desired capacity and of deep-well pumps for large-capacity installations has been a deterrent in the development of these sub-till ground-water bodies for large-scale irrigation.

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DEPENDABILITY OF THE GROUND-WATER SUPPLY

PAST

Though a decline in the level of the ground water has been noted at times in several places within the county, no instance is known of serious permanent depletion of any of the ground-water bodies. The 10-ft decline of the water level in the Esperance sand member throughout the Seattle Heights district during the years 1920–30 was apparently due to a protracted deficiency in precipitation. The decline of artesian-pressure head in the Arlington and Roosevelt Corners districts apparently is only the normal difference between the original head of a newly developed artesian aquifer and the lower level accompanying sustained withdrawals. There was reported to have been a 10-ft decline in the level of the ground water of the Esperance sand member in the Beverly Park area during the late 1930's and early 1940's, but probably this reported lowering was an effect of the concentrated pumping in that vicinity, where 700 or 800 gpm is withdrawn from an area only about 1,200 ft in diameter.

Records of ground-water levels consist of a few substantiated reports for earlier years and the measurements started in 1944 and 1945 at the time of this investigation. The measurements made during the investigation are given in part in figures 15 to 19. All are published in Water-Supply Paper 990 and later publications of the Geological Survey.

FUTURE

Though long-term records are not available, theoretical deductions based on the nature of the aquifers as regards shape, continuity, permeability, and opportunity for recharge may, along with the short-term records available, be used as a basis for judgment of the expected pumping effects.

Generally the small aquifers in the Admiralty clay can be expected to show relatively quick depletion with only small withdrawals. this is due to the low permeability and the thinness of the water-bearing strata in the Admiralty. The yield of well 29/6–8F4, for example, after only a few weeks' use declined from 80 to only 30 or 35 gpm after 12 hr of pumping each day.

The Esperance sand member (and the comparable sub-till deposit of sand and gravel at some places where the Esperance has not been identified) is only lightly developed except in the Beverly Park district. No instances of perennial depletion have been noted. However, though a great deal of water is in storage in this aquifer, and though the many small or medium-sized pumping plants have not depleted the supply, any proposed large withdrawals should be planned with care to avert local overdraft. Natural hydraulic gradients of 25 to 100 ft per mile convey this water at present to its marginal discharge areas. Similar gradients imposed by pumping would, in at least some places, reverse the natural gradient. Thus such withdrawals would salvage a great deal of water otherwise discharged by natural flow from the Esperance sand member.

The ground-water bodies in the recessional outwash deposits, and to a certain extent in the surficial Recent alluvium, differ from the aforementioned aquifers of the Esperance sand member and the Admiralty clay by the directness of their recharge. Whereas the outwash and alluvium are largely recharged directly by precipitation, the older units receive their recharge more or less indirectly, as described previously. The younger deposits consequently are recharged each year to the point of rejecting additional water, or to the point where the outflow increases enough to dispose of all the water. They may receive as much as 12 or 15 in. of accepted recharge (perhaps half the rain), as compared with the 2 or 3 in. of water that is calculated to be the average annual increment to the Esperance sand member and other sub-till sands. Thus the coarse recessional outwash deposits, such as the gravel trains and terraces of the major river valleys (the Pilchuck Valley, the Marysville trough, and Arlington Heights), and the alluvial deposits of the river valleys (Monroe alluvial valley floor, Stillaguamish Valley above Silvana) are potential sources of comparatively large perennial water supplies. The sub-till strata are potential sources of somewhat smaller perennial supplies, but, where adequate provision is made to salvage natural discharge, rather large perennial supplies can be obtained.

WELL CONSTRUCTION

At present there are four well-drilling companies or individual well drillers regularly operating in the county. In addition, several companies in the Seattle area include this county within their drilling area. At the present time some 15 to 20 wells are being drilled each year and the water-well drilling business in the county approaches $100,000 annually.

Almost all the drilling is done by percussion machines. Rotary machines have been considered less adaptable to this region because of (1) a belief that they are not capable of a sensitive determination of thin water-bearing sands and (2) the difficulty, frequently reported, of penetrating the bouldery phases of the glacial till. However, there is no reason why rotary machines should not be fully adaptable to drilling in the alluvial deposits, the Admiralty clay and similar materials, and all but the most bouldery glacial deposits.

The customary prewar price for well drilling was $1 per foot per inch of diameter and included standard steel well casing. The cost of screens or perforations was commonly added to the footage charge. Since the war the price has risen. The footage rate has been increased in some cases, moving charges have been made, or daily rental charges have been added for time when drilling was not under way.

There is one regular well-digging firm in the county, and in adjacent areas there are two others that dig wells in this county. Many of the dug wells are constructed by the owners themselves. The wells dug in the till do not ordinarily require any lining other than surface curbing. Those in outwash or alluvial materials—some of them dug by water jetting—are usually lined with concrete culvert pipe 3 or 4 ft in diameter.

WELL AND SPRING RECORDS

As shown in table 4, the depths of most wells are based on reports by the owners or drillers, because few wells can be entered for measurement. Those depths shown to the nearest tenth of a foot were sounded by the Geological Survey. The depths shown with plus-or-minus signs (±) were estimated or were based on reports that may not be authentic.

Water levels are expressed in feet below a land-surface datum, a plane of precise reference at each well that coincides with the general level of the land immediately adjacent. Those levels given to the nearest whole foot and not followed by plus-or-minus signs are reported and are considered dependable within a few feet. Those followed by plus-or-minus signs are approximate or estimated.

The statements on the occurrence of the ground water at each well (table 4, column 9D) have been interpreted from the record on that particular well and may seem to involve some inconsistencies; for example, in the case of certain wells that tap a regional body of unconfined water, the occurrence may be listed as "confined" because local bodies of clay or silt excluded water from the well until it extended some depth below the normal water-table level of the vicinity.

Except in those wells for which logs are given on page 57, the character of the water-bearing material (table 4, column 9C) is largely that reported by the owner. Although this is usually a well-known feature of each well and the data are considered largely authentic, there probably are some discrepancies. Such discrepancies are most likely with respect to shallow wells that derive water from streaks of sand and gravel in or close to the glacial till.

The data on the capacity of the pump (table 4, column 12) are necessarily approximate. They do not show the ultimate yields of the wells, some of which have potential capacities much greater than the current rate of use.

In all, about 800 wells were examined, 690 of which are described in the tables. The wells range in depth from 5 to 1,545 ft, but most of them are less than 200 ft deep. Only six wells are more than 500 ft deep, and only one is more than 1,000 ft deep. The diameters of the wells range from 1¼ in., in the shallow driven wells on the river flood plains, to 25 ft, in the municipal dug wells at Monroe. The casing is commonly 6 in. in diameter in the drilled wells of the upland areas and 3 to 6 ft in diameter in the dug wells. The casings of the drilled wells are mainly steel drive pipe, with a perforated or screened section at or near the bottom. Most wells dug in glacial till are lined only through the soil zone, but dug wells that penetrate glacial outwash or valley alluvium commonly are lined to the bottom with masonry or timber.

Here follow the logs of representative wells in Snohomish County. Table 4, which will be found at the end of this section, gives pertinent data on these and other wells in the county; table 5, chemical analyses of water from Snohomish County wells and springs; and table 6, information on typical perennial springs in the area.

Logs of representative wells in Snohomish County, Wash.

[Stratigraphic designations by R. C. Newcomb]

Well 27/3-24Q1, City of Edmonds

[About 400 ft east of 9th Avenue and 50 ft south of Main Street. Altitude about 225 ft. Drilled by N. C. Jannsen Drilling Co., 1929. Casing set to bottom; later plugged at 48 ft and perforated]

	Thickness (feet)	Depth (feet)
Clay	2	2
Esperance sand member:		
Sand	4	6
Gravel	2	8
Sand	2	10
Sand and gravel; boulder at 17 ft	10	20
Boulders	1	21
Gravel	7	28
Sand and gravel	2	30
Sand	18	48
Admiralty clay:		
Clay, blue	29	77
Sand, water-bearing	3	80
Clay, blue and soft, with layers of fine sand	15	95
Shale or clay, gritty	38	133
"Shale," hard	5	138
"Shale"	18	156
"Sandstone," hard	2	158
Clay	8	166
"Shale"	14	180
"Sandstone"	34	214
Silt, black	2	216
"Sandstone," fine and light-colored	14	230
"Sandstone" and "shale" (interlaminated?)	16	246
Wood, rotten	2	248
Admiralty clay—Con.		
"Shale," sandy	27	275
Wood and black shale	5	280
"Shale" and sand	14	294
Sand, coarse and hard, with some gravel	14	308
Boulders, cemented	16	324
Uncorrelated:		
Sand, hard	18	342
"Sandstone"	98	440
Clay, blue	3	443
"Sandstone," with thin streaks of "shale"	61	504
"Sandstone"	2	506
Clay, blue	25	531
"Sandstone," hard	17	548
Clay, blue, with streaks of "sandstone"	92	640
Clay, blue	21	661
"Sandstone"	2	663
Clay, blue	33	696
Sand and gravel	2	698
"Clay" and "shell" (shale with sandstone layers?)	51	749
Clay, blue and sticky	116	865
Clay, blue and sandy	67	932
Sand, packed, dry	10	942
Clay, blue and sticky	30	972
Clay, blue and sandy	20	992

Logs of representative wells in Snohomish County, Wash.—Continued

Well 27/3-24Q2, City of Edmonds

[Approximately 60 ft west of 10th Avenue and 60 ft south of Maple Street. Altitude about 280 ft. Drilled by N. C. Jannsen Drilling Co. about 1929]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Esperance sand member:			Admiralty clay—Con.		
Sand (dug for "cellar")	18	18	Boulders, with clay and hard sand (embedded log)	13	341
Sand, "shot" with gravel	57	75	Clay, with much wood	1	342
Sand and gravel; water at 78 ft	5	80	Clay, with streak of hard sand	3	345
Quicksand	15	95	Clay and wood	15	360
Sand	15	110	Not reported	3	363
Admiralty clay:			Clay with rotten wood	10	373
Clay, blue, or shale	2	112	Not reported	10	383
Sand	21	133	Uncorrelated:		
Clay, blue, or shale	4	137	Sandstone, hard	3	386
Sand, with some clay	9	146	Not reported	1	387
Clay, blue, or shale	138	284	"Gravel," very hard and cemented	3	390
Sand, hard	21	305			
Sand, hard, with some gravel	23	328			

Well 27/3-24Q4, City of Edmonds

About 60 ft west of 10th Avenue and 100 ft south of Maple Street. Altitude about 285 ft. Drilled by C. E. Crary, 1931. Ten-inch casing set to 98-ft depth; 30-mesh screen, 83 to 98 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	2	2	Esperance sand member:		
			Sand with pebble gravel	96	98
			Silt and clay	2	100

Well 27/3-24Q5, City of Edmonds

[About 400 ft east of 9th Avenue and 70 ft south of Main Street in concrete pump house. Altitude about 225 ft. Drilled by C. E. Crary, 1931. Twelve-inch casing set to 48 ft; perforations, 28 to 48 ft]

Soil	2	2	Esperance sand member:		
			Sand with pebble gravel	46	48
			Silt	2	50

Well 27/4-5Q1, P. M. Rushmore

[Approximately 0.5 mile east of Meadowdale. Altitude about 450 ft. Dug in 1925]

Soil	4	4	Esperance sand member—Con.		
Till of the Vashon glaciation:			Gravel, clean	6	156
"Hardpan"	96	100	Sand, water-bearing	51	207
Esperance sand member:			Sand, gravel, and blue clay	(?)	--------
Sand	50	150			

Well 27/4-9D1, Mrs. G. S. Blethen

About 400 ft north of Meadowdale road and 0.75 mile west of U. S. Highway 99. Altitude about 450 ft. Drilled by N. C. Jannsen Drilling Co., 1936. Eight-inch casing; set to 88 ft; 6-in., to 123 ft]

Old well; no record of materials	67	67	Esperance sand member—Con.		
Esperance sand member:			Gravel, fine, and sand	8	111
Gravel, clay, and cobbles	10	77	Gravel, coarse, and sand, water-bearing	9	120
Sand and fine gravel	11	88	Sand, coarse	15	135
Sand, water-bearing	15	103			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 24/4-15F1, Jennie Hunter

[Approximately 0.7 mile north of Alderwood Manor. Altitude about 515 ft. Bored in 1909. Ten-inch casing set to 113 ft; open at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Esperance sand member:		
"Hardpan"	25	25	Sand, gray, medium to coarse, water-bearing	95	120
			"Hardpan" (clay?)	4	124
			Gravel	(?)	--------

Well 27/4-23F1, Fred Hall

[Approximately 2.75 miles north of south boundary of county, 0.5 mile west of Swamp Creek. Altitude about 405 ft. Drilled by N. C. Jannsen Drilling Co., 1930]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Esperance sand member:		
Not reported	8	8	Gravel and sand; water bearing at 74 ft	11	75
Boulders, "granitic"	13	21	Sand	10	85
Boulders and "hardpan"	27	48	Sand, red	12	97
Boulders	12	60	Not reported; water at 98 ft	4	101
"Shale"	4	64			

Well 27/4-30K1, S. S. Atwood

[Approximately 0.2 mile northwest of Esperance School. Altitude about 400 ft. Dug in 1915]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Esperance sand member:		
Soil, gravelly, with organic material	4½	4½	Sand, firm	59	90
"Hardpan"	26½	31	Sand, caving; saturated below 121 ft	43	133

Well 27/4-32K1, Nile Temple Country Club

[Approximately 0.4 mile north of county boundary and 0.35 mile east of U. S. Highway 99. Altitude about 345 ft. Drilled by N. C. Jannsen Drilling Co., 1930]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till and associated deposits:			Esperance sand member—Con.		
Boulders and gravel; water at 10 ft	15	15	Sand, hard	8	118
Esperance sand member:			Sand, hard, and some gravel; some water at 120 ft	5	123
Sand and gravel	27	42	Sand and gravel, cemented	7	130
Clay, blue	23	65	Sand and gravel, water-bearing	5	135
Clay, red, with gravel	8	73	Clay	15	150
Clay, blue, with streaks of "shale" (silt?)	24	97			
Clay, blue, with "shale" (silt?)	13	110			

Well 27/5-1R1, Cathcart School District

[In schoolyard. Altitude about 250 ft. Drilled by C. E. Miller, 1939]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium: Clay	30	30	Undifferentiated Tertiary (?) rocks: "Rock," blue (volcanic tuff or shale), with marine fossils; water bearing from 140 to 150 ft	120	150

Well 27/5-4D1, Tri-Way Grange No. 1093

[At road junction 0.5 mile south of Thomas Lake. Altitude about 430 ft. Drilled by C. D. Marks, 1929. Six-inch casing set from 35 to 70 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Dug well; material not reported	47	47	Esperance sand member:		
			Sand, cemented	4	51
			Sand and fine gravel	13	64
			Sand, with fine to coarse gravel	6	70

Logs of representative wells in Snohomish County, Wash.—Continued

Well 27/5-12J1, M. S. Dunlap

[About 0.5 mile south of Cathcart School. Altitude about 355 ft. Drilled by C. E. Miller, 1939. Six-inch casing set to 70-ft depth; screen at bottom]

	Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	60	60
Advance outwash of the Vashon glaciation: Gravel, water-bearing	10	70
Undifferentiated Tertiary or pre-Tertiary crystalline rocks:		
"Hard rock," tough and blue (igneous?)	210	280
"Mud," blue (shale or tuff?)	20	300

Well 27/5-13L1, A. D. Crow

[About 1.25 miles north of Maltby, along west side of Cathcart road. Altitude about 450 ft. Drilled by C. E. Miller, 1943. Six-inch casing set to 160 ft; bottom 3 ft perforated]

	Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:		
Soil	24	24
"Hardpan"	31	55
Esperance sand member:		
"Sandstone," dark-gray and fine-grained	23	78
Sand, gravelly, tight	34	112
Esperance sand member—Con.		
Sand, fine, water-bearing	10	122
Sand, medium, water-bearing	16	138
Peat or lignite	2	140
Sand, coarse; grades to coarse gravel in lower part; water bearing	21	161

Well 27/5-21M1, Rex Smith

[About 1.5 miles east of Elder Lake and south of road junction. Altitude about 410 ft. Drilled by D. K. Shilling, 1944. Six-inch casing set to 139 ft; screen at bottom]

	Thickness (feet)	Depth (feet)
Till (?) of the Vashon glaciation:		
"Hardpan"	120	120
Clay, blue	10	130
Esperance sand member: Gravel, water-bearing	9	139

Well 27/5-24Q1, D. J. Charrier

[About 0.3 mile east of Maltby Station, on crest of hill. Altitude about 465 ft. Drilled by C. E. Miller, 1939. Six-inch casing set to 124 ft; screen at bottom]

	Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	60	60
Esperance sand member:		
Sand, "crusted"	60	120
Gravel, water-bearing	4	124

Well 27/5-26R1, E. H. Tuggle

[About 1 mile southwest of Maltby Station. Altitude about 450 ft. Drilled by Wilson, 1939]

	Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	43	43
Esperance sand member:		
Sand	90	133
Gravel	11	144

Well 27/5-32R1, L. J. Mitchell

[About 1 mile northeast of Bothell, in valley of North Creek. Altitude about 50 ft. Drilled by J. J. Bell]

	Thickness (feet)	Depth (feet)
Alluvium:		
Clay, brown	15	15
Sand and gravel, water-bearing	8	23
Admiralty clay:		
Clay, sandy, blue	27	60
Clay, blue, fat	146	206
"Sandstone," blue	11	217
Admiralty clay—Con.		
Sand, silty and blue, with clay (laminated?); water bearing	24	241
Clay, blue	4	245
Sand and clay, laminated	175	420
Clay, blue and fat	78	498

Logs of representative wells in Snohomish County, Wash.—Continued

Well 27/5-35E1, Ray Butler

[About 0.4 mile north of road junction east of highway. Altitude about 150 ft. Drilled by D. K. Shilling 1944]

	Thickness (feet)	Depth (feet)
Alluvium and till of the Vashon glaciation (?): Soil and sand, gravelly	35	35
Admiralty clay:		
Clay, blue	45	80
Gravel, water-bearing	5	85
Clay, blue	(?)	

Well 27/5-35P1, Wellington Hills Country Club

[At club buildings about 0.6 mile east of road junction at Grace. Altitude about 360 ft. Drilled by N. C. Jannsen Drilling Co., 1931. Eight-inch casing set from 4 to 142 ft]

Dug well; no record of material	105	105
Esperance sand member:		
Sand, brown	10	115
Esperance sand member—Con.		
Sand and gravel, in part very "dirty"; water bearing	27	142
Clay, brown	(?)	

Well 27/5-36Q1, Crystal Lake Club

[About 20 ft from west bank of Crystal Lake. Altitude about 360 ft. Drilled by N. C. Jannsen Drilling Co., 1931. Ten-inch casing set to 140 ft and perforated from 30 to 140 ft]

Pit; no record	7	7
Esperance sand member:		
Sand and gravel	2	9
Sand	11	20
Sand and gravel	10	30
Gravel and boulders	23	53
Sand and gravel	4	57
Sand, fine, water-bearing	19	76
Gravel, coarse	4	80
Sand, hard, with gravel and small boulders	20	100
Esperance sand member—Con.		
Sand and boulders	8	108
Sand and gravel	34	142
Admiralty clay (?):		
Clay, blue	9	151
Clay, blue, with "shale" (silt?) and some gravel	14	165
Clay, blue	13	178
Clay, blue, with shale (silt?)	17	195
"Sandstone" or boulder	4	199

Well 27/5-36R1, L. C. Green

[At east side of Crystal Lake in pit near dwelling. Altitude about 375 ft. Drilled by N. C. Jannsen Drilling Co., 1933]

Till of the Vashon glaciation (?):		
Clay, brown, with gravel	50	50
Esperance sand member:		
Sand and gravel	8	58
Not reported	8	66
Sand	(?)	

Well 27/6-2J1, M. F. Wiese

[About 0.75 mile west of Monroe and 0.25 mile north of State reformatory. Altitude about 70 ft. Drilled by C. E. Miller. Six-inch casing, set from 3 to 60 ft; screen from 60 to 65 ft]

Pit; no record of materials	4	4
Alluvium:		
Soil	6	10
Gravel, tight	2	12
Clay	5	17
Recessional outwash of the Vashon glaciation and contemporaneous stream deposits:		
Gravel, tight	45	62
Sand and gravel, water-bearing	8	70

Well 27/6-3Q1, L. Erlywine

[About 2 miles west of Monroe. Altitude about 50 ft. Drilled by C. E. Miller, 1944. Six-inch casing set to 41 ft; screen at bottom]

Alluvium: Clay, sandy	12	12
Till of the Vashon glaciation (?):		
"Hardpan"	13	25
Advance outwash of the Vashon glaciation:		
Sand, fine	3	28
Clay, blue	3	31
Sand	8	39
Gravel	2	41

Logs of representaiive wells in Snohomish County, Wash.—Continued

Well 27/6-10R2, Alpha Helm

[About 2 miles southwest of Monroe in "hill swale." Altitude about 150 ft. Drilled by O. Wood. Abandoned "dry hole"]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation and associated deposits:			Undifferentiated Tertiary rocks:		
"Hardpan"	33	33	Shale; "swelling ground"	6	72
Sand	28	61			
Gravel, some water	1	62			
"Hardpan"	4	66			

Well 27/6-14E2, W. R. Paddock

[About 1.5 miles southwest of State reformatory, near right bank of Skykomish River. Altitude about 40 ft. Drilled by C. D. Marks, 1928. No casing set; dry hole]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation (?):			Undifferentiated Tertiary rocks—Continued		
"Hardpan"	10	10	Shale, brown	91	443
Sand; some water	2	12	Shale, blue	62	505
Undifferentiated Tertiary rocks:			Basalt	5	510
Basalt, very hard from 162 to 168 ft (boulder)?	170	182	Shale, blue	17	527
Shale, blue and sandy	170	352			

Well 27/6-17A1, Robert H. Anderson

[In gorge of Snohomish River at foot of bluff to west and about 1 mile below mouth of Skykomish River. Altitude about 70 ft. Drilled by D. K. Shilling, 1944. Six-inch casing set to develop water at 32 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium: "Soil," including "water gravel" just above base	32	32	Undifferentiated Tertiary rocks: Shale, compact, "marine"	6	176
Undifferentiated Tertiary rocks (?): "Hardpan," with thin seams of coal	138	170	Basalt	78	254

Well 27/7-5J1, Don Smith

[About 1.5 miles east of Monroe and just south of Great Northern Railroad. Altitude about 70 ft. Drilled by C. E. Miller, 1945]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Vashon glacial deposits, etc.—Con.		
Sandy surface soil	14	14	Silt and clay	8	90
Sand and gravel	4	18	Clay, blue, tight, with vegetation seams	6	96
Gravel, coarse "iron water"	7	25	Sand, dry	16	112
Vashon glacial deposits and contemporaneous stream-laid materials:			Sand; insufficient water	5	117
Gravel, tight and heavy	3	28	Clay, blue	13	130
Sand, coarse	18	46	Sand	60	190
Clay	1	47	Sand, with some gravel	50	240
Clay, sandy, water-bearing	13	60	Clay, silty, and fine sand	85	325
Clay	18	78	Clay, silty, and coarse sand	2	327
Clay, fine sand, and peat, with gaseous (methane) water that flowed at surface	4	82	Clay, silty, and fine sand	51	378

Well 28/4-22B1, U. S. Army Air Corps

[Half a mile east of State Highway 11 just south of crossing of NW.-SE. and NE.-SW. landing strips at Payne Field. Altitude about 580 ft. Drilled by WPA about 1938. Cased with 10-, 8-, 6-, and 4½-in. casings; no record of perforations]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	2½	2½	Admiralty clay:		
Till of the Vashon glaciation:			Clay and silt	17	337
"Hardpan" (called "shale and gravel")	181½	184	Clay and pea gravel	14	351
"Hardpan" and sand, mixed	6	190	Clay and silt	33	384
Esperance sand member: Sand; water bearing below depth of 240 ft	130	320	Sand	4	388
			Silt with 2-in. gravel streak at 470 ft	155	543
			Gravel, pea-sized, with coarse sand and streaks of clay	4	547

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/5-2L1, H. H. Seaman

[One mile southwest of Forbes School. Altitude about 310 ft. Drilled by C. E. Miller, 1930. Six-inch casing set to 109 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium: Soil	3	3	Pilchuck clay member: Blue clay; sandy zones; water bearing at 72–74 and 109–112 ft	182	205
Till of the Vashon glaciation: "Hardpan" (?)	20	23			

Well 28/5-2Q1, H. W. Moser

[About 1 mile southwest of Forbes School on south side of road. Altitude about 320 ft. Dug, 1942]

Alluvium: Soil	5	5	Till of the Vashon glaciation: "Hardpan"	3	40
Recessional outwash of the Vashon glaciation, undifferentiated: Sand; clean, sharp, medium to coarse, containing pea-sized gravel	32	37	Uncorrelated: Sand	1	41

Well 28/5-5B1, Everett Pulp and Paper Co.

About 0.4 mile south of Lowell Station and on river bank just east of Great Northern Railroad. Altitude about 10 ft. Drilled by N. C. Jannsen Drilling Co., 1936]

Recent alluvium (estuarine deposit):			Admiralty clay:		
Sand and rotten wood	6	6	Clay, blue, sandy, with streaks of sand	47	440
Sand, decayed wood, and silt	106	112	Clay, blue, with layers of sand	80	520
Recessional outwash of the Vashon glaciation and contemporaneous stream deposits (?):			Clay, blue, with hard spots	62	582
Sand	10	122	Clay, blue and sandy	30	612
Silt	17	139	Sand	5	617
Clay and fine sand	22	161	Clay, blue, with layers of sand	17	634
Sand, coarse	9	170	Clay, blue, with some black mud	38	672
Clay and fine sand	77	247	Sand and clay	11	683
Silt; water	18	265	"Hardpan"	4	687
Sand	5	270	Clay, blue	23	710
Till of the Vashon glaciation and associated deposits (?):			Sand, hard, mixed with thin layers of clay	21	831
Rock, hard (boulder?)	4	274	Clay, blue, with some very soft spots	44	775
Not reported	1	275			
Clay, sandy	31	306			
Clay, blue; small amount of water	67	373			
Sand	10	383			
Rock, hard	10	393			

Well 28/5-7G2, Beverly Park Water Co.

[About 500 ft west of State Highway 2A, east of elevated storage tanks. Altitude about 475 ft. Drilled by C. E. Miller, 1936]

Soil	3	3	Esperance sand member—Con.		
Till of the Vashon glaciation:			Gravel, cemented	10	90
Gravel, cemented	50	53	Sand, gray	5	95
Esperance sand member:			Gravel, loose	17	112
Gravel, loose; little water	2	55	Sand, gray, gravelly	32	144
Gravel, cemented	10	65	Sand, gray, gravelly, wet	16	160
Sand, gravelly and loose	3	68	Sand, gravelly	19	179
Gravel, cemented	8	76	Sand	38	217
Gravel, loose	4	80			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/5-7H1, Pinehurst Water District

[East side of State Highway 2A a mile north of its intersection with State Highway 1. Altitude about 410 ft. Drilled by C. E. Miller, 1942. Ten-inch casing set to 170 ft; 8-in., to 257 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
			Esperance member—Con.		
Soil	6	6	Clay, blue	6	180
Till of the Vashon glaciation:			Gravel	1	181
"Hardpan"	6	12	Clay, sandy	8	189
Boulders	8	20	Sand, fine, sharp; coarse streaks	50	239
"Hardpan"	45	65	Admiralty (?) clay:		
Esperance sand member:					
Sand and gravel; dry clay	61	126	Clay; some wood	2	241
Sand, black, silty	24	150	Sand and clay layers	6	247
Clay, blue, sticky	15	165	Clay	0.5	247.5
Sand and gravel, tight; water bearing near base	9	174	Sand, water-bearing	8.5	256
			Clay, blue	2	258

Well 28/5-10R1, Martin Misich

[One mile west of Riverview Chapel on right bank of Snohomish River. Altitude about 20 ft. Drilled by C. D. Marks, 1940]

Recent alluvium (estuary deposit):			Recessional outwash of the Vashon glaciation (?):		
Sand, silty, gray	20	20	Sand, fine, and gravel	3	72
Sand, silty, blue	5	25	Gravel, coarse	2	74
Clay, blue	33	63			
"River muck"	6	69			

Well 28/5-11G2, Clarence Dubuque

[Approximately half a mile northeast of Riverview Chapel. Altitude about 255 ft. Drilled by C. D Marks, 1942]

Till of the Vashon glaciation: "Hardpan"	96	96	Advance outwash of the Vashon glaciation: Sand, "glacial"	3	99

Well 28/5-18D1, L. E. Sorenson

[Approximately 0.7 mile south of Beverly Park. Altitude about 570 ft. Drilled by C. E. Miller, 1940. Five-inch casing set to 246 ft; screen in lowest part]

Dug well; no record of materials	27	27	Esperance sand member:		
Till of the Vashon glaciation: "Hardpan"	53	80	Sand with gravel; cemented gravel	138	218
			Sand, with pebble gravel; water-bearing	29	247

Well 28/5-21D1, A. C. Lindell

[Approximately 1 mile northeast of Silver Lake on rim of Snohomish River gorge. Altitude about 350 ft. Hand-dug, 1937 and 1940. Eighteen-inch casing set from 94 to 100 ft; 3-in., upward to surface]

Till of the Vashon glaciation: "Hardpan"	40	40	Esperance sand member: Sand, compact, medium-grained	60	100

Well 28/5-27L1, Paul McClellan

[Approximately 0.8 mile southwest of Marshland School. Altitude about 375 ft. Drilled by C. D. Marks, 1941. Six-inch casing set to 119 ft; screen in lowest part]

Topsoil	5	5	Esperance sand member:		
Till of the Vashon glaciation and associated deposits:			Sand and gravel, brown	40	90
			Sand, fine, water-bearing	29	119
"Hardpan," soft, yellow	12	17			
Sand, yellow	13	30			
"Hardpan," brown	20	50			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/5-27M1, Charles Fitzgerald

[Approximately 1 mile southwest of Marshland School on crest of gorge slope and just north of road. Altitude about 385 ft. Drilled by C. D. Marks, 1945. Six-inch casing set to 109 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	6	6	Esperance sand member—Con.		
Till of the Vashon glaciation:			Sand, fine, wet	22	105
"Hardpan"	14	20	Sand and gravel, water-bearing	3	108
Esperance sand member:			Clay, blue	2	110
Sand, dry	63	83			

Well 28/5-27N1, C. H. Sedgewick

[Approximately 1.2 miles southwest of Marshland School. Altitude about 435 ft. Drilled by C. D. Marks, 1945. Six-inch casing set to 115 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till (?) and associated deposits:			Esperance sand member:		
Sand, dry	102	102	Sand, gravelly, water-bearing	8	110
			Sand, fine	6	116
			Clay, blue	3	119

Well 28/5-28N1, U. S. Civil Aeronautics Administration

[Approximately 1.2 miles east of Murphys Corner. Altitude about 435 feet. Drilled by C. D. Marks, 1940. Six-inch casing set to 71 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Esperance sand member:		
Till of the Vashon glaciation:			Sand, cemented	5	67
"Hardpan," brown	22	25	Sand with fine gravel, water-bearing	4	71
"Hardpan," gray	15	40			
Clay, blue	22	62			

Well 28/5-28P1, F. R. Stump

[Approximately 1.4 miles east of Murphys Corner. Altitude about 430 ft. Drilled by C. E. Miller, 1939. Six-inch casing set to 131 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Esperance sand member:		
"Hardpan"	60	60	Sand	68	128
			Gravel, pea-sized, with sand	3	131

Well 28/5-29N1, W. M. Oberlander

[In northeast quadrant of Murphys Corner. Altitude about 465 ft. Drilled by C. D. Marks, 1935. Six-inch casing set to 109 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Esperance sand member:		
"Hardpan" (former dug well)	24	24	Sand, cemented	24	70
"Hardpan" (drilled)	17	41	Gravel, dry	1	71
Boulders, gravel	5	46	Gravel, fine, sandy, water-bearing	24	95
			Sand, fine, gravelly, water-bearing	7	102

Well 28/5-29N2, Silver Lake Union School District

[In schoolyard. Altitude about 455 ft. Drilled by C. D. Marks, 1938. Six-inch casing set to 96 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Esperance sand member:		
"Hardpan" (former dug well)	58	58	Sand, with yellow clay and fine gravel; water-bearing	6	78
"Hardpan" (drilled)	14	72	Sand, hard and cemented	23	101
			Sand, coarse, with gravel	10	111

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/5-31A1, E. C. Minge

[Approximately 0.25 mile southwest of Murphys Corner. Altitude about 445 ft. Drilled by C. E. Crary, 1919. Five-inch casing set to 125 ft; screen in lowest part]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	4	4	Esperance sand member: Sand, coarse in lower part	62	125
Till of the Vashon glaciation:					
"Hardpan"	56	60			
Cobbles, loose	3	63			

Well 28/5-33F1, James Garrison

[Approximately 0.5 mile northeast of Thomas Lake. Altitude about 430 ft. Drilled by C. D. Marks, 1945. Six-inch casing set to 73 ft; screen at bottom]

Soil	3	3	Esperance sand member: Sand, fine and gravelly, water-bearing	13	73
Till of the Vashon glaciation: "Hardpan"	57	60			

Well 28/6-6Q1, Carl A. Sorgenfrei

[A quarter of a mile northeast of Stillaguamish (Blackmans) Lake. Altitude about 200 ft. Drilled by C. E. Miller, 1931. Six-inch casing set to 183 ft; perforated from 178 to 183 ft]

Till (?); dug well	40	40	Admiralty clay:		
Sloughed debris	10	50	Clay	20	120
Till of the Vashon glaciation: "Hardpan"	50	100	Clay and sand beds with gravel streaks	58	178
			Gravel, pea-sized, water-bearing	5	183

Well 28/6-9P1, Melvin Ohlde

[Approximately 1.7 miles east-northeast of Snohomish. Altitude about 344 ft. Drilled by C. D. Marks, 1941. Eight-inch casing set to 12 ft; open below]

Till of the Vashon glaciation: "Hardpan"	12	12	Undifferentiated Tertiary rocks:		
			Sandstone, blue	68	80
			Gravel, sandy, water-bearing	2	82
			Sandstone; water (?)	90	172
			Shale	28	200

Well 28/6-11C1, N. K. Johnson

[One mile south of Panther Lake. Altitude about 560 ft]

Till of the Vashon glaciation: "Hardpan"	60	60	Pilchuck clay member:		
			Sand, water-bearing	12	72
			Gravel and sand, water-bearing	3	75

Well 28/6-22A1, U. S. Civilian Conservation Corps

[Approximately 0.9 mile north of Roosevelt road junction. Altitude about 225 ft. Drilled by J. J. Bell, 1937. Six-inch casing set to 110 ft; 4½-in, to 494 ft]

Recessional outwash of the Vashon glaciation, undifferentiated:			Undifferentiated Tertiary rocks:		
Gravel, fine; one-half gallon of water a minute at 25 ft	25	25	"Granite" (reported as actually basaltic rock)	103	212
Clay, blue	20	45	Clay, white and chocolate, interbedded	312	524
Gravel, fine	64	109			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/6-22A2, Carl Clapp

[About 0.3 mile west of Conservation Corps camp and approximately 1 mile northwest of Roosevelt road junction. Altitude about 230 ft. Drilled by J. Dunnevent, 1924. Six-inch casing set to 144 ft; bottom open]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	10	10	Undifferentiated Tertiary rocks:		
			Sandstone	134	144
			Sand, coarse, water-bearing	6	150

Well 28/6-22J1, M. Milligan

[Approximately 0.3 mile northwest of Roosevelt road junction. Altitude about 55 ft. Drilled by C. D. Marks, 1927]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	27	27	Alluvium (older):		
			Clay, blue, smooth	90	117
			Gravel, water-bearing	9	126

Well 28/6-29H1, C. R. Cedergreen

[At Pleasant View Ranch, approximately 2.5 miles southeast of Snohomish. Altitude about 50 ft. Drilled by C. E. Miller, 1939. Six-inch casing set to 132 ft; screen from 132 to 138 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil, sandy	12	12	Pilchuck clay member (?)—Con.		
Pilchuck clay member (?):			Muck (probably dark, peaty clay)	50	130
Muck (probably dark, peaty clay)	66	78	Gravel, water-bearing	8	138
Gravel	2	80			

Well 28/6-30M1, Earl Bailey

[About 0.2 mile north of road junction at south edge of valley floor on first north-south road east of Rees Corner. Altitude about 15 ft. Drilled by C. D. Marks, 1941. Six-inch casing set to 35 ft; screen at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	5	5	Alluvium—Con.		
Alluvium:			Clay, blue	12	27
Sand, brown	10	15	Sand and gravel, water-bearing	8	35

Well 28/6-35E2, Bozeman Canning Co.

[About 5 miles southeast of Snohomish at south side of main cannery building at Fryland. Altitude about 25 ft. Drilled by J. J. Bell, 1945. Twelve-inch casing set to 200 ft; 10-in., to 300 ft; perforated from 96 to 150 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Recent alluvium:			Recessional outwash—Con.		
Peat, black	5	5	Sand, fine, blue, with wood	24	80
Clay, blue	8	13	Clay, blue, and silt, laminated	15	95
Recessional outwash of the Vashon glaciation, undifferentiated (?):			Clay, silt, and peat	12	107
			Gravel, cemented	18	125
Sand, coarse, with gravel; water	5	18	Gravel, loose, water-bearing	73	198
			Clay, sandy, and boulders	7	205
Sand, fine, blue, with water	38	56	Gumbo clay, blue	95	300

Well 28/7-16J1, L. A. O'Dell

[Approximately 0.5 mile south of Lake Cochran. Altitude about 345 ft. Drilled by C. D. Marks, 1931. Six-inch casing set to 40 ft; open at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	6	6	Pilchuck clay member: Gravel, water-bearing	3	40
Till of the Vashon glaciation (?):					
"Hardpan"	31	37			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/7-20P1, J. E. Hunziker

[Approximately 2.5 miles northeast of Monroe. Altitude about 490 ft. Drilled by C. E. Miller, 1945. Six-inch casing set to 111 ft; open at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	106	106	Pilchuck clay member: Gravel, heavy, coarse	6	112

Well 28/7-25L1, E. E. Geyer

[Approximately 2 miles northwest of Sultan. Altitude about 330 ft. Drilled by C. E. Miller, 1933. Six-inch casing set to 148 ft; screen at bottom]

Alluvium: Clay, subsoil	28	28	Pilchuck clay member: Gravel, loose, "river-type"; water-bearing below 135 ft	102	148
Till of the Vashon glaciation: "Hardpan"	18	46			

Well 28/7-29R1, Chester Love

[Near terminus of lumber railroad spur approximately 2.5 miles northeast of Monroe. Altitude about 330 ft. Drilled by C. E. Miller, 1944. Six-inch casing set to 108 ft; screen at bottom]

Till of the Vashon glaciation: "Hardpan"	80	80	Pilchuck clay member:		
			Sand, crusted	16	96
			Sand, gravelly, water-bearing	12	108

Well 28/7-31H1, City of Monroe (well 3)

[Approximately 1.5 miles northeast of Monroe. Altitude about 250 ft. Drilled by C. E. Miller, 1944. Twelve- and ten-inch casing set to 220 ft; water gravels developed by screen sections]

Soil	8	8	Pilchuck clay member—Con.		
Till of the Vashon glaciation (?):			Sand, gray, with fine gravel; water-bearing	20	190
Clay, sandy	32	40	Clay, hard	3	193
Pilchuck clay member:			Sand, gray, with gravel; water-bearing	19	212
Gravel, tight	20	60	Clay	8	220
Clay, blue, sticky	65	125			
Clay, sandy	22	147			
Sand and fine gravel, tight	23	170			

Well 28/7-32E1, City of Monroe (well 1)

[Approximately 1.5 miles northeast of Monroe, near reservoir on brow of hill north of Woods Creek. Altitude about 250 ft. Drilled by C. E. Miller, 1937. Ten-inch casing set to 183 ft; 8-in., to 209 ft; 50-slot screen from 209 to 231 ft]

Till of the Vashon glaciation:			Pilchuck clay member—Con.		
Clay and "hardpan"	25	25	Sand, dry, and layers of silt	45	185
Pilchuck clay member:			Sand, coarse, gray, water-bearing	17	202
Gravel, dry	15	40	Sand, coarse, gray, and gravel, pea-sized	29	231
Sand, wet	5	45	Clay, silt, wood, and bark, interlayered	1	232
Gravel, dry	17	62			
Sand, water-bearing	8	70			
Sand, gray, tight	20	90			
Clay, blue and sticky	50	140			

Well 28/7-32E2, City of Monroe (well 2)

[Approximately 1.5 miles northeast of Monroe; more western of two wells at reservoir. Altitude about 250 ft. Drilled by C. E. Miller, 1937. Twelve-inch casing set to 138 ft; 10-in., to 201 ft; 40- and 50-slot (bottom 10 ft) screen from 201 to 226 ft]

Till of the Vashon glaciation:			Pilchuck clay member—Con.		
Clay and "hardpan"	35	35	Sand, gray, water-bearing	10	190
Pilchuck clay member:			Sand, clean, gray, coarse, with 5 percent gravel, pea-sized	30	220
Gravel, dry	25	60	Sand, coarse, gray, and 10 percent pea gravel	6	226
Sand, fine, water-bearing	10	70			
Clay, blue, sticky	68	138			
Sand, silty, dry	34	172			
Sand, tight, dry	8	180			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 28/7-32F1, City of Monroe

[Approximately 0.25 mile east of reservoir on slope of bluff northeast of Monroe. Unnumbered and unused well. Altitude about 225 ft. Drilled by N. C. Jannsen Drilling Co., 1942. Eighteen-inch casing set to 118 ft; 12-in. to 210 ft; 8-in. to 716 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Uncorrelated:			Uncorrelated—Con.		
Sand, gravel; boulders	66	66	Sand; gravel, boulders	69	344
Clay, blue	30	96	Clay, blue	54	398
Boulders	5	101	Sand	3	401
Clay, blue	26	127	Clay, blue	49	450
Sand; gravel	10	137	Sand; some washed gravel; water	100	550
Clay, blue	19	156	Boulders	3	553
Clay, blue; boulders	40	196	Clay, blue	16	569
Silt	45	241	Sand, water-bearing	131	700
Sand	12	253	Boulders	16	716
Sand; gravel	22	275			

Well 28/7-33R1, J. F. Sleisman

[Approximately 1.5 miles east of Monroe Cemetery. Altitude about 290 ft. Drilled, 1929]

Till of the Vashon glaciation:			Pilchuck clay member:		
"Hardpan"; some water at 64 ft)	68	68	Sand and gravel, water-bearing	44	112
			"Hardpan"	13	125
			Sand, fine, wet	(?)	

Well 28/7-34P1, William Davis

[Approximately 2 miles east of Monroe Cemetery. Altitude about 310 ft. Drilled by C. E. Miller, 1933. Six-inch casing set to 133 ft; screen from 134 to 137 ft]

Recessional outwash of the Vashon glaciation, undifferentiated:			Recessional outwash—Con.		
Gravel, loose	100	100	Sand and drift (?)	30	130
			Sand; water	7	137

Well 28/7-36P1, Ben Stuckey

[Approximately 1.7 miles west of Sultan, north of road and just west of lumber railroad spur. Altitude about 380 ft. Drilled by owner, 1925. Six-inch casing set to 110 ft; screen from 110 to 125 ft]

Till of the Vashon glaciation (?):			Pilchuck clay member—Con.		
"Hardpan"	48	48	Sand, coarse, water-bearing	25	125
Pilchuck clay member:			Sand, fine	5	130
Gravel, sandy, and sand, gravelly, interbedded	52	110			

Well 28/8-21M1, W. H. Sheeler

[Approximately 0.5 mile northwest of Mountain View School. Altitude about 625 ft. Drilled by C. D. Marks, 1933]

Till of the Vashon glaciation:			Pilchuck clay member—Con.		
"Hardpan"	64	64	Sand, hard and dry	15	125
Pilchuck clay member:			Gravel, fine	9	134
"Shale"	5	69	Sand, with gravel, hard; air blow at 136 ft	57	191
Clay, brown	20	89	Gravel, water-bearing	19	210
Gravel, fine	21	110			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 29/4-1A1, Priest Point Beach Water Co.

[Just west of Priest Point, west of road on upper terrace level. Altitude about 125 ft. Drilled by C. E. Miller, 1941. Eight-inch casing set to 54 ft; 6-in. to 160 ft; screen from 160 to 172 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	2	2	Esperance sand member—Con.		
Alluvium and estuarine deposits:			Sand, fine and silty, wet	15	145
Sand, dry	30	32	Beach sand, with clay and wood	12	157
Clay, blue	10	42	Sand, coarse; water	6	163
Till of the Vashon glaciation and associated deposits:			Clay	1	164
"Hardpan"	6	48	Sand, coarse, loose, gravelly (10 percent fine pea gravel, 5 percent heavy gravel); water	8	172
Sand	4	52	Sand, fine, and clay	(?)	
"Hardpan" and clay	23	75			
Esperance sand member:					
Sand and gravel, dry	15	90			
Sand, tight	40	130			

Well 29/5-2F1, L. Falkner

[Approximately 0.7 mile east of Sunnyside School, east of road on hill. Altitude about 275 ft. Dug, 1940. Concrete curb to till; plaster walls to water]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	6	6	Esperance sand member (?):		
Till of the Vashon glaciation:			Gravel; sandy upper part, coarse and bouldery lower part	74	115
"Hardpan"	35	41			

Well 29/5-8R1, Weyerhauser Timber Co.

[At present site of "outside" warehouse at mill B on left bank of Snohomish River, 0.5 mile east of American Legion Park in Everett. Altitude about 10 ft. Drilled by N. C. Jannsen Drilling Co., 1929]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Younger alluvium (estuarine deposit):			Pre-Vashon deposits—Con.		
Clay	5	5	Clay, blue	3	328
Sand and logs	13	18	Sand	34	362
Sand and sticks	14	32	Admiralty (?) clay:		
Sand, clay, and sticks	14	46	Clay	8	370
Older alluvium or recessional outwash of the Vashon glaciation (?):			Sand, gravel, and clay	20	390
Sand, clay, and gravel	11	57	Clay	219	609
Sand	22	79	Sand and gravel	2	611
Sand and clay	3	82	Uncorrelated:		
Clay, sand, and gravel	50	132	Clay, black	67	678
Sand and boulders	22	154	Clay	57	735
Till of the Vashon glaciation (?):			"Coal"	3	738
Boulders, sand, gravel, and clay	149	303	Clay, blue	62	800
Pre-Vashon deposits, undifferentiated (?):			Clay	395	1,195
Sand and clay	22	325	Shale and sand	61	1,256
			Boulders	2	1,258
			Clay	248	1,506
			Clay, black	39	1,545

Well 29/5-10B1, L. H. Triesch

[Approximately 0.7 mile due south of Sunnyside School, on tide flat just west of Ebey Slough. Altitude about 10 ft. Drilled by C. E. Miller, 1931. Twelve-inch casing set to 98 ft; 30-slot screen from 98 to 101 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	3	3	Uncorrelated—Con.		
Uncorrelated (till?):			Sand and gravel, pea-sized; water	4	101
"Hardpan"	80	83	"Hardpan"	1	102
Clay	14	97			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 29/5-19K1, Soundview Pulp Co.

[Approximately 1,100 ft east and 2,400 ft north of S¼ corner sec. 19. Most northerly of three wells. The mill's well 1. Altitude about 15 ft. Drilled by C. E. Miller, 1940. Eight-inch casing set to 90 ft; No. 60 screen from 90 to 110 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Fill	16	16	Admiralty clay—Con.		
Till of the Vashon glaciation:			Clay, blue	10	162
Clay, sandy	4	20	Sand, gray; 50± gal of water per minute	3	165
Clay, yellow	5	25	Sand and layers of clay	35	200
"Hardpan"	8	33	Sand, soft, silty	30	230
Esperance sand member:			Sand and clay, tight	102	332
Sand	5	38	Clay, soft and sandy	60	392
Sand, tight, gray	6	44	Clay, sticky, blue	33	425
Sand and pea gravel, loose; water	61	105	Shale, black; show of gas	115	540
Sand and clay, tight	5	110	Clay, blue, with thin layers of sand; show of water at 548 ft; gas	8	548
Admiralty clay:			Clay, blue, and layers of brown shale	112	660
Clay and wood	5	115			
Clay, sandy	12	127			
Sand, silty, and clay	18	145			
Clay and wood	7	152			

Well 29/5-19K2, Soundview Pulp Co.

[Approximately 1,100 ft east and 2,220 ft north of S¼ corner sec. 19. Center of three in-line wells at pulp mill. The mill's well 2. Altitude about 15 ft. Drilled by C. E. Miller, 1941. Twelve-inch casing set to 74 ft; screen in water zone]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Esperance sand member—Con.		
Sand	10	10	Sand	11	69
Silt, wood, and logs	15	25	Sand, coarse, gray	2	71
Till of the Vashon glaciation and associated deposits (?): Gravel and clay, tight	5	30	Sand, coarse, and gravel	19	90
Esperance sand member:			Sand	10	100
Sand and gravel, coarse	28	58	Clay	--------	--------

Well 29/5-19K3, Soundview Pulp Co.

[Approximately 1,100 ft north and 1,700 ft east of S¼ corner sec. 19. Southernmost of three in-line wells at pulp mill. The mill's well 3. Altitude about 15 ft. Drilled by C. E. Miller, 1941. Ten-inch casing set to 75 ft, No. 50 screen below]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Esperance sand member:		
Sand	8	8	Sand, water-bearing	5	70
Logs	4	12	Sand, coarse, gray, water-bearing	5	75
Till of the Vashon glaciation and associated deposits:			Sand and pea gravel	15	90
"Hardpan"	12	24	Sand	9	99
Gravel, tight	20	44	Sand, coarse, and gravel	7	106
Sand, tight	21	65	Sand, fine, hard	4	110

Well 29/5-19P1, American Ice and Cold Storage Co.

[Approximately 8 ft southwest of plant building. Altitude about 25 ft. Drilled by C. E. Miller, 1945. Ten-inch casing set to 122 ft with No. 40 screen in 85- to 97-ft zone and No. 30 in 112- to 122-ft zone]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium: "Surface drift"	14	14	Esperance sand member—Con.		
Till of the Vashon glaciation and associated deposits (?): "Hardpan"	8	22	Sand and gravel, red	14	81
Esperance sand member:			Clay, tight	4	85
Sand and gravel, gray	15	37	Sand and fine gravel; water	12	97
Sand, yellow, water-bearing	20	57	Clay and fine sand	12	109
Clay, "hardpan"	10	67	Sand and fine gravel; water	13	122
			Clay, blue	2	124

Logs of representative wells in Snohomish County, Wash.—Continued

Well 29/5-29G1, Eclipse Mill Co.

[Approximately 40 ft east of north point of circular brick incinerator at mill southwest of Northern Pacific station. Altitude about 20 ft. Drilled by N. C. Jannsen Drilling Co., 1929. Sixteen-inch casing set to 33 ft; 8-in. to 215 ft; perforated from 75 to 95 ft and from 125 to 205 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sawdust and slabs	15	15	Admiralty clay—Con.		
Alluvium: Sand	11	26	Sand and gravel	30	155
Esperance sand member:			Clay, sandy	10	165
Gravel, cemented	51	77	Clay	5	170
Sand and gravel; water	9	86	Sand; water	20	190
Admiralty clay:			Clay	27	217
Shale, brown, hard	39	125			

Well 29/5-31Q1, Meadowmoor Ice Cream Co.

[Sixty feet east of southeast corner of concrete-block plant building. Altitude about 320 ft. Drilled by C. Ruby, 1946. Six-inch casing set to 139 ft; perforated for 12 ft in 105- to 139-ft zone]

Till of the Vashon glaciation	(?)		Esperance sand member—Con.		
Esperance sand member:			Sand; no water	5	105
Sand	84	84	Sand with gravel zones; water bearing	34	139
Gravel, water-bearing	10	94			
Clay	6	100			

Well 29/6-7D3. Snohomish County Public Utility District No. 1

[About one-quarter mile north of grandstand at Lake Stevens. Altitude about 230 ft. Drilled by C. E. Miller, 1947]

Till of the Vashon glaciation: "Hardpan"	100	100	Advance outwash—Con.		
Advance outwash of the Vashon glaciation:			Sand, gravelly, water-bearing	3	108
Clay, silty	2	102	Gravel, with dirt and sand, tight	35	143
Sand, fine, with some silt; water bearing	3	105	Admiralty clay: Clay, sticky, blue, dry	257	400

Well 29/6-7J1, H. L. Oldfield

[On hillside above road around north side of Lake Stevens and 0.7 mile southeast of village of Lake Stevens. Altitude about 320 ft. Drilled by D. K. Shilling, 1942. Six-inch casing set to 352 ft with screen in lowest part]

Soil, gravelly	15	15	Admiralty clay:		
Till of the Vashon glaciation: "Hardpan"	115	130	Clay, blue	210	340
			"Hardpan"	6	346
			Sand, gravelly; water	6	352

Well 29/6-8F4, Snohomish County Public Utility District No. 1

[About 250 ft south of Lake Stevens High School grounds. Altitude 255 ft. Drilled by C. E. Miller, 1946. Eight-inch casing set to 308 ft; No. 40 screen from 308 to 318 ft]

Till of the Vashon glaciation: "Hardpan" and tight gravel	70	70	Admiralty clay—Con.		
Admiralty clay:			Sand, gray, coarse-grained, water-bearing	3	315
Clay, tight	20	90	"Hardpan" shot with "crushed" gravel and sand	30	345
Clay, hard, with sand streaks	55	145	Sand	1	346
Clay, bright-green	5	150	Clay, blue, and brown peat	2	348
Clay, fine, silty	5	155	Clay, blue, dry, tight	76	424
Sand, medium	3	158	Clay, blue and gray, with some wood and peat at 450 ft	41	465
Clay, tight, hard; sand at 171 ft	152	310			
Sand, gray, medium-grained, water-bearing	2	312			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 30/4-1C1, U. S. Department of Commerce

[Approximately 0.7 mile north of John Sams Lake. Altitude about 590 ft. Drilled by C. D. Marks, 1940. Six-inch casing; no record, but open to water zones above 40 ft in depth]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	2	2	Till of Vashon glaciation—Con.		
Till of the Vashon glaciation:			"Hardpan," blue, with boulders	68	108
"Hardpan," gray; water bearing in sandy (?) zones from 23 to 28 ft and 35 to 39 ft	38	40	Not recorded	17	125

Well 30/4-7G1, O. C. Rupp

[Near toe of alluvial slope 1,000 ft south of foot of road grade down sea cliff. Altitude about 30 ft. Drilled by C. D. Marks, 1947. Six-inch casing set to 325 ft; perforated from 44 to 67 ft]

Admiralty clay:			Admiralty clay—Continued		
Sand, fine, clayey	36	36	Clay, with gravel pebbles	55	176
Clay, blue	8	44	Clay	34	210
Gravel and sand, water-bearing	23	67	Sand, fine, silty	50	260
Silt and clay	24	91	Sand, fine, blue, water-bearing	61	321
Clay, blue	30	121	Clay, hard, blue	4	325

Well 30/47-H1, O. C. Rupp

[About 800 ft northeast of top of road grade down sea cliff to beach. Altitude about 425 ft. Drilled by C. D. Marks, 1946. Casing pulled; hole abandoned]

Soil	2	2	Admiralty clay:		
Till of the Vashon glaciation: "Hardpan"	83	85	Clay, yellow	28	346
Esperance sand member:			Sand, fine, yellow, dry	34	380
Gravel	1	86	Clay, yellow	3	383
Clay, yellow	7	93	Clay, with fine sand	16	399
Sand, fine, with clay	7	100	Sand, fine, clayey	31	430
Sand, with gravel streaks	35	135			
Sand, yellow	183	318			

Well 30/4-17C1, Subeebeda Water Co.

On slope 400 ft north of boathouse in center of Subeebeda Cove shore line. Altitude about 45 ft. Drilled by C. E. Miller, 1947. Six-inch casing set to 372 ft; perforated from 367 to 372 ft]

Esperance sand member:			Esperance sand member—Con.		
Sand and gravel, dry	102	102	Sand, medium-fine	4	298
Sand, fine, with clay	2	104	Clay and fine sand in thin layers	7	305
Gravel, pea-sized	2	106	Sand, fine	9	314
Clay, yellow, sandy	3	109	Sand, fine, with clay layers	29	343
Sand, silty, wet	5	114	Sand, crusted, hard	½	343½
Clay, gray	5	119	Sand, medium, with 15 percent pea gravel	9½	353
Clay, blue	13	132	Sand, medium	5	358
Clay, sandy	17	149	Sand, hard, crusted	4	362
Sand, gray; water	4	153	Sand, coarse, with pea gravel	5	367
Clay, stiff, gray	6	159	Gravel, heavy, with 50 percent coarse sand	10	377
Sand, dark-gray; quicksand; water-bearing	101	260			
Sand, hard, fine	33	294			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 30/4-17K1, T. G. Mortland

[On sea cliff at Tulalip Shores subdivision. Altitude about 180 ft. Drilled by C. E. Miller, 1947. Eight-inch casing set to 363 ft; 6-inch, to 515± ft; perforated]

	Thickness (feet)	Depth (feet)
Soil and alluvium	10	10
Till of the Vashon glaciation: "Hardpan"	5	15
Admiralty clay:		
Sand, dry	50	65
Sand and gravel	20	85
Sand, tight, fine	56	141
Clay, sandy	9	150
Sand, fine, gray	5	155
Clay, sandy	49	204
Sand, black, with fine gravel; little water	2	206
Sand, gray, clayey, with clay layers	3	209
Admiralty clay—Continued		
Sand, fine, sharp, and pea gravel	9	218
Sand and some dark clay	2	220
Sand, fine, and wood	5	225
Sand, fine, silty, with clay layers	258	483
Sand, coarse, gray, with 25 percent pea gravel; water-bearing	17	500
Sand, coarse, and gravel	6½	506½

Well 30/4-35R1, Potlatch Beach Water District

[Approximately 1.3 miles west of Priest Point and just back from coastal bluff. Altitude about 135 ft. Drilled by C. E. Miller, 1945. Six-inch casing set to 155 ft; No. 70 screen from 155 to 170 ft]

	Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	30	30
Esperance sand member:		
Sand, with gravel	35	65
Clay, blue	4	69
Sand, with gravel, tight and cemented	73	142
Sand, medium to coarse, water-bearing	7	149
Esperance sand member—Con.		
Sand, medium-grained, light-gray, containing pebble gravel	3	152
Sand, medium-grained, dark-blue, containing 5 percent grit	5	157
"Glacial till"	1	158
Clay, blue	2	160
Sand, medium-grained	11	171

Well 30/5-26A1, C. F. Smith

[One mile southwest of Getchell siding. Altitude about 400 ft. Drilled by W. B. Gemmil, 1946]

	Thickness (feet)	Depth (feet)
Soil	10	10
Till of the Vashon glaciation: "Hardpan"	174	184
Advance outwash of the Vashon draft, undifferentiated: Sand	29	213
Pilchuck clay member (?): Clay	1	214

Well 30/5-26M1, H. Morney

[Approximately 1.5 miles east of Marysville. Altitude about 150 ft. Drilled, 1922. Four-inch casing set to 82 ft; screen at bottom]

	Thickness (feet)	Depth (feet)
Soil	12	12
Recessional outwash of the Vashon glaciation, undifferentiated:		
Clay	50	62
Sand	4	66
Till of the Vashon glaciation and associated deposits:		
"Hardpan"	10	76
Sand and gravel	2½	78½
"Hardpan"	3½	82

Well 30/5-27L1, L. B. Hickok and others

[Approximately 0.5 mile east of Marysville. Altitude about 55 ft. A dug well; log reported by owner]

	Thickness (feet)	Depth (feet)
Not reported; apparently soil and sand	25	25
Till of the Vashon glaciation: "Hardpan"	70	95
Pilchuck clay member: Sand and gravel	1	96

Logs of representative wells in Snohomish County, Wash.—Continued

Well 30/5-27P1, Walter Faulstick

[Approximately 0.5 mile east of Marysville on south side of Snohomish road. Altitude about 35 ft. Drilled by C. E. Miller, 1942. Six-inch casing set to 115 ft; perforations in the 100- to 115-ft zone]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	3	3	Advance outwash of the Vashon glaciation:		
Till of the Vashon glaciation:			Gravel, cemented	16	115
Clay, "hardpan"	4	7	Gravel, tight	10	125
Clay, blue	19	26	Clay, sandy	8	133
"Hardpan"	73	99			

Well 30/7-18N2, Town of Granite Falls

[Approximately 300 ft south of town grade school. Altitude about 380 ft. Drilled by N. C. Jannsen Drilling Co., 1931]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Recessional outwash of the Vashon glaciation, undifferentiated:			Uncorrelated (may be old till, coarse sediment series, or talus):		
Gravel, loose, water-bearing	2	2	Gravel, cemented, white	5	157
Gravel, loose, with sand; water bearing	9	11	Gravel, cemented, white, or hardpan	3	160
Gravel, "washed," with boulders; water-bearing	12	23	Rock, mineralized	10	170
Sand, with water under pressure	12	35	Gravel, cemented	70	240
Gravel, loose	5	40	Gravel, cemented, and hard green clay	9	249
Till of the Vashon glaciation and associated deposits:			Clay, hard, green, mixed with rock	21	270
"Hardpan"	17	57	Pre-Tertiary crystalline rocks (Paleozoic metasediments?):		
Clay, blue	10	67	Rock, green	42	312
Gravel	3	70	Rock, green, changing to yellow	15	327
Sand and pea gravel	20	90	Pre-Tertiary crystalline rocks (Mesozoic acid intrusives?):		
Clay	17	107	Rock, blue	5	332
Clay, blue, mixed with boulders	27	134	Granite, blue	8	340
Clay, blue, with boulders, and sandy clay; water bearing	16	150			
Boulder, granitic, large, or bedrock	2	152			

Well 31/3-24Q1, J. W. Terry

[Approximately 1.2 miles south of Warm Beach on brink of sea cliff. Altitude about 150 ft. Drilled by C. E. Miller, 1945. Six-inch casing plugged at 183 ft; No. 30 screen from 173 to 178 ft, No. 20 from 178 to 183 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation:			Admiralty clay:		
"Hardpan"	60	60	Clay	6	186
Esperance sand member:			Sand, fine, with clay	4	190
Sand, dry	45	105	Clay and silty sand in beds 40 ft thick alternating with beds of sand 5 to 10 ft thick	247	437
Sand, gravelly, dry	64	169			
Sand, medium-grained; water bearing below 170 ft	4	173			
Sand, uniform beach-type	7	180			

Well 31/3-36B3, Elmer Jackaway

[On beach at Kayak Point. Altitude about 10 ft. Drilled by C. E. Miller, 1945. Eight-inch casing set to 85 ft; 7½ in. slotted pipe from 85 to 100 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Esperance sand member:		
"Drift" and silt	14	14	Sand, fine, saturated	7	80
Gravel, beach-type	14	28	Pea gravel, medium-coarse	5	85
Silt, black	2	30	Gravel, coarse, with 10 percent coarse sand	15	100
Till of the Vashon glaciation:					
"Hardpan," clayey, tight	43	73			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 31/4-6C1, Snohomish County Department of Roads

[On right bank of Hat Slough 0.75 mile below Florence-Warm Beach road. Altitude about 10 ft. Drilled by seismographic crew, 1945]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Alluvium—Continued		
Sand	20	20	Gravel, fine, with occasional boulder	35	95
Log, tree	3	23	Boulder	(?)	
Sand, coarse	7	30			
Sand	30	60			

Well 31/4-18E1, A. H. Reinecke

[Approximately 1 mile northeast of Warm Beach. Altitude about 160 ft. Drilled by C. E. Miller, 1943. Six-inch casing set to 224 ft; No. 25 screen from 215 to 224 ft]

Soil	4	4	Admiralty clay—Continued		
Till of the Vashon glaciation: "Hardpan"	76	80	"Hardpan"; some wet sand at 200 ft	3	200
Esperance sand member: Sand, gravelly, dry	45	125	Sand and clay; alternating beds	15	215
Admiralty clay:			Gravel, tight	3	218
Clay, blue	70	195	Sand, gravelly, water-bearing	6	224
Sand, dry	2	197	Clay, hard	1	225

Well 31/4-22B2, John Sedy

[Approximately 1.2 miles northeast of Lake Goodwin. Altitude about 435 ft. Drilled by C. E. Miller, 1944. Six-inch casing set to 142 ft; No. 30 screen from 136 to 142 ft]

Till of the Vashon glaciation: "Hardpan"	85	85	Esperance sand member—Con.		
Esperance sand member:			Sand, coarse and yellow-colored, with pea gravel; water bearing	6	135
Sand, light-yellow	10	95	"Hardpan"	1	136
Sand, soft	5	100	Sand, gray, with pea gravel and 10 percent heavy gravel; water bearing	6	142
Sand, tight	24	124			
Sand, red, water-bearing	5	129			

Well 31/4-22N1, G. A. Schuh

[Just north of Lake Goodwin, on hill slope. Altitude about 375 ft. Drilled by C. E. Miller, 1939. Eight-inch casing set to 72 ft; perforations from 62 to 72 ft]

Till of the Vashon glaciation: "Hardpan"	52	52	Esperance sand member:		
			Sand and clay, wet	10	62
			Sand and gravel, water-bearing	10	72

Well 31/4-24N1, Town of Marysville

[Approximately 2.9 miles west of Rex Corner, in ravine on bluff slope. Altitude about 300 ft. Drilled by C. E. Miller, 1944]

Esperance sand member:			Esperance sand member—Con.		
Sand with gravel, tight	12	12	Clay, "hardpan," and sand, tight	8	60
Sand, loose and wet	14	26	Sand, medium- to coarse-grained, with gravel	10	70
Sand, sharp, with 5 percent pea gravel; water bearing	9	35	Sand, uniform	6	76
Clay	3	38	Gravel, heavy and tight	1½	77½
Sand, sharp, loose	5	43			
Sand, gray, medium-grained	9	52			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 31/4-24N2, Town of Marysville

[Approximately 2.7 miles west of Rex Corner, near concrete springworks house along ravine in bluff slope. Altitude about 250 ft. Drilled by C. E. Miller, 1946. Eight-inch casing set to 203 ft; perforations from 164 to 173 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Esperance sand member:			Esperance sand member—Con.		
Sand and gravel, water-bearing	60	60	Sand, medium, with pea gravel	14	164
Sand, coarse, and gravel, coarse, cobbly; water flows at 65 gpm	20	80	Sand, coarse, and gravel, coarse	10	174
Sand, medium, with gravel	16	96	Admiralty clay:		
Clay; "hardpan"	6	102	Clay and sand layers, tight	81	255
Sand, coarse, and gravel	18	120	Sand, with 10 percent pea gravel; water bearing	7	262
Clay and silty sand layers	30	150	Clay and sand, silty in alternate layers	96	358

Well 31/5-7G1, Peter Henning

[Approximately 0.5 mile south of Stillaguamish River and 0.3 mile west of U. S. Highway 99, at Sylvan Jersey Farm. Altitude about 45 ft. Drilled by C. E. Miller, 1940. Six-inch casing set to 143½ ft; gravel strainer from 143½ to 150 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Uncorrelated—Continued		
Surface soil, clayey	20	20	Sand, tight, with layers of hardpan	50	145
Sand, with layers of wood	20	40	Sand, blue, with gravel; water bearing	5	150
Uncorrelated:			"Hardpan-gravel" bottom	(?)	--------
Gravel	32	72			
Clay, blue	16	88			
Gravel, water-bearing	7	95			

Well 31/5-10J1, Pearlie Robb

[Approximately 0.5 mile southwest of Arlington. Altitude about 60 ft. Drilled by A. Countryman, 1922. Four-inch casing driven to 89 ft; open at bottom]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium:			Uncorrelated:		
Soil, gravelly	10	10	Clay, hard, strongly indurated at base	31	88
Sand, silty, red, water-bearing	2	12	Not reported; water bearing	1	89
Recessional outwash (Marysville sand member): Sand and clay interbeds	45	57			

Well 31/5-15R2, U. S. Navy Department

[Approximately 1.5 miles southwest of Arlington and 0.25 mile west of Northern Pacific Railroad. Altitude 140.5 ft. Drilled by J. J. Bell, 1943. Casing (size not reported) set to 167 ft; perforations from 135 to 166 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	2	2	Recessional outwash (Marysville sand member)—Continued		
Recessional outwash (Marysville sand member):			Sand, coarse, brown	31	166
Sand, brown, with gravel	133	135	Clay, laminated, brown	1	167

Well 31/5-21H1, U. S. Navy Department

[Approximately 1.2 miles northeast of Rex Corner and 1 mile west of Northern Pacific Railroad. Altitude about 130 ft. Drilled by C. D. Marks, 1945]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Recessional outwash (Marysville sand member):			Uncorrelated:		
Gravel, sandy	47	47	Clay	4	132
Sand, fine, water-bearing	81	128	Sand, fine	53	185

Logs of representative wells in Snohomish County, Wash.—Continued

Well 32/4-7N2, Edward McKain

[About 1.5 miles north of East Stanwood. Altitude about 110 ft. Drilled by Kounkel Brothers, 1946. Six-inch casing set to 170 ft; screen from 170 to 183 ft.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium (older): Clay and sand beds	54	54	Pilchuck clay member:		
Till of the Vashon glaciation: "Hardpan"	8	62	Clay, soft, with sand beds and wood layers	90	170
Esperance sand member: Sand, water-bearing	18	80	Sand, fine, water-bearing	13	183

Well 32/4-11N1, Leonard Johnson

[Approximately 0.25 mile north of Freeborn Church. Altitude about 455 ft. Drilled by J. J. Bell, 1944]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Dug well; materials not reported	20	20	Undifferentiated Tertiary rocks:		
Till of the Vashon glaciation:			Shale, brown	154	220
"Hardpan"	45	65	Sandstone, gray, hard; water at 230 ft	140	360
Gravel, cemented; some water	1	66			

Well 32/4-17C1, C. U. Ipsen

[Approximately 0.8 mile north of Cedarhome. Altitude about 220 ft. Drilled by C. E. Miller. Six-inch casing set to 120 ft; openings in sand zone from 104 to 120 ft and in gravel above]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	20	20	Esperance sand member:		
			Sand and gravel, interbedded	84	104
			Sand, fine, water-bearing	16	120

Well 32/4-18B1, L. Ronnestat

[Approximately 1 mile due south of west end of Lake Ketchum. Altitude about 200 ft. Drilled by C. E. Miller, 1941. Six-inch casing set to 150 ft; perforations not entirely known, but open in 148- to 150-ft zone]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	60	60	Esperance sand member—Con.		
Esperance sand member:			Sand, water-bearing	1	131
Sand, gray, "dry"	10	70	Gravel, tight	17	148
Gravel, tight	25	95	Boulders, water-bearing	2	150
Gravel, loose, heavy	35	130	"Hardpan," clay	1	151

Well 32/4-19K3, Peter Henning

[In yard of large frame house one-half mile west of Lincoln School in East Stanwood. Altitude about 175 ft. Drilled by C. E. Miller, 1925. Casing pulled and hole abandoned]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	80	80	Admiral clay—Continued		
Admiralty clay:			Gravel, cemented; some water	30	380
Clay, silt, and fine sand in alternating layers	270	350	Clay	20	400
			Silt, sandy, gray, swelling in part	272	672

Well 32/4-19P1, Pict Sweet Co.

[Forty feet south of Highway 1E and 50 ft west of cannery plant. Altitude about 20 ft above sea level. Drilled by J. J. Bell & Son, 1946-47. Ten-inch casing carried to bottom; top 500 ft removed]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Admiralty clay:			Admiralty clay—Con.		
Clay, gritty	65	65	Clay and silt, mixed	100	500
Sand and gravel; little water	5	70	Clay	500	1,000
Silty sands; small amounts of water	330	400			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 32/4-20N1, Gustav Gilbertson

[Approximately 0.3 mile southeast of Lincoln High School. Altitude about 130 ft. Log from owner. Six inch casing set to 133 ft; perforations not reported but are in 80- to 133-ft zone]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Alluvium (older):			Alluvium (older)—Con.		
Soil	5	5	Clay, blue	60	80
Sand, fine, wet (terrace cover, marine?)	15	20	Gravel, water-bearing	53	133

Well 32/4-23Q2, Strand

[One-half mile north of Sunday Lake. Altitude approximately 360 ft. Drilled by G. A. Bezona, 1946. Six-inch casing set to 180 ft; further drilling postponed]

Till of the Vashon glaciation:			Pilchuck clay member—Con.		
"Hardpan"	52	52	Cobbles, dry	31	100
Pilchuck clay member:			Gravel, fine	12	112
Clay, blue	4	56	Gravel, coarse	8	120
Clay, yellow	6	62	Clay and gravel	20	140
Sand, blue, medium	3	65	Clay and sand	20	160
Clay and sand; little water	4	69	Sand	20	180

Well 32/4-28B1, M. A. Montgomery

[One mile northeast of Woodland School. Altitude about 285 ft. Drilled by G. A. Bezona, 1946. Six-inch casing set to 32 ft; perforated from 24 to 32 ft]

Soil and rubble	5	5	Till of the Vashon glaciation:		
			"Hardpan"	19	24
			Gravel, water-bearing	2	26
			"Hardpan"	6	32

Well 32/4-29D1, Ole Sather

[Approximately 0.5 mile south of Lincoln High School. Altitude about 115 ft. Drilled by C. E. Miller, 1928. Log from owner]

Alluvium (older):			Alluvium (older)—Con.		
Soil	6	6	Clay, blue	102	110
Sand, fine, wet (terrace cover)	2	8	Gravel, water-bearing	5	115

Well 32/4-30L1, Stanwood Water Co.

[On right bank of Stillaguamish River at west edge of Florence road. Altitude about 15 ft above sea level. Drilled by N. C. Jannsen Co., 1947]

Alluvium: Silt	68	68	Alluvium or undifferentiated glacial outwash—Con.		
Alluvium or undifferentiated glacial outwash:			Gravel and clay	17	112
Gravel and cobbles, water-bearing	27	95	Sand and gravel; saline water	30	142
			Clay with peat	3	145

Well 32/4-33F1, Albert Fredrickson

[About 1 mile southeast of Woodland School. Altitude about 15 ft. Drilled by Bezona and Son, 1946. Six-inch casing set to 70 ft; perforated from 60 to 70 ft]

Alluvium:			Alluvium—Con.		
Mud and soil (river alluvium)	30	30	Sand, fine, loose, water-bearing	10	60
Sand, fine, loose, water-bearing	17	47	Sand and gravel	10	70
Silt, blue, soft	3	50			

Logs of representative wells in Snohomish County, Wash.—Continued

Well 32/5-22K1, Joseph Wagner

[Approximately 0.8 mile northeast of Bryant. Altitude about 250 ft. Drilled by A. Countryman, 1933. Four-inch casing set to 86 ft; screen in 68- to 86-ft zone]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Till of the Vashon glaciation: "Hardpan"	68	68	Pilchuck clay member: Sand and gravel	18	86
			"Hardpan" (believed to have been clay or Vashon till)	18	104

Well 32/6-18H1, A. L. Kester

[About 2 miles northwest of Trafton. Altitude about 440 ft. Drilled by J. J. Bell, 1945. Six-inch casing set to 110 ft; perforated from 100 to 110 ft]

Sand and soil	7	7	Pilchuck clay member: Silt and fine sand beds, water-bearing	10	110
Till of the Vashon glaciation: "Hardpan"	93	100			

TABLE 4.—*Representative wells in Snohomish County, Wash.*

1 Well designation	2 Owner or occupant of property	3 Topographic situation [1]	4 Approximate altitude above sea level (feet)	5 Type [2]	6 Depth (feet) [3]	7 Diameter (inches)	8 Depth of casing (feet)	9 Water-bearing zone or zones: A Depth to top (feet)	9 B Thickness (feet)	9 C Character of material	9 D Ground-water occurrence	10 Water level: A Feet below land-surface datum [3]	10 B Date of measurement	11 Type of pump [4]	12 Yield (gallons per minute)	13 Use of water [5]	14 Remarks [6]
								T. 27 N., R. 3 E.									
24Q1	City of Edmonds	S	225	Dr	992			20	28	Sand with gravel.	Unconfined.	7±	Mar. 1944			PS	See log; temperature of water 43 F.
24Q2	do	U	280	Dr	390			78	32	Sand	do					PS	See log.
24Q3	do	U	290	Dg	106	144				do	do		1938	T		PS	
24Q4	do	U	285	Dr	98	10	98	65	33	do	do	54	1931	T		PS	Do.
24Q5	do	S	225	Dr	48	12	48	20	28	do	do	Flows	1931			PS	Do.
24Q6	do	S	225	Dg	40			20	20	do	do	Flows	1938			PS	
36B1	E. V. Berquist	U	325	Dg	64.1	48				do	do	59.3	Mar. 5, 1945	J	8	D, S	
36G1	C. M. Morehouse	U	380	Dg, Dr	126	60.8	126	105	21	do	do	117	Mar. 1945	P	4	D, S	Deepened 17 ft since dug in 1920.
36K1	D. K. Shilling	U	325	Dg, Dr	80	6							Feb. 1945	P	5	D, S	
								T. 27 N., R. 4 E.									
3A1	Puget Mill Co	U	525	Dg	221	72		200±	21±	Sand	Unconfined.	218	When dug			D, S	
3J1	Frank Sypes	U	475	Dr	120	5	120			do	do	110	1931	P	5	D, S	
3N1	H. Engler	U	575	Dg	184	46		90	94+	do	do	178	1942			N	Materials reported as 90 ft of till overlying aquifer.
3P1	Puget Mill Co	U	475	Dr	230	5	230			do	do	218	1928			N	
3R1	Clyde Randall	U	525	Dg, Dr	149	5	143			Sand, black			Mar. 1945	P	7	D, S	Reportedly has iron water at 122 ft; materials of upper 90 ft reported to be till.
5Q1	P. M. Rushmore	U	450	Dg	207	46		200±	7±	Sand	do	201	1925			N	See log.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation[1]	Approximate altitude above sea level (feet)	Type[2]	Depth (feet)[3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum[3]	Date of measurement	Type of pump[4]	Yield (gallons per minute)	Use of water[5]	Remarks[6]
T. 27 N., R. 4 E.—Continued																	
9D1	Mrs. G. S. Blethen	U	450	Dr	135	8–6	123	77	58±	Sand and gravel.	Unconfined			P		D	See log.
10P1	E. A. Lichtenstein	U	505	Dr	121.7	5	122±			do	do	108.7	Mar. 10, 1945			N	
11C1	——— Macomber (formerly Puget Mill Co.).	U	360	Dr	175	7	175	150±	25±	do	do	150±	1928			N	Reported to be plugged.
14D1	P. O. Swanson	U	395	Dg	50	48	50	48	2	do	do	40	Mar. 20, 1945			N	Reported to have penetrated "hardpan" (glacial till?).
14P1	O. J. Seline	U	430	Dr	118±	5				do				P	5	N	Water reported to fail after pumping 1 hour but to recover in 30 min.
15F1	Jennie Hunter	U	515	Bd	113±	10	113	107	6±	do	do	107±	1909	P	3	N	Well dry in 1945; see log.
15Q1	E. L. Viney	U	430	Dr	165	8–5	165	130	35	Gravel, sandy.	Unconfined (?).	130	1939	P	6	D, S	
17N1	Jennie Swartz	U	405	Dr	190	5	190	125	65	Sand	Unconfined.	125	1927			N	
18P1	Olie Nygaard	U	390	Dr	170	5	170	150±	20	do	do	150±	1927			N	
18R1	——— Berger	U	400	Dr	180	5	180	153	27	do	do	153	1928			N	
19D1	Maplewood Hills Community.	U	335	Dr	170	5	170	150±	20±	do	do	150±	1926			N	
19J1	C. X. Nicoulin	U	425	Dr	210	5	210	150±	60±	do	do	150±	1928	P	10	N	Former domestic supply for real-estate subdivision.
20D1	U. S. Army Signal Corps.	U	425	Dg, Dr.	185	6	185			do	do						Abandoned and plugged.
20D2	L. Heinz	U	410	Dg, Dr.	162	5	162	130±	32	do	do	130	1928			N	

20E1	E. Robinson	U	440	Dg	160±			155±	5	do	do	155±	1927			N	Do.
21G1	C. A. Hallund	U	440	Dg	20	48				Sand in glacial till.	do	5	Mar. 1945	P	4	D	
21K1	C. H. Willerling	U	360	Dg	53.4	48		51	5	Sand	do	51.4	Mar. 20, 1945	B		N	
22B1	Washington Co-operative Hatcheries, Inc.	U	425	Dr	102	5	102			do	do	80	1928			N	
23F1	Fred Hall	U	405	Dr	100	6	100	64-75 97-101	11	Gravel, sandy	do	64±	Mar.10, 1945	P	7	D	Adequate for lawn; see log.
24C1	C. H. Hildebrant	U	430	Dr	180	6	180	150	30	do	do	150	1941	P	6	D, S	
28P1	Peter Peisch	U	485	Dg, Dr	109.3	6	115±	106	9	do	do	106.2	Mar. 20, 1945			N	Dug to 109 ft, drilled to 115 ft.
29M1	Ranch Tavern	U	350	Dg	81.2	60		80±	1	Sand	do	80.1	Feb. 25, 1945			N	Abandoned.
30A1	Don Shaffer	U	425	Dg, Dr	229	8	229	169	60	do	do	169	Mar. 1945	P	10	D, S, Irr.	
30A2	do	U	410	Dr	180	6	198	144	54±	do	do	143.8	Mar. 13, 1945			N	
30C1	Sarah Loerpabel	U	450	Dg	195	48	196	185	11	do	do	168 184.8	1922 Mar. 5, 1945			N	
30F1	Everett Reed	U	455	Dg	170	48	170	167	3	do	do	167	1917			N	Abandoned and filled.
30H1	C. Polzin	U	385	Dg	118.8	48	115	116	2.8	do	do	109 116.7	1915 Mar. 5, 1945	P	3	N	
30J1	John Ditch	U	375	Dg	113.2	48	112	Dry		do	do	108 113	1916 Feb. 26, 1945	P	6	N	
30J2	J. Secor	U	380	Dg	112	36	112	109	3	do	do	109	1920			N	Well digger reports "hard-pan" to 22 ft, sand from 22 ft to bottom.
30K1	S. S. Atwood	U	400	Dg	124	48	133	121	12	do	do	121 121 121 127 130	1915 June 1920 May 1921 June 1927 July 1932			N	See log.
30K2	——— Ferguson	U	405	Dr	170	5	170	150	20	do	do	150	1928			N	
31K1	Charles Souter	U	450	Dr	230	5	230	200	30	do	do	200	do			N	
31Q1	——— McKenzie	U	375	Dr	145±	5	145				do					N	Well plugged above water level.
32D1	Henry Cassies	U	350	Dg	68	48		63	5	Sand, gravelly	do	63	Mar. 1945			N	
32K1	Niles Temple Country Club	U	345	Dr	150	6	150	130	5	do	do			T	10	F	See log.
32M1	R. E. Williamson	Uv	295	Dr	50		50±			Gravel and sand	do			N		N	Old public-supply well. Drilled to depth of 500 ft but finished at about 50 ft.
33P1	John D. Henry	U	380	Dr	115	6	115			Gravel, coarse	do	59	1931	P	6	D, S	

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation[1]	Approximate altitude above sea level (feet)	Type[2]	Depth (feet)[3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Tuickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum[3]	Date of measurement	Type of pump[4]	Yield (gallons per minute)	Use of water[5]	Remarks[6]
T. 27 N., R. 5 E.																	
1A1	W. N. Smith	U	265	Dg	25	60		24	1	Gravel in till	Perched	6	Feb. 1945	P	4	D	
1F1	Fred April	U	375	Dg	16	30		8	0.5	Sand above till.	do	4	do	J	5	D	Reported to be dry from August to March.
1R1	Cathcart School District.	U	250	Dr	153	6	153	140	10	Basalt (?)	Confined (?).	70	do	J	5	PS	See log.
2P1	Charles Gardner	U	600	Dg	31	54		28	3	Gravel in till	Perched	8.1	Feb. 17, 1945	P	4	D, S	
4D1	Tri-Way Grange No. 1093.	U	430	Dg, Dr	70	6	35–70	43	27	Sand, gravelly.	Unconfined.	47.1	Feb. 13, 1945			N	Do.
4Q1	J. A. Hardy	U	445	Dr	95	6	95	86	9	Sand	Confined	74	1944	J	4	D	"Hardpan" reported to overlie aquifer.
5L1	A. Donaldson	U	425	Dg	20	48		0	20	Gravel in till	Perched	1	Feb. 1945	B		D	Goes dry in late summer.
9C1	A. Lindstrom	U	405	Dr	53	6	53	50	3	Gravel, sandy	Unconfined.	44	do	J	4	D, S	
9E1	Myra Peters	U	375	Dg	15	48				Sand in till	Perched (?).	3	do	J	5	D, S	Barely adequate in late summer.
11F1	George Nygaard	U	570	Dg	51.5	71	8			do	Perched	38.7	Feb. 17, 1945	J	4	D	Almost dry in late fall.
11Q1	L. E. Roudebush	U	575	Dg	29.2	60				do	do	9.1	Feb. 20, 1945	P		D	Small capacity only.
11R1	Walter Jasna	U	600	Dr	258+	6–4	258	230	28+	Sand	Unconfined.	230±	Apr. 1947				Penetrated sand continuously below 80 ft of till.
12A1	F. E. Van Horn	U	230	Dg	16	144	15	12	4	Gravel	Perched	8	Feb. 1944	P	4	D, S	Supplies several families.
12J1	M. S. Dunlap	U	355	Dr	300	6	70	60	10	do	Confined	30	do	J	4	D, S	Water reported to be hard; see log.
12Q1	G. E. Dye	U	380	Dg	14	48				Sand in till	Perched	4	do	P		D, S	
13F1	Alys Pichler	U	435	Dg	16	48				do	do	12	do	P	4	D, S	
13L1	A. D. Crow	U	450	Dr	160	6	160	140	21	Sand, gravelly.	Unconfined.	117.0	Sept. 10, 1945	P	8	D, S	Supplies large poultry farm; see log.
13Q1	Carl Pichler	U	390	Dg	20	72	6	13	2	Gravel in till	Perched	6	Feb. 1945	P	4	D, Ind	Yield only 300 gal a day in summer.
14B1	W. D. Begis	U	575	Dg	82.2	48		81	1	Sand in till	do	78.8	Feb. 21, 1945	J	3	D, S	Well reported dry at times.

14C1	A. Crowe	U	520	Dg	20	48				do	do	Surface	Feb. 1945	J	4	D, S	Water reported low in late summer and autumn.
16D1	B. J. Einarsson	U	340	Dg	40	48				Sand	Unconfined.	30	do	P	4	D, S	Three wells required to supply large dairy farm in fall and winter.
16E1	Peter Botto	U	375	Dr	79	6	79	60	19	Gravel, coarse	do	59	1943	P	5	D, S	"Hardpan" reported to 45 ft, sand from 45 to 60 ft.
17J1	Omer De Wilde	U	340	Dg	39	48		37	2	Sand under till.	do	37	Feb. 1945	P	5	D, S	Dry in fall of 1944 for first time in 31 yr.
20N1	Robert Ormsby	Uv	140	Dr	34	6	34			Gravel and sand.	do		1944				Clay underlies 34 ft of sand and gravel.
21C1	Ada H. Morginer	U	380	Dr	120±	6	120±						1945	P	5	D, S	
21D1	Vincent Nardoni	U	385	Dr	132	6	132	95	27	Gravel, sandy	Confined (?).	86.1	Sept. 7, 1945	P	4	D, S	
21F1	Johan Johansen	U	400	Dg	37	48				Sandy till (?)	Perched.	18	Feb. 1945	P	4	D, S	Reported entirely in "hardpan" (till).
21M1	Rex Smith	U	410	Dr	139	6	139	130	9	Gravel, sandy	Unconfined.	130	1944	P	6	D, S Irr.	See log.
21N1	Cora Gale	U	405	Dg	103.8	48		102.1	1.6	Sand	do	102.1	Feb. 27, 1945			N	Reportedly once irrigated 1.5 acres.
21Q1	William Patterson	U	400	Dg, Dr	135	6	135						Feb. 1945	P	1	D, S	
24F1	B. H. Hoggart	U	425	Dr	110	4	110			Gravel				P	4	D, S	Supplies several families.
24J1	William H. Lee	U	400	Dr	121	6	121	114	7	Gravel, sandy	Confined (?).	106	1938	P	4	D, S	
24K1	Northern Pacific Railway.	U	410	Dr	104	6	104	95±	9	Gravel	Unconfined.	95	Feb. 1945	P	4	D, RR	
24L1	V. G. Adams	U	415	Dg, Dr	127	6	127			do				P	4	D, S	
24N1	John M. Fickle	U	435	Dr	120	5	120	108	12	Gravel, coarse	do	108	1938				Water reported slightly hard.
24P1	Thomas Grover	Uv	400	Dg, Dr	128	6	128	93	35	Sand and gravel.	do	93	1945	J		D	
24P2	Maltby School District No. 31.	U	415	Dr	100±	6	100	90	10	Gravel	do	90	Feb. 1945	P	5	PS	Supplies six to eight families.
24Q1	D. J. Charrier	U	465	Dr	124	6	124	120	4	do	do	120	1939	P	5	D, S	See log.
24Q2	——— Kissel	U	425	Dr	104	6	104	100	4	do	Unconfined (?)		1945	P	4	D	
25A1	A. Lans	U	485	Dr	168	6½	168	157	11	Gravel, coarse	Unconfined.	157	1931	P	10	D. Irr.	
25B1	W. F. Pepperill	U	450	Dr	153	6	153	151	2	Gravel	Confined	138	1938	J	8	D, S	Supplies large dairy farm.
25C1	E. D. Rany	U	415	Dr	102	6	102					85	1940	P	5	D, S	
26D1	Richard Layton	Uv	225	Dr	39	6	39			Pea gravel	do	+14	1944	P	4	D, S	Supplies two small farms.
26K1	H. W. Flanagan	U	400	Dr	80	6	80	78	2	Gravel	Unconfined.	55.7	Sept. 7, 1945	P	3	D, S	
26R1	E. H. Tuggle	U	450	Dr	144	6	143	133	11	Gravel, sandy	do	133	1939	P	5	D, S	Water reported soft; see log.
31R1	A. E. Long	U	270	Dr	208	6	208	195	13	Gravel	do	165	1944	J	5	D	Do.
32R1	L. J. Mitchell	Uv	50	Dr	498	8	261	217	24	Sand, silty	Confined	±1½	Mar. 1944			N	Flows at rate of 1 gpm; water yellowish with sulfurous odor; see log.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1 Well designation	2 Owner or occupant of property	3 Topographic situation [1]	4 Approximate altitude above sea level (feet)	5 Type [2]	6 Depth (feet) [3]	7 Diameter (inches)	8 Depth of casing (feet)	9 Water-bearing zone or zones: A Depth to top (feet)	9 B Thickness (feet)	9 C Character of material	9 D Ground-water occurrence	10 Water level: A Feet below land-surface datum [3]	10 B Date of measurement	11 Type of pump [4]	12 Yield (gallons per minute)	13 Use of water [5]	14 Remarks [6]
T. 27 N., R. 5 E.—Continued																	
35E1	Ray Butler	Uv	150	Dr	85	6	85	80	5	Sand, gravelly	Confined	12	Feb. 1945	J	6	D	Water reported to contain iron and to have sulfurous odor; temperature 48 F; see log.
35P1	Wellington Hills Country Club.	U	445	Dg, Dr	142	8	142	115	27	do	Unconfined.	120	Mar. 1944	T	50	Irr	See log.
35P2	George Pantell	U	450	Dr	149.2	6	149.2	140	9.2	Gravel, sandy	do	140	Feb. 22, 1945			PS	
36Q1	Crystal Lake Club	Uv	360	Dr	199	10	140	20+	122	Sand and gravel.	do	28±	Mar. 1944	T		PS	Supplies 26 dwellings; see log.
36R1	L. C. Green	Uv	375	Dr	66	4½	66	50	8	Sand, gravelly	do	43	do	J		D	See log.
T. 27 N., R. 6 E.																	
2J1	M. F. Wiese	Fp	70	Dr	70	6	65	62	8	Sand and gravel.	Confined	29	Jan. 1940		10	D	Drawdown 6 ft after 2 hours' pumping at 10 gpm; see log.
3D1	Aaron Vogan	Fp	35	Dr	42	6	42	40	2	Gravel	do	10	Feb. 1945	J	5		Drawdown 30 ft when pumped at 5 gpm.
3K1	J. P. Posey	Fp	50	Dr	45	6	45			do	do	8	do	J	5	D, S	Water reported to contain iron.
3Q1	Lyle Erlywine	Fp	50	Dr	41½	6	41	31	10	do	do	8	do	J	5	D	Water reported to be turbid in stormy weather and to taste of iron; see log.
5G1	E. Bebout	U	500	Dg	14	48		10		Sand under clay.	Perched	6	do	P		D, S	Small yield; water reported soft.

5L1	Frank Johnson	Fp	25	Dg	20	48		18	2	Gravel	Confined	10	do	P		10 S	Water level reported to fluctuate with river; water reported to contain iron.
6D1	Robert Strom	S	260	Dg	7	60				do	Perched	2	do	J	5	D, S	
6E1	J. S. Johnson	S	265	Dr	145±	6	145±						do	J	3	D	
8F1	Henry Lambert	Fp	25	Dr	54	6	54			Sand	Unconfined.	27	do	P	5	D, S	
8N1	T. A. Martin	S	90	Dg	10	60				Bedrock (basalt?).	do	5	do	J	5	D, S	Water issues from crack in bedrock beneath clay.
10H1	Daniel Stoller	S	130	Dg	14	60		12	2	Gravel under glacial till (?).	Perched	3	do	P		D, S	Supplies several families; water reported soft and iron-free.
10J1	William Treosti	S	130	Dr	38	6	38			Gravel in till	do		do			N	Abandoned; water reported to taste strongly of iron.
10R1	Alpha Helm	S	125	Dg	18	48				Sand in till (?)	do	2	do	P	4	D	Barely adequate for two families; water reported to taste slightly of iron.
10R2	do	S	150	Dr	72	6							do				Dry hole. See log.
12R1	John O'Dell	Fp	50	Dr	40	6	40			Gravel	Unconfined.	14	Mar. 1945	P	5	D, S	
13D1	W. Wolfe	Fp	40	Dg, Dr.	25	4	25	22	3	do	Confined.	6	do	P	5	D, S	
13L1	Public School District No. 322.	Fp	45	Dr	30	6	30			do	Unconfined.	10±	1933	P	4	P S	Water reported to taste strongly of iron.
14E1	W. R. Paddock	S	50	Dg	25	60				Sand under till	Confined	6	Feb. 1945	J	6	S	Do.
14E2	do	S	40	Dr	627	6	None									N	Dry hole. See log.
14K1	Elmer Frohning	Fp	45	Dr	32	6	32	12	20	Gravel	Unconfined.	12.4	Mar. 1, 1945			N	Pump to be installed.
14R1	W. F. Shannahan	Fp	45	Dr	45	6	45	12	33	Gravel, fine	do	11.8	do			N	Pump to be installed; very strong iron taste to water reported.
41R2	Shannahan Estate	Fp	45	Dr	42	6	42	14	28	Gravel	do	14	1933	P	6	D, S	
15E1	Mrs. Alma George	S	75	Dg	2	60		20	2	Gravel in till	Perched	8	Feb. 1945	P		D	Water reported to contain some iron.
17A1	Robert H. Anderson	S	70	Dr	254	6	254	31	1	Sand in till(?)	do	6	do	P	4	D	Dry below 22 ft; see log.
17E1	C. L. Bowes	S	175	Dr	90	6	30	50	13	Sand, coarse	Confined (?)	40	1942	P	5	D, S	
17M1	Frank Fales	U	220	Dg	9	60		8	1	Gravel under clay.	do	4	Feb. 1945	J	4	D, S	Aquifer underlies gumbo clay.
18P1	Frank Faust	U	360	Dg	60	48					Unconfined.	57	do	J	4	D, S	Dry in late autumn and early winter.
24N1	M. Borsheim	Fp	45	Dr	35	6	35			Gravel			Mar. 1945	J	4	D, S	Mucky sand tested from 35 to 55 ft and casing pulled back.

See footnote at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
								T. 27 N., R. 7 E.									
1C1	T. Blake	St	380	Dr	132	6	132	100	32	Sand, gravelly	Unconfined.	100	1930	P	5	D, S	Fine sand reported below 125 ft.
2C1	R. S. Hansen	St	370	Dr	190	6	190			Sand	do			P	5	D, S	Once deepened 15 ft to case off "bad" sand.
5J1	Don Smith	St	70	Dr	378	6	370	78	4	Sand, fine	Confined	Flow	Mar. 1945			N	Water charged with methane gas; no water developed below 82 ft; see log.
5J2	Demar Flemming	St	75	Dr	135	6	50	50	5	do	do	Flow	do			S	Inner casing of 4-in. diameter extends to land surface and has outside seal at 55 ft; flow estimated at 3 gpm of water charged with methane gas.
						4	130	130	5	Sand, gravelly	do	7	do	C	10	D, Irr	
5L1	Don Smith	St	75	Dr	30	10–8	30	26	4	Gravel	Unconfined.	12	do	C	20	Irr, S	Water has strong taste of iron.
6L1	City of Monroe	Fp	65	Dg	20.7	300	20		2+	Gravel, sandy	do	17.8	July 31, 1944	C	400	PS	For emergency use only; water reportedly contains iron or "acid."
6L2	do	Fp	65	Dg	26	300	25		8+	do	do		July 1944			PS	Do.
7A1	Ohlson Brothers	Fp	65	Dr	30	6	30	16	14	Gravel	do	16	Mar. 1945	P	7	D, S	Adequate for dairy; water level reported to fluctuate with river.
7D1	E. Niederle	Fp	65	Dr	25	6	25	15	10	do	do	15	do	P	8	D, S	
7F1	M. W. Shrum	Fp	70	Dr	29	6	29	13	16	do	do	11.4	Mar. 1, 1945	C	20	D, Irr, S	Drawdown 1.1 ft after pumping at rate of 20 gpm for 15 min.

T. 28 N., R. 4 E.																	
9Q1	—— Dodd	U	435	Dr	215+	6							1944			N	Abandoned.
13H1	A. H. Dorr	U	530	Dg	22±	48				Sand and gravel.	Perched	5.1	Dec. 27, 1945	P	5	D	
14A1	Town of Mukilteo	U	600	Dr	500±	6 (?)				Sand, fine							Choked with sand; abandoned.
22B1	U. S. Army Air Corps.	U	580	Dr	547	10–4½					Unconfined.		Mar. 1944		240 (?)	N	Abandoned owing to inadequate yield; see log.
24K1	John Taylor	U	515	Dg	15	60				Sand in till (?)	Perched	3	Jan. 1945	P	5	D	
T. 28 N., R. 5 E.																	
2L1	H. H. Seaman	U	310	Dr	205	6	112	109	3	Sandy zone in blue clay.	Unconfined.	109	1930			N	Small yield of water with earthy taste reported; see log.
2Q1	Harry W. Moser	U	320	Dg	41			37	4	Sand, gravelly	Perched	37	Jan. 1945	J	3	D	See log.
2R1	Walter Deierling	U	325	Dg	32	48		29	3	Gravel, sandy	do	29	do	B		S	One of two similar wells.
3Q1	Peter Wallin	S	140	Dg	30					Sand in till (?)	do	10	do	J	4	D, S	Estimated capacity 700 gpm; not used; see log.
5B1	Everett Pulp and Paper Co.	S	10	Dr	776	18	776									N	
6J1	—— Montgomery	U	400	Dr	200	8		120	10	Gravel, pea-sized.	Unconfined.					N	Yielded 40 gpm; formerly property of Lowell Water District; abandoned.
6R1	Pinehurst Water District.	U	410	Dr	257	10–8		{170 / 247	4 / 8	}Sand, gravelly	do	170	June 1942			PS	
7G1	Beverly Park Water Co.	U	490	Dr	192	6				Gravel, sandy	do			T	150	PS	Temperature of water 45 F.
7G2	do	U	500	Dr	217	8	212	144	73	do	do	138	1936	T	250	PS	Estimated capacity 200 gpm; see log.
7G3	do	U	475	Dr	180±					do	do						All characteristics similar to those of well 7G2.
7H1	Pinehurst Water District.	U	410	Dr	170	10–8	257			do	do			T	325	PS	Characteristics similar to those of well 7G2; see log.
10H1	A. Orup	S	130	Dg	30	30	30	29	1	Sand under clay.	do	10	Jan. 1945	P	4	D, S	
10L1	Anna Melnyk	Fp	20	Dg	70	3	70			Sand	do	8	Feb. 1945	P	4	D, S	Water reported to have iron taste.
10M1	George Levich	Fp	20	Dg	18	22		18		do	do	15	do	P		D	Do.
10R1	Martin Misich	Fp	20	Dr	74	4	74	69	5	do	Confined.	13	Sept. 1940				See log.
11E1	J. E. Campbell	S	120	Dg	20	48				Sand in till (?)	Perched	15.4	Sept. 10, 1943	P	4	D, S	

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 28 N. R. 5 E.—Continued																	
11G1	Clark Aubert	S	225	Dr	197	5	175	175	4	Gravel, silty	Unconfined.	161.1	Feb. 5, 1945	J	6	D, S	Water reportedly has slight swampy taste in late summer and is turbid. Quicksand below, till and clay above aquifer.
11G2	Clarence Dubuque	S	255	Dr	99	6	97	96	3	Silt, sandy	Perched.	97±	1945	J	3	D	See log.
11G3	E. W. Goldinger	S	265	Dr	70	5	70			Sand			do	P		D	Small yield.
11P1	Otto Bucher	S	60	Dg	24	48		22	2	Sand, gravelly	Confined.	12	Jan. 1945	J	4	D, S	Sand reported down to 20 ft, clay from 20 to 22 ft.
11Q1	Independent Order of Oddfellows (Woodlawn Cemetery).	S	125	Dr	150±	3							do	P	4	Irr	Water reported to have slight iron and strong swampy taste in late summer.
12A1	C. L. Poier	S	105	Dr	64	6	64	60	4	Gravel	do	20	do	C	30	S, Irr	Reported to have small drawdown after 72 hours' pumping at 30 gpm.
12C1	J. H. Vail	S	140	Dg	48	48	48	47	1	Sand, gravelly	Confined (?)	42	do	P	2	D	Materials reported as blue clay from surface to aquifer.
13K1	E. W. Peacore	Fp	10	Dr	139	4	139	139			Confined.	Flow	Feb. 1945			N	Flow estimated at 5 gpm; reportedly no flow at low tide in late summer.
17K1	E. G. Aney	U	470	Dg	15	48		13	2	Gravel	Perched.	Surface.	do	P	4	D	
18A1	Cypress Lawn Cemetery.	U	530	Dr	280	6	260	240	20	Gravel with coarse sand.	Confined.	170	1943	P	20	D, Irr	Drawdown 2 ft after 20 minutes' pumping at 50 gpm.
18D1	Lynn E. Sorenson	U	570	Dr	246	5	246	220	26	Sand with gravel, fine.	Unconfined.	217.8	Feb. 5, 1945	P	4	D, O	See log. Water has chloride content of 5 and hardness of 50 ppm.

19P1	Snohomish County Fair Grounds.	U	460	Dg	148	30		145	3	Gravel, sandy	do	145.4	Feb. 7, 1945	P	10	N	Pump capacity about 10,000 gal a day; well used for fair events.
20D1	F. A. Franke	U	470	Dr	185	6				Sand, silty	do	120.0	Jan. 24, 1945		20	N	Reported to have had turbid water.
21D1	Arthur C. Lindell	U	350	Dg	100	3-18	100	97	3	Sand, gravelly	Perched (?).	97	Feb. 1945	P	5	D, S	Adequate for three families; see log.
21N1	William Mark	U	400	Dg	65	60		61	4	Sand under till.	Unconfined (?).	61	do	P	3	D, S	Thirty-five feet of till reported at top.
24H1	Noble Harvey	Fp	20	Dn	18	2½	18	17	1	Sand, fine			do	P		N	
27L1	Paul McClellan	S	375	Dr	119	6	119	90	29	do	do	74	Aug. 1943	J	4	D, S	May be perched water; see log.
27M1	Charles Fitzgerald	U	385	Dr	110	6	109	105	4	Sand, gravelly.	Unconfined.	70	June 1945			D, S	See log.
27N1	C. H. Sedgewick	U	435	Dr	119	6	115	102	8	do	do	94.2	Aug. 30, 1945				New well; pump not installed; see log.
27N2	P. L. White	U	395	Dr	106	6	105	93	12	Sand	do	56.6	do				New well; pump not installed.
28J1	Gilbert Hazle	U	380	Dr	90	6	90	87	3	Sand, gravelly.	do	69	June 1944	J	3	D	Drawdown 0.5 ft after pumping 2 hr at 50 gpm in June 1944.
28N1	U. S. Department of Commerce.	U	435	Dr	71	6	71	67	4	Sand with fine gravel.	Unconfined(?).			P	5	D	See log.
28P1	F. R. Stump	U	430	Dg, Dr	131	6	131	128	3	Gravel, sandy	do	63	May 1943	J	4	D, S	Negligible drawdown reported after 5 hours' pumping at rate of 16 gpm; see log.
28R1	R. G. Osborn	U	375	Dg, Dn	57½	60	1½	56	1½	Sand, fine	Unconfined.	56	Feb. 1945	P	3	D, S	Season water-level fluctuation reported to be less than 1 ft.
29D1	W. E. Stubbs	U	440	Dg	35	60		26	2	Gravel in till (?).	Perched	6	do	P	3	D	
29N1	W. M. Oberlander	U	465	Dr	109	6	109	95±	14	Gravel	Unconfined.	84	Mar. 1943	P	5	D, Irr	Supplies 18 families in dry seasons; see log.
29N2	Silver Lake Union School District.	U	455	Dr	96.1	6	96+	93±	3		do	93.5	Feb. 13, 1945			N	See log.
31A1	E. C. Minge	U	445	Dr	125	5-4	125	74±	51	Sand, coarse	do	74.0	Feb. 7, 1945	P	4	D	Do.
32A1	N. A. Nelson	U	400	Dg	18	48				Sand in till(?)	Perched	12	Feb. 1945	P	5	D, S	Inadequate.
32R1	George Day	U	420	Dg	25					do	do	22	do	B		D, S	
33B1	D. O. Tallman	U	455	Dr	102	6	102			Sand	Unconfined.	82	Aug. 1944	P	5	D, S	
33F1	James Garrison	U	430	Dr	73	6	73	60	13	Sand, gravelly.	do	51	Mar. 1945			N	New well; pump to be installed; see log.
33P1	Robert Holzerland	U	410	Dg	40	72		38+	2	Sand, fine	do	38	Feb. 1945	J	3	D, S	"Hardpan" (till?) reported from surface to depth of 30 ft.
36G1	R. J. Stark	S	125	Dg	14					Sand in till	Perched	11	July 1945	P		S	
36P1	Fred Munt	S	325	Dr	51	4	50	50	1	do	Perched (?).	10	Feb. 1945			N	New well; pump to be installed.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground-water occurrence	A Feet below land-surface datum [3]	B Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 28 N., R. 6 E.																	
4L1	J. F. Scott	S	220	Dg	20	48		18	2	Gravel, sandy	Perched	6	Jan. 1945	P		D, S	Water reported to have slight iron content.
6D1	George Surdyk	Uv	225	Dr	68	6		63	5	Sand	do	63	1944	P	3	D, S	
6Q1	Carl A. Sorgenfrei	U	205	Dr	183	6	183	178	5	Gravel	Confined	168	1931			N	Log reported as till to 100 ft, then clay to aquifer; see log.
8H1	P. A. Pedersen	S	155	Dg	10	48		9	1	Gravel in till	Perched	Surface	Feb. 1945	Sy		D, S	
9P1	Melvin Ohlde	U	344	Dr	200	8	12	80	2	Sandstone	Unconfined.	103.8	Jan. 31, 1945	P	3	D, S	Inadequate; yield 500 gal. a day; see log.
11C1	N. K. Johnson	U	560	Dg, Dn	75	6	75	60	15	Gravel, sandy	Confined	50	Jan. 1945	P	4	D, S	See log.
12N1	J. W. Spada	U	500	Dg	23	60				Sand in till	Perched	13	Feb. 1945	P	4	D, S	One of three wells of similar character.
14D1	A. J. Lane	U	375	Dg	12	48				do	do	4	do	P		D, S	
15G1	D. E. Black	S	350	Dg	12	48		10	2	do	do	5	do	P	3	D, S	
15R1	G. E. Dougherty	S	225	Dg	65	60		63	2	Gravel	Confined	12	do	P	4	D, S	Water level reportedly never more than 40 ft below surface.
16R1	do	S	110	Dg	14	48		12	2	Gravel in till (?).	do	Surface	do	J	4	D	
17B1	H. H. Thieschafer	S	190	Dg	14	60		11	3	Sand in till	Perched	Surface	do	P		D, S	Inadequate in late summer.
19P1	Peter Van Soest	Fp	20	Dn	30	2½	30	29	1	Gravel	Confined (?).	20	do	J	4	D, S	Inadequate in dry season; water reported to have strong iron taste.
22A1	U. S. Civilian Conservation Corps.	S	225	Dr	524	6-4½	494	25		Gravel, fine			1937			N	Yields only one-half gallon a minute at 25 ft; see log.
22A2	Carl Clapp	S	230	Dr	150	6	144	144	6	Sand, coarse	Confined	60	1924			N	Abandoned; see log.
22J1	C. B. Downing	S	55	Dr	126	6	126	117	9	Gravel	do	8.6	Dec. 28, 1945	J	5	D, S	See log. Water has chloride content of 35 and hardness of 150 ppm.

22P1	B. M. Tester	Fp	30	Dg,Dn	50	2½	50	40	10	Sand	do	Surface	Mar. 1945	P	5	D, S	Another well in sand at same depth yields water with iron taste and hydrogen sulfide odor.
22R1	John C. Torvig	Fp	30	Bd	32	2	32	32		Gravel under clay.	do	+6	Feb. 1945	J	5	D, S	One of two similar wells.
23N1	L. H. Jones	Fp	35	Bd	25	12–8	25	25		do	do	+3	do	J	5	D, S	
26D1	E. C. Medill	S	40	Bd	32	8	32	32		Gravel	do	+2	do	J	10	D	Pumps dry in 1 hr at 10 gpm; clay from surface to aquifer.
27H1	Lars Lund	Fp	35	Bd	50	2	50			do	do	+20	1925			D, S	
29H1	C. R. Cedergreen	S	50	Dr	138	6	138	130	8	do	do	12	Feb. 1945	T	80	S. Irr	Drawdown 13 ft when pumped at 80 gpm; water has strong iron taste; see log.
29J1	Gerald Drennen	S	75	Dg	6	24	6	4	2	do	Perched (?).	4	do	C	10	D	Water piped to two families, hauled to several others in dry season.
30M1	Earl Bailey	Fp	15	Dr	35	6	35	27	8	Sand, gravelly	Confined	14	June 1941	C	10	Ind	See log.
31A1	O. F. Peter	Fp	20	Dg	14	36	14			Sand	Unconfined.	6	Feb. 1945	J	4	D, S	
31E1	Earl Jarnigan	St	190	Dg, Dn	40	2½	40	40		Gravel	do	20	do	J	4	D	
31H1	——— Stevens	Fp	20	Dr	45	6	45			do	Unconfined (?).	10	do	J	4	D, S	Water reported to have iron taste.
32H1	Paul Delnhoff	U	200	Dg	25	48		23	2	Gravel under till.	Confined.	13	Aug. 1944	P	4	D, S	
32M1	E. A. Douglas	Fp	25	Dr	40	6	40			Gravel	do	12	Feb. 1945	J	4	D, S	Do.
35E1	Bozeman Canning Co.	Fp	25	Dr	127	6	127				do	Flow	Mar. 21, 1945	C	70	Ind	Water reported to carry much methane gas.
35E2	do	Fp	25	Dr	193.4	12–10	300	124	69	Gravel	do	6.5	do				New well; pump to be installed; see log.

T. 28 N., R. 7 E.

16J1	L. A. O'Dell	S	345	Dr	40	6	40	37	3	Gravel	Confined.	6	1931	P		D, S	See log.
20P1	John E. Hunziker	U	490	Dr	111.3	6	111	88	23	do	Unconfined.	87.1	Mar. 2, 1943			N	New well; pump to be installed; see log.
25L1	E. E. Geyer	S	330	Dr	148	6	148	102	46	Gravel, sandy	do	135	1933	P	6	D, S	See log.
29R1	Chester Love	St	330	Dr	108	6	108	96	12	Sand, gravelly	Confined (?).	82	1944	J	4	D, S	Do.
31H1	City of Monroe	S	250	Dr	220	12–10	220	{170 193	20 19	}Sand	do	58	do	T	600	PS	City well 3. Drawdown 67 ft after several hours' pumping at 600 gpm; see log.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 28 N., R. 7 E.—Continued																	
31H2	City of Monroe	S	255	Dr													City well 40. Very similar to well 31H1.
32E1	do	S	250	Dr	232	10–8	232	185 202	17 29	Sand, gravelly Sand, coarse	Unconfined (?).	174	1937	T	350	PS	City well 1. Drawdown 17 ft when pumping at 500 gpm (1937); see log.
32E2	do	U	250	Dr	226	10	226	190 220	30 6	Sand, gravelly	Unconfined.	179	do	T	500		City well 2. Drawdown 16 ft when pumping at 500 gpm (1937); see log.
32F1	do	U	250	Dr	716	18–8	716	550 569	3 147	do Sand	Confined	150±	June 1942			N	Unnumbered city well. Reported to have very limited capacity; see log.
32N1	Burke Andrews	Fp	75	Dg	11	48	11	2	9	do	Unconfined.	2.3	Mar. 24, 1945	P	5	D, S	Water reported to have strong iron taste.
33R1	J. F. Sleisman	St	290	Dg, Dr	119	6	119	110	2	Sand and gravel.	do	110	1929	P	6	D, S	See log.
34M1	Julius Cast	St	290	Dr	115	6	115			Gravel, sandy	do	96.4	Mar. 3, 1945	P	5	D, S	
34N1	T. Mittlider	St	290	Dg	118	6	115			Gravel			1920	P	6	D, S	
34P1	William Davis	St	310	Dr	137	6	137	130	7	Sand	do	126	1933	P	6	D, S	Do.
36P1	Ben Stuckey	St	380	Dr	130	6	125	100	25	Sand, coarse	do	100	1925	P	6	D, S	Do.
T. 28 N., R. 8 E.																	
21M1	W. H. Sheeler	U	625	Dr	210	6	210	191	19	Gravel, sandy	Confined (?).	180	July 1940			N	Abandoned and plugged; see log.

										T. 29 N., R. 4 E.							
1A1	Priest Point Beach Water Co.	S	125	Dr	174	8-6	172	157	15	Sand, fine gravel.	Confined.	120	Apr. 1941	T	50	PS	Serves about 50 homes see log.
1D1	Hal N. Snyder	S	85	Dr	120	6	120			Sand and gravel.	Unconfined.			P		D	Water has hardness of 170 and chloride content of 7 ppm.
1G1	Steven Saunder	S	40	Dg	14			8	6	Sand, gravelly	Unconfined (?).	8	July 1944	R		D	Sand from surface to bottom.
1G2	Earl Edgar	S	85	Dr	132	6	132			Sand and gravel.	do			R		D	Water has hardness of 75 and chloride content of 19 ppm.
1G3	Robert Best	S	85	Dr	130	6	130			do	do			J		D	Water has hardness of 105 and chloride content of 9 ppm.
										T. 29 N., R. 5 E.							
1B1	Bert Tastad	U	350±	Dg	32	72	6	15	17±	Sand in till (?)	Perched	15	Aug. 1944	P		D	Yield only 80 gal a day in dry season.
1C1	Otto Viklund	U	325	Dg	26.7		2	20.7	6	Sand, fine	do	20.7	Aug. 21, 1944	B		D	Till to 18 ft, sand to bottom.
1F1	John Wiklund	U	335	Dg	52		5			Clay, sandy	do	39.9	Aug. 18, 1944	J	5	D, S	Till to 40 ft, clay to bottom.
1P1	J. R. Shiek	U	365	Dr	180	6	180	176	4	Gravel and sand.	Confined	132	Aug. 1944	P	5	D, S	Drawdown 7.5 ft after 3.5 hours' pumping at 16 gpm; till, silt, and clay to 176 ft and blue clay at 180 ft.
2B1	Benjamin Thompson.	U	275	Dg	12			8	4	Gravel in till	Perched	8	do	P		D	Till to 8 ft; water level rises to 3 ft in winter.
2F1	L. Falkner	U	275	Dg	115			110	5	Gravel, coarse	Unconfined.	111.9	Sept. 25, 1944	P	5	D, O	Supplies two families; see log.
2J1	John Van Meter	U	275	Dg	24					Sand in till	Perched	5.9	Aug. 21, 1944	P		D	One of two adjacent, interconnected wells.
2L1	Jeanette C. Meyer	U	230	Dg	25.6					Sand in till (?)	do	13.7	do	P		PS	Inadequate; water rises almost to land surface in winter.
2R1	H. H. Bryby	U	275	Dg	19.3	120				Gravel in till	do	11.2	do	P		D	One of three similar wells; low in dry season.
3H1	Mrs. O. W. Johnson	S	135	Dg	40					Glacial till	do	Dry	Aug. 1944			N	Abandoned.
3R1	A. L. Putnam	S	75	Dg	21.1	60	5			Sand in till (?)	do	17.6	Aug. 16, 1944	J	7	D	Inadequate in dry season; water has hardness of 130 ppm.
4G1	Herbert Connor	Tf	5	Dr	120±						Confined	2	Sept. 1, 1944			N	Water reported to be red, gaseous, unpotable.
8R1	Weyerhauser Timber Co. (mill B).	Fp	10	Dr	1545											N	Abandoned; reported to have hydrogen sulfide water; see log.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 29 N., R. 5 E.—Continued																	
10A1	L. H. Triesch	S	50	Dr	97			96	1	Gravel			Aug. 1944	P		D, S	Water has hardness of 110 ppm.
10B1	do	Tf	10	Dr	136	12	101	97	4	Sand and gravel	do	12 1	1931 Aug. 1944			N	See log.
11C1	Thomas Rowe	S	50	Dg	40					Sand in clay	Unconfined.	25	do	P		D	Inadequate in dry season.
11F1	Carl Neilson	S	40	Dg	62.7	48				Sand in till (?)	do	38.8	Aug. 22, 1944	P	5	D	Overflows in wet season and pumps dry in summer.
11L1	R. Smith	S	50	Dg	21.4					Sand, silty	do	20.7	do				
13B1	M. N. Honeycutt	U	340	Dg	21±			18	3±	Sand below till	Perched (?).	11	Aug. 1944	P	5	D, Irr	
14H1	George A. Bolton	U	230	Dg	13	72	13	13		Sand	Perched	2.3	Aug. 21, 1944	P	10	D, S	Water level reported fairly constant.
19K1	Soundview Pulp Co.	Tf	15	Dr	110	8	110	90	20	Sand, medium	Confined	12	1940	T	300	Ind	Company well 1. Drawdown 8 ft after 16 hours' pumping at 300 gpm. Test hole drilled to 660 ft; see log.
19K2	do	Tf	15	Dr	100	12	100	71	29	Sand and gravel	do	3	1941	T	500	Ind	Company well 2. See log; see table 5 for chemical analysis.
19K3	do	Tf	15	Dr	110	10	110	75	31	do	do	8	do	T	350	Ind	Company well 3. See log.
19P1	American Ice and Cold Storage Co.	Tf	25	Dr	124	10	122	85 109	12 13	Sand, fine gravel	do	11	May 1945			Ind	See log; hardness of water is 110 and chloride content is 10 ppm.
23Q1	Alex Anderson	S	240	Dg	20	48		17	3	Gravel, sandy	Perched	3	Jan. 1945	P	4	D, S	One of two similar wells.
24C1	Harry Treider	U	390	Dg	24	36	28	28	1	Sand in till	do	13.6	do	P	5	D	
24N1	C. B. Keith	U	310	Dg	32	48		29	3	do	do	27	do	P	4	D	
24R1	A. W. Chick	U	390	Dg	113	48		12	1	do	do	4	do	P	4	D, S	Inadequate in dry season.
25N1	John Crowley	S	190	Dg	29	48		26	3	do	do	8	do	P	4	D	
25N2	Henry L. Boroup	S	200	Dr	150	6	120	80		Sand	Confined	18	do	P	4	D	

28P1	John Brandsma	Fp	20	Dn	65	2½	65			Sandy, peaty	do	Surface	Feb. 1945	P		S	Water reported to be un potable.
29G1	Eclipse Mill Co.	Fp	20	Dr	217	16–8	215	77	9	Sand, gravelly	do	Flow	Mar. 1944	C	400	Ind	Reported to flow at rate of 100 and pump at rate of 300 gpm with 7-ft draw-down. See log; see table 5 for chemical analysis.
31Q1	Meadowmoor Ice Cream Co.	U	320	Dr	140	6	139			Gravel	Unconfined.	104.0	June 25, 1946			Ind	See log.
33F1	George Pinkston	Fp	20	Dr	110	8					Confined	Surface	Feb. 1945			N	Abandoned and plugged; small seep at surface; water tastes salty.
36G1	John W. Cockran	U	350	Dg	3.5	36	3	0.5	3	do	Perched	0.5	Jan. 27, 1944			D	Aquifer overlies till.
										T. 29 N., R. 6 E.							
4A1	J. Bertsch	U	350	Dr	186	6				Gravel				J	10	D, S	Hardness of water 85 ppm.
4A2	George Hungar	U	360	Dg	9.1	30					Perched	4.5	Aug. 24, 1944	P	4	D, S	
4J1	W. K. Weisner	U	285	Dg	21.7					Sand in till (?).	do	17.9	Aug. 22, 1944	P	4	D	Inadequate in dry season.
4Q1	J. L. Stribling	U	300	Dg	24.0	48				do	do	8.9	Aug. 24, 1944	P	4	D, S	Barely adequate in dry season.
5A1	August Nelson	S	265	Dg	54.4	48		45	9	Gravel, sand	Unconfined.	49.3	Aug. 22, 1944	J	5	D	Till overlies aquifer.
5G1	R. Morrison	U	265	Dg	56.8					Sand in till (?).	do	46.1	do	J	5	D, S	
5L1	G. W. Bryn	Uv	300	Dg	6					Gravel under till.	Perched	Surface.	Aug. 1944	C		D	Well overflows; may have been a spring.
6A1	E. A. Thomas	Uv	320	Dg	22					Sand in till (?).	do	Dry	Aug. 18, 1944	P		D	
6D1	Paul Tastad	U	359	Dr	247	6	247	200	47	Gravel, coarse	Confined.	40	Aug. 1944	J	10	D, S	Reportedly 100 ft of till and 100 ft of sand over aquifer. Hardness of water 90 ppm; drawdown 10 ft after 1 hour's pumping at 10 gpm.
6F1	Joseph Gregor	U	365	Dg	19.0	30				Gravel in till	Perched	11.7	Aug. 18, 1944	J	5	D, S	Barely adequate in dry season. Water enters well from sides.
6N1	W. E. Forest	S	250	Dg	16					do	do		1944	P	6	D	
6R1	Alfred T. Martina	U	420	Dg	24.7	60				do	do	22.6	Aug. 22, 1944	P		D	Till from surface to bottom.
7D1	H. J. Carlson	Uv	230	Dg	40±					Sand in till (?).	do	Dry	Aug. 21, 1944				Inadequate; one of two interconnected dug wells.
7D2	do	Uv	230	Dr	109	6	109	99	10	Gravel and sand.	Confined.	7–8	July 1945	J	9	D	Till reported to 65 ft, clay from 65 ft to aquifer.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water bearing zone or zones				Water level					
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground water occurrence	A Feet below land-surface datum [3]	B Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 29 N., R. 6 E—Continued																	
7D3	Snohomish County Public Utility District No. 1.	Uv	230	Dr	400	8		102	6	Sand, tight	Confined	15±	Feb. 1946			N	Test indicated capacity of only 15 gpm; see log.
7J1	H. L. Oldfield	S	320	Dr	352	352	4	346	6	Gravel, fine	do	100±	Aug. 1944	P	6	D, Irr	See log. Water hardness is 15 ppm.
8E1	Thomas Kennaugh	S	350	Dr	53	6	53	50	3	Gravel, coarse			1944	J		D, Irr	Till reported to 43 ft, clay from 43 to 50 ft, overlying aquifer. Hardness of water is 65 ppm.
8E2	Hugo Backstrom	S	320	Dr	50	6	50	44	6	Sand, black	do	6	Nov. 1944	J	5	D	Till reported to 40 ft, then blue clay to 44 ft.
8E3	—— Knudson	S	320	Dr	65	6	65	59	6	do	do	20	1940	J	5	D	
8F1	Lake Stevens School District.	S	280	Dg	45	48	45			do		35±	Aug. 1944	J	15	PS	Furnishes drinking water only. Till overlies aquifer.
8F2	F. M. Taro	S	290	Dg	23					Sand in till (?)	Perched	19.0	Aug. 18, 1944	P	5	D	"Cobbly" till from surface down.
8F3	do	S	300	Dr	148	6	148				do			P	4	D	Reportedly 10 ft of soil and 138 ft of till.
8F4	Snohomish County Public Utility District No. 1.	S	255	Dr	318	8	318	310	5	Sand	Confined	70±	Feb. 1946	T	85	PS	See log. Water has chloride content of 4 and hardness of 40 ppm.
8H1	Joseph DeBaer	Uv	230	Dr	52	6	52	51	1	Gravel			1944	P		S, Irr	Till from surface to aquifer. Water reported "swampy" and turbid.
8H2	Snohomish County Public Utility District No. 1.	Uv	210	Dr	108	20-12	104	53	51	do	do	25	June 1947	P	700	PS	Large yield from sub-till gravel reported.
8L1	F. M. Taro	S	220	Dr	120	6	120	115	5	Sand	do	+2	June 1945	P	5	S, Irr	Till to 65 ft, then clay to depth of 115 ft.

8M1	William Owens	S	310	Dr	66	6	66	60	6±	Sand, black	do	12±	1940	P	6	D, S	Till to depth of 60 ft.
9D1	W. R. Morris	Uv	230	Dg	21					Sand in till (?)	Perched	12±	Aug. 1944	P	4	D	Perennial; till throughout entire depth.
9E1	J. E. Nelson	Uv	190	Dg	12	24		8±	16±	Sand, gravel	Unconfined.	8±	do	P	4	D, S	Sand and gravel reported throughout entire depth.
16C1	H. Bakker	Uv	180	Dn	32			26±	6±	Gravel	do	26	do	P	5	D, S	Sand and gravel throughout entire depth. Water hardness 35 ppm.
16C2	J. Meagher	Uv	180	Dg	18.8					Gravel (?)	do	16.9	Aug. 24, 1944	P	5	D, S	
18K1	O. M. Haig	S	250	Dg	30					Sand in till	Perched	5	Jan. 1945	P	5	D, 4	
30N1	E. K. Erlandsen	U	345	Dg	12			10	2	do	do	4	do	P	4	D, S	Till overlies aquifer.
31C1	C. H. Burns	U	355	Dg	24	48		14	10	Gravel (?)	do	14	do	P	4	D, S	Materials reported as 4 ft of gravel and 10 ft of clay over aquifer.
33B1	Edmond Hawk	U	330	Dg	12	48		10	2	Sand in till (?)	do	5	Feb. 1945	P	4	D, S	
36R1	W. T. Block	U	600	Dg	30	60				do	do	Surface	Mar. 1945	P		D, S	
										T. 29 N., R. 7 E.							
21P1	Richard Roesiger	U	580	Dr	86	6	86	79	7	Gravel, coarse	Confined.	50	1938	P		D	Adequate for small lake resort; water reported turbid.
										T. 30 N., R. 4 E.							
1C1	U. S. Department of Commerce.	U	590	Dr	125	6		23; 35	5; 4	Sand in till (?)	Perched	22	1940			D	Yield limited; see log.
7G1	O. C. Rupp	S	30	Dr	325	6	325	44	23	Gravel and sand.	Confined.	8	Feb. 1947				See log.
7H1	do	U	425	Dr	430	10-6										N	Do.
17C1	Subeebeda Water Co.	S	45	Dr	377	6	372	367	5	Sand and gravel.	do	64	Jan. 1947		30	PS	Do.
17K1	T. G. Mortland	S	180	Dr	515±	8-6	515	500	15	do	do	200±	Apr. 1947			PS	Do.
35R1	Potlatch Beach Water District.	S	135	Dr	171	6	170	149	22	Sand, coarse	Confined (?)	123.9	Mar. 1, 1946	P	10	PS	Do.
36J1	Ralph Patrick	S	130	Dg	11.8	30				Sand in till (?)	Perched	4.1	Aug. 2, 1944	J	4	D	
36P1	D. R. Smythe	S	120	Dr	152	6	147	130±	22±	Sand, gravelly.	Confined (?).	115	do	P	6	D	Serves two families; water reported to draw down "little" when pumped at 400 gal an hour.
36Q1	Milton Hutchinson	S	135	Dg	31.5					Sand in clay	Perched	8.3	do	J	4	D, S	Dry in summer; hardness 120 ppm.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9 Water-bearing zone or zones				10 Water level		11	12	13	14
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground-water occurrence	A Feet below land-surface datum [3]	B Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 30 N., R. 5 E.																	
1R1	C. F. Kilvington	U	425	Dg	40	60	5			Sandy zones in till.	Perched	15	July 1944	J	6	D	Goes dry in summer.
2A1	A. L. Nelson	U	310	Dg	10±	48				Sand in till	do		Aug. 1944	P		D	
3F1	Louis Abels	Op	75	Dn	12	1½	12	3	9	Sand and gravel.	Unconfined.		July 1944	P		D	Do.
4A1		Op	75	Dg	11	24	11			Sand	do	6.5	July 12, 1944			D, S	
4C1	Edward Hovik	Op	80	Dn	10								1944	P		D	Water reported to contain iron.
4C2	Sigurd Ronning	Op	80	Dg	10.4	30	10			do	do	6.4	July 15, 1944	P		S	Do.
4L1	C. P. Leifer	Op	75	Dg	18.9						Unconfined (?).	7.8	July 14, 1944	P		Irr	Water once used to irrigate small field.
4P1	do	Op	75	Dg	9								1944	P		D	
5E1	H. C. Yandle	Op	80	Dg	9.1	18	9			Sand, gravelly	Unconfined.	3.7	July 14, 1944	P	5	D	
5K1	Frank Schueller	Op	75	Dg	6	48	6			Sand	do	3.1	do	P	4	D	
5M1	L. M. Lester	Op	75	Dn	11					Sand (?)	do		1944	P	4	D	Water reported to contain iron.
8L1	B. M. Harrison	Op	75	Dg	12	28	12	6	6	Sand	do	8.1	Sept. 12, 1945	P	4	D, S	Dry after 32 hours' pumping at 4 gpm in summer.
9E1	Murl Cook	Op	70	Dg	25.6	36	30	21	9	do	do	19.0	July 14, 1944	P	4	D	Barely adequate in dry season.
9F1	N. R. Jewett	Op	70	Dg	23	30-12	30	17±	6±	do	do	17.5	do	P	5	D	
9F2	C. A. Erwin	Op	70	Dg	21	30	30	17	4	do	do	19	July 1944	C	15	D	
9G1	E. L. Dufy	Op	70	Dg	23.9	48	24	22		do	do	22.4	July 14, 1945	C		D	Water level reported lowest in December and January.
10D1	H. A. Holmberg	Op	65	Dg	7	48	7			do	do	1	Aug. 1944	P	6	D	
10E1	M. Losacco	Op	75	Dg	22.8	30	23			Sand, fine	do	16.5	Aug. 29, 1944	P	4	D, S	
10E2	H. W. Kirby	Op	70	Dg	32	30	32	28	4	Sand	do	28	Aug. 1944	P		D	
10F1	Ole Sylte	Op	85	Dg	13.2	60	13	7	6	do	do	7.5	July 12, 1944	P	4	D, S	

10M1	C. H. Campbell	Op	75	Dg	16	90	16			do	do	8	Aug. 1944	C	125	D, S, Irr.	Drawdown is 6 ft after 1 hour's pumping at 125 gpm.
11Q1	H. D. Westland	U	220	Dg	39.5			34	5	Sand in till (?)	Perched	34.4	Aug. 28, 1944	P	4	D, S	
15C1	Jack Filbert	Op	65	Dg	7	18				Sand (?)	Unconfined.	5.1	July 14, 1944	P	4	D, S	Goes dry occasionally in late fall.
15L1	William Turk	Op	65	Dn	9		9				do		1944	P		D	
15N1	Otto Hanson	Op	65	Dn	14	2¼	14	11	3	Sand	do	11±	July 1944	P		D	
16A1	Charles Dudek	Op	70	Dg	11	33	11	9	2	do	do	9	Aug. 28, 1944	J	5	D	Barely adequate in dry months.
16H1	Grace Gallaugher	Op	60	Dg	33	33	32	30	2	do	do	29.5	July 11, 1944	P	4	D	Supplies two homes; 5 to 6 hours' pumping exhausts supply; recovers quickly; water reported to have no iron content.
16R1	Harry Hammerly	Op	55	Dg	24.7	36	24	22	3	do	do	21.9	Aug. 29, 1944	P	8	D	Material is fine, buff sharp sand throughout entire depth.
21B1	L. M. Benson	Op	55	Bd	18	12					do	11	July 1944	P	5	D, Irr	
21H1	John Robinson	Op	55	Dg	18.8					do	do	17.4	Aug. 25, 1944	P	4	D	
21K1	Emil Thompson	Op	45	Dg	18±					do			1944	P	6	D, S	
21Q1	Arne Amundsen	Op	45	Dg	10.9	24	11	9	2	do	do	9	Aug. 25, 1944	J	4	D, S	Reported to go dry; water said to contain iron.
22A1	G. Torie	Op	75	Dg	42	36	42	40	2	Gravel	do	21.3	July 6, 1944	P	4	D	Materials reported as 22 ft of sand and 20 ft of clay overlying aquifer.
22A2	Christian Anderson	S	85	Dg	42	48	4				do	24	July 1944	P	5	D	Till exposed in walls to water level.
22A3	R. A. Bashore	S	90	Dg	52	48	6			do	do	35	do	J	5	D	
22C1	Ida M. Badgley	Op	60	Dg	25	36	25	14	11	Sand	do	23	June 1944	P	3	D	
22D1	A. J. Cooper	Op	60	Dg	16.5	40	16.5				do	14.8	July 6, 1944	P	7	D	
22K1	A. J. Olson	Op	55	Dg	18		18			do	do	16	Aug. 1944	P	4	D, S	
22L1		Op	55	Dg	24.8						do	19.5	Aug. 22, 1944			D, S	
22M1	Frances Howell	Op	50	Dg	18	36				Sand, fine	do	17.2	do	P	4	D	
22M2	G. Langdal	Op	55	Dg	27.2	18				Sand	do		Aug. 26, 1944	P	4	D, S	Material is sand for entire depth.
22Q1	D. C. Aldridge	Op	55	Dg	21	30	21			Sand, fine	do	15.8	Aug. 22, 1944	J	5	D	
22R1	Mrs. Harvey Bacon	Op	65	Dg	28	36	28			Gravel, very coarse.	do		1944	J	4	D	
23J1	A. B. Franzen	U	340	Dg	26					Sand streaks in till.	Perched		do	J	6	D, S	Inadequate in dry months, when yield is only 30 gal a day; see table 5 for chemical analysis of water.
23N1	Thomas Quast	Op	50	Dg		48				Sand in till	do	8	Aug. 1944	C	10	Irr	Inadequate; yield about 4 gpm.
23Q1	——— Lockert	S	225	Dg	60±					do	do		Aug. 1945	P	3	D, S	
26A1	C. F. Smith	S	310	Dr	214	6	210	184	29	Sand						D, S	See log.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 30 N., R. 5 E.—Continued																	
26C1	C. A. Olson	S	140	Dg	17.6	60				Gravel	Unconfined.	9.2	Aug. 26, 1944	P	4	D, S	Materials are reported to be gravel and clay over aquifer. Water has hardness of 65 ppm.
26E1	Hans Bocklund	S	145	Dg	6	36	8			Sand in till	do	Surface	Aug. 1944	P	4	D. S	
26F1	V. Bingham	S	149	Dg	12	24	12			Sand in till (?)	do	do	do	P	5	D	
26J1	G. J. Larson	U	360	Dg	13	24					Perched	5.3	July 1945	P	4	D	
26M1	H. Morney	S	150	Dr	82	4	82			Gravel, sandy	Confined (?).	37	Aug. 1944	P	5	D. S	See log; water has hardness of 85 ppm.
27B1	Jonas Holstrom	Op	55	Dg	14.0	36				Sand	Unconfined.	11.0	do	P	4	D. S	Material reported as sand for entire depth.
27C1	Adam Miller	Op	50	Dg	26.9	24				do	do	18.4	Aug. 26, 1944	P	4	D	Material reported as sand for entire depth; hardness of water 40 ppm.
27D1	E. W. Sutherland	Op	50	Dg	21.5	72	22			do	do	18	Aug 1944	J	16	D. S	Material reported as sand for entire depth.
27E1	W. A. West	Op	55	Dg	27.2	30	27			Sand, silty	do	20.1	Aug. 25, 1944	P	4	D	Material reported as sand for entire depth; water has hardness of 100 ppm.
27G1	J. E. Golding	Op	55	Dg	30	42				Sand, gravelly	do		1944	P	4	D. S	Inadequate in dry months.
27L1	L. B. Hickock and others.	Op	55	Dg	96					do	Confined	46	Aug. 1944	J	5	D. S	Adequate for three families; see log.
27M1	Carl Haaland	Op	55	Dr	131	6				do	do	25	do	J	4	D. S	Water level reported to vary slightly; water hardness 75 ppm.
27N1	John Sander	Op	30	Dg	8	48	48			Sand	Unconfined.	Low	do	P	4	D	Reported as usually dry in fall; water reported to have high iron content.

27P1	Walter Faulstick	Op	35	Dr	125	6	115	99	26	Gravel	Confined	10	1942		3	D	Drawdown 90 ft (to top perforations) when pumped at 24 gpm for 5 hr; see log.
27Q1	Carl Stone	Op	60	Dg	27					Sand, gravelly	Unconfined.	10	Aug. 1944	J	.5	D	Reportedly can be pumped dry after 7 hr at 5 gpm. Aquifer underlies 26 ft of clay and sand and probably overlies till.
28B1	J. Dickson	Op	40	Dg	18	30	18			Sand	do		1944	C		D	
28H1	Fred Hjort	Op	45	Dg	30	36		28	2	Sand, fine	do	28	Aug. 1944	J	8	D	Drawdown 2 ft after 1 hour's pumping at 8 gpm.
29C1	G. R. Stevens	Op	25	Dg	17	48	16	14	3	Sand	do	14.4	July 13, 1944	P	9	D	
34F1	Oscar Johnson	Op	15	Dg	16.8			14	2	do	do	8.9	Aug. 18. 1944	P	4	D	
34J1	Ray Knight	S	100	Dg	10.7					Sand in till	Perched (?).	5.2	Aug. 6, 1944	J	4	D	
34K1	Rena Olson	S	50	Dg	30.3					Sand in till (?)	do	17.8	Aug. 16, 1944	P	5	D, S	Barely adequate in dry months.
34R1	H. H. Michelbrink	S	210	Dg	21.6						do	14.1	do			D, S	Inadequate in dry season.
35E1	C. W. Hanson	S	235	Dg	23					Permeable zones in till.	do	14.9	Aug. 26, 1944	P	4	D, S	Inadequate in dry months. Material reported as "till" for entire depth.
35F1	Lida Ketchum	S	285	Dg	13	30	13			Gravel in till	Perched	7.3	Aug. 1944	B		D	
35H1	Olaf Swedman	U	380	Dg	31		8			Permeable zones in till.	do	23	July 1944	J	4	D	Inadequate yield.
35N1	Fred Semays	U	295	Dg	15					Sand in till (?)	Perched (?).	9.0	July 13, 1944	P	4	D	
36E1	Thomas Hasen	U	400	Dg	22					Permeable zones in till.	Perched	Dry	July 1944	P		D	Inadequate in dry months.
36H1	R. H. Galbraith	U	375	Dg	14			9	5	Gravel under till.	do	10	Aug. 1944	P	6	D, S	
36M1	Nels Ekrem	U	375	Dg	11	48				Sand, coarse, under till.	do	4	July 1944	P	8	D, S	Supplies three families.

T. 30 N., R. 6 E.

4B1	Carl E. Ekstrom	U	450	Dg	27.9					Permeable zones in till.	Perched	18	Aug. 1944	B		D	
6L1	Arthur Baxter	U	450	Dg	28					do	do	24	July 1944	B		D	
6N1	Mrs. S. E. Creeden	U	440	Dg	20					do	do	8.9	Sept. 11, 1945	B		D	
10J1	C. C. Moen	S	300	Dg	56.5	24	56.5			Gravel	Unconfined.	52.6	Sept. 26, 1944	J	4	D, O	Hardness of water 50 and chloride content 5 ppm.
15G1	Jacob Shichiger	St	305	Dg	32		32	10	22	do	do	25	Aug. 1944	J	10	D, S	
15J1	F. M. Nicholson	St	305	Dg	52					Gravel (?)	do	36+	do	P	6	D, S	

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 30 N., R. 6 E.—Continued																	
17M1	George Griffith	U	425	Dg	22.3					Permeable zones in till.	Perched.	14.1	Aug. 17, 1944	P	5	D	Inadequate during fall months.
18E1	W. R. Rodsek	U	390	Dg	17.8	48				do	do	14.8	July 31, 1944	P		D, S	Do.
19E1	A. H. McLaughlin	U	365	Dg	16.3					do	do	11.5	Aug. 17, 1944	P		D	Inadequate during fall months; hardness of water 50 ppm.
19M1	C. E. Westlund	U	360	Dg	22.7	42				Sandy streaks in till.	do	12.3	Aug. 1944	P	7	D, S	
20K1	F. W. Lindborg	U	375	Dg	41.2					Gravel	Unconfined.(?).	35.7	Aug. 15, 1945	J		D, S	Hardness of water 50 ppm.
20L1	C. J. Siggins and D. E. King.	U	390	Dg	14					Sand in till	Perched.	10	Aug. 1945	P	5	D, S	Supplies several families in dry months.
20M1	C. J. Siggins	U	405	Dg	24	24	24			do	do	14.3	Sept. 10, 1945	P	3	D, S	
21G1	H. A. Cook	U	360	Dg	75			4	71	Permeable zones in till.	do		1944	P	5	D	Inadequate in dry months.
22A1	Mrs. Frank Fixsen	Uv	280	Dg	27.4	24	27				Perched (?).	21	Aug. 15, 1944	P	5	D, S	Barely adequate in dry months.
22E1	E. Ridgeway	Uv	285	Dg	35					do	do	15	Aug. 1944	P		D	Do.
23M1	W. Faye	Uv	275	Dg	18					do	do		1944	P	5	D	
27M1	C. E. Leighton	Uv	247	Dg	19±					Permeable zones in till (?).	do	14	Aug. 1944	P	5	D	
31B1	J. Vanhr	U	345	Dg	17.2					Gravel in till	do	11.7	Aug. 17, 1944	P			
31E1	William N. White	U	325	Dg	30					Gravel under till.	do		1944	P		D	
32D1	Jack Klepper	U	380	Dg	42.8		4			do	do	22	Aug. 17, 1944	J	6	D, S	Water has hardness of 50 ppm.
32Q1	Russel Sheppard	S	275	Dg	18.7		48	5		Permeable zones in till.	do	12.6	Aug. 22, 1944	P		D	Barely adequate in dry months.
33A1	Glen Palmer	Uv	240	Dg	18			12±	6±	Gravel	Unconfined.	16	Aug. 1944	S	4	D, S	Do.

33H1	Edward Meyers	Uv	235	Dn	10±					do	do	8	do	S	6	D	Water reportedly has high iron content; hardness 50 ppm; dug well nearby exposes 10 ft of clay over gravel aquifer.
33N1	Bert Hansen	Uv	215	Dg	14±		14			do	do		1944	P		D	Water exhausted after pumping of 30 gal, but well refills quickly.
T. 30 N., R. 7 E.																	
4E1	Joseph Mueller	St	500±	Dr	87	6	87	82	5	Sand, black, with gravel.	Confined	13	1942	J	5	PS	Well supplies four families of Hidden Valley settlement. Interbedded clay and gravel overlie aquifer. Water reportedly contains iron and is hard.
18C1	Charles Jensen	St	350±	Dg	55.3	48	55		5+	Sand	Unconfined.	50.1	Aug. 23, 1943	None		D	New well; pump to be installed; sand and gravel layers reported from surface to aquifer.
8L1	Town of Granite Falls.	St	390	Dr	42.9	42.9				Gravel, sandy	do	17.5	Sept. 26, 1944	T	150	PS, O	For stand-by use only.
18N1	do	St	380	Dg	14	108				do	do	6.4	Oct. 10, 1940	P	100	O	Do.
18N2	do	St	380	Dr	340	12						7.5	do	None		O	Not operated; see log.
18P1	do	St	390	Dr	72.5	{12– {10	73	60 58	9 2	Sand, fine Sand, gravelly	}Confined	6	1941	T	250	PS, O	Draws down 19 ft after 8 hours' pumping at 250 gpm.
18P2	do	St	390	Dr	73	{12– {10	73	62 70	8 4	do Sand, fine	}do	7	do	T	250	PS, O	Draws down 17 ft after 8 hours' pumping at 250 gpm.
19L1	L. Smeling	St	375	Dg	16.5	36	16			Sand	Unconfined.	7.4	Aug. 23, 1944	B		D	
T. 30 N., R. 8 E.																	
8Q1	Mrs. E. G. Baker	Uv	900	Dr	75	6	75	70	5	Gravel with coarse sand.	Confined	8	1940	P	5	D, PS	Layers of sand and clay reported from surface to aquifer.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
Well designation	Owner or occupant of property	Topographic situation[1]	Approximate altitude above sea level (feet)	Type[2]	Depth (feet)[3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground-water occurrence	A Feet below land-surface datum[3]	B Date of measurement	Type of pump[4]	Yield (gallons per minute)	Use of water[5]	Remarks[6]
T. 31 N., R. 3 E.																	
24Q1	J. W. Terry	S	150	Dr	437	6	183	170	10	Sand	Unconfined.		June 1945	P	8	D	See log. Water has hardness of 60 and chloride content of 22 ppm.
25A1	E. P. Johnson	S	220	Dr	245	6	245	235±		do	do	215	Mar. 1945	P		D	Water has hardness of 70 and chloride content of 23 ppm.
36A1	Mrs. Eva Houghton	S	210	Dr	265	6	265			Gravel	Confined (?).	207.3	Sept. 12, 1945			D	
36B1	Arthur Killian	Tf	10	Dr	75	8	75	72	3	Gravel, coarse	do	2.0	Aug. 30, 1944	P	16	D, PS	Materials reported as "blue clay" to aquifer; water has hardness of 85 ppm; water level reportedly fluctuates with tide.
36B2	do	S	150	Dg	56±					Sand	Unconfined.	56	Aug. 1944	P	5	D	Materials reported as sand to 56 ft and clay below.
36B3	Elmer Jackaway	Tf	10	Dr	100	8	100	85	15	Sand, gravel	Confined	Flows	June 1943			D	Water level reportedly fluctuates with tide; see log.
36R1	Ira Brown	S	10	Dr	96	6	96	85±	11±	Gravel	do	5	Aug. 1944			N	Not used; water reported good; blue clay reported from surface to aquifer.
T. 31 N., R. 4 E.																	
1F1	J. C. Hevly	Fp	30	Dn	23	1¼	23			Sand	Unconfined.	16	July 1944	P	8	S	Twenty feet of silt and clay overlies sand; water reported to contain iron.
1H1	Alex B. Anderson	Fp	35	Dn	16	1¼	16			Sand, gravelly	do	15	do	P		D	Water reported to contain iron.
1K1	Mrs. Gusta Ottem	Fp	30	Dn	18	1½	18			Sand	do	16	do	P	4	D, S	Do.

2D1	A. A. Satrum	Fp	30	Dn	22		22						1944	P	3	D	Another well 38 ft deep yields water reported to contain more iron than that from this well.
3C1	Hartvig Rod	Fp	25	Dn	30		30			Gravel	do	30	July 1944	P	10	S	Materials reported as 10 ft of clay, then quicksand overlying water gravel; water reportedly has high iron content.
3L1	Alfred Hovig	St	110	Dg	12.1	24	12			Gravel, sandy	Perched	11.5	July 19, 1944	J	4	D	Dry 4 months of year. Soil overlies gravel, and clay underlies it.
3N1	Anton Schroedl	St	180	Dg	12.0		12			do	Perched (?).	11	July 20, 1944	P	4	D, S	
4C1	Arnold Robb	Fp	20	Dr	260±	6	260±				Confined	1	July 1945	P		D, S	Originally flowed over casing.
6C1	Snohomish County Department of Roads.	Fp	10	Dr	95	6	None						1945			N	Test hole; see log.
6R1	Mrs. Caroline Satra	S	55	Dg	6.1		6			Sand, gravelly	Perched	2	July 17, 1945	P	5	D	
7G1	W. R. Pettit	S	125	Dg	6						do	2	July 1944	P	5	D, Irr	
7J1	Roy Peer	S	170	Dg	9	48	9			Sand	do	6.9	July 17, 1944	P		D	
9B1	Vern Hurbert	S	310	Dg	50	48	5	47	3	Sand, gravelly	Unconfined (?).	47	July 1944	P	4	D, S	Till and "hardpan" overlie aquifer.
9F1	H. D. Oliver	U	365	Dg	19.1		7	18±	1	Gravel, sandy	Perched	10.8	July 20, 1944	P		D	Do.
10B1	M. W. Clark	S	150	Dg	10.5	48				do	do	8.4	July 1944	P		D	Sometimes dry in summer.
11F1	Albert M. Stenvik	S	260	Dg	20.5					Permeable zones in till.	do	3.3	July 20, 1944	P		D	Barely adequate in dry months.
11N1	Martin Nysethe	S	180	Dg	18.6					do	do	12.4	do	P		D	Do.
12C1	John Brekhus	Fp	35	Dn	43	1¼	43	39	3	Gravel	Unconfined.	39	1944	P	5	D	Water reported to contain iron; sand and clay reported to overlie aquifer.
12H1		Fp	35	Dg	5					Sand	do		do	P	4	D, S	Water reported to contain iron.
12Q1	Berend Groendyk	Op	70	Dn	20	1¼	20	17	3	Gravel	do	6	July 1944	P	15	D, S	
13B1	——— Zuicker	S	100	Dg	7.5					Gravel, sandy	do	4.8	July 21, 1944	P		D	Sandy gravel underlies pebbly soil.
13N1	Elmer Whitman	S	150	Dg	25.5	60	4			Permeable zones in till.	Perched	10.9	do	P		D	
13R1	Marie Mandis	Op	130	Dg	54					Permeable zones in till (?).	Perched (?).	46	July 1944	P		D, S	
14D1	Kate Foley	S	180	Dg	6					Sand	do	3.2	July 20, 1944	P		D	
17D1	Andrew Folden	S	220	Dg	15.6	48	15+			do	do	13	do	P		D, S	
18E1	A. H. Reinecke	S	160	Dr	225	6	224	218	5+	Sand, gravelly	Confined.	187	1943	P		D, S	Water has hardness of 130 ppm; see log.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground-water occurrence	A Feet below land-surface datum [3]	B Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
								T. 31 N., R. 4 E—Continued									
20B1	William Sinn	U	340	Dg	16					Permeable zones in till.	Perched	9.1	July 18, 1944	P		D	Inadequate; goes dry.
21F1		U	375	Dg	23.1					do	do	11.4	do	P		S	
21K1	M. Lewis	U	370	Dg	22.3					do	do	9.3	do	P		S	
21L1	do	U	390	Dg	14					Gravel in till	do	11.9	Sept. 12, 1945	J		D, S	Water has chloride content of 27 and hardness of 60 ppm.
21B1	Mrs. L. Leonard	U	325	Dg	13.6					Permeable zones in till.	do	2.0	July 18, 1944		5		
22B1	John Sedy	U	435	Dg	25.8	72	3	18	7.8	Gravel in till	do	15.0	do	P	10	D, S	Inadequate in dry months.
22B2	do	U	440	Dr	142	6	142	136	6	Sand, gravelly	Confined.	102.0	July 1944				See log.
22L1	O. E. Engstrom	U	430	Dg	78					Permeable zones in till.	Perched	Dry	July 18, 1942				Reported dry from July to January of each year.
22M1	A. Peterson	U	450	Dg	24.0	60				do	do	23.0	July 1944	P		S	Do.
22M2	H. Jacobsen	U	430	Dr	158	5	158	100	58	Sand	Unconfined.	108	1941	P	6	D, S	Small drawdown reported after 2 hours' pumping at 6 gpm; 100 ft of glacial till over aquifer.
22N1	G. A. Schuh	U	375	Dr	72	8	72	62	10	Gravel and sand.	Confined.	20	August 1944	J		D, PS	Drawdown reported as 11 ft after 5 hours' pumping at 10 gpm; hardnes of water 80 ppm; see log.
24N1	Town of Marysville	S	300	Dr	78	10	78		78	Sand	Unconfined.	Surface.	Constantly			PS	Develops aquifer that normally fed nearby springs; see log.
24N2	do	S	275	Dr	358	8	203	164	10	Sand and gravel.	Confined.	Flows	do		250	PS	See log; well used for stand-by.
25A1	Bert C. Scott	S	160	Dg	23.3					Permeable zones in till.	Perched	6.5	July 21, 1944	P	4	D	

25B1	Peter Baumsgard	S	250	Dg	14	48	3	11	3	Gravel under till.	Unconfined.	11	July 1944	P		D	
25H1	E. C. Carlson	S	275	Dg	19					Permeable zones in till.	Perched		1944	P		D	
25J1	Russell Sarsten	U	340	Dg	26.2					do	do	13.6	July 21, 1944	P		D	
34G1	Camp Fire Girls of America.	U	430	Dr	160	6	160	120	40	Sand and gravel.	Unconfined.	160	About 1935	P		D	
										T. 31 N., R. 5 E.							
2D1	Pius Biber	Fp	65	Dg	18			3	15	Gravel	Unconfined.	15	July 1945	P	5	D, S	
2H1	C. C. Wright	Fp	70	Dn	18	1¼	18	12	6	Gravel, fine	do		1944	P		D, S	
2L1	Town of Arlington	Fp	75	Dg	20±	120	20±			Sand, gravelly	do		July 1944	C	450	PS	Water has hardness of 40 ppm; reportedly no iron.
3H1	P. V. Robertson	Fp	65	Dg	13.4	33	13				do	11.7	July 28, 1944	P		D, S	Barely adequate in dry season.
5D1	F. M. Thomas	S	165	Dn	18		18	17	1	Gravel	do	17±	1944	P	4	D	Clay and sand overlie aquifer.
6M1	E. L. Madson	Fp	40	Dg	17.5	60	17±			Sand	do	15.7	July 25, 1944	C		D	Water reported to be high in iron; filter treatment used.
7B1	Peter Henning	Fp	40±	Dr	40.5	8					Unconfined (?).	9.7	Sept. 25, 1944			Irr. O	
7D1	Ivar Shudshist	Fp	35	Dg	15.0	18	15			Gravel	do	13.9	July 17, 1944	P	5	D, S	Reported low in dry months; some iron present.
7D2	Christ Gunderson	Fp	35	Dg	18	18	18	16	2	Gravel, sandy	do	16	do	P		D	Water reported to have no iron content.
7E1	Clifford Turk	Fp	35	Dn	20±						do	12	do	P		D, S	Water reported to be high in iron; filters used.
7G1	Peter Henning	Fp	45	Dr	150	6	150	{88 145	7 5	Gravel Sand	} Confined.	12	1940	J	10	D, S	Drawdown 53 ft when bailed at rate of 20 gpm; see log; see table 5 for chemical analysis of water.
7H1	Andrew J. Strotz	Fp	40	Dg	17.6	48	17+			do	Unconfined.	16.2	July 17, 1944	C		D, S	Inadequate; dry every August; see table 5 for chemical analysis of water.
7L1	John Mikelson	Fp	35	Dn							do		1944	P		D, S	
8B1	William Strotz	Fp	45	Dn	44	1¼	44			Gravel, sandy	do	19	July 1944	P		D, S	Clay and sand reported to overlie aquifer.
8E1	Martin Stensen	Fp	40	Dn	16	2	16	10	6	Gravel	do	11	do	P	9	D, S	Water reported to be iron-free.
8L1	Henry D. Sesby	Fp	45	Dg	16.3	15	16			do	do	13.5	July 25, 1945	P		D, S	Do.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 31 N., R. 5 E.—Continued																	
8P1	Floyd Downing	Fp	40	Dg	12						Unconfined (?).		1944			D, Irr	Water reportedly high in iron; filter treatment used.
8Q1	William K. Anderson.	Fp	40	Dg	18.2	18	18				do	17.3	July 26, 1944	P		D. S	Inadequate in dry months.
9N1	P. Borland	Fp	45	Dg	16±	12				Gravel	do	15	July 1944	P		D, S	Inadequate in dry months, water reported to have high iron content; filter required.
10J1	Pearlie Robb	Fp	60	Dr	89	4	89	88	1		Confined.	2	do	P	7	D	See log.
10J2	Albert Countryman	Fp	75	Dr	92	3	92	91	1		do	2	do	P	4	D	Water reported to have hardness of 75 ppm; materials reported similar to those of well 10J1.
10J3	John W. Monigar	Fp	75±	Dr	120	6	120	117	3	Sand, fine	do	27.5	Sept. 11, 1945	J	10	D	Drawdown 60 ft after 4 hours' pumping at 10 gpm; water has chloride content of 10 and hardness of 105 ppm.
11F1	Snohomish County Dairymen's Association.	Fp	65	Dg	18	240	18			Gravel	Unconfined.	3.8	Aug. 12, 1944	C	350	Ind	Hardness of water 45 ppm.
12C1	Elmer Erickson	St	170	Dg	13.2	60	13+			Sand	do	10.8	Aug. 15, 1944	P		D. S	
12M1	Wallace Oliver	S	170	Dg	12.0		12	10	2	Gravel	do	10.6	do	P		D. S	Has yielded 200 gpm; hardness of water 55 ppm.
13K1	Carl Frazzini	U	425	Dg	21	48	21			Gravel in till	Perched	15	Aug. 1944	P		D	Barely adequate in dry months.
15A1	Town of Arlington (cemetery).	Op	125	Dr	120	5				Gravel with coarse sand.	Confined (?).	50	1944	P	10	Irr	See table 5 for chemical analysis of water.

15J1	Charles Grew	Op	145	Dr	108					Sand			do	P		D	Water reported to contain some iron.
15R1	Mrs. Minnie Smith	Op	145	Dr	106					do			do	P		D	
15R2	U. S. Navy Department.	Op	140	Dr	167		167	135	31	Sand, coarse	Confined.	45	Apr. 1943	T	250	PS	Drawdown 26 ft at rate of 200 gpm; see log; see table 5 for chemical analysis.
16D1	Clifford Rod	Fp	45	Dn	12±					Sand	Unconfined.		1944	P		D, S	Water reportedly contains much iron.
16G1	Mrs. Marie Spoerhase.	Fp	50	Dn	9					Gravel	do	1	do	P		D, S	Reported to be no iron in water.
17L1	Frank E. Bohl	St	80	Dg	6.5	36	6+			Sand	do	4.8	July 26, 1944	P	4	D	
17N1	Sverre Olson	Op	105	Dg	20		20			do	do	16	July 1944	P		D, S	Some years well is dry in fall months; materials reported as sand for entire depth.
17R1	F. Marinos	Op	120	Dg, Dn	13					Gravel, fine	do		1944	P		D	Water reported free of iron.
17R2	E. W. Homer	Op	120	Dg	26.7						do	24.9	July 26, 1944	P		D	
18H1	J. E. Richardson	St	65	Dg	8.9		9				do	6.5	do	P		D	
18M1	Joseph Cote	St	95	Dg	12	48	12			Gravel, sandy	do	10	July 1944	P	5	D	Till reported to underlie aquifer.
19H1	Harold Bjorn	Op	115	Dg	8	36	2			Sand	do	5	do	P		D, S	
19K1	Einar Brevig	S	150	Dg	22	48	3.5			Permeable zones in till.	Perched	12	July 26, 1944	C	10	D	Inadequate in dry months.
19M1	E. M. McGerry	S	155	Dg	20					do	do		1944	P		D, S	This and two other wells go dry in fall months of each year.
19P1	John Anderson	S	150	Dg	17.5	48	3			do	do	7	July 1944	C	4	D	Goes dry in fall of each year.
19R1	E. L. Cruver	S	120	Dg	20	48				do	do	17	do	P	5	D	Do.
19R2	Rasmus Jensen	Op	120	Dg	11	48				Gravel in till	Perched (?).	3	do	P		D	
20C1	Sven Svensen	Op	110	Dg	7.9	12	8			Sand, gravelly	Unconfined.	4.3	July 26, 1944	P		D, S	Gravel and sand overlie aquifer.
21H1	U. S. Navy Department.	Op	130	Dr	188	10	184	{47 {132	81} 53}	Sand, fine	Confined.	30	Aug. 1945			PS	Drawdown reported to be 13 ft after 6 hours' pumping at 400 gpm; see log.
21N1	Carl E. Edlund	Op	120	Dg	11.5	36	12				Unconfined.	7.2	July 8, 1944	P		Ps, O	Water has hardness of 30 and chloride content of 5 ppm.
22A1	L. F. Snyder	Op	135	Dg	16.4						do	14.6	July 31, 1944			D	
22H1	L. W. Dimmock	S	160	Dg	21.7	48	6			Gravel in till	Perched	11.1	do	P		D	
23R1	Mrs. Simon Carlson	U	380	Dg	13	48	2			Permeable zones in till.	do	11.2	do	P		D	
25C1	Lilla Putnam	U	455	Dg, Dr.	102	4				do						N	Abandoned; materials reported as till for entire depth.
25C2	H. E. Putnam	U	465	Dg	20	48				do	do	11.0	do	J	11	D	Barely adequate in dry season.

See footnotes at end of table.

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground-water occurrence	A Feet below land-surface datum [3]	B Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 31 N., R. 5 E.—Continued																	
25D1	John A. Martin	U	385	Dr	64	18	64				Unconfined.	52±	"Constantly."	J		D, S	
27C1	W. E. Cornehl	Op	125	Dg	18	34	18	15 16	1 2	Gravel Sand	do	12	July 1944	P	6	D, S	
27K1	L. Roth	Op	110	Dr	140	12–8	140			do			1944			N	Not used; reported to yield 28 gpm of high-iron water.
27M1	do	Op	110	Dg	9	30	9	7	2	do	do	6	July 1944	P	6	S	Water reported to contain iron.
28C1	Washington Co-operative Association.	Op	120	Dg	13	48	13	8	5	Sand, gravelly	do	8	July 1945	C	50	D, S, Irr	See table 5 for chemical analysis of water.
28E1	do	Op	115	Dg	11	48	11	6	5	do	do	6	do	P		D, S, Irr	
28Q1	Harold Carlson	Op	105	Dg	12	36	12			Sand	do		1944	P		D, S	Water has hardness of 80 ppm; considerable iron reported present.
29C1	O. P. Morton	Op	120	Dn	14	2	14			Sand, fine	do	6	July 1944	P	5	D	
29P1	Emil Alvestad	Op	100	Dn	18	2	18			Sand	do	6	do	P		D, S	
29R1	Peter Jensen	Op	100	Dg	6					do	do	8	Aug. 1944	P		D, S	Water reported to have slight iron taste.
30A1	Emma Nelson	Op	120	Dg	18	48	18+			do	do	6.9	July 10, 1944	P	6	D	
30A2	Lakewood School District No. 303.	S	125	Dg	44	48				Permeable zones in till.	Perched	24±	Aug. 1944	P	8	PS	Water has hardness of 70 ppm.
30C1	John Jacobson	S	150	Dg	17.5	60				do	do	10	July 11, 1944	P	8	D, S	
30H1	G. Masterson	S	120	Dg	53	72	6	30	5	do	do	19	Aug. 1944	J	8	D, S	Materials are 3 ft of soil and 20 ft of blue clay over glacial till to bottom. Water hardness is 110 ppm.

30K1	Charles Johnson	S	160	Dg	16					do	do	8	July 1944			D	Inadequate in dry season.
31A1	Charles Rapp	Fp	117	Dg	26.9					do	do	7.9	Aug. 29, 1944	P		D	
31B1	L. D. Shultz	S	190	Dg	20.9					Sand, coarse, under till.	Perched (?).	11.6	July 15, 1944	P		D	Reported to be 4 ft of soil and 15 ft of till overlying aquifer.
32A1	Arthur Jacobson	Op	105	Dg	14						Unconfined.		1944	C	5	D	Water reported very high in iron.
32F1	Mrs. Raymond Lark.	Op	100	Dg	15+	18				Gravel over clay.	do	6	July 1944	P		D, S	Materials reported as 5 ft of soil and 10 ft of gravelly sand over clay.
32L1	J. D. Strauss	Op	95	Dg	11	24					do	6.9	July 15, 1944	P		D, S	Water reported high in iron.
32N1	John Secalling	Op	100	Dg, Dn	19			18	1	Gravel	do	14	July 1944	P	8	D, S	
32Q1	C. F. Clark	Op	95	Dg	12	48	12	11	1	Gravel, sandy	do	6	do	C	16	S, Irr	
32R1	Herman Lark	Op	95	Dg	12	24	12	7	5	do	do	6	do	C	7		
32R2	L. W. Larson	Op	95	Dg	14±						do		1944	P	5	D, S	
33H1	Nils Holmberg	Op	100	Dn	16±	2					do		do	P		D, S	
33J1	Carl C. Hanson	Op	100	Dg	5±						do		do	P		D, S	Water reported to have some iron content "like all such wells in this vicinity."
33N1	Mrs. Anna Kylling	Op	95	Dg	11	24				Sand	do		do	P	8	D	
34C1	Emma Witlof	Op	105	Dn	5±						do		do	P	5	S	Water reported high in iron.
34H1	F. Carlson	Op	118	Dg	17	36	17			Gravel	do	12	Aug. 1944	P	5	D, S	Clay and sand overlie aquifer.
35L1	Lyle Wade	S	225	Dg	21					Sand, fine	do		do	P	5	D, S	Well at end of adit 70 ft long driven in top of sand formation underlying till; clay underlies sand aquifer 27 ft thick.
35N1	A. J. Hutchins	Op	125	Dg	8	48				Permeable zones in clayey silt.	do	Surface	do			D, S	

T. 31 N., R. 6 E.

3D1	George Wallitner	St	265	Dr	82	4	82	82		Sand under till (?).	Confined	+7	1936			D	Flowing at rate of 3 gpm at 7+ ft on Aug. 14, 1944; hardness of water 125 ppm; temperature 49 F.
3H1	Charles W. Gaffney	Uv	335	Dr	85±					Sand	do	4	1944				
4C1	E. J. Brown	Op	315	Dn	14	3	14			Sand, coarse and gravelly.	Unconfined.	12	July 1944	P	5	D	
4L1	M. W. Jackson	Op	310	Dn	18	1¼	18			Sand, fine	do	13	do	P		D, S	Materials reported to be sand for entire depth.
4M1	A. Adolphson	Op	300	Dg	13.8	48				do	do	10	July 27, 1944	P	4	D	
5K1	Emil Freberg	Op	300	Dn	16					Sand	do	11	July 1944	P		D, S	

See *footnotes at end of table.*

TABLE 4.—*Representative wells in Snohomish County, Wash.*—Continued

1 Well designation	2 Owner or occupant of property	3 Topographic situation[1]	4 Approximate altitude above sea level (feet)	5 Type[2]	6 Depth (feet)[3]	7 Diameter (inches)	8 Depth of casing (feet)	9 Water-bearing zone or zones: A Depth to top (feet)	9 B Thickness (feet)	9 C Character of material	9 D Ground-water occurrence	10 Water level: A Feet below land-surface datum[3]	10 B Date of measurement	11 Type of pump[4]	12 Yield (gallons per minute)	13 Use of water[5]	14 Remarks[6]
T. 31 N., R. 6 E.—Continued																	
6F1	J. B. Norman	Op	285	Dg	64	36	63	58	6	Sand, fine	Unconfined.	58	1945	J	5	D, Irr	Materials reported to be sand from soil zone down.
8K1	Victor Freyd	Op	280	Dg	16	36	16	10	6	Silt, sandy	do	10	July 1944	P	8	D, S	
19E1	Art Anderson	U	500	Dg	26	30				Permeable zones in till.	Perched	8.8	Aug. 15, 1945	P		D	Water has hardness of 55 and chloride content of 6 ppm.
19K1	G. F. Lange	U	525	Dr	190					Sandstone			1926			N	Dry hole. Materials reported as 120 ft of glacial till overlying sandstone.
20R1	Howard H. West	St	190	Dg	20	48				Permeable zone in till.	Perched	10	Mar. 1945	J	4	D, S	
27Q1	Gus Asplund	St	270	Dg	35	30	35	32	3	Sand	Unconfined.	5.1	Mar. 16, 1945	J	4	D, S	Materials reported as sand to 16 ft and gravel, sand, and silt to 32 ft.
31K1	John Loth	U	535	Dg	14.8	72	14			Gravelly zones in till.	Perched	9	July 1944	B		D	
T. 32 N., R. 4 E.																	
3D1	James Colouzis	U	350	Dg	15.2	60	15			Sand in till	Perched	10.2	Aug. 7, 1944	J		D, S	Barely adequate in dry season.
3M1	J. G. Anderson	U	350	Dg	8			6	2	do	do	5	Aug. 1944	P	6	D, S	Do.
4K1	S. N. Sorenson	U	305	Dg	33					do	do	26	do	P		D, S	Barely adequate in dry season; materials reported as till above and beneath "water seam."
5J1	R. L. Dawson	U	260	Dg	32					do	do	22	do	J		D, S	

5L1	John Malley	U	240	Dr	142					Sand	Unconfined (?).		1944	P		D, S	Well reported to have penetrated till.
5Q1	Elmer Norgaard	U	225	Dr	149	6				Pea gravel	do		do	P		N	
6D1	George Keenan	Fp	10	Dg	18	72	18			Permeable zones in till.	Perched	Surface.	Aug. 1944	P	5	D, S	Materials reported as sand and gravel overlying till. Water has hardness of 75 and chloride content of 5 ppm.
7N1	Edward McKain	S	110	Dg	63.4	60	9			Sand layers in till.	do	51.6	Aug. 3, 1944	P	4	D, S	Water-bearing sand layers near bottom of well.
7N2	do	S	110	Dg, Dr	183	60-6	183	170	13	Sand, fine	Unconfined.	99	May 24, 1946			D	New well drilled in well 7N1; see log.
7P1	—— Davidson	S	150	Dr	150±	6				Sand and gravel under till.	do					D	
7R1	C. Knudsen	U	225	Dg	20	36	20			Permeable zones in till.	Perched	13	Aug. 1944	P	5	D, S	
8G1	Elmer Norgaard	U	250	Dg	10					Gravel over till.	Perched (?).	9	do	P		D, S	Equipped with windmill and tank.
8Q1	Herman Kyndell	U	220	Dg	26.8	48		26	1	Sand in till	Perched	25.7	Aug. 3, 1944	J	5	D, S	Inadequate in dry season.
9R1	Edward Cash	U	230	Dg	21		5			Permeable zones.	do	16	Aug. 1944	P	4	D	
10G1	C. O. Davis	U	350	Dg	20.2					Permeable zones in till.	do	15.2	Aug. 7, 1944	P		D, S	Inadequate in dry season; a 300-ft dry well drilled nearby. Water has hardness of 105 and chloride content of 13 ppm.
10R1	O. T. Stave	U	355	Dg	61.5	48	15	61±		Shale, fractured.	Confined	34.7	do	P		D	Materials reported as till to 47 ft; sand, gravel, and clay to 61.5 ft; and fractured shale below. Water has hardness of 95 ppm.
11N1	Leonard Johnson	U	455	Dr	360			230 65	 1	Sandstone, hard. Gravel, cemented.			1944			D	See log.
11Q1	Alfred Holm	U	475	Dg	17			15	2	Gravel	Perched	11	Aug. 1944	J	8	D	Soil and till reported to overlie aquifer.
12P1	O. Wold	U	610	Dg	42.5	60	5			Sand in till	do	27.0	Aug. 7, 1944	J	4	D	Barely adequate in dry months.
13A1	Edward Garberg	U	500	Dg	18.4	84	6	14	2.4	do	do	15.2	do	P	4	D	Dry during fall months of each year.
13J1	Odin B. Olson	U	430	Dg	32					Permeable zones in till.	do	Dry	Aug. 8, 1944				Inadequate; spring water added in dry season.
17C1	Carl U. Ipsen	U	220	Dr	120	6	120			Sand; gravel, sandy.	Unconfined.	50	Aug. 1944	P		D, Irr	Pumps sand at times; see log.
17F1	W. A. Peugh	U	205	Dg	65					Sand beneath till.	do		1944	P		D, S	Yield reported small at all times.
18B1	L. Ronnestat	U	200	Dr	150	6	150	148	2	Boulders	do	105	May 1946	P		D, S	Drawdown reported as 5 ft when pumped at 10 gpm; see log.

See footnotes at end of table.

TABLE 4.—*Representative wells in in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	A Depth to top (feet)	B Thickness (feet)	C Character of material	D Ground-water occurrence	A Feet below land-surface datum [3]	B Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
								T. 32 N., R. 4 E.—Continued									
18D1	Leo Dannsmiller	S	105	Dg, Dr.	90					Sand			1944	P		D, S	Hardness of water 105 ppm.
19H1	Peter Henning	U	220	Dr	250					do			do	P			Hardness of water 110 ppm.
19K1	Stanwood Water Co. and East Stanwood Fire Department.	S	50	Dg	54					Gravel	Unconfined.	42	Aug. 1944	T	100±	F	
19K2	Bozeman Canning Co.	S	35	Dg	50					do	do	42	do	T	200±	Ind.	Pumped continuously for 14 hr at times; inadequate in summer; hardness 90 ppm.
19K3	Peter Henning	U	175	Dr	672			350	30	Gravel, cemented.	Confined					N	Abandoned; insufficient water; see log.
19P1	Pict Sweet Co	S	20	Dr	1,000	10											See log.
20C1	Cedarhome Water Co.	U	175	Dr	73	6	73			Sand, coarse, with pebbles.	do	26	do	J	10	PS	Supplies five families; materials reported as 25 ft of till, then white hard clay to aquifer.
20L1	Stanwood Water Co	St	80	Dr	249	20–12	249	80	90	Gravel	do	18.6	Mar. 4, 1949			PS	See table 5 for chemical analysis of water.
20M1	East Stanwood School District No. 317.	U	175	Dr	245	8	245			Sand, fine		80	1944	P	10	PS, Irr	Aquifer is developed by long screen section in bottom of casing.
20N1	Gustav Gilbertson	U	130	Dr	133	6	133	80	53	Gravel	Unconfined.	60	Aug. 1944	P	4	D, S	See log.
21L1	John Solheim	U	235	Dg	102					do	Confined	42	July 1944	P		D, S	Aquifer beneath glacial till.
21Q1	Mrs. E. A. Nelson	U	280	Dg	68	48	6		18	Gravel under till.	do	18	do	P		D, S	Aquifer reported to underlie till.
22A1	Lars Langland	U	330	Dg	36	48	11	27	9	Gravel in till	Perched	30	Aug. 1944	J	5	D, S	Materials reported as 11 ft of gravel over water-bearing zone.

22C1	Edvald Lund	U	330	Dg	23					Permeable zones in till.	do	11.1	Aug. 8, 1944			D, S	Another (dry) well 73 ft deep reported to have penetrated 10 ft of sand beneath 63 ft of till.
22D1	William Ruetkert	U	300	Dg	15.1	48	15			do	do	9.4	do	P		D, S	Barely adequate in dry season.
22D2	Arvid Osell	U	300±	Dr	231	6	231	175	56	Sand	Confined (?).		1944	P	6	D, S	Materials reported as till and clay to 175 ft; hardness of water is 80 ppm.
22P1	Charles Erickson	U	380	Dg	24					Permeable zones in till.	Perched.	8	July 1944	P	7	D, S	Barely adequate in fall of year.
23Q1	——— Strand	U	350	Dg	30.4	48	5	30	.4	Gravel and sand streak in till.	do	17.8	July 19, 1944	P	5	D	Glacial till contains aquifer; nearby deep test well dry to 180 ft.
23Q2	do	U	350	Dr	180	6	180									N	Drilling stopped above regional ground-water level; see log.
24H1	Robert Kunhausen	U	260	Dg	15		6			Sand, very fine.	Perched (?).	11	Aug. 1944	P	4	D	Small yield in dry months; glacial till reported to overlie aquifer.
25A1	Elmer Elfstrom	U	230	Dg	18	48	8			Gravel	do		1944	P		D	
25H1	H. Friedlund	U	200	Dg	10					Gravel bed in till.	Perched.	1.5	Aug. 9, 1944	P		D	Inadequate; goes dry in late summer and overflows in winter.
25P1	H. B. Caylor	U	185	Dg	20				4	do	do			P		D	Owner also has a dry well 60 ft deep.
27A1	D. Stangland	U	330	Dg	21	60	5	20	1	do	do	13	July 1944	P	5	D	
28B1	H. A. Montgomery	U	285	Dr	32	6	32	24	2	Gravel streak in till.	do	4.8	May 24, 1946			D	See log.
28D1	A. Kjelstad	U	130	Dg	16.7							13.1	Aug. 9, 1944	R		D, S	
29B1	Roy Martin	U	130	Dg	14.8	66	15±					12.1	July 19, 1944			D, S	
29D1	Ole Sather	U	115	Dr	115	6	115	110	5	Gravel	Confined.	90	1928	P	4	D, S	See log.
29E1	Fred Cooper	S	80	Dg	99±		4			Sand, fine (?).	Unconfined.	88		P	2	D, S	
29Q1	Ivar Thomle	S	60	Dr	290	6		87		do						N	Materials reported as "quicksand [for] nearly entire depth"; well abandoned.
30K1	Stanwood Water Co.	Fp	15	Dr	68	12	68				Confined.	4.8	June 4, 1947			PS	Water has hardness of 60 and choride content of 47 ppm.
30L1	do	Fp	15	Dr	145	20-12	145	68	27	Gravel, coarse.	do						See log; water saline.
32Q1	John Stensea	Fp	15	Dg	15.8		15					14.1	July 24, 1944	P	5		Inadequate; small yield in summer.
32R1	Mrs. Belle Danielson	Fp	15	Dn	35			32	3	Sand	Unconfined.	20	July 1944	P		D, S	Water filtered for culinary use because of iron content; hardness of 110 and chloride content of 75 ppm.
33F1	Albert Frederickson	Fp	15	Dn	70	2	70	67	3			7	1946	P		D, S	See log.
33Q1	Mrs. Bessie Birkstol	Fp	15		25					Gravel, sandy	do	16	July 1944	P		D, S	
35H1	Alvin Anderson	St	35	Dg	5.3	48	5+				do	0.8	July 17, 1944	P		D, S	

See footnotes at end of table.

TABLE 4.—*Representative wells iu in Snohomish County, Wash.*—Continued

1	2	3	4	5	6	7	8	9				10		11	12	13	14
								Water-bearing zone or zones				Water level					
								A	B	C	D	A	B				
Well designation	Owner or occupant of property	Topographic situation [1]	Approximate altitude above sea level (feet)	Type [2]	Depth (feet) [3]	Diameter (inches)	Depth of casing (feet)	Depth to top (feet)	Thickness (feet)	Character of material	Ground-water occurrence	Feet below land-surface datum [3]	Date of measurement	Type of pump [4]	Yield (gallons per minute)	Use of water [5]	Remarks [6]
T. 32 N., R. 5 E.																	
7P1	Gustave Olson	U	480	Dg	20.9	60				Sand in till	Perched	11.8	Aug. 8, 1944	P		D, S	
7R1	Mrs. John Erickson	U	510	Dg	10	60				do	do	4.1	do			D, S	Water has hardness of 45 ppm.
9D1	Thomas Bollingberg	Uv	240	Dg	29			28	1	Sand, gravelly, within till.	do	14	Mar. 1945	P		D, S	
9E1	J. A. Thomas	Uv	210	Dg	32			25	7	Sand, gravelly, under till.	Unconfined (?).	10	do	P		D, S	
9K1	Andrew Arvidson	St	340	Dg	27					Gravel	Perched	10	do	P		D, S	
9L1	J. E. Lawson	Uv	190	Dg	30	48				Sand			1944	P			Water reported to have "swampy" taste.
13M1	H. J. Pearson	U	350	Dg	15	48				Sand in till	do	6	Mar. 1944	J	4	D, S	Supplies several families in dry season.
14P1	George H. Fulfs	U	300	Dg	25					Permeable zones in till.	do	Surface.	do	J	4	D. S	Barely adequate in fall months.
16A1	Alfred Otin	Uv	150	Dg	18	48				Sand	Unconfined (?).		1945	J		D, S	
20R1	Sigurd Gilbert	St	140	Dn	6	1¼				do	Perched (?).		1944	P	4	D, S	
22H1	Benjamin Pryor	S	250	Dg	18	18	18	10	8	Sand over till	Perched	6	Mar. 1944	P	4	D, S	
22K1	Joseph Wagner	S	250	Dr	108	4	86	68	19	Sand, gravelly, in till (?).	Perched (?).	60	1933	P		D, S	See log.
22L1	Ray Hall	S	250	Dr	68	6		65	3	do	do	65	1940	P	4	D	
23D1	Helen Sill	U	240	Dg	10			10		Sand, white, in till.	Perched	4	Mar. 1944	J	4	D, S	
27Q1	Mrs. E. M. Taylor	Op	160	Dg	30					Gravel	Unconfined. (?).		1944	P		D	Water reported to contain iron.

27Q2	Oscar Carlson	Op	165	Dg	14.1					do	Unconfined	10.4	July 27, 1944	P		D, S	
28R1	Luther Orr	St	140	Bd	59.0					Gravel, sandy	do	42.7	July 28, 1944	P	3	D	
30N1	A. O. Ream	St	150	Dg	14							13+	Aug. 1944	P		D	
32A1	August Jacobs	U	220	Dg	22					Permeable zone in till.			1944	P		D	Inadequate; dry during fall months.
33G1	George Murphy	Op	180	Dg	21	43	21	17	4	Gravel	do	17	July 1944	C	12	D, S	Barely adequate in dry months.
36R1	Elmer W. Lohr	Op	190	Dg	14		14	10	4	do	Unconfined (?)	10	Aug. 1944	P	4	D, S	Water reported to contain iron.
T. 32 N., R. 6 E.																	
12M1	L. R. Talmar	Fp	135	Dg	14					Gravel	Unconfined (?)		Aug. 1944	P	10	D	
17E1	Oscar Oquist	U	460	Dg	45	48				Permeable zones in till.	Perched	6	Mar. 1945	P	6	D, S	
18E1	J. D. Eads	U	440	Dg	42	48		41	1	Sand in till	Unconfined.	4.2	Mar. 17, 1945	P	5	D	
18H1	A. L. Kester	U	440	Dr	110	6	110	100	10	Sand, fine	Confined	+1.0	May 23, 1946	P	5	D, Irr	See log.
20G1	William Kiolie	Fp	95	Dg	12	33	12			Gravel	Unconfined.	10.5	Aug. 10, 1945	P	5	D	Water reported to have slight iron content; hardness is 45 ppm.
21A1	George E. Taylor	Fp	120	Dg	19	24				Gravel, coarse, with boulders.	do		1944	P		D, S	
28K1	A. J. Anderson	Op	350	Dg	58	8	58	43	15	Gravel	do	43	Aug. 1944	P	9	D, S	Materials reported as sand and gravel for entire depth; hardness of water is 50 ppm.
29A1	Steven Oshampaugh	Op	200	Dg	23					Gravel, sandy	Unconfined(?)	13	do	P	5	D	
29E1	A. Clebish	Op	190	Dg	9	16	9			Gravel	do	7	do	P	8	D	
30P1	Paul Hass	Op	185	Dg	5±						Unconfined.		1944	P	4	D	
32E1	J. Rice	Op	300	Dg, Dn	20						do		do	P	4	D	
32L1	Bert Zavada	Op	325	Dg, Dn	28					Sand, fine	do		do	J		D	Materials reported as fine sand for entire depth.
32P1	Niles Darrow	Op	325	Dg, Dn	20±					Sand (?)	do		do	P		D	Do.
32Q1	R. Hershberger	Op	325	Dg	27	36	27			Sand, fine	do	23.8	July 27, 1944	P			Do.
33H1	George Wallitner	Op	340	Dr	86±					Gravel	Confined (?)	40	Aug. 1944	P		D	
33P1	Helen Hart	Op	315	Dn	25±					Gravel, fine, with sand.	Unconfined.	16	July 1944	P	4	D	
34L1	E. R. Holden	Fp	280	Dg	14		14			Sand and gravel.	do		1944	P		D	Barely adequate in dry months.

See footnotes at end of table.

TABLE 4.—*Representive wells in Snohomish County, Wash.*—Continued

Well designation	Owner or occupant of property (2)	Topographic situation[1] (3)	Approximate altitude above sea level (feet) (4)	Type[2] (5)	Depth (feet)[3] (6)	Diameter (inches) (7)	Depth of casing (feet) (8)	Water-bearing zone or zones (9) A: Depth to top (feet)	B: Thickness (feet)	C: Character of material	D: Ground-water occurrence	Water level (10) A: Feet below land-surface datum[3]	B: Date of measurement	Type of pump[4] (11)	Yield (gallons per minute) (12)	Use of water[5] (13)	Remarks[6] (14)
T. 32 N., R. 7 E.																	
8P1	V. H. Aldridge	Fp	180	Dg	10		10				Unconfined.	6.5	Aug. 10, 1944	R		D	Water reported to have high iron content.
8P2	George Anderson	St	200	Dr	90±					Gravel and sand.	Confined	3	Aug. 1944			N	Materials reported as clay with interbedded sand overlying glacial till, which in turn overlies aquifer.
8Q1	S & A Store, Inc	Fp	170	Dg	16±	36	16			Gravel, coarse, with boulders.	Unconfined.	12	do	P		D, PS	Water reported to contain iron; hardness is 50 ppm.
10N1	Andrew Hartl	St	350	Dg	18±	12	18			do	do	13	do	P	5	D, S	
10P1	N. E. Nordstrom	St	325	Dr	91±	4	91±			Gravel, sandy	Confined	10	do	P		D, S	Drawdown reported to be less than 1 ft when pumping is at rate of 25 gpm; materials reported as gravel and sand with wood down to glacial till, which overlies aquifer and confines water; hardness of water 70 ppm.
10Q1	H. Bredkveldt	St	300	Dr	124			90	34	Gravel, coarse	do	10	do	P	8	D, S	Aquifer underlies 60 ft of "gravel and sand-streaked clay."
18B1	S. H. Aldridge	Fp	160	Dg	21±		21±			Gravel	Unconfined.		1944	J		D, S	Water reported to have iron content in dry seasons.

T. 32 N., R. 8 E.

10J1	B. V. Pumpella	St	460	Dr	75	6							1944	P		D, S	Water has hardness of 35 ppm.

T. 32 N., R. 9 E.

8N1	H. J. Engles	Op	450	Dg	9	33	9			Gravel, sandy	Unconfined.	6	Aug. 1944	J			
8Q1	W. L. Rinker	Op	450	Dg	17	48				Gravel with bounders.	do	14.5	Aug. 12, 1944	P			
14J1	W. H. Large	Op	550	Dr	60±	6				Gravel and sand.	Confined (?).	26	Aug. 1944	J		Ind	Water has hardness of 50 ppm.
14R1	U. S. Forest Service	Op	550	Dr	90±					do	do	26	do	P		PS	Water has hardness of 30 ppm; temperature 41F.
15G1	—— Ritchie	Op	540	Dg	18					do	Unconfined.	13	do	P		D, S	Water has hardness of 50 ppm.
15G2	do	Op	540	Dr	120±					do	Confined (?).	25 (?)	1929 (?)	N			

[1] Fp, Flood plain of river; Op, outwash plain; S, slope to Puget Sound or major valley; St, stream terrace; Tf, tidal flat or longshore beach; U, rolling upland; Ud, undrained depression on upland; Uv, upland valley of minor stream. Altitudes interpolated from topographic maps or from barometric traverses.

[2] Bd, Bored; Dg, dug; Dn, driven; Dr, drilled; J, jetted.

[3] Depths and water levels expressed in feet and decimals were measured by the Geological Survey; those in whole feet are reported by owner or driller; those with plus-and-minus signs are estimated. "Flows" indicates flowing well, static level not known; plus measurement, known static level above surface; "surface," well full but not flowing.

[4] A, Air lift; B, bucket; C, centrifugal; J, jet; P, plunger; R, rotary; Sy, syphon; T, turbine.

[5] D, Domestic; F, fire protection; Ind, industrial; Irr, irrigation; N, none; O, observation; PS, public supply; RR, railroad; S, stock.

[6] Chemical quantities, where given, are in parts per million of water by weight.

TABLE 5.—*Chemical analyses of water from wells and springs in Snohomish County, Wash.*

[Analyses by T. Downer, of Geological Survey, unless otherwise shown]

Well No.	Description of well and source of water	Date of collection of sample	Temperature (F)	Hydrogen-ion concentration (pH)	Specific conductance (K x 10^5 at 25 C)	Parts per million (by weight): Dissolved solids at 180 C	Silica (SiO_2)	Iron (Fe) [1]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Borate (BO_3)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$
28/5-8	Water from Woods Creek (see U. S. Geol. Survey Water-Supply Paper 339, p. 40). Mean of 33 analyses of samples taken at intervals during year. Flow of Woods Creek represents largely discharge through springs from regional ground-water body in Esperance sand member.	Mar. 1910; Jan. 1911.				86	25	0.01	8.6	4.5	7.6		0	51	7.1	2.9			0.6	
29/5-19K2	Soundview Pulp Co. well 2. Drilled industrial well 12 in. in diameter and 100 ft in depth. Casing-screen 74 to 100 ft deep in sand and gravel of pre-Vashon age.	Nov. 18, 1944			28	178	.31	[2] .37	16	16	14	4.7		115	15	24	0.2	0.2	.05	106
29/5-29G1	Drilled industrial well of Eclipse Mill Co., 16 and 8 in. in diameter and 217 ft deep. Casing perforated in 75- to 95- and 125- to 205-ft zones. Water probably from gravel, sand, and silt of pre-Vashon age.	do			37	227	40	[3] 2.1	16	13	38	3.0		144	3.2	43	.2	.2	.05	93
30/5-23J1	Dug domestic well, 26 ft deep, belonging to A. B. Franzen. Perched water from sand seams in glacial till of Vashon age.	Sept. 2, 1944		7.5	25	[4] 151	23	.10	22	13	8.5	4.1	0	138	7.4	7.4	.2	.1	2.7	108
31/4-24N3	Water from Edwards Springs. Natural flow from outwash gravel beneath till. Source used for supply of city of Marysville.	do	50	7.5	11.9	90	31	.01	9.0	6.2	5.6	1.4	0	66	3.4	3.6	.1	.2	.6	48
31/5-7G1	Drilled domestic well belonging to Peter Henning, 6 in. in diameter and 150 ft deep; screen open for lowest 6½ ft. Water probably from pre-Vashon (?) sand and gravel forming valley-trough fill.	do	51	8.0	47.3	271	39	[5] 1.1	37	22	27	4.9	9.8	213	1.0	41	.1	.1	6.5	183

31/5-7H1	Dug domestic well, 4 ft in diameter and 17.6 ft deep, belonging to Andrew J. Strotz. Water from sand in Recent river alluvium. Well pumpage small. Sampled during low-water season.	do	-----	6.7	21.7	131	28	[3] 9.4	17	14	5.5	2.3	0	128	3.0	4.6	.2	0	[6] 4.5	100
31/5-15A1	Arlington Cemetery well. Dug irrigation well 5 in. in diameter and 120 ft deep. Water probably from pre-Vashon sand and gravel but possibly from recessional outwash of Vashon drift.	do	48	7.4	13.8	101	28	.10	9.4	9.0	4.7	1.5	0	76	7.0	2.8	.1	.1	1.2	60
31/5-15R2	Drilled public-supply well of U. S. Navy Department. Diameter unknown; depth, 167 ft. Water from coarse sand and gravel of glacial outwash. Analysis by Laucks Laboratories, Inc.	May 13, 1943	-----	6.8	-----	[7] 104	18	[5] .03[8]	12.4	[8] 6.7	[8] 3.6	-----	-----	-----	[8] 12	7.9	-----	-----	-----	[9] 67
31/5-28C1	Dug domestic and irrigation well, 4 ft in diameter and 13 ft deep, of Washington Co-operative Association. Water from recessional-outwash sand and gravel that overlies till.	Sept. 2, 1944	-----	7.4	8.4	65	12	.01	5.4	3.1	4.7	0.7	0	22	3.2	6.4	0	.1	12	26
32/4-20L1	Drilled public-supply well of Stanwood Water Co., tapping water in advance-outwash gravels beneath till at depth below alluvial terrace. Stand-by supply for Stanwood. Analyses by Thomas H. Williams.	Feb. 17, 1948	50	7.9	-----	247	30	0	22.6	16	10	-----	0	183	8.4	9.4	-----	-----	-----	122
		Jan. 31, 1949	-----	8.0	-----	230	42	0	16.9	16	7.2	-----	0	-----	6.2	6.3	-----	-----	1.0	107

[1] Total iron present when sampled.
[2] When analyzed, 0.12 part in solution.
[3] When analyzed, 0.10 part in solution.
[4] Ignition loss, 8.6 parts.
[5] When analyzed, 0.16 part in solution.
[6] Ignition loss, 5.7 parts.
[7] Ignition loss, 15.1 parts.
[8] Computed value.
[9] Soap hardness as $CaCO_3$.

TABLE 6.—*Typical perennial springs in Snohomish County, Wash.*

[For location see pl. 1]

(1) Designation of spring	(2) Owner or occupant of property	(3) Popular name of spring	(4) Topographic situation [1]	(5) Altitude above sea level (feet)	(6) Water-bearing material	(7) Ground-water occurrence	(8) Yield: A Gallons per minute [2]	(8) Yield: B Date of measurement	(9) Use [3]	(10) Temperature (F) [2]	(11) Remarks
27/3-25F1	City of Edmonds	South Edmonds Springs.	S	220	Sand and gravel	Flow from sub-till beds.	55	Feb. 14, 1947	PS		Supplies water for southern part of Edmonds.
27/4-26D1	O. B. Hergert		S	275	do	Seepage from sub-till beds.	5 e	Dec. 6, 1946	D, S		One of several seeps; water has hardness of 55 and chloride content of 7 ppm.
27/5-18E1	R. O. Himple		S	250	do	do	30–40	Feb. 14, 1947	D		
27/5-20P1	——— Shinkle	Thrashers Corner Spring.	S	250	Sand	do	75 r	Dec. 6, 1946	PS		Water has hardness of 35 and chloride content of 5 ppm.
27/5-26F1	H. W. Flanagan		S	350	Sand and gravel	do	50 e	Dec. 13, 1946	D		
27/5-28M1	Mrs. Lankow	Pearl Springs	S	250	do	do	200 e	Dec. 6, 1946	Fc	45r	
28/8-9G1	Sultan Water District.	Lake Sixteen Spring.	Op	675	Gravel	Drain from outwash-plain deposits.	5,600 r	Dec. 11, 1946	D, PS		Do.
29/6-7C1	Arthur Bailey Estate.	Bailey Springs	S	375	Soil zone over till	Drain from side-hill soil.	5–50		PS		Supplies water for about 30 homes.
29/7-34E1	City of Monroe	Syke Springs	Uv	500	Sand and gravel	Drain from sub-till beds.	600 r	Dec. 11, 1946	None	46	Water has hardness of 50 and chloride content of 6 ppm; formerly source of city water supply.
30/4-21G1	Ed Pool		S	40	Sand	do	45 r, m	Dec. 10, 1946	D		Used as public supply for six houses.
30/5-11C1			S	300	Sand and gravel	do		Aug. 28, 1944	D, S		Supplies water for 10 farmhouses.
30/5-11J1			S	300		do		do	D, S		Owned and operated by 15 farmers.
30/5-14A1	Nelson Creek Water Co.		S	300				Aug. 17, 1944	PS		Owned by company of 20 farmers.
30/5-34H1	Snohomish County Department of Public Highways.		S	100	Alluvium		50 e	Aug. 28, 1944	D, S		

30/6-11M1	Alfred Nelson		S	250	Gravel	Drain from outwash-gravel train.	50 e	Dec. 7, 1946	D, S		Water has hardness of 50 and chloride content of 5 ppm.
30/6-11P1	O. C. Brenner		S	250	do	do	900 e	do	FC	51–55	Water has hardness of 40 and chloride content of 4 ppm.
31/4-5F1	Stanwood Water Co.	Hat Slough Springs.	S	40	Sand and gravel	Drain from subtill beds.	500 r	Dec. 12, 1946	PS		Water has hardness of 40 and chloride content of 6 ppm.
31/4-24N3	City of Marysville	Edwards Springs	S	260	do	do	950 r	Aug. 1, 1944	PS	50	Public supply for city of Marysville. See table 5 for chemical analysis of water.
31/5-11F2	F. W. Nettleship		S	50	do	Drain from outwash-gravel train.	300 e	Aug. 14, 1944	D, Ind	48	Supplies creamery and service station. Water has hardness of 40 ppm.
31/5-11G1	Silvana Water District.	Silvana Springs	S	150	do	Drain from subtill beds.	200 e	Dec. 10, 1946	D, PS		Water has hardness of 95 and chloride content of 6 ppm.
31/5-34R1	Ed Nelson		S	115	Sand	Seepage from subtill beds.	36 m	Aug. 31, 1944	D, S, Irr.	48	Water has hardness of 95 ppm.; reported to contain iron and sulfur.
32/3-12J1	Stanwood Water Co. (lessee).	Dettling Crossing Springs.	S	20	Sand and gravel	do	100 r	Dec. 12, 1946	D, PS		Developed for public supply by Stanwood Water District. Water has hardness of 60 and chloride content of 5 ppm.
32/6-29P1	C. M. Giebel		S	250	do	Drain from outwash terraces.	250 e	Dec. 9, 1946	None		
32/6-31M1	Elmer W. Lohr		S	220	do	do	500 e	Aug. 14, 1944	None		Water has hardness of 35 ppm.

[1] S, Slope to Puget Sound or major valley; Op, outwash plain; Uv, upland valley of minor stream.
[2] e, Estimated; m, measured; r, reported.
[3] D, Domestic; S, stock; PS, public supply; FC, fish culture; Ind, industrial; Irr, irrigation.

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