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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOLOGY AND GROUND-WATER RESOURCES OF THE UMATILLA RIVER BASIN AREA, OREGON

by

G. M. Hogenson

Open-file report. Not reviewed for conformance with editorial standards of the Geological Survey

Prepared as a part of the Federal program of the Geological Survey in part through the staff and facilities of the continuing cooperative program with the Oregon State Engineer

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GEOLOGY AND GROUND-WATER RESOURCES OF THE UMATILLA RIVER BASIN AREA, OREGON

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ABSTRACT

The Umatilla River is a tributary of the Columbia River and drains about 2,700 square miles of the Columbia Plateau physiographic province in northeastern Oregon. The southern and eastern parts of the basin lie in the highlands of the Blue Mountains. These highlands, which reach a general altitude of about 5,000 feet, are separated from the lower land in the northwestern part of the area by the ramplike Blue Mountain slope.

The climate of the Umatilla River basin area ranges from mild and semiarid in the Umatilla lowlands to cool and temperate in the Blue Mountain highlands. Average annual precipitation increases with altitude from about 8 inches at Umatilla to about 35 inches in the highlands.

The oldest rocks of the Umatilla River basin area are pre-Tertiary in age and consist of schists and gneisses of the amphibolite facies which were intruded by a composite igneous body of norite and quartz diorite. This pre-Tertiary material is overlain unconformably by a fairly thick deposit of lavas and continental sediments of Eocene age (Clarno formation). The lavas are of acidic to intermediate composition and the sediments are sandstone, silt, and shale, some of which are highly carbonaceous. The pre-Tertiary rocks and the Clarno formation crop out only in the Blue Mountain highlands and the higher parts of the Blue Mountain slope.

The Eocene rocks, in turn, are overlain by the Columbia River basalt of Miocene age. On the basis of extent, thickness, and structural control of the topography, this thick series of accordantly layered basaltic lava flows is the most important rock unit in the basin.

The basalt is overlain by five types of terrestrial sediments. The oldest of these is fanglomerate containing lenses of sand and silt. The gravels of this fanglomerate are composed of basalt pebbles, cobbles, and boulders. The fanglomerate was deposited during Pliocene time after deformation of the basalt had started.

Below an altitude of 1,150 feet the basalt (and in places the Pliocene fanglomerate) is overlain by Pleistocene glacial-lake beds and, below 750 feet, by glaciofluviatile deposits.

All of the pre-Pleistocene rock units of the area are mantled in places by a veneer of loess which was derived, in part at least, from the glacial lake-bed deposits.

Thin ribbons of Recent alluvium border the larger streams. These alluvial deposits are composed mostly of basaltic gravels in the Blue Mountains and of reworked loess in the lowland districts. In some places, small deposits of white volcanic ash are found in the alluvium.

The major topographic features in the area are controlled by structural units in the Columbia River basalt. The area, as a whole, is a westward plunging synclinorium bounded on the southeast by the northeasterly-trending crest of the Blue Mountains and on the northeast by the northwesterly trending crest of the Horse Heaven anticlinal ridge. These major structures are complicated by lesser structures such as the transverse Rieth anticlinal ridge, which trends northeasterly and separates the Pendleton plains on the east from the Umatilla lowland on the west. The ridge formed by the Service anticline has been mostly removed by erosion but a vestigial row of buttes trends northerly from Service Buttes to Sillusi Butte. The axis of the Agency syncline extends northeasterly from the city of Pilot Rock to Athena beneath the topographically low area which served as a depository for part of the Pliocene fanglomerate.

The Columbia River basalt is the most productive and widespread aquifer in the Umatilla River basin area. The fractured scoriaceous zones at the tops of many of the flows are porous and permeable but the more compact central and lower parts of most flows are relatively impermeable. The ground water lies mostly in tabular bodies confined within these scoriaceous zones. Where the lava beds are tilted, the parts that lie down dip at lower elevations may contain water under artesian pressure. Recharge to these ground-water bodies occurs where the beds are tilted and the upturned edges of the scoriaceous zones are exposed in slopes and stream valleys, as in the Blue Mountain slope and the west limb of the Rieth anticline. Large quantities of ground water are available in the basalt at places where structural conditions are favorable and recharge is available, as in the lower parts of the Blue Mountain slope and the Agency syncline and in most of the Umatilla lowlands. In less favored areas, such as the higher parts of the Blue Mountains and the Rieth and Horse Heaven anticlines, ground water is available only in limited quantities from small zones of perched water.

Moderate quantities of ground water are present under water-table conditions in parts of the glaciofluviatile deposits where these are thick enough to provide an adequate storage reservoir. Within these deposits layers of coarse, well sorted sand transmit water readily. The glaciofluviatile deposits lie in an area of low annual precipitation and probably receive most of their recharge from water spread for irrigation and from streams which cross the deposits.

The gravelly deposits of the Recent alluvium in and near the Blue Mountains transmit water readily. In most places the ground water in this alluvium is in hydraulic continuity with the nearby streams.

With few exceptions, the quality of the ground water in the Umatilla River basin is excellent. In general, the water ranges from soft to moderately hard, has a moderate mineral content, and does not contain significant concentrations of objectionable constituents.

GEOLOGY AND GROUND-WATER RESOURCES OF THE UMATILLA RIVER BASIN AREA, OREGON

INTRODUCTION

Purpose and History of the Investigation

The study of the geology and ground-water resources of the Umatilla River basin area was begun in 1951. Plans called for a reconnaissance study of the geology of the area, a well inventory and water-use survey, and compilation of a report listing and interpreting the data obtained.

The project was interrupted by assignment of the author to military duty in 1951, but was resumed in December 1952. Field work for the project was accomplished mainly in the 11 months from December 1952 to November 1953. In June 1955 the geologic section of the report was released to the open file.

Base maps for the project include standard thirty-minute United States Geological Survey topographic maps of the Blalock Island, Umatilla, and Pendleton quadrangles (see pl. 2B), a Forest Service planimetric map of the Pendleton Ranger district of the Umatilla National Forest (pl. 2C), and -- in the area south of the Willamette Baseline and west of longitude 118°30' -- a planimetric map which was compiled by the author from air photos, Forest Service maps, and field reconnaissance (pl. 2A).

The investigation has been made in large part under the noncooperative Federal program of the Geological Survey, and in part as a portion of the Statewide investigation in cooperation with the State Engineer of Oregon.

Previous Work in the Area

The Umatilla River basin area has received intermittent and limited attention of geologists during the last 30 years or more. In the 1920's

J. Harlan Bretz (1920, 1923, 1925, 1912, 1930) presented a series of papers reporting field evidence and advancing a theory to explain the origin of the scablands and glaciofluviatile deposits bordering the Columbia River. In 1931 Hodge (1931, p. 985-1010) published a paper reporting "Exceptional morainelike deposits in Oregon" involving the glaciofluviatile deposits. In 1933, Allison (1933, p. 675-722) published a paper advancing a new theory to explain the relation of the scablands farther north to glaciofluviatile deposits of which a part occurs in the lower limits of the Umatilla basin.

In 1937, Thomas Hite compiled a rough reconnaissance geologic map of Umatilla County for the Soil Conservation Service of the Department of Agriculture. In 1949, Hite's map was published by Wagner (1949, p. 4) in a report for the Oregon Department of Geology and Mineral Industries.

Acknowledgments

Valuable professional assistance was given by Roland W. Brown and Mrs. Jean Hough, paleobotanist and vertebrate paleontologist, respectively, of the United States Geological Survey.

W. D. Wilkinson and William Taubeneck, professors of the Department of Geology of Oregon State College, offered much technical assistance and many helpful suggestions.

Local citizens, city and county officials, and people connected with the construction and operation of water wells were cooperative and helpful. Commercial well drillers who contributed well logs and other information include Bert Gladney of Pendleton, Oregon; Harold Yager, A. A. Durand and Son, the firm of Moor and Anderson, and D. K. Smith, of Walla Walla, Wash.; A. M. Jannsen of Reedville, Oregon; R. J. Strasser and Sons of Portland, Oregon; and

A. M. Edwards of Lexington, Oregon. Well information was given by officers of the Walla Walla District of the Corps of Engineers on wells at the McNary damsite and by officers of the Umatilla Ordnance Depot.

The U. S. Soil Conservation Service at Pendleton furnished aerial photographs and valuable information concerning the soil types and their distribution within the area. U. S. Forest Service officials furnished some of the base maps that were used.

Location Symbols

Wells and springs in this report are designated by symbols which indicate their location according to the official rectangular survey of the public land. An example is well 2N/32-10F1. The number and letter forming the numerator of the fraction designate the township north (or south, if the letter S is used) of the Willamette baseline. The denominator of the fraction indicates the range east of the Willamette meridian. The number following the hyphen is the section number (sec. 10). The letter following it designates a particular 40-acre tract within the section, according to the diagram below, and the final number is a serial number of this well with respect to the other wells and springs scheduled within that 40-acre tract.

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

Thus, the example above indicates that the well is located in the SE¼ of the NW¼ of sec. 10, T. 2 N., R. 32 E., and that this well is the first that is scheduled in this 40-acre tract.

In the tables, well and spring numbers are arranged according to their location in townships which are listed successively from south to north, starting with those in T. 5 S. and ending with those in T. 6 N; and within ranges which are arranged in order of increasing numbers. In tables 1 and 2, these location symbols are not given in full for each well. They are arranged by township and range, under appropriate subheads, and each well or spring is designated only by that part of the symbol which indicates section number, 40-acre tract, and serial number.

Location and Description of the Area

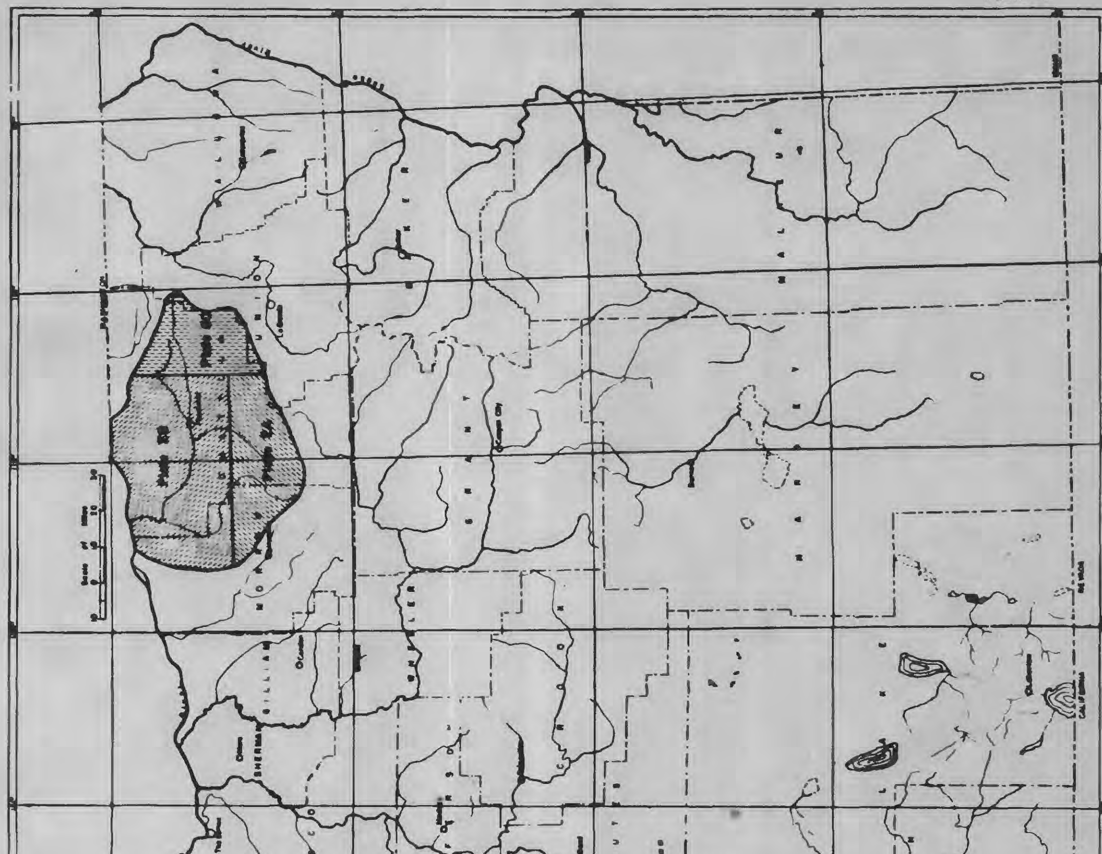
Geography

This report is concerned with that portion of Umatilla and Morrow Counties in northeastern Oregon that is drained by the Umatilla River and several smaller streams as shown on plate 1. The area is roughly oval and covers about 2,700 square miles.

Among the cities and towns within the area are Pendleton, Hermiston, Umatilla, Pilot Rock, Stanfield, Athena, Echo, Helix, Adams, Meacham, Rieth, and Kamela, listed in order of decreasing size. The city of Pendleton (population 12,291), centrally located within the area, is a main railroad, highway, and airline station.

The area is well served by roads and highways, although most of the Blue Mountains region is accessible by forest roads only in fair weather.

Plate I



Map of the State of Oregon showing area covered by this investigation

Major industries within the area are agriculture and lumbering. Dominant agricultural products are small grains, peas, and cattle. Sawmills in Pendleton Pilot Rock, and some smaller places produce lumber from the pine and fir forests of the Blue Mountain highlands.

Topography and Drainage

General subdivisions.- The Umatilla River basin lies entirely within the physiographic province described by Fenneman (1931, p. 237) as the Columbia Plateau. Two of Fenneman's subdivisions are represented. These are the Blue Mountain section and the North Central Oregon district of the Walla Walla section. In this report, Fenneman's Blue Mountain section is divided into two major components, the upland plateau of the Blue Mountain highland and the ramplike slope descending northwestward from the Blue Mountain highland. This feature is referred to as the Blue Mountain slope in this paper.

Blue Mountain highland.- The highlands of the Blue Mountain section have been eroded to a youthful to mature stage by consequent streams which have produced many steep-walled canyons. In the more maturely dissected regions, which lie near the edges of the highland area, the canyons are separated by sharp razorbacked ridges and narrow remnants of the older surface on the bedrock lavas. In the less maturely eroded portions, which lie near the summit of the Blue Mountains, the deep, narrow canyons are separated by fingers of the broad, relatively flat plateau which comprises the Blue Mountain highland. The elevation of the Blue Mountain highland ranges from 3,500 feet at Cabbage Hill to more than 5,000 feet at Huckleberry Mountain.

The highlands receive precipitation slightly in excess of 35 inches annually and have a large volume of surface runoff. The streams have produced a well developed consequent system within which both rectangular and dendritic patterns occur. Northeast of Meacham and Kamela the drainage pattern is mainly rectangular and is controlled chiefly by the pattern of fracturing in the bedrock. In the rest of the highland area the pattern is dendritic and the streams flow mainly in the direction of the dip on the slopes of the old surface of the lava bedrock.

Branches of several of the larger streams are confluent south of the northwest dipping basalt layers in the monoclines which underlie the Blue Mountain slope. For example, Squaw Creek, Meacham Creek, Ryan Creek, and the forks of the Umatilla River all join the Umatilla River between Bingham Springs and Gibbon (see pl. 2C). There the river flows almost parallel to the strike of the basalt but just downstream it flows across the monocline west of Gibbon. Similarly, the tributaries of McKay Creek and upper East Birch Creek merge above monoclinal slopes which the creeks cross near Pilot Rock.

Blue Mountain slope.- The descent from the Blue Mountain highlands to the lowlands of the North Central Oregon district is a gentle, ramplike, maturely dissected declivity. The slope occupies a northeast-southwest belt that is 15 miles wide east of Athena. Northwest of Emigrant Hill it narrows to a width of about 5 miles and maintains this dimension southwest to Battle Mountain. West of Pilot Rock and Battle Mountain the Blue Mountain slope broadens into a much gentler slope which extends about 25 miles south from the edge of the lowlands at Pine City to the summit of the Blue Mountains at Arbuckle Mountain.

North-central Oregon district.- The remainder of the Umatilla River basin area lies within the North-central Oregon district and consists of a broad, general east-west topographic and structural trough lying between the Blue Mountain slope and the relatively low Horse Heaven Hills on the north. This general trough is divided in Range 31 East by the northerly trending crest of Rieth Ridge. In this report that portion of the lowland which lies east of Rieth Ridge is called the Pendleton plains and that portion west of the ridge is called the Umatilla lowland.

The Pendleton plains form a roughly triangular area which is bounded on the southeast by the Blue Mountain slope, on the northeast by the crest of the Horse Heaven Hills, and on the west by the crest of Rieth Ridge. The northern part of the Pendleton plains consists of a gently rolling loess-covered surface which slopes gently southward from the crest of the Horse Heaven Hills.. These hills trend east-southeast and rise to a maximum altitude of 2,100 feet just north of Helix. Their gentle southerly slope into the Umatilla valley contrasts with a much steeper descent into the Walla Walls basin on the north. The southern portion of the Pendleton plains area is a slightly dissected piedmont alluvial plain sloping gently away from the Blue Mountain slope. All the streams traversing the Pendleton plains are consequent, although the Umatills River is antecedent in its relation to Rieth Ridge which bounds the Pendleton plains on the west. The Rieth Ridge is a broad upland extending north-northeast from the Blue Mountain slope to the Horse Heaven Hills. The Umatilla River cross-cuts the ridge in a sharp canyon just below Pendleton.

The Umatilla lowland comprises the remainder of the area. It is a slightly dissected surface of gently rolling topography rising from an altitude of about 200 feet at Irrigon southward to the foot of the Blue Mountain slope and eastward to the crests of Rieth Ridge and the Horse Heaven Hills. It is divided into three areas which have different altitudes and surface characteristics. These are the river-scoured topography below an altitude of 750 feet, the dissected glacial lake-bed zone between altitudes of 750 feet and 1,150 feet, and the loess-covered, youthfully dissected and rolling plains above 1,150 feet.

The scablands consist of a stream-channelled area of water-scoured, relatively horizontal basaltic bedrock. In places the basalt has been covered by glaciofluviatile deposits that reach a maximum depth of 150 feet. The glaciofluviatile deposits are easily eroded by the wind and are therefore dotted by many blowouts. The area is traversed by numerous longitudinal sand dunes oriented generally parallel with the direction of the prevailing wind. The interesting genesis of the scablands has been treated adequately by Bretz (1930, p. 92-93), Allison (1933, p. 675-722), and others.

The dissected glacial lake beds, lying between altitudes of 750 feet and 1,150 feet, are so badly eroded by wind and water that only a few remnants of the old lakebed surface remain. These are long, low terraces lying at altitudes of 1,000 feet to 1,150 feet in Tps. 3 and 4 N., R. 30 E. The terraces are underlain by thick deposits of crudely stratified lacustrine silt with a little erratic ice-rafted sand, gravel, and boulders. In places the silt has been much reworked by wind. These reworked materials are similar to the loess that lies at higher altitudes.

The loess, derived in part from the glacial-lake silts, forms a veneer over most of those pre-Pleistocene rocks that lie above an altitude of 750 feet. South of the Umatilla River it is a fairly thin deposit generally not exceeding 10 feet in thickness, and it becomes thinner with increasing distance south. The loess hills have an overall southwest-northeast alignment indicating the material was deposited by predominantly southwesterly winds. It ranges up to 50 feet in thickness in the district around Holdman, Helix, and Adams northeast of the old glacial lake site.

The Umatilla River is a consequent stream in most of its course across the Pendleton plains and the Umatilla lowland. Where it crosses Rieth Ridge, however, the river seems to be antecedent. It flows through a shallow canyon where it traverses the lowlands east of Pendleton, then crosses Rieth Ridge in a sharp canyon between Pendleton and Echo. The canyon is narrow and steep walled and reaches a maximum depth of about 750 feet. Two miles north of Echo the river reaches the lowland area covered by the glaciofluviatile deposits. From there to the mouth of Butter Creek its valley is broad and shallow. West of the mouth of Butter Creek, the Umatilla River turns northward and flows through a shallow, narrow canyon to the Columbia River.

All the streams tributary to the Umatilla River are consequent. Ryan Creek, Meacham Creek, Squaw Creek, and several smaller streams drain the Blue Mountain highland and join the Umatilla River in the highland area. Wildhorse Creek drains part of the Blue Mountain slope and the south flank of the Horse Heaven Hills and enters the Umatilla River in the Pendleton plains. McKay and Birch Creeks drain part of the Blue Mountain highlands and the Blue Mountain slope. They also flow into the Umatilla River in the Pendleton plains. Butter Creek drains that part of the Blue Mountain slope west of Rieth Ridge and joins Umatilla River in the Umatilla lowlands.

Hydrographs of the discharge of some of these streams are shown on plates 3 to 8. Nearly all the summer runoff of the Umatilla River is used for irrigation or the public supply of the city of Pendleton. Winter runoff in McKay Creek, Cold Springs Canyon, and part of that in the Umatilla River is stored behind dams for release to irrigation projects during the summer.

Climate

The climate of the Umatilla River basin ranges from a mild, semiarid temperate climate in the Umatilla lowland to a cool temperate climate in the Blue Mountains highlands. In the weather summations given below, all data are taken from records of the U. S. Weather Bureau. The total annual precipitation increases progressively with the altitude from about 8 inches at Umatilla to about 35 inches in the higher portion of the Blue Mountains. It falls mostly in the winter months, as may be seen illustrated on plate 9. The precipitation falls mostly as rain in the lower parts of the mountains and as rain and snow on the upland.

The relationship of altitude to average annual temperature, length of growing season (in which air circulation also is a factor), and average annual precipitation is shown by the following list:

Station	Altitude	Average annual temp. (°F)	Average highest annual temp. (°F)	Average lowest annual temp)°F)	Frost-free period (days)	Average annual precip. (inches)
Umatilla	285	54.2	102	0	173	7.86
Hermiston	624	52.7	103	-5	158	8.24
Pendlston Airport	1,492	52.7	100	1	184	12.96
Pilot Rock	1,697	52.1	102	-3	152	13.29
Meacham	4.050	46.3	92	-3	115	34.69

For this table the average highest and lowest annual temperatures are based on records for the period 1945-54, and the average annual frost-free period on records for 1948-54. Average annual temperature and precipitation are based on the entire period of record up to 1954 for each station.

Unpublished records subject to revision

PLATE 3

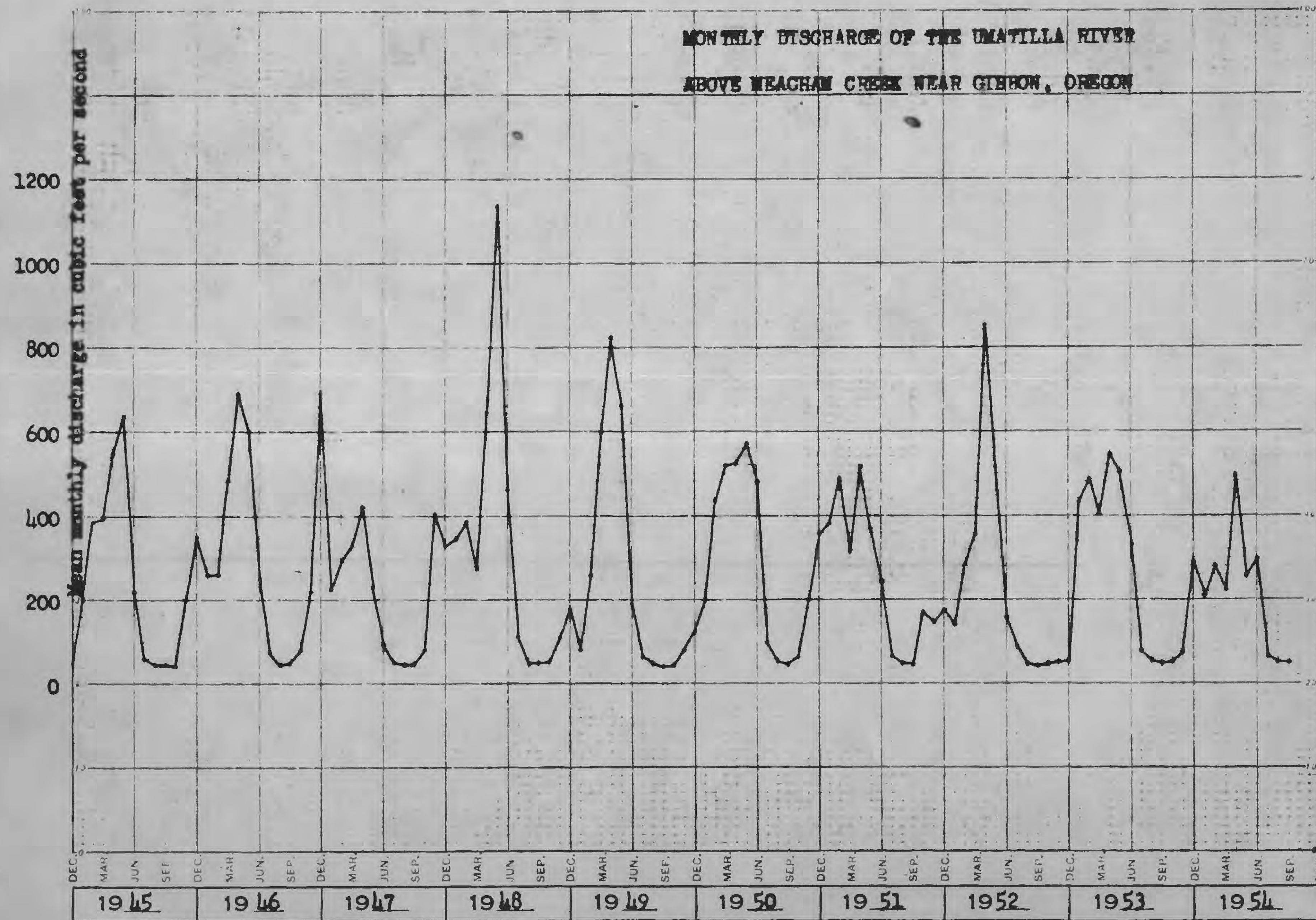
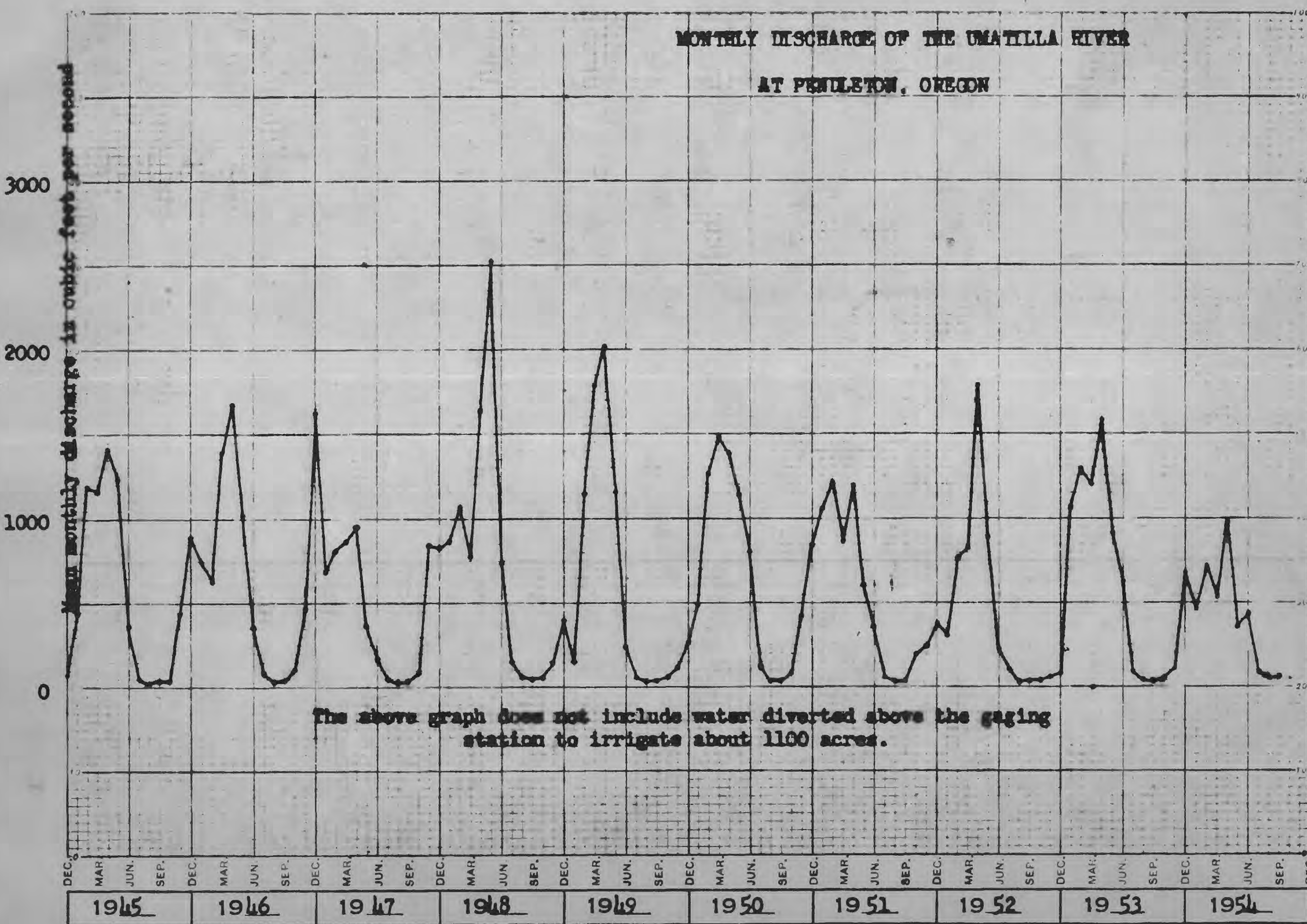
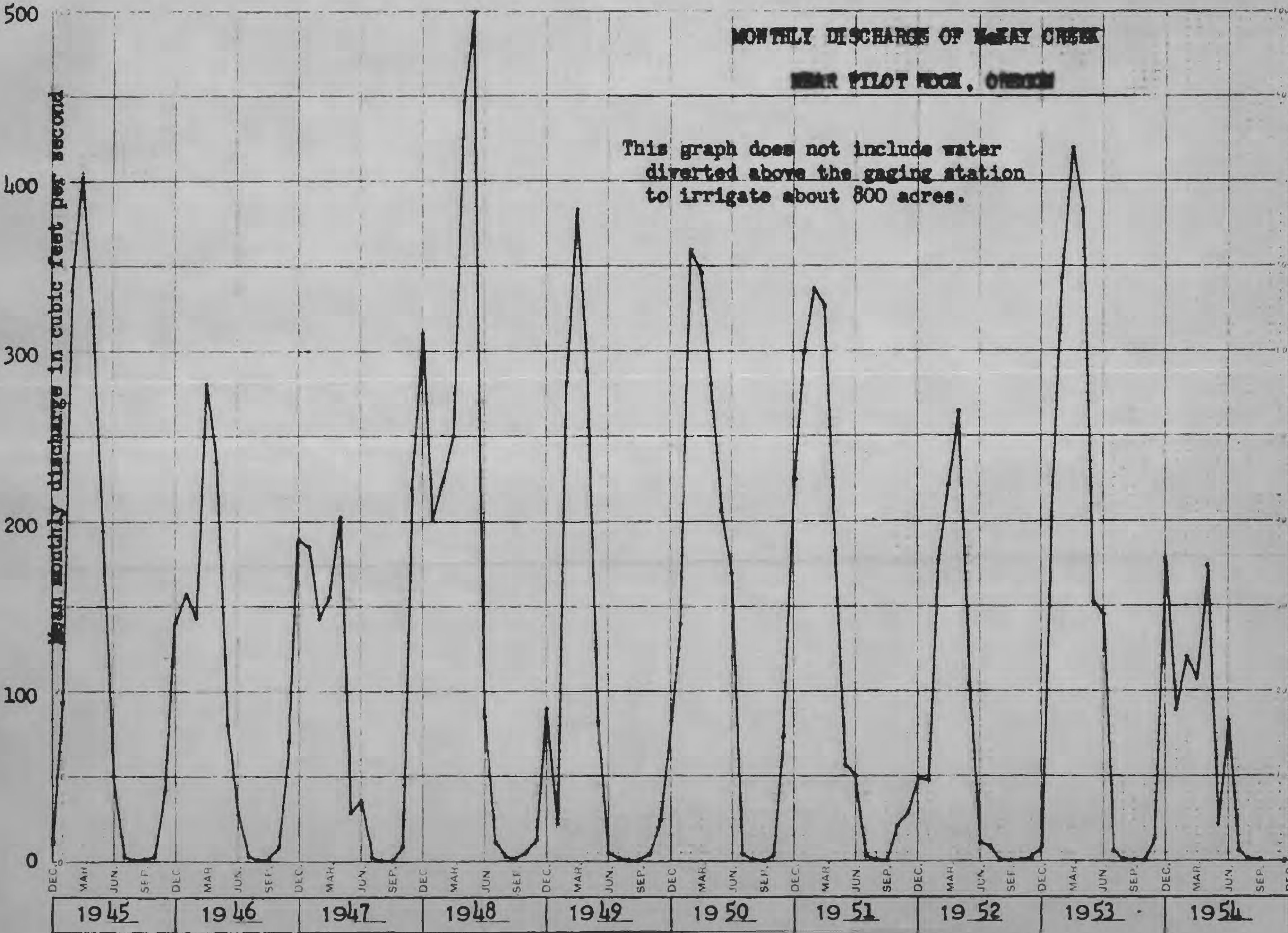

MONTHLY DISCHARGE OF THE UMATILLA RIVER
ABOVE MEACHAM CREEK NEAR GIBBON, OREGON
Mean monthly discharge in cubic feet per second
1200
1000
800
600
400
200
0
DEC.
MAR.
JUN.
SEP.
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954

PLATE 4


MONTHLY DISCHARGE OF THE UMATILLA RIVER
AT PENDLETON, OREGON
Mean monthly discharge in cubic feet per second
3000
2000
1000
0
The above graph does not include water diverted above the gaging station to irrigate about 1100 acres.
DEC. MAR. JUN. SEP.
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954



MONTHLY DISCHARGE OF McKAY CREEK
NEAR PILOT ROCK, OREGON
This graph does not include water diverted above the gaging station to irrigate about 800 acres.
Mean monthly discharge in cubic feet per second
500
400
300
200
100
0
DEC. MAR. JUN. SEP.
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954

PLATE 5

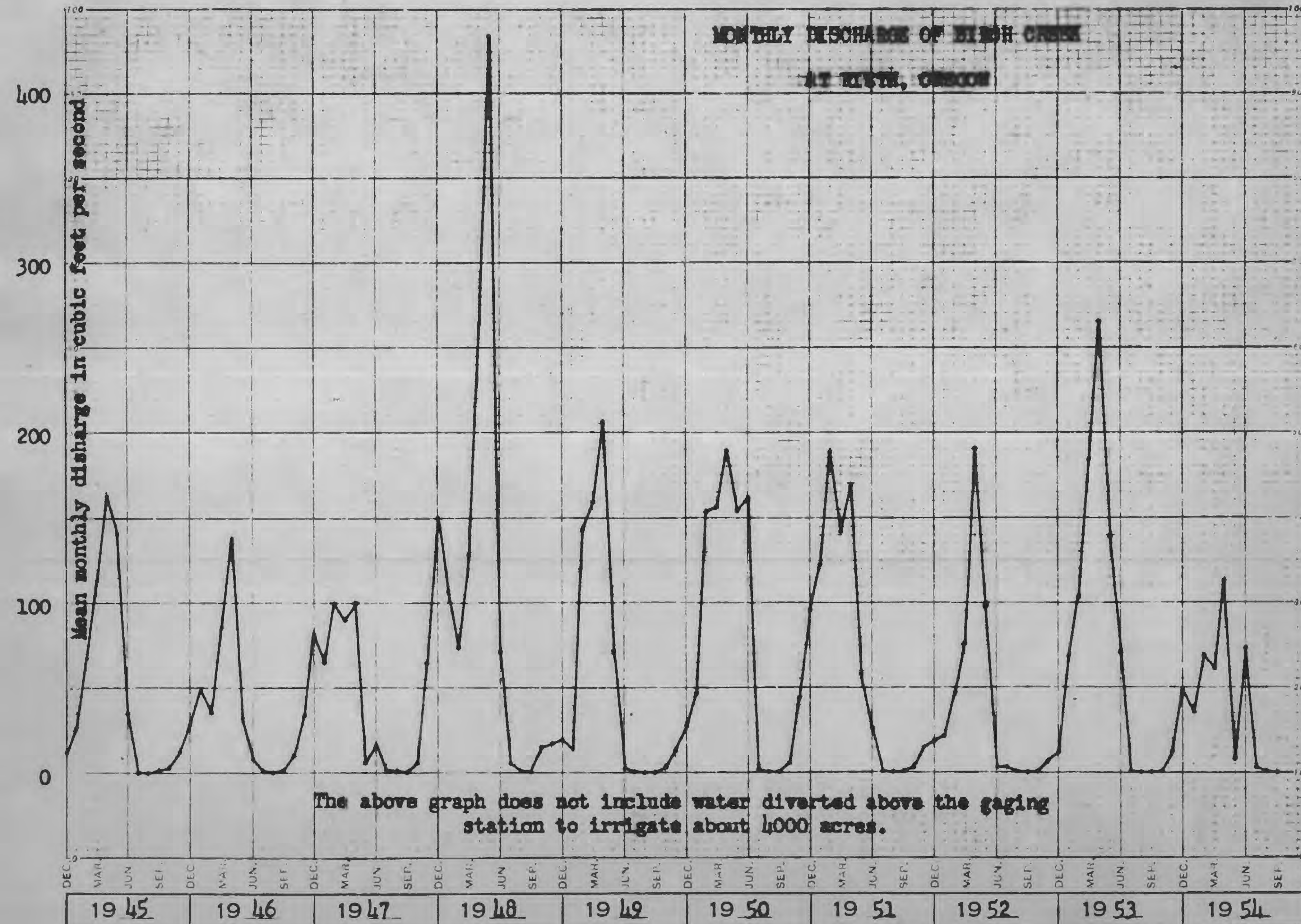
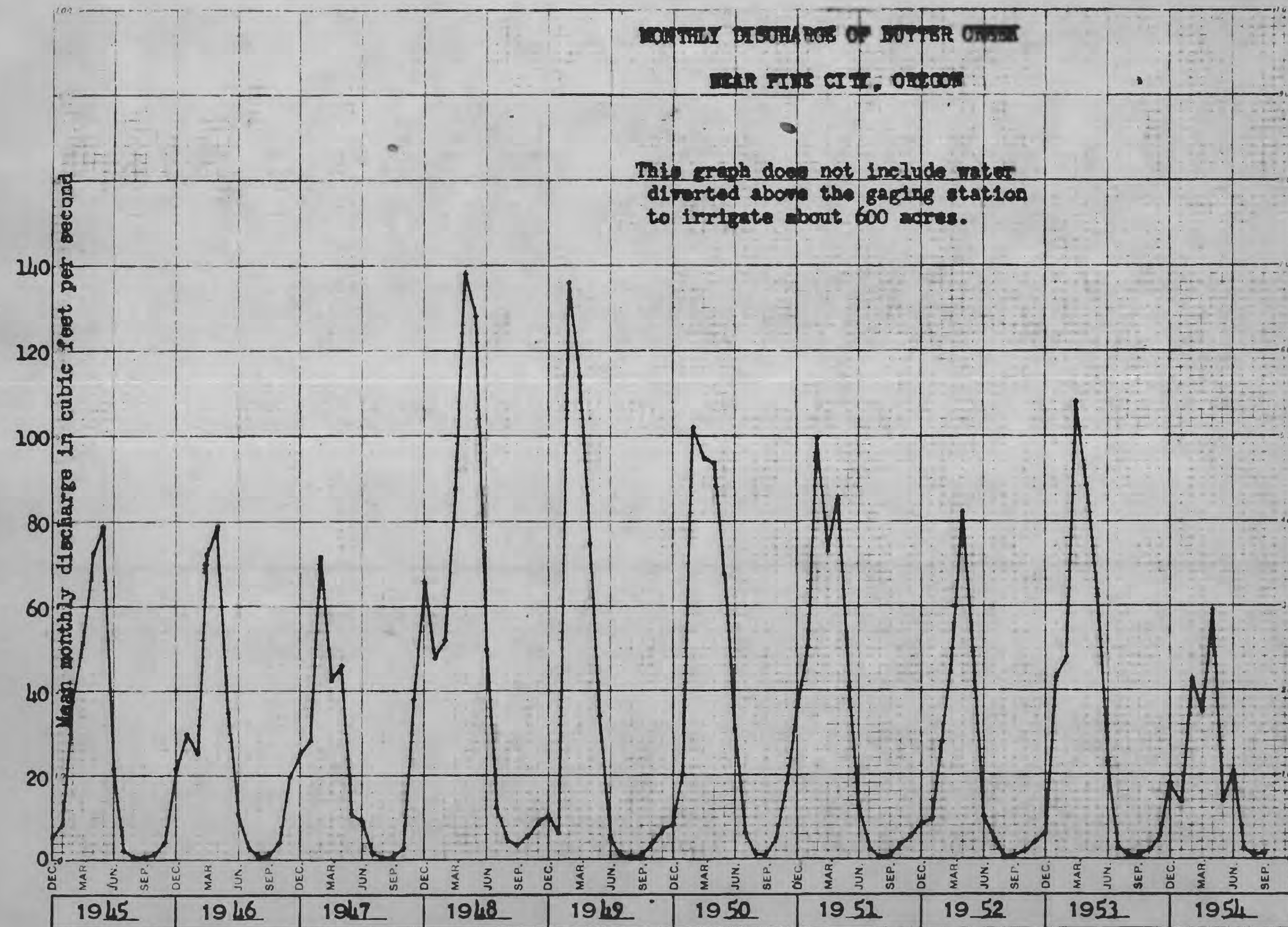

MONTHLY DISCHARGE OF
Mean monthly discharge in cubic feet per second
400
300
200
100
0
The above graph does not include water diverted above the gaging station to irrigate about 4000 acres.
DEC. MAR. JUN. SEP.
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954

PLATE 6

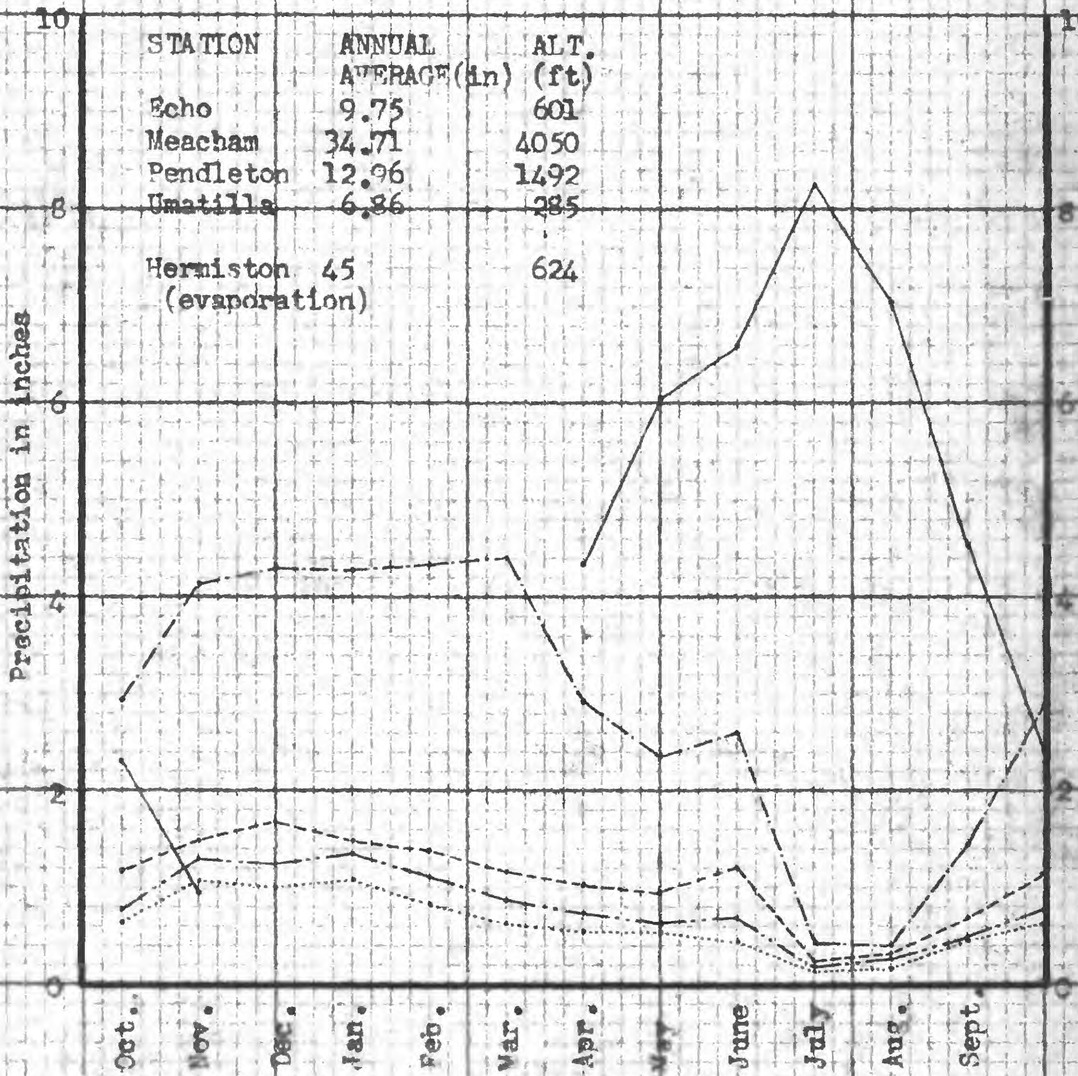
PLATE 7



MONTHLY DISCHARGE OF BUTTER CREEK
NEAR PINE CITY, OREGON
This graph does not include water diverted above the gaging station to irrigate about 600 acres.
Mean monthly discharge in cubic feet per second
140
120
100
80
60
40
20
0
DEC. MAR. JUN. SEP.
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954

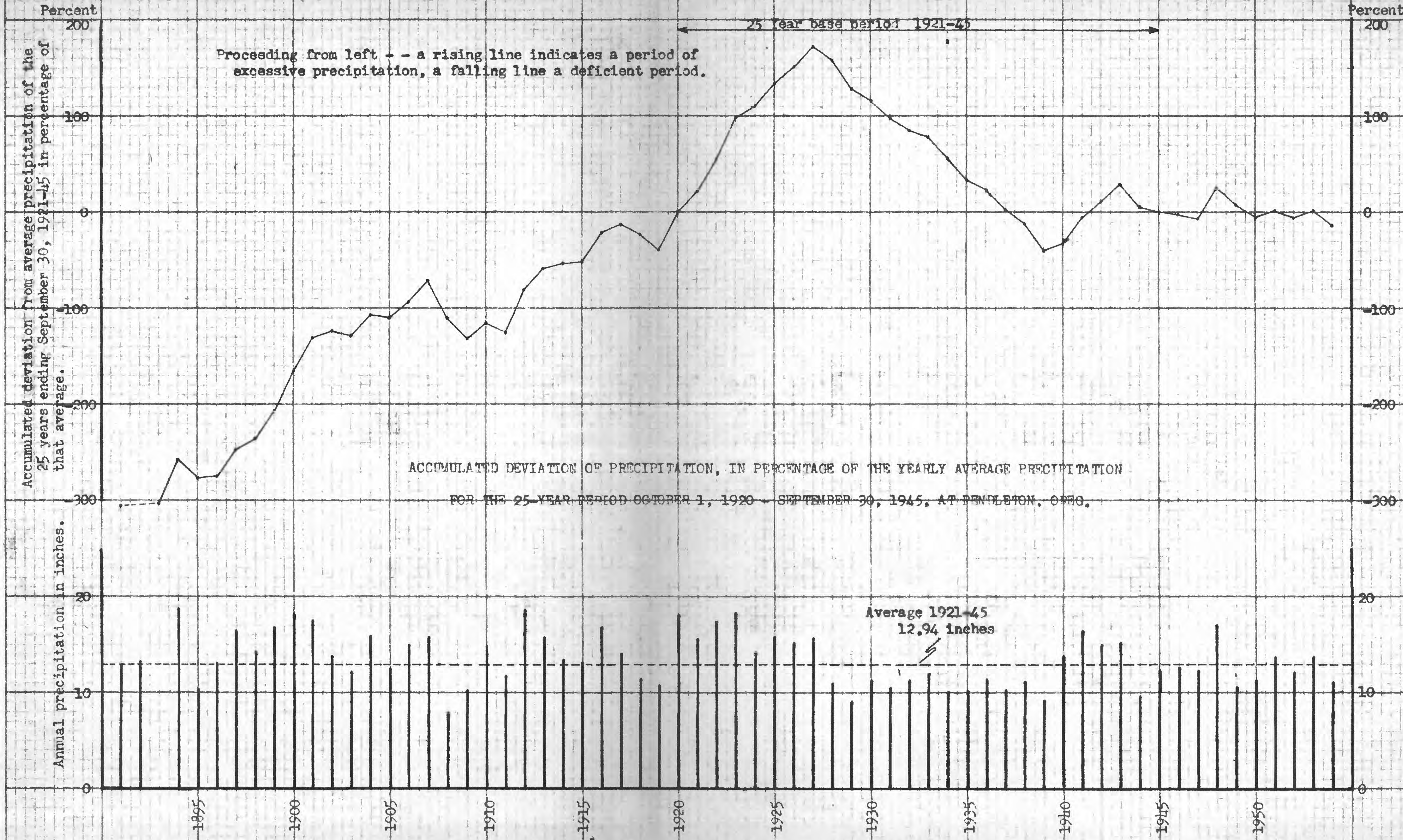
PLATE 6


MONTHLY DISCHARGE OF THE UMATILLA RIVER
ABOVE MEACHAM CREEK NEAR GIBBON, OREGON
Total monthly discharge in thousands of acre feet
70
60
50
40
30
20
10
0
19 35
19 36
19 37
19 38
19 39
19 40
19 41
19 42
19 43
19 44
19 45
19 46
19 47
19 48
19 49
19 50
1951
19 52
19 53
19 54
Unpublished records
subject to revision



Average monthly precipitation at four stations in the Umatilla River basin, Oregon, and average monthly evaporation at Hermiston, Oregon. (Average annual evaporation at Hermiston was obtained by assuming a total of 4 inches of evaporation for the winter months during which the evaporation station was not maintained.)

Unpublished records subject to revision



PRECIPITATION AT PENDLETON, OREGON, DURING CLIMATIC YEARS ENDING ON SEPTEMBER 30 OF EACH YEAR 1891-1954

Unpublished records subject to revision

Records of evaporation measurements, made in a sunken pan 24 inches in depth and 6 feet in diameter, have been kept at Hermiston for the years 1947-54, exclusive of the winter months. Evaporation during the winter months is assumed to be small, not exceeding a total of 4 inches per year. The resulting figures indicate an average annual evaporation from the pan used of about 45 inches for the Hermiston area. Average monthly evaporation figures are indicated on plate 9.

Wind-velocity records were kept at hermiston for nearly all months of the period 1951-54. They indicate an average wind velocity of 3.45 miles per hour. The windiest month of the average year is May, with an average of 4.8 miles per hour, and the month with the least wind is November, with an average wind velocity of 1.8 miles per hour. This is not consistent every year; although May has the highest average wind velocity for the four years, it does not have the highest in every year. For single months, January had the highest average velocity in 1951, March in 1952 and 1953, and June in 1954.

GEOLOGY OF THE AREA

General Character and Relations of the Rock Units

The oldest rocks in the Umatilla River basin are pre-Tertiary in age and consist of a metamorphic mass that was intruded by a large composite igneous body of norite and quartz diorite. This pre-Tertiary material is overlain unconformably by a fairly thick deposit of Eocene volcanics and terrestrial sediments (Clarno formation) which are of comparable age and somewhat analogous in lithology to the Swauk formation (Smith, G. O., 1904, p. 1) of central Washington. The outcrops of these pre-Miocene rocks are shown on plate 2A.

The Eocene rocks, in turn, are overlain by the Columbia River basalt of Miocene age. This basalt is the most important rock unit in the area as to areal extent, thickness, and structural control of the topography.

The basalt is overlain by five types of terrestrial sediments. The oldest of these is a fanglomerate composed of silts and basaltic conglomerate. This fanglomerate was deposited during Pliocene and possibly early Pleistocene time after mild deformation of the Columbia River basalt. It was derived by erosion of the basalt at higher elevations and deposition of the debris upon the basalt at lower elevations.

Below an altitude of 1,150 feet the basalt (and in places the Pliocene fanglomerate) is overlain by Pleistocene glacial-lake beds and, below 750 feet, by glaciofluviatile deposits.

All pre-Pleistocene rock units in the area are overlain by a veneer of loess. This silt deposit of Pleistocene age was derived at least partly by wind action on the glacial-lake beds previously mentioned.

The youngest materials in the area are the narrow, shallow deposits of Recent alluvium which border the streams. This alluvium is composed mostly of basaltic gravels in the Blue Mountains district and of reworked loess in the lowlands districts.

In some places small amounts of white volcanic ash occur in the alluvium, forming minor local terraces along the edges of the canyon bottoms and on the adjacent slopes. Each of these rock units is discussed in more detail below.

Geologic Units

Pre-Tertiary Rocks

Metamorphic complex.- Metamorphic rocks are exposed in the southwest part of the area in the region previously described as the Blue Mountain slope. The topography of this region is mature and in places the deep canyons have been cut through the Columbia River basalt and Clarno formation into the underlying rocks. The metamorphic rocks are now exposed in a total area of almost 15 square miles (see pl. 2A). These rocks are rather highly metamorphosed and are members of the amphibolite facies (Turner, 1948, p. 61).

The metamorphic rocks consist of a fairly thick series of gneisses and schists intruded by small bodies of granite pegmatite and ultra-basic rocks. A broad zone of migmatite is exposed in Bear Creek canyon near the contact of the metamorphic rocks and the intrusive mass of quartz diorite. In this zone the schists and gneisses are cut by many nearly vertical dikes of rock similar in appearance to the quartz diorite intrusive. These dikes, ranging from a few inches to several feet in thickness, parallel the foliation of the metamorphic rocks.

The schists are of the amphibolite or amphibolite-epidote type. Some of them contain appreciable quantities of calcite in distinct, though anhedral, crystals.

The gneisses are composed almost entirely of alternating layers of hornblende and plagioclase, usually andesine. Some of them contain minor amounts of calcite and epidote. The hornblende and plagioclase layers range up to 5 millimeters in thickness. With decrease in grain size and plagioclase content, the gneisses grade into the schists.

The bodies of granite-pegmatite and hornblende in places are some distance from the exposures of the quartz diorite. In the NE$\frac{1}{4}$ sec. 4, T. 3 S., R. 32 E., a mass of hornblendite and one of pegmatite lie within a few feet of each other more than 3 miles from the nearest exposure of quartz diorite. The pegmatite contains garnet, schorlite, and muscovite in a ground mass of potash feldspar and quartz. The hornblendite is composed almost entirely of hornblende. The hornblendite body lies parallel to the foliation of the hornblende-plagioclase gneiss surrounding it but the pegmatite body is not oriented with that foliation.

Other pegmatite bodies occur near the center of sec. 33, T. 3 S., R. 30 E., near the center of sec. 8, T. 3 S., R. 32 E., and elsewhere.

Intrusive rocks.- The metamorphic rocks are in contact with a large composite igneous intrusive mass. This material is exposed over about 8 square miles in the vicinity of Battle Mountain State Park. The intrusive mass consists of a large quartz diorite body and a smaller norite body. The norite is nearly surrounded by exposures of the quartz diorite.

The quartz diorite is composed of about 38 percent andesine, 30 percent quartz, 28 percent hornblende, and 4 percent biotite, with traces of sphene, apatite, and iron minerals. Xenoliths of darker quartz diorite are present and many small dikes cut the rock. These dikes range in width up to 3 inches and are composed of leucocratic quartz diorite. Most of the contacts between the dikes and the country rock are fairly sharp but in some places they are gradational. The quartz diorite at the surface is badly disintegrated and is readily eroded. Its exposures occur mainly in steep-walled valleys beneath basalt-capped ridges.

The norite is composed of approximately 63 percent labradorite, 16 percent hypersthene, and 21 percent hornblende, with accessory sphene, apatite, and iron minerals. Some of the hornblende crystals contain small cores of augite.

A small igneous body of quartz diorite is exposed in Pearson Creek Canyon in the NE$\frac{1}{4}$ sec. 9, T. 3 S., R. 34 E. This exposure is less than one-fourth square mile in areal extent. It lies more than 10 miles from the larger quartz diorite body and is richer in quartz than the larger mass. This smaller body therefore may be a separate intrusive, although it is possible that it is a part of the larger body.

Tertiary Rocks

Clarno formation.- Approximately 18 square miles of volcanics and terrestrial sediments of Eocene age are visible in T. 4 S., R. 29 E., in the extreme southerly portion of the Umatilla River basin. Twenty miles northeast of this exposure, scattered outcrops of this same material total approximately 2 square miles in T. 2 S., R. 32 and 33 E.

The lower part of the Clarno formation consists of sandstones, micaceous shales, and siltstones. The sandstones make up the bulk of the material and are composed mostly of massive quartz sand with some feldspar, white mica, and rock fragments in varying proportions. The cementing material is predominantly calcium carbonate. The grains of feldspar, mostly andesine, are fairly fresh. The mineral grains are angular to subangular. The shales are made up mostly of clay, very fine grains of quartz, and white mica. Some of the beds contain much carbonaceous material.

The upper part of the formation contains several lava flows of a light-brown to gray color, in addition to the shales and sandstones previously described. The individual lava flows are of limited areal extent, although some of them are more than 100 feet thick. The rock is characterized by phenocrysts of feldspar in a fine-grained and dense groundmass. Quartz phenocrysts are present in many of the flows.

A sample from a representative lava flow is found to be a dacite porphyry in which phenocrysts of quartz and andesine constitute more than 50 percent of the rock and are set in a dense groundmass. Mica phenocrysts make up about 5 percent of the rock and are partly altered to chlorite and iron oxide.

Another sample from a different flow is porphyritic andesite with phenocrysts of andesine, augite, and hornblende in a dense groundmass. Both samples were highly weathered.

Many of the shales, as mentioned above, contain much carbonaceous matter, some of which has been altered to lignite or bituminous coal. The coal beds are thin and contain much "bone." Plant fossils from several of these carbonaceous seams were studied by Roland W. Brown of the U. S. Geological Survey. He determined the Eocene age of the formation from his fossil identifications, listed by their locations:

NW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 12, T. 2 S., R. 32 E. Fossils from shale bed in the north wall of East Birch Creek canyon:

Allantodiopsis erosa (Lesquereux) Knowlton and Maxon
Lastrea fischeri Heer
Equisetum sp.
Glyptostrobus dakotensis Brown
Sabalites sp.
Betula sp.
Quercus banksiaefolia Newberry
Numerous other dicotyledonous leaves.

NW$\frac{1}{4}$NE$\frac{1}{4}$ sec. 31, T. 2 S., R. 33 E. Fossils from shale bed on west bank of Pearson Creek:

<u>Aneimia</u> sp.
<u>Lastrea fischeri</u> Heer
<u>Glyptostrobus dakotensis</u> Brown
Numerous other dicotyledonous leaves.

NE$\frac{1}{4}$NW$\frac{1}{4}$ sec. 20, T. 4 S., R. 9 E. Fossils taken from shale bed underlying massive sandstone bed which forms a ridge top:

<u>Aneimia</u> sp.
<u>Glyptostrobus dakotensis</u> Brown
<u>Sabalites</u> sp.
<u>Quercus banksiaefolia</u> Newberry
<u>Magnolia</u> sp.
<u>Carpites verrucosus</u> Lesquereux
Numerous other dicotyledonous leaves.

An outcrop of these rocks in Willow Creek Canyon, southwest of the Umatilla River basin area was referred to the Clarno formation by Mendenhall (1909, p. 406-408).

<u>Columbia River basalt</u>.- The Clarno formation is unconformably overlain by the Columbia River basalt. The basalt is by far the most extensive rock unit in the Umatilla River area, as it is in the rest of the Columbia Plateau Province. In all but a few of the 2,700 square miles within the Umatilla River basin, the basalt either crops out or underlies the surface at relatively shallow depths. According to Fenneman (1931, p. 25), the basalt covers about 100,000 square miles of Oregon, Washington, and Idaho to depths, in some places, in excess of 4,000 feet.

The maximum thickness of the basalt in the Umatilla River basin area has not been determined but is known to be more than 2,500 feet. In the vicinity of Pendleton, Echo, Umatilla, and Athena, water wells have penetrated more than 1,000 feet of basalt without reaching the bottom. The canyon of the Umatilla River near Bibbon cuts through a total of 2,500 feet of basalt without exposing its base. Only in the southern part of the drainage basin, where the basalt thins over the older rocks, is the bottom of the Columbia River basalt exposed.

This Miocene volcanic composite consists of a thick sequence of basaltic lava flows lying accordantly one above the other. The individual flows range in thickness from 10 to 100 feet and in lateral extent from less than 1 to more than 10 miles.

The bottom few inches of each lava flow generally consists of fine-grained, glassy, fractured rock grading upward into a coarser-grained, but still dense, rock which is separated into polygonal, usually hexagonal, columns by sets of roughly vertical cooling-contraction joints. These columns may be a few inches to several feet in diameter in the bottom half of the flow but become progressively smaller and more perfectly formed in the upper portion of most flows. The upper few feet of the flow is commonly finer grained but vesicular or scoriaceous. Variations of this structure are common, dependent upon the chemical composition of the lava, the temperature at which it was extruded, its rate of cooling, and the amount of movement that took place during cooling. Some flows are composed almost entirely of blocky, columnar basalt while others have in their upper parts thick zones of greatly inflated honeycomb lava. One flow, at Eagle Rock near Mount Emily, is slightly less than 100 feet thick and composed mostly of a volcanic breccia -- the larger fragments of which are basaltic and apparently pyroclastic in origin -- resting in a matrix of fine-grained lava or welded tuff.

Weathered soil zones are comparatively rare between the lava flows, although the upper portions of some flows were weathered a reddish-brown color to a depth of a foot or two feet prior to burial by the next flow. Apparently, most of the flows were exposed for only a short time before being buried by subsequent flows.

A few tuffaceous lacustrine interbeds lie between the flows in some parts of the area. Apparently these were deposited when the lava flows disrupted the drainage. Within the Columbia Plateau province, particularly farther northwest, the largest of these interbeds is called the lower part of the Ellensburg formation from its type locality near Ellensburg, Wash. The lower part of the Ellensburg formation is not known to crop out in the Umatilla River basin but does occur a few miles farther northwest in the escarpment north of the Columbia River and has been encountered by water-well drillers in the Umatilla-Echo area. The approximated extent of its occurrence is delineated on plate 2B. Another of these interbeds, of uncertain extent and identity, was reported by well drillers to have been encountered in wells near Athena.

Only one sedimentary interbed was found cropping out. The outcrop is in sec. 19, T. 2 S., R. 33 E., at the bottom of the east wall of Pearson Creek canyon. The exposure is about 600 feet long and consists of about 60 feet of tuffaceous, slightly sandy shale. Individual beds range from one-sixteenth inch to three inches in thickness and their composition ranges from fine-grained sandstone to claystone. Numerous poorly preserved leaf fossils are present, and, on the basis of these, the Miocene age of the Columbia River basalt at that place is confirmed. Fossil determinations were made by Roland W. Brown and a list of his findings follows:

Quercus pseudolyrata Lesquereux
Zelkova oregoniana (Knowlton) Brown
Cedrela pteraformis (Berry) Brown

The shale is soft and incompetent. Consequently, huge blocks of the overlying basalt have broken loose and slumped down, slightly deforming the outcrop and obscuring its northern and southern ends. The presence of similar slump blocks up the slope to the east indicates that this shale bed extends eastward under the basalt ridge at least a mile from the outcrop. The fact that none of this shale was found on the west side of the canyon indicates that the canyon may follow a fault line along which the west side is downdropped. The basalt overlying the shale dips about 3 degrees northwest and the Clarno formation crops out about 2 miles farther south in this same canyon. Therefore, this shale deposit is stratigraphically low in the Columbia River basalt of the Blue Mountain slope.

That the basalt issued quietly from fissures or low shield volcanoes is the generally accepted belief. As single flows are seldom traceable for more than 10 miles, large numbers of fissures must have once existed over most of the basin area, and one would expect the lower lava flows to be cut by many small dikes. However, such dikes are rarely observed. Only one basalt dike was recognized in the 2,500 square miles covered by the Columbia River basalt. That dike is mapped on plate 2C in T. 2 N., R. 37 E. Its trend is arcuately north-south, concave easterly. Such a trend does not conform to the main regional northwest-southeast faulting and jointing pattern now present in the basalt.

Black Mountain, 2 miles southwest of this dike, has the shape of a shield volcano and may have been a source of some of the basalt.

Fanglomerate of Pliocene age.- Two large deposits of fanglomerate of Pliocene age immediately overlie the Columbia River basalt at low altitude. Both these units contain subangular to well-rounded basaltic conglomerate particles ranging in size from grit to boulders. Thick silt and sand lenses are included. The deposits are rather impermeable, the interstices having been almost completely filled by silt and clay during deposition.

Though there is a great variety in the size of particles, most range in size from pebbles to cobbles. Essentially all pebbles, cobbles, and boulders are of basalt derived from nearby basaltic highlands. In all the gravels observed, only one cobble was seen which was not composed of basalt. This one was a piece of brown, waxy chert, a secondary material commonly found in the basalt.

The bedding structure of the fanglomerate is crude, nearly horizontal, with some crossbedding of the type common to torrential deposition. In most places the master bedding dips at low angles in a northerly direction.

One of the larger deposits of fanglomerate gravel underlies the Pendleton plains in the vicinity of McKay Reservoir (pl. 2B), and has been referred to informally as the McKay beds. The other large deposit lies west of Butter Creek and was designated by Hodge (1942, p. 19) as the lower part of the Shutler formation.

The so-called McKay beds are composed of Pliocene fanglomerate material deposited in the northeast-trending trough of the Agency syncline which lies at the foot of the Blue Mountain slope. The beds underlie about 50 square miles in a roughly triangular area whose points are at Pendleton, Pilot Rock, and Blakely.

The so-called McKay beds are composed of basaltic pebble and cobble conglomerate with silt-filled interstices. There are many siltstone and sandstone lenses, some of which are several hundred feet long and as much as 40 feet thick, but most of the lenses are somewhat smaller. The material has been fairly well indurated by compaction and cementation with carbonate material. It is sufficiently consolidated to stand intact for several years in vertical cliffs.

The structure of the so-called McKay beds is essentially horizontal, with some local crossbedding that dips northwesterly. The size of the gravel particles ranges from angular boulders, mostly located near the foot of the Blue Mountain slope, to well-rounded grit, pebbles, and cobbles which are common near Pendleton.

The Pliocene age of the so-called McKay beds is established by its stratigraphic position (overlying the Columbia River basalt of Miocene age and underlying the Quaternary loess) and by fossil evidence. Vertebrate fossils from a silt lens on the east bank of McKay reservoir were identified by Jean Hough of the National Museum as follows:

Dipoides sp.	Age - - - - Pliocene
Castor sp.	Age - - - - Pliocene to Recent

The gravels of the lower part of the Shutler formation of Hodge (1942, p. 19) are exposed west of Butter Creek north of the Willamette Baseline and above the 750-foot contour. Their attitude, composition, and structure are very similar to those of the so-called McKay beds. They were derived from the basalts of the Blue Mountains to the south and were deposited on the nearly horizontal basalts of the Umatilla lowland. The maximum thickness of the gravels is about 100 feet. They are slightly thinner than the McKay beds but are laterally much more extensive. They extend westward beyond the Umatilla River basin.

Quaternary Units

Pleistocene deposits.- Two deposits of Pleistocene age are represented in this area. One is a lacustrine sediment deposited in a lake of late-glacial age. The other is a sand and gravel deposit of glaciofluviatile type.

The glacial-lake deposits lie mostly between the 1,150-foot contour and the 750-foot altitude (pl. 2B). They consist of poorly stratified silts and sands with local inclusions of gravel and scattered ice-rafted erratic sand, pebbles, cobbles, and boulders. The beds are generally less than 80 feet thick and rest upon the basalts and Pliocene fanglomerate. In size the erratics range from sand grains up to boulders weighing several tons.

The glaciofluviatile deposits are scattered over the "scabland" area bordering the Columbia River. Their upper limit approximates the 750-foot contour line in most places, although it ranges up to the 1,150-foot contour between Juniper and Cold Springs canyons just southeast of Wallula Gap. The outwash deposits consist of rather clean sand and fine gravel with some large boulders and local silt lenses. Their thickness is variable, ranging up to 200 feet. Locally they may rest upon Pliocene gravel but in most of the area they rest directly upon the Columbia River basalt. The outwash material is very crudely stratified, with crossbedding of torrential-current type. The material is permeable, and surface drainage has not developed upon much of the area it underlies. Surface water percolates quickly downward into the outwash materials and escapes by subsurface flow. The finer-grained portions of this material are readily susceptible to wind erosion, and many small dunes and deflation basins occur irregularly over the area.

The glacial-lake deposits are believed to be equivalent to the Touchet beds of Flint (1938, p. 461-523). The Pleistocene material of the whole Columbia basin has been described in some detail by Bretz (1927, p. 617-649; and 1925, p. 97-115, 236-239), Allison (1933, p. 675-722), and others.

Pleistocene to Recent deposits.- There are one major and two minor deposit of Pleistocene to Recent age. The major deposit is the loessial Palouse formation of Pleistocene age, and the minor ones are volcanic ash and alluvium of Recent age.

The Palouse formation is a widely spread veneer of windblown loessial silt derived in part from the glacial-lake-bed silts previously mentioned. The loess occurs widely spread throughout the Umatilla River basin in depths which range from 1 to 2 feet on the summit of the Blue Mountains to more than 50 feet in the Horse Heaven Hills country around Holdman and Helix. The prevailing wind which deposited this loess was from the southwest, so the loess is thickest and of coarsest grain size in the area northeast of the original lake. As a result, there are several hundred square miles of northeast-trending dunelike ridges of loess in the area around Holdman (see pl. 2B). Above 750 feet almost all the area of the Pendleton Plain and the Umatilla lowland is covered with several feet of loess.

In the author's opinion the loess ranges in age from Pleistocene to Recent. However, it is probable that the bulk of the eolian erosion and redeposition took place shortly after the drainage of the glacial lake, and soon thereafter both the loess and the glacial-lake silts were comparatively stabilized by a cover of prairie vegetation.

Near the lake beds the loess consists of a sandy silt but at greater distance is a fine powdery soil. As it is rather permeable and the annual precipitation is low, much of the rainfall percolates into it rather than running off. In many places minor drainage patterns have not re-established themselves once they have been obscured by the shifting loess.

A few small patches of volcanic ash occur in talus slopes and beneath terraces along the edges of streams. The ash is white, fine grained, and uniformly textured. It commonly shows some thick stratification, indicating that it has been reworked by water. Most of the beds are less than four feet thick and are of small areal extent. They are usually both underlain and overlain by Recent alluvium, most of which was derived from the loess.

The tributary streams of the Umatilla River have steep gradients and flow swiftly through narrow, steep-walled canyons with only very small flood plains. Consequently, the Recent alluvium is represented by narrow ribbons of river-washed gravel, reworked loess, and volcanic ash at the borders of the streams. As there is a high ratio of silts to gravel-sized particles, the alluvium is not very permeable. In the area covered by glaciofluviatile deposits, the Recent alluvium is largely indistinguishable from the outwash material.

Structure of the Rock Units

General Character

Structurally, the Umatilla River basin consists of a broad westerly plunging syncline between two anticlines. The large anticline to the south is the northeast-trending structure which forms the Blue Mountains. Its axis lies close to the south edge of the Umatilla River basin. The smaller anticline to the north is the south-southeast-trending structure which has formed the Horse Heaven Hills. The axis of the Horse Heaven anticline merges with the flank of the Blue Mountain anticline just east of Athena. The Umatilla syncline is crossed by several smaller structures including the Rieth anticline, Agency syncline, and Service anticline, but its generalized axis plunges westerly from the vicinity of Athena and parallels the course of the Columbia River downstream from Irrigon. Each of these features will be discussed in more detail in the section on the structure of the Columbia River basalt.

The tectonic structures of the bedrock units of the Umatilla River basin area are dominated by those visible in the Columbia River basalt. For this reason, it is convenient to discuss the structural geology in three phases;

the structure of the pre-Miocene material, the structure of the Columbia River basalt, and the structure of the post-Miocene material.

Locations of major structural features of the basalt are shown on plate 11.

Structure of the Pre-Miocene Rocks

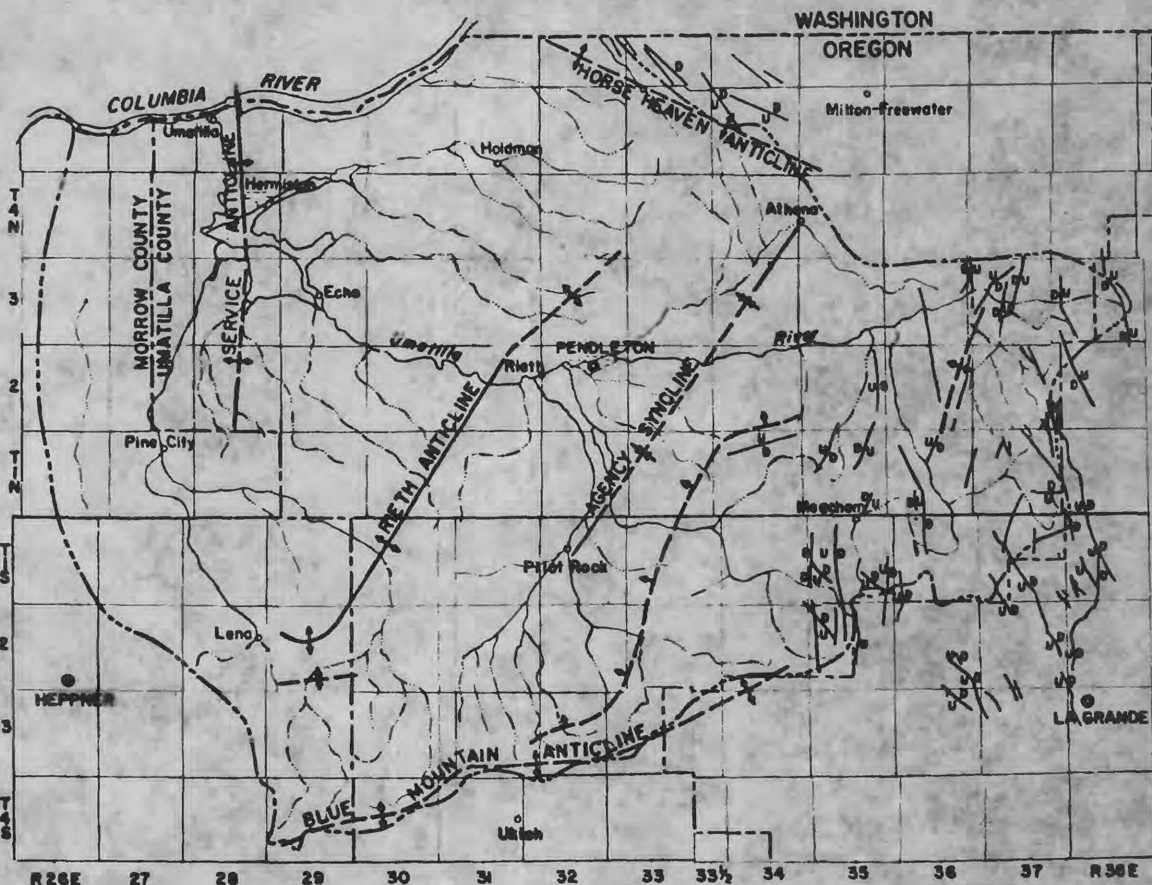
The geologic map (pl. 2A) shows the pre-Miocene rocks exposed in a narrow belt extending almost 40 miles southwest from East Birch Creek to Arbuckle Mountain. The Clarno formation of Eocene age is exposed at the northeastern end of this belt, where it dips northeasterly, and at the southwest end, where it dips westerly. The intrusive quartz diorite lies in the center of the belt, and the metamorphic rocks occupy an area between the quartz diorite center and the Clarno formation on the flanks. Therefore, the regional structure of the pre-Miocene material seems to be a broad, gentle upwarp with its apex in the region of the quartz diorite.

Structure of the Columbia River Basalt

General character of the basalt deformation.- The topography of the Umatilla River basin is largely a result of the tectonic structure imposed upon the Columbia River basalt. Therefore, in general, the topographic units coincide with structural units in the basalt. The Blue Mountain slope is underlain by the northwest limb of the Blue Mountain anticline, but for the purposes of this report it may be regarded as a monocline dipping northwesterly down from the Blue Mountain upland to the relatively horizontal basalt flows of the Umatilla lowlands and the Pendleton plains.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE II



MAP OF THE UMATILLA RIVER BASIN AREA, OREGON

SHOWING THE LOCATIONS OF MAJOR STRUCTURAL FEATURES OF THE COLUMBIA RIVER BASALT

EXPLANATION

Boundary of the area covered by this investigation.

FOLD AXIS
Dashed where approximately located

Anticline

Syncline

Upper fold of a monocline

Fault. "U" and "D" mark the upthrown and downthrown blocks.

Preliminary open-file release. Subject to revision.

Deformation of the basalt in most of the area was accomplished by folding or warping of the beds and associated fracturing and minor faulting. However, in that portion of the Blue Mountain upland east of longitude 118°30', much of the deformation was by movement along faults.

The structure of the basalt of the Blue Mountain upland.- The Blue Mountain upland is a nearly horizontal, platformlike crest of a broad anticline. The axis of this anticline is fairly distinct in T. 4 S., R. 28 E., eastward from Arbuckle Mountain to the vicinity of Kamela. The basalt on either side of this axis dips gently away at inclinations which are mostly less than 3 degrees. Northwest of Meacham a subordinate anticlinal axis borders the upland area and forms Emigrant Hill.

East of Meacham and Kamela (see pl. 2C) the anticlinal axis is interrupted by a broad trough trending north-northwesterly and produced by gentle warping of the basalt and by movement along faults and minor fractures. The trough is bounded on the northeast by faults which run along Ryan Creek, Camp Creek, and probably the main branch of Meacham Creek. It is bounded on the southwest by a fractured downwarp which passes through the towns of Meacham and Kamela.

East of the Meacham Creek trough the Blue Mountain highland is a large upraised block of nearly horizontal basalt flows. Locally there is considerable topographic relief produced by movements along a northwest-southeast fracture pattern.

This portion of the Blue Mountain highland is bounded on the east by the Mount Emily fault zone. The individual fractures of that fault zone trend slightly west of due north but the zone as a whole has a northerly trend which farther north becomes more easterly. The western block at Mount Emily was upthrown more than 3,000 feet, but the magnitude of that displacement decreases to the north.

<u>The structure of the basalt of the Blue Mountain slope.</u>- In a long, gentle monocline, dipping from 1 to 3 degrees, the basalt layers descend from the highlands of the Blue Mountains northwesterly to the lower lands of the Pendleton plains and the Columbia lowlands. The otherwise fairly uniform angle of descent is interrupted by several local steepenings where the dips range from 3 to 30 degrees.

<u>The structure of the basalt northwest of the Blue Mountain slope.</u>- The basalt flows beneath the Pendleton plains and the Umatilla lowland have a gentle northwesterly regional dip. This regional attitude is interrupted by several structures which are of minor magnitude as compared to the Blue Mountain anticline, but which have considerable local importance. These are the Horse Heaven anticline, Rieth anticline, Agency syncline, and Service anticline. The Horse Heaven anticline continues to the northwest of the Umatilla River basin and becomes a prominent feature in the State of Washington. The anticlines form topographic ridges which were mentioned by corresponding names in the section on topography and drainage. Each of these structural features is discussed in more detail below.

The axis of the Horse Heaven anticline trends northwesterly from Athena, along the ridge between Vansycle Canyon and Juniper Canyon, and continues beyond Wallula Gap through which the Columbia River crosses the structure. South of the anticlinal axis the basalt dips less than 1 degree in a southerly direction unter the Umatilla Valley. The north limb breaks off rapidly into the Walla Walla Valley over a series of northward-tilted fault blocks, whose echelon-type high-angle faults trend slightly more southerly than the axis of the anticline. General dips in this northerly limb are from 2 to 5 degrees.

The axis of the Rieth anticline branches off the northwestward-dipping Blue Mountain slope southwest of Pilot Rock and trends northeasterly until it loses its identity west of Helix in the rising slope of the Horse Heaven anticline. Dips on either side of the axis of the Rieth anticline are less than 3 degrees.

The Agency syncline was first named by Allen (1939) in unpublished records, and the name was formalized by Wagner (1949, p. 8). It lies at the foot of the Blue Mountain slope southeast of Pendleton along the structural sag separating the Blue Mountain slope from the Rieth and Horse Heaven anticlines as shown on plate 2B. Its axis trends southwest from Athena to the vicinity of Pilot Rock. This syncline and the Rieth anticline are of special economic importance because of their effect on the position of the water table in the basalts beneath the valley area. The basalt is overlain by the so-called McKay beds of Pliocene fanglomerate in the sags produced by the Agency syncline.

The axis of the Service anticline trends northerly from Service Buttes, northeast of Pine City, to Sillusi Butte, which is in Washington across the Columbia River from Umatilla, Oregon. At one time, an anticlinal ridge probably extended between these buttes but,if so, it has been mostly removed by erosion. Remnants of this former ridge appear at Service Buttes, Emigrant Buttes, Hermiston Buttes, Umatilla Buttes, and Sillusi Butte. The east limb of this anticline dips more steeply than does the western one. At Service Buttes the east limb dips 11 degrees and the west limb only 2 degrees. At Sillusi Butte the east limb immediately adjacent to the axis dips 12 degrees, the west limb only 6 degrees. The folding of this anticline was sharp and the basalt flows were locally closely jointed and faulted.

Questions that should be considered regarding the earth movements that create the present large structures, such as the Blue Mountain and Horse Heaven anticlines, concern the time or age of the movements and the question of whether the dominant structural deformation was an uplifting of the Blue Mountain district or a depressing of the lower lands to the northwest.

The attitudes of the successive basalt flows in any given section are remarkably concordant. If the deformation were concurrent with the extrusion of the basalt, one would expect appreciable discordance in the attitudes of the successive flows. As this discordance does not exist on a large scale this writer believes that the warping postdates the extrusion of the basalt.

Another bit of evidence regarding the age of the movement is the position of the so-called McKay beds. This fanglomerate lies upon the basalt in the lowland of the Agency syncline and obviously was derived from the higher basalt of the Blue Mountain slope. As these Pliocene gravels owe their origin and position to the structure, they therefore must postdate at least part of the movement.

Some of the stream canyons show two stages of erosion in the Blue Mountain slope district. This feature can be seen in the south wall of East Birch Creek near Gibbon. It indicates that there must have been at least two stages of deformation.

The deformation that created the Horse Heaven anticline has been dated by other workers from evidence gathered outside the Umatilla River basin. Warren (1941, p. 209-232) has found that the Columbia River was brought into the Pasco basin north of Wallula Gap by the uplift of the Horse Heaven Hills. After entering the Pasco basin the Columbia deposited fluviatile sediments (the Ringold formation) which have been dated as middle to late Pleistocene age by

Strand and Hough (1952, p. 152-153). Therefore, the age of deformation of the Horse Heaven Hills is middle to late Pleistocene and the cutting of Wallula Gap by the Columbia River has continued from the time of that deformation to the present. The canyon of the Umatilla River through Rieth Ridge shows a degree of erosional maturity similar to that of Wallula Gap, so the deformation that formed the Rieth anticline possibly was contemporaneous with that of the Horse Heaven anticline.

As to the nature of the dominant deformation, it is significant that a section of basalt about 2,500 feet thick is exposed in the canyon of the Umatilla River at Gibbon in the Blue Mountains. The remnant of the pre-erosion surface of the basalt at Pendleton lies at an altitude of about 1,300 feet. Therefore, if the movement consisted of uplifting the Blue Mountains from the pre-deformation level of the Pendleton area, the lowermost flows now exposed at Gibbon must have been deposited at least 1,000 feet below sea level. These flows do not show any sign of the pillow structure, zeolite mineralization, or interflow marine sediments that one might expect under conditions of submarine extrusion; therefore, the logical conclusion is that the basalt was deposited above sea level and the subsequent deformation consisted, at least in part, of depression of the lowland area.

In summary, the above evidence leads to the opinion that the deformation producing the present structure of the basalt consisted of at least two major stages of movement and that the movement started after the extrusion of the basalt in late Miocene or early Pliocene time and continued until middle to late Pleistocene time. Most of the deformation which formed the Horse Heaven anticline, and probably much of that which formed the Blue Mountain anticline, occurred in middle to late Pleistocene time. The difference in altitude between the Blue Mountains and the lower land to the northwest was accomplished in part by depression of the latter area, although the lesser structures forming the Horse Heaven Hills and Rieth Ridge were uplifted with respect to the lowlands.

Structure of the Post-Miocene Material

As previously described, the post-Miocene material consists of Pliocene fanglomerate, Pleistocene glacial-lake beds and glaciofluviatile sediments, and Pleistocene to Recent eolian and alluvial sediments. These materials disconformably and unconformably overlie the Columbia River basalt. Their crude, obscure primary structures are described in the sections on lithology. They have no discernible secondary structure.

Geologic History

Little is known of the pre-Tertiary geologic history of the area beyond the fact that old rocks of igneous and sedimentary origin were intruded by, and metamorphosed, in part, by the large compositequartz diorite-norite mass.

During the Eocene epoch, the area had fairly high relief and abundant rainfall and a subtropical climate. The old metamorphic and intrusive rocks were being eroded and the materials were redeposited as alluvial sands and silts. The Eocene was a time of vulcanism, and several acidic to intermediate lava flows were extruded upon the old land surface. These volcanic rocks dammed the drainage system and created lakes and ponds which served as depositories for micaceous and carbonaceous lacustrine silts and clays.

The Oligocene epoch apparently was a time of erosion in this area. While the tuffs of the John Day formation were being deposited farther south, this area was uplifted and eroded.

This period of erosion was interrupted during the Miocene epoch when fissures opened and flow after flow of very fluid black basaltic lava was extruded upon the surface. These flows first filled the valleys of the youthful landscape and then spread out over the uplands until probably all but the very highest portions of the ancestral Blue Mountains were covered by basaltic lava. Short periods of time separated successive extrusions. Only rarely was an appreciable soil zone developed on top of one flow before it was covered by the next. At times the drainage was dammed locally by the lava to form lakes in which silts and clays were deposited. By the time the vulcanism ceased near the end of the Miocene or in early Pliocene time, at least 2,500 feet of lava had been deposited upon the northern parts of this area.

The Pliocene epoch was a transitional period between the vulcanism of the Miocene and the glaciation of the Pleistocene. The deformation that was later to produce the Blue Mountains had started but probably had not progressed far. After the deformation had begun, the fanglomerates were deposited in the lower lands along the face of the growing Blue Mountains.

The deformation of the basalt reached a climax during middle or late Pleistocene time when the Horse Heaven anticlinal ridge was formed, and the ancestral Blue Mountain anticline was uplifted farther. The glacial stages of the Pleistocene are generally regarded as periods of cooler climate than the present. Toward the end of the Pleistocame, continental and valley glaciers existed farther north in Washington and Canada in the Columbia basin. Ice blocks from those glaciers were floating down the Columbia River and probably adding their mass to the ice from the annual freeze-up of the river itself. Many of these ice blocks carried rock and soil from up river. According to Allison (1933, p. 721), during Wisconsin time these ice blocks, supplemented by ice from the annual freeze-up of the river, were obstructed by a landslide and formed an ice jam downstream in the vicinity of The Dalles. This ice jam grew in height and extended itself upstream, damming the river and causing a lake to form upstream from The Dalles. The waters of this lake quickly rose to an altitude of about 1,150 feet and deposited stratified sands and silts. Occasional pockets of erratic sand, gravel, and boulders mark the locations where rock-laden ice blocks melted and dropped their loads. The lake surface was constantly changing in elevation and failed to remain stationary long enough to cut a prominent strand line.

Eventually the lake level reached its maximum elevation, then began to lower as the ice jam melted and eroded. When the lake surface had lowered to an altitude of about 750 feet, the current in the Umatilla area was reestablished and the stream stripped the basaltic bedrock of its cover of Pliocene gravels and lacustrine silts and even cut deep channels in the basalt itself, thus forming the channeled scablands on some of the bedrock benches along the river.

After the ice jam melted and the lake disappeared, the exposed lacustrine silts were subjected to strong wind erosion by the variable but dominantly southwesterly winds. A veneer of these silts was deposited by the wind over the entire Umatilla River basin area, and thicker deposits of sandy loess were formed to the northeast of the lake beds.

The geologic history of the area since the close of the Pleistocene epoch has been largely one of relative crustal stability and of stream erosion. There was one brief, though probably intense, fall of white pumiceous volcanic ash. This ash apparently originated with volcanic action in some other area and was borne into the Umatilla basin area by the winds. Initially it probably covered the entire area to a depth of several inches but was eroded and, in places, concentrated by wind and stream erosion. It exists now only as minor terrace deposits in the upland stream valleys and as lenses and scattered inclusions in the loess and the Recent alluvium and colluvium.

GROUND-WATER RESOURCES

General Character of the Ground Water

Ground water is the most important economic mineral resource obtained from the rocks in the Umatilla River basin. However, it is not uniformly distributed throughout the area. Because of the topographic and structural conditions, some districts, such as the Umatilla lowland and parts of the Pendleton plains, possess potentially good economical supplies of ground water, while other districts, such as the higher portions of the Horse Heaven Hills and the Rieth Ridge, have little ground water within economic reach.

The Columbia River basalt is the most widespread and productive aquifer within the area, although the younger deposits are important in some places.

Ground Water of the Pre-Miocene Rocks

The older rocks, underlying the Columbia River basalt, are exposed in the Blue Mountain slope. This is a region of high topographic relief where little arable land exists; consequently, very little ground-water development has been attempted. Within this region, surface streams supply most of the irrigation water needed, and springs flowing from the basalt, as well as from the soil zones overlying the consolidated rocks, supply most of the domestic and stock water.

The quartz diorite rocks originally were compact and possessed little porosity. However, near the surface they are now badly disintegrated, and weathering has produced sufficient secondary porosity to permit the rocks to yield small amounts of water from zones near present or former erosion surfaces.

The norite is relatively fresh and is still firm and compact. Little ground water can be expected from it except for small amounts from the joints and other fractures.

The metamorphic rocks have a wider range of textures than the igneous rocks, but, where unweathered, are similarly compact and impermeable. A few shallow wells dug into the soil overlying the metamorphic rocks produce water for the domestic use of several ranches in the vicinity of Gurdane.

No wells are known to produce water from the Clarno formation in the Umatilla River basin area, although some domestic shallow wells of small yield are dug into the soil and alluvium overlying the Clarno. The most likely aquifers in the Clarno formation are the coarser sandstones. Microscopic examination shows even these to be rather tightly cemented with calcium carbonate.

Ground Water of the Columbia River Basalt

As stated above, the Columbia River basalt is the most productive and widespread aquifer in the Umatilla River basin area. The main permeable zones are (1) tabular bodies comprising the scoriaceous and fractured zones at the tops of some lava flows, and (2) bodies of irregular form comprising the joints and other fractures within some of the lava flows. In places sedimentary beds are present between the lava flows, but most of them are silt and clay and do not yield water readily. The fractured and scoriaceous zones at the tops of many of the flows are porous and permeable but the more compact center parts of most flows are relatively impermeable. Therefore, water can move with relative ease and rapidity laterally parallel to the flows but does not readily pass vertically through the denser parts of the flows. Each tabular porous zone is at least partly limited in a vertical direction by the denser parts of the flows and, where the lava beds are tilted, the porous parts farther downdip at lower altitudes may contain water under relatively high artesian pressure. Where the zones are continuous through great horizontal distances, even minor changes in the direction or angle of dip of the basalt flows can produce marked changes in the vertical position of the aquifers and in the pressurehead of the ground water.

The tabular ground-water bodies generally are not perfectly continuous. Each lava flow lenses out between the overlying and underlying flows. Consequently its scoriaceous water-bearing zone may be cut off or may merge with that of an adjacent flow. Sharp folding or warping of the beds may have caused flows to slide past each other, thereby grinding up the weaker scoriaceous zone and partially destroying its permeability. Furthermore, faults and other fractures strongly influence the occurrence of ground water. Where much movement has taken place along a fault, the water-bearing zones may be offset and may butt against impermeable zones. Fault gouge decomposes into clayey material which may form a barrier to the movement of ground water. On the other hand, if little movement has occurred along a fracture, the fracture may be a conduit for the percolation of water vertically across the less permeable zones. Many of the lava flows do not contain permeable zones. In some flows no such zones were formed and in others they were eroded away prior to the extrusion of the subsequent flows.

Owing to the discontinuity of the ground-water bodies and imperfect hydraulic connections between water-bearing zones, the concept of the "water table" or "piezometric surface" is not generally applicable, especially in the upland areas. Rather, any one water-bearing zone may have its own water table or piezometric surface. Thus, it is common for the static water level in a well to rise or lower as different water-bearing zones are penetrated during well-drilling operations. This situation is noted in table 2 in the logs of wells 1S/32-9N1 and -23J1, 2N/31-2B2, 2N/32-7B1 and -10N1, 3N/29-16G1, 3N/34-3C1, 3N/35-19L1, 4N/27-27R1, 4N/28-27G1, and 4N/34-22H1. More accurate and complete drilling logs may in the future reflect this situation more extensively.

Most of the recharge to the ground water is accomplished at places where the lava flows have been warped or deformed over a wide area and the tilted beds reach the surface, where they receive infiltrating water directly or by transfer from the surficial deposits. Thus, the Blue Mountain slope is the main recharge area for the water in the basalt beneath the Umatilla River basin. Lesser recharge areas probably exist; one in particular probably exists where the Umatilla River and smaller streams cross the west limb of the Rieth anticline.

The lithology of the basalt is remarkably constant throughout the Umatilla River basin, but its water-bearing characteristics are greatly influenced by the tectonic structures and vary from place to place. For this reason, it is convenient to discuss by subordinate areas the ground water in the basalt. These areas are analogous to those designated in the section on structural geology.

Water in the Basalt of the Blue Mountain Upland

The highlands of the Blue Mountains are underlain by nearly horizontal basalt flows which in places have been deeply eroded by streams. Because of their horizontal attitude, water does not enter the beds readily, and that which does has a tendency to drain out of them rather readily. Except in the towns of Meacham and Kamela, there is little demand in the highland district for ground water in addition to that obtained from springs and shallow wells tapping the water perched in the soil on top of the basalt.

Irregularities in the dip of the basalt flows cause the ground-water situation to be favorable locally. The highland community of Meacham is located on a slight eastward-dipping downwarp and has several drilled wells that are reliable sources of water. One 278-foot drilled well in the basalt (1S/35-10C1) flowed 25 gpm when first drilled and was test pumped at 314 gpm with a drawdown of 24 feet. Several other drilled wells in the vicinity yield domestic supplies reliably. Only about 5 miles to the south, however, the community of Kamela lies near the crest of the Blue Mountain anticline. Here a 996-foot drilled well in the basalt (1S/35-36N1) was abandoned because of low yield and deep water level.

Numerous springs of low yield occur at scattered localities in the highland districts. Most of these yield less than 2 gallons of water per minute and are located at or just below the rims of the upland plateaus. Most of them discharge water from the soil overlying the basalt. A few emerge from fractures or scoria in the second or third lava flow below the rim.

Only one "hot" spring is known to exist in the area. This is Bingham Spring (3N/37-18H1), whose water has a temperature of 94°F and issues from a fractured zone in the lava in the south wall of the canyon of the Umatilla River. This spring discharges about 80 gpm from three openings, two of which are close to each other and about 50 feet above river level, while the third, and smallest, is about 50 feet farther downstream and about 10 feet above river level. The spring lies just west of the axis of the Blue Mountain anticline.

Water in the Basalt of the Blue Mountain Slope

As the basalt layers in the Blue Mountain highland lie generally horizontal and water has little opportunity to percolate into them, much of the annual precipitation must be disposed of by evapotranspiration and surface runoff.

As the streams flow northerly and westerly from the highland area and cross the beveled edges of the northwest-dipping basalts of the Blue Mountain slope, the water has an opportunity to enter the scoriaceous interflow zones. From there it percolates generally northwestward under the Pendleton plains and the Umatilla lowland.

Wells in the Blue Mountain slope encounter ground water under a variety of conditions. In some places water is present in large quantities under considerable pressure. Several strongly flowing artesian wells have been drilled in the canyon of the North Fork of Butter Creek east of Pine City. Well 1N/28-28D1, near the lower end of the monocline forming the Blue Mountain slope, yields 1,300 gpm by free flow from a 12-inch hole penetrating 365 feet of basalt. Well 1S/29-3A1, also near the foot of the slope, is a 5½-inch well which penetrates 161 feet of basalt and flows at the rate of 550 gpm. To the south, higher on the slope, several reliable, though less spectacular, wells furnish water for stock, domestic use, and limited irrigation.

Numerous small springs occur in the southerly walls of the east-west segments of the canyons cut in the Blue Mountain slope. Most of these are of small yield, generally less than 3 or 4 gpm. Many of them merely create damp spots in the soil. Such small springs supply domestic water for most of the ranches of the slope.

Water in the Basalt of the Pendleton Plains

As was seen in the section on physiography, the land below and to the northwest of the foot of the Blue Mountain slope is divided by the crest of the Rieth Anticline into two sections, the eastern one being called the Pendleton Plains. As seen in the structural-geology section, the main structural feature of the basalt within the plains area is the Agency syncline, the axis of which lies close along the foot of the Blue Mountain slope.

A principal recharge area for the basalt of the Pendleton Plains is in the Blue Mountain slope to the south and east. The main ground-water movement is northwesterly through the Agency syncline, where it is under considerable artesian pressure, and part way through the limbs of the Horse Heaven and Rieth anticlines. Along the axis of the syncline and to the east of this axis, the water is under sufficient pressure to permit the water to flow at the surface from a belt of artesian wells which extend from Pilot Rock to Athena and include the municipal wells of these two cities. Almost any well drilled sufficiently deep in this belt of confined ground water is likely to yield flowing water.

The artesian head decreases rapidly with distance northwest from the axis of the syncline and static water levels in wells become progressively deeper until, at Pendleton, the hydrostatic surface of the deeper water bodies is about 150 feet below the level of the Umatilla River. Some bodies of perched water at shallower depths have higher hydrostatic levels.

The upper 700 feet of basalt in the Rieth anticline is cut by the canyon of the Umatilla River west of Pendleton. The lava strata of this anticline dip slightly to the north, and that portion of the anticline south of the Umatilla River is largely drained to the 700-foot depth. Wells south of the river commonly penetrate only to perched water bodies in the basalt. These perched bodies are discontinuous and for water supply depend upon local recharge. The annual precipitation there is only about 12 inches and the resulting annual recharge to the perched water bodies is small. Consequently, wells less than 700 feet deep have small yields and slow recovery of water level after being pumped. If wells located along this anticlinal crest can be drilled to a depth that would penetrate stratigraphic horizons not cut by the Umatilla River they might reach undrained zones below the regional water table.

The area north of the Umatilla River is an upland plain, uplifted by the movement that formed the Rieth and Horse Heaven anticlines. The shallower water-bearing zones are cut and drained by the Umatilla River in its canyon through Rieth Ridge to the south and by the Columbia River in Wallula Gap to the northwest. This northerly drainage of the shallower ground water is probably facilitated by canyons trubutary to the Columbia, such as Cold Springs, Juniper, and Vansycle Canyons. The annual precipitation here is about 12 to 14 inches per year and the topography favors absorption of most of it by the soil and later discharge from the soil by evapotranspiration, so local recharge must be negligible. The consequence of all these factors is that economical ground-water development by means of wells becomes progressively more difficult with distance northwest of the Agency syncline. In the broad upland area between Despain Gulch and the axis of the Horse Heaven anticline, northwest of the axis of the Rieth anticline, wells are deep and have poor yields and low static water level. Only one large producing well (4N/32-2M1) is known on this upland surface. Its yield reportedly is decreasing with use.

Water in the Basalt of the Umatilla Lowlands

The west limb of the Rieth anticline slopes gently westward under the Umatilla lowlands. The shallower zones of the nearly horizontal basalt of the lowlands receive their principal recharge from three sources: Butter Creek and many minor creeks where they cross the northerly dipping basalt of the Blue Mountain slope above Pine City, the Umatilla River where it crosses the westerly dipping basalts of the west limb of the Rieth anticline, and, to a lesser extent, the Columbia River and local intermittent creeks where they cross the southwesterly dipping basalts of the south limb of the Horse Heaven anticline. As the entry points for the water from Umatilla River and Butter Creek are relatively high, a pressure gradient is established and flowing artesian water is obtained from wells scattered throughout the main part of the Umatilla lowland in the Nolin and Hermiston areas, as well as near Pine City and Echo. In nearly all wells in basalt in this area, the water is confined under pressure and rises above the point where it enters the well, even if it does not flow at the surface.

Two structural variations from a uniform, even slope of the basalt necessitate caution in locating water wells in the Umatilla lowlands. These two structures are the Service anticline and the inferred Butter Creek fault.

The Service anticline trends diagonal to the northwesterly direction of ground-water movement and is a minor barrier to that movement. The anticline is low, sharply warped, and locally faulted. The permeability of the water-bearing zones may have been partly destroyed by the grinding action of the lava beds sliding past each other during the folding, thus reducing the horizontal permeability within the narrow structural flexure. Wells drilled within the structure would tap the zone of lowered permeability and would be generally of low yield; furthermore, it is commonly difficult and expensive to drill wells in rock disturbed by faults. New wells, therefore, should not be located within the anticlinal area or close against the axis shown on plate 2. The other variation to be considered is a presumed fault just west of and parallel to Butter Creek, north of Pine City and south of the confluence of Butter Creek and the Umatilla River. The existence of this fault is not certain, but its presence is indicated by the low, straight scarp forming the west bank of Butter Creek north of Pine City. This scarp is composed of gravel (Pliocene fanglomerate) and does not exhibit the usual fault features such as slickensides, fault gouge, or fault-line springs. If a fault exists, however, one would expect it to impede the northwesterly flow of ground water in the basalt from the Butter Creek recharge area. This effect does seem to exist, because wells to the southeast, along Butter Creek, have notably large yields and high static levels, whereas those to the northwest, such as well 2N/27-20J1, have smaller yields and lower pressure. Farther north, in T. 4 N., R. 27 E., the effects of this hypothetical fault seem to be negligible or nonexistent.

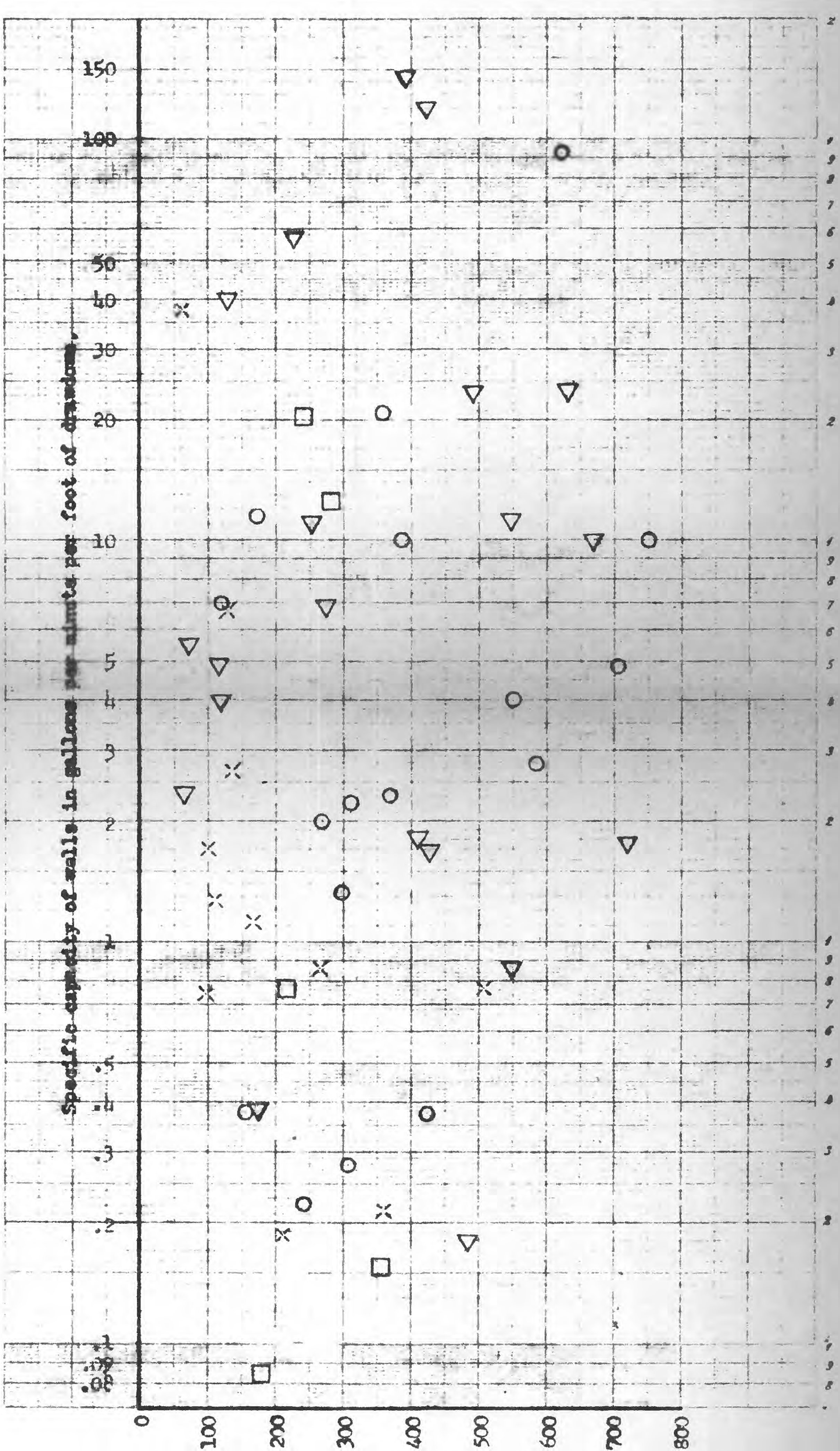
Aquifer Constants of the Basalt

The permeability (see Brown, 1953, for definition of this term) of the basalt differs both horizontally from place to place and vertically from flow to flow. The ground water is in a series of super-posed tabular bodies, each of which differs from the others in permeability and porosity. Consequently, reliable determinations of values for the permeability, transmissibility, and storage coefficients of the basalt would require a large amount of data whose collection is beyond the scope of this investigation. However, some characteristics have been determined which are of aid in planning wells in basalt. Newcomb (1951, p. 52) has found that the average yield of deep wells 12 inches in diameter in basalt is at the approximate rate of 1 gpm per foot of depth below the static water level. This estimate is based on a study of several hundred wells, each of which penetrated at least 300 feet of basalt below the static water level and were pumped with a drawdown of about 50 feet. In favorable areas, such as that near the Agency syncline, the lower part of the Blue Mountain slope near Pine City, and the lower parts of the Columbia lowland, this estimate is valid, though for many wells it has proved to be conservative.

Well 1S/32-9M1, near the axis of the Agency syncline, extends to 649 feet below the basalt surface. Thus, the well penetrates to a level 676 feet below the piezometric surface of the ground water. The well yields 650 gpm, or just slightly less than the estimate. Within half a mile of this well, another (1S/32-9N1) yielded 1,500 gpm from a penetration 359 feet below the piezometric surface, or about 4 times as much as the estimate. Of the wells in Pendleton, two of the city wells (2N/32-2R1 and -10F1) and the Smith cannery well (2N/32-10M1)greatly exceed this average yield, while the State Hospital well (2N/32-9B1) equals it and the third city well (2N/32-10N1) falls far short of it. On the other hand, in unfavorable areas such as the crests of the Rieth and Horse Heaven anticlines and in the Blue Mountain highlands, the yield per foot of depth is small. Well 4N/32-2M1, high on the Horse Heaven anticline, penetrates 507 feet of basalt below the piezometric surface and produces only 115 gpm, or about 0.23 gpm per foot of penetration. Even that yield reportedly is decreasing with use, and the well may tap perched water rather than the regional zone of saturation. This well is the farthest northwest of any well of moderate yield in the Pendleton plains area. All other wells to the north and west either are unsuccessful or yield only small quantities of water suitable for domestic or stock needs, but not for large-scale irrigation. This unfavorable situation in the anticlinal uplands continues to the west for about 15 miles to the Umatilla lowlands, where wells of large yield tap aquifers in the synclinal situation.

Some of the general hydrologic characteristics of the basalt can be inferred from the drillers' logs in table 2. The vertical footage of basalt drilled below the hydrostatic level and the amount of basalt reported by the driller to be water bearing were both totaled for 52 of the most reliable and complete of these logs. In individuals wells, the percentage of total basalt drilled and reported as water bearing ranges from 0.9 percent for well 3N/29-11G2 to 48 percent for well 1N/32-34P1. The total footage of basalt drilled below the hydrostatic level in all 36 wells was 15,675 feet, and 1,840 feet, or 11.7 percent, was reported to be water bearing. Of these 52 wells, 21 penetrated more than 300 feet of basalt, of which 8 percent was reported to be water bearing. Certain hazards in recognizing a water-bearing zone during drilling in the basalt may render these percentage figures too low. Few wells have been test pumped at more than one depth during the drilling. Drillers commonly use changes in static water levels, change in drill-mud consistency, and bailing tests as criteria for recognizing water-bearing zones, and, if these changes are not noticeable, a water-bearing zone may not be recorded on the log. For example, in the log of well 4N/34-24J1 in table 2, a total of 54 feet was reported as "water-bearing" material. However, below the first water encountered, at 182-193 feet, another 139 feet of material was reported as "broken" and, therefore, potentially water bearing. If this 130 feet is added to the 54 feet of reported water-bearing material, the percentage of basalt that is water bearing would be raised from 4.8 to 17.1 for this well. In other wells scoriaceous, broken, creviced, honeycomb and fractured zones are reported, and, in part, may have been water bearing, but were not detected to be water bearing by the normal drilling criteria. The estimated average percentage of basalt below the piezometric surface and capable of yielding water may be somewhere between 20 percent and the 11.7 percent derived from the reports of the drillers.

Some of the wells have been test pumped by the drillers or by pump service men. These tests are primarily machinery and short-term capacity tests which are unsuitable for determining coefficients of permeability, transmissibility, or storage. Some of these tests are adequate to obtain the specific capacities



Depth of basalt, below the static water level, penetrated by the wells.

THE RELATIONSHIPS BETWEEN THE SPECIFIC CAPACITIES OF 53 WELLS DRILLED INTO THE BASALT, THE DEPTH OF WELL PENETRATION BELOW THE STATIC WATER LEVEL, AND THE GENERAL LOCATION OF THE WELL.

WELL SYMBOL	GENERAL LOCATION
▽	Umatilla lowland.
✕	Near the axis of the Agency syncline.
○	On the Rieth anticlinal ridge.
□	In the Blue Mountain highlands or on the Blue Mountain slope.

Unpublished records subject to revision

of the individual wells during short-term periods of pumping. The specific capacity of a well is the ratio of the yield of that well, usually expressed in gpm, to the single unit of drawdown in the water surface, usually expressed in units of 1 foot. The specific capacity of a given well varies with increased pumping, changes in the diameter of the well, and changes in the drawdown. Consequently, it cannot be relied upon as a constant quantitative characteristic of the aquifer. However, it is useful for comparing, in a general way, similar wells withdrawing water from the same aquifer with the same general order of drawdown. For purposes of such comparison, the specific capacities of 53 wells, scattered throughout the basin, were plotted against the total amount of basalt penetrated below the hydrostatic surface obtained in each well. The results are given in plate 11, which is designed to show the effects of structure on the water-bearing characteristics of the basalt. The general area, with respect to structure, in which each well is located is indicated by the symbol with which its point is plotted. The plate shows that, of the 11 wells located in the uplands of the Rieth and Horse Heaven anticlinal ridges, only 2 have specific capacities greater than 3 gpm per foot of drawdown. These two wells are numbers 2N/32-7L1 and -7N1 in table 1, and owe their greater yield to their position in the bottom of the canyon of the Umatilla River through Rieth Ridge. Although they are near the anticlinal axis, they penetrate lava flows that are not cut and drained by canyons. Further, the plate shows that, of the 17 wells having specific capacities of 10 or greater, 9 are in the Umatilla lowlands and 5 are near the axis of the Agency syncline. Nevertheless, plate 11 shows also that all four areas are represented among those wells having specific capacities of less than 1.

Ground Water in the Sediments Overlying the Basalt

The fanglomerate, glacial-lake-bed sediments, and loess lie in areas having low annual precipitation. In large part, these deposits cap ridges and terraces and are cut off from surface water of other areas. Therefore, what ground water they contain is derived mostly from local precipitation and is "perched" above the basalt while in transit to deeper percolation or to the surface.

Though the glaciofluviatile deposits and the Recent alluvium lie in a low-precipitation area, unlike the bulk of the fanglomerate they lie mostly at lower elevations and their ground-water bodies are recharged partly by percolation from streams. The ground water in all these deposits lies in thin sheets or layers, largely perched upon the surface of the underlying basalt. The deposits are less than 100 feet thick at most places, and consequently, do not contain thick zones of saturation. The temperature of the ground water in these deposits is about the same as the mean annual air temperature.

Ground Water in the Fanglomerate of Pliocene Age

As described in the geology section above, the fanglomerate of Pliocene age consists of a heterogeneous mixture of poorly sorted, crudely stratified gravel, silt, and clay. Silt lenses are common and the interstices in the gravel are filled with silt and clay which is rather tightly cemented with calcium carbonate. Clean layers of sand or gravel are rare. All these factors cause the fanglomerate to be rather impermeable.

The lack of permeability, coupled with the location of the fanglomerate in an area of low precipitation and its position capping basalt ridges and terraces which stand above nearby streams, render the fanglomerate rather unproductive of ground water.

Many ranches and residences, however, rely upon ground water from the fanglomerate, especially the so-called McKay beds, for domestic and stock-water supply. Water is withdrawn from shallow dug or drilled wells, most of which yield less than 3 gallons of water per minute. The water levels in many such wells lower considerably after years of less-than-average precipitation.

Ground Water in the Glacial Lake-Bed Sediments and in the Loess

These sedimentary units are considered together since they contain similar materials, silt with some sand, and have similar hydrologic characteristics and situations. The lake sediments also contain sand and gravels, partly of ice-rafted origin, but these are not su'ficient in quantity to affect the ground-water situation.

The ground water within these silts lies in thin lenses or sheets perched upon the underlying basalt. Most wells that are dug to the basalt have less than 6 feet of water. Where the silts are underlain by Pliocene fanglomerate, they are largely devoid of usable quantities of ground water. As the silts are drained by the streams, they are dependent entirely upon precipitation for recharge. In their localities the annual precipitation is low, and evaporation is high; consequently, the ground-water bodies in the silts receive little recharge.

In spite of the lack of recharge, the low permeability of the silts, and the limited amount of water available from them, both the loess and the lake sediments are widely used as sources of domestic and stock water. In areas such as Rieth Ridge and the high plains north of Pendleton, where surface sources are limited and water in the basalt is deep or of small quantity, many ranches are partly or entirely dependent upon water from shallow wells in the loess.

The water exists under perched or unconfined conditions in the silts and, in general, tends to collect in low places in the surface of the underlying basalt. Such hollows in the basalt generally occur beneath the canyons and sags of the surface topography. Plate 2B shows that most of the successful wells in loess north of Pendleton are in minor valleys. Attempts to develop water from the loess on the ridges and knolls have generally failed.

Ground Water in the Glaciofluviatile Deposits

The glaciofluviatile deposits are composed of coarser particles than the loess and lake sediments and are cleaner and better sorted than fanglomerate. Therefore, they are more permeable and contain more storage space for ground water. However, these deposits also lie in an area of low annual precipitation and contain appreciable amounts of ground water only in areas where they are recharged by streams or by irrigation.

The area underlain by the glaciofluviatile deposits is divided into an eastern and western part by the courses of Butter Creek and the lower 10 miles of the Umatilla River.

The eastern part lies about one-half below and one-half above the 750-foot topographic contour. Above 750 feet the glaciofluviatile deposits have been reworked by the wind and in places overlie the loess and lake sediments, from which they are distinguishable by their coarser texture. At these higher altitudes, the glaciofluviatile deposits have the ground-water characteristics of the loess, as previously described.

Below the 750-foot contour, the eastern part of the area of the glaciofluviatile deposits is rather heavily populated and is traversed by numerous irrigation ditches. The ground water is perched upon the basalt and is recharged largely by the Umatilla River, by seepage of irrigation water, and by discharge from the intermittent streams that drain the higher lands farther east. The glaciofluviatile sediments here range in thickness from less than 10 feet to about 100 feet. The water table lies within a few feet of the surface in the lower areas, such as Fourmile Gap and the other abandoned river channels east of Hermiston and Umatilla Buttes. These are the most heavily populated and irrigated areas. During the spring months and following irrigation seasons, the water sometimes rises above the surface of the ground locally. The ground water has been developed mostly for domestic uses, as the people here rely upon the Umatilla River and the Cold Springs reservoir for irrigation and stock water.

Most of the western part of the area of the glaciofluviatile deposits is occupied by a U. S. Army installation. Only a few wells in this area develop water in the sedimentary deposits. Those wells are clustered in the south part of T. 4 N., R. 27 E., and their water levels, 60 to 65 feet below the land surface, coincide roughly with the elevation of the Umatilla River to the east. Fire-protection wells at the Army installation are equipped with casing down into the basalt and therefore, do not draw water directly from the overlying glaciofluviatile deposits. However, the drillers' reports indicate that the deposits contain water in this area.

Wells 4N/27-33H1 and -J2 are irrigation wells which were tested at 500 and 750 gallons per minute, respectively, reportedly with "no" drawdown. Seemingly the drawdown is too small to be noticed by the owners after pumping each well at 520 gpm for 3 months. If such ground-water conditions extend northward from these wells as far as the Columbia River, this part of the glaciofluviatile deposits is a potentially important aquifer.

Recharge of this part of the glaciofluviatile deposits comes from the Umatilla River and Butter Creek to the east and from intermittent streams flowing across the fanglomerate farther south. It is to be noted that surface drainage is well developed on the Pliocene fanglomerate but disappears entirely on the glaciofluviatile deposits. Some recharge water may come to the glaciofluviatile deposits directly from the precipitation. This is likely to be a very small amount, as the annual precipitation is small, only about 8 inches per year, and the evaporation rate is large, more than 40 inches per year. Artificial recharge might be accomplished readily by ditch or pump diversion of excess flood waters from the Umatilla River or Butter Creek. Such water could be recharged to the glaciofluviatile deposits by basin or ditch infiltration in the sandy depressions near the south border of T. 4 N., R. 27 E.

Ground Water in the Alluvium of Recent Age

The alluvium of Recent age, as has been noted previously, consists mainly of a thin, narrow ribbon underlying the flood plains along the larger streams. Where such streams traverse the Blue Mountain slope the alluvium is composed of well-washed, fairly clean though poorly sorted gravel and sand which are capable of storing water to a relatively large percentage of their volume and are capable of yielding it readily. However, the alluvium here is of such small quantity that to withdraw water from it, as does the city of Pendleton, would have the same quantitative effect as to withdraw it directly from the stream.

Where these streams traverse the Pendleton plains and the higher parts of the Umatilla lowland the deposits consist mostly of reworked material from the loess and fanglomerate. Those reworked deposits are relatively tight and impermeable. Even so, the alluvium there is widely used as a source of ground water for domestic use at the ranches and dwellings bordering the streams.

Where the streams traverse the area underlain by glaciofluviatile deposits, alluvium of Recent age is commonly lacking. Where it exists, it is nearly indistinguishable from the glaciofluviatile deposits. Recent alluvium occurs in three large areas. One is a broad flood plain extending upstream for about 7 miles from Pendleton. The alluvium there is composed mostly of gravel but is less than 40 feet thick, and ground water from it is used only for domestic supply at a few dwellings.

The second large area underlain by Recent alluvium occurs in a mile-wide flood plain bordering the lowest 12 miles of Butter Creek. This alluvium also is shallow; it is composed almost entirely of reworked loess and is therefore rather impermeable. It contains a few scattered lenses of fairly clean sand, but the ground-water yields are sufficient only for domestic and stock water. Some of the ranches are having deeper wells drilled to obtain water from the underlying basalt.

The third large deposit of alluvium of Recent age underlies the broad flood plain of the Umatilla River northwest from Echo to the confluence with Butter Creek. The alluvium there is composed mostly of reworked glaciofluviatile material and is fairly coarse and permeable. Its depth is not known, as no wells are known to penetrate it entirely, but it is presumed to be shallow. It is crossed and almost completely surrounded by irrigation ditches and is crossed by the Umatilla River. The water table is within 6 feet of the surface over most of the area and rises to the surface over large areas during the spring months. Drainage is a problem in this area. The ground water in the alluvium is developed only by domestic and stock wells at the ranches. The wells are dug, bored, or driven and are pumped at low rates.

Chemical Quality and Temperature of the Ground Water

With few exceptions, the quality of the ground water in the Umatilla River basin is excellent. In general, the water ranges from soft to moderately hard, has a moderate mineral content, and does not contain significant concentrations of objectionable constituents.

Samples of water from 24 wells and springs within the area were analyzed by the Geological Survey. Chemical analyses of water samples from 6 wells and springs were obtained from other sources. In addition, water samples from 132 wells and springs were tested by field methods for hardness and chloride. In the field determinations standard soap solution was used to estimate hardness, and silver nitrate solution with potassium chromate indicator solution was used to determine chloride. The results of these field tests are shown on table 1, columns 16 and 17, and table 3, column 11.

Hardness

Hardness of water is caused essentially by calcium and magnesium compounds, such as the carbonates, bicarbonates, sulfates, and chlorides of these metals. Hard water deposits scale when the water is heated, affects the use of detergents and dyestuffs, and consumes soap in laundry operations. Hardness, with respect to use of the water, has been classified by the U. S. Geological Survey (1953) according to the following scale:

Hardness as $CaCO_3$ (parts per million)	Class
0 - 60	Soft
61 - 120	Moderately hard
121 - 200	Hard
201 -	Very hard

Hardness determinations were made by field methods for 104 springs and wells which draw water from the basalt. The hardness as $CaCO_3$ in the samples examined ranged from 15 to 225 ppm and averaged 77 ppm. Thus, the water from the basalt may be soft to very hard and the average hardness is in the moderately hard category. Also, of the 104 samples, 22 were soft, 59 were moderately hard, 21 were hard, and only 2 were very hard.

Field determinations of the hardness of water from 97 wells and springs in the basalt were grouped according to the depths of the sources from which the water was obtained. Water from 20 springs, the water from which probably never had been more than 100 feet below the land surface, had an average hardness of 62 ppm. The average hardness of water from 26 wells drilled less than 200 feet into the basalt was 90 ppm, that for 20 wells between 200 and 300 feet deep was 80 ppm, and that for 31 wells more than 300 feet deep was 74 ppm.

Water in the sedimentary deposits overlying the basalt ranges in hardness from a minimum of 40 ppm in the Recent alluvium to a maximum of 195 ppm in the loess. Average hardness values and the number of wells upon which the values were established for each of the sedimentary units is as follows: Pliocene fanglomerate, 5 wells, 93 ppm; loess, 14 wells, 124 ppm; glaciofluviatile deposits, 6 wells, 101 ppm; and Recent alluvium, 9 wells, 97 ppm.

Salinity

The chloride content in any of the sampled water is not sufficient to be objectionable for ordinary uses. The highest concentration of chloride was 104 ppm in water from a shallow well in the loess. The upper limit of concentration of chloride in domestic water recommended by the U. S. Public Health Service (1946) is 250 ppm, and a concentration of 300 ppm or more ordinarily is necessary before the water tastes noticeably salty.

Water from the loess contains more chloride than that from other rock units. In samples of water from 14 wells in the loess the chloride content was found to range from 10 to 104 ppm and to average 41 ppm. In the water withdrawn from 104 springs and wells in the basalt, the chloride content ranged from 4 to 99 ppm and averaged 22 ppm. Water from 20 wells in the Pliocene fanglomerate, glaciofluviatile deposits, and the Recent alluvium had chloride concentrations ranging from 6 to 70 ppm and averaging 21 ppm.

Detailed chemical analyses of water from 25 springs and wells indicate that the sulfate and nitrate concentrations are not excessive. The U. S. Public Health Service suggests a maximum permissible sulfate concentration of 250 ppm for drinking water. The maximum concentration in these ground waters was 42 ppm. The National Research Council (Maxcy, K. F., 1950) recommends a limit of 44 ppm of nitrate in water for domestic use. Only one well (4N/33-29K1) in the Umatilla Basin exceeds this, with a concentration of 57 ppm of nitrate. The other waters tested have concentrations ranging from 0.1 ppm to 11 ppm of nitrate.

Minor Constituents of the Water

Boron.- In small amounts, boron is essential to the growth of practically all plants. In only slightly greater amounts, however, it is detrimental to plant growth. Plants are rated (Wilcox, 1948) as sensitive, semitolerant, and tolerant according to their ability to withstand boron concentrations. Irrigation waters are rated in five classifications--from "excellent" through "unsuitable"--for each of these classes of plants. Water with boron concentrations of less than 0.33 ppm is regarded as excellent for the sensitive plants and water with more than 3.75 ppm of boron is regarded as unsuitable even for the tolerant plants.

Nineteen of the chemical analyses of table 3 list boron concentrations. Of these, 18 have less than 0.33 ppm of boron and are, therefore, "excellent" irrigation water in this respect. Only one sample (3N/37-18H1), from a hot spring, has an objectionable amount of boron (10 ppm) and is rated "unsuitable" for even the most tolerant of plants.

Fluoride.- A concentration of fluoride of about 1.0 ppm in drinking or culinary water is considered beneficial to children's teeth (Dean, 1936, p. 1269-1272). In higher concentrations fluoride may cause a dental defect known as mottled enamel, and accordingly, the Public Health Service recommends a maximum limit of 1.5 ppm in water to be used for drinking and cooking.

Determinations of fluoride were made on water from 22 springs and wells. Concentrations ranged from 0.2 to 0.9 ppm in most of the waters. In the samples from wells 4N/28-10P1 and 3N/37-18H1, the fluoride concentration was 1.7 and 4.0 ppm, respectively. This latter source is the same hot-spring water that contained 10 ppm of boron.

Iron.- Water containing more than about 0.3 ppm of iron, or of iron and manganese together, may stain fixtures, utensils, and laundry. Water samples from one well in the loess and from one well in the Pliocene fanglomerate have concentrations in excess of this amount. One well (3S/30-29R2) that draws water from the metamorphic rocks has a very high concentration of iron (47 ppm). However, in all other samples, 20 in number, in which iron was determined, the concentrations were less than 0.3 ppm.

Gaseous constituents.- Several of the wells and springs discharging water from the basalt have a noticeable odor of hydrogen sulfide. This condition seems to be normal (especially in newly drilled wells) for water from the basalt of the Pacific Northwest. The gas, in part, may be released by the decomposition of iron sulfides in the lava rock.

Drilling operations in well 1N/30-24E1 encountered a small amount of combustible gas which ignited with a muffled report when pieces of burning paper were dropped into the well. The gas, which probably was methane, apparently came from an interflow soil zone and probably was formed by the decomposition of organic matter in that zone.

Gas can be easily removed from water by aeration.

Suitability of the Water for Irrigation

The U. S. Department of Agriculture (1954) has stated that the characteristics most important in determining the quality of an irrigation water are (1) total concentration of soluble salts or salinity, (2) relative proportion of sodium to the principal cations as a whole, and (3) concentration of boron (which was discussed previously) or other elements that may be toxic. The concentration of soluble salts in water can be determined approximately by measuring the electrical conductivity of the water. This determination can be made readily and is reasonably accurate for the purpose. Conductivity is usually expressed in micromhos per centimeter and is a partial measure of the suitability of water for irrigation use.

The sodium (alkali) hazard involved in the use of water for irrigation is determined by the absolute and relative concentration of the cations. If the proportion of sodium is high the alkali hazard is high; if the calcium and magnesium predominate, the hazard is low.

A useful index for designating the sodium hazard is the sodium-adsorption ratio (SAR), which is related to the absorption of sodium by the soil. The sodium-adsorption ratio may be calculated from the formula

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

where all the cations are expressed in equivalents per million. The classification of waters with respect to SAR is based primarily on the effect of exchangeable sodium on the physical condition of the soil.

A diagram used for the classification of irrigation waters on the basis of electrical conductivity and the sodium-adsorption ratio is reproduced on plate 13. This diagram classified irrigation waters into 16 types ranging

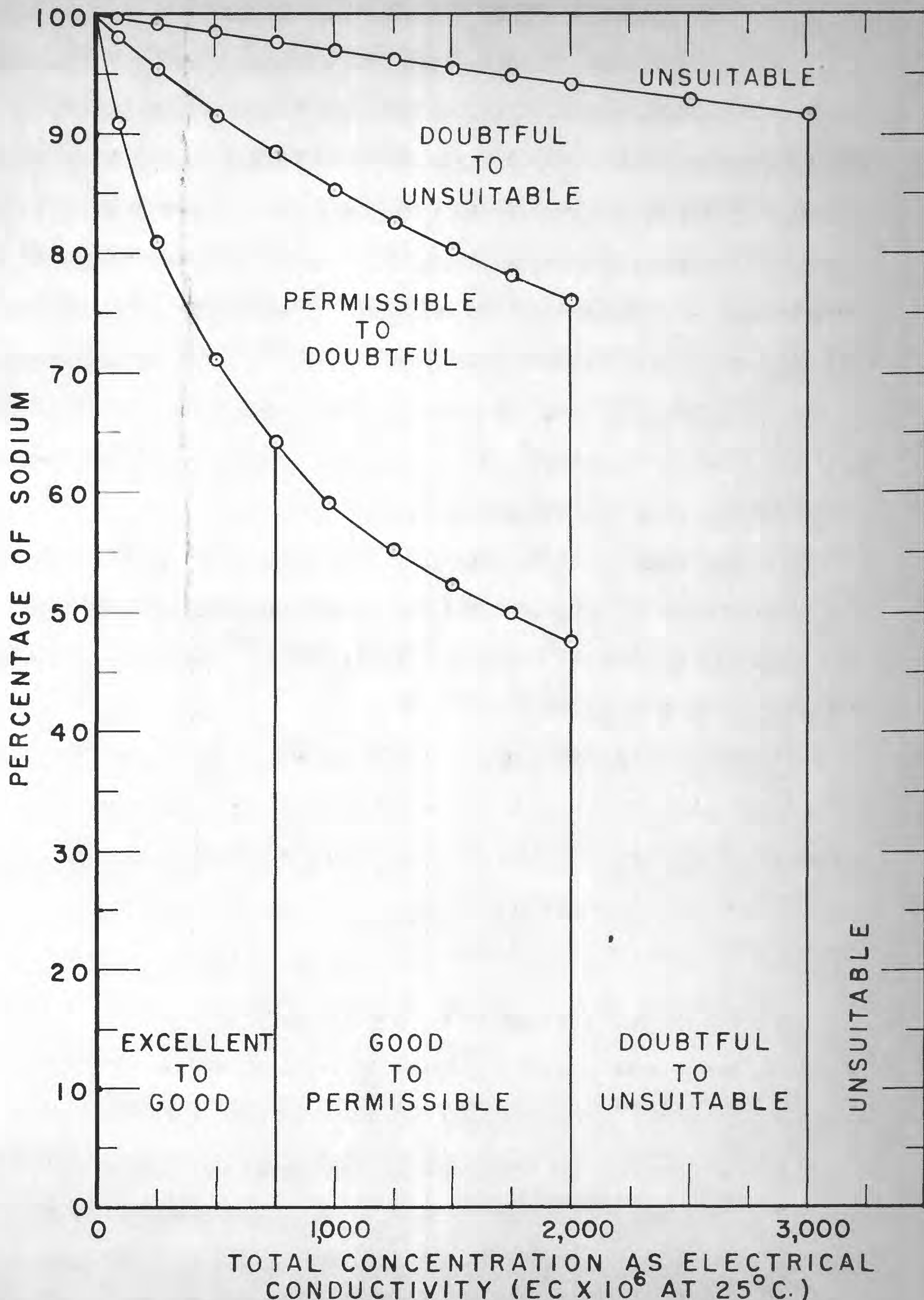


DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF AN IRRIGATION WATER

(TAKEN FROM U.S. DEPT. OF AGRI. CIR. 784.)

from low salinity (C1) and low sodium (S1) to high salinity (C4) and high sodium (S4). Water classed as C1-S1 can be used on practically all soils with little danger of harmful effects on the soil or crops, whereas a water classified as C4-S4 is not suitable for irrigation of any type of crops or any kind of soil except in very special situations.

Of 19 waters, analyses of which give adequate information, 15 fall into class C2-S1. Water of this class can be used for irrigation if a moderate amount of leaching occurs. Plants having moderate salt tolerance can be grown without special practices for salinity control. This type of water can be used on almost all soils with little danger of developing harmful levels of exchangeable sodium.

Two of the waters fell into class C1-S1; this type of water can be used for irrigating most crops on most soils with little likelihood that soil salinity or harmful concentrations of sodium will develop.

One sample (5N/32-31F1) was classed as C2-S2. This water will not create a salinity hazard if a moderate amount of leaching occurs but will present an appreciable sodium hazard in fine-textured soils having high cation-exchange capacity. It can be used on coarse-textured or organic soils of good permeability.

The remaining sample is from a hot spring (3N/37-18H1) and is classed as C3-S2. This has sodium-hazard characteristics similar to the sample just discussed. With respect to salinity hazard, the water in the C3-S2 class may not be suitable for use on soils having restricted drainage. Even with adequate drainage, if this water is used for irrigation, special management for salinity control may be required and plants having good salt tolerance may need be selected.

Temperature of the Ground Water

The average temperature of rocks lying at a depth of less than about 100 feet below the ground surface is commonly about the same as the mean annual temperature of the atmosphere at the ground surface. Wells and springs that discharge water from the pre-Miocene rocks tap water bodies in the weathered zones of these rocks. These ground-water bodies lie within a few feet of the ground surface and the water temperature approximates the mean annual air temperature.

Similarly, the sedimentary deposits overlying the basalt are commonly shallow, the depths of wells seldom exceeding 150 feet and being mostly less than 100 feet. The temperature of the water they contain also is at about the same as the mean annual air temperature.

Ground water from the basalt comes from porous zones which are tapped by wells ranging in depth from about 100 feet to more than 1,000 feet below the ground surface. Such waters show a distinct, though irregular, increase of water temperature with increasing depth of the water source.

The temperature of the water and other derived information for 26 wells in basalt are tabulated below:

Well	Mean depth[a] of aquifer (in feet)	Temperature of the water (°F)	Mean annual[b] temperature (°F)	Temperature difference (°F)	Temperature increase (°F/100 ft of depth)
2S/27-8P1	221	56	48	8	3.6
1S/27-18M1	126	55	48	7	5.6
1S/32-9L1	465	66	52	14	3.0
-9N1	348	64.5	52	12.5	3.6
-17F1	301	65	52	13	4.3
1S/32-19Q1	160	55	52	3	1.88
-23J1	710	68	52	15	2.1
1N/28-28D1	355	64	48	16	4.5
1N/30-4C1		65	58	17	
2N/27-11H1	427	61	48	13	3.0
2N/29-30H1	59	62	48	14	23.8
2N/32-10M1	421	51.5	49	2.5	.059
-10N1	580	56	49	7	1.21
-29D1	294	58	49	9	3.1
2N/33-21H1	450	66	51	15	3.3
3N/29-16G1	307	65	48	17	5.5
4N/27-27R1	540	58	50	8	1.47
4N/28-10C1	157	62	60	12	7.6
-10P1	375	76	60	26	6.9
-11N1	699	71	50	21	3.0
4N/31-9P1	311	61	50	11	3.5
5N/28-19A1	770	71	50	21	2.7
5N/29-13E1	272	63	50	13	4.8
5N/32-18C1		61	50	11	
-31F1	66	58	50	8	12.1
5N/33-31A1	253	58	50	8	2.9

a Mean depth of aquifer is taken as the depth of a point halfway between the top and bottom of the reported water-bearing zones, and for depths in which the water-bearing rock was not reported, it is taken as the depth of a point halfway between the static water level and the bottom of the well.

b Mean annual temperature is estimated from the elevation of the well site and the proximity of the site to temperature-recording stations at Echo, Hermiston, McNary, Meacham, Pendleton, Pilot Rock, Ukiah, Umatilla, and Weston. Mean annual temperatures for these stations were computed from weather records for the years 1945-54.

Of the temperatures recorded for the ground water in wells, the highest was 76°F in well 4N/28-10P1 in the Umatilla lowland, the lowest was 51.5° F in well 2N/32-10M1 in the Pendleton plains, and the average temperature for all 26 wells was 62.2°F.

The average rate of increase in temperature below the first 100 feet is generally 1° to 2°F per hundred feet. The temperature of the first 100 feet of depth is usually expected to average about the same as the mean annual temperature for that locality. This common assumption apparently is not entirely valid for the Columbia River basalt of the Umatilla River basin, as water from wells 2N/29-32H1 and 5N/32-31F1 show greater-than-mean annual temperature for aquifers whose mean depth is less than 100 feet. For this reason, the thermal gradients in the foregoing table were computed directly from the earth's surface.

Of the 24 wells for which data are complete, only 4 had temperature gradients of less than 2° per hundred feet. Of these, 2 are in the Pendleton plains area, 1 is in the Umatilla lowlands, and the remaining 1 is at the foot of the Blue Mountain slope.

Of the wells that show unusually high thermal gradients, more than 5°F per 100 feet of depth, nearly all are located in areas that contain lines of significant tectonic deformation. Well 1S/27-18M1 is on the Blue Mountain slope; 4N/28-10C1 and -10P1 are near the axis of the Service anticline, and 5N/32-31F1 is high on the Horse Heaven anticline. Wells 2N/29-30H1 and 3N/29-16G1 are in a trough between the Service and Rieth anticlines.

Possibly well 2N/29-30H1 may be bridged or obstructed in such a manner that only part of the depth to its water-bearing zone could be measured; thus, its erroneous depth measurement would account for its apparently very high water temperature per measured depth.

Near Pilot Rock, where the mean annual temperature for the years 1945-54 was 51.8°F, the water temperatures are from wells drawing water at different depths. One well (1S/32-19Q1) yields water at 55°F from an aquifer whose mean depth is 160 feet, and another (-17F1) yields water at a temperature of 65°F from an aquifer whose mean depth is 301 feet. A third well (-9L1) yields water at a temperature of 66°F, mainly from an aquifer whose mean depth is 465 feet, and a fourth (-23J1) yields water at 68°F from an aquifer whose mean depth is 710 feet. These four wells would indicate a temperature gradient of 1°F per 50 feet of depth to 160 feet, 1°F per 14 feet of depth from 160 to 301 feet, 1°F per 164 feet of depth from 301 feet to 465 feet, 1°F per 122 feet of depth from 465 feet to 710 feet, and an overall gradient of 1°F per 43.8 feet of depth from 0 to 710 feet. If these data were plotted, temperature against depth, the result would not be a smooth curve. The roughness of the curve seems to indicate that the ground water from the main producing zone of some wells may be mixed with water from higher or lower water-bearing zones.

The warmest ground water known in the Umatilla River basin area issues from Bingham Spring (3N/37-18H1) in the canyon of the Umatilla River near the crest of the Blue Mountain anticline. Hot springs are commonly considered to represent water that has risen along faults or other conduits from deeper strata. Using a temperature gradient of 1°F for each 50 feet of depth and starting from a mean annual temperature of 50°F, the 94°F temperature of the spring would require that its water rise without temperature loss from a depth of some 2,000 feet. However, the nearest recognizable fault is about half a mile downstream from the spring, and the position of the spring near the crest of the anticline makes it difficult to explain the source of sufficient hydraulic head to cause the water to rise in such volume from such a depth.

The water possibly could have reached a depth of 2,000 feet in its percolation to the springs if it came from the south and passed under the high mountain mass south of the spring. Fractures along the crest of the anticline may be open slightly, thus creating a greater vertical permeability than is common. If water was traveling in a straight line from the junction of the south fork of Umatilla River and Thomas Creek (altitude about 3,500 feet) to Bingham Spring (altitude about 2,200 feet) the water would have to descend vertically 1,300 feet in the basalt and would pass under a mountain mass which reaches an elevation about 4,500 feet above sea level, or 2,300 feet above Bingham Springs.

Another possible source of the heat is residual heat in an igneous intrusive mass near the surface. However, this hypothesis is doubted, because only one hot spring is known and because the only other possible indication of the presence of such a mass is the high concentration of boron in the water from this spring (see table 4). The possibility exists that fault zones may contain abnormally warm rock due to mechanical disruption of the rock during fault movements and may pass such heat on to the circulating ground water.

Use of the Ground Water

History of Ground-Water Development

There have been three major periods of ground-water development in the Umatilla Basin area. These correspond to periods of general increase in population, agriculture, and industry.

The earliest period of settlement in the area was largely devoid of ground-water development. Prior to the termination of the Indian wars in 1857, the population was transient and consisted mostly of trappers, traders, small settlements of white stockmen and missionaries, and Indians. Most of the settlements were of short duration and several were destroyed or the people were frightened away during the Indian wars. In 1863, gold mining was started in the Powder River valley to the southeast and several ranches were started in the Umatilla area to raise cattle, sheep, and foodstuffs for the miners. During that time the ranches and settlements were widely scattered and relied mostly on surface or spring water for domestic and stock use and upon surface water for such irrigation as was accomplished.

The switch of emphasis from stock to grain as a dominant agriculture product took place between 1875 and 1900. By the end of that period, most of the Pendleton plain and much of the Umatilla lowlands were under cultivation. Many of the settlements and ranch headquarters were located on the narrow flood plains of the larger streams. The people there relied upon surface water for irrigation and stock use and upon shallow dug wells in the Recent alluvium for domestic use. Ranches on the terraces and plains between the streams used shallow dug wells in the loess or other sediments overlying the basalt for domestic and stock water and practiced dry farming. The first exploratory wells into the basalt were drilled about the turn of the century. Many of these were shallow and were either failures or only moderately successful.

During the period 1912 to 1920, high wheat prices, stimulated by the first World War, caused many lands previously regarded as submarginal to be brought under cultivation. Many drilled wells were developed during this period of prosperity. The emphasis at that time was on dry farming and the wells were needed only for domestic and stock use. The wells were generally small in diameter--6 inches or less-- and in each case drilling was discontinued as soon as a small amount of water was obtained. With the decline in grain prices after the first World War, many of the poorer lands, such as those on the Rieth anticline and the Blue Mountain slope, reverted to grazing use and many farmsteads were abandoned as the land was consolidated into larger units. Many of the farmstead wells either fell into disuse or served only for stock water.

A period of minor ground-water development occurred during the drought of the 1930's, when the Government financed the drilling of several low-yield drought-relief wells.

The greatest period of ground-water development was from 1940 to the present. This recent activity has been caused by three dominant factors: first, the general period of prosperity during and after the second World War has made it possible for people to finance ground-water development; second, the local people are finding that large quantities of ground water are available under some parts of the area; and third, many of the ranchers are turning their attention to crops other than small grains. Some of those crops require irrigation. The second factor is probably the dominant one, and wells have been, and are now being, drilled for domestic, industrial, and municipal use as well as for irrigation.

Present Use of Ground Water

At the present time ground water has been developed for rural domestic and stock supply, irrigation, public supply, and industrial use; at one spring it has been developed for recreational use.

Rural domestic and stock water.- Most of the wells in the Umatilla River basin area are used for rural domestic and stock supply. In many places water from these wells is used also to irrigate small gardens or yards of generally less than 1 acre. About 600 representative wells of this class are listed in table 1.

The population of Umatilla County is 41,703, according to the 1950 census. If one subtracts from this the 19,696 who live within incorporated towns having municipal water supplies and the estimated 5,500 people living in that part of the Walla Walla drainage basin which lies within Umatilla County, a rural population of approximately 15,900 is obtained for the Umatilla River basin.

Per-capita water use for a rural population is commonly about the same as for a small city without industry--about 50 gallons per day. Therefore, the rural domestic use of water, all of which is withdrawn from wells or springs, is about 795,000 gpd, or about 890 acre-feet per year. Most of this water is withdrawn from the basalt.

Irrigation.- Quantities of water used for irrigation were estimated from data available for individual wells. Most of the data was obtained from annual reports of the well owners to the State Engineer of Oregon. Where such reports were not made the total water use was derived from an estimated average use of 3 acre-feet per acre irrigated per year. Where the total acreage was not known, the estimate was based on the reported yield of the well, in gpm, extended over a 3-month irrigation season.

The estimated total amount of ground water used for irrigation in the Umatilla River basin is 8,100 acre-feet per year. Of this amount, 6,350 acre-feet is withdrawn from the basalt, 1,700 acre-feet from the glaciofluviatile deposits, and the remainder from the fanglomerate and the alluvium.

Public-supply and industrial use.- Some of the industries within the area obtain all or part of their water from public-supply sources, while others furnish water to public-supply agencies, especially during periods of water shortage. For this reason, public-supply and industrial uses of ground water are grouped in this report.

Water-use figures were obtained from city officials or the State Engineer of Oregon where records were adequate, or were estimated for cities and industries where records are inadequate. Such estimates are made by multiplying the city population by 50 gallons per day per person for the domestic use, or by comparing reported well yields against the work schedules of industrial water users.

The estimated total amount of ground water used for industrial and public supply is 7,100 acre-feet per year. Of this, 3,800 acre-feet is withdrawn from wells in the basalt. The city of Pendleton obtains about 3,200 acre-feet per year from infiltration galleries in the Recent alluvium under the flood plain south of that part of the Umatilla River which lies in R. 35 E. The city of Stanfield obtains about 30 acre-feet per year from a well in the glaciofluviatile deposits overlying the basalt, and the city of Helix gets about 40 acre-feet per year from a dug well in the loess. The latter is the highest production rate (about 25 gpm) known for any well in the loess.

Total withdrawals of ground water.- From the foregoing paragraphs, it can be seen that the total consumption of ground water for all purposes in the Umatilla River basin area is about 16,100 acre-feet per year. Of this, 8,800 acre-feet per year is used for irrigation and seasonal industries and its withdrawal is concentrated in the summer months. The remainder includes usage for domestic and public supply and for nonseasonal industries. The withdrawal of this 7,300 acre-feet of water is distributed fairly evenly over the year, with perhaps a slight increase during the summer months when irrigation of yards and small gardens and a slight rise in population during the harvest season raises the rate of water use.

Table 1.- Representative Wells

[Well locations

Topography where well is located: Apd, alluvial plain, dissected; Fp, flood plain; Rc, former river channel; S, slope to major valley; Sc, scabland; T, terrace; U, upland; Uv, upland valley of minor stream.
Type of well construction: Bd, bored; Dg, dug; Dn, driven; Dr, drilled.
Ground-water occurrence: C, confined; P, perched; U, unconfined.
Water-level information: Depths and water levels expressed in feet and decimals were measured by the Geological Survey; those in whole feet
Chemical analyses listed in this table were determined by field methods

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone of zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 S., R. 29 E.								
7A1	Mrs. Ralph Jones	Uv	Dr	150	6	34.5			Basalt
9B1	J. G. Barratt	Uv	Dr	208	8	22	160	48	do.
10C1	Raymond French	Uv	Dr	150	8	50	135	15	do.
	T. 3 S., R. 30 E.								
1F1	Joseph Pedro	Uv	Dr	149	6	19	149		do.
29R1	George Egg	Uv	Dg	15.2	48				Metamorphic rocks
29R2	do.	Uv	Dr	85.0	6				do.
33C1	Orville Carley	Uv	Dg	16.1	60				
	T. 3 S., R. 30½ E.								
1B1	Joseph Pedro	Uv	Dr	99	6				

Unpublished records subject to revision

in the Umatilla River Basin Area

shown on plates 2A, 2B, 2C

were reported by the owner or the driller; those with plus and minus signs were estimated mostly by the owner. "F" indicates well flowing at land surface.

Type of pump: B, bucket; C, centrifugal (volute type); J, jet; P, piston; R, rotary; T, turbine-type centrifugal.

Use of water: D, domestic; Ind, industrial; Irr, irrigation; N, none; PS, public supply; RR, railroad; S, stock.

by the field personnel.

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
11	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	50		J, 20	S				Bailed 17 gpm for 17 min. with 10 ft drawdown; see table 2 for log.
C	50		T	D, S				
C	F		J	D, S	65	8		Water trickles over top of casing.
C	20			D				Test pumped at 410 gpm.
U	5.91	10/26/53	C	D	80	8		
U	3.83	10/25/53	P	D	100	8		See table 3 for chemical analysis of water.
U	5.42	10/25/53	P	N				
C	24.57	8/29/53	N	N				See plate 14 for water-level record.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 S., R. 27 E.								
5B1	Don Robinson	Uv	Dr	320					Basalt
8P1	Samuel Turner	Uv	Dr	256	6				do.
	T. 2 S., R. 28 E.								
12E1	W. E. Hughes	Uv	Dr	150	8		100	50	do.
13C1	Randel Martin	Uv	Dr	90	6				
	T. 2 S., R. 30 E.								
4H1	Daniel Doherty	Uv	Dg	16	13				
9L1	Joseph Doherty	Uv	Dr	117	8	24	110	7	do.
9L2	do.	Uv	Dg	16	36	16			
17F1	do.	UV	Dg	9	60				
28B1	Mary Pedro	Uv	Dr	400	10		370	30	do.
	T. 2 S., R. 30½ E.								
13J1	Virgil Rhinhart	U	Dr	104	6		84	20	do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	F		J, 10	S, Irr				Flows at the rate of 2 gpm; supplies irrigation water for 4 acres.
C	186		P	S	55	14	56	
C	23.85	10/23/53	T	D, S	70	8		See plate 15 for water-level record.
			J	D, S				
U	9.91	10/24/53	C	D, S				
C	7.27	10/24/53	T	D				Test pumped at 70 gpm for 2½ hours with 51 ft of drawdown.
U			C	D				Affords insufficient water during dry season.
U	9.12	10/24/53	C	S				
C	110	10/24/53						Test pumped at 265 gpm.
P	72		P, 2	D, S	65	48		Reported 27 ft of overburden overlies the basalt.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 S., R. 31 E.								
8D1	Mary Pedro	U	Dr		7				
14A1	Harry Snow	Uv	Dr						
20G1	Walde Markgraf	Uv	Dr		6				
	T. 2 S., R. 32 E.								
3N1	A. R. McBroom	Fp	Dn						Alluvium
10C1	Marius Jensen	Fp	Dg	22					do.
12M1	Arvine Porter	Fp	Dg	20					do.
12R1	do.	Fp	Dn	15					do.
	T. 2 S., R. 33 E.								
7N1	Arthur Osdorne	Fp	Dn	15					
	T. 2 S., R. 35 E.								
28A1	U. S. Forest Service	U	Dg	6.7					Old lake bed
	T. 1 S., R. 27 E.								
18M1	Samuel Turner	Uv	Dr	140	6	8			
19N1	Donald Evans	Uv	Dr		8				
	T. 1 S., R. 28 E.								
7G1	O'Brien	Fp	Dg	19.5	36				Alluvium

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			P	S				
U			C	D	110	11		
			P	D				
U			C	D				
U	19		B	D				
U			C	D				
U			C	D				
U			C	D				
U	.3	8/ 4/53	P	D, S				Well located in marshy upland meadow.
C	113		P, 14	D	115	50	55	
C	11.67	8/27/53	P	D, Irr				
U	10.62	10/23/53	C	D				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 S., R. 28 E. - Continued								
28D1	George Kern	S	Dg	10					Alluvium
31M1		Uv	Dg	31.2					
35B1	Tony Vey	Uv	Dr	323	6	46			Basalt
	T. 1 S., R. 29 E.								
1Q1	John Owen	Fp	Dn	17	1¼				Alluvium
3A1	Lowell Rugg	S	Dr	161	5½	40	160	1	Basalt
14G1	do.	Uv	Dr	440	6				do.
	T. 1 S., R. 30 E.								
1K1	Mrs. Elliot	Uv	Dr	595	8	20			do.
3C1	John Reeder	U	Dr	114	6				do.
4L1	J. M. Kramer Estate	U	Dr						
12F1	Victor Roumagaux	Uv	Dr	200	6				do.
12M1	Nelson Murray	U	Dr	670	6				
17J1	Wayne Bowman	S	Dg	24	36				
21F1	Daniel Doherty	T	Dr	225	10				Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U			P	D				May have been developed in a spring-discharge area.
U	27.71	8/27/53	P	D				
C	21	1948	P	S				Bailed 28 gpm; see table 2 for log.
U			C	D				
C	F			D, Irr	90	15		Flows 550 gpm; water has slight sulfur odor; supplies irrigation water for 13 acres.
C	30		P	S				
C	40		P	D, S	80	22		Water surface reportedly fluctuates with barometric pressure; sometimes flows.
C	34		P, 10	D	120	20		
			P	S				
			P	D, S				
	630		P	D, S				Reportedly yields 14 gpm with no drawdown.
U	12		P	D, S				
C	14.82	9/24/53						Test bailed at 12 gpm; see plate 16 for water-level record.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 S., R. 30 E. - Continued								
26Q1	Leroy Bowman	Uv	Dr	49	6				Basalt
	T. 1 S., R. 30½ E.								
1L1	Thomas Elliot	Uv	Dr	390	6				
12Q1	Mrs. Elliot	Uv	Dr	130	6				
	T. 1 S., R. 31 E.								
1L1	Jack Sacrison	U 1,940	Dr	427					Basalt
2B1	do.	Uv 1,880	Dg	12					
3P1		U 2,150	Dg	10.1	48				
4E1	Peter H. Schmidt	Uv 2,255	Dr	110	2				
11D1	H. A. Main	Uv 2,045	Dg	18	100	10			"Blue clay below bedrock"
17Q1	Whitaker	Uv	Dr	800					
19R1		Uv	Dg	20.2	48				Basaltic alluvium
22H1		Uv	Dg	12.1					

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	36.56	9/24/53						
P				D, S				
P				D, S				Reportedly has low yield.
	345		P	D				Reportedly yields 20 gpm.
U	9		P	S				
U	7.51	10/23/53	P					Not in use (1953).
	Dry	2/25/53						Measuring tape may have hit obstruction and not reached bottom.
U	12.17	10/25/53	P	D, S				
			P	D, S				
U	12.14	8/29/53	P	D				
U	11.7	8/ 5/53	P	S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 S., R. 32 E.								
5F1	John S. Robertson	S 1,635	Dr	100+	6				
8J1	Glen Newquist	S	Dr	115	8	18			Basalt
9G1	V. Jacobsen	S 1,600	Dr	150	6	85	92	58	do.
9L1	Wayne Chapman	T 1,590	Dr	491	12	44	440	40	do.
9M1	Oregon Fibre Products Co.	Fp 1,600	Dr	735	12	47	200		do.
9N1	Pilot Rock Lumber Co.	Fp	Dr	365	10	41	50	315	do.
10H1	Ralph Hemphill	Apd	Dg	30	36				
15C1	Lon Etter	S	Dr	450	6				
16L1	Wm. Etter	Fp	Dr	265	6				do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
	100+		P	D, S				Obstruction prevents measuring tape from reaching bottom.
C	85	1956	T	D, Irr				Test pumped for 4 hrs at 75 gpm with 8 ft of drawdown; see table 2 for log.
C	150		20	D, Irr				Well supplies irrigation water for 3½ acres; see table 2 for log.
C	F	4/ 6/53		D, Irr	111	9	66	Flowed 500 gpm when drilled; see table 2 for log and table 3 for chemical analysis of the water.
C	17.21	4/30/53	T, 600	Ind				Reportedly supplied 225 acre-ft of water during 1954; see table 2 for log.
C	6	9/12/52	T, 1,500	Ind	97	17	64	Reportedly supplied 415 acre-ft of water during water year 1954; see table 2 for log.
U			P	D				
			P	D				
C	15		T, 150	D, S, Irr				Test pumped for 1 hr at 120 gpm with 101 ft of drawdown; supplies irrigation water for 30 acres; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 S., R. 32 E. - Continued								
17G1	City of Pilot Rock	Fp	Dr	309	12	31	293	16	Basalt
17K1	do.	Fp	Dr	486	12	101	232		do.
18B1	Jack Luck	Fp	Dr	82	12				
19Q1	Arnold Hoeft	Fp	Dr	165	8		154	11	do.
20A1	R. Roy	S	Dr	300	6	89	278	22	do.
21M1	J. A. Porter	S	Dr	100	6				do.
21N1	Arthur Kelly	S	Dr		6				do.
23J1	Hilmer Horn	Uv 1,990	Dr	774	10	28	705	90	do.
28E1	Levi Eldridge	S	Dr	160	6	23			do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	F		C	PS			65	Flowed 1,420 gpm in 1946; well supplied an estimated 300 acre-ft of water during 1955; see table 2 for log and table 3 for partial chemical analysis of the water.
C	F	3/ 5/56		N				New well, not yet in use (1956); flows about 10 gpm; test pumped for 1 hr at 450 gpm with 192 ft of drawdown; see table 2 for log.
				S				Reportedly yields 45 gpm.
C	F			D	120	26	55	Free flow is 35 gpm; has 10 lbs pressure at surface when shut off.
C	32	1951	J, 30	D				See table 2 for log.
C			J	D				
			C	D, S				
C	89.39	10/28/53	T, 130	Irr			68	Supplies irrigation water for 40 acres; reportedly supplied 109 acre-ft of water during 1952; see table 2 for log and table 3 for chemical analysis of the water.
C	F		J, 30	D	80	22		Flows 1 gpm; see table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 S., R. 32 E.- Continued								
33K1	W. C. Baker	Fp	Dn	20					Alluvium
	T. 1 S., R. 33 E.								
4K1	Orin Sampson	Fp 1,660	Dn	10	1½				do.
5F1	Mrs. Georgia Wickert	Fp 1,620	Dg	12	60	12			do.
6G1	Jennie Red Hawk	Fp 1,575	Dn	10	1½				do.
12H1	Orin Sampson	Fp	Dn	12	1½				do.
	T. 1 S., R. 34 E.								
18E1	Lewis Umbager	Fp	Dn	10	1½				do.
19Q1	Mrs. Forth	Uv	Dn		1½				do.
	T. 1 S., R. 35 E.								
3G1	Earl Gillander	S	Dg	9	48				
3K1	Emil Johnson	S	Dr		6				
3K2	Earl Gillander	S	Dr	383	6	65			Basalt
3Q1	Oregon Highway Department	S	Dr	388	8		380	4	do.
10C1	Union Pacific Railroad	T	Dr	279	20 16	12 125	28	75	do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U			C	D, S				
U			P	D				
U	10		P	D				
U	8		P	D, S	40	8		
U			C	D				Yield inadequate for domestic supply.
U			P	D	40	6		
U			P	D	60	14		
U	8.55	10/29/33						
			J	D				
	26	1/29/45	17	D				See table 2 for log.
C	20		J, 20	D, Ind				Do.
C	F	1944	T, 314	N				Flows 25 gpm; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 S., R. 35 E. - Continued								
36N1	**Union Pacific Railroad**	**U**	**Dr**	**996**	**20** **16**	**51** **141**			**Basalt**
	T. 1 N., R. 26 E.								
2A1		**Apd** **1,100**	**Dr**	**185**					
5G1		**Apd** **1,240**	**Dr**						
6H1		**Apd** **1,125**	**Dr**		**6**				
9K1		**Apd** **1,225**	**Dr**		**8**				
10B1	**Wm. J. Doherty**	**Apd** **1,200**	**Dr**	**150**	**6**				**Basalt**
10L1		**Apd** **1,255**	**Dr**	**189**	**6**				
12C1	**G. D. Abercrombie**	**Apd** **1,165**	**Dr**	**143**	**6**	**40**	**128**	**12**	**Basalt**
23E1		**Fp** **1,300**	**Dr**	**58.4**	**6**				**Alluvium**
24D1	**Howard Kelly**	**Uv** **1,410**	**Dr**	**351**	**8**		**324**	**13**	**Basalt**
25G1	**Claude White**	**U** **1,610**	**Dr**	**492**	**6**				
26M1		**Uv** **1,420**	**Dr**		**6**				
27F1		**Apd** **1,450**	**Dr**	**100**	**4**				

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
	264	1946	N	N				Well not used because of insufficient yield; see table 2 for log.
			P					
			P					
			P	D				
			P	S				
C	56		T, 20	D, S	90	91		Static water level is reported to have dropped steadily from 10 ft in 1913 to below 56 ft in 1952.
	152.3	8/25/53	P					See plate 17 for water-level record.
C	24	1950	P, 50	D	115	27		Water has slight sulfur odor; see table 2 for partial log.
U	9.72	8/18/53	P					
C	135	1952	T, 50	D				See table 2 for log.
	336		T	D	90	18		
			P	D				
	96.33	8/19/53	P	D				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 27 E.								
3Q1	E. W. Wattenburger	Fp 1,025	Dr	97	6		25	72	Basalt
3R1	do.	Fp 1,040	Dr	120	8		90		do.
7D1	Campbell	Uv 1,200	Dr	290	6				
10H1	Kamerrer	Fp 1,050	Dr	110	6		90		Basalt
14N1	Doherty	Fp 1,175	Dr		4				
16Q1	J. E. Meyers	Fp 1,250	Dr	240	6				do.
18N1		Uv 1,420	Dr		6				do.
21R1	James Daly	Fp 1,385	Dg	10.6					Alluvium
27F1	John Healy Estate	Uv 1,400	Dg	25					do.
	T. 1 N., R. 28 E.								
4P1		Uv 1,400	Dr						
6C1		U 1,375	Dr						
13G1		Uv 1,805	Dr		6				
20C1		U 1,965	Dr	32.3	6				
21Q1	Tony Vey	S 1,440	Dr	270	12	45	225	45	Basalt

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (^{o}F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	20		C	D	90	11		
C	4		T, 235	Irr				Test pumped for 1 hr at 200 gpm with 55 ft of drawdown; supplied 73 acre-ft of water to irrigate 19 acres during 1954; see table 2 for log.
C	116.8	8/19/53	P					
C			C	D, S				
	10.15	4/27/53	C	D				
C			J	D, S	70	22		
			T	D				
U	6.26	8/28/53	J	D				
U	22		C	D				
			P	S				
			P					
			P	S				
	Dry							
C	30							See table 2 for log and plate 18 for water-level record.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 28 E. - Continued								
28C1	Tony Vey	T 1,400	Dr	500	12	29	178	21	Basalt
28D1	do.	T 1,390	Dr	365	12	16			do.
30G1	do.	S 1,425	Dr	150	4				do.
	T. 1 N., R. 29 E.								
6A1	Joseph Cunha	Uv 1,290	Dr		4				
7B1	do.	Uv 1,430							
14R1	Cunningham Sheep Co.	Uv 2,050	Dr	340	6½		325	15	Basalt
	T. 1 N., R. 30 E.								
4C1	Cunningham Sheep Co.	Uv 1,760	Dr		6				Do.
11B1	Clara B. Buttke	Uv 1,840	Dr		6				
11H1	Cunningham Sheep Co.	Uv 1,950	Dr	300					
14E1	R. M. Warren	Uv 2,200	Dr	49.2					
23P1	Mark Cargill	Uv 2,150	Dg	22	30				

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	0.0	7/18/53		D, S, Irr				See table 2 for log.
C	F			Irr	60	16	64	Flows 1,300 gpm; see table 2 for log and table 3 for chemical analysis of the water which has a sulfur odor.
C	30		P	S	120	14		Water has a turbid appearance.
			P	N				
C	F		N	S	110	26		May have been constructed in spring outlet.
C	210		P, 8	S				
C	F		N	N	110	18	65	Flows at the rate of 6 gpm.
			P	N				
				S				
U	48.0	7/ 1/53	P	D, S				
U	10.64	6/24/53		D, S				

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 30 E. - Continued								
24E1	T. A. Cross	Uv 2,220	Dr	576	12		327		Basalt
27D1	Leslie Owen	Uv 2,350	Dg	15					Loessial soil
31J1		U 2,590	Dg	16.0					do.
	T. 1 N., R. 31 E.								
1P1	Leroy Beilke	Uv 1,400	Dg	18	36				Alluvium
4N1	Willis Lecklider	U 1,950	Dr	119	6				
5A1	Lewis Livestock Co.	Uv 1,700	Dr		6				
7B1	W. C. Warren	U 2,080	Dr	502	6	20			Basalt
8K1		Uv 1,650	Dg	16.4	26				Alluvium
9R1		Uv 1,545	Dg	21.4	8				
10L1	Cunningham Sheep Co.	Uv 1,480	Dg	40					
11L1		Uv 1,445	Dg	13.3					Alluvium

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	247.27	3/ 2/54	N					Test pumped at rate of 30 gpm, see table 2 for log.
U	0.0	7/ 9/53	P	D	140	48		
U	8.34	6/24/53	N	D, S				
U	6		2	D				
	Dry							
			P	S				
			P	D, S				
U	10.3	2/17/53	P	S				See plate 19 for water-level records.
U	17.8	2/19/53						
U			P	D, S				
U	11.8	2/17/53						

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 31 E.- Continued								
12A1	O. L. Straughn	U 1,555	Dr	230	6	15			Basalt
13E1	do.	Uv 1,540	Dg	10					
17E1	T. A. Cross	Uv 1,750	Dr	327	6	20			Basalt
23L1	Frank Leeper	Uv 1,750	Dr	200	6				do.
25J1	Carl Jensen	Uv 1,690	Dr		2				
26E1	do.	Uv 1,830	Dr		2				Basalt
27H1	Herman Beilke	Uv 1,880	Dr		2				do.
28C1	John S. Robertson	Uv 1,910	Dg	15.7	84				Alluvium
30B1	T. A. Cross	Uv 2,050	Dr	550	6				Basalt
30C1	do.	Uv 2,080	Dr	50	6				do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	123		P, 1	S				
U	8		P	S				
C	160	12/ 8/53	P, 120	S				Test pumped for 2½ hours at 120 gpm with 105 ft of drawdown.
			P	D, S				
				S				
			P	S				
			P	S				
U	5.12	2/25/53	P					
C	190	7/ 1/53	T, 20	D, S				Test pumped for 12 hrs at 25 gpm with 55 ft of drawdown; see table 3 for chemical analysis of the water.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 31 E.- Continued								
34J1	Fred Rauch	Uv 2,030	Dr	385	6				Basalt
35J1	Charles Winget	Uv 1,830	Dr	332	6				do.
	T. 1 N., R. 32 E.								
1D1	J. R. Hanna	Apd 1,360	Dg	28.2	108				Older alluvium
1J1	Roy Horn	Apd 1,435	Dr	95					Gravel
1M1	Peter Timm	Apd 1,395	Dg	64	120-36		60	4	do.
1M2	do.	Apd 1,410	Dr	504	8	185	501	3	Basalt
4G1	Nellie Sparks	T 1,210	Dr						
4R1	Ed Kangas	S 1,205	Bd	12.5	6				
6R1	O. L. Straughn	Uv 1,485	Dr	260	6				Basalt
8H1		S 1,360	Dr		2				do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
P	365.0	10/27/53	P	D, S	85	20		Yield inadequate for domestic supply.
	110		P	S				Test pumped for 20 min. at 15 gpm with 190 ft of draw-down.
U	22.68	1/21/53	P, 30	D, S, Irr	75	9	53	Reported to supply water to irrigate 4 acres; see plate 20 for water-level records and table 3 for analysis of the water.
U	40		P	D				
U	55.31	7/16/53	J	D, S				Entire depth reportedly in Palouse formation and Pliocene fanglomerate.
C			T, 80	Irr,				Supplied 45 acre-feet of water to irrigate 15 acres during 1956; see table 2 for log.
				D, S				
U	9.5	7/17/53	C	D				
C	80		P	S				
			P					

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 32 E. - Continued								
9H1	Jack Sparks	Fp 1,240	Dr		10				Alluvium
10G1	G. A. McKay	Apd 1,350	Dr	389	8				Tuff(?)
12Q1	T. C. Holmes	Apd 1,400	Dg	40	48				
15D1	Wm. Eldridge	S 1,310	Dr	284	12	24			Basalt
15D2	Robt. Schuening	S 1,310	Dr	80	6	23	57		do.
18Q1	O. L. Straughn	Uv 1,545	Dr	218			203		do.
18R1	do.	Uv 1,540	Dg, Dr	110					do.
19M1	do.	Uv 1,650	Dr	40	6				
20F1	do.	Uv 1,410	Dg	18.3	36				
20L1		Uv 1,490	Dg	12.3	48				

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	15			D, S				Well is 30 ft from Birch Creek and static water level is at stream surface level.
C	190		P	D				
U			P	D				Requires 24 hrs to recover after being pumped dry.
C	12			D				Test pumped for 6 hrs at 320 gpm with 5 ft of drawdown; see table 2 for log.
C	17			D				Well reported to yield 25 gpm; driller reports 23 ft of soil, gravel, and boulders overlies red and black porous basalt.
			J, 10	D				
	50		P	D, S				
	20		4	D, S				
U	13.4	2/27/53	P					
U	Dry	2/27/53	P	N				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 32 E.- Continued								
22B1	J. L. Eldridge	Fp 1,345	Dr	406	10	20			Basalt
22B2	John Hummell	S 1,355	Dr	110	6	4	85	25	do.
22G1	J. L. Eldridge	Fp 1,345	Dr	540	12	30			
23G1	Ed Shaw	Fp 1,355	Dg	20	4				Gravel
23J1	C. S. Holmes	Fp 1,395	Dg	15.8	36				
24N1	Robert Shaw	S 1,395	Dr	122	6				
24R1	V. A. Bolt	Apd 1,420	Dg	29.8					Gravel
26R1	J. W. Miller	Fp 1,430	Dg	12	60				
26Q1	Guy Rockwell	Fp 1,440	Dr	2000	6				
27P1	Adolph Weinkes	Fp 1,420	Dr	134		30	117	17	Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	20		T, 500	Irr				Test pumped for 15 min at 400 gpm with 52 ft of drawdown; well supplied 159 acre-feet of water to irrigate 80 acres during 1953; see table 2 for log.
C	70			D				Test pumped for 8 hrs at 23 gpm with 30 ft of drawdown; driller reports 10 ft of soil and cemented gravel overlying basalt
C	9.46	7/17/52	T, 450	Irr				Well supplied 154 acre-ft of water to irrigate 77 acres during 1953.
U			P	D				
U	8.29	7/16/52	P	D				
				D, S				
U	17.9	1/21/53	P	D, S	55	16	51	See table 3 for chemical analysis of the water and plate 21 for water-level records.
U	8.17	7/16/53	P, C	D, S				Reported 6 ft of loess overlying basalt.
			N	N				Oil test well; plugged at about 8 ft.
C	16	1948	28	D				See table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 32 E. - Continued								
28D1	Edwin Hoeft	Uv 1,510	Dr	583	12	20			Basalt
29N1	do.	Uv 1,610	Dr	500	6				
29P1	do.	Uv 1,600	Dr	110	2				
30F1	Army Korvola	Uv 1,640	Dr	185	6				do.
30H1	do.	Uv 1,580	Dg	19.7					
30L1	do.	Uv 1,660	Dr	358	10	22	225		Basalt
34P1	Everett Hawkes	S 1,510	Dr	200	6	52	125	75	do.
35G1	Guy Rockwell	Fp 1,430	Dg	33	8		20	13	Gravel
35K1	Tom Ellis	Fp 1,450	Dr	273	8	193			Gravel or fault breccia(?)
35K2	do.	Fp 1,450	Dg	80	48				

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GROUND WATER BRANCH
Box 3418-1001 NE. Lloyd Boulevard
Portland 8, Oregon

June 11, 1957

U. S. Geological Survey
Chief, Ground Water Branch
Washington 25, D. C.

Under separate cover there is being sent to you a copy of a duplicated report entitled "Geology and ground-water resources of the Umatilla River basin area, Oregon" by G. M. Hogenson, which has been prepared in this office

The report is distributed at this time to make the information as widely available as possible in its present form. Any additional ground-water information that you may be able to furnish us will be greatly appreciated.

A duplicate of this letter with a format for receipting delivery is enclosed, together with a stamped, addressed envelope. We shall appreciate your signing the receipt and mailing it to us.

Sincerely yours,

G M Hogenson

R. C. Newcomb
Administrative Geologist
By G. M. Hogenson, Geologist

Enclosures

6/17/57

P. S. A suggested press release is enclosed also, for your approval and publication.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	F	1956	N	N			66	Not yet in use (1956); flows 30 gpm and has shut-in pressure of 1 pound; tested at 600 gpm with 200 ft of drawdown; see table 2 for log.
			T	D, S				
			P	N				Abandoned because of inadequate yield.
C			P, 9	D				
U	Dry	2/27/53	N	N				
C	94	7/15/52	T, 180	Irr				Test pumped for 1-3/4 hrs at 177-210 gpm with 167 ft of drawdown.
C	44	1948	21	D				See table 2 for log.
U			P	D, S				Entire depth in Quaternary alluvium.
	36.44	7/16/52	30	N				Well was 350 ft deep but caved in.
U			P	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 33 E.								
3G1	Herb Thompson	Apd 1,695	Dr	800	8	74			Basalt
3R1		Apd 1,820	Dr	121	10	20	16	105	do.
5A1	Roy Horne	Apd 1,530	Dr						
7F1	Marvin Cargill	Apd 1,480	Dr	160					Older alluvium
8A1	Patton	Apd 1,610	Dr	250	6				
9B1		Apd 1,610	Dg	19.3	18				do.
10D1		Apd 1,740	Dg	42.4	24				do.
16R1	Patton	Apd 1,930	Dg	40	20				
16R2	do.	Apd 1,950	Dg	35.6					
18H1	Roy Horne	Apd 1,565	Dr	180.2	6				
19R1	W. H. Caplinger	Apd 1,715	Dr	150	12				Basalt
22F1	Patton	S 2,050	Dr	100	6				do.
	T. 1 N., R. 34 E.								
5R1	Jim Luellan	U 3,520	Dr		6				

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
	161							
C	F							Flows 2 gpm; reportedly 16 ft of loess and older alluvium overlying basalt.
			P					Not in use (1953).
			P	D	80	6	56	See table 3 for chemical analysis of the water.
								Not in use (1953).
U, P	5.25	2/21/53						Do.
U, P	1.6	2/21/53	P					
U, P	20			Irr				Used only to irrigate lawn.
U, P	3.4	2/21/53	P	D				Refills in 3 days after being pumped dry; see plate 22 for water-level records.
C	124.9	1/21/53						See plate 23 for water-level record.
	78.76	9/ 8/54						Drilling not yet completed (1956); see plate 24 for water-level record.
			P	S				
			P	S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 1 N., R. 34 E. - Continued								
8E1	Herbert Thompson	U 3,350	Dr	380	8				
17F1	Cabbage Hill School	U 3,340	Dr	103					
19G1		U- 3,450	Dg	46.8	36				
21B1		U 3,495	Dg, Dr	80	36				
	T. 1 N., R. 35 E.								
28M1	Gus Moll	S	Dr	180	6				
29C1	Oregon Highway Dept.	S	Dr	286	6				
	T. 2 N., R. 26 E.								
2P1		Apd 810	Dr	147	6				
14K1		Apd 905	Dr		6				Basalt
14K2		Apd 905	Dr	229	6				do.
19R1	D. O. Nelson	Apd 1,010	Dr	343	8	40	294	49	do.
20L1	do.	Apd 960	Dr	116	6				
35C1	W. B. Gottschalk	Apd 1,045	Dr	114	6				
35C2	Fred Rauch	Apd 1,045	Dr	160	6				

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			P	S				
			P	D				
U	16.2	10/29/53	P	N				
	Dry	10/28/53	P	S				
C	80		J	D, S				
C	16		J	PS				Supplies water for a public park.
	142.9	6/10/53						
								See plate 25 for water-level record.
C	2.08	8/14/53						
C	168	1948	T, 50	D				Water has a slight sulfur odor.
	Dry	8/18/53						
C	31.7	8/18/53	J	D, S	160	36		
C	70		J, 35	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 27 E.								
1F1	Ammon Bros.	Fp 785	Dr	554	15	140			Basalt
1M1	Catherine M. Stanfield	Fp 780	Dr	504	8-5½	170-441			do.
6F1	Corrigal Ranch	Apd 1,010	Dr	447		300	413	14	do.
11H1	J. S. Williams	Fp 825	Dr	525	10	185	330	195	do.
11R1	Sloan Thompson	Fp 855	Dr	270	6				do.
12D1	J. S. Williams	Fp 815	Dr	50	5				
14N1	McCarty	Fp 880	Dr	280	12				do.
20J1	Ed tucker	Apd 1,120	Dr	370	10	53			
22A1	D. W. Terry	Fp 910	Dr	370	6	230			

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	330	3/ 1/55	T, 1,000	Irr				Reported to yield 1,000 gpm with 65 ft of drawdown; in 1955 supplied 570 acre-ft of water to irrigate 221 acres; see table 2 for log.
	19	1935	P, 20	D				See table 2 for log.
C	280			D				Bail test indicates yield of 40 gpm; see table 2 for log.
C	F	4/22/53	T, 900	Irr	65	14	61	Supplied 33 acre-ft of water to irrigate 105 acres during 1953; see table 2 for log and table 3 for chemical analysis of the water.
C	F	4/22/53	J	D, S				
			C	D	135	19		Supplies irrigation water for 1 acre.
C	45	1953	T, 2,000	Irr				Well supplied an estimated 720 acre-ft of water to irrigate 400 acres during 1953; see table 2 for log.
C	250	1948						Test pumped 200 gpm; see table 2 for log.
			J	D, S	120	15		See table 2 for partial log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 27 E.- Continued								
27E1	John Kilkenny	Fp 950	Dr	260	6				Basalt
27E2	do.	Fp 950	Dr	120	4				do.
27E3	do.	Fp 950	Dr	598	16	29			do.
28H1	Ed Tucker	Fp 950	Dr	263	12	32.5	242	12	do.
28K1	L. H. Vanbusker	Fp 980	Dr	92	8	18			
29N1	Leland Archer	Apd 1,160	Dr	439	10				
32G1	Harold G. Campbell	Apd 1,200	Dr	334	6				Basalt
34L1	B. P. Dougherty	Fp 1,055	Dr	100±					
34N1	Lou Wattenburgher	Uv 1,150	Dr	72	6				Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness o water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	10		C, 150	D, Irr	80	11		The water level in this well said to be lowered by pumping neighbor's well.
C	10		J	D				Do.
C	50		N	N				Test pumped for 5 hrs at 780 gpm with 150 ft of drawdown; owner plans to use well as water supply for irrigation; see table 2 for log.
C	10		T, 620	Irr				Supplied 330 acre-ft of water to irrigate 250 acres during 1953; see table 2 for log and plate 26 for water-level record.
C	20		J, 110	D, Irr				
C	190							Test bailed at 20 gpm.
C	215		T, 35	D, Irr				Supplies irrigation water for 2 acres.
			C	D	75	17		
C	F			D				Well reported to flow 15 gpm.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 28 E.								
2Q1		Apd 750	Dg	18.8	36				
4L1	Eagle Valley Ranch	Apd 800	Dr		6				
11R1		Uv 930	Dg	14.3					
16K1	Tony Vey	Uv 1,240	Dr	185	6	52	130	55	Basalt
28K1	Joseph Vaia	Uv 1,100	Dr	400	8		200		do.
35F1	do.	Uv 1,280	Dr	200	6				
	T. 2 N., R. 29 E.								
8R1	Rosa Monese	Uv 940	Dr		4				
14N1	Pendleton Ranches, Inc.	Uv 1,355	Dr		6				
18M1	Rosa Monese	Uv 980	Dr		6				
26A1	Ella Weinke	U 1,490	Dr		4				
30H1	Joseph Cunha	Uv 1,180	Dr	119	6				Basalt
35Q1	do.	Uv 1,390	Dr		3				
	T. 2 N., R. 30 E.								
6G1	C. C. Crowner	Fp 735	Dg	10	42				Gravel
6H1	Cunningham Sheep Co.	T 730	Dr	233	8		225	8	Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	11.91	7/16/53	C	S				
			P	D				
U	11.43	7/16/53	P	D				
C	100	1948	P, 14	S	100	16		See table 2 for log.
			P	S				
			P	S				
			P	S				
			P	D, S				
			P	D, S				
			P					
C	F	7/ 8/53		S	90	14	62	Flows about 1 gpm.
			P	S				
U	4			N				Not in use (1956); reportedly supplied water to irrigate 1 acre during 1950.
C	F	1946	C	D, S				Flows 100 gpm; see table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 30 E.- Continued								
9F1	Edward DuPuis	Fp 780	Dg	10	24				Gravel
17K1	Cunningham Sheep Co.	Uv 1,080	Dr	158	8				Basalt
20N1	do.	Uv 1,275	Dr		6				do.
21H1	Pendleton Ranches, Inc.	Uv 1,350	Dr		2				
25L1	Cunningham Sheep Co.	Uv 1,645	Dr	150	2				
28F1	do.	Uv 1,440	Dr	81.1					
28R1	Pendleton Ranches, Inc.	Uv 1,480	Dr		2				
35N1	Clara Buttke	Uv 1,740	Dr		6				
	T. 2 N., R. 31 E.								
2B1	Leo Gorger	U 1,545	Dr	282	6				
2B2	do.	U 1,555	Dr	310	8	25	289	14	Basalt
4C1	E. A. Fanshier	U 1,560	Dr	720	6	12			do.
11J1	Dean Forth	S 1,100	Dr	382	6	22	350	32	do.
12R1	Rieth School	S 1,150	Dr	268	6				do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	6		P	D, S				
C	F	7/14/53		S				
			P	S	110	20		
			P					
			P					Not in use (1953).
C	64.88	17/10/53	P	D, S				See plate 27 for water-level record.
			P	S				
			P	S				
			P, 2	S				
C	260		T, 40	D	15	28		See table 2 for log.
	600±		P	D	90	13		Can be pumped dry in 4 hrs at 5 gpm.
			J	D, S				
			T	D				Reported to yield 100 gpm with drawdown to 250 ft after 1 hr.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 31 E.- Continued								
13L1	Oregon State Hospital	S 1,050	Dr						
15K1	Brown Bros. Dairy	Fp 900	Dr	150	6				
15L1	Union Pacific Ry.	Fp 895	Dr	161					Basalt
31D1	Ernest French	Uv 1,930	Dr	624	6				
31Q1	do.	U 2,090	Dr		6				
36N1	Picket	Uv 1,275	Dg	15.9	36				
	T. 2 N., R. 32 E.								
1P1	S. E. Allen	Fp 1,120	Dg	16	48				Gravel
1Q1	E. C. Ralls	Fp 1,117	Dg	8.0	48				
2D1	H. M. Peringer	S 1,355	Dr	600		600			
2R1	City of Pendleton	T 1,120	Dr	935	20	147	680	43	Basalt
4R1	Wilbur Jones	S 1,050	Dg	22.4	60				Colluvium
4R2	do.	S 1,060	Dr	224	8				Basalt

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			T	PS				
C	8		C	D, S				
C	3	1/ /40	C, 40	D				Well named Barnhart no. 1; see table 2 for log.
C	50	1947	P, 6	S				
			P	S				
U, P	10.62	4/ 8/53	P	D, S				
U	2			D, Irr				Supplies water to irrigate 3 acres.
U	6.47	10/ 8/45	C	D				
			N	N				Oil test well; water cased out; see table 2 for partial log.
C	185	1948	T, 1,800	PS	95	51		Known as the Byers Street well; test pumped 1,155 gpm with 12 ft of drawdown; see table 2 for log and table 3 for partial chemical analysis of the water.
U	9.8	4/13/53	C	D				
C	90		N	N			56	New well not yet in use (1954); reported to yield 220 gpm with 5 ft of drawdown.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 32 E.- Continued								
7L1	Union Pacific Ry.	Fp 1,000	Dr	188	12				Basalt
7N1	do.	Fp 1,000	Dr	287	12-10	55	127		do.
9B1	Oregon State Hospital	Fp 1.040	Dr	851	20	57			do.
10F1	City of Pendleton	Fp 1,054	Dr	761	16	80.5			do.
10M1	Smith Cannery Co.	Fp 1,045	Dr	665	12	35			do.
10N1	City of Pendleton	S 1,040	Dr	1008	20-16	81			do.
11B1	George Byers	Fp 1,080	Dr	387	8				
11D1	First National Bank of Portland	Fp 1,060	Dr	703	10				Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	65			RR				Not in use (1953); known as Rieth well no. 1.
C	65	7/19/42	T, 638	RR				Known as the Rieth well no. 2; see table 2 for log.
C	135	1954	T	PS				Well is connected to the Pendleton city water system; tested for 12 hrs at 810 gpm with 178 ft of drawdown; see table 2 for log.
C	139	11/22/48	T, 2,500	PS	120	21		Known as the Round-Up Park well; tested at 1,670 gpm with 18 ft of drawdown; see table 2 for log and table 3 for chemical analysis of the water.
C	178		T, 900	Ind			51½	See table 2 for log.
C	153		T, 585	PS			56	City well no. 3; water temperature increases to 64° after heavy pumping; see table 2 for log.
C	18	7/ 9/52	30	Irr				Supplies irrigation water for yard.
			T					Supplies water for air conditioning unit; see table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T. 2 N., R. 32 E.- Continued									
13J1	Fred Peterson	Apd 1,240	Dg	11.9	84				Loessial soil
16A1	J. O. Winslow	S 1,075	Dr	206					Basalt
16D1	Charles Ford	Fp 1,090	Dr	280					do.
16M1	Gilbert Struve	Fp 830	Dr	385	6	75			do.
16P1	Clifford N. Clark	S 1,160	Dr	257	6	16	71		do.
18N1	W. Enbysk	Fp 1,050	Dr	150	6				do.
19N1	Milton Carter	S 1,090	Dr	200			130		do.
19P1	do.	Fp 1,075	Dr	229	8	57			do.
21C1	Neal Riddle	Fp 1,090	Dr	315	8				do.
23E1	Glenn Rogers	S 1,190	Dr	225					do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	4.77	6/22/53	P	D	160	20		
	27		J	D, Irr			52	Reported to yield 30 gpm with 113 ft of drawdown; see table 2 for log.
	120	1956	T, 30	D				Well reported to yield 30 gpm; see table 2 for log.
	182	1950	T, 8	D				Owner plans to irrigate 3 acres of pasture; see table 2 for log.
C	60		J	D, S	105	15		
C	103	1952	20	D				See table 2 for log.
C	60		T, 385	Irr				Reportedly supplied 270 acre-ft of water to irrigate 107 acres during 1953; see table 2 for log.
	180			D				Water level reportedly draws down 70 ft after 3 hrs of pumping at the rate of 45 gpm.
C	200	1955	T, 40	D				When first drilled, well was test pumped for 6 hrs at 100 gpm but in later use broke suction at 40 gpm; drawdown present in both instances is unknown.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 32 E.- Continued								
28H1	Henry Lembke	Fp 1,100	Dg	6	30				Gravel
29D1	John Korvola	Fp 1,075	Dr	280	10	20			Basalt
29F1	do.	Fp 1,075	Dr	56	8		32	24	do.
29F1	W. E. Russell	S 1,250	Dr		6				do.
29R1	O. L. Straughn	S 1,110	Dg	15					
34G1	G. R. Patterson	S 1,200	Dg	13					
34K1	U. S. Bureau of Reclamation	S 1,300	Dg	15					
35H1	John Crow	S 1,300	Dr	244	8	15	70		Basalt
36E1	O. A. Bowman	S 1,305	Dg	24					Sand
	T. 2 N., R. 33 E.								
2K1	Luke Cowapoo	Fp 1,230	Dn		1¼				Young alluvium
6M1	Lester Moens	Fp 1,145	Dr	95	6	24	65		Basalt

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	4			Irr				Well reportedly supplied 6 acre-ft of water for irrigation of 2 acres during 1954; reportedly yielded 28 gpm with "no" drawdown after 10 hrs pumping; water level fluctuates with the level of nearby McKay Creek.
C	108			N			58	Test pumped at 525 gpm for 1 hr with 52 ft of drawdown.
C	14	1950	J, 200	D				See table 2 for log.
			P	D, S				
U			P	D				
U	9		P	D, S				
U				D				
C	40		J	D, S	45	29		See table 3 for chemical analysis of the water.
U				D				
U			P	D, S	95	20		
	50.98	11/28/56	N	D				New well not yet in use (1956); driller reports 10 ft of san[d] and gravel overlying basalt; and "no" drawdown after bailing 30 gpm of water for 30 m[in]

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 33 E.- Continued								
6N2	Lester Moens	Fp 1,145	Dr	95	6	24	65		Basalt
6N3	Crispin Bros.	Fp 1,140	Dr	500	10	60			do.
8G1	William Purchase	Fp 1,135	Dr	30	10	13	13	17	do.
8G2	Henry P. Shafer	Fp 1,135	Dr	200	8				do.
8J1	William Purchase	T 1,225	Dr	779	8	95½			do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			N	D				Well located about 60 ft southwest of -6N1; new well (1956) not yet in use; driller reports log, yield, and water level are the same as -6N1.
P	Unknown		N	N				Proposed water supply for suburban water district; sound of cascading water audible in well; see table 2 for log.
U	8			D				Owner's well no. 2; reportedly supplied 10 acre-ft of water to irrigate 3 acres during 1954; see table 2 for log.
C	F		T, 80	Irr				Well supplied 7 acre-ft of water for irrigation of 7 acres during 1955; reportedly has 9 lbs per sq inch artesian pressure when not being pumped; water level is reported to lower when wells -8Q1, -8J1 and -8K1 are pumped.
C	19	1949	T, 100	D, S				Owner's well no. 1; originally used for irrigation until its capacity was lowered by interference of well -8K1; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 33 E- Continued								
8K1	William Purchase	T 1,225	Dr	604	12	64			Basalt
10E1	Neal H. Loughlin	Fp 1,210	Dr	252	6				
10E2	Roy Morris	Fp 1,210	Dr	275	6	19			Basalt
11F1	Mrs. Joseph Allen Est.	Fp 1,255	Dn	12	1½				Sand and gravel
13Q1	Lewis Shipentower	Apd 1,570	Dg	25.6	72				
18Q1	Matlock	Apd 1,260	Dg	25					Loessial soil
20D1	M. F. Umbarger	Apd 1,290	Dr	472	6	8			Basalt
21H1	Richard Curl	Apd 1,395	Dr	900	6				do.
22P1	James Thompson	Apd 1,435	Dr	50	6				Gravel
22P2	do.	Apd 1,435	Dg	34					do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	20	1953	T, 500	Irr				Owner's well no. 3; test pumped about 615 gpm for 6½ hrs with 220 ft of drawdown; reportedly supplied 221 acre-ft of water to irrigate 80 acres during 1955; see table 2 for log.
	22		T, 500					Supplies irrigation water for 1 acre; see table 2 for log.
C	17	1/25/57	N	N				Proposed water supply for irrigation; test pumped at 40 gpm for 10 hrs with 6 ft of drawdown; see table 2 for log.
U	9		C	D, S				
U	8.63	8/31/53	J	D				
U	10		P	D	155	16		
C	9		J	D, S	110	30		
C	F	6/22/53		N	20	8	66	Reported abandoned because of sulfur content of water, although no sulfurous odor is apparent in 1953; test pumped 85 gpm; flows about 1 gpm.
U	20		J	D	95	6		
U	12		N	N				In about 1950 water was contaminated by gasoline from nearby underground storage tank.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 2 N., R. 33 E.- Continued								
24N1	Audrey Pichard	Apd 1,640	Dr	110	6				
29B1	Umbarger	Apd 1,380	Dg	12					
29C1	Tutuilla Mission	Apd 1,390	Dr						
33N1	Guy Mueller	Apd 1,525	Dr	310	12	119			Basalt
	T. 2 N., R. 34 E.								
3D1	Layton Mann	S 1,710	Dg	25	36				
4R1	Union Pacific Ry.	T 1,400	Dr	85	8	40	50	35	Basalt
7P1	Ester Temple	S 1,400	Dg	13.5	48				
8C1	Clinton Case	T 1,360	Dg	10	36	8			Gravel
17A1	Philip Guyer	S 1,540	Dg	11	48				
	T. 3 N., R. 26 E.								
4L1	Luther Cramer	T 640	Dr	358	12	96			Glaciofluviatile deposits

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			N	N				
			P	D				
			J	D				
C	F	6/22/53	T, 550	Irr	80	8		Test pumped for 2½ hrs at 456 gpm with 205 ft of drawdown; supplies irrigation water for 100 acres; see table 2 for log.
U	20.68	8/31/53	P	D				
C	4	1941	P, 30	D				See table 2 for log.
U	6.17	8/31/53	P	D				
U	7.2	8/31/53	C	D				
U	9.48	8/31/53	P	D				Goes dry in summer.
U	166	1955	N	N			66	Test pumped 350 gpm with drawdown of 98 ft after 4 hrs; drilled for irrigation water supply; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 26 E.- Continued								
14J1	Willard Jones	T 640	Dr	197	8				Basalt
	T. 3 N., R. 27 E.								
4R1	Dean Hall	T 590	Dr	185	12	89			Basalt(?)
25J1	George Wallace	Fp 720	Dr	320	8	216			Basalt
36A1	do.	Fp 740	Dg	24.5					Younger alluvium derived from loess
36H1	Ralph Saylor	Fp 755	Dg	24.2					
36P1	Wm. L. Green	Fp 765	Dr		6				
36Q1	do.	Fp 765	Dg						
	T. 3 N., R. 28 E.								
1A1	Lee Beckner	Fp 600	Dg	10	42				
8P1	Ralph Saylor	Fp 655	Dg	24.8					
12J1	Coppinger	Fp 590	Dg	30	2				Alluvium
14L1	John Ubanks	Fp 630	Dg	14					do.
18H1	Fred Davis	Fp 655		40					
18H2	do.	Fp 650	Dr	500	6				

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	84	1954	T, 450	Irr				Supplies water to irrigate 40 acres; test pumped 200 gpm with 25 ft of drawdown after 4 hrs pumping; see table 2 for log.
U			N	N				New well (1956) planned for irrigation supply; reportedly yields 360 gpm with 110 ft of drawdown after 8 hrs of pumping; see table 2 for log.
C	196	1935	P, 20	S				See table 2 for log.
U	14.45	4/22/53		S	185	19	52	See table 3 for chemical analysis of the water.
U	12.6	4/22/53	C	D	120	11		
				D, S	75	12		
U	13.4	4/22/53		N				
U	4.7	9/17/53	C	D				
U	13.33	7/28/53						
U			P	D				
U	3		C	D, S	120	70		Water probably comes from nearby irrigation ditch.
U			C	D				Well under lawn in yard.
C	15		N	N				Well closed by silt.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 28 E.- Continued								
19N1	Avis M. Moore	Fp 700	Dr		3				
19Q1		Fp 695	Dg	26.2					
23D1	John Ubanks	Fp 690	Dg	17.1					Alluvium
	T. 3 N., R. 29 E.								
5C1	Helen R. Ohlsen	Fp 605	Dr	235	6				Basalt
8F1	Frank Correa, Sr.	Fp 620	Dm		2				Alluvium
8L1	John B. Correa	Fp 620	Dn		1½				do.
10P1	D. R. Long	S 780	Dr	170	6				Basalt
11G1	Peter Meyers	U 885	Dg	80					Gravel
11G2	Claude Meyers	U 890	Dr	675	10	106			Basalt
15E1	Stanfield Irrigation District	S 730	Dr		6				
16C1	L. L. Fife	Fp 600	Dg	12	36				Alluvium

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			C	S				
U	9.64	7/28/53	P	S				
U	7.17	7/29/53	N	N				
C	75	1954	S, 80	Irr				Supplied 20 acre-ft of water to irrigate 6 acres during 1954; test pumped 80 gpm with 50 ft of drawdown after ½ hr.
U			C	Irr				Supplies irrigation water for one-half acre of lawn.
U			C	D				
			P	D				
U	75		J, 5	D				See table 2 for log.
C	F		C	Irr			72	Reportedly flows at the rate of 665 gpm; the water has a head of 46.2 ft ar the land surface; supplies irrigation water for 240 acres; see table 2 for log.
			P					
U	4		C, 150	Irr				Water level fluctuates with change in level of Umatilla River; supplied 29 acre-ft of water to irrigate 14 acrer during 1954; drawdown 4 ft after pumping 150 gpm for 8 h

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 29 E.- Continued								
16G1	City of Echo	Fp 630	Dr	490	10	169	442	18	Basalt
16K1	C. F. Grossmiller	Fp 610	Dg	36					Alluvium
24J1	Homer Coppinger	U 1,045	Dr	285	5				Basalt
26K1	Mary Raines	Fp 750	Dr	6	16				do.
29K1	Teal Irrigation District	T 780	Dr		6				
32L1	John Pedro	Uv 890	Dr	183	8				
	T. 3 N., R. 30 E.								
1A1	Brian Branstetter	Uv 1,100	Dr		6				
1A2	do.	Uv 1,050	Dg	135					
4D1	Coleman	Uv 850	Dr	290	5.7				
7E1	Marshall Meyers	Uv 840	Dg	12	30				
7M1	do.	Uv 840	Dg	20					"Soil"

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	95	1951	T, 400	PS			65	Supplied an estimated 12 acre-ft of water during 1,637 hrs of operation during water-year 1955; see table 2 for lo
U	6		C, 120	Irr				Supplies supplemental irrigation water for 8 acres; can be emptied by present pump in 15 min; requires 2 hrs to refill.
			P	D	70	16		
			J	D				
			P	S				
C	127.8	7/ 8/53	P	S				
			P	D				
	11.6	6/13/53	P	N				
C	18.02	5/13/53	N	N				See plate 28 for water-level record.
U	6		C	Irr				Supplies irrigation water for 5 acres.
U	10		P	D				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 30 E.- Continued								
9M1	Leon Reese	Uv 910	Dr	141	6				
10K1	A. H. Rohde	Uv 980	Dr	200	6				
13E1	Arthur Lorenzen	Uv 1,120	Dr	500					
14M1	Whitmore	Uv 1,045	Dr	264					
18F1	Vollendorf	Uv 930	Dr						
21M1	Homer Coppinger	Uv 1,030	Dr		4				
22P1	Leon Reese	Uv 1,100	Dr	239	6				
28A1		U 1,100	Dg	24					
30J1	Clarence Weltzin	U 1,050	Dr	260	6				Basalt
32M1	C. A. Moll	U 1,160	Dr	220	6				do.
	T. 3 N., R. 31 E.								
1E1	Chadwick	Uv 1,340	Dr	637	8		632	5	Basalt
1G1	C. Jacobsen	Uv 1,400	Dg	24.4					
2A1	Chris Jacobson	Uv 1,350	Dg	30					

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	90	11/27/53	J, 115	D	115	52		Test pumped at 115 gpm for 1 hr with 20 ft of drawdown.
C	50±		J	D	105	62		
			T	D, Irr	70	22		
C	150		P	D	90	41		
			P	D	45	24		
			P	N				
C	176	11/30/53	P, 120	N				Test pumped at 120 gpm for 1 hr with 20 ft of drawdown.
U	20		P	D				
C	200		P	D	75	19		
C	70		P	D	55	14		
	300		S	D				Well reported to yield 20 gpm.
U	17.02	4/16/53	N	N				
U	22		P	D, S				

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 31 E.- Continued								
7G1	Leonard Lorenzen	Uv 1,070	Dr	175	6				
8Q1	Earnest T. French	Uv 1,140	Dr	416	6	12			Basalt
11G1	Andrew Harvey	Uv 1,260	Dr	641	6	14	641		do.
22L1	Herman Lorenzen	Uv 1.230	Dr	320	6				do.
26A1	Engdahl	Uv 1.290	Dr	400	6				do.
31C1	B. E. Isom	U 1,360	Dr	555	6				do.
33P1	Ronald Rew	U 1,540	Dr	620	6				do.
34C1	R. H. Sievers	U 1,440	Dr	520	6	50			do.
	T. 3 N., R. 32 E.								
1B1		U 1,740	Dr	156	6				do.
2B1	Struve Estate	U 1,650	Dr	500	6				do.
2C1	do.	U 1,670	Dr	175					do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			P	D				Static water level reported to be very low in well.
C	90		P	D				
C	340		P, 25	D, S	55	12		Water level rose to surface from aquifer at 89 ft but at 340 ft a porous layer was struck and all water was lost; at 640 ft another aquifer was hit but the water level would not rise above 340 ft where the dry "cavern" remains uncased.
	300±		J, 10	D	80	18		
	350		P	D	85	18		
	400±		P, 7	D	100	17		
	Dry							Not in use (1953).
C	490		P, 6	D	80	14		Air passes in and out of well with variations in atmospheric pressure.
	115.4	2/ 9/53	T	D				
C	260		P, 10	D, S				
			P, 2.5					Inadequate for domestic supply.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 32 E.- Continued								
4D1	James Daniel	U 1,560	Dr	210	8	18	180		Basalt
6D1	S. Westersund	U 1,480	Dr	600	6				do.
9A1	Arthur Lindbergh	U 1,695	Dr	530	6	118			do.
10G1	Herman Mum	Uv 1,605	Dr	800	6	10			do.
13P1	Herman Rosenburg	U 1,540	Dr	90	6	90			
13P2	do.	U 1,540	Dr	120	6				Basalt
14J1		U 1,560	Dg	61	72	12			
16F1	Hagen	U 1,450	Dr	345					
16F2	do.	Uv 1,440	Dg	49			38		Basalt
16L1	Joseph Snyder	Uv 1,455	Dr	550	6	None			do.
16L2	do.	Uv 1,445	Dr	235	6	None			do.
17E1	John Lorenzen	Uv 1,390	Dr		6				
18B1		Uv 1,360	Dg	17					
22C1	George Mumm	U 1,605	Dr	236.7	6				Basalt
27F1	Chas. Goodyear	U 1,495	Dr	509	6				do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	65		P	D				
			P	D	75	19		
C	300±		P, 30	D				
				D, S				
C	50		J	D, S				Inadequate; easily pumped dry.
C	63		J	D, S				
U								Not in use (1953).
			P	D, S				
U			60	Irr				Supplies irrigation water for about 1 acre.
C	250		P	D, S				Well -16L1 is 40 ft south-east of -16L2.
			P	D, S				Reportedly pumping does not greatly lower water level in well -16L1.
			T	D (?)				
U	8.52	4/16/53	P	S				
C	145.7	2/12/53	P	D, S	115	25		See table 3 for chemical an-alysis of the water.
			J	D, Ind				Water has seasonal use at chicken farm.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 32 E.- Continued								
29D1	Dr. Miller	U 1,390	Dr	365	3				Basalt
32P1	Pendleton city Airport	U 1,490	Dr	825	6				do.
33R1	Nelson	Uv 1,325	Dr	420					do.
	T. 3 N., R. 33 E.								
1N1	L. Straughn	S 1,590	Dg	29					
2Q1	C. C. Curl	Uv 1,560	Dr	295	8	30			Basalt
3H1	Laura Enbysk	Uv 1,595	Dg	25	60	14			
5Q1	Schaeffer	U 1,595	Dg		40				Loessial soil
6R1	Barney Anderson	U 1,625	Dg, Dr	60 (?)					
9Q1	Jack Shafer	U 1,575	Dg	33	60				
10B1	Mrs. Fred Brown	U 1,580	Dg, Dr	38 (?)					
11B1	Everett Rothrock	U 1,605	Dr	98	6				Basalt
14L1	McCormack Bros.	S 1,450	Dr	96	8	60	32	22	do.
17A1	Ben Cresswell	U 1,575	Dr	111	6				
17L1		U 1,515	Dg	33	52				

Umatilla River Basin Area - Continued

	Water level							
Ground-water occurrence	Feet below land-surface datum	Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	100		P	D				
				N				Formerly pumped at 12 gpm; not used (1953); caved to 350 ft; see table 2 for log.
	400		P	D, S				
U	26.05	8/28/53	J	D, S				
C	15		T, 75	D, S, Irr				Supplies irrigation water for 3 acres.
U	13.72	9/ 1/53	J	D, S				
U			P	D, S	195	46		
U				D, S				Well was dug 60 ft, went dry; later drilled deeper, never dry since.
U	21.53	9/ 1/53	P	D, S				
U	26.20	8/28/53	P	D, S				Drilled well in bottom of dug well.
			J	D, S				
C	20	8/ /53	J, 70	D, S				Well flows as much as 1 gpm during rainy season; see table 2 for log.
C	51	6/13/53	P, 5					Not in use (1954).
U	25.18	4/14/53						Do.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 33 E.- Continued								
18A1	G. W. Temple	U 1,545	Dg	38.5					
22M1	McCormack Bros.	Fp 1,260	Dr	181	6				
23B1	Louis Kruse	Fp 1,290	Dr		6				
24Q1	U. S. Dept. Agri. Pendleton Experiment Station	U 1,490	Dr	268	6				
27H1	Frank Duff	Uv 1,410	Dr	564	10	25	540	24	Basalt
27H2	do.	Uv 1,405	Dr	280	10	15			do.
27M1	George Moens	U 1,440	Dr	148	6	60			do.
29Q1	Ralph Tachella	T 1,200	Dr	200	6				
31K1	James Rutten	T 1,125	Dr	300	6				
31Q1	do.	Fp 1,120	Dg	35					
31Q2	do.	Fp 1,120	Dr	608	12	23			Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
P	19.55	1/30/53	P	D				See plate 29 for water level record.
	12			S				Reportedly yields 15 gpm with 158 ft of drawdown.
			C	D, S				
C	39	1/ 8/54	P, 115	D				Test pumped at 105 gpm for 3½ hrs with 46 ft of drawdown.
C	20	11/21/53		N				Plugged and abandoned.
C	39	3/ /53		N				New well, not yet in use (1954); test pumped at 30 gpm.
C	60		J	D				
C	15.06	9/ 1/53	J	D, S				
				Irr				Supplies irrigation water for lawn; pumps dry in 1 hr.
			P	Irr				Supplies irrigation water for 2 acres of pasture.
	247	1956		Irr			54	New well, not yet in use (1956); driller reports a yield of 400 gpm; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 33 E. - Continued								
32D1	Chas. Cunha	Fp 1,200	Dr	500	6				
33J1	Roy Duff	U 1,420	Dg	70	96	10	10	60	Basalt
34B1	Jack Duff	U 1,460	Dr	425	6	50	50	350	do.
35G1	Lee Foster	U 1,430	Dr	600	8	70			do.
	T. 3 N., R. 34 E.								
1R1	Mrs. M. E. Pamburn	Uv	Dg	23	36				
2E1	F. C. Lieuallen	S 1,620	Dr	150	6				Basalt
3C1	B. A. Davis	Uv 1,560	Dr	163	6	25	160	3	do.
3D1	do.	Uv 1,560	Dr	298	12	60	283	15	do.
3L1	S. J. Lieuallen	S 1,510	Dr	180	6	55			do.
4G1	City of Adams	S 1,570	Dr	163	16	35	93	40	do.
6A1	Georgia B. Johnson	Uv 1,550	Dg	16	48				
9K1	L. L. Rogers	S 1,520	Dr	390	8				

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			J	D				
P	45.55	8/27/53	J	D, S				
			P	D, S				Penetrated gravel to 50 ft(?).
			J, 100	D	128			Reportedly 70 ft of gravel overlying basalt.
U	19		C	D				Inadequate in summer; may have been dug in spring area.
			J	D, S, Irr				Supplies irrigation water for 3 acres of pasture.
C	15	3/ /44	J	D	50	16		See table 2 for log.
C	7		T, 500	Irr	60	12		Supplies irrigation water for 60 acres; reportedly supplied 46 acre-ft of water during 1954; see table 2 for log and plate 30 for water-level record.
C	30	1948	J	D, S	105	22		See table 2 for log.
C	F		100	PS				Reportedly supplied 17 acre-ft of water during 1954; see table 2 for log.
U	6		C	D				
			P	D				

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 34 E.- Continued								
10D1	Wm. Coppock	S 1,510	Dr	190	8	20			Basalt
11H1	L. L. Rogers	Uv 1,660	Dr	340	6		65		do.
11Q1	John Pierce	S 1,740	Dg	20	60				Loessial soil
12E1	W. P. Allen	Uv 1,680	Dg	29	60				
12P1	Chas. Betts	Uv 1,720	Dr	140					
14R1	Mrs. Rondeau	U 1,775	Dg	35	72				
17D1	Bert G. Haynes	S 1,430	Dr	503	6	27	444	19	Basalt
17M1	Standard Oil Co.	U 1,550	Dr	386	8		338	5	do.
18M1	Bob Rothrock	S 1,450	Dr	175	6	30			do.
20E1	Bert G. Haynes	S 1,480	Dr	155	8	7	131	13	do.
22Q1	Irvine Mann	Uv 1,625	Dr	315	8	63			do.
25B1	C. C. Curl	S 1,800	Dr	305	8	86			do.
25C1	do.	S 1,800	Dg	26.3	60				
32D1	J. H. Maloney	U 1,535	Dr	159	8	54	110	44	Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (^oF)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	30		J	D, S, Irr				Supplies irrigation water for 9 acres.
C	30		T, 130	Irr				Reportedly supplied 72 acre-ft of water to irrigate 26 acres during 1954; see table 2 for log.
U	17		P	D	90	10		
U			P	D				
			C	D, S				
U	16		P	D, S				
C	40	1950	J, 13	D				See table 2 for log.
C	61	1950	C, 100	Ind				Supplies water for fire protection; see table 2 for log.
C	23	11/ 2/45	P, 10	D, S				See table 2 for log.
C	14	8/28/53	J, 30	D	80	16		Do.
P	18	5/ 8/44	T, 40	D				Do.
C	125	1940	N	N				Abandoned, insufficient water; see table 2 for log.
U	15.42	8/28/53	C	D, S				
C	47.60	8/28/53	T, 30	S, Irr	95	18		Supplies irrigation water for 2 acres; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 34 E.- Continued								
33B1	Mary Lawyer	Uv 1,630	Dg	20.3	96	8			Loessial soil
33L1	Wade Menthorn	Uv 1,570	Dr		6				
33M1	do.	Uv 1,570	Dr	190	6	22	151	41	Basalt
33Q1	L. L. Rogers	Uv 1,640	Dr	414	10				do.
	T. 3 N., R. 35 E.								
4D1	Anna Bell	Uv	Dg	16.9	48				
7P1		Uv	Dg	10	36				
9H2	Davis	Uv	Dr	298	6				
9J1	E. B. Foster	Uv	Dr	481	8				Basalt
15B1	Walter Adams	Uv	Dr	100	8	38	38	62	do.
17M1	Al Cox	Uv	Dr						
18H1	Frank Williams	Uv	Dr	176	6		100		Basalt
19K1	Harold Barnett	Uv	Dr	200	6	18			

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	15.98	8/28/53	P	D	125	16		Inadequate for domestic supply during dry season.
			C	D				
C	22			D				Reported to yield 28 gpm with 22 ft of drawdown.
P	14		T, 200	Irr				Reportedly supplied 92 acre-ft of water to irrigate 186 acres during 1954; see table 2 for log.
U	13.2	9/ 3/53		D, S				
U	7.83	9/ 3/53	P					
	282.0	9/ 2/53						See plate 31 for water-level record.
C	51		P	D				Pumps dry; see table 2 for log.
C	20		T, 80	Irr				Supplies irrigation water for 10 acres; see table 2 for log.
			J	D, S				
C	F		J	D, S				Pumps dry; see table 2 for log.
C	18		P	D				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 3 N., R. 35 E.- Continued								
19L1	**Harold Barnett**	**Uv**	**Dr**	**968**	**8**	**22**			**Basalt**
20E1		**Uv**	**Dg**	**47.5**	**36**				
21N1	**Freida Lent**	**Uv**	**Dg**	**30**	**10**				
28K1	**Ritz Thompson**	**U**	**Dr**	**470**					**Basalt**
	T. 3 N., R. 36 E.								
17L1		**U**	**Dg**	**19.4**					
18K1		**U**	**Dg**						
29L1	**Gibbon School**	**Fp**	**Dg** **Dr**	**28** **60**	**6**		**50**	**4**	**Basalt**
31G1	**Union Pacific Ry.**	**Fp**	**Dr**	**80**	**6**	**56**	**71**	**9**	**do.**
	T. 4 N., R. 26 E.								
25E1		**T** 580	**Dr**	**170**	**6**				
	T. 4 N., R. 27 E.								
5B1	**U. S. Army Installation**	**T** 545	**Dr**	**710**	**16**				**Basalt**
8J1	**do.**	**T** 625	**Dr**	**453**	**15** **12**	**256**			**do.**
18P1	**do.**	**Rc** 585	**Dr**	**618**	**16** **12**	**560**			**do.**

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	275	9/19/53	T	D, S	65	12		See table 2 for log.
U	25.02	9/ 2/53						
U	10		P	D				
	310	1955	T, 15	D				
U	8.84		P	S				
U	4.4	8/ 3/53						
U				D				See table 2 for log.
	8			RR				Do.
C	50.2	6/10/53	J	S				See plate 32 for water-level record.
C	80	1954	T, 100	Ind				Reportedly test pumped at 1,080 gpm with 6 ft of draw-down; see table 2 for log.
C	138	1941	T, 600	PS, Ind				Owner's well no. 3; see table 2 for log.
C	110		T, 1,000	PS, Ind				Owner's well no. 5; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 27 E.- Continued								
19C1	U. S. Army Installation	Rc 585	Dr	600	16 12	430			Basalt
20M1	Union Pacific Ry.	Rc 500	Dr	457	12	175	450	7	do.
22K1	U. S. Army Installation	T 585	Dr	360	15 12	218			do.
22L1	do.	T 585	Dr	327	12	150			do.
27R1	do.	T 600	Dr	543	16 12 10	146 346 530	538	5	do.
28E1	V. R. Fulton	T 545	Dr	102	6	97	90	97	Loose gravel
28E2	do.	T 550	Dr	119	12		72	8	"Pea gravel"
28G1	S. F. Hoyt	T 570	Dr	126	12	126	73		Gravel
32A1	R. G. Holzapfel	T 575	Dr	106	16	100			Glaciofluviatile deposits

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	110		T, 800	PS				Owner's well no. 4; see table 2 for log.
C	43	1945	T, 316	RR				Owner's "Munley" well; reportedly yields 300 gpm with 9 ft of drawdown after 3½ hrs pumping; see table 2 for log.
C	95							Owner's well no. 2; see table 2 for log.
C	18	5/ 1/53	T, 1,000	PS, Ind				Owner's well no. 1; reportedly supplied 92 acre-ft of water during 1953; see table 2 for log and table 3 for partial chemical analysis of water.
C	121		T, 750	PS			58	Owner's housing project well; see table 2 for log.
U	64			D				Reportedly yields 30 gpm with no drawdown; see table 2 for log.
U	64							Reportedly test pumped 820 gpm for 17 hrs with no drawdown; see table 2 for log.
U	73	1954	T, 1,250	Irr				Supplies irrigation water for 150 acres; see table 2 for log.
U	65		T,	Irr				Test pumped at 960 gpm for 7 hrs with no drawdown reported.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 27 E.- Continued								
32G1	G. B. Holzapfel	T 590	Dr	123	12				Glaciofluviatile deposits
32J1	R. G. Holzapfel	T 595	Dr	310	12			90	Glaciofluviatile deposits and basalt
33C1	C. F. Gollman	Rc 560	Dr	100	16			32	do.
33H1	McDole Bros.	Rc 560	Dr	96	12	96			Glaciofluviatile deposits
33J1	do.	Rc 560	Dr	126	8	100			do.
33J2	do.	Rc 560	Dr	96	12	75			do.
36E1	G. W. Redwine	T 575	Dr	194	12				do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
	77	1954	T, 450	Irr				Entire depth drilled into glaciofluviatile sand, gravel, and clay; supplies irrigation water for 18 acres.
	90		T, 600	Irr			70	Supplies irrigation water for 111 acres; see table 2 for lo-
	20		T, 2,000	Irr				Reportedly drilled through 32 ft of glaciofluviatile sand and gravel overlying water-bearing scoriaceous lava; has been test pumped at 2,300 gpm for 1 hr with 7 ft of draw-down; reportedly supplied about 15 acre-ft of water for 60 acres during 1955.
U	63	1950	T, 520	Irr			62	Supplies irrigation water for 80 acres; see table 2 for log.
C	65		P	D				
	69	12/ 1/54	T, 520	Irr			62	Supplies irrigation water for 80 acres; well was reportedly in operation for 1,440 hrs during 1953; see table 2 for log.
U	55	1955	T, 225	Irr				Supplied 141 acre-ft of water to irrigate 40 acres during 1954; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 28 E.								
1H1	A. J. Rathke	Rc 470	Dr	100	6	100			Sand
1J1	W. R. Bensel	Rc 490	Dr	360					Basalt
10F1	City of Hermiston	Rc 470	Dr	160	12	64	154	6	do.
10P1	do.	Rc 475	Dr	500			375		do.
11N1	do.	Rc 455	Dr	962	20	92			do.
11R1	do.	Rc 500	Dr	918	18	598			do.
16B1	A. C. Langenwalter	T 500	Dr	282	8				do.
16J1	Bill Westgate	T 495	Dr	82	6				
18D1	Otto Lubbes	T 530	Dr	57	6	57			Sand and gravel
20H1	E. L. Jackson	S 490	Dg	31	16	6	10	21	Gravel
20N1	C. O. Porter	S 510	Dr	145	8	125	125		Basalt

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	55	1949	J	D	95	14		
			J					
C	30	1937	T, 175	N			62	Not in use (1954); see table 2 for log.
C	F		T, 250	PS	66	14	76	Supplied 38 acre-ft of water during 1954; see table 3 for partial chemical analysis of the water.
C	12	1954	T	PS			71	Pumped 2,315 gpm for 3 hrs with 134 ft of drawdown.
C	F		T, 1,200	PS				Reportedly supplied 800 acre-ft of water during 1954; see table 2 for log and table 3 for partial chemical analysis of the water.
	90	1953	T	D			70	Test pumped at 35 gpm for 3/4 hr with 120 ft of drawdown.
			J	D				
U				D				
U	25		C	D, S				
P			N	Irr				New well, not yet in use (1956); reported yield is 40 gpm with 50 ft of drawdown; see table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
T. 4 N., R. 28 E.- Continued									
21A1	Cleve Clark	T 560	Dr	65	4		52	13	
24A1	Ray Moses	T 655	Dr	427	6	30	402	25	Basalt
24A2	Frank Ille	T 655	Dr	155	8	30	100	55	Sandy "clay"
24C1	W. R. Ille	T 645	Dr	105	6	28	100	5	do.
27J1	Union Pacific Ry.	T 610	Dr	553	16 12	547	512	35	Basalt
28N1	N. R. Mueller	Fp 590	Dr	100	6				
T. 4 N., R. 29 E.									
3L1	Gene Gray	Rc 610	Dr	140	6				
3N1	do.	Rc 610	Dr	754	12-10	167			Basalt
4C1	K. H. Williams	Rc 495	Dr	140	6				
5R1	C. C. Harpster	Rc 615	Dr	770	10		140	120	Basalt
6L1	Frank Rodda	Rc 460	Dr	200	6	100			do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	20		J	D, S	110	12		
C	15		J	D				See table 2 for log.
C	16		J	D				Reportedly entire depth is in glaciofluviatile deposits.
C	18		J	D				
C	155	1950	T, 1,150	RR				Test pumped at 1,200 gpm for 1 hr with 10 ft of drawdown; owner has water right for 801 acre-ft per year; see table 2 for log.
	20		J	D				
C	35		J	D, S				
C	35			Irr				Supplies irrigation water for 64 acres; test pumped at 350 gpm; see table 2 for log.
C	2		C	D, S				
C	66	9/18/53	T, 135	Irr	75	10		Supplied 29 acre-ft of water to irrigate 20 acres during 1955.
C	11		J	D, Irr	50	18		Penetrated only sand to 100 ft depth.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 29 E. - Continued								
8A1	G. W. McCracken	T. 610	Dr	85	6				
8G1	Hermiston Farms, Inc.	T 640	Dr	170	6				
9E1	E. Walchli	T 635	Dr	240	6	200	200	40	Basalt
10A1	T. Higgenbotham	T 630	Dr	73.8	6				Glaciofluviatile deposits
11B1	Marvin Hurd	Rc 650	Bd	30	6	20	20	10	Gravel and clay
12B1	Peter Kosmos	Rc 640	Dr	330	6				
13C1	Ray Meyersick	Rc 625	Dr	70	4				
13K1	Edwards' Farms, Inc.	Rc 740	Dr	527	12				Basalt
13N1	do.	Rc 680	Dr	425	6	140	410	15	do.
17C1	Ben Dryer	T 680	Dr	245	12		101		Glaciofluviatile deposits
18J1	I. J. Couch	T 675	Dr	262	12				Basalt
23G1	Carl Johnson	Rc 700	Bd	26.8	6				Glaciofluviatile deposits

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
			C	D, S				
C	100		J	D				
C	30		P	D, S				
U	10.64	9/18/53	C	D	110	42		
U	5.14	9/16/53	C, 6	D				See table 2 for log.
C	230		P	S				
	12		C	D, S				
C	76	1954	T	Irr				Supplies irrigation water for 360 acres; reportedly supplied 1,475 acre-ft of water during 1954; see table 2 foe log.
C	55		T, 300	Irr	60	54		Reportedly supplied 142 acre-ft of water to irrigate 80 acres during 1954; see table 2 for log.
C	90	1955	T	Irr				Reported to have been test pumped at 1,500 gpm; supplies irrigation water for 110 acres; see table 2 for log.
C	65	1954		Irr				New well (1956); owner plans to irrigate 160 acres; driller reports 225 ft of soil and clay overlying basalt; well tested at 1,250 gpm with 83 ft of drawdown.
U	11.73	9/16/53	J	D, S	95	64		

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 29 E.- Continued								
26D1	Otto Broker	Rc 650	Dg	14	36		12	2	Glaciofluviatile deposits
27L1	R. P. Leslie	Rc 650	Dr	52.4	4				
28Q1	Vernon Bryant	Rc 650	Dg	18.3	36	10			
29L1	Del Harmon	T 700	Dr	122.5	6				Glaciofluviatile deposits
29L2	W. C. Gifford	T 725	Dr	126	6	97	40		
32L1	City of Stanfield	Rc 605	Dr	187	10-6				
33N1	C. Boylen	Rc 660	Dr	80	6				
34R1	George Ransier	T 755	Dr	300					
34R2	do.	T 755	Dr	160.8	7				
	T. 4 N., R. 30 E.								
8J1	Pete Kosmos	T 800	Dr	230	6				
13M1	Bob Terney	Uv 1,020	Dr	240	6				
14F1	do.	T 1,060	Dr	365	6				Basalt
25B1	Hockensmith	Uv 945	Dr	310	6				do.
26A1	J. J. Lorenzen	Uv 925	Dr	240	6				
32P1	G. M. Ransier	Uv 720	Dr	65	8				

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	11.07	9/25/53	C	D, S	120	8		
	9.82	9/18/53	C	D, S				
U	10.24	9/25/53	P	N				
U	17.70		J	D	75	6		
C	30		J	D, S				
C	23	1945		PS				
			125					
			J	D, S				
			T	D, S	20	33		
	81.12	5/22/53	N	N				See plate 33 for water-level record.
	200		P	D, S				
			P	N				
C	175		P	S				
C	35		P	D				
	100		P	D	40	36		
	10		J, 20	D, S	90	35		

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no. (1)	Owner or occupant of property (2)	Topography and approximate altitude (ft above sea level) (3)	Type of well construction (4)	Depth (feet) (5)	Diameter (inches) (6)	Depth of casing (ft) (7)	Water-bearing zone or zones: Depth to top (ft) (8)	Thickness (ft) (9)	Character of material (10)
	T. 4 N., R. 30 E.- Continued								
33Q1	Coleman	Uv 850	Dg	25					Loessial soil
33Q2	do.	Uv 870	Dr	260	6				Basalt
35Q1	Leonard Lorenzen	Uv 955	Dr	612	6		574	38	do.
	T. 4 N., R. 31 E.								
2F1	Glen Thorne	Uv 1,185	Dg	25	48				
5E1	Guerrant	Uv 1,005	Dg	16			10	6	Basalt
8B1	M. Kilgore	Uv 1,070	Dr	430	6	27	400	30	
8H1	do.	Uv 1,090	Dg	30					
9P1	R. E. Bissinger	Uv 1,200	Dr	342	8	25	280	62	Basalt
9Q1	Dewey Purcell	Uv 1,275	Dr	175	8	12			do.
14E1	Fell	Uv 1,305	Dg	20					Soil
14L1	Lee Bissinger	Uv 1,320	Dr	280					
18D1	Bob Terney	U 1,230	Dr	350	6		290		Basalt
22B1	Robert Bissinger	U 1,450	Dr		6				
23H1	A. H. Schluter	Uv 1,370	Dr	463			447	16	Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	9.4	6/13/53	J, 12	Irr	85	49		Supplies irrigation water for lawn.
C	30		P	D, S	90	37		
C	65		T, 130	Irr				Supplies irrigation water for 25 acres; reportedly 27.6 acre-ft of water was withdrawn in 1954.
U	12		P	D, S				Water level in well is on level with stream 60 ft away.
P	5		J	D, S				
C			P, 20	D	75	27		
U	10		P	S				
C	160	1952	T, 15	D, S			61	See table 2 for log and table 3 for chemical analysis of the water.
C	20		5	D				See table 2 for log.
U	14.13	4/15/53		D, S				
			T	D, S	220	99		
	290		P	D				
			P	D				
C	130		20				62	See table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 31 E.- Continued								
24P1	R. O. Earnheart	Uv 1,400	Dr	250	6	16	50		Basalt
25A1	Groth	Uv 1,425	Dr						
28L1	Swen Westersund	Uv 1,170	Dr		4				
29B1		Uv 1,150	Dg	24.6	30				
29D1	C. A. Case	Uv 1,050	Dr	270	6				
29M1	Terney	Uv 1,025	Dg	97		20			
29P1	Henry Nelstrom	Uv 1,125	Dr	400	6	19			Basalt
29P2	do.	Uv 1,050	Dg	33					
30F1	Glen Simpson	Uv 970	Dr	310	6	29	283	22	Basalt
32B1	Reeder	Uv 1,075	Dr	613	6				
33K1	John Holmgren	Uv 1,125	Dr	219	6	8	100	119	Basalt
34F1	Tom Fraser	Uv 1,245	Dg	24					Loessial soil
34K1	A. Westgate	Uv 1,290	Dr	500					

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
	175		T	D, S				
			P	D, S				
			P	S				
U	11.8	4/16/53	P	N				
C	30		P	D, S	20	48		
U	Dry	4/16/53	J	D, S				Well usually dries up late in each summer.
C	110		P, 16	D				Water reportedly escapes from well at the 110-ft depth level.
U	20		P	S				
	80			D				Reported to yield 24 gpm with 3 ft of drawdown; see table 2 for log.
			P	D				
	119		P	D, S				
U			P	D, S	105	50		
			P	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 32 E.								
1K1		Uv 1,740	Dg	23.9					
2K1		Uv 1,690	Dg	38					
2M1	L. King	Uv 1,660	Dr	527	10				
3C1	E. C. Enoch	Uv 1,600	Dg	22					
3J1	L. King	Uv 1,655	Dr	168	8	46			Basalt
12N1	Janith Dand Est.	Uv 1,720	Dr	72	6				
18Q1	H. H. McIntyre	Uv 1,325	Dg	25					
18R1	Wm. R. Meiner	Uv 1,320	Dr	200	8				Basalt
21L1	Don Hawkins	Uv 1,470	Dg	50					
24D1	Mrs. A. Baker	U 1,670	Dg	30	60	8			
26K1	Robert Campbell	U 1,610	Dr	168	6				
32C1	Henry Wichiman	Uv 1,550	Dr	280					
33A1	Lorenzen	U 1,640	Dr	300					
33R1	do.	Uv 1,590	Dr	545	6				
35J1	Kenneth Bowman	U 1,690	Dr	200					

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level		Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
	Feet below land-surface datum	Date						
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	22.1	4/14/53	P	N				
U	29.6	4/14/53	P	N				
C	20		T, 115	Irr				See plate 34 for water-level record.
U	17			D, S				
C	32	1947	32	D				See table 2 for log.
	40		J	D, S				
U			P	D				
C	20			D				Well reportedly yields 10 gpm with 36 ft of drawdown; see table 2 for log.
U			P	D, S				
U	29.96	9/15/53	P	D, S				
			T	D				Test pumped at 7 gpm for 2 hrs with 150 ft of drawdown.
				D. S				
C	150		P	D, S				
C	112.0	4/13/53	N	N				Pumped only 2½ gpm on test; see plate 35 for water-level record.
			P	D, S	85	20		

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 33 E.								
1F1		U 1,860	Dg	50.1	36	12			Loess
2P1	City of Helix	U 1,760	Dg	52.5					do.
2P2	do.	U 1,760	Dr	600	6				Basalt
5L1	R. H. Leisinger	U 1,795	Dg	65					Loess
6M1		Uv 1,740	Dg	37					Loessial soil
6R1	Ernest Koepke	Uv 1,780	Dg	70					do.
8C1	Sid Crabill	U 1,830	Dr	290	6				Basalt
11R1	Mrs. Roy Penland	U 1,740	Dg	50.5	48	3			Loess
14J1	S. E. Brogoitti	U 1,745	Dg	46	48				do.
15Q1	Lester Wilson	U 1,810	Dg	79.5	48	12			Loessial soil
18R1	John Cooper	U 1,760	Dr	200	6				Basalt
21Q1	Mrs. Adele Kupers	U 1,760							
23F1		U 1,780	Dg	92.5	48				
24R1	George Woodward	U 1,720	Dg	84.3	36	15			
28P1	John Molstrom	U 1,920	Dr	192	6	20			

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	40.2	4/15/53	P	N				
U	30.0	7/30/53	T, 200	PS				Pumps dry in 3 hrs; furnishes city 36,000 gallons per day.
C	125		T	N				Abandoned because of crooked hole.
U	59		J	D	200	44		
U	28.56	4/14/53	P	S				
U	50		P	S				
			P	D, S				
U	30.46	9/15/53	J	D				
U	43.68	9/15/53	P	D, S				
U	66.7	9/ 4/53	J	D, S				
				D				
			P	D, S				
U	80.62	9/ 4/53	P	N				
U	70.28	9/ 4/53	P					
	50	1951	J	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 33 E.- Continued								
29C1	Peterson Bros.	Uv 1,710	Dr	155	6	40			Basalt
29K1	J. C. Hawkins	U 1,740	Dr	211	6	60	199	12	Shale interbedded in basalt.
32N1	Carl Hudeman	U 1,670	Dg	46.6	36				
33B1	Frank Molstrom	U 1,680	Dr	200	8				Basalt
33C1	F. Hudeman	U 1,690	Dg	50.4	60				
33R1	Fred Hendrickson	U 1,710	Dg	75	72				
35Q1		U 1.640	Dg	32.5	48				
36R1	John Hales	U 1,670	Dg	37	60	10			Loess
36R2	do.	U 1,630	Dr	258	6	69	90	8	Basalt
	T. 4 N., R. 34 E.								
1E1	Richard Thompson	Uv 1,850	Dg	33.4	60	12			Loess
6H1	George Piper	Uv 1,760	Dg	21	60		13	8	Gravel underlying loessial soil
6L1	R. B. Taylor	U 1,895	Dr	505	8		470	500	Basalt

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	45		P, 20	D				Reported 40 ft of loess overlies basalt.
C	53		J, 20	D	235	45		See table 3 for chemical analysis and table 2 for log.
U	39.96	4/ 4/53	P	D, S				
C	35			D				Reported to yield 30 gpm with 35 ft of drawdown; see table 2 for log.
U	42.35	9/ 4/53	P	D, S				
U			P	D				
U	23.6	9/ 1/53	P	N				
U	34.62	9/ 1/53	J	D	85	16		
C	43	1948	J, 18	D, S	85	16		See table 2 for log.
U	12.9	9/ 9/53	P	D, S				
U	13.14	9/10/53	C	D	90	40		
C	90	1952	T	D, S	75	12		Quickly pumps dry; reported to yield about 18 gpm; see table 3 for partial chemical analysis of the water and table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 34 E.- Continued								
10D1	Joe Cannon	Uv 1,800	Dg	27	36				
12G1		Uv 1,820	Dg	14.1	36				
12L1	Herbert Whitmore	Uv 1,800	Dr	800	6	185			Basalt
15G1	Jay Scott	Uv 1,760	Dr	205	8				do.
17A1	H. M. Hale	Uv 1,745	Dg	20	8				Gravel
18P1	R. A. Bregoitti	Uv 1,690	Dr	116	8	26	60	12	Basalt
20N1	Harold Gerking	U 1,610	Dg	40	48				
22H1	Dean Dudley	U 1,720	Dr	260	6	117	63 210	11 10	Gravel and sand Basalt
22K1	Sampson	U 1,700	Dg	30					Loess
24J1	Roger's Canning Co.	Uv 1,645	Dr	1,148	24 20 16 12	22 102	1,025 1,144	6 4	Basalt do.
26H1	M. F. Sheard	Uv 1,645	Dr	65	8	32			
26J1	O. L. Straughn	Uv 1,650	Dr	333	8	28	265		Basalt
26J2	Niel McIntyre	Uv 1,650	Dr	200	4	138			do.
27Q1		Uv 1,590	Dg	12.9	48				
28E1	Nettie E. Woodward	U 1,675	Dr	979	8				Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	16.75	9/10/53	P	D, S				
U	7.94	9/ 9/53	P	D, S				
C	120		T, 15	D, S				See table 2 for log.
C	30	1946	J, 7	D, S				Do.
U	12		C	D, S				
C	12	8/ /53	T, 40	D, S, Irr				Supplies irrigation water for 2 acres.
U	22.48	9/ 4/53	J	D, S				
P	200	1945	C	D, S				Bails dry at 20 gpm; see table 2 for log.
U	27		P	D	135	21		Pumps dry in 1 hr; see table 3 for chemical analysis of the water.
C	F		T, 550	Ind				Supplies water for cannery; flows during winter season; Reportedly supplied 65 acre-ft of water during June and July 1954; see table 2 for log
	15	10/24/45	40	D				See table 2 for log.
C	25		25	D				
C	34	10/16/45	C	D				See table 2 for log.
U	9.51	4/24/53	N	N				
C	121	1946	T, 18	D, S				See table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 34 E. - Continued								
30R1	Vina Hales	U 1,660	Dg	57.3	60	6			
32M1	L. L. Rojers	Uv 1,555	Dr	842	10	42.5	600		Basalt
32N1	do.	Uv 1,555	Dr	451	8				do.
33Q1	do.	Uv 1,560	Dr	414	10	20			do.
34F1	Wild Horse Grange	Fp 1,555	Dr	209	6	23	165	3	do.
	T. 4 N., R. 35 E.								
8E1	F. Swaggart	U	Dg	23.5					
8M1	J. H. McDougal	U	Dr	106	8	20	70		Basalt
18H1	C. J. Scheard	U	Dr	100	6	60	90	10	do.
19E1	Rogers Canning Co.	U	Dr	1,070			270		do.
19E2	do.	U	Dr	1,156	12				do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	54.28	8/29/53	J	D				
C	13		T, 120	Irr				Reportedly supplied 60 acre-ft of water to irrigate 46 acres during 1954; owner's well no. 1; see table 2 for log.
C	40	1953	T, 80	Irr				Owner's well no. 3; pump capacity too large for well; well reportedly supplied 6½ acre-ft of water for 20 acres during 1954.
			T	Irr	70	16		Supplies irrigation water for 43 acres; owner's well no. 2; see table 2 for log.
C	18	1947	T					See table 2 for log.
U	18.89	9/ 3/53	P	D, S				
			T	D	80	8		Do.
C	42		J	D, S				
C	5	4/ /41	T	Ind				Reportedly supplied 63.6 acre-ft of water during 1953; see table 2 for log.
C	16	1944	N	N				Not in use (1953); see table 2 for log.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Water-bearing zone or zones: Thickness (ft)	Water-bearing zone or zones: Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 4 N., R. 35 E.- Continued								
19E3	Athena Mill Co.	U	Dr	46	12	44			Gravel
19L1	City of Athena	Uv	Dr	680	12	82			Basalt
19L2	do.	Uv	Dr	1,200	12				do.
21K1	Lee Bannister	Uv	Dg, Dr	100	6				
29P1	Henry Koepke	Uv	Dr	486	8				Basalt
34M1	R. V. Wood	U	Dr	900					
	T. 5 N., R. 26 E.								
26E1	Charles E. Early	T 325	Dr	235	6				Basalt
	T. 5 N., R. 28 E.								
9Q1	Bonneville Power Administration	S 299	Dr	115¼	8	115	98	13	Gravel
10R1	U. S. Engineer Department	S 370	Dr	167	12 10	127 167	95	51	Alluvium
10R2	do.	S 370	Dr	704	16	320	470		Basalt

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	6	7/ /56		Ind				Will be used to supply mill pond; reported to yield 90 gpm with 40 ft of drawdown after ½ hr; see table 2 for [illegible]
C	F		T, 75	PS				Stand-by well known as the "older" well; see table 2 for log.
C	15	1948	T, 500	PS				Supplies city with a population of 750; reportedly supplied 23.8 acre-ft of water during 1953.
			J	D, S				Dug to 8 ft; drilled to 100 ft.
C			T	D				See table 2 for log.
			P	D, S				
C	F		T	N				Owner plans to irrigate 40 acres.
U	54	1953	T, 350	Ind				Reportedly pumped 225 gpm with 13 ft of drawdown.
U	96	1947	224	N				See table 2 for log.
C			T, 2,400	PS				Equipped with submersible type pump; see table 2 for log.

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 28 E.- Continued								
10R3	U. S. Engineer Department	S 360	Dr	777	24	300			Basalt
15N1	Ramsey	S 430	Dr	90	6	16			do.
16A1	Ben Shapler	S 450	Dr	385	8				do.
16R1	Power City	S 430	Dr	222	16		198	24	do.
17G1	City of Umatilla	T 295	Dr	536	10-8	66			do.
17J1	do.	T 295	Dr	133	6				
18H1	Union Pacific Ry.	T 290	Dr	192			170	22	Basalt
19A1	City of Umatilla	S 540	Dr	785	16-10-8	170 310-373 361-535	755	30	do.
22D1	Munson Court	Sc 450	Dr	189	6	8			do.
22D2	C. L. Kik	Sc 450	Dr	170	6				do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness as water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	145	1952	T, 1,300	PS				This well and -11M2 have mutual drawdown of water level see table 2 for log.
	50		J					
	100		T	PS				Reportedly yields 25 gpm with 20 ft of drawdown after 30 hrs pumping.
C	100		T, 18	PS				Inadequate to supply 15 families; a community well.
C	70	1953	T	PS				City auxiliary well; flowed until 1944; water level dropped to 32 ft by 1947 and to 70 ft by 1953; see table 2 for log.
			N	N				Abandoned city well known as well no. 1; now bridged at 12 ft.
				RR				
C	115	11/19/47	T, 1,000	PS			71	Known as well no. 3; see table 2 for log.
C	7.02	9/26/53	P	D	100	22		Pumping draws water level down 13 ft; see plate 36 for water-level record.
C	10	1948	P	D				Driller reports 8 ft of soil and hardpan overlying basalt.

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 28 E.- Continued								
23M1	Bill Kik	Rc 460	Dr	160	6	21	89	6	Basalt
26Q1	C. P. Baggett	T 480	Dr	54	4				
27B1	Charles Tracts Water Co.	T 465	Dr	200					
27F1	do.	T 540							
34H1	Malcomb Trott	U 520	Dr	154	6	90	90	64	Basalt
34H2	F. C. Booth	U 520	Dr	161	10	100	150	11	do.
34H3	do.	U 520	Dr	162	10		120		
35N1	Ruby V. Welch	T 525	Dr	178	6	168	92		Glaciofluviatile deposits
	T. 5 N., R. 29 E.								
13K1	Walso Birchman	S 400	Dr	505					Basalt
14H1		Fp 380	Dr	56.6	6				
19N1	W. A. Olson	S 450	Dr	40	6				

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	68	11/ 1/44	J, 3	D				See table 2 for log.
U	32		J	D, S				Supplies water for turkey farm.
			T	PS				Supplies 20 families but is inadequate at times in summer.
			J	PS				Barely adequate for supply of 3 families.
U	90		J	D				
C-	85		T, 200	PS	110	12		Supplies domestic water for 25 families.
	85		T, 300	PS				Auxiliary to well -34H2; driller reports 110 ft of sand and clay overlying basalt.
			N	N				Driller reports 168 ft of glaciofluviatile sand and gravel overlying broken basalt; yields 125 gpm with 78 ft of drawdown after 4 hrs pumping; owner plans to irrigate 30 ac[illegible]
C	39	1948		D			63	Reportedly test pumped 1,089 gpm with 108 ft of drawdown; see table 2 for log.
	4.83	9/30/53						
			C	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 29 E.- Continued								
22F1	C. J. Jones	S 420	Dn	18	1½				
27C1	Thompson Meat Co.	S 470	Dr	102	6	6	100	2	Basalt
27Q1	H. W. Lambert	S 550	Dr	136	6	11	107	29	Soft rock and "clay"(?)
28B1	W. O. Whitsett	S 460	Dg	98	22	20			
28R1	Golda Myrick	S 465	Dr	100	6				
29E1	Gordon Spearman	S 455	Dn, Dr	43.3	4	40.3	20	13	Sand and gravel
29J1	Don DeMoss	S 455	Bd	20					
32L1	Columbia School	S 460	Dr	285	6				
32N1	M. A. McPheters	S 450	Dn	30	1½	30			Sand
33R1	Union Pacific Ry.	T 615	Dr	298	10	111			Basalt
34C1	Curtin Walls	S 545	Dr	60	6	12	45	5	Porous rock
36H1	R. L. Brock	S 650	Dr	280	6				
	T. 5 N., R. 30 E.								
25F1	Peter Kosmos	Uv 850	Dg	18	36				
25J1	Dale Tucker	Uv 860	Dg	18					Soil
26L1	Peter Kosmos	Uv 850	Dg	23.2	36				

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U			C	D				
C	12		J, 16	Ind				
C	15		J	D, S	85	24		
U	5.85	9/29/53	P	D				
	15		J	D, S				
U	19.35	9/29/53	C	D				Entire depth is in glaciofluviatile deposits.
U			C	D, S				
			J					
U	13		C	D				
C	58		J, 36	D			62	See table 2 for log.
U	45		P, 2	D, S				
			P	D, S				
U	16.7	9/28/53	J	D, S				
P	15		J	D				
U	21.00	9/28/53	C	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 31 E.								
1B1	Peter Kosmos	Uv 1,150	Dr	97	6	30	54	43	Basalt
12H1	do.	U 1,325	Dr	300	6		270	30	do.
29C1		Uv 900	Dg	24.5					Alluvium
33D1		Uv 970	Dg	10.2					do.
33H1	School Dist. #105	Uv 1,000	Dr	200					
34P1	Holdman	Uv 1,050	Dr	220	8				
	T. 5 N., R. 32 E.								
3P1	S. Ornlid	Uv 1,525	Dg	41.5	36				
4J1		Uv 1,450	Dg	16	72				
10A1	Knutson Bros.	Uv 1,600	Dg	31.8	60				
11L1	E. L. Smith, Est.	Uv 1,640	Dr	290	6				
15A1	Newt Newtson	U 1,780	Dr	365	6				
16Q1	Einer Knutson	Uv 1,455	Dg	15.6	96				Loess reworked by water
18B1	Chester Gordon	Uv 1,475	Dr	325	6	8	300	25	Basalt
18C1	C. F. Westersund	Uv 1,475	Dr	302	6				do.
21J1	Walter Egg	Uv 1,540	Dg	22.5	72				Loess

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level		Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (^oF)	Remarks
	Feet below land-surface datum	Date						
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
C	23	1950	J, 10	D				See table 2 for log.
U	280		P					
U	15.62	4/14/53	C	S				
U	9.57	4/15/53	P					
			P	D				
	110		P	D, S				
U	17.40	9/11/53	J	D, S				
U	11.83	9/11/53	P					
U	24.43	9/11/53	P	D, S				
			P	D, S				
			P	D				
U	7.72	9/15/53	P	D, S	100	98		
C	295		P	D, S	70	20		
			P, 3	D, S	55	16	61	See table 2 for log.
U	16.6	9/15/53	P	D, S				

Unpublished records subject to revision

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones: Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 32 E.- Continued								
25D1	L. McRae	Uv 1,570	Dg	23.4	36				Loess
25E1	do.	Uv 1,580	Dr	220	6	14			Basalt
27C1	Vern Terjeson	Uv 1,570	Dg	25.4	60				Loess
30N1	O. G. Bissinger	Uv 1,305	Dg	21.1	60				
31F1	E. N. Brown	Uv 1,400	Dr	98	6	8			Basalt
33N1	Leonard King	Uv 1,510	Dr	520	8				
	T. 5 N., R. 33 E.								
6F1	Roscoe C. Lee	Uv 1,650	Dr	140	6				Basalt
9P1		Uv 1,650	Dg	35.4	52				Loess
15N1		Uv 1,730	Dg	14.0	48				do.
16G1		Uv 1,760	Dg	19.3	72				do.
16N1	Mrs. G. B. Terjeson	U 1,850	Dg	85.6	36				
19P1	Melvin Winn	Uv 1,790	Dr	120	6				Basalt
20N1	E. W. Muller	U 1,850	Dr	380	6				do.
23Q1	Stewart Place	Uv 1,930	Dg	74.9	48				
25Q1	W. M. Stimmel	Uv 1,910	Dr	202	6				Basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	17.75	9/12/53	D	S				
C	50		P	D	105	34		
U	9.19	9/12/53	C	D, S	75	104		
U	9.98	4/15/53		D				
	35		J	D, S	20	31	58	See table 3 for chemical analysis of the water.
								Well abandoned because of insufficient yield.
	120	1951	J	D, S				
U	15.55	9/11/53	P	S				
U	11.25	9/11/53	J	D, S				
U	14.45	9/11/53	C	D, S				
U	81.21	9/14/53	J	D, S				
			P	D, S				
C	155		T	D, S				
U	35.80	9/11/53	P					
C	40.62	9/ 9/53	P	D, S				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 33 E.- Continued								
26C1	Bill Timmerman	U 1,925	Dg	47.1	36				Loess
27N1	Rees Bros.	U 1,800	Dr	300	6	50			Basalt
31A1	Earnest Koepke	Uv 1,845	Dr	394	8	47			do.
32D1	do.	Uv 1,840	Dg	76.0					
35N1	Henry Kupers	U 1,820	Dg, Dr	165	6				Basalt
	T. 5 N., R. 34 E.								
16R1	R. M. Thompson	U 1,960	Dr	228	6				do.
20A1	A. H. McIntyre	U 2,060	Dr	212					do.
22L1	do.	U 1,965	Dr	350	8 6	25 350	 200	 20	do.
27B1	Frank Sanders	Uv 1,970	Dg	28.6	60	10	12	16	Soft rock
28N1	Paul W. Froese	Uv 1,940	Dg	25	48				Loess
29J1	A. W. Logsdon	Uv 1,990	Dr	300	6				Basalt
30Q1	R. B. Taylor	Uv 1,940	Dr	195	6				do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	40.98	9/11/53	P	D, S				
C	100		P	D, S				
C	92	1954		D				Driller reportedly bailed 35 gpm for 30 min. with 40 ft of drawdown; see table 2 for log.
	68.62	4/14/53	P	D, S				See plate 37 for water-level record.
C	90		P	D, S				Dug to 80 ft; drilled to 165 ft.
C	148.5	9/ 9/53	P	D, S				See plate 38 for water-level record.
			P					See table 2 for log.
C	115		P	D, S				
U	15.22	9/ 9/53	P	D, S				
U	18.95	9/10/53	J	D, S				
			J	D, S				
C	45		P	D				

Table 1.- Representative Wells in the

Well no.	Owner or occupant of property	Topography and approximate altitude (ft above sea level)	Type of well construction	Depth (feet)	Diameter (inches)	Depth of casing (ft)	Water-bearing zone or zones		
							Depth to top (ft)	Thickness (ft)	Character of material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	T. 5 N., R. 34 E.- Continued								
35G1		Uv 1,890	Dg	27.2	36				Loess
	T. 6 N., R. 31 E.								
25H1	A. Peterson	Uv 1,310	Dg	19	36				do.
	T. 6 N., R. 32 E.								
21Q1	Rogers	U 1,800	Dr	827	6	80	800	27	Basalt
28Q1	Fred Peterson, Est.	U 1,660	Dr	534	8	80			do.
30E1	Arnold Peterson	Uv 1,350	Dr	250	6				do.
	T. 6 N., R. 33 E.								
31J1	A. Campbell	Uv 1,350	Dr	130	8		100	30	do.

Umatilla River Basin Area - Continued

Ground-water occurrence	Water level: Feet below land-surface datum	Water level: Date	Type of pump and yield (gallons per minute)	Use of water	Hardness of water as $CaCO_3$ (parts per million)	Chloride (Cl) (parts per million)	Temperature (°F)	Remarks
(11)	(12)	(13)	(14)	(15)	(16)	17	18	(19)
U	9.32	9/ 9/53	P	D, S				
U	17.37		C	D, S				
C	540		P, 1.5	D, S	80	10		Entire depth reportedly in gray, broken basalt.
	434		P	D, S				
	200		P	S				
C	60		P, 3	D, S				Driller reports 15 ft of alluvium over the basalt.

Table 2.- Drillers' Logs of Representative Wells

[Tentative stratigraphic designations by G. M. Hogenson]

3S/29-7A1. Mrs. Ralph Jones. Drilled by Bert Gladney, 1951

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil and small gravel	12	12
Soil, brown, claylike, mixed with rock	20	32
Columbia River basalt:		
Soil, brown, claylike (or soft rock?)	15	47
Rock, creviced	7	54
Rock, brown, sugary textured	24	78
Rock, brown, sugary, creviced	34	112
Rock, brown, sugary, with ash layers	12	124
Rock, brown, sugary	4	128
Rock, soft, brown, sugary, with volcanic ash	20	148
Rock, hard, gray	2	150

1S/28-35B1. Tony Vey. Drilled by Harold Yager, 1948

Palouse formation:		
Soil	7	7
Columbia River basalt:		
Gravel (broken basalt?)	55	62
Basalt, black	90	152
Basalt, gray	88	240
Basalt, gray, water-bearing	20	260
Basalt, gray	6	266
Basalt, brown	57	323

1S/32-8J1. Glen Newquist. Drilled by Turner and Son, 1956

Palouse formation and fanglomerate of Pliocene age, undifferentiated:		
Sand and gravel	18	18
Columbia River basalt:		
Basalt, black	37	55
Basalt, red	7	62
Basalt, gray	13	75
"Soapstone" (weathered basalt)	2	77
Basalt, gray	13	90
Basalt, broken, water-bearing	13	103
Basalt	12	115

Unpublished records subject to revision

Table 2.—Drillers' Logs of Representative Wells — Continued

1S/32-9G1. V. Jacobsen. Drilled by D. K. Smith

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	3	3
Fanglomerate of Pliocene:		
Gravel, cemented	55	58
"Rock," brown, broken	13	71
Sand	1	72
Gravel, cemented	20	92
Columbia River basalts		
Rock, brown, broken, cemented	40	132
Basalt, brown	18	150

1S/32-9K1. Wayne Chapman. Drilled by Bert Gladney, 1953

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Rock and gravel	44	44
Columbia River basalt:		
Basalt, brown	71	115
Basalt, black	45	160
Basalt, brown and black	150	310
Basalt, brown	13	323
Basalt, gray	52	375
Basalt, gray, very hard	53	428
Basalt, honeycomb	12	440
Basalt, honeycomb, water-bearing	40	480
Basalt, honeycomb, and soapstone	11	491

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/32-9M1. Oregon Fibre Products Co. Drilled by A. M. Janssen, 1952

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Gravel, rubble	12	12
Fanglomerate of Pliocene age:		
Gravel, cemented	5	17
Gravel, rocks, rubble	33	50
Gravel, coarse, cemented	36	86
Columbia River basalt:		
Basalt, hard	14	100
Basalt, layered and creviced	15	115
Basalt, gray	20	135
Basalt, soft, decomposed	6	141
Basalt, hard, layered	31	172
Basalt, honeycomb, hard, in layers, some crevices	14	186
Basalt, hard, layered	29	215
Basalt, gray, crevice at 216 feet	16	231
Basalt, black, loose in places	11	242
Basalt, hard, layered	21	263
Basalt, hard, black, creviced	19	282
Basalt, sofr, loose	14	296
Basalt, hard, brown	25	321
Basalt, black, hard and soft layers	34	355
Basalt, brown, soft	27	382
Basalt, black	3	385
Basalt, yellowish, creviced, layered	27	412
Basalt, yellowish brown	12	424
Basalt, yellowish brown with hard layers	7	431
Basalt, bad crevice	3	434
Basalt, yellowish	11	445
Basalt	11	456
Basalt, hard, brown	17	473
Basalt, brown, soft; crevice at 482 feet	16	489
Basalt, brown, hard and soft layers	12	501
Basalt, brown, very hard	41	542
Basalt, honeycomb, water-bearing	15	557
Basalt, gray, hard layers	24	581
Basalt, gray, softer	19	600
Basalt, gray, broken	6	606
Basalt, gray, hard and soft layers	14	620
Basalt, gray, broken	7	627
Basalt, gray, "cube rock"	8	635
Basalt, gray, hard layers	12	647

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/32-9M1. - Continued

Materials	Thickness (feet)	Depth (feet)
Columbia River basalt: (continued)		
Basalt, gray and black	48	695
Basalt, broken, with crevices	13	708
Basalt, gray, broken, with crevices	6	714
Basalt, gray	5	719
Shale(?), gray, caving (sample is basalt cuttings)	11	730
Shale(?), hard (sample is basalt cuttings)	5	735

1S/32-9N1. Pilot Rock Lumber Co. Drilled by A. M. Jannsen, 1952

Quaternary alluvium:		
Gravel, rubble, water-bearing below 25 feet	26	27
Columbia River basalt:		
Basalt, red	14	41
Basalt, black, some water at 50 feet with water level at 30 feet	21	62
Basalt, layered	38	100
Basalt, hard, solid	15	115
Basalt, creviced, water level standing at 17 feet	2	117
Basalt, red	3	120
Basalt, gray, hard	2	122
Basalt, creviced	1	123
Basalt, broken, caving	3	126
Basalt, gray, hard	21	147
Basalt, gray, softer	39	186
Basalt, hard, water-bearing at 209 feet and at 211 ft	29	215
Basalt, layered, hard and soft	30	245
Basalt, black, hard	53	298
Basalt, softer	3	301
Basalt, black, hard	17	318
Basalt, gray	13	331
Basalt, yellow, water-bearing 331 ft to 336 ft	9	340
Basalt, brown, hard; water flowed over top of casing at 356 ft	23	363
Basalt, creviced	2	365

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/32-16L1. Wm. Etter. Drilled by D. K. Smith

Materials	Thickness (feet)	Depth (feet)
Dug well, no record	31	31
Fanglomerate of Pliocene age:		
Gravel, cemented	14	45
Columbia River basalt:		
Basalt, brown, broken	33	78
Basalt, gray, hard	11	89
Basalt, brown, broken	17	106
Basalt, brown and red	19	125
Basalt, black	116	241
Basalt, black, broken	24	265

1S/32-17G1. City of Pilot Rock. Drilled by A. M. Edwards, 1945

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	10	10
Gravel	4	14
Hardpan, very hard	5	19
Hardpan	8	27
Columbia River basalt:		
Basalt, blue, hard	23	50
Basalt, porous, water-bearing; water level at 10 ft	15	65
Basalt, very hard	70	135
Basalt, porous, water-bearing; water level at 4 ft	23	158
Basalt, hard	19	177
Basalt, porous, water-bearing; drill cuttings washed away	5	182
Basalt, hard	15	197
Basalt, soft and hard	18	215
Basalt, with seams and crevices	2	217
Basalt, moderately hard	15	232
Basalt with seams and crevices	3	235
Basalt, porous, soft, water-bearing; water flows over top of casing	15	250
Basalt, moderately hard	38	288
Basalt, crevices and broken rock	2	290
Basalt, fairly hard	3	293
Basalt, porous, water-bearing; water overflowing casing at an estimated 700 gpm	16	309

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/32-17K1. City of Pilot Rock. Drilled by D. K. Smith, 1956

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil, brown	4	4
Rock, broken, and brown clay	5	9
Gravel, cemented	6	15
Rock, broken, caved during drilling	2	17
Gravel, cemented	8	25
Columbia River basalt:		
Basalt, gray and black, broken	25	50
Basalt, hard, gray, black, and brown	62	112
Basalt, red	20	132
Basalt, brown, broken	10	142
Basalt, black	90	232
Basalt, brown, broken, water-bearing	3	235
Basalt, gray	37	272
Basalt, brown, broken, water-bearing	27	299
Basalt, gray	48	347
Basalt, brown and black	83	430
Basalt, brown, broken, water-bearing	56	486

1S/32-20A1. Robert Roy. Drilled by D. K. Smith, 1951

Palouse formation:		
Soil	5	5
Fanglomerate of Pliocene age:		
Rocks and boulders	3	8
Gravel, cemented	42	50
Gravel, cemented, water-bearing	1	51
Gravel, cemented	37	88
Columbia River basalt:		
Basalt, gray, hard	39	127
Basalt, black	118	245
Basalt, gray	15	260
Basalt, brown and gray, creviced	18	278
Basalt, black, with water-bearing seams	22	300

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/32-23J1. Hilmer Horn. Drilled by A. A. Durand and Son, 1950

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	4	4
Clay, hardpan	10	14
Columbia River basalt:		
Basalt, blue, broken	8	22
Basalt, blue, very hard	80	102
Basalt, blue, very hard	2	104
Basalt, blue, hard, water-bearing	28	132
Basalt, blue, broken, water-bearing; static water level about 90 ft	4	136
Basalt, blue, hard	72	208
Basalt, blue, broken	15	223
Basalt, blue, hard	5	228
Basalt, blue	4	232
Basalt, broken	11	243
Basalt, blue, medium hard	1	244
Basalt, blue, hard	6	250
Basalt, gray, hard	29	279
Basalt, gray	8	287
Basalt, gray, very hard	3	290
Basalt, gray	26	316
Basalt, gray and broken, and brown	24	340
Basalt, broken	48	388
Basalt	10	398
Basalt, firm and broken	17	415
Basalt, broken	15	430
Basalt	15	445
Basalt, black	45	490
Basalt, gray, very hard	2	492
Basalt, dark gray, hard	126	618
Basalt, light gray	4	622
Basalt, gray, hard	5	627
Basalt, light gray, hard	48	675
Basalt, dark gray	7	682
Basalt, black, water-bearing at 705 ft; static water level at 68 ft	33	715
Basalt, gray, hard	26	741
Basalt, brown, hard	7	748
Basalt, gray, hard	46	794

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/32-28E1. Levi Eldridge. Drilled by A. A. Durand and Son, 1949

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	2	2
Fanglomerate of Pliocene age:		
Gravel	1	3
Gravel and boulders	21	24
Columbia River basalt:		
Basalt, blue, broken	6	30
Basalt, blue, hard	23	53
Basalt, blue, broken	19	72
Basalt, blue, hard	13	85
Basalt, blue, broken	7	92
Basalt, blue, hard	3	95
Basalt, blue, broken	25	120
Basalt, brown	5	125
Conglomerate(?)	20	145
Basalt, blue, hard	15	160

1S/35-3K2. Earl Gillanders. Drilled by A. A. Durand and Son, 1945

Materials	Thickness (feet)	Depth (feet)
Palouse formation and recent deposits, undifferentiated:		
Soil	3	3
Clay and shale(?)	13	16
Clay and cobbles	4	20
Clay, blue, and pea gravel	12	32
Columbia River basalt:		
Basalt, brown and blue, decomposed	48	80
Basalt, brown and gray	194	274
Basalt, red	32	306
Basalt, gray	25	331
Basalt, red and brown	29	360
Basalt, gray	23	383

1S/35-3Q1. State Highway Department. Drilled by A. A. Durand and Son, 1935

Materials	Thickness (feet)	Depth (feet)
Palouse formation and recent deposits, undifferentiated:		
Soil	12	12
Columbia River basalt:		
Basalt, very hard	188	200
Basalt, honeycomb	25	225
Basalt, very hard	155	380
Basalt, porous	4	384
Basalt, solid	4	388

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/35-10C1. Union Pacific Railway. Drilled by A. A. Durand and Son, 1944

Materials	Thickness (feet)	Depth (feet)
Residual soil and Palouse formation, undifferentiated:		
Top soil	3	3
Soil and boulders	10	13
Columbia River basalt:		
Basalt, black	5	18
Basalt, black, with clay seams; water-bearing at 28 ft	10	28
Basalt, black	16	44
Clay, blue	2	46
Lava sand (scoria), water-bearing; water level even with top of casing when well at 60 ft	14	60
Basalt, disintegrated, and clay, water-bearing; flows at rate of 22 gpm	3	63
Lava sand (scoria?); water flow increased to 35 gpm, later decreased to 25 gpm	12	75
Basalt, black, solid	5	80
Basalt, black, with seams (fractured?)	5	85
Basalt, black, solid	10	95
Basalt, black, with seams (fractured?)	3	98
Basalt, black and gray, solid	18	116
Basalt, gray, with "cinders," and blue clay	6	122
Basalt, black, with "cinders," and blue clay	5	127
Basalt, black, some "cinders"	19	146
Basalt, black, very hard	31	177
Basalt, black, with blue clay	12	189
Basalt, black, with small layer of blue clay at 219 ft	88	277
Basalt, shattered, with blue clay	2	279

Table 2.- Drillers' Logs of Representative Wells - Continued

1S/35-36N1. Union Pacific Railroad. Drilled by A. A. Durand and Son, 1946

Materials	Thickness (feet)	Depth (feet)
Palouse formation and residual soil:		
Clay, brown, and hardpan	49	49
Columbia River basalt:		
Basalt, black, hard	32	81
Basalt, black, soft	10	91
Basalt, black, with streaks of black "shale"	10	101
Basalt, black	12	113
Basalt, brown, porous	32	145
Basalt, black and red	60	205
Basalt and clay	60	265
Basalt, red, hard	150	415
Basalt, black and brown, hard	39	454
Basalt, brown, hard and broken	13	467
Basalt, red and brown, with clay seams	41	508
Basalt, brown, porous	23	531
Basalt, gray, porous	5	536
Basalt, red, with some clay	15	551
Basalt, porous, decomposed	65	616
Basalt, black and gray, hard	42	658
Basalt, gray and blue, with some clay	18	676
Basalt, blue, hard	17	693
Basalt, red	69	762
Basalt, gray, hard	8	770
Basalt, broken, with red clay	37	807
Basalt, gray	32	839
Basalt, gray and red, porous	54	893
Basalt, red	11	904
Basalt, brown	9	913
Basalt, gray	83	996

1N/26-12C1. C. D. Abercrombie. Drilled by A. M. Edwards, 1950

No records; old drilled well	100	100
Columbia River basalt:		
Basalt	28	128
Basalt, honeycomb	12	140
Basalt	3	143

Table 2.- Drillers' Logs of Representative Wells - Continued

1N/26-24D1. Howard Kelly. Drilled by Moore and Anderson, 1952

Materials	Thickness (feet)	Depth (feet)
Palouse formation and residual soil, undifferentiated:		
Soil	1	1
Columbia River basalt:		
Basalt, brown	55	56
Basalt, gray, soft	23	79
Basalt, gray, hard	29	108
Basalt, gray, boulders(?)	42	150
Basalt, gray, hard	21	171
Basalt, blue-black, with blue clay	39	210
Basalt, black, hard	19	229
Basalt, black, with soapstone	6	235
Basalt, black, soft	39	274
Basalt, black, hard	60	334
Basalt, brown, water-bearing	13	347
Basalt, black, hard	4	351

1N/27-3R1. Earl W. Wattenberger. Drilled by Ben Dreyer, 1952

Quaternary alluvium:		
Soil	16	16
Sand and gravel, water-bearing	13	29
Columbia River basalt:		
Basalt, black, moderately hard	9	38
Basalt, red, soft	18	56
Basalt, black, hard	48	104
Basalt, red, soft, water-bearing	4	108
Basalt, black, hard	12	120

1N/28-21Q1. Tony Vey. Drilled by H. Yager, 1953

Quaternary alluvium:		
Gravel, cemented	24	24
Columbia River basalt:		
Basalt, gray	6	30
Basalt, red	15	45
Basalt, gray	38	83
Basalt, black	91	174
Basalt, gray	51	225
Basalt, black, broken, water-bearing	45	270

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative Wells - Continued

1N/28-28C1. Tony Vey. Drilled by H. Yager, 1953

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Gravel, cemented	8	8
Silt and clay	12	20
Columbia River basalt:		
Basalt, gray	9	29
Basalt, black	70	99
Basalt, porous, soft, water-bearing; water flowing over casing at 50 gpm	1	100
Basalt, gray, hard	78	178
Basalt, black, hard, water-bearing; flow increased	21	199
Basalt, black, hard	13	212
Basalt, gray, hard	41	253
Basalt, black, medium hard	7	260
Basalt, gray, hard	79	339
Basalt, gray, soft	95	434
Basalt, gray, hard	2	436
Basalt, brown, medium hard	13	449
Basalt, gray, hard	25	474
Basalt, brown, medium hard	5	479
Basalt, gray, hard	21	500

1N/28-28D1. Tony Vey. Drilled by H. Yager, 1953

Quaternary alluvium:		
Gravel, cemented	10	10
Columbia River basalt:		
Basalt, gray, broken	32	42
Basalt, gray, hard	35	77
Basalt, black, hard	44	121
Basalt, gray, hard	54	175
Basalt, gray, medium hard	107	282
Basalt, black, broken	30	312
Basalt, gray, soft, with "soapstone"	33	345
Basalt, red, soft	20	365

Table 2.- Drillers' Logs of Representative Wells - Continued

1N/30-24E1. T. A. Cross. Drilled by Bert Gladney, 1953

Materials	Thickness (feet)	Depth (feet)
Columbia River basalt, fault zone:		
Soil and "gravel," gray	80	80
"Gravel" and clay, gray	10	90
Boulders and clay, red	30	120
Gravel and clay, gray	12	132
Basalt, gray	6	138
Clay, gray, and green gravel (basalt fragments coated with green encrustation)	62	200
Columbia River basalt:		
Basalt	5	205
Basalt, red	7	212
Basalt, black, a green layer at 235 ft, water-bearing at 327 ft	172	384
Basalt, gray, hard	203	587

Well was drilled with 12-inch diameter to 299 ft and with 8-inch diameter to bottom. Later the hole was reamed 12-inch diameter to 350 ft depth with the cuttings filling the hole up to 440 ft depth from the surface. Drilling subsequently abandoned.

1N/32-1M2. Peter Tim. Drilled by Turner, 1955.

Palouse formation:		
Soil	2	2
Fanglomerate of Pliocene age:		
Gravel	4	6
Clay, red	119	125
Gravel, water-bearing, 8 gpm	10	135
Gravel and blue clay	50	185
Columbia River basalt:		
Basalt, black, broken	110	295
Basalt, red	10	305
Basalt, gray	75	380
Clay, blue, and gravel	10	390
Basalt, black	20	410
Basalt, gray	25	435
Basalt, red	35	470
Basalt, black	31	501
Basalt, black, water-bearing	3	504

Table 2.- Drillers' Logs of Representative Wells - Continued

1N/32-15D1. Wm. Eldridge. Drilled by Roy French, 1956

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	4	4
Gravel	4	8
Clay, red, sandy	16	24
Columbia River basalt:		
Rock, red, water-bearing	46	70
Basalt, gray	20	90
Rock, red, water-bearing	12	102
Basalt, black and gray	71	173
Rock, red, water-bearing	12	185
Basalt, black and gray	51	236
Basalt, red and black, with clay seams, water-bearing	47	283
Basalt, gray	1	284

1N/32-22B1. J. L. Eldridge. Drilled by Bert Gladney

Quaternary alluvium:		
Soil	10	10
Sand	5	15
Columbia River basalt:		
Basalt, gray	32	47
Basalt, brown	99	146
Basalt, gray	11	157
Basalt, red and brown	38	195
Basalt, gray	159	354
Basalt, black	52	406

1N/32-27P1. Adolph Weinkes. Drilled by H. Yager, 1948

Quaternary alluvium:		
Clay and gravel	50	50
Columbia River basalt:		
Basalt, black	30	80
Basalt, gray	37	117
Basalt, red, water-bearing	17	134

Table 2.- Drillers' Logs of Representative Wells - Continued

1N/32-28D1. Edwin Hoeft. Drilled by D. K. Smith, 1956

Materials	Thickness (feet)	Depth (feet)
Palouse formation and Quaternary alluvium, undifferentiated:		
Silt and sand	12	12
Sand and gravel	2	14
Columbia River basalt:		
Basalt, broken, gray and brown	40	54
Basalt, brown and black	46	100
Basalt, brown, broken, water-bearing	10	110
Basalt, brown and gray	63	173
Basalt, reddish brown	9	182
Basalt, black and gray	158	340
Rock, broken, and mud	10	350
Basalt, brown and black	44	394
Basalt, brown, and clay	11	405
Basalt, brown and black	108	513
Basalt, brown, water-bearing	12	525
Basalt, black; well tested at 200 gpm with 200 ft of drawdown	15	540
Basalt, black and gray	32	572
Basalt, red and brown, broken, water-bearing	3	573
Basalt, hard, brown	8	583

1N/32-34P1. Everett Hawkes. Drilled by H. Yager, 1948

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	8	8
Columbia River basalt:		
Basalt, brown, broken	52	60
Basalt, red, broken	15	75
Basalt, black, broken	50	125
Basalt, gray, broken, water-bearing	75	200

Walls of well sloughing in during entire drilling operation.

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/27-1F1. Ammon Bros. Drilled by Ben Dreyer, 1952

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	12	12
Gravel	2	14
Clay, yellow	36	50
Rock, shaly	20	70
Clay, yellow	15	85
Clay, red	35	120
Clay, green	10	130
Clay, blue	40	170
Columbia River basalt:		
Basalt, black, moderately hard	33	203
Basalt, black, soft	18	221
Basalt, black, hard	34	255
Basalt, red, soft	37	292
Basalt, blue, hard	130	422
Basalt, black, moderately hard	27	449
Basalt, black, hard	30	479
Basalt, black, soft	21	500
Basalt, black, moderately hard	54	554

2N/27-1M1. Catherine Stanfield. Drilled by A. A. Durand, 1935

Materials	Thickness (feet)	Depth (feet)
Quaternary and older alluvium, undifferentiated:		
Soil	10	10
Gravel, cemented	12	22
Gravel, water-bearing	3	25
Gravel and boulders	7	32
Clay and loose gravel	17	49
Gravel, cemented	22	71
Clay, red	44	115
Clay, blue	41	156
Shale, blue	34	190
Columbia River basalt:		
Basalt	299	489
"Water sand" (scoriaceous basalt?)	15	504

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/27-6F1. Corrigal Ranch. Drilled by A. M. Edwards, 1938

Materials	Thickness (feet)	Depth (feet)
Lake sediments of Pleistocene age:		
Top soil and sandy soil	40	40
Fanglomerate of Pliocene age:		
Gravel, cemented	60	100
Clay, yellow	20	120
Gravel, cemented	80	200
Clay, red	10	210
Clay, blue	7	217
Gravel, cemented	67	284
Columbia River basalt:		
"Rock," brown, broken and seamy	4	288
"Rock," brown, solid	62	350
Basalt, blue and gray	63	413
Basalt, black, water-bearing	14	427
Basalt, gray, hard	20	447

2N/27-11H1. John S. Williams. Drilled by Ben Dryer, 1952

Quaternary alluvium:		
Soil	12	12
Gravel	10	22
Shale, blue	41	63
Columbia River basalt:		
Basalt, blue, medium hard	12	75
Clay, blue, sandy	57	132
Basalt, blue, medium hard	12	144
Clay, blue	6	150
Basalt, blue, hard	12	162
Shale(?)	24	186
Basalt, black, medium hard	29	215
Basalt, red, medium hard	27	242
Basalt, black, hard	68	310
Basalt, black, medium hard	20	330
Basalt, black, hard, water-bearing	41	371
Basalt, black, soft	27	398
Basalt, black, hard	26	424
Basalt, black, soft	101	525

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/27-14N1. McCarty. Drilled by Ben Dreyer, 1952

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	12	12
Soil and gravel	33	45
"Shale rock"	43	88
Columbia River basalt:		
Basalt, blue and black, hard	104	192
Basalt, black, soft, water-bearing	28	220
Basalt, blue, hard	20	240
Basalt, black, soft	40	280

2N/27-20J1. Ed Tucker. Drilled by Moore and Anderson, 1948

Materials	Thickness (feet)	Depth (feet)
Lake sediments of Pleistocene age:		
Soil	10	10
Fanglomerate of Pliocene age:		
Gravel	12	22
Scab rock (hardpan?)	13	35
Columbia River basalt:		
Basalt, black	20	55
Basalt, brown, with clay seams	35	90
Basalt, black	14	104
Basalt, brown, with clay seams	23	127
Basalt, brown	7	134
Clay	6	140
Basalt, black	93	233
Basalt, brown	4	237
Basalt, black	17	254
Basalt, red, water-bearing	4	258
Basalt, gray	45	303
Basalt, brown, water-bearing	52	355
Clay	2	357
Basalt, gray	13	370

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/27-22A1. D. W. Terry. Drilled by A. M. Edwards

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Sand with some cobbles	200	200
Clay, yellow	30	230
Columbia River basalt:		
Basalt, porous	8	238
Basalt, blue, medium hard	62	300
Clay, blue, loose (runs easily), contains some water	26	326
Basalt, hard	44	370

2N/27-27E3. John F. Kilkenny. Drilled by Ben Dryer, 1957

Quaternary alluvium:		
Soil	14	14
Gravel	7	21
Clay	9	30
Columbia River basalt:		
Rock, blue, hard	94	124
"Boulders" (broken basalt?)	4	128
"Shale," blue (weathered basalt?); well tested at 500 gpm	12	140
Rock, black, hard	74	214
"Boulders"	5	219
Rock, black, soft	16	235
Rock, gray, hard	11	246
Rock, black, soft	14	260
Rock, gray, hard	109	369
"Shale," black (weathered basalt?)	7	376
Rock, black, soft	14	390
Rock, gray and black, hard	101	491
Rock, black, soft	18	509
Rock, gray, hard	15	524
Rock, red, soft; well tested at 780 gpm	6	530
Rock, black, hard	41	571
"Boulders"	27	598

Table 2.- Drillers' Logs of Representative Wells. - Continued

2N/27-27H1. Ed Tucker. Drilled by Moore and Anderson

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	6	6
Gravel, cemented	5	11
Gravel	20	31
Columbia River basalt:		
Basalt, gray	56	87
Basalt, blue-black, water-bearing	17	104
Basalt, black, broken	46	150
Basalt, black	50	200
Basalt, gray	13	213
Basalt, gray, hard	29	242
Basalt, black, broken, water-bearing	12	254
Basalt, blue-black	9	263

2N/28-16K1. Tony Vey. Drilled by H. Yager, 1948

Palouse formation and residual soil, undifferentiated:		
Soil	6	6
Columbia River basalt:		
Basalt, brown, decomposed, and clay	46	52
Basalt, broken, brown	78	130
Basalt, broken, brown, water-bearing	55	185

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/30-6H1. Cunningham Sheep Company. Drilled by A. A. Durand and Son, 1946

Materials	Thickness (feet)	Depth (feet)
Dug pit, no record	8	8
Quaternary alluvium:		
Gravel, coarse, and boulders	7	15
Bravel, boulders, and some clay	9	24
Gravel, coarse	3	27
Columbia River basalt:		
Basalt	6	33
Basalt, hard, water-bearing	40	73
Basalt, hard, gray	11	84
Basalt, black	8	92
Basalt, hard, blue	4	96
Basalt, gray	46	142
Basalt, gray, hard, water-bearing	11	153
Basalt	3	156
Basalt, hard	12	168
Basalt, black	15	183
Basalt, firm	8	191
Basalt, hard	18	209
Basalt	5	214
Basalt, hard	11	225
Basalt, porous, brown, flowing water	8	233

2N/31-2B2. Leo Gorger. Drilled by D. K. Smith

Palouse formation:		
Top soil	2	2
Older alluvium:		
Gravel, cemented	18	20
Columbia River basalt:		
Basalt, broken	4	24
Basalt, gray	43	67
Basalt, brown, broken	18	85
Basalt, brown	4	89
Basalt, gray	69	158
Basalt, black	33	191
Basalt, gray	11	202
Basalt, black, water level standing at 142 ft	71	273
Basalt, gray	16	289
Basalt, brown, water-bearing	14	303
Basalt, gray	1	304
Basalt, black, water level standing at 260 ft	6	310

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/31-15L1. Union Pacific Ry. Barnhart #1. Drilled by A. A. Durand and Son, 1940

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil and gravel	10	10
Columbia River basalt:		
Basalt, broken	18	28
Basalt, gray, hard	5	33
Basalt, gray	45	78
"Rock," porous, and shale	21	99
Basalt, gray, hard	56	155
"Rock," porous, and "soapstone"	6	161

2N/32-2D1. H. M. Peringer. Drilled by Bert Gladney

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	35	35
Columbia River basalt:		
Sand and gravel (broken basalt?)	10	45
Basalt, gray	95	140
Gravel	15	155
Basalt, gray	19	174
Basalt, gray-black	74	248
Basalt, brown, hard	24	272
Basalt, black	20	392
Basalt	208	600

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-2R1. City of Pendleton, well no. 1. Drilled by A. A. Durand and Son, 1948

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Gravel	14	14
Columbia River basalt:		
Basalt, black, soft	11	25
Basalt, black, hard	48	73
Basalt, soft, and "soapstone"	12	85
Basalt, black, hard	24	109
Basalt, soft and medium hard	32	141
Basalt, hard	18	159
Basalt, black, soft	21	180
Basalt, black, soft, water-bearing	11	191
Basalt, hard	5	196
Basalt, black, soft	14	210
Basalt, red, soft	7	217
Basalt, black, medium hard	48	265
Basalt, gray, hard	62	327
Basalt, black, medium hard	6	333
Basalt, gray	12	345
Basalt, red, soft, broken	30	375
Basalt, gray, hard	51	426
Basalt, black, soft, water-bearing	24	450
Basalt, black, hard	3	453
Basalt, black, soft	11	464
Basalt, gray, hard	8	472
Basalt, black, medium hard	54	526
Basalt, black, hard	154	680
Basalt, black, medium hard, water-bearing	43	723
Basalt, gray, hard	4	727
Basalt, black	24	751
Basalt, gray, hard	22	773
Basalt, brown, red, and gray, soft, water-bearing	11	784
Basalt, gray, hard	17	801
Basalt, brown	5	806
Basalt, black	15	821
Basalt, gray, hard	20	841
Basalt, black	39	880
Basalt, gray	4	884
Basalt, black	12	896
Basalt, black, porous, water-bearing	16	912
Basalt, black	23	935

Well redrilled in adjacent hole to depth 774 ft.

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-7N1. Union Pacific Ry. Rieth no. 2. Drilled by A. A. Durand and Son, 1942

Materials	Thickness (feet)	Depth (feet)
Artificial fill (cinders)	7	7
Quaternary alluvium:		
Gravel	7	14
Columbia River basalt:		
Basalt	4	18
Basalt, black	11	29
Basalt, gray, hard	14	43
Basalt, broken, water-bearing (little water)	3	46
Basalt, gray, hard	14	60
Basalt, black, with clay-filled fractures	15	75
Basalt, gray, hard	10	85
Basalt, red, crumbling into hole	16	101
Basalt, brown, hard	2	103
Basalt, black and gray, broken	24	127
Basalt, broken, water-bearing	11	138
Basalt, hard	43	181
Basalt, alternatingly hard and broken	7	188
Basalt, broken	15	203
Basalt, gray, very hard	7	210
Basalt, gray, hard, fractured, water-bearing	7	217
Basalt, brown, fractured	11	228
Basalt, brown, hard	7	235
Basalt, fractured	26	261
Basalt, gray, fractured	19	280
Basalt, fractured, water-bearing	7	287

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-9B1. Oregon State Hospital. Drilled by R. J. Strasser, 1953-54

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Top soil	4	4
Boulders and clay	5	9
Sand and clay	9	18
Gravel and clay	6	24
Columbia River basalt:		
Basalt, brown and gray; water standing at 32 ft	32	56
Basalt, gray	13	69
Basalt, red and gray	8	77
Basalt, gray	2	79
Basalt, gray, broken; water standing at 27 ft	2	81
Basalt, gray	7	88
Basalt, broken, with green clay	3	91
Basalt, gray	43	134
Basalt, gray and red	35	169
Basalt, gray	59	228
Basalt, gray and red	6	234
Clay, brown, sticky	4	238
Basalt, gray	9	247
Basalt, gray, broken	10	257
Basalt, brown, honeycomb	17	274
Basalt, gray	36	310
Basalt, gray, creviced	3	313
Basalt, gray	24	337
Basalt, gray and brown, porous	13	350
Basalt, gray and brown, porous, water-bearing; water standing at 116 ft	11	361
Basalt, gray	18	379
Basalt, gray and red, porous	28	407
Basalt, gray	6	413
Basalt, gray, creviced	2	415
Basalt, gray	14	429
Basalt, gray, water standing at 135 ft	5	434
Basalt, gray	29	463
Basalt, gray, broken	8	471
Basalt, gray	45	516
Basalt, gray, creviced	3	519
Basalt, gray	34	553
Basalt, gray, creviced	1	554
Basalt, gray	126	680
Basalt, brown, porous, water-bearing	11	691
Basalt, gray, water standing at 135 ft.	160	851

Table 2.--Drillers' Logs of Representative wells - Continued

2N/32-10F1. City of Pendleton, well no. 2. Drilled by A. A. Durand and Son, 1948

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Gravel and rock	17	17
Columbia River basalt:		
Basalt, black	53	70
Basalt, black, broken	7	77
Basalt, black, hard	182	259
Basalt, black, broken	57	316
Basalt, black	47	363
Basalt, black, broken	7	370
Basalt, black, creviced at 428, 615, 650, and 668 ft	344	714
Basalt, red	14	728
Basalt, black	33	761

2N/32-10M1. Smith Canning Company. Drilled by A. A. Durand and Son, 1942.

Quaternary alluvium:		
Gravel, loose	23	23
Columbia River basalt:		
Basalt, broken	2	25
Basalt	7	32
Gravel, sand, clay (fractured basalt?)	28	60
Basalt, brown, broken	38	98
Basalt, red	17	115
Basalt, brown, decomposed	10	125
Basalt, gray, porous	5	130
Basalt, gray	4	134
Basalt, red	6	140
Conglomerate, gray	9	149
Basalt, gray, soft	9	158
Basalt, gray, solid	67	225
"Volcanic ash," red, muddy	33	258
Basalt, red	17	275
Basalt, brown	30	305
Basalt, red	15	320
Basalt, brown	42	362
Basalt, gray	23	385
Basalt, brown	17	402
Basalt, gray	27	429
Basalt, black	21	450
Basalt, gray	147	597
Basalt, brown	38	635
Basalt, gray	30	665

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-10N1. City of Pendleton, well no. 3. Drilled by A. A. Durand and Son, 1952

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium and Palouse formation:		
Rock, brown, and clay	4	4
Columbia River basalt:		
Basalt, broken	2	6
Basalt, brown, medium hard, broken	23	30
Basalt, black, hard	2	32
Basalt, broken	12	44
Basalt, broken, yellow, water standing at 20 ft	6	50
Basalt, broken	3	53
Basalt, hard	3	56
Basalt, gray, hard	8	64
Basalt, brown and red, medium hard, broken	4	68
Basalt, brown, medium hard, broken, with mud	7	75
Basalt "shells" (alternating hard and soft layers) and brown mud	6	81
Basalt, brown, broken, medium hard	4	85
Basalt, brown, hard	3	88
Basalt, gray, hard; water standing at 30 ft	2	90
Basalt, brown, hard	7	97
Basalt, brown, broken, some mud	3	100
Basalt, gray, hard	2	102
Basalt, black, broken, with gray mud	7	109
Basalt, gray, hard; water standing at 20 ft	14	123
Basalt, gray, hard	2	125
Basalt, black, medium hard	2	127
Basalt, gray, hard	8	135
Basalt, red, broken, with soft mud	3	138
Basalt, brown, medium hard, with mud	6	144
Basalt, brown, hard	8	152
Basalt, gray, hard	12	164
Basalt, brown and red, broken, some mud	4	168
Basalt, brown, hard	5	173
Basalt, gray, hard	54	227
Basalt, gray, medium hard	3	230
Basalt, brown, broken, with mud	7	237
Basalt, brown, broken, soft, with mud	3	240
Basalt, brown, broken	14	254
Basalt, black, medium hard	5	259
Basalt, gray, medium hard	14	273
Basalt, gray, hard	32	305
Basalt, broken, some mud	15	320
Basalt, gray, hard; water standing at 50 ft	11	331
Basalt, black, medium hard	4	335
Basalt, red, medium hard	4	339

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-10N1 - Continued

Materials	Thickness (feet)	Depth (feet)
Columbia River basalt, Continued:		
Basalt, black, medium hard; water standing at 155 ft	13	352
Basalt, red	2	354
Basalt, black	4	358
Basalt, gray, hard	26	384
Basalt, brown, broken, medium hard	16	400
Basalt, black, medium hard	15	415
Basalt, black, hard	2	417
Basalt, gray, hard	5	422
Basalt, black, medium hard and hard	39	461
Basalt, black, medium hard	15	476
Basalt, brown, broken, with some clay	7	483
Basalt, dark, medium hard	102	585
Basalt, brown, broken, medium hard	5	590
Basalt, red, broken, soft	2	592
Basalt, brown, medium hard	2	594
Basalt, gray, hard	9	603
Basalt, broken, variable color	12	615
Basalt, gray and black, hard and medium hard	48	663
Basalt, red, soft, broken, with brown clay	2	665
Basalt, brown, broken, with mud	6	671
Basalt, black, medium hard; static water level at 153 ft	32	703
Basalt, black, hard and medium hard	40	743
Basalt, black and brown, broken	16	759
Basalt, black and brown, medium hard	13	772
Basalt, black, hard and medium hard	55	827
Basalt, gray, very hard	16	843
Basalt, gray, hard	1	844
Basalt, black, medium hard and hard	75	919
Basalt, gray, hard	12	931
Basalt, black, medium hard	4	935
Basalt, gray, hard	8	943
Basalt, black, medium hard	22	965
Basalt, gray, hard	14	979
Basalt, black, medium hard	18	997
Basalt, gray, hard; static water level at 153 ft	11	1,008

2N/32-11D1. First National Bank of Portland. Drilled by A. M. Jannsen, 1940

Columbia River basalt:		
"Rock"	115	115
"Lava rock," brown	30	145
"Rock," gray and black	556	701
Sand	2	703

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-16D1. Charles Ford. Drilled by D. K. Smith

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	4	4
Hardpan	12	16
Gravel	2	18
Columbia River basalt:		
Rock, broken, cemented	17	35
Rock, broken, brown	13	48
Rock, red	21	69
Basalt, brown, broken	61	130
Basalt, red	5	135
Basalt, brown, broken	112	247
Basalt, black	33	280

2N/32-16M1. Gilbert Struve. Drilled by Roy French, 1956

Quaternary alluvium:		
Soil	17	17
Columbia River basalt:		
"Volcanic ash," red and black (decomposed basalt?)	13	30
Rock, red	18	48
Basalt, gray, small amount of water	62	110
Rock, red	40	150
Basalt, gray	35	185
Rock, red, with clay seams, static water level 40 ft below land surface	115	300
Basalt, red and black, water-bearing at 385 ft; static water level dropped to 120 feet	85	385

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-16P1. Clifford N. Clark. Drilled by D. K. Smith, 1950

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	12	12
Hardpan	2	14
Columbia River basalt:		
Basalt, brown, broken	21	35
Basalt, gray	5	40
Basalt, brown	10	50
Basalt, black	15	65
Basalt, brown	6	71
Basalt, red, water-bearing	1	72
Basalt, gray	66	138
Basalt, red	20	158
Basalt, brown	19	177
Basalt, gray	53	230
Basalt, brown and red	27	257

2N/32-19N1. Milton Carter. Drilled by D. K. Smith, 1952

Palouse formation:		
Soil	3	3
Quaternary alluvium:		
Gravel, cemented	10	13
Columbia River basalt:		
Basalt, broken	3	16
Basalt, gray, hard	14	30
Basalt, gray	5	35
Basalt, gray, hard	16	51
Basalt, brown	24	75
Basalt, brown, broken	15	90
"Mud"	3	93
Basalt, brown	16	109
Basalt, gray	21	130
Basalt, brown, fractured, water-bearing	5	135
Basalt, gray	29	164
Basalt, black, water-bearing	18	182
Basalt, gray	11	193
Basalt, brown	5	198
Basalt, black	2	200

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/32-19P1. Milton Carter. Drilled by D. K. Smith, 1951

Materials	Thickness (feet)	Depth (feet)
Palouse formation and Quaternary alluvium, undifferentiated:		
Soil	10	10
Columbia River basalt:		
Basalt, broken, cemented	10	20
Basalt, brown	24	44
Basalt, gray	20	64
Basalt, brown, broken	34	98
Basalt, gray	4	102
Basalt, black	12	114
Basalt, gray, hard	18	132
Basalt, black	3	135
Basalt, gray	2	137
Basalt, black	1	138
Basalt, gray	6	144
Basalt, brown, broken	11	155
Basalt, gray	12	167
Basalt, brown, broken	32	199
Basalt, black; static water level at 10 ft	14	213
Basalt, brown, broken; static water level at 60 ft	16	229

2N/32-29F1. John Korvola. Drilled by Bert Gladney, 1950

Quaternary alluvium:		
Soil and gravel	12	12
Columbia River basalt:		
Basalt	20	32
Basalt, red	24	56

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/33-6N3. Crispin Bros. Drilled by Roy French, 1956

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	4	4
Gravel	14	18
Columbia River basalt:		
Basalt, black	22	40
Sand, black, heaving	3	43
Basalt, gray	54	97
Basalt, red and black, (decomposed)	31	128
Basalt, gray	19	147
Basalt, red	13	160
Basalt, black and gray	80	240
Basalt, red and black, decomposed	40	280
Basalt, gray and black	85	365
Basalt, red and black	15	380
Basalt, gray	85	465
Basalt, red, static water level 26 ft	10	475
Basalt, red; during drilling of this section the static water level dropped twice, first to 66 ft, then to 108 ft	25	500

After drilling was completed, water level dropped twice, first to 155 ft and then to an unknown depth below 200 ft.

2N/33-8G1. William Purchase. Drilled by D. K. Smith, 1953

Quaternary alluvium and fanglomerate of Pliocene age, undifferentiated:		
Soil	5	5
Gravel, cemented	5	10
Gravel, loose	2	12
Columbia River basalt:		
Basalt, black, broken, water-bearing	8	20
Basalt, gray, hard, with water-bearing crevices	6	26
Basalt, black; water level standing at 8 ft	4	30

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/33-8J1. William Purchase, well no. 1. Drilled by D. K. Smith, 1949

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Sandy soil	6	6
Fanglomerate of Pliocene age:		
Gravel, cemented	34	40
Clay, sandy	5	45
Gravel, cemented	45	90
Columbia River basalt:		
Basalt, black, broken	25	115
Basalt, black, solid	90	205
Basalt, brown	15	220
Basalt, red	15	235
Basalt, brown	38	273
Basalt, black	97	370
Basalt, gray, with clay seams	33	403
Basalt, brown, porous	5	408
Basalt, gray	57	465
Basalt, red	7	472
Basalt, brown	13	485
Basalt, black	30	515
Basalt, gray	47	562
Basalt, red, green, black, brown	4	566
Basalt, red	14	580
Basalt, red-brown	5	585
Basalt, gray, hard	12	597
Basalt, black	15	612
Basalt, gray, hard	10	622
Basalt, black; static water level at 23 ft	31	653
Basalt, gray	23	676
Basalt, black, porous	10	686
Basalt, gray	14	700
Basalt, black; static water level at 26 ft	27	727
Basalt, black	52	779

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/33-8K1. Wm. Purchase well no. 3. Drilled by D. K. Smith, 1953

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	15	15
Fanglomerate of Pliocene age:		
Gravel, cemented	2	17
Gravel, loose	2	19
Gravel, loosely cemented	6	25
Clay, brown	2	27
Gravel, cemented	3	30
Gravel and clay	11	41
Gravel, cemented, and sand	91	132
Columbia River basalt:		
Basalt, red	16	148
Basalt, brown	17	165
Basalt, black	25	190
Basalt, gray	12	202
Basalt, brown, broken	5	207
Basalt, brown	23	230
Basalt, black	10	240
Basalt, dark gray	15	255
Basalt, black	95	350
Clay, dark, sticky	6	356
Basalt, gray, hard, with shale(?) seams	38	394
Basalt, brown, porous, water-bearing	16	410
Basalt, dark gray	48	458
Basalt, red	7	465
Basalt, brown	15	480
Basalt, gray	23	503
Crevice, muddy (decomposed tuff layer?)	4	507
Basalt, gray, hard	38	545
Basalt, brown, water-bearing	15	560
Basalt, gray	19	579
Basalt, brown	6	585
Basalt, red, brown, and black, broken	5	590
Basalt, black	13	603
Basalt, gray	1	604

Table 2.- Drillers' Logs of Representative Wells - Continued

2N/33-10E1. Neal H. Laughlin

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	5	5
Gravel and soil	7	12
Gravel, loose, water-bearing	4	16
Sand	4	20
Sand and gravel, cemented	7	27
Columbia River basalt:		
Basalt, broken	8	35
Basalt, solid, black and gray	194	229
Basalt, black, porous, water-bearing	23	252

2N/33-10E2. Roy Morris. Drilled by owner, 1957

Quaternary alluvium:		
Soil	4	4
Gravel, cemented	15	19
Columbia River basalt:		
Basalt, water-bearing	73	92
Basalt, blue	128	220
Clay, green	39	259
Basalt, porous, and clay	16	275

2N/33-33N1. Guy Mueller. Drilled by Bert Gladney, 1951

Palouse formation:		
Soil	6	6
Fanglomerate of Pliocene age:		
Gravel and clay	99	105
Columbia River basalt:		
Basalt	32	137
Basalt, gray	92	229
Gravel (broken basalt?)	2	231
Basalt, gray	4	235
Basalt, black	75	310

2N/34-4R1. Union Pacific Ry. Drilled by A. A. Durand and Son, 1941

Quaternary alluvium:		
Gravel	15	15
Columbia River basalt:		
Basalt, gray, hard	35	50
Basalt, brown, porous	35	85

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/26-4L1. L. W. Cramer. Drilled by owner, 1955

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand and silt	92	92
Clay, tan	21	119
Columbia River basalt:		
Wenas basalt member and interbedded sediments:		
Basalt, gray	15	134
Clay, tan	40	174
Basalt, gray	67	241
Lower part of Ellensburg formation:		
Gravel, clay, and sand, water-bearing	2	243
Clay, blue	70	313
Sand, yellow, coarse, water-bearing	30	343
Clay and gravel	7	350
Gravel, cemented	8	358

3N/26-14J1. Willard Jones. Drilled by Troy Griffin, 1954

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Soil	80	80
Sand	20	100
"Hardpan"	10	110
Clay and gravel	20	130
Columbia River basalt:		
Wenas basalt and interbedded sediments:		
Rock, red, rotten	10	140
Clay and gravel	20	160
Rock, porous	20	180
Clay and gravel	10	190
Rock, rotten	7	197

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/27-4R1. Dean Hall. Drilled by Ben Dryer, 1955

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Soil, sandy	3	3
Gravel, sandy	22	25
Clay, yellow	5	30
Gravel	4	34
Clay, white	16	50
Sand, white	39	89
Columbia River basalt:		
Clay, red	22	111
Rock, black, shaly, water-bearing	24	135
Clay, red	11	146
Rock, black, shaly, water-bearing	39	185

3N/27-25J1. George Wallace

Quaternary alluvium and older gravels, undifferentiated:		
"Earth"	20	20
Clay and gravel	49	69
Clay, sticky, and gravel	31	100
Clay, blue, and gravel	85	185
Columbia River basalt:		
Basalt, black	40	225
Basalt, "blue lava rock"	18	243
Basalt, red and blue	17	260
Basalt, blue	10	270
Basalt, "iron rock"	48	318
Basalt, red	18	336
Basalt, gray	64	400

3N/29-11G1. Peter Myers

Lake sediments of Pleistocene age:		
Silt	12	12
Fanglomerate of Pliocene age:		
Gravel	13	25
Sandstone	55	80

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/29-11G2. Claude Meyers. Drilled by Roy French, 1954

Materials	Thickness (feet)	Depth (feet)
Lake sediments of Pleistocene age:		
Soil and gravel, cemented	52	52
Sandstone	31	83
Columbia River basalt:		
Basalt, brown and black	57	140
Basalt, gray, with crevices	58	198
Basalt, black and gray, solid	320	518
Basalt, black, with crevices	37	555
Basalt, black and gray, solid	22	577
Basalt, black, soft, with red and green streaks	31	608
Basalt, gray	62	670
Basalt, red, changing to green, with increasing depth, water-bearing; water flows at the surface	5	675

3N/29-16G1. City of Echo. Drilled by A. A. Durand and Son, 1951

Quaternary alluvium:		
Soil, brown	14	14
Gravel, water-bearing	11	25
Columbia River basalt:		
Basalt, broken, and gravel	7	32
Basalt, hard	3	35
Basalt, gray, hard, static water level at 10 ft	50	85
Basalt, black, medium hard	18	103
Basalt, black, broken	13	116
Clay, blue	2	118
Basalt, black, broken	14	132
Basalt, black, medium hard, broken 137 to 138	27	159
Basalt, black, medium hard, broken	5	164
Basalt, black, static water level at 10 ft	15	179
Basalt, black, broken, with soft clay	5	184
Basalt, gray, hard	3	187
Basalt, gray, medium hard	88	275
Basalt, black, soft, honeycomb, static water level at 107 ft	15	290
Basalt, black	70	360
Basalt, gray, hard	2	362
Basalt, gray, very hard	44	406
Basalt, gray, firm	24	430
Basalt, black, soft, broken	5	435
Basalt, gray, hard, static water level at 100 ft	55	490

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/32-32P1. Pendleton Airport. Drilled by W. E. Ruther, 1934; deepened, 1936

Materials	Thickness (feet)	Depth (feet)
Palouse formation and Columbia River basalt, undifferentiated:		
Top soil, clay, gravel and boulders	80	80
Columbia River basalt:		
Basalt, gray, medium hard	185	265
Basalt, honeycomb, water-bearing	20	285
Basalt, gray, medium hard; lost all water at 511 ft	226	511
Basalt, red, honeycomb; well "blew and sucked" air from this formation; water bearing at bottom of original hole (573 ft); static water level at 521 ft; yield 12 gpm with little drawdown	62	573
Basalt, blue, hard	190	763
Basalt, blue, honeycomb; static water level, 573 ft	62	825

3N/33-14L1. McCormack Bros. Drilled by D. K. Smith, 1950

Palouse formation:		
Soil	10	10
Columbia River basalt:		
Basalt, brown, broken	9	19
Basalt, brown	13	32
Basalt, brown and red, water-bearing	22	54
Basalt, brown, hard	13	67
Basalt, brown	13	80
Basalt, brown, broken	9	89
Basalt, black, static water level at 7 ft	7	96

3N/33-31Q2. James Rutten. Drilled by Roy French, 1956

Alluvium:		
Sand and soil	18	18
Boulders	5	23
Columbia River basalt:		
Basalt, black	52	75
Basalt, red and black	32	107
Basalt, gray and brown	185	292
Clay, green, sticky	23	315
Basalt, gray	49	364
Clay, red (weathered basalt)	12	376
Basalt, red, water-bearing	19	395
Basalt, red and black	15	410
Basalt, gray	40	450
Basalt, red	25	475
Basalt, brown and gray	75	550
Basalt, red and black, water-bearing	58	608

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/34-3C1. B. A. Davis. Drilled by A. A. Durand, 1944

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	10	10
Columbia River basalt:		
"Boulders and hardpan"	11	21
Basalt, gray, static water level at 20 ft	41	62
Basalt, soft, static water level at 15 ft	10	72
Basalt, hard, static water level at 25 ft	15	87
Basalt, soft, static water level at 30 ft	33	120
Basalt, hard	28	148
Basalt, static water level at 15 ft	12	160

3N/34-3D1. B. A. Davis. Drilled by D. K. Smith, 1952

Palouse formation:		
Soil	3	3
Hardpan	6	9
Columbia River basalt:		
"Rock," broken, cemented	9	18
Basalt, broken	4	22
Basalt, gray, hard	2	24
Basalt, gray, hard with black "fault seam"(?)	37	61
Basalt, gray	58	119
Basalt, black	2	121
Basalt, gray	4	125
Basalt, black, pprous	20	145
Basalt, black, broken	20	165
Basalt, gray	30	195
Basalt, black	35	230
Basalt, gray	18	248
Basalt, black, porous	5	253
Basalt, black, broken lowest 15 ft	45	298

3N/34-3L1. S. J. Lieuallen. Drilled by A. A. Durand and Son, 1948

Undifferentiated:		
Dug pit	6	6
Columbia River basalt:		
Basalt, brown, loose	11	17
Basalt, brown	19	36
Basalt, blue, hard	25	61
Basalt, blue	6	67
Basalt, blue, hard	17	84
Basalt, blue	1	85
Basalt, blue, hard	52	137
Basalt, blue, medium hard and hard	43	180

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/34-4G1. City of Adams. Drilled by W. E. Ruther, 1938

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Top soil and sand	35	35
Columbia River basalt:		
Basalt, black, hard	58	93
Basalt, porous, soft, water-bearing	40	133
Basalt, black, hard	30	163

3N/34-11H1. L. L. Rogers. Drilled by A. A. Durand and Son, 1940

Palouse formation:		
Soil	29	29
Columbia River basalt:		
Basalt, black, hard	6	35
Basalt, brown	10	45
Basalt, black and gray, hard	130	175
Basalt, black, soft	3	178
Basalt, black, hard	109	287
Basalt, soft, and clay	14	301
Basalt, hard	6	307
Clay and rock	2	309
Basalt, black, hard	31	340

3N/34-17D1. B. G. Haynes. Drilled by D. K. Smith, 1950

Palouse formation:		
Soil	7	7
Hardpan, sandy	7	14
Columbia River basalt:		
Basalt, brown	22	36
Basalt, gray	39	75
Basalt, brown	5	80
Basalt, brown with red streaks, water-bearing	15	95
Basalt, brown	9	104
Basalt, black	26	130
Basalt, gray and black	314	444
Basalt, black, porous, water-bearing	19	463
Basalt, brown	32	495
Basalt, gray	8	503

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/34-17M1. Standard Oil Company. Drilled by A. A. Durand and Son, 1950

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	20	20
Fanglomerate of Pliocene age:		
Gravel, cemented	35	55
Clay and rock	3	58
Columbia River basalt:		
Basalt, porous, with some clay	12	70
Basalt, brown	10	80
Basalt	25	105
Basalt, porous	20	125
Basalt, broken	12	139
Basalt, porous	48	185
Basalt, hard	4	189
Basalt, porous	16	205
Basalt	15	220
Basalt, porous, and clay	30	250
Basalt, broken	5	255
Basalt, porous	15	270
Basalt, broken	15	285
Basalt, hard, static water level at 61 ft	4	289
Basalt	21	310
Basalt, broken	7	317
Basalt, gray	4	321
Basalt, hard, water-bearing at 338 to 343 ft	24	345
Basalt	15	360
Basalt, hard	26	386

3N/34-18M1. Robert Rothrock. Drilled by A. A. Durand and Son, 1950

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	6	6
Quaternary alluvium:		
Gravel and clay	6	12
Grabel	4	16
Columbia River basalt:		
Basalt, static water level at 23 ft	159	175

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/34-20E1. B. G. Haynes. Drilled by A. A. Durand and Son, 1947

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	4	4
Columbia River basalt:		
Basalt, brown, soft	3	7
Basalt, blue, hard	4	11
Basalt, brown	14	25
Basalt, blue, medium hard	20	45
Basalt, brown, and clay	21	66
Basalt, blue, hard	65	131
Basalt, brown, medium hard, water-bearing	13	144
Basalt, blue, hard	11	155

3N/34-22Q1. Irvine Mann. Drilled by A. A. Durand and Son, 1944

Palouse formation:		
Soil	3	3
Hardpan	7	10
Older alluvium(?):		
Gravel	3	13
Columbia River basalt:		
"Shale" (weathered basalt?), red, hard	3	16
Basalt, broken	24	40
Basalt, red, soft	20	60
Basalt, blue, hard	78	138
Basalt, broken	22	160
Basalt	20	180
Basalt, soft	15	195
Basalt, hard	33	228
"Shale"(?)	17	245
Basalt, dry crevice at 315 ft	70	315

Concrete plug from 310 to 315 ft.

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/34-25B1. C. C. Curl. Drilled by A. A. Durand and Son, 1947

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	4	4
Older alluvium(?):		
Gravel and boulders	13	17
Shale	5	22
Columbia River basalt:		
"Rock," soft	60	82
Basalt, black, hard	13	95
Basalt, gray	12	107
Basalt, black	85	192
Basalt, gray	10	202
Basalt, black	23	225
Basalt, gray, static water level at 125 ft	55	280
"Rock," black	24	304
Clay, black	1	305

3N/34-32D1. J. H. Maloney. Drilled by D. K. Smith

Palouse formation:		
Soil	14	14
Older alluvium or Columbia River(?) basalt:		
"Rock," broken, cemented	51	65
Columbia River basalt:		
Basalt, gray, hard	22	87
Basalt, gray, seamy	23	110
Basalt, brown, broken, water-bearing	30	140
Basalt, red, water-bearing	14	154
Basalt, gray, static water level at 46 ft	5	159

3N/34-33Q1. L. L. Rogers. Drilled by Geroge Scott, 1951

Palouse formation:		
Soil	11	11
Columbia River basalt:		
Basalt, broken	9	20
Basalt, hard	28	48
Basalt, soft	30	78
Basalt, black, form	32	110
Basalt, reddish	13	123
Basalt, black, with crevices	169	282
Basalt, black	132	414

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/35-9J1. E. B. Foster. Drilled by A. A. Durand and Son, 1950

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	11	11
Columbia River basalt:		
Basalt, blue, broken	3	14
Basalt, blue, hard	121	135
Basalt, gray, hard	65	200
Basalt, gray, broken	12	212
Basalt, blue, hard	44	256
Basalt, broken, and clay	12	268
Basalt, blue, broken, and clay	11	279
Basalt and clay	6	285
Basalt, blue, hard	17	302
Basalt, broken, and clay	8	310
Basalt, blue	14	324
Basalt, blue, hard	51	375
Basalt, black	9	384
Basalt, broken	11	395
Basalt, blue	54	449
Basalt, gray, hard	9	458
Basalt, blue	7	465
Clay, blue, sticky	5	470
Basalt, blue	11	481

3N/35-15B1. Walter Adams. Drilled by Moore and Anderson

Materials	Thickness (feet)	Depth (feet)
Palouse formation and Quaternary alluvium:		
Gravel and "dirt"	7	7
Boulders	31	38
Columbia River basalt:		
"Rock," brown, water-bearing	62	100

3N/35-18H1. Frank Williams. Drilled by A. A. Durand and Son, 1947

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Topsoil	10	10
Quaternary alluvium:		
Gravel, cemented	4	14
Columbia River basalt:		
Basalt, hard	1	15
Basalt, black	83	98
Basalt, gray, bailed 5 gpm of water	2	100
Basalt, black, water trickling over top of casing	34	134
Basalt, black, hard	42	176

Unpublished records subject to revision

Table 2.- Drillers' Logs of Representative wells - Continued

3N/35-19L1. Harold Barnett. Drilled by A. A. Durand and Son, 1946

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	7	7
Columbia River basalt:		
"Boulders"	21	28
"Boulders," basalt, gray	12	40
Basalt, gray, hard	2	42
Basalt, porous	26	68
Basalt, gray	8	76
Basalt, black, porous	24	100
Basalt, black	14	114
Basalt, gray; static water level at 16 ft	88	202
Basalt, gray, hard	16	218
Basalt, black, porous and creviced; with "soapstone"	94	312
Basalt, black	113	425
Basalt, red, soft	20	445
Basalt, black	48	493
Basalt and clay	14	507
Basalt, decomposed, hard, caving	11	518
Basalt and clay	20	538
Basalt, gray, hard	18	556
Basalt and clay	6	562
Basalt, gray, hard	11	573
Basalt with some clay	28	601
Basalt, hard	24	625
Basalt, decomposed	15	640
Material unreported; water level dropped from 16 to 200 ft	13	653
Basalt	9	662
Basalt, decomposed; static water level at 272 ft	10	672
Basalt, hard	6	678
Basalt, gray	24	702
Basalt and red clay	28	730
Basalt, black	14	744
Basalt, broken	39	783
Basalt, black, hard	58	841
Basalt, brown, soft	5	846
Basalt, porous	33	879
Basalt, black, with "soapstone"	21	900
Basalt, black, hard	68	968

Table 2.- Drillers' Logs of Representative Wells - Continued

3N/36-29L1. Gibbon School District. Drilled by Bert Gladney, 1953

Materials	Thickness (feet)	Depth (feet)
Dug well, no record	28	28
Columbia River basalt:		
Basalt, hard	22	50
Basalt, soft, water-bearing	4	54
Basalt, broken	6	60

3N/36-31C1. Union Pacific Railroad. Drilled by A. A. Durand and Son

Quaternary alluvium:		
Gravel and boulders	12	12
Gravel, cemented	12	24
Boulders, blue, basaltic	2	26
Columbia River basalt:		
Basalt, platy, caving	3	29
Basalt, gray	2	31
Basalt, black, broken	22	53
Basalt, black, solid, hard	4	57
Basalt, black, with crevices	9	66
Basalt, gray, hard	5	71
Basalt, black, "honeycomb," water-bearing	9	80

4N/27-5B1. U. S. Army Installation

Glaciofluviatile deposits:		
Gravel, fine	10	10
Sand, fine	57	67
Clay	20	87
Sand	35	122
Clay	19	141
Columbia River basalt:		
Basalt, soft	557	698
Basalt, red, porous	12	710

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-8J1. U. S. Army Installation, well no. 3. Drilled by A. A. Durand and Son, 1941

Materials	Thickness (feet)	Depth (feet)
Dug pit, no record	10	10
Glaciofluviatile deposits:		
Sand	73	83
"Shale," sandy, brown	22	105
Clay, sandy, yellow	32	137
Clay, gray	38	175
Sand, cemented	15	190
Columbia River basalt:		
Wenas basalt member:		
Basalt, black, hard	150	340
Basalt, black, with green clay	20	360
Lower part of the Ellensburg formation:		
Clay, green and blue	5	365
"Volcanic ash," black	15	380
Basalt, black, hard (interbedded in the Ellensburg formation	51	431
Basalt, blacy (interbedded in the Ellensburg formation	7	438
Clay, green	15	453

4/N-18P1. U. S. Army Installation, well no. 5. Drilled by R. J. Strasser

Glaciofluviatile deposits:		
Sand and gravel	100	100
Clay	40	140
Columbia River basalt:		
Basalt	40	180
Clay (probably the Lower part of the Ellensburg formation	20	200
Basalt	418	618

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-19C1. U. S. Army Installation, well no. 4. Drilled by R. J. Strasser

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand and gravel	115	115
Columbia River basalt:		
Basalt	190	305
Shale (probably the Lower part of the Ellensburg formation)	45	350
Basalt (interbedded basalt in the Lower Ellensburg formation)	35	385
Clay (probably the Lower part of the Ellensburg formation)	30	415
Basalt	180	600

4N/27-20M1. Union Pacific Ry. Drilled by A. M. Jannsen, 1945

Glaciofluviatile deposits:		
Sand, black, fine, static water level at 50 ft	105	105
Sand, fine to coarse	40	145
Sand, coarse, and gravel	25	170
Columbia River basalt:		
Wenas basalt member:		
Basalt, gray, static water level at 40 ft	5	175
Basalt, gray, hard, static water level at 35 ft	12	187
Basalt, gray, broken	4	191
Basalt, gray, hard	118	309
Basalt, some clay	16	325
Lower part of the Ellensburg formation:		
"Lava sediment" with some blue clay	45	370
Yakima basalt member:		
Basalt, gray, broken	10	380
Basalt, broken	3	383
Basalt, dark gray	5	388
Basalt, gray, broken	59	447
Basalt, gray, hard	3	450
Basalt, gray, hard, water-bearing; static water level at 43 ft	7	457

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-22K1. U. S. Army Installation, well no. 2. Drilled by A. A. Durand and Son, 1941

Materials	Thickness (feet)	Depth (feet)
Dug pit, no record	12	12
Glaciofluviatile deposits:		
Gravel, coarse, some boulders	31	43
Sand and coarse gravel	23	66
Sand	3	69
Sand and coarse gravel	11	80
Sand and small gravel	15	95
Gravel	54	149
Gravel, cemented	6	155
Columbia River basalt:		
"Rock," hard, with clay seams	42	197
Clay and shale	7	204
Basalt, gray, hard	3	207
Basalt,and blue clay	6	213
Basalt, black	2	215
Clay, blue	1	216
Basalt, black, hard	7	223
Basalt, black, very hard	41	264
Basalt, gray	13	277
Basalt, black, creviced	5	282
Basalt, gray, hard	6	288
Basalt, black, hard	8	296
Basalt, black, honeycomb	20	316
Basalt, black	4	320
Basalt, black, honeycomb	10	330
Basalt, black	5	335
Basalt, black, honeycomb	18	353
Basalt, gray, hard	3	356
Basalt, black	4	360

Table 2.--Drillers' Logs of Representative Wells - Continued

4N/27-22L1. U. S. Army Installation, well no. 1. Drilled by A. A. Durand and Son, 1941

Materials	Thickness (feet)	Depth (feet)
Dug pit, no record	4	4
Glaciofluviatile deposits:		
Gravel and sand, loose	57	61
Gravel and boulders	2	63
Gravel	3	66
Gravel and clay	21	87
Gravel, fine	15	102
Gravel and sand	2	104
Gravel, fine, loose, and sand	45	149
"Shale"	2	151
Gravel	6	157
Columbia River basalt:		
Basalt, black	3	160
Gravel, cemented	20	180
Basalt, black	15	195
Basalt and clay	5	200
Basalt	6	206
Basalt, black, hard	57	263
Basalt, gray, hard	32	295
Basalt, black, with clay	6	301
Basalt, gray, hard	7	308
Basalt, black, honeycomb	10	318
Basalt, gray, very hard	9	327

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-27R1. U. S. Army Installation (Housing Project)

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand	4	4
Gravel, loose	127	131
Gravel and clay	4	135
Gravel, small, water-bearing; static water level at 100 ft	5	140
Gravel, loose	6	146
Boulders	24	170
Clay, brown	32	202
"Soapstone"	6	208
Columbia River basalt:		
Basalt, black	97	305
Clay, sticky	7	312
Basalt, black, honeycomb, water-bearing; static water level at 99 ft	18	330
Basalt, black	27	357
Basalt, gray	4	361
Basalt, black	14	375
Basalt, black, soft	10	385
Clay	6	391
Basalt, honeycomb, water-bearing, and blue clay; static water level at 98 ft	21	412
Basalt, black	21	432
Basalt, brown	2	434
Basalt, gray	57	491
Basalt, red, and "shale"	23	514
Basalt, gray	2	615
Basalt, brown	22	638
Basalt, red, porous, water-bearing; static water level at 121 ft	5	643

4N/27-28E1. V. R. Fulton, Drilled by A. M. Edwards, 1953

Glaciofluviatile deposits:		
Soil, sandy	3	3
Gravel, cemented	18	21
Gravel, loose	12	33
Hardpan	2	35
Gravel, loose, with sand layers	67	102

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-28E2. V. R. Fulton. Drilled by A. M. Edwards, 1954

Materials	Thickness (feet)	Depth (feet)
Glaciofluviative deposits:		
Soil, sandy, loose	2	2
Gravel, cemented	3	5
Boulders, gravel and sand	13	18
Hardpan	3	21
Boulders	10	31
Clay, yellow	4	35
Gravel	2	37
Clay, blue	5	42
Clay, yellow, sandy	18	60
Sand, coarse, and "pea gravel"	1	61
Clay, blue, and heavy boulders	3	64
Clay, yellow, mixed with gravel	8	72
"Pea gravel," sandy, water-bearing	8	80
Gravel, large and small, mixed	7	87
Gravel, cobble-size, and smaller gravel	11	98
Gravel, pebbles	3	101
Gravel, cobbles	4	105
"Pea gravel" and sand	4	109
"Pea gravel" and cobbles	10	119

4N/27-28G1. S. F. Hoyt. Drilled by A. M. Edwards, 1954

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Topsoil	4	4
Gravel, boulders, cemented	9	13
Clay with imbedded cobbles and boulders	25	38
Clay, blue, mixed with gravel and boulders	6	44
Clay, blue and yellow, with gravel layers	25	69
Clay, red	4	73
Gravel, coarse, 3 inches and smaller, water-bearing	8	81
"Pea gravel" and sand, some cobbles	21	102
Gravel, coarse	4	106
"Pea gravel," "heaving" water-bearing	20	126

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-32J1. R. G. Holzapfel

Materials	Thickness (feet0	Depth (feet)
Glaciofluviatile deposits:		
Loam, sandy	6	6
Sand	20	26
Gravel	37	63
Gravel with clay binder	27	90
Clay, "burnt," water-bearing	3	93
Clay	17	110
Columbia River basalt:		
Wenas basalt member:		
Basalt, black	26	136
Basalt, gray	21	157
Lower part of the Ellensburg formation:		
Clay, green, and sand	30	187
Yakima basalt member:		
Basalt, black, water-bearing	5	192
Basalt, black	103	295
Basalt, black, "burnt out" (scoriaceous?) water-bearing	15	310

4N/27-33H1. McDole Bros. Drilled by L. E. Wallis, 1950

Glaciofluviatile deposits:		
Sandy soil	5	5
Sand, black, with a few "rocks"	31	36
Gravel, pea sized, and sand	29	65
Sand, coarse, and pea gravel, water-bearing	30	95
Clay, soft	1	96

4N/27-33J2. McDole Bros.

Glaciofluviatile deposits:		
Sandy topsoil	7	7
Sand, gray	26	33
Gravel, "egg size," and sand	32	65
Gravel, pea size, and coarse sand	29	94
Older alluvium or Columbia River basalt:		
Clay, broken, "weathered" (basalt?)	2	96

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/27-36E1. G. W. Redwine. Drilled by Bert Gladney, 1952

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Loam, sandy	20	20
Sand and gravel	10	30
Gravel	65	95
Clay, gray	10	105
Columbia River basalt:		
Rock, gray	30	135
Clay and shale, blue (lower member of Ellensburg formation?)	57	194

4N/28-10F1. City of Hermiston

Glaciofluviatile deposits:		
Soil	5	5
Sand	29	34
Gravel, water-bearing (water cased out)	10	44
Clay, blue	20	64
Columbia River basalt:		
Basalt	90	154
Basalt, water-bearing; water level standing at 30 ft	6	160

Casing, 12-1/4-inch, set to 64 feet. Open 12-1/4-inch hole below.

4N/28-11P1. City of Hermiston. Drilled by A. A. Durand and Son, 1949

Glaciofluviatile deposits:		
Soil, sandy	30	30
Mud, blue	14	44
Columbia River basalt:		
Basalt, blue, hard, broken, with soft layers	51	95
Basalt, blue, hard, broken layers	140	235
Basalt, broken, with gumbo mud	41	276
Basalt, "mixture," some gumbo and dark sand	206	482
Basalt, gray, hard, broken	436	918

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/28-20N1. C. O. Porter. Drilled by W. R. Ille, 1956

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand and gravel	25	25
Silt and sand	45	70
Clay, silt, and gravel	25	95
Clay, blue	30	125
Columbia River basalt:		
Basalt, water-bearing	20	145

4N/28-20N1. Ray Moses. Drilled by W. R. Ille, 1952

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand and gravel	30	30
Clay	60	90
Columbia River basalt:		
"Rock"	312	402
Basalt, vesicular, water-bearing	25	427

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/28-27J1. Union Pacific Ry., Hinkle Station. Drilled by A. A. Durand and Son, 1950

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand	31	31
Gravel	21	52
Boulders and coarse gravel	46	98
Gravel, coarse	6	104
Gravel and sand	9	113
Gravel	32	145
Gravel, fine	10	155
Columbia River basalt:		
Wenas basalt member:		
Basalt, blue, medium hard, and blue clay	12	167
Basalt	3	170
Basalt, blue, broken	10	180
Lower part of the Ellensburg formation:		
Clay or shale, blue	20	200
Clay, gray, with some broken basalt	20	220
Clay, green, stocky	25	245
Gravel	2	247
Yakima basalt member:		
Basalt, brown	3	250
Basalt, black	41	291
Basalt, hard	9	300
Basalt	8	308
Basalt, dark	16	324
Basalt, dark, hard	9	333
Basalt, gray, hard; crevice at 352 ft	27	360
Basalt, brown, water-bearing; static water level at 125 ft	5	365
Basalt, brown, broken	11	376
Basalt, black	11	387
Shale, blue	10	397
Basalt	8	405
Basalt, dark	10	415
Basalt, dark, fractured	3	418
Shale, blue; static water level at 132 ft	5	423
Basalt, dark, broken	12	435
Basalt, dark, hard, fractured 458-460	29	464
Basalt, dark, broken; static water level at 137 ft	6	470
Basalt, dark, hard; static water level at 140 ft	20	490
Basalt, gray, hard; static water level at 160 ft	23	513
Basalt, broken, loose	4	517
Basalt, gray, hard	10	536
Basalt, gray, creviced; static water level at 156 ft	1	537
Basalt, gray, hard	16	553

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/29-3N1. Gene Gray. Drilled by Ben Dryer, 1953

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Soil, sandy	20	20
Clay, red	45	64
Clay, blue	13	78
Clay, yellow, sandy	2	110
Sand	17	127
Columbia River basalt:		
Basalt, red, soft	40	167
Basalt, blue, hard	88	255
Basalt, black, medium hard	39	294
Clay, blue	12	306
Basalt, blue, medium hard	74	380
Basalt, blue, hard	54	434
Basalt, red, soft	20	454
Basalt, black, medium hard and hard	300	754

4N/29-11B1. Marvin Hurd. Bored by owner

Glaciofluviatile deposits:		
Sand	6	6
Hardpan	3	9
Sand, fine, water-bearing	11	20
Clay and gravel	10	30

4N/29-13K1. Edwards Farms, Inc.

Glaciofluviatile deposits:		
Soil, sandy	27	27
Gravel	4	31
Clay, red	45	76
Boulders and sand	35	111
Columbia River basalt:		
Basalt, black	20	131
Clay, blue, and sand	16	147
Boulders and sand (broken basalt?)	20	167
Basalt, black, soft	89	256
Basalt, red and black	252	508
Basalt, red	14	522
Basalt, black, hard	5	527

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/29-13N1. Edwards Farms, Inc. Drilled by Ille Bros., 1954

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand and silt	30	30
Sand and gravel	32	62
Columbia River basalt:		
"Flow breccia"	16	78
Basalt, with clay layer	169	247
Basalt, broken	73	320
Interbed (sedimentary?)	27	347
Basalt, dense and broken layers	63	410
"Flow breccia"	15	425

4N/29-17C1. Ben Dryer. Drilled by owner, 1952

Glaciofluviatile deposits:		
Soil	18	18
Clay, red	83	101
Sand and gravel	44	145
Clay, red	42	187
Sand, white	25	212
Clay, white	8	220
Columbia River basalt:		
Basalt, black, soft	25	245

4N/31-9P1. R. E. Bissinger. Drilled by D. K. Smith, 1952

Palouse formation:		
Soil	12	12
Columbia River basalt:		
"Rock," cemented	18	30
Basalt, gray, hard	6	36
Basalt, black	10	46
Basalt, gray, hard	24	70
Basalt, black	2	72
Basalt, red, water-bearing	10	82
Basalt, brown	13	95
Basalt, black, gray and green in layers	185	280
Basalt, black, hard, water-bearing	62	342

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/31-9Q1. Dewey Purcell

Materials	Thickness (feet)	Depth (feet)
Dug well, no record	18	18
Columbia River basalt:		
Basalt, broken	2	20
Basalt, gray and brown, hard	45	65
Basalt, black, soft	10	75
Basalt, gray	4	79
Basalt, brown, water-bearing	6	85
Basalt, black and gray	70	155
Basalt, black, water-bearing; static water level at 20 ft	20	175

Casing, 8-inch, set to 20 feet, open 8-inch hole to bottom.

4N/31-23H1. A. H. Schluter. Drilled by D. K. Smith

Palouse formation:		
Soil	6	6
Hardpan	16	22
Columbia River basalt:		
Basalt, brown, broken	53	75
Basalt, black, porous	5	80
Basalt, brown, broken, muddy	20	100
Basalt, black	22	122
Basalt, gray	22	144
Basalt, black, water-bearing	34	178
Basalt, gray	12	190
Basalt, brown	18	208
Basalt, gray, seamy	12	220
Basalt, black, porous, water-bearing	30	250
Basalt, black	82	332
Basalt, gray, creviced (cuttings washed away)	17	349
Basalt, gray, soft streaks	71	420
Basalt, gray, very hard	5	425
Basalt, gray	22	447
Basalt, black, water-bearing	14	461
Basalt, gray, water-bearing	2	463

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/31-30F1. Glen Simpson. Drilled by D. K. Smith

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	12	12
Columbia River basalt:		
Rock, cemented	14	26
Sand (decomposed basalt?)	2	28
Basalt, gray and black	255	283
Basalt, black, broken, water-bearing	22	305
Basalt, gray	5	310

4N/32-3J1. Lester King. Drilled by A. A. Durand and Son, 1947

Palouse formation and Quaternary alluvium:		
Soil	10	10
Clay, brown	12	22
Columbia River basalt:		
Basalt, brown	6	28
Basalt, blue, hard	4	32
Basalt, brown	11	43
Basalt, blue, hard	40	83
Basalt, brown, soft	16	99
Basalt, blue and brown layers	43	142
Basalt, brown, medium hard	3	145
Basalt, brown, very hard	19	164
Basalt, blue, hard, broken	4	168

4N/32-18R1. Wm. Meiner. Drilled by A. A. Durand and Son, 1948

Palouse formation:		
Soil	6	6
Clay	10	16
Columbia River basalt:		
Basalt, broken	1	17
Basalt, blue, hard	32	49
Basalt, blue, broken	9	58
Basalt, blue, hard	97	155
Basalt, blue, broken	19	174
Basalt, blue, hard	11	185
Basalt, gray, broken	15	200

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/33-29K1. J. C. Hawkins. Drilled by W. E. Ruther

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	63	63
Columbia River basalt:		
"Rock"	133	299
Shale, green	12	311

4N/33-33B1. Frank Molstrom. Drilled by D. K. Smith, 1954

Palouse formation:		
Soil	2	2
Hardpan and "shellrock"	42	44
Columbia River basalt:		
Basalt, brown	6	50
Basalt, gray, hard	38	88
Basalt, red	7	95
Basalt, brown	38	133
Basalt, black, broken	3	136
Basalt, black	18	154
Basalt, black, broken	31	185
Basalt, black, hard	10	195
Basalt, black, soft	5	200

4N/33-26R2. John Hales. Drilled by D. K. Smith, 1948

Palouse formation:		
Soil	6	6
Hardpan	2	8
Clay, brown	12	20
Undesignated:		
Hardpan (decomposed basalt?)	18	38
Columbia River basalt:		
Basalt, black	6	44
Clay, sandy, brown (decomposed basalt?)	4	48
Basalt, black	5	53
Clay, sandy, brown	7	60
Basalt, black and gray	30	90
Basalt, black, porous, water-bearing; static water level at 40 ft	8	98
Basalt, black	3	101
Basalt, porous, water-bearing	1	102
Basalt, gray	22	124
Basalt, black, porous, water-bearing	16	140
Basalt, black and gray	75	215
Basalt, black, water-bearing	30	245
Basalt, black	13	258

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-6L1. R. B. Taylor. Drilled by Bert Gladney, 1951

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	36	36
Columbia River basalt:		
Basalt, with a few soft porous zones	434	470
Basalt, porous, water-bearing	30	500
Basalt	5	505

4N/34-12L1. Herb Whitmore. Drilled by D. K. Smith

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	18	18
Undesignated:		
Gravel and sand, water-bearing	1	19
Columbia River basalt:		
Basalt, brown and black, broken	84	103
Basalt, black	19	122
Clay, yellow	2	124
Basalt, red	1	125
Basalt, brown, broken	13	138
Clay, yellow	2	140
Basalt, brown, broken	20	160
Basalt, black, hard	7	167
Clay, yellow	15	182
Basalt, gray and black	63	245
Basalt, gray, hard	6	251
Basalt, black and gray	89	340
Basalt, gray, hard	20	360
Basalt, black	20	380
Basalt, gray, hard	47	427
Basalt, black	3	430
Basalt, gray, hard	116	546
Basalt, black	39	585
Basalt, gray, hard	45	630
Basalt, black	10	640
Basalt, gray, hard	50	690
Basalt, black	31	721
Basalt, gray, hard	57	778
"Shale," black	22	800

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-15G1. Jay Scott. Drilled by A. A. Durand and Son, 1946

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	15	15
Older alluvium:		
Gravel, cemented	10	25
Columbia River basalt:		
Basalt, hard	25	50
Basalt, blue, hard	13	63
Basalt, black	82	145
Basalt, gray, brown, black and dark layers	60	205

4N/34-22H1. Dean Dudley. Drilled by A. A. Durand and Son, 1945

Palouse formation:		
Soil	8	8
Older alluvium:		
Clay, sandy	55	63
Gravel and sand, water level at 60 ft	11	74
Gravel, cemented	6	80
Sand, brown, hard	10	90
Gravel, cemented, static water level at 50 ft	14	104
Columbia River basalt:		
"Sand rock," brown, hard (decomposed basalt)	7	111
Basalt, hard, crevice at 112 ft; static water level at 50 ft	99	210
Basalt, soft, static water level at 46 ft	10	220
Undesignated interbeds:		
Clay, blue	5	225
Clay, brown	10	235
Gravel	2	237
Shale, green; static water level at 200 ft	23	260

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-24J1. Roger's Canning Co. well no. 3. Drilled by A. A. Durand and Son, 1946

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Silt, yellow	7	7
Gravel, water-bearing	15	22
Columbia River basalt:		
Basalt, dark	2	24
Basalt, gray, hard	7	31
Basalt, broken	7	38
Shale, brown	3	41
Basalt, gray	15	56
"Rock," broken, and brown shale	14	70
Basalt, alternatingly hard and soft layers with gray clay	5	75
Basalt, gray, hard	5	80
Basalt, dark	45	125
"Rock," broken	9	134
Basalt, dark gray, broken	8	142
Basalt, broken, with blue shale	40	182
Basalt, black, soft, broken, water-bearing	11	193
Basalt, dark	4	197
Basalt, gray, hard	5	202
Basalt, dark, broken	28	230
Basalt, gray, hard	14	244
Basalt, dark, medium hard	56	300
Basalt, gray	10	310
Basalt, dark	5	315
Basalt, gray	10	325
Basalt, dark, gray, lower 14 ft	45	370
Shale, blue	10	380
Basalt, dark, medium hard	44	424
Basalt, gray, brown upper 17 ft	64	488
Shale, brown (decomposed basalt)	12	500
Basalt, dark	41	541
Basalt, gray	29	570
Basalt, dark, broken upper 38 ft	102	672
Shale, blue, sticky	6	678
Basalt, dark gray, water-bearing 700 to 713 ft	52	730
Basalt, black, water-bearing	6	736
Basalt, gray, hard	4	740
Basalt, dark, and dark gray	26	766
Basalt, dark, broken, water-bearing 796 to 810 ft	74	840
Basalt, alternately dark and gray	95	935
Mud, gray, sticky	5	940
Basalt, gray	6	946
Basalt, brown	14	960
Basalt, red-brown, broken	47	1,007
Basalt, broken, dark	18	1,025

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-24J1 - Continued

Materials	Thickness (feet)	Depth (feet)
Columbia River basalt - Continued:		
Basalt, broken, dark, water-bearing; artesian water flowing from casing	6	1,031
Basalt, gray	11	1,119
Basalt, dark, black, brown and broken 1,132 to 1,139 ft	25	1,144
Basalt, gray, water-bearing	4	1,148

4N/34-26H1. M. F. Sheard. Drilled by A. A. Durand and Son, 1945

Quaternary alluvium:		
Soil	13	13
Gravel with boulders	5	18
Boulders	7	25
Gravel and clay	5	30
Columbia River basalt:		
Basalt	30	60
Basalt, soft, and sand	5	65

4N/26J2. Neil McIntyre. Drilled by A. A. Durand and Son, 1945

Old well, no record	65	65
Columbia River basalt:		
"Shale" (weathered basalt), brown; static water level at 30 ft	12	77
"Shale," blue	10	87
Basalt	23	110
Clay	18	128
Basalt	7	135
Basalt with blue clay (caving from above?)	31	166
Basalt	18	184
Basalt, soft; static water level at 34 ft	16	200

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-28E1. Nettie E. Woodward. Drilled by A. A. Durand and Son, 1940

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	7	7
Undesignated:		
Dirt, yellow (weathered basalt?)	49	56
Columbia River basalt:		
Basalt, black	21	77
Basalt, blue and black, hard	58	135
Basalt, red, soft, and clay	18	153
Basalt, black	2	155
Basalt, brown, soft, and mud	10	165
Basalt, black and gray, hard	45	210
Basalt, brown, "muddy"	2	212
Basalt, black	31	243
Basalt, blue, very hard	21	270
Basalt, black	20	290
Basalt, gray, hard, with crevices	9	299
Basalt, gray, hard	21	320
Clay, blue	1	321
Basalt, gray and black, hard	65	386
Basalt, black, with clay seams	19	405
Basalt, gray and black, hard	15	420
"Rock," hard and soft streaks	7	427
Basalt, blue, very hard	29	456
Basalt, black, with clay	3	459
Basalt, black, hard	6	465
Basalt, gray and black, hard, creviced	4	469
Basalt, gray, very hard	24	493
Basalt, black, with clay streaks	62	555
Basalt, brown and black, medium hard	24	574
Basalt, gray, hard	19	598
Basalt, black, and clay	34	632
Basalt, blue, hard	8	640
Basalt, black, water-bearing	3	643
Basalt, gray, hard, static water level at 64 ft	2	645
Basalt, blue, black and gray, hard	155	800
Shale, brown, sticky	10	810
Shale, blue, sticky	12	822
Shale, gray, sandy	20	842
Basalt, black	16	858
Basalt, gray, hard	89	947
Basalt, brown, hard	4	951
Basalt, red, hard; static water level at 121 ft	28	979

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-32M1. L. L. Rogers. Drilled by George Scott

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	11	11
Columbia River basalt:		
Basalt, broken	5	16
Basalt, black and gray, hard	65	81
Basalt, reddish brown	11	92
Basalt, black	18	110
Shale (weathered basalt?)	16	126
Basalt, black	14	140
Clay, blue	5	145
Basalt, black and gray	167	312
Basalt, black, caving	24	336
Basalt, black, static water level at 12 ft	64	400
Basalt, black, caving	16	416
Basalt, black	10	426
Basalt, black, water-bearing	7	433
Basalt, black	89	524
Shale, blue	3	527
Basalt, black	5	532
Shale, blue	3	535
Basalt, black, hard	116	651
Basalt, broken and creviced, caving	19	670
Shale, hard, greenish	3	673
Basalt, black, hard	54	727
Basalt, soft, and clay	10	737
Basalt, broken	5	742
Basalt, hard	52	794
Clay, pasty	6	800
Basalt, black	42	842

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-32N1. L. L. Rogers. Drilled by Ben Dryer, 1953

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil, sandy	6	6
Columbia River basalt:		
Basalt, black, hard	30	36
Boulders, loose	33	69
Basalt, red, hard	11	80
Boulders and sand	5	85
Basalt, red, soft	7	92
Basalt, black, hard	158	250
Boulders and sand	6	256
Basalt, red, soft, becoming harder with depth	32	288
Basalt, blue, hard	47	335
Boulders and sand	33	368
Basalt, black, hard	60	428
Shale, green	6	434
Boulders and sand	17	451

4N/34-33Q1. L. L. Rogers. Drilled by George E. Scott

Palouse formation:		
Soil	11	11
Columbia River basalt:		
Basalt, broken	9	20
Basalt, hard	28	48
Basalt, softer	30	78
Basalt, firm	24	102
Basalt, black	8	110
Basalt, red	13	123
Basalt, black	7	130
Basalt, black, water-bearing	14	144
Basalt, black	16	160
Basalt, black, crevices at 161 and 210 ft	110	270
Basalt, black, harder, water-bearing	20	290
Basalt, black, broken top 2 ft	40	330
Basalt, black, water-bearing top 25 ft	84	414

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/34-34P1. Wild Horse Grange. Drilled by A. A. Durand and Son, 1947

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Clay and boulders	17	17
Columbia River basalt:		
Basalt, black	3	20
Basalt, gray	10	30
Basalt, dark, hard	22	52
Basalt, gray	14	66
Basalt, black, hard	13	79
Basalt, dark	13	92
Basalt, gray, soft	8	100
Basalt, black	12	112
"Shale, brown" (decomposed basalt?)	5	117
Basalt, dark, hard	26	143
Basalt, gray	17	160
Basalt, black, with hard layers	4	165
Basalt, black, water-bearing	3	168
Basalt, black, with hard streaks	41	209

4N/35-8M1. J. H. McDougal. Drilled by D. K. Smith, 1952

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil, sandy	14	14
Columbia River basalt:		
Basalt, broken	13	27
Basalt, gray	2	29
Basalt, brown, broken, water-bearing	8	37
Basalt, gray, hard	3	40
Basalt, gray and black layers	50	90
Basalt, black, water-bearing	16	106

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/35-19E1. Roger's Canning Co. well no. 1. Drilled by A. A. Durand and Son, 1941

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	10	10
Older alluvium:		
Clay, gray, with gravel	5	15
Gravel, cemented	36	51
Columbia River basalt:		
Basalt, black	40	91
Basalt, black, with blue clay	39	130
Basalt, black, porous	15	145
Basalt, black, porous, with "soapstone"	11	156
Basalt, black	75	231
"Soapstone," blue (clay?)	4	235
Basalt, black	18	253
Basalt, black, porous	17	270
Basalt, black, static water level at 8 ft	12	282
Basalt, gray, hard; static water level at 6 ft	80	362
Basalt, black, porous	28	390
Basalt, gray, hard	66	456
Basalt, black, porous	2	458
Basalt, black, porous with "soapstone"	13	471
Basalt, black, porous	59	530
Basalt, gray, hard	46	576
Basalt, brown porous	45	621
Basalt, brown and black	37	658
Basalt, black, hard	92	750
Shale, black; static water level at 8 ft	23	773
Basalt, gray and black; static water level at 6 ft	91	864
Basalt, red	5	869
Clay, blue	16	885
Basalt, black	12	897
Basalt, gray, hard	95	992
Basalt, brown and black	89	1,061
Basalt, gray, caving in bottom	9	1,070

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/35-19E2. Rogers Canning Co. Drilled by A. A. Durand and Son, 19--

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	4	4
Old alluvium (Pliocene fanglomerate?):		
Gravel	15	19
Gravel, cemented, hard	3	22
Gravel and clay	4	26
Gravel, cemented	21	47
Gravel and red and brown clay	22	69
Boulders	3	72
Gravel and brown clay	8	80
Gravel, cemented	4	84
Gravel and clay, water standing at 35 ft	2	86
Columbia River basalt:		
Basalt, black, hard, water standing at 25 ft	74	160
Basalt, black, porous, and clay	18	178
Basalt, black, hard; at 245 ft depth water level rose to 18 ft	127	305
Clay, green, sticky	7	312
Basalt, black and gray, hard; at 475 ft depth the water level rose to 16 ft	451	763
Basalt, soft	102	865
Basalt, gray, hard	67	932
Basalt, medium hard	16	948
Basalt, brown	47	995
Basalt, red and black	82	1,077
Basalt, red	79	1,156

4N/35-19E3. Athena Mills Company. Drilled by Ben Dryer, 1956

Palouse formation and Quaternary alluvium, undifferentiated:		
Soil	10	10
Gravel, water-bearing	6	16
Clay	13	29
Gravel, sandy, water-bearing	7	36
Clay	5	41
Columbia River basalt:		
Rock, shaly (decomposed basalt)	3	44
Basalt, blue, hard	2	46

Table 2.- Drillers' Logs of Representative Wells - Continued

4N/35-19L1. City of Athena well no. 1. Drilled by A. A. Durand and Son, 1935

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	25	25
Columbia River basalt:		
"Rock," broken	57	82
Basalt, gray, brown 144-195 ft	168	250
Conglomerate	100	350
Basalt, black, gray upper 45 ft	80	430
Basalt	69	499
Basalt, black	81	580
"Rock," broken	70	650
Basalt, gray	30	680

4N/35-29P1. Henry Koepke. Drilled by A. A. Durand and Son, 1940

Palouse formation:		
Soil	16	16
Columbia River basalt:		
"Boulders"	4	20
Basalt, hard	29	49
Basalt, medium hard	7	56
Basalt, soft	74	130
Basalt, medium hard	15	145
Basalt, soft	51	196
Basalt, hard, gray	96	292
Basalt, gray	31	323
Basalt, hard	9	332
Basalt, gray and black	89	421
Basalt, gray, hard	57	478
Basalt, black	8	486

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/28-10R1. U. S. Engineer Dept. Drilled by A. A. Durand and Son, 1947

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand	6	6
Gravel and small boulders	6	12
Boulders	18	30
Gravel	5	35
Gravel and sand	33	68
Gravel and silt	12	80
Gravel and sand	8	88
Gravel; static water level at 95 ft	13	101
Gravel and boulders	9	110
Gravel	5	115
Gravel and sand	1	116
Sand	1	117
Gravel and coarse sand	6	123
Boulders and fine sand	2	125
Boulders	3	128
Sand, fine	2	130
Boulders	8	138
Boulders and sand	8	146
Columbia River basalt:		
Wenas basalt member:		
Basalt and shale (clay?)	8	154
Basalt, firm	6	160
Basalt, creviced	3	163
Basalt, hard	4	167

5N/28-10R2. U. S. Engineer Dept. Drilled by A. A. Durand and Son, 1948

Glaciofluviatile deposits:		
Overburden (see strata recorded in log of well -10R1)	100	100
Columbia River basalt:		
Wenas basalt member:		
Basalt	130	230
Lower part of the Ellensburg formation:		
"Interbed" (clay?)	40	270
Yakima basalt member:		
Basalt	300	570
Basalt, scoriaceous	10	580
Basalt	80	660
"Interbed basalt"	10	670
Basalt	34	704

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/28-10R3. U. S. Engineer Dept. Drilled by R. J. Strasser, 1952

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Soil	6	6
Sand, loose	14	20
Gravel and boulders, cemented	12	32
Gravel and boulders, cemented very tightly	3	35
Gravel and boulders	5	40
Sand and gravel, cemented	11	51
Sand and gravel, loose	11	62
Gravel, some boulders and clay	2	64
Gravel and boulders with clay binder	8	72
Gravel, cemented, hard	14	86
Gravel	11	97
Gravel, cemented	3	100
Boulders and loose gravel	7	107
Gravel, cemented	10	117
Columbia River basalt:		
Wenas basalt member:		
Basalt, black and red, broken	7	124
Basalt, flow breccia	9	133
Basalt, gray, hard, creviced at 182 and 194 ft	116	249
Lower part of the Ellensburg formation:		
Shale, green	24	273
Clay, gray	15	288
"Selvage"	12	300
Yakima basalt member:		
Basalt, black, porous	6	306
Basalt, gray	51	357
Basalt, black, softer, porous	41	398
Basalt, medium hard	7	405
Shale, green	2	407
Basalt, medium hard	15	422
Basalt, gray, hard	36	458
Basalt, black, porous	8	466
Basalt, black hard	5	471
Basalt, brown and black, creviced	5	476
Basalt, gray	20	496
Basalt, porous, caving	16	512
Basalt, black, broken	6	518
Basalt, gray, hard	11	529
Basalt, broken, with clay	15	544
Basalt, gray, medium hard	38	582
Basalt, gray, hard	5	587

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/28-10R3.- Continued

Materials	Thickness (feet)	Depth (feet)
Columbia River basalt - Continued:		
Yakima basalt member - Continued:		
Basalt, red, black, brown, porous	9	596
Basalt, gray	26	622
Basalt, black, porous, broken	11	633
Basalt, gray, medium hard	17	650
Basalt, black, porous, loose	20	670
Basalt, black	13	683
Basalt, gray, medium hard	12	695
Basalt, gray, hard	3	698
Basalt, gray, medium hard	9	707
Basalt, broken, and blue clay	2	709
Basalt, broken, green coating in vesicles	3	712
Basalt, broken, and green "slate;" mineralized with iron pyrites	$1\frac{1}{2}$	$713\frac{1}{2}$
Basalt, black	$9\frac{1}{2}$	723
Basalt, black, porous, and green "slate"	5	728
Basalt, black	16	744
Basalt, porous, some green "slate"	12	756
Basalt, black	15	771
Basalt, black, broken	6	777

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/28-19A1. City of Umatilla, well no. 3. Drilled by A. M. Jannsen, 1947

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Clay and topsoil	17	17
Gravel and boulders	10	27
Sand	11	38
Gravel	132	170
Columbia River basalt:		
Wenas basalt member:		
Basalt	175	345
Lower part of the Ellensburg formation and interbedded basalt:		
Clay, blue	28	373
Basalt, broken	42	415
Basalt	90	505
Clay	30	535
Yakima basalt member:		
Basalt	215	750
Sandy formation (decomposed basalt?)	5	755
Basalt	30	785

Casing, 16-inch, set to 170 feet; 10-inch set from 310 ft to 373 ft; 8-inch set from 361 ft to 535 ft. Open 8-inch hole from 535ft to 785 ft.

5N/28-23M1. Bill Kik. Drilled by A. A. Durand and Son, 1944

Glaciofluviatile deposits:		
Sand	15	15
Columbia River basalt:		
Basalt, broken	2	17
Basalt	70	87
Basalt, water-bearing	8	95
Basalt	32	127
Basalt, alternating hard and soft; thin layers	33	160

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/29-13E1. Walso Birchman. Drilled by A. A. Durand and Son, 1948.

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Sand	15	15
Boulders and sand	5	20
Columbia River basalt:		
Basalt, hard	14	34
Basalt, broken	4	38
Basalt, brown, broken	4	42
Basalt, very hard	34	76
Basalt, honeycomb, water-bearing	14	90
Clay and "soapstone"	4	94
Basalt	91	185
Basalt, water-bearing; water level stands at 36 ft	10	195
Basalt	8	203
Basalt, gray, hard	51	254
Basalt, black	24	278
Basalt, gray	62	340
Basalt, black	20	360
Basalt	130	490
Basalt, very hard; water level standing at 39 ft	15	505

5N/29-33R1. Union Pacific Ry. Drilled by A. A. Durand and Son, 1952

Glaciofluviatile deposits:		
Sand, silty, soft, brown	9	9
Sand and gravel	6	15
Gravel	3	18
Gravel and boulders	4	22
Gravel, cemented	13	35
Gravel, coarse	2	37
Gravel, fine, gray, loose	28	65
Clay, brown, soft	9	74
Gravel	4	78
Clay, brown	2	80
Gravel	2	82
Columbia River basalt:		
Basalt, black, medium hard	26	108
Basalt, brown, broken	3	111
Basalt, gray, hard	41	152
Basalt, black, medium hard, and some clay	33	185
Basalt, gray, hard, broken	14	199
Basalt, black and gray, hard	46	245
Basalt, gray, hard	13	258
Basalt, fractured, some clay	16	274
Basalt, black, alternating soft and hard layers	24	298

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/31-1B1. Pete Kosmos. Drilled by H. Yager, 1950

Materials	Thickness (feet)	Depth (feet)
Quaternary alluvium:		
Soil	25	25
Gravel	1	26
Sand and gravel	14	40
Sand	10	50
Sand and boulders	4	54
Columbia River basalt:		
Basalt, brown, water-bearing	43	97

5N/32-18C1. C. F. Westersund. Drilled by H. Yager, 1950

Old well, drilled, no record	177	177
Columbia River basalt:		
Basalt, black	8	185
Basalt, gray	41	226
Basalt, black	16	242
Basalt, gray	60	302

Table 2.- Drillers' Logs of Representative Wells - Continued

5N/33-31A1. Earnest Koepke. Drilled by A. A. Durand and Son, 1954

Materials	Thickness (feet)	Depth (feet)
Palouse formation:		
Soil	10	10
"Hardpan," yellow	33	43
Columbia River basalt:		
Basalt, gray, very hard	43	86
Basalt, black, medium hard	21	107
Basalt, gray, very hard, water-bearing crevice at 117 ft; water level standing at 75 ft	10	117
Basalt, black, medium hard	3	120
Basalt, gray, very hard	40	160
Basalt, black and gray, medium to very hard	71	231
Basalt, brown, soft, vesicular	2	233
Basalt, gray, medium hard; water level qt 75 ft	5	238
Basalt, brown, vesicular	7	245
Basalt, black and gray, hard	80	325
Basalt, brown, water-bearing; water level at 75 ft	5	330
Basalt, black and gray	57	387
Basalt, black, medium hard, water-bearing; water level at 92 ft	2	389
Basalt, black, hard	5	394

Well bail-tested when at 330 ft depth; drawdown was 30 ft after 10 minutes bailing at 29 gpm.

5N/34-20A1. A. H. McIntyre

Materials	Thickness (feet)	Depth (feet)
Palouse formation (and fault gouge?):		
Soil	147	147
Columbia River basalt:		
"Soapstone"	15	162
Basalt	50	212

Table 3.- Chemical Anglyses of water from

(In parts per million
/Analysis by U. S Geological

Well or spring number Date of collection	3S/30-29R2 3/29/54	1S/32-9L1 4/27/53	1S/32-17F1 1946 1/
	Well	Well	Well
Temperature (°F.)		66	65
Silica (SiO_2)	20	71	60*
Iron (Fe) (Total)	47	.0	.2*
(In solution)	.0		
Manganese (Mn)			
Calcium (Ca)	48	28	
Magnesium (Mg)	8.6	10	
Sodium (Na)	22	22	
Potassium (K)	3.1	5.5	
Bicarbonate (HCO_3)	224	167	137
Carbonate (CO_3)		.0	5.1
Sulfate (SO_4)	15	13	
Chloride (Cl)	5.5	8.5	
Fluoride (F)	.8	.5	
Nitrate (NO_3)	.3	1.8	
Boron (B)	.06	.01	
Dissolved solids			
Sum	234	243	
Residue at 180° C.		240	
Hardness as $CaCO_3$	155	111	
Noncarbonate	0	0	
Sodium-adsorption ratio (SAR)	.8	.9	
Specific conductance (micromhos at 25° C.)	395	310	
pH	7.9	7.8	7.7*

1/ Items marked with an asterisk were determined by Northwest Filter

Unpublished records subject to revision

Wells and Springs of the Umatilla River Basin

except first and last 3 items)
Survey unless otherwise indicated7

1S/32-23J1 12/22/54	1N/28-28D1 4/28/53	1N/31-30B1 4/27/53	1N/32-1D1 4/27/53	1N/32-24R1 4/27/53	1N/33-7F1 4/27/53
Well	Well	Well	Well	Well	Well
68	64		53	51	56
70	70	66	61	13	68
.0	.2	.1	.0	2.7	.1
22	15	36	18	13	25
6.3	5.7	12	6.8	5.8	12
24	40	22	20	17	20
5.6	5.2	4.4	3.2	2.8	4.8
154	163	154	130	93	167
	0	0	0	0	0
7.9	.6	26	5.6	8.6	9.5
5 0	15	20	4.5	8.0	.6
.5	.1	.4	.6	.3	.5
.3	.4	9.9	.9	.6	1.5
.02	.23	.00	.00	.01	.02
218	233	273	185	115	230
	225	277	181	118	225
81	61	139	73	56	112
0	0	13	0	0	0
1.2	2.2	.8	1.2	.9	.8
263	285	378	224	188	296
7.9	8.1	7.8	7.9	7.3	7.7

CO., Seattle. Wash. Other items determined by Perolin Co., New York.

Table 3.– Chemical Analyses of Water from Wells

Well or spring number Date of collection	2N/27-11H1 4/28/53	2N/32-2R1 1/7/49 1/	2N/32-10F1 6/13/52 2/
	Well	Well	Well
Temperature (°F.)	62		
Silica (SiO_2)	66	40	49
Iron (Fe) (Total)	.1	.01	.03
(In solution)			.01
Manganese (Mn)			
Calcium (Ca)	14	27	32
Magnesium (Mg)	7.5	7.6	12
Sodium (Na)	32	(31	30
Potassium (K)	9.0	(	5.2
Bicarbonate (HCO_3)	161	130	220
Carbonate (CO_3)	0	0	
Sulfate (SO_4)	.8	21	11
Chloride (Cl)	9.5	26	7.9
Fluoride (F)	.6	.3	.2
Nitrate (NO_3)	.2		2.9
Boron (B)	.08		.08
Dissolved solids			
Sum	219	217	259
Residue at 180° C.	211		
Hardness as $CaCO_3$	66	98	129
Noncarbonate	0		0
Sodium-adsorption ratio (SAR)	1.7		1.2
Specific conductance (micromhos at 25° C.	273		385
pH	8.1	7.7	7.8

1/ Analysis by Charlton Laboratories, Inc., Portland, Oregon.
2/ Lithium 0.0 parts per million.
3/ Analysis by Oregon State Board of Health.

and Springs of the Umatilla River Basin - Continued

2N/32-35H1 3/3/53	3N/27-36A1 4/28/53	3N-32-22C1 3/3/53	4N/27-22L1 4/26/41 1/	4N/28-10P1 8/3/50 3/	4N/28-11N1 8/10/50 3/
Well	Well	Well	Well	Well	Well
	52				
43	47	49			
.06	.0		.15		
.06		.11			
.00		.00			
9.2	47	28	38		
2.8	16	13	11		
70	58	43			
9.9	5.4	7.6			
145	333	186	148		112
9	0				28
35	14	31	11		
21	9.5	23	11	14	23
.7	.5	.7		.9	1.7
.1	11	3.2			
.01	.03	.05			
272	372	290		329	239
	376				
34	184	123	140	66	15
0	0	0			
5.2	1.9	1.7			
383	571	433			
8.5	7.4	8.0	7.7	8.4	8.4

Table 3.- Chemical Analyses of Water from

Well or spring number	4N/31-9P1	4N/33-29K1	4N/34-6L1
Date of collection	4/27/53	4/27/53	1/
	Well	Well	Well
Temperature (°F.)		54	
Silica (SiO_2)	52	52	20
Iron (Fe) (Total)	.1	.0	1.4
(In solution)			
Manganese (Mn)			
Calcium (Ca)	18	65	
Magnesium (Mg)	9.1	30	
Sodium (Na)	41	25	
Potassium (K)	8.7	2.6	
Bicarbonate (HCO_3)	173	236	
Carbonate (CO_3)	0	0	
Sulfate (SO_4)	18	32	
Chloride (Cl)	7.8	45	20
Fluoride (F)	.6	.4	
Nitrate (NO_3)	6.3	57	
Boron (B)	.02	.01	
Dissolved solids			
Sum	247	425	
Residue at 180° C.	248	436	
Hardness as $CaCO_3$	82	286	132
Noncarbonate	0	92	
Sodium-Adsorption ratio (SAR)	2.0	.6	
Specific conductance (micromhos at 25° C.)	346	656	
pH	8.0	7.9	

1/ Analysis by L L Meyers Laboratory. Oakland, Ohio

Wells and Springs of the Umatilla River Basin - Continued

4N/34-22K1 4/28/63	5N/32-31F1 4/27/53	2S/28-23E1 4/1/54	3N/37-18H1 4/1/54
Well	Well	Spring	Spring
		58	94
49	52	55	68
.0	.0	.08	.20
		.02	.00
64	2.8	26	14
18	2.2	5.8	3.5
56	106	22	133
1.0	11	3.9	7.6
370	224	144	64
0	0		
8.4	42	7.0	.2
13	23	6.0	192
.5	.6	1.0	4.0
20	.3	4.4	.2
.01	.04	.05	10
412	350	202	464
415	350		
234	16	89	50
0	0	0	0
1.6	11	1.0	8
642	510	274	765
7.9	8.3	8.1	8.6

Table 4.- Representative Springs in the

/Spring locations shown

Topography of spring area: Cb, canyon bottom; Fp, flood plain; S, slope;
Use of water: D, domestic; FC, forest camp; Irr, irrigation; N, none;
Remarks: Abbreviation ppm means parts per million by weight.
Altitudes are approximated from map and barometer surveys.

Location	Owner or occupant	Name	Topography and altitude above sea level (feet)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
	T. 5 S., R. 29 E.				
2D1	U. S. Forest Service	Ellis Guard Station	Um	Basalt	Seeps outward from soil overlying basalt
	T. 4 S., R. 29 E.				
29G1	U. S. Forest Service	Chicken Spring	S	do.	Seepage from soil overlying basalt
29R1	do.	Happy Home Spring	S	do.	do.
	T. 4 S., R. 30 E.				
21K1	do.	Log Spring	Uv	do.	do.
	T. 4 S., R. 32 E.				
5C1	do.	Cold Spring	Uv	do.	Large marshy seep in soil overlying basalt
	T. 3 S., R. 29 E.				
19K1	Paul Hisler		S	do.	

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Umatilla River Basin Area
on plate 2.7

T, terrace; U, upland; Um, upland meadow; Uv, upland valley.
S, stock; Spa, recreational resort

Yield		Use	Temperature (°F.)	Remarks
Gallons per minute	Date			
(7)	(8)	(9)	(10)	(11)
3	Sept.24, 1953	D. S.		Spring is enclosed by a 4-ft by 6-ft concrete box.
3	do.	FC	44	Improved in small reservoir and $1\frac{1}{2}$-inch pipe outlet.
1-	do.	FC	44	Enclosed by small wooden box.
1-	Oct. 6, 1953	FC		Do.
5	Aug. 5, 1953	FC		Dam in ditch below spring impounds 275 cubic ft of water; much algae in spring and pool; hardness of water is 40 ppm and chloride 2 ppm.
		D, S		Improved by 6-by-6-by-4-ft concrete reservoir.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 3 S., R. 30 E.					
33E1	Orville Corlley		Uv		
T. 3 S., R. 32 E.					
4N1	Pine Grove School		S	Gneiss	Flows from crevices in weathered rock
26M1	Charles Carnes		Uv	Basalt	Seep from soil overlying basalt
27G1	Roley	Roley Cabin Spring	Uv	do.	Flows from broken basalt
T. 3 S., R. 33 E.					
12K1		McLellan Spring	Um	Soil	Shallow seepage beneath upland meadow marsh
16J1	U. S. Forest Service	Klondike Spring	S	Soil overlying basalt	Flows from soil just below base of basalt rimrock
T. 2 S., R. 28 E.					
22E1	W. W. Weaver		S	Basalt	Flows from broken basalt; numerous other springs flow from horizontal linear aquifers cropping out on steep hillsides, especially on north

Umatilla River Basin Area - Continued

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
		D, S		Reported to have small yield in summer; hardness of water 50 ppm and chloride 6 ppm.
2	Aug. 10, 1953	D	52	Piped to school from 2-ft circular concrete spring box; hardness 225 ppm and chloride 5 ppm.
2		D		Spring enclosed by 4-by-5-ft concrete box.
2	Aug. 11, 1953	D		Water is rather milky in appearance.
		D		Do.
2	Aug. 11, 1953	FC		Water appears milky; hardness of water 75 ppm and chloride 32 ppm.
		D, S		Owner reports that water stains user's teeth; see table 3 for chemical analysis of water.

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 2 S., R. 28 E. - Continued					
24A1	Zetta Brosnan		S	Basalt	
T. 2 S., R. 29 E.					
4Q1	W. H. Wachter		Uv	do.	
T. 2 S., R. 31 E.					
1D1	Arthur Nieson		Uv	Alluvium in canyon bottom	Shallow seepage beneath marshy area
29B1			Uv	Basalt	Flows from fractures in basalt
30F1	Archie S. Warner		S	do.	Flows from fracture in basalt of the canyon wall
T. 2 S., R. 33 E.					
18Q1	Arvine Porter		Uv	do.	
T. 2 S., R. 35 E.					
31H1	U. S. Forest Service	Flat Spring	Uv	do.	Seeps out through soil that covers the basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield		Use	Temperature (°F)	Remarks
Gallons per minute	Date			
(7)	(8)	(9)	(10)	(11)
		D		Hardness of water 60 ppm, and chloride 8 ppm.
10		D, S		
0.5	Aug. 6, 1953	D		Hardness of water 140 ppm and chloride 26 ppm.
2	do.	D		Hardness of water 105 ppm and chloride 12 ppm.
0.5	Aug. 10, 1953	D		Reservoir enclosing spring is formed by a 6-ft adit into hill-side and the entrance sealed by concrete wall.
		D		Hardness of water 70 ppm and chloride 10 ppm.
1	Aug. 4, 1953	FC, S		Water appears milky.

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 1 S., R. 26 E.					
1E1	John Graves		Uv 1,620	Basalt	Percolates upward through soil overlying basalt
T. 1 S., R. 27 E.					
17B1			Uv	do.	Seeps from many openings in thick soil cover over basalt in canyon bottom
21R1	E. C. Doherty		Uv	do.	Seeps through soil overlying basalt
29C1	Ferguson		Uv	Alluvium	Seeps into reservoir from alluvium in bottom of canyon carved in the basalt
T. 1 S., R. 28 E.					
20M1	Joe Kenny		Uv	Basalt	Flows from soil overlying basalt
T. 1 S., R. 30 E.					
32C1			Uv	Soil	Forms small pools in loessal alluvium of canyon bottom; no running water visible

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
3	Aug. 27, 1953	D		
12	do.	S		Overlying soil is swampy and has a high content of organic material.
3	do.	D		
		D		
		D, S		
1-	Sept.24, 1953	S		Much algae growth in and around the pools.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 1 S., R. 31 E.					
31A1	Krosting		Uv	Basalt	Seeps from talus in canyon bottom
T. 1 S., R. 33 E.					
1P1	Wilfred Minthorn		S 1,860	do.	Flows from soil covering basalt
19N1	Grant Horn		Uv	Alluvium	
20E1	R. B. Rugg		S	Basalt	
T. 1 S., R. 36 E.					
12J1		Tie Camp Spring	U	do.	Seeps upward through soil that covers the basalt
T. 1 S., R. 37 E.					
10N1	U. S. Forest Service	Yarn Spring	U	do.	Flows through thin soil covering basalt
16A1	do.	Indian Spring	S	do.	do.
16N1	do.	Allan Spring	S	do.	do.

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield		Use	Temperature (°F)	Remarks
Gallons per minute	Date			
(7)	(8)	(9)	(10)	(11)
		D, S		
2	Oct. 2, 1953	D, S		Reportedly flows heavier during wet season; hardness of water 50 ppm and chloride 6 ppm.
10	Oct. 28, 1953	D, S		Reportedly flows heavier during the spring months of each year.
		D		Hardness of water 70 ppm and chloride 4 ppm.
2	Sept. 9, 1953	D, FC	45	
2	do.	FC	44	
2	do.	FC	42	Located in an upland meadow
1	do.	FC	44	Water appears milky.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 1 S., R. 38 E.					
1D1	U. S. Forest Service	Pot Spring	Uv	Basalt	Flows through thin soil covering basalt
T. 1 N., R. 27 E.					
28N1			Uv 1,550	do.	Flows from basaltic alluvium overlying solid basalt
T. 1 N., R. 29 E.					
22E1			Uv 1,900	do.	Flows from fracture in basalt
T. 1 N., R. 30 E.					
23C1	T. A. Cross		Uv 2,050	Basaltic alluvium	Seeps from basaltic alluvium overlying basalt
T. 1 N., R. 31 E.					
11A1	LeRoy Beilke		Uv 1,330	Alluvium	Flows from several openings in silty alluvium and basalt bedrock
11K1			Uv 1,460	Basalt	Seeps from perched water zone through soil overlying basalt at edge of narrow valley bottom

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
1	Sept. 3, 1953	FC	44	
2	Aug. 28, 1953	S	64	Small amount of sulfurous gas bubbles up from opening.
1	July 9, 1953	S	56	Hardness of water 85 ppm and chloride 25 ppm.
		S		
93	Feb. 24, 1953	S		
2	Feb. 23, 1953	N		

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 1 N., R. 31 E. - Continued					
32K1	Hemphill		Uv 2,140	Basalt	Seeps from basaltic and silty alluvium in valley bottom; bedrock is basalt
T. 1 N., R. 32 E.					
20G1	Ray Eckles		Uv 1,460	do.	Flows upward through soil overlying basalt
T. 1 N., R. 34 E.					
32N1	Herman Rosenburgh		S 1,950	do.	Flows from fractures in basaltic hillside
T. 1 N., R. 35 E.					
29B1	State Highway	Emigrant Springs	S 3,810	do.	Flows from several openings and seepage areas in soil overlying basalt; most openings yield less than 1 gallon per minute and the openings are separated by distances of 50 ft to several hundred feet

Umatilla River Basin Area - Continued

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
		D, S		
4	Feb. 27, 1953	D, S		
		D, S		Hardness of water 35 ppm and chloride 4 ppm.
		N		These springs once supplied water to emigrant trains and later to a State park; their use was abandoned when a well was drilled.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 1 N., R. 37 E.					
6F1	U. S. Forest Service		S	Basalt	Flows from wet area in soil covering basalt
6K1	do.	Black Mountain	S	do.	Flows from soil overlying basalt
23J1	do.	Farley Spring	U	do.	Seeps from muddy area in soil overlying basalt
24G1	do.	Pole Spring	U	do.	Flows from soil overlying basalt
34P1	do.	Bear Camp Spring	S	do.	Seeps from soil overlying basalt
T. 2 N., R. 28 E.					
9G1		Service Spring	S 1,000	do.	Flows from fractures in basalt
10E1		Service Spring	S 1,100	do.	Flows from wet area extending 100 yards along face of steep hillside in basaltic rubble and soil overlying basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
1-	Sept. 3, 1953	S		
2	do.	FC	43	Hardness of water 20 ppm and chloride 4 ppm.
1-	do.	FC		Supplies very little water.
3	Sept. 7, 1953	FC	46	
1-	Sept. 9, 1953	FC		
3	July 16, 1953	S		Developed by 3½-ft cubic concrete box set into hillside; water has a slight sulfur odor; hardness of water 95 ppm and chloride 22 ppm.
1	do.	S		Hardness of water 115 ppm and chloride 18 ppm; small nodules of carbonate material have been deposited on the end of a pipe leading to a stock trough.

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 2 N., R. 28 E. - Continued					
10J1		Service Spring	S 930	Basalt	Flows from basaltic rubble and soil overlying basalt
11R2		Vais Spring	Uv 925		Flows from soil in valley bottom
30D1			980		
T. 2 N., R. 30 E.					
14N1		Lower Mud Spring	Cb 1,100	Basalt	Seeps from loessal alluvium overlying basalt
23D1		Upper Mud Spring	S 1,250	do.	do.
29C1			Cb 1,310		
T. 2 N., R. 32 E.					
26N1	Robert Bowman		Uv 1,225	Soil	Seeps from perched water table in soil overlying basalt
33L1	Bigham		Fp 1,150	Alluvium	Rises through alluvium in canyon floor

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield		Use	Temperature (°F)	Remarks
Gallons per minute	Date			
(7)	(8)	(9)	(10)	(11)
1	July 16, 1953	S		Hardness of water 90 ppm and chloride 16 ppm.
1	do.	S	60	Hardness of water 115 ppm and chloride 18 ppm.
3	July 15, 1953	S	58	
5	July 1, 1953	S		Seepage area extends about 150 yards up the canyon.
5	July 7, 1953	N		Seepage area extends about 1/4 mile up a gully.
		D, S		
70	Apr. 8, 1953	D, S		

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 2 N., R. 33 E.					
26J1	Hobby		S 1,740	Basalt	Flows from perched aquifer in basalt hillside
T. 2 N., R. 34 E.					
18Q1	Melisse Abrahams		S 1,600		
30E1	St. Andrews School		Uv 1,900	Basalt	Flows from fractures in basalt
T. 2 N., R. 37 E.					
25E1	U. S. Forest Service	Ruckel Spring	Uv	do.	Seeps into reservoir from soil and basalt rubble
T. 2 N., R. 38 E.					
5E1	U. S. Forest Service	Squaw Spring	Uv	do.	Seeps through soil covering basalt
7K1	do.	Portugese Spring	Uv	do.	do.
T. 3 N., R. 29 E.					
7C1	Zina Houser		Fp 590	Gravel	Percolates upward out of marshy lowland

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
		D		Water used to irrigate 1/4 acre of lawn.
4	Aug. 31, 1953	D		Hardness of water 70 ppm and chloride 6 ppm.
30	Apr. 30, 1953	D		Hardness of water 50 ppm and chloride 6 ppm.
		FC	49	Hardness of water 45 ppm and chloride 6 ppm.
1	Aug. 22, 1953	FC	42	
3	Sept. 3, 1953	FC	45	Hardness of water 30 ppm and chloride 6 ppm.
10	Oct. 1, 1953	D, S		Yields slightly more water when irrigation ditches are full.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 3 N., R. 29 E. - Continued					
36G1	L. G. Matheny		S 760	Basalt	Flows from perched aquifer cropping out in basalt hillside
T. 3 N., R. 33 E.					
21G1	Hans Pahl		Uv 1,320	do.	Flows from a series of small openings along bottom of steep side canyon
T. 3 N., R. 35 E.					
3M1	Bessie Bill and sons		Uv	do.	
T. 3 N., R. 37 E.					
18H1	Bar M. Ranch	Bingham Spring	S	do.	Flows from 3 fissures in cliff face; located near where fault crosses the river
T. 3 N., R. 38 E.					
29D1	U. S. Forest Service	Shamrock Springs	S	do.	Seeps from soil overlying basalt

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield: Gallons per minute	Yield: Date	Use	Temperature (°F)	Remarks
(7)	(8)	(9)	(10)	(11)
5	Oct. 1, 1953	D, S		
		D, S		Hardness of water 65 ppm and chloride 52 ppm.
4	Sept. 2, 1953	D, S		Reportedly has greater yield during rainy season.
85	Dec. 19, 1953	Spa	94	Water has strong sulfur odor and taste; see table 3 for chemical analysis of water.
1-	Aug. 22, 1953	FC	42	Hardness of water 20 ppm and chloride 6 ppm.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)
T. 4 N., R. 31 E.					
12J1	D. Casteei		Uv 1,340	Basalt	Seeps from soil overlying basalt
T. 4 N., R. 34 E.					
22G1	Sampson		Uv 1,680	Loess	Bubbles up through loessal silt from perched water table in silt overlying basalt; water is confined by layer of hardpan
T. 5 N., R. 37 E.					
11R1	R. R. Raymond		Uv 1,750	Basalt	Flows from fracture in basalt; area is marshy with many springs

Unpublished records subject to revision

Umatilla River Basin Area - Continued

Yield		Use	Temperature (°F)	Remarks
Gallons per minute	Date			
(7)	(8)	(9)	(10)	(11)
		D, S		
35	Apr. 24, 1953			
10	Sept.10, 1953	D, S		Hardness of water 90 ppm and chloride 44 ppm.

Unpublished records subject to revision

Table 4.- Representative Springs in the

Location	Owner or occupant of property	Name	Topography and altitude (feet above sea level)	Water-bearing material	Occurrence
(1)	(2)	(3)	(4)	(5)	(6)

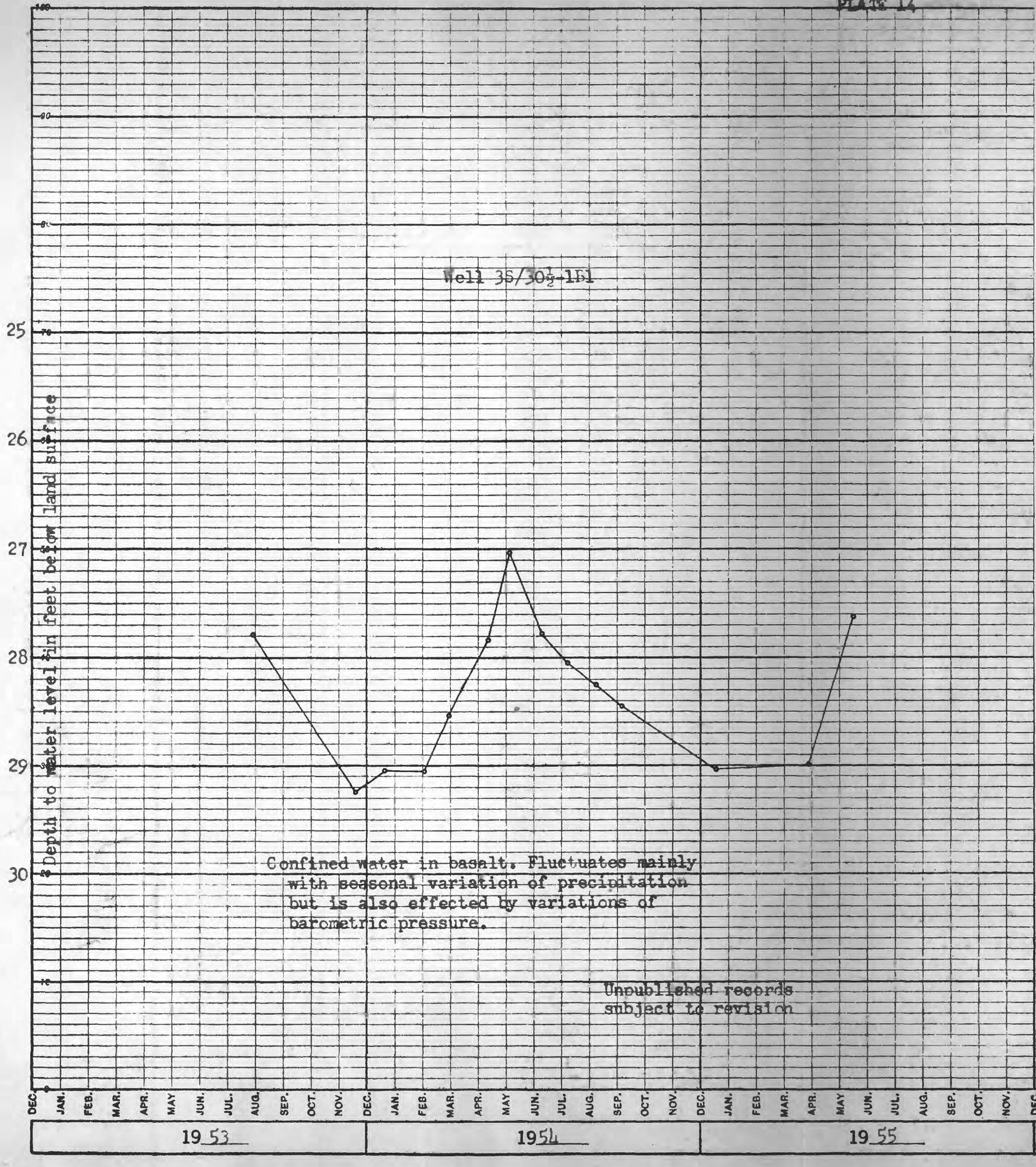

Well 3S/30½-1B1
Depth to water level in feet below land surface
25
26
27
28
29
30
Confined water in basalt. Fluctuates mainly
with seasonal variation of precipitation
but is also effected by variations of
barometric pressure.
Unpublished records
subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1953
1954
1955

PLATE 14

PLATE 15

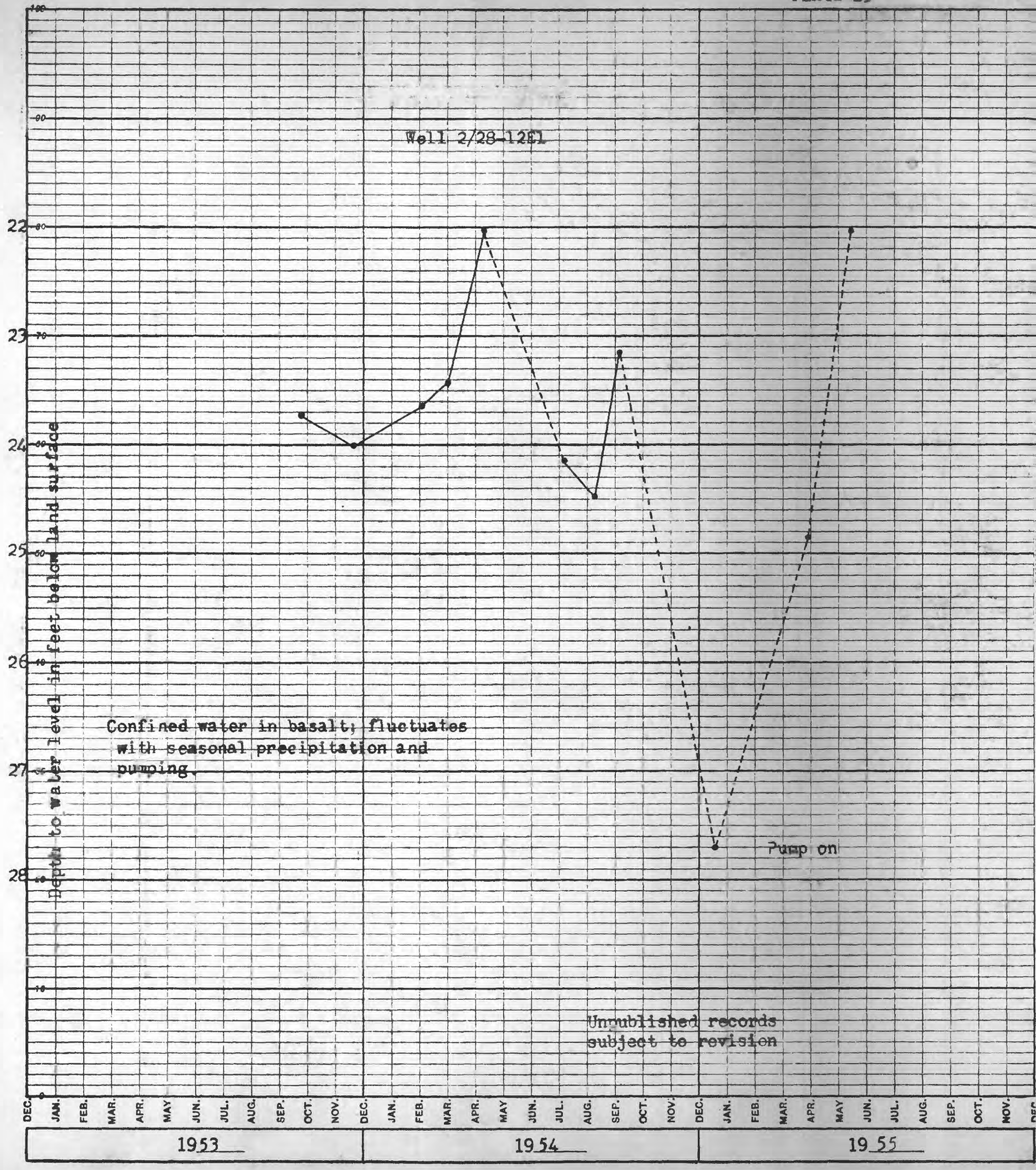

Well 2/28-12E1
Depth to Water level in feet below land surface
22
23
24
25
26
27
28
Confined water in basalt; fluctuates with seasonal precipitation and pumping.
Pump on
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
1953
1954
1955

PLATE 15

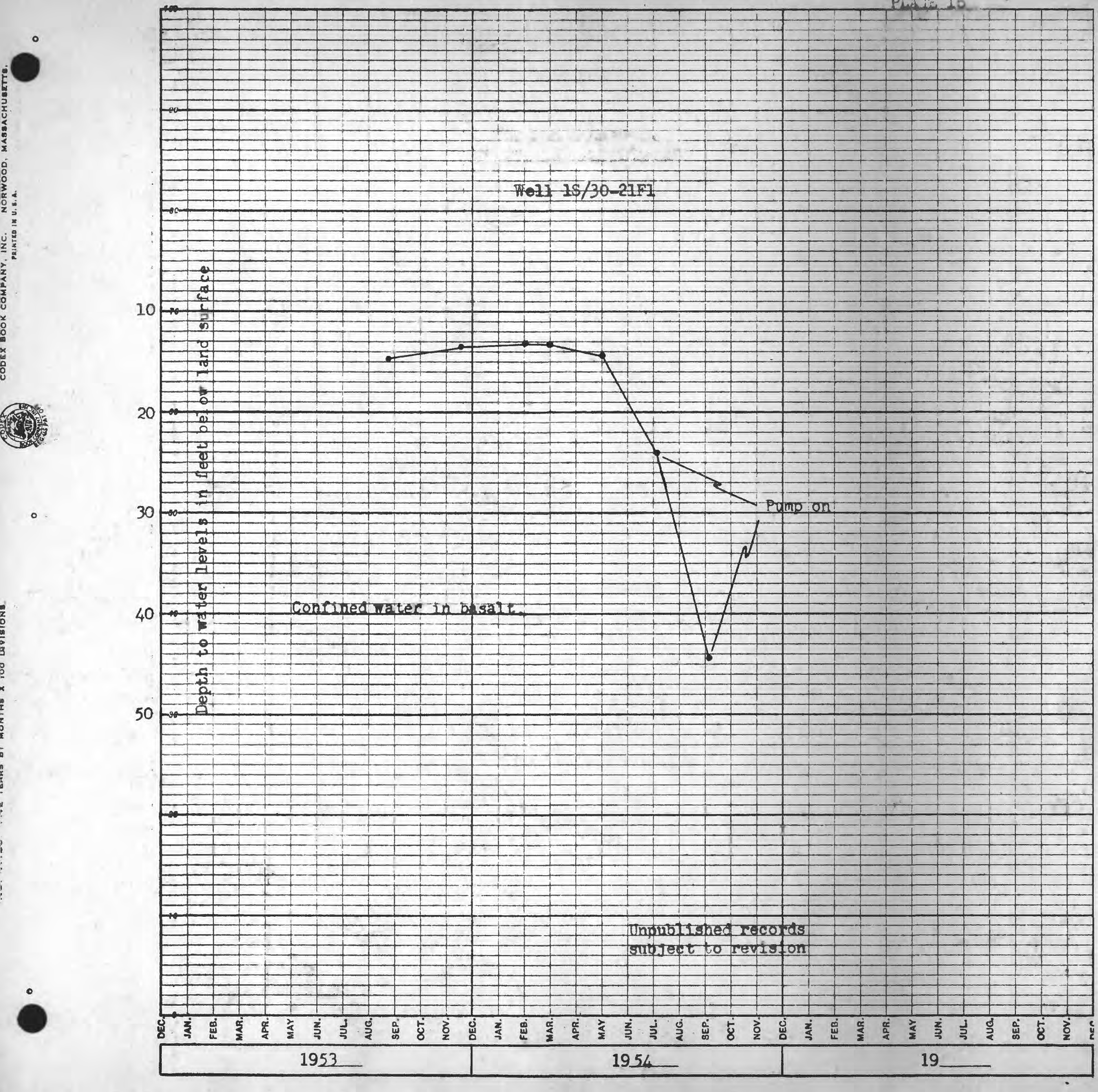
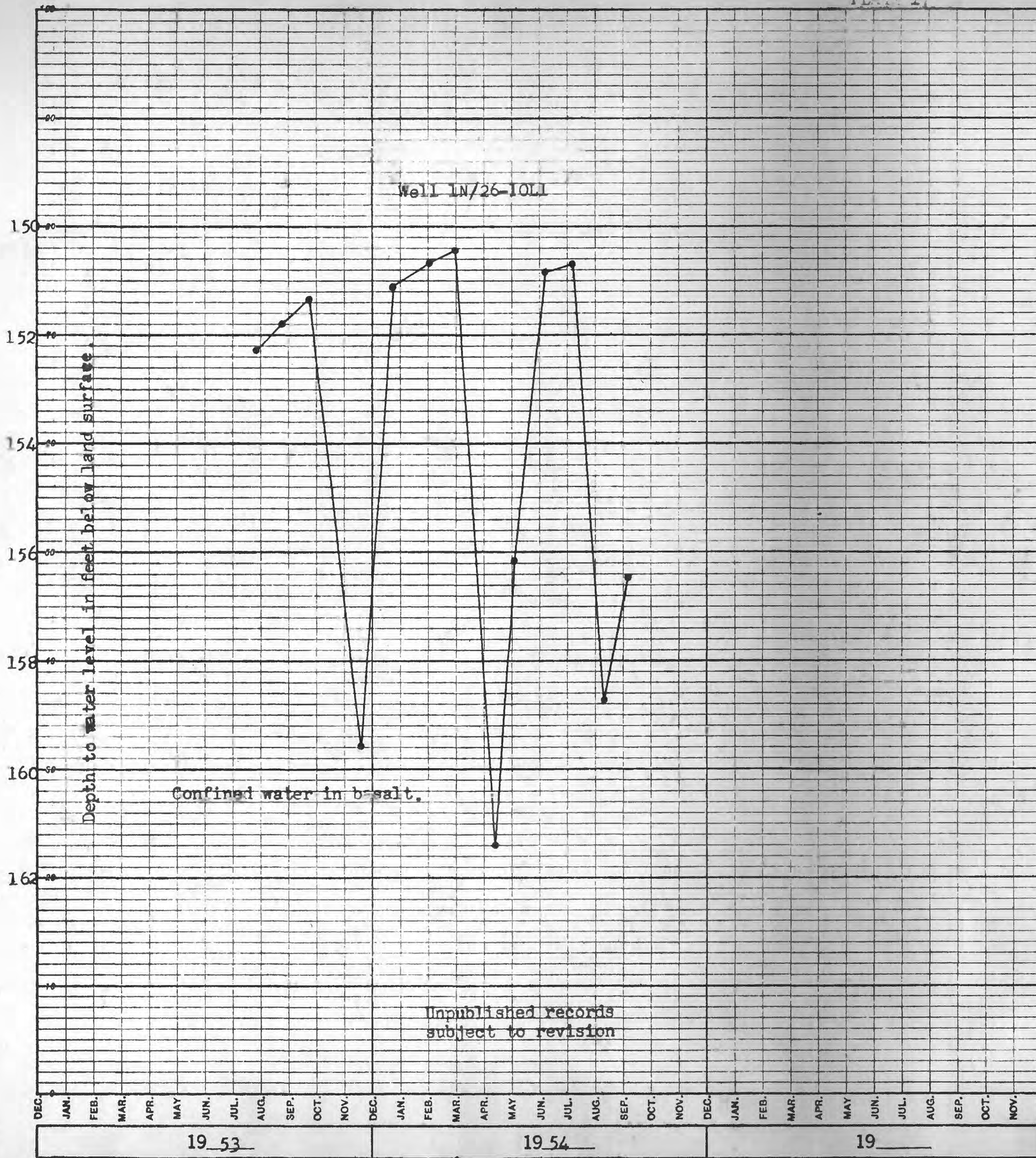

Well 1S/30-21F1
Depth to water levels in feet below land surface
10
20
30
40
50
Pump on
Confined water in basalt
Unpublished records
subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
19

PLATE 16

PLATE 17



Well 1N/26-10L1
Depth to water level in feet below land surface.
150
152
154
156
158
160
162
Confined water in basalt.
Unpublished records
subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
19 53
19 54
19

PLATE 17

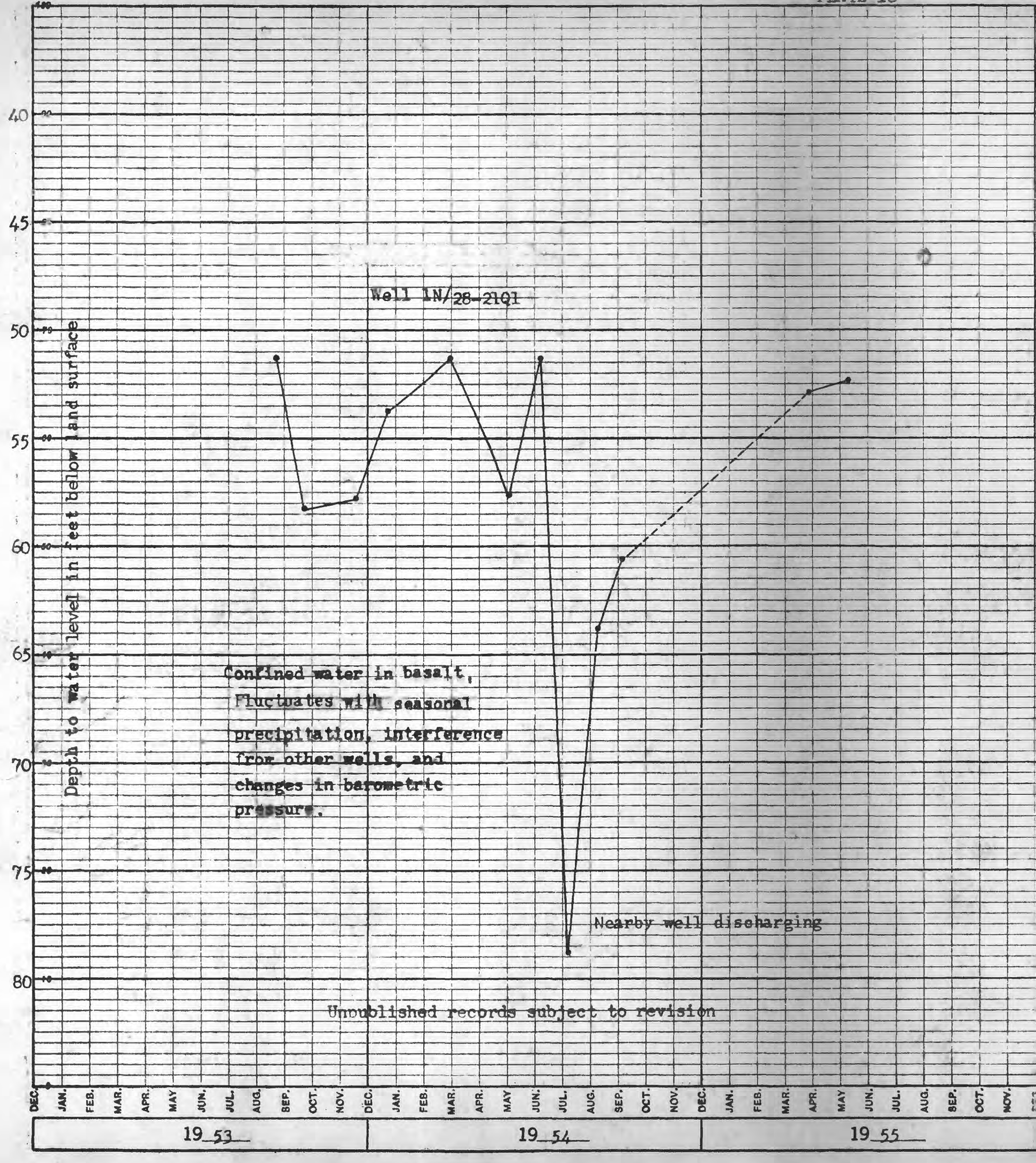

Well 1N/28-21Q1
Depth to water level in feet below land surface
40
45
50
55
60
65
70
75
80
Confined water in basalt,
Fluctuates with seasonal
precipitation, interference
from other wells, and
changes in barometric
pressure.
Nearby well discharging
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
19 53
19 54
19 55

PLATE 18

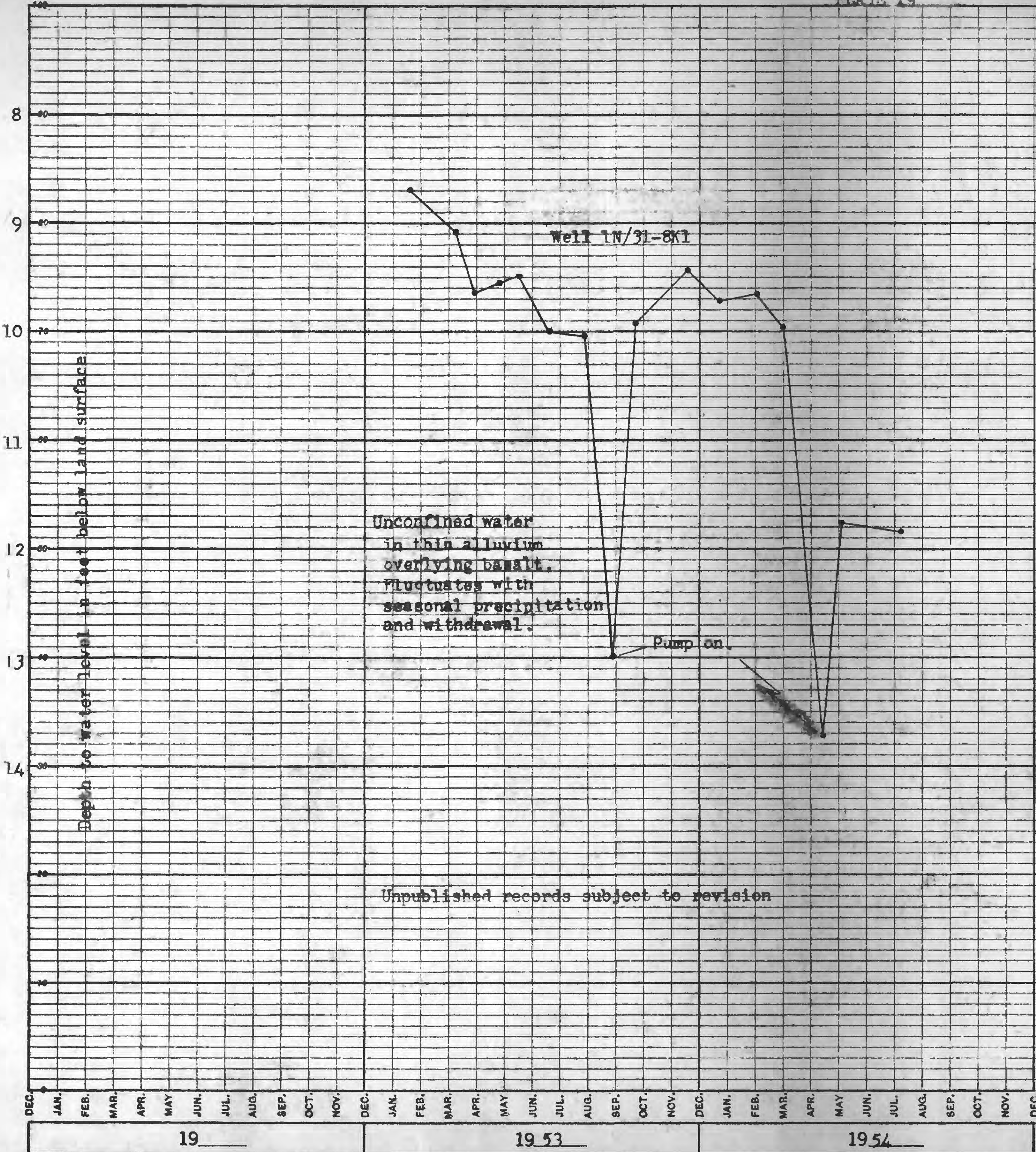
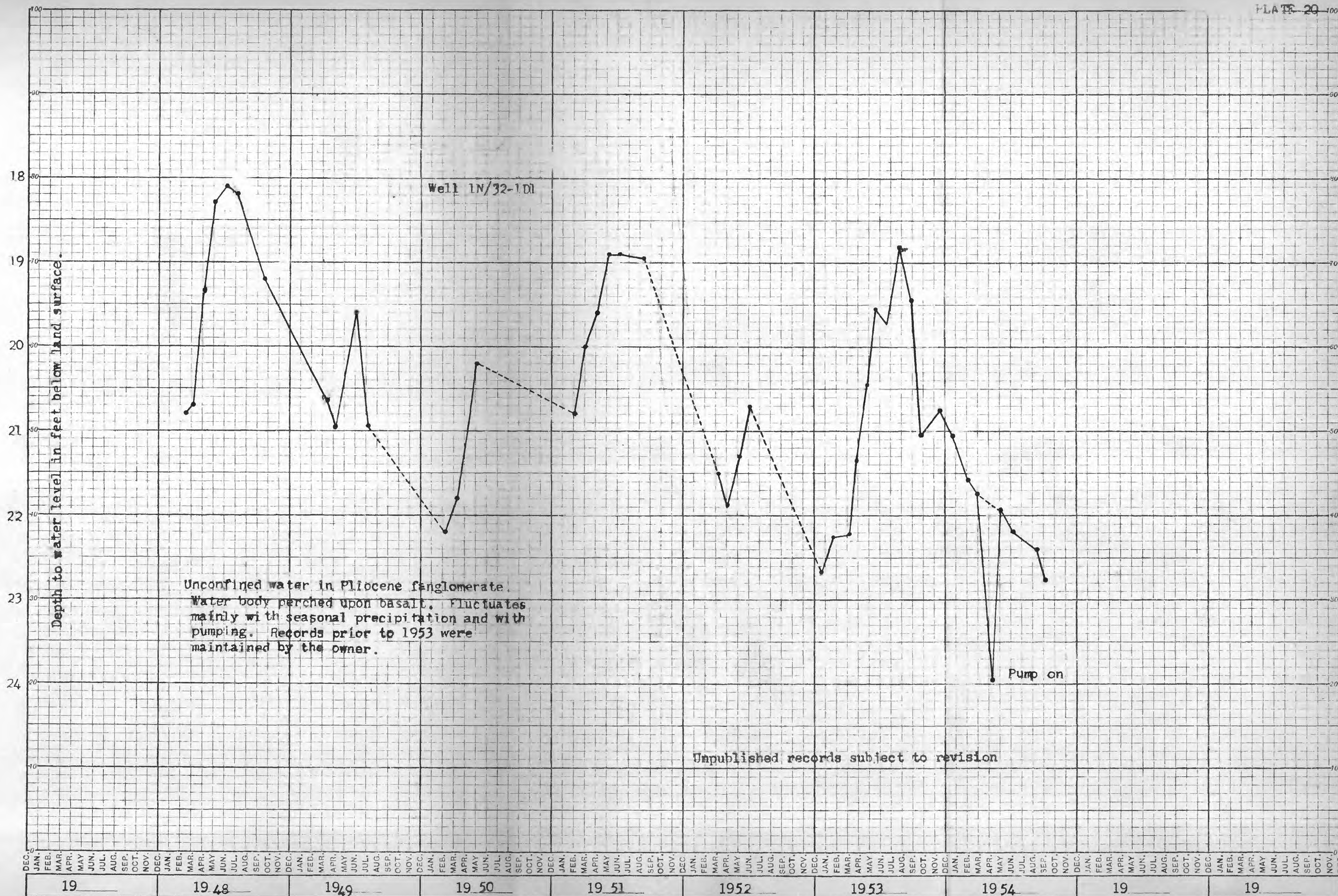

Well 1N/31-8K1
Depth to water level in feet below land surface
8
9
10
11
12
13
14
Unconfined water in thin alluvium overlying basalt. Fluctuates with seasonal precipitation and withdrawal.
Pump on.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
19
1953
1954

PLATE 19

PLATE 19


Well 1N/32-1D1
Depth to water level in feet below land surface.
18
19
20
21
22
23
24
Unconfined water in Pliocene fanglomerate. Water body perched upon basalt. Fluctuates mainly with seasonal precipitation and with pumping. Records prior to 1953 were maintained by the owner.
Pump on
Unpublished records subject to revision
19
1948
1949
1950
1951
1952
1953
1954
19
19

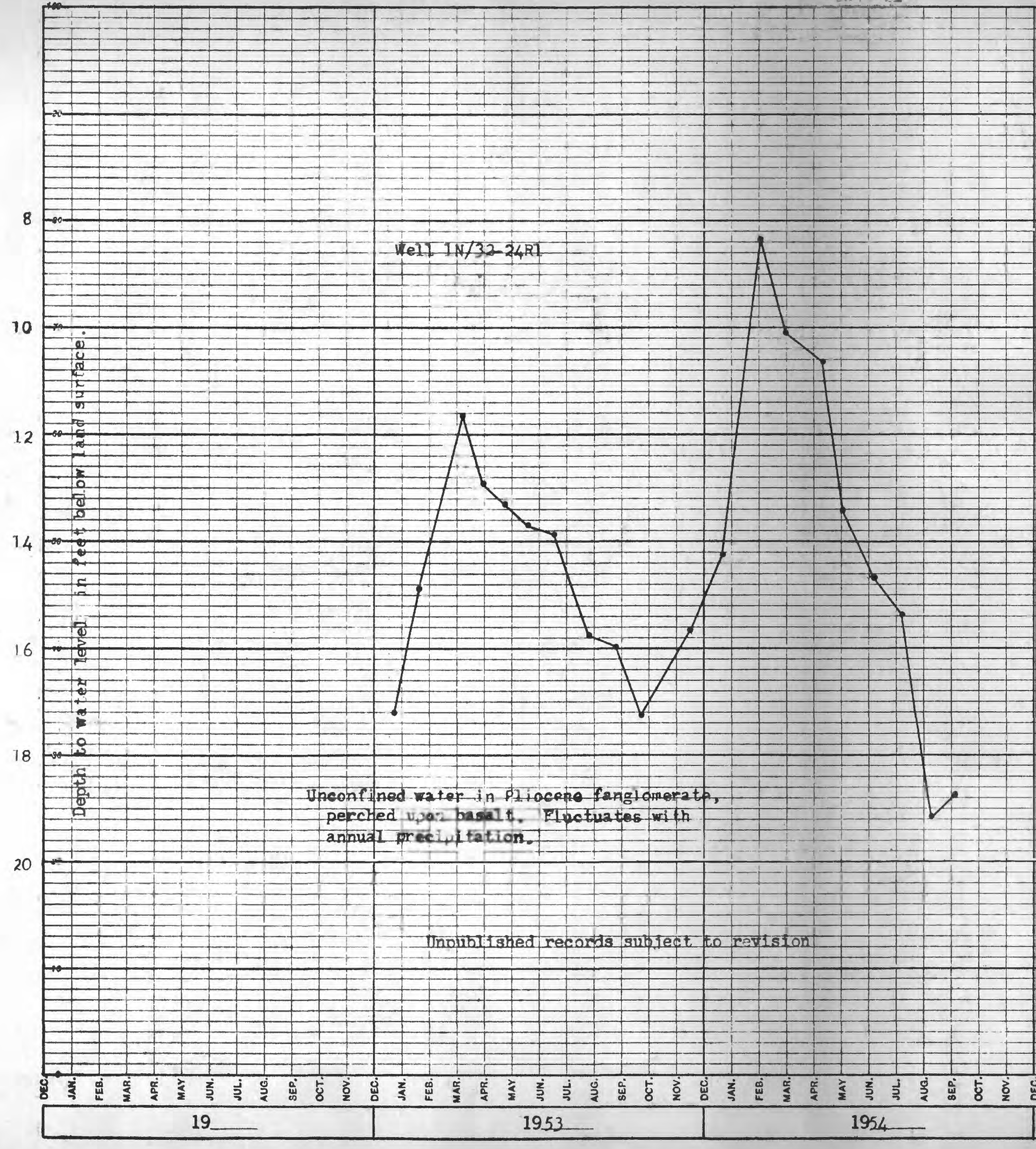

Well 1N/32-24R1
Depth to water level in feet below land surface.
8
10
12
14
16
18
20
Unconfined water in Pliocene fanglomerate,
perched upon basalt. Fluctuates with
annual precipitation.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.
19
1953
1954

PLATE 21

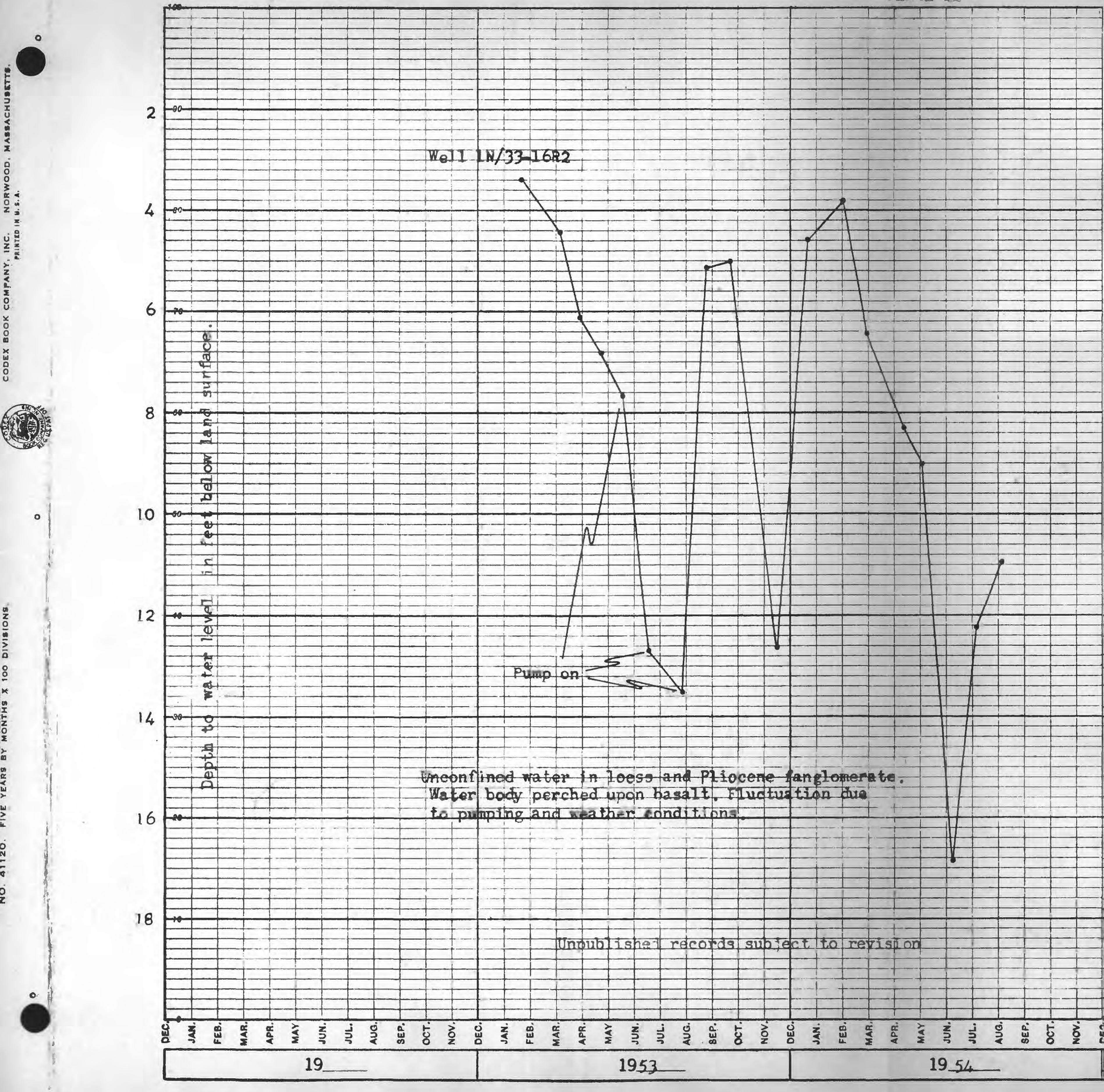

Well 1N/33-16R2
Depth to water level in feet below land surface.
2
4
6
8
10
12
14
16
18
Pump on
Unconfined water in loess and Pliocene fanglomerate. Water body perched upon basalt. Fluctuation due to pumping and weather conditions.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
19
1953
1954
NO. 41120. FIVE YEARS BY MONTHS X 100 DIVISIONS.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.
PRINTED IN U.S.A.

PLATE 22

PLATE 23

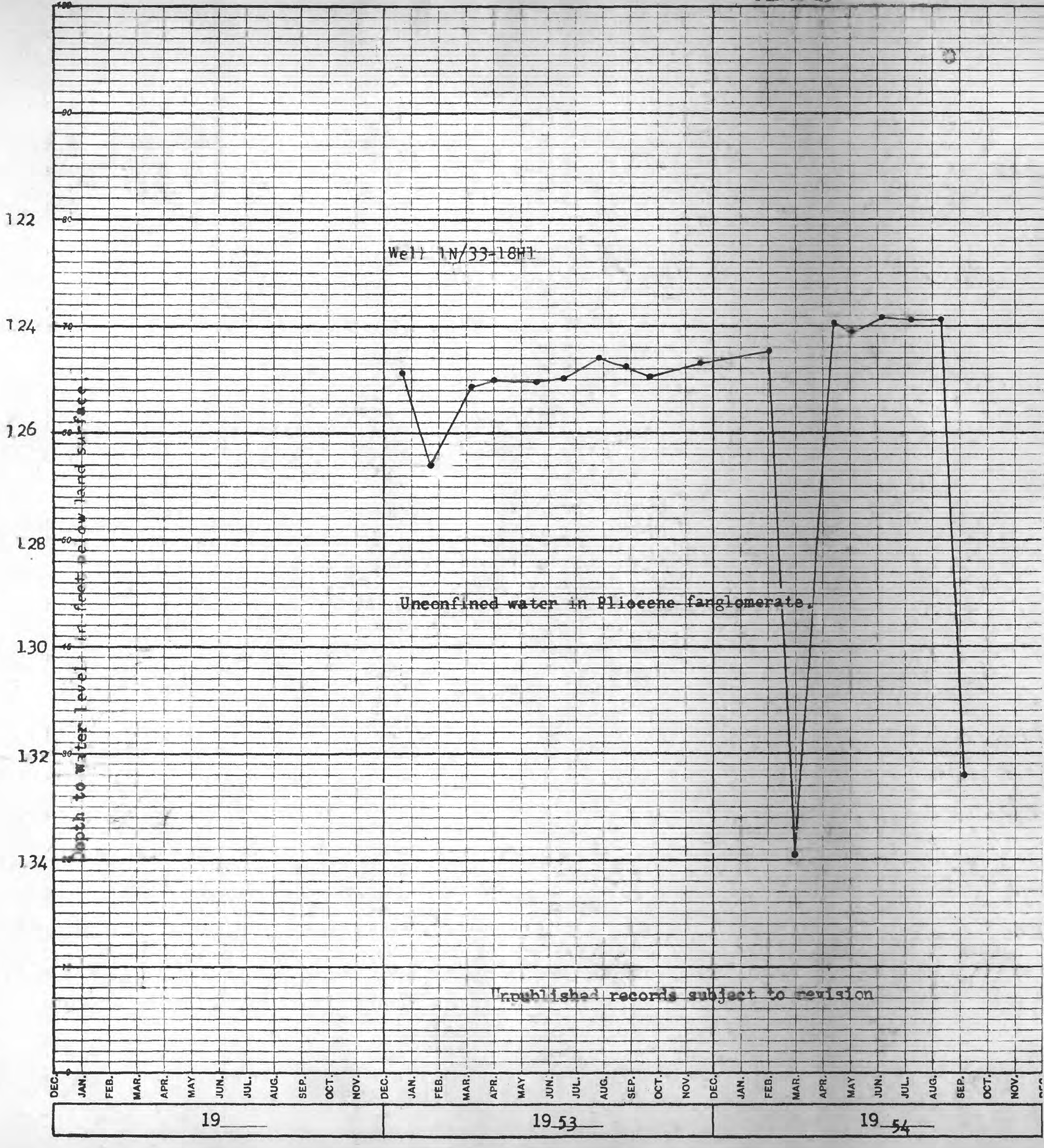

Well 1N/33-18H1
Unconfined water in Pliocene fanglomerate.
Depth to water level in feet below land surface
122
124
126
128
130
132
134
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
19
1953
1954

PLATE 23

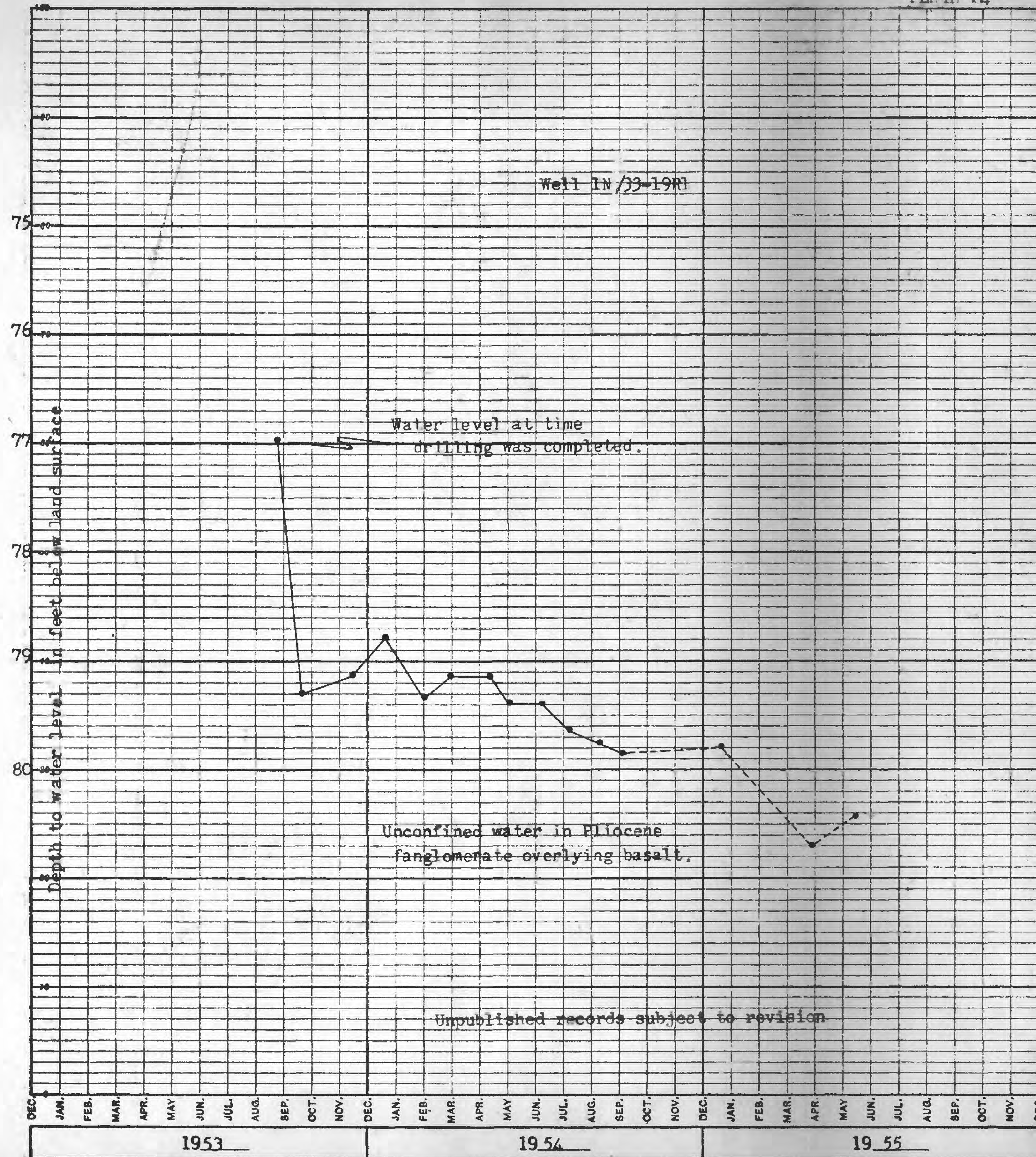
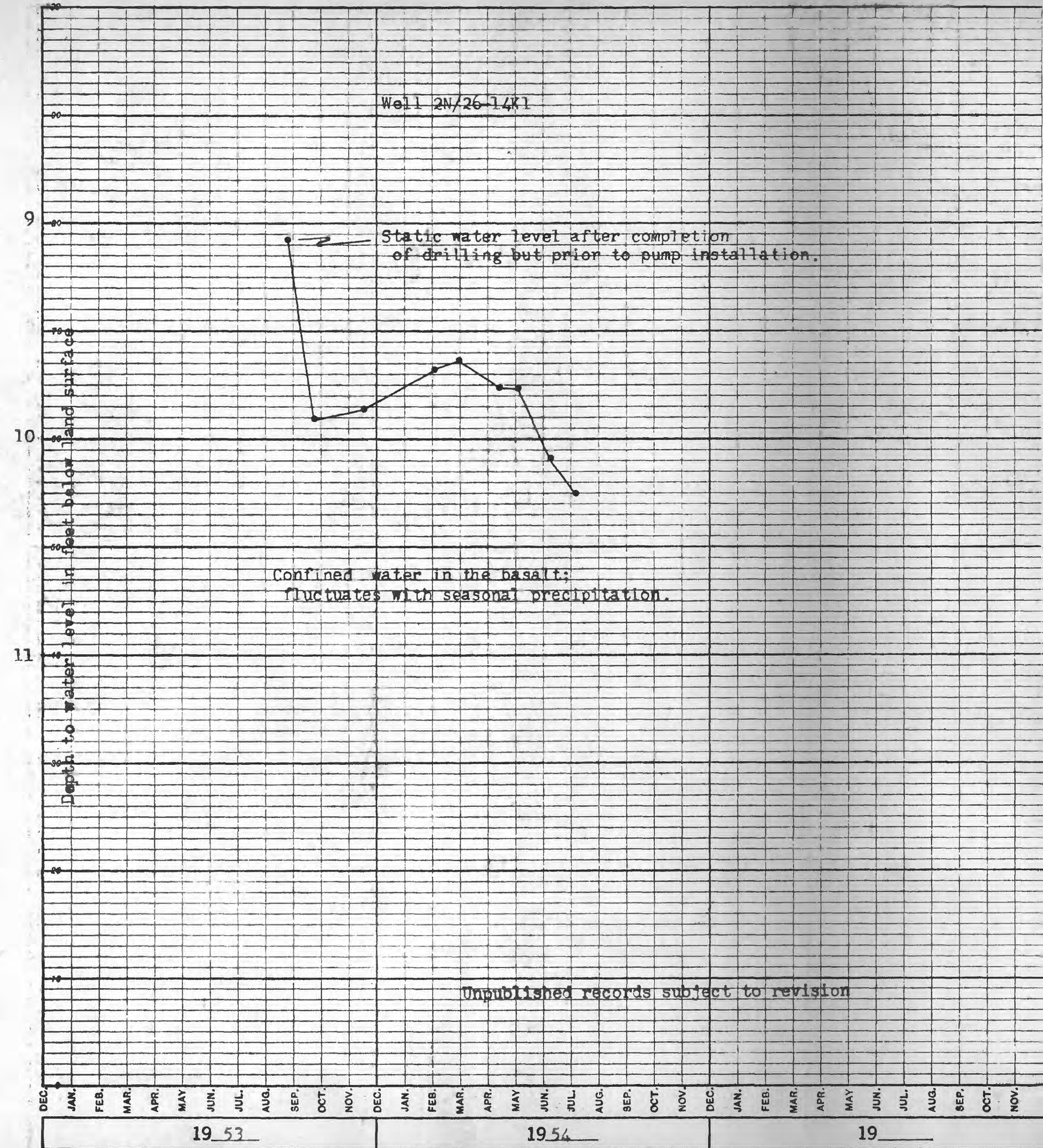

Well 1N/33-19R1
Depth to water level in feet below land surface
75
76
77
78
79
80
Water level at time drilling was completed.
Unconfined water in Pliocene fanglomerate overlying basalt.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 24



Well 2N/26-14K1
Static water level after completion of drilling but prior to pump installation.
Confined water in the basalt; fluctuates with seasonal precipitation.
Unpublished records subject to revision
Depth to water level in feet below land surface
9
10
11
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
19

PLATE 25

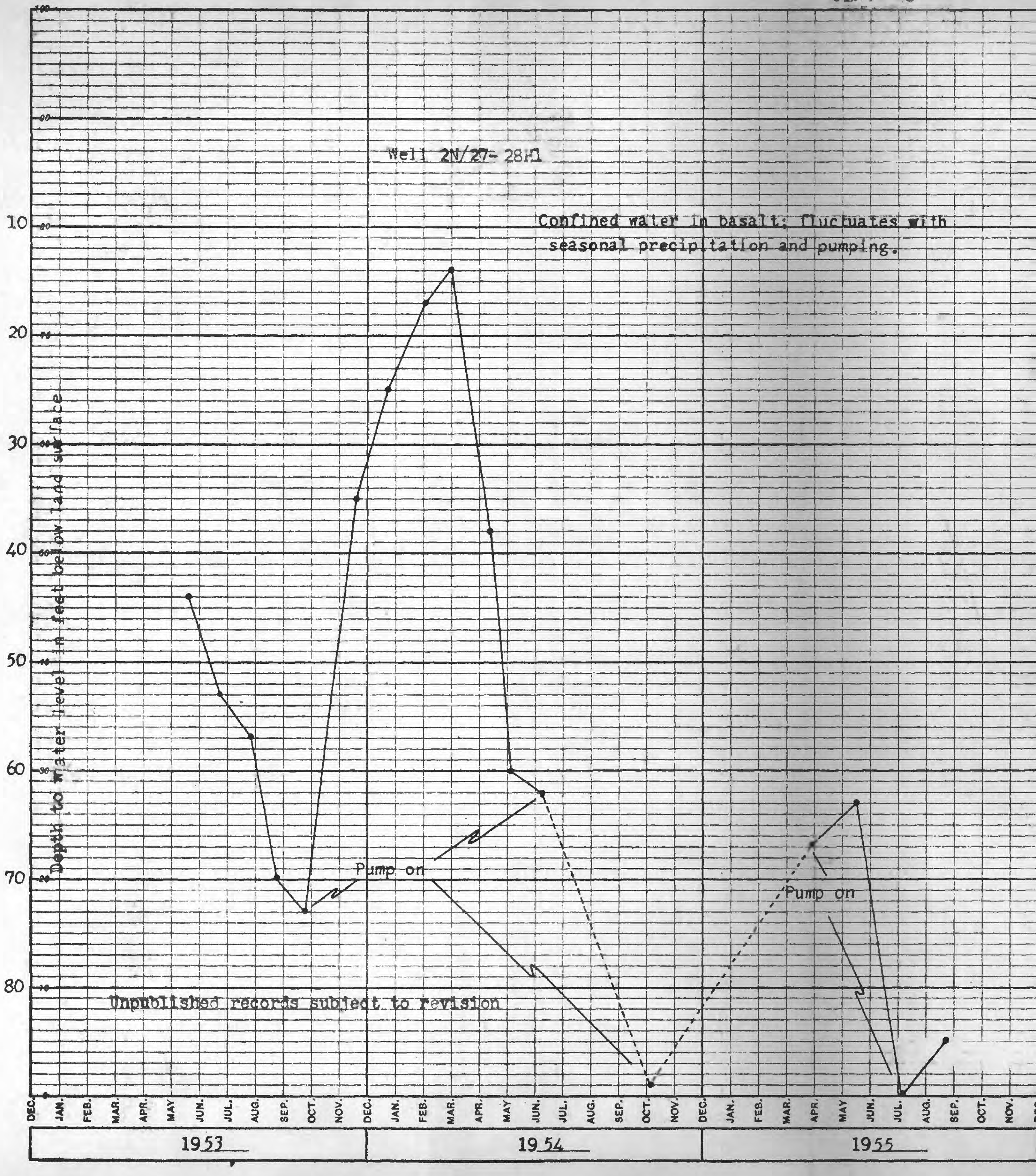

Well 2N/27-28H1
Confined water in basalt; fluctuates with seasonal precipitation and pumping.
Depth to water level in feet below land surface
10
20
30
40
50
60
70
80
Pump on
Pump on
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 26

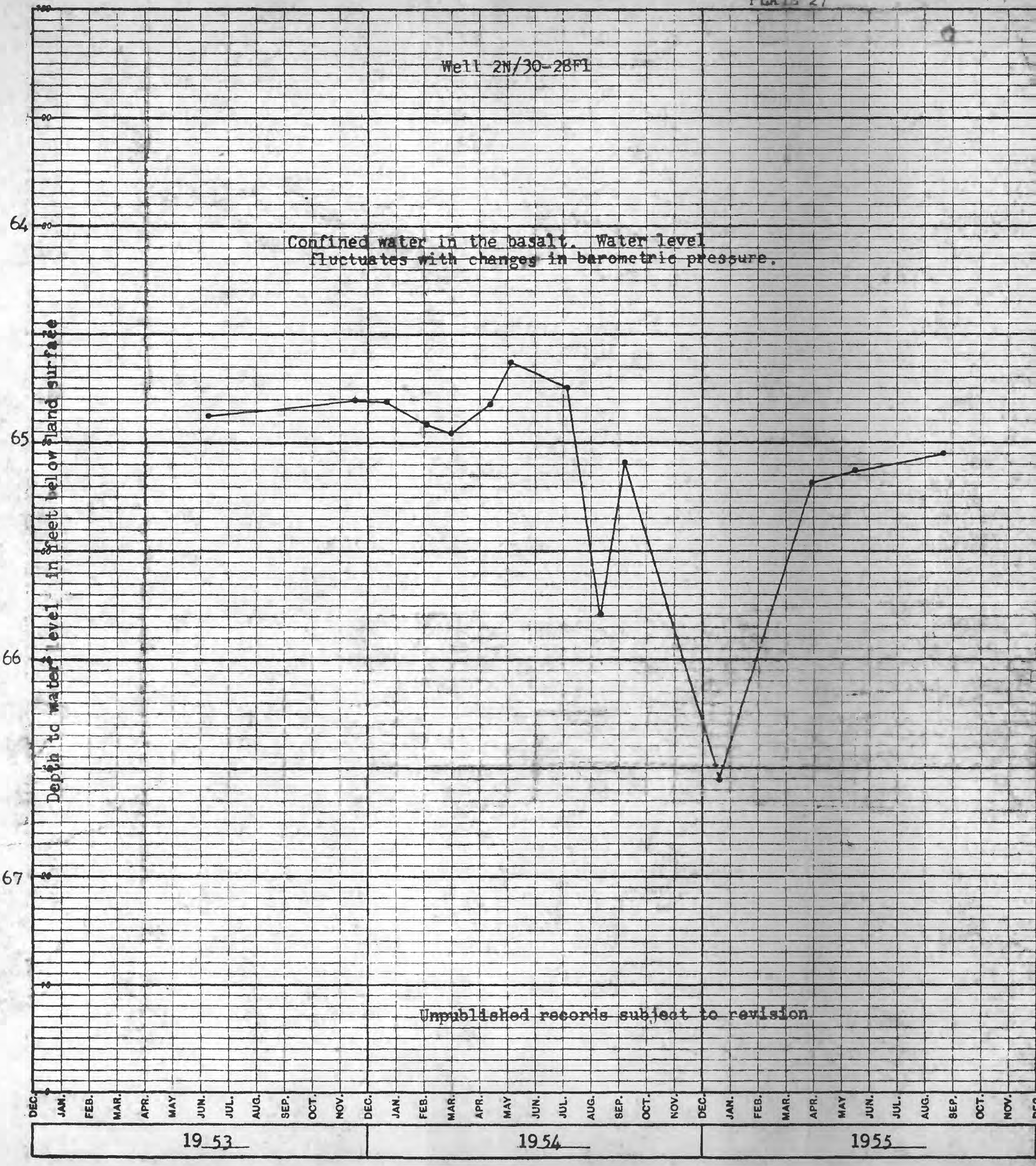
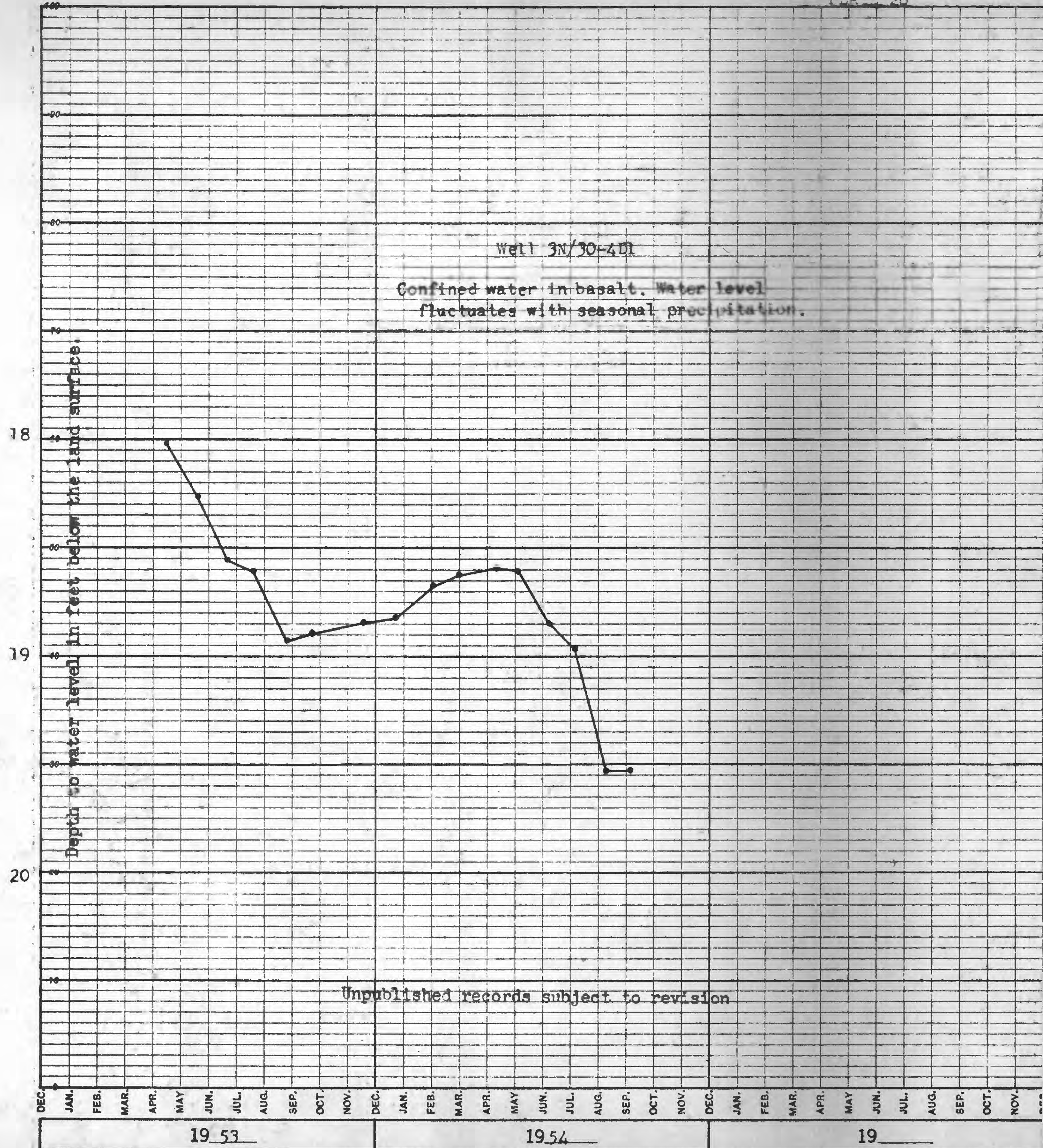

Well 2N/30-28F1
Confined water in the basalt. Water level fluctuates with changes in barometric pressure.
Depth to water level in feet below land surface
64
65
66
67
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 27

PLATE 28



Well 3N/30-4D1
Confined water in basalt. Water level fluctuates with seasonal precipitation.
Depth to water level in feet below the land surface.
18
19
20
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
19

PLATE 28

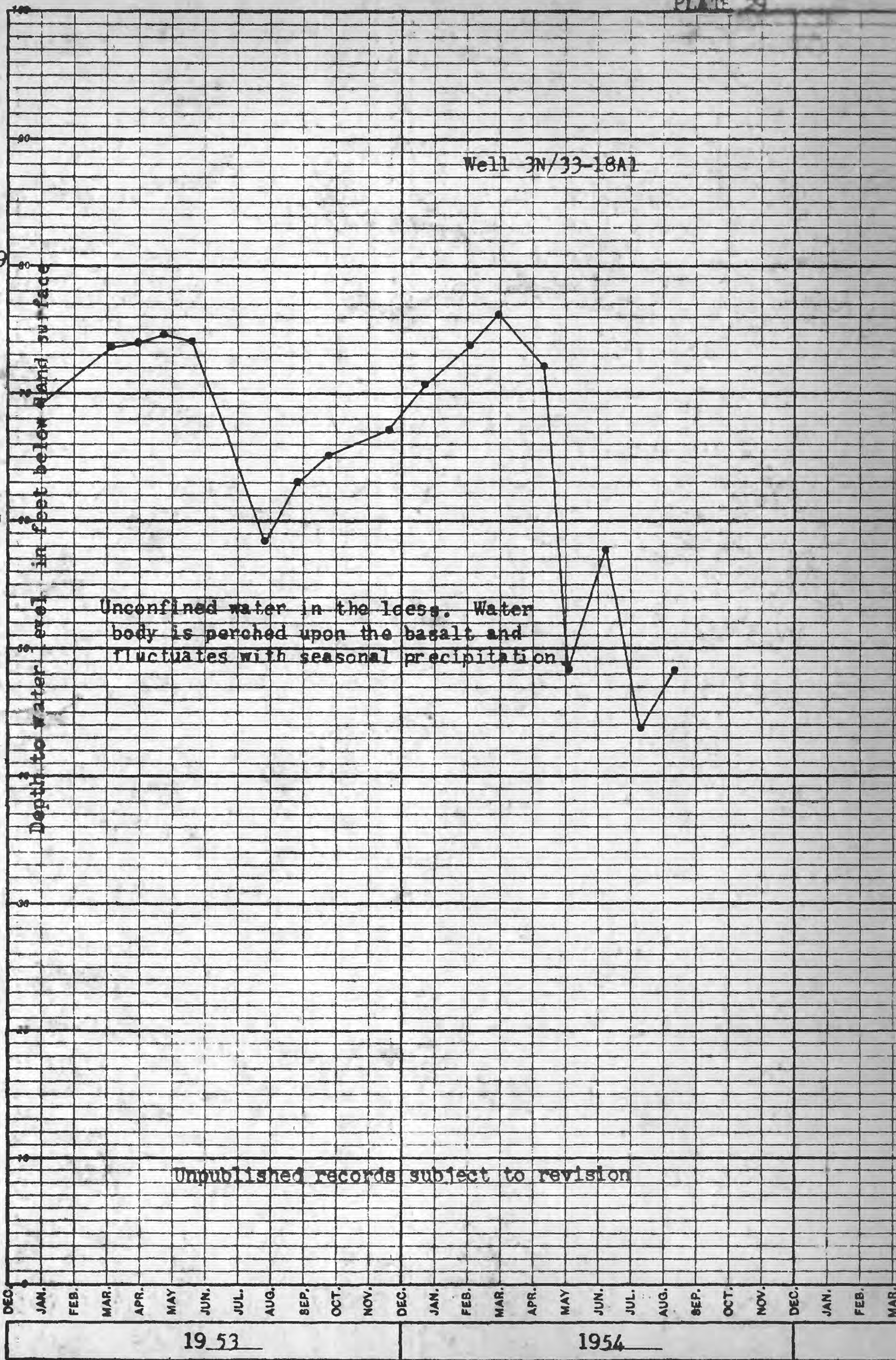

Well 3N/33-18A1
Depth to water level in feet below land surface
19
20
21
Unconfined water in the loess. Water body is perched upon the basalt and fluctuates with seasonal precipitation.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR.
1953
1954

PLATE 30

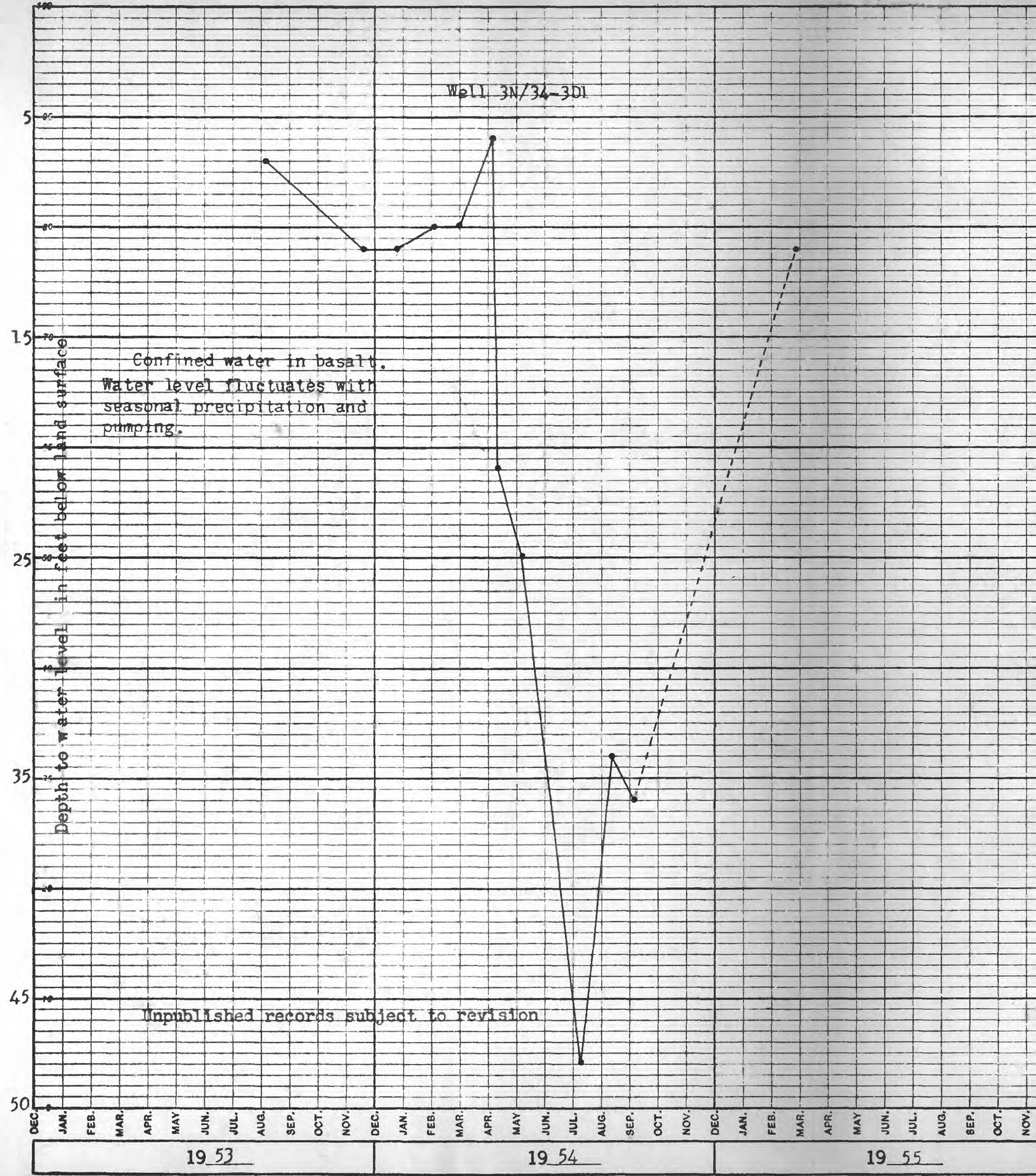
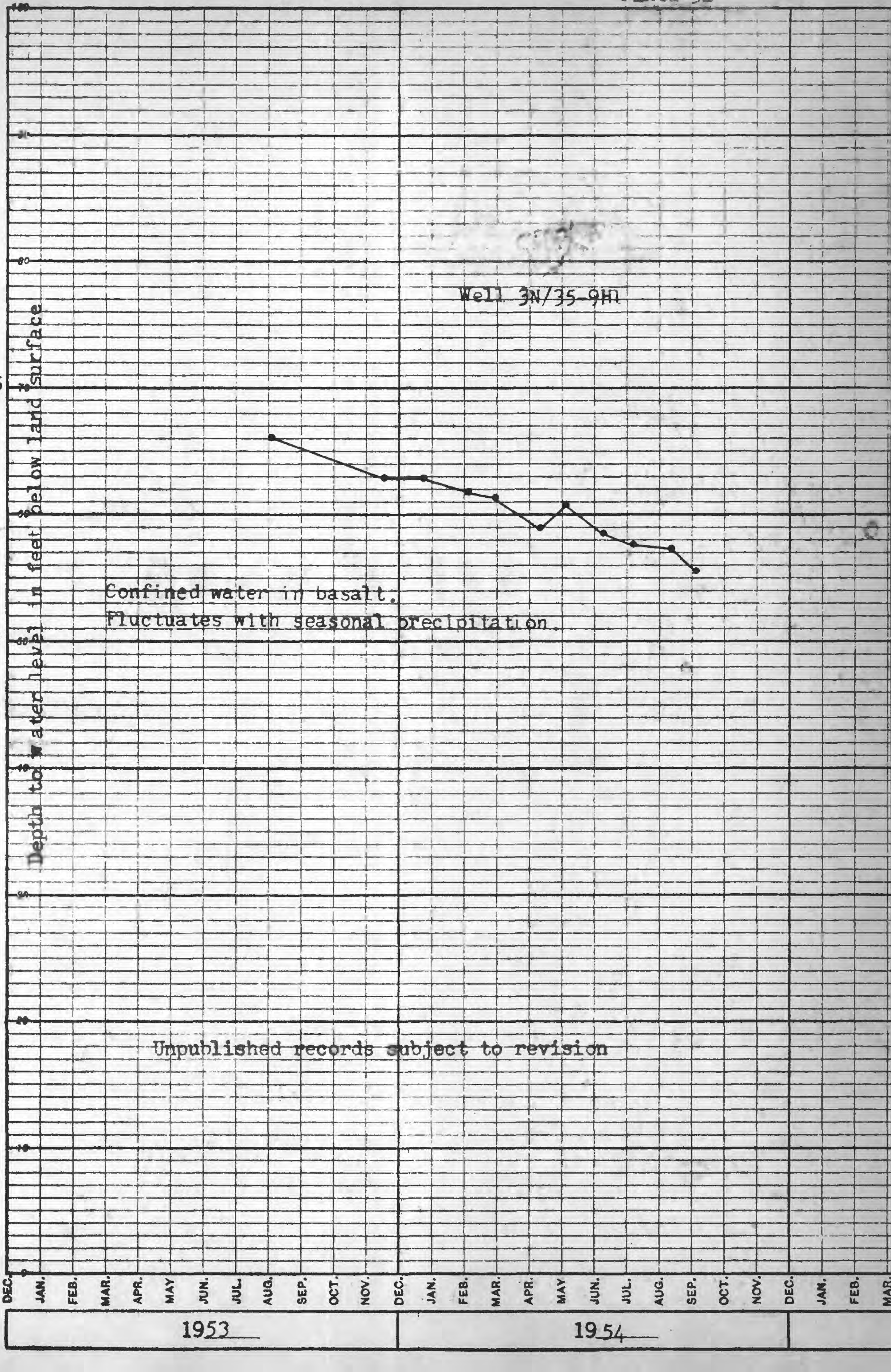
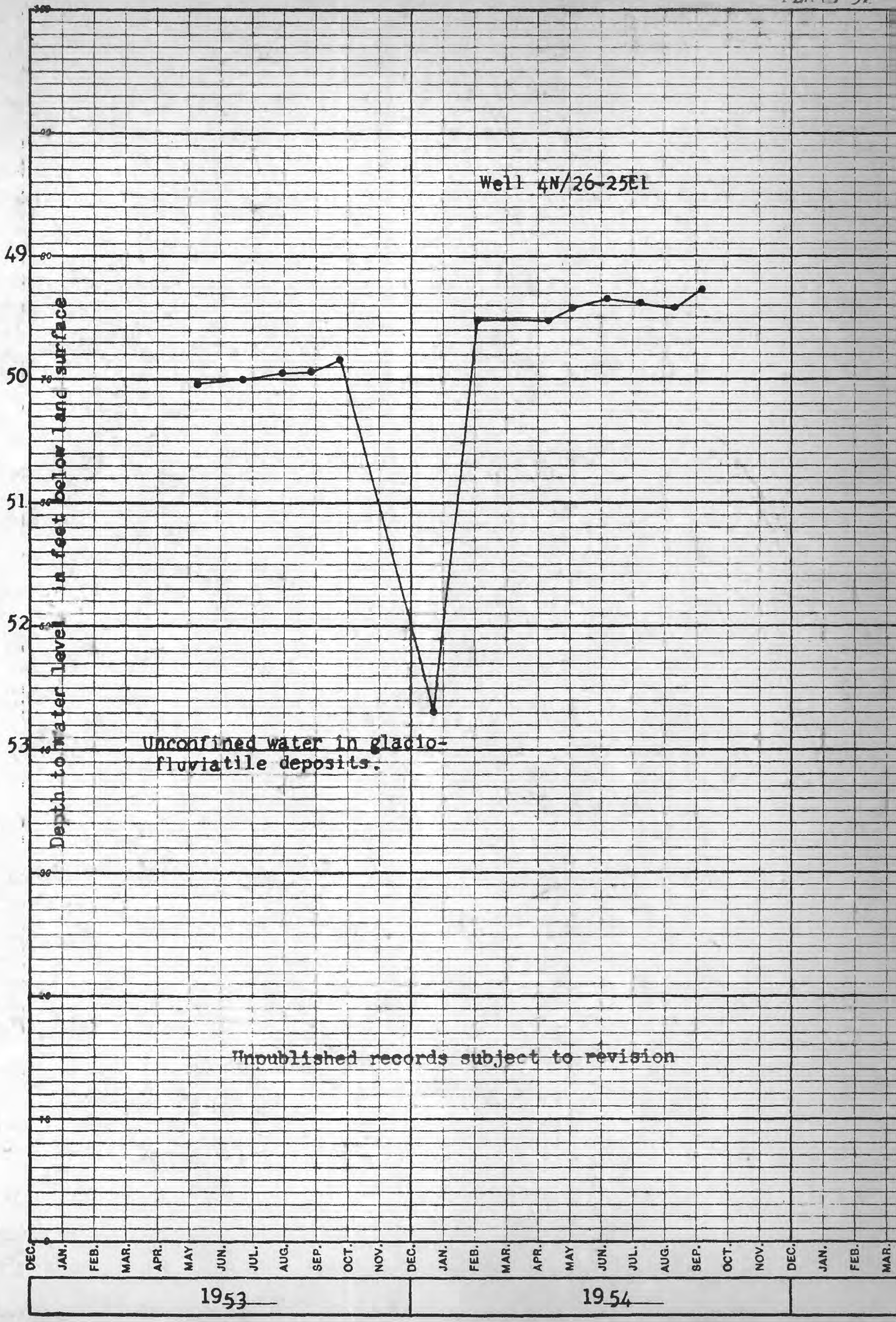
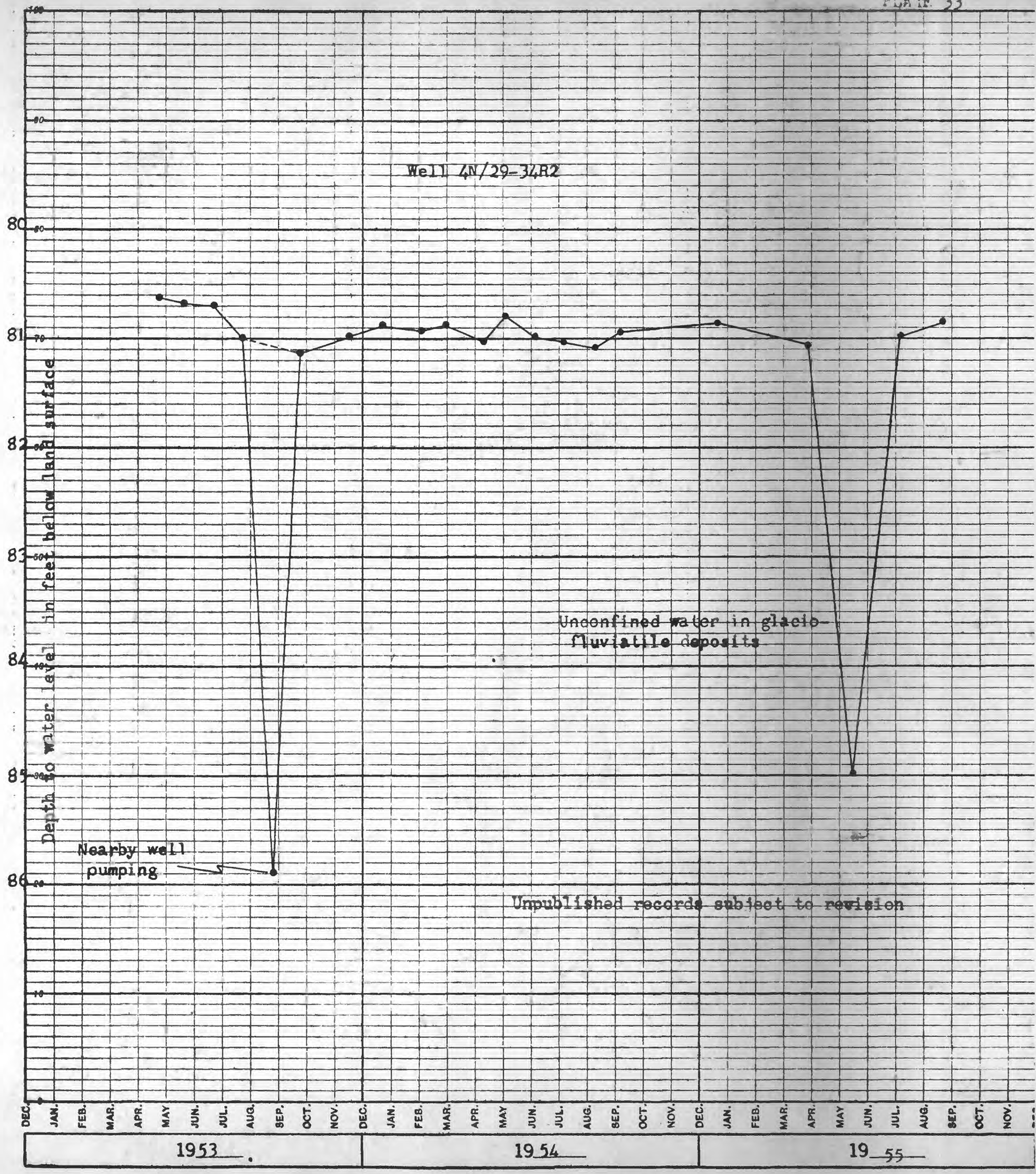

Well 3N/34-3D1
Confined water in basalt. Water level fluctuates with seasonal precipitation and pumping.
Depth to water level in feet below land surface
5
15
25
35
45
50
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 30

PLATE 31


Well 3N/35-9H1
Depth to water level in feet below land surface
285
295
Confined water in basalt.
Fluctuates with seasonal precipitation.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR.
1953
1954


Well 4N/26-25E1
49
50
51
52
53
Depth to water level in feet below land surface
Unconfined water in glacio-
fluviatile deposits.
Unpublished records subject to revision
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
1953
1954



Well 4N/29-34R2
Depth to water level, in feet below land surface
80
81
82
83
84
85
86
Unconfined water in glacio-fluviatile deposits
Nearby well pumping
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 33

PLATE 34

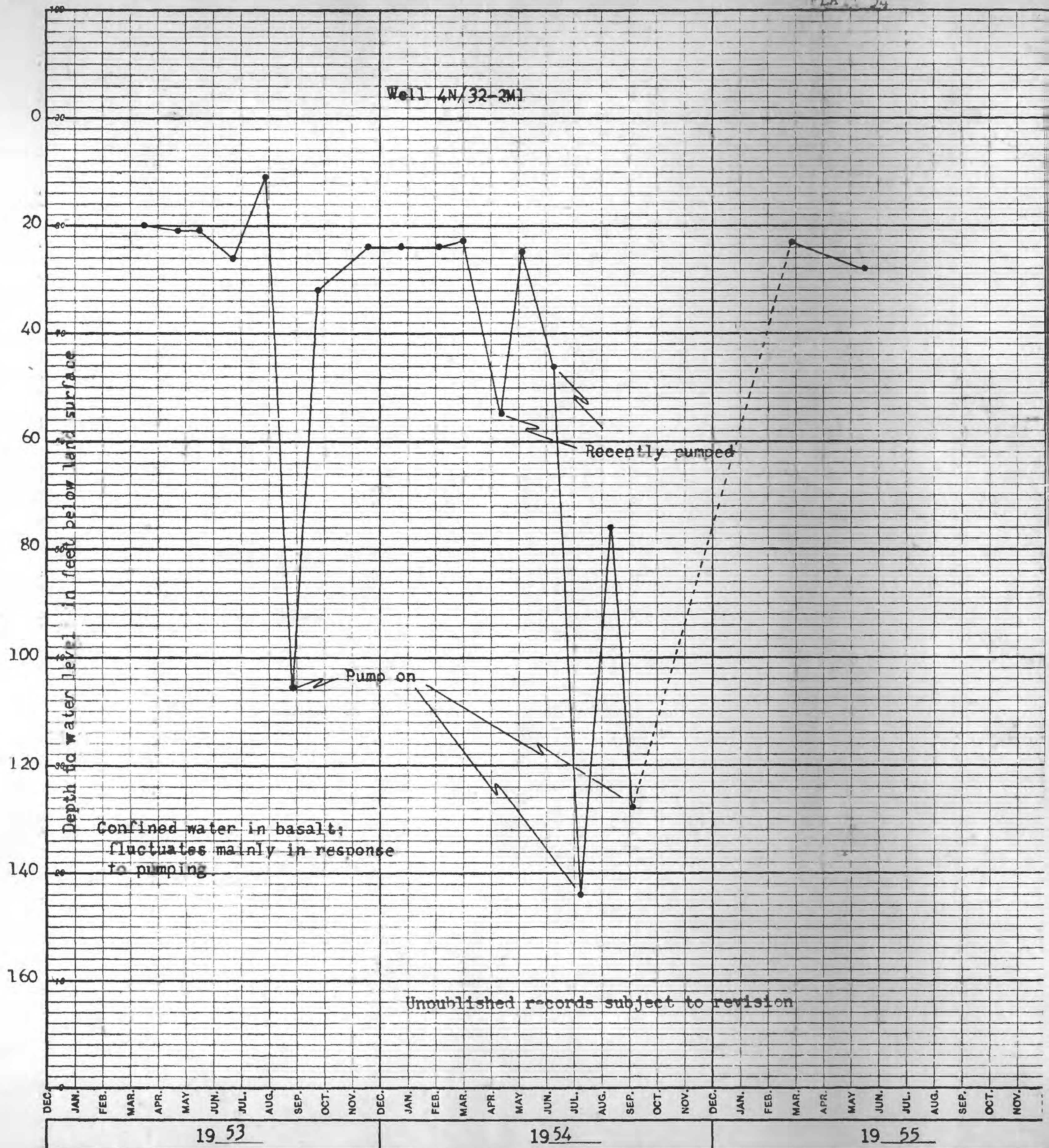
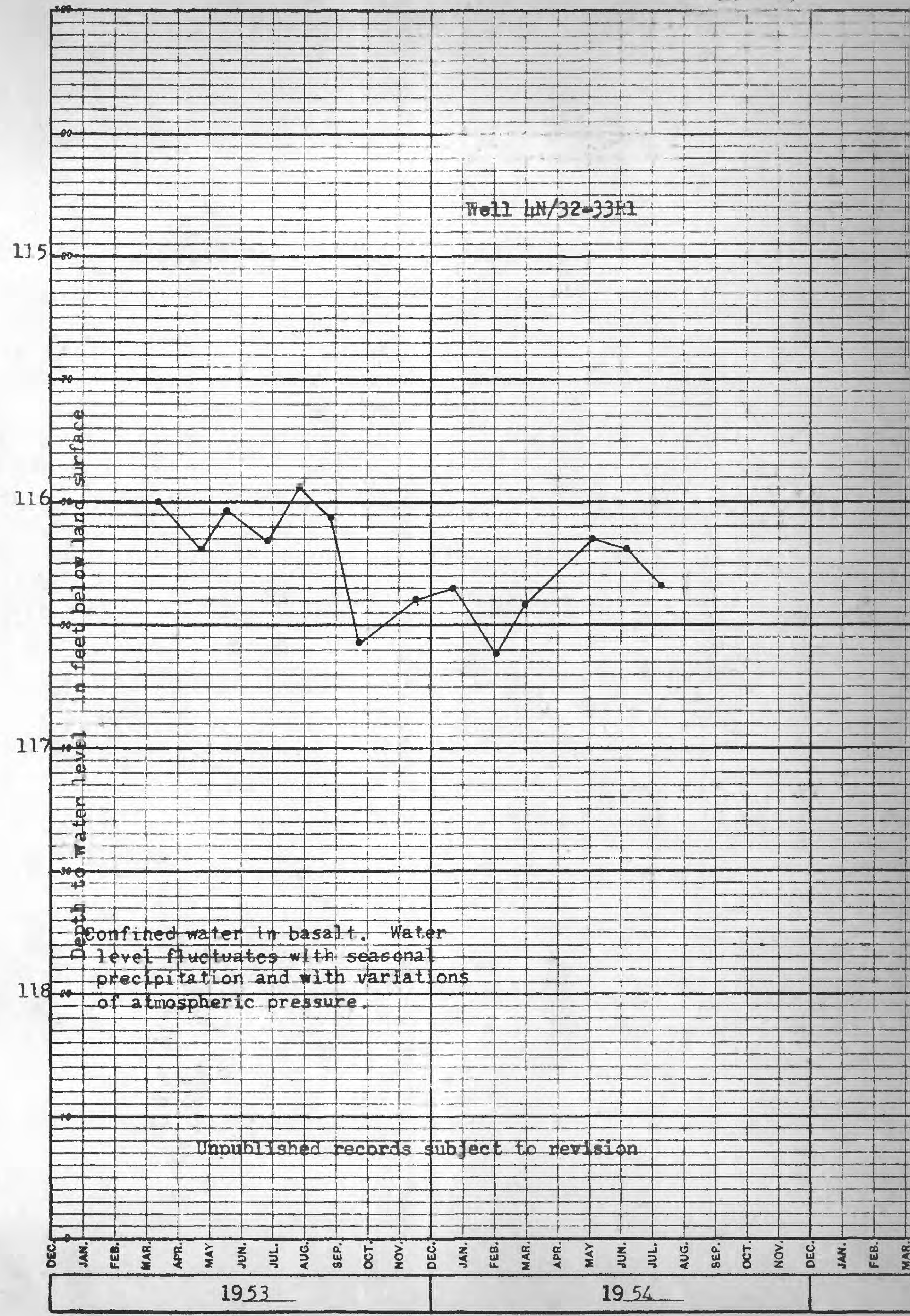

Well 4N/32-2M1
Depth to water level in feet below land surface
0
20
40
60
80
100
120
140
160
Recently pumped
Pump on
Confined water in basalt; fluctuates mainly in response to pumping.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
19 53
19 54
19 55

PLATE 34

PLATE 35


Well 4N/32-33H1
Depth to water level in feet below land surface
115
116
117
118
Confined water in basalt. Water level fluctuates with seasonal precipitation and with variations of atmospheric pressure.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR.
1953
1954

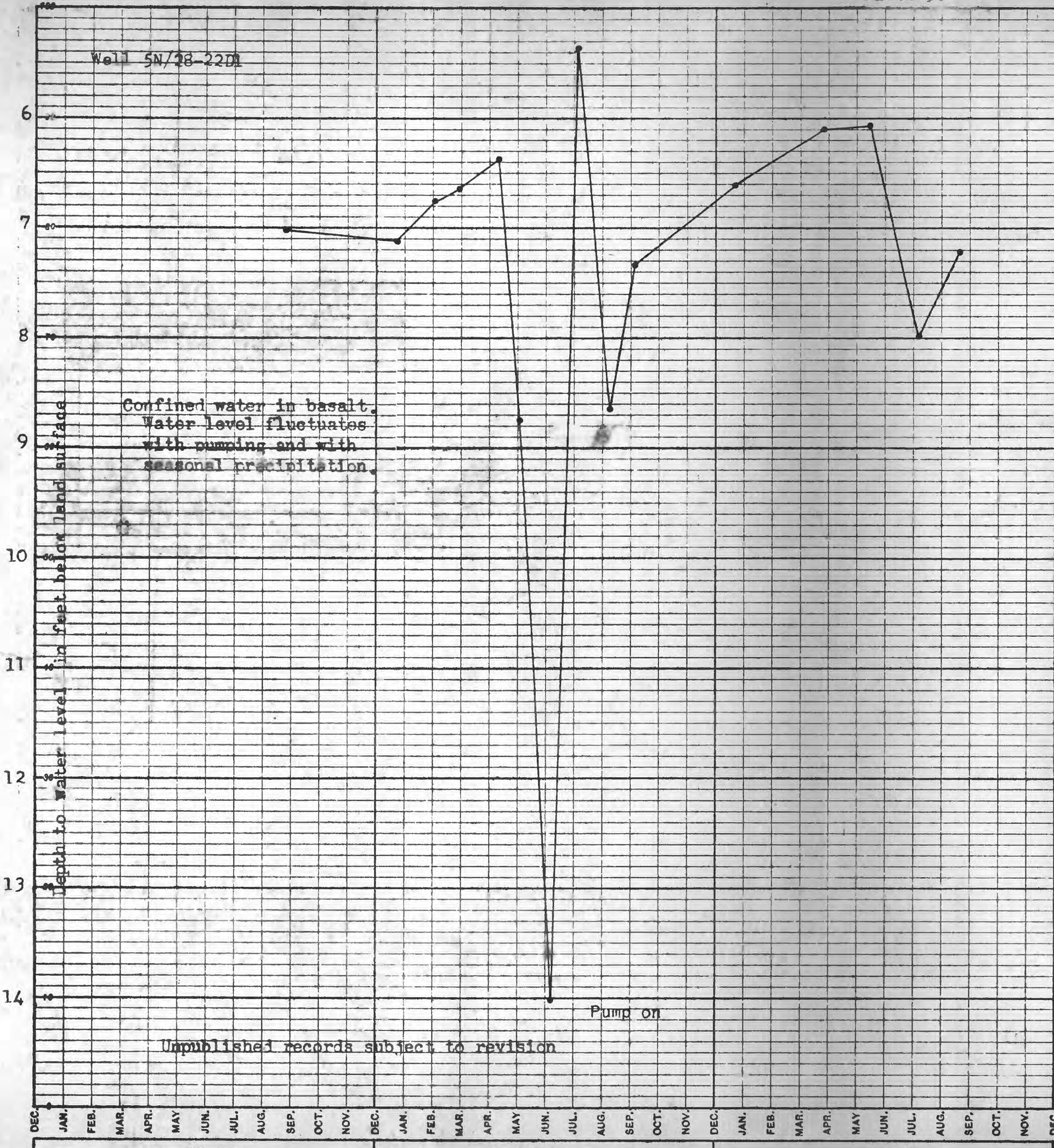

Well 5N/28-22D1
Confined water in basalt. Water level fluctuates with pumping and with seasonal precipitation.
Depth to water level in feet below land surface
6
7
8
9
10
11
12
13
14
Pump on
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 36

PLATE 37

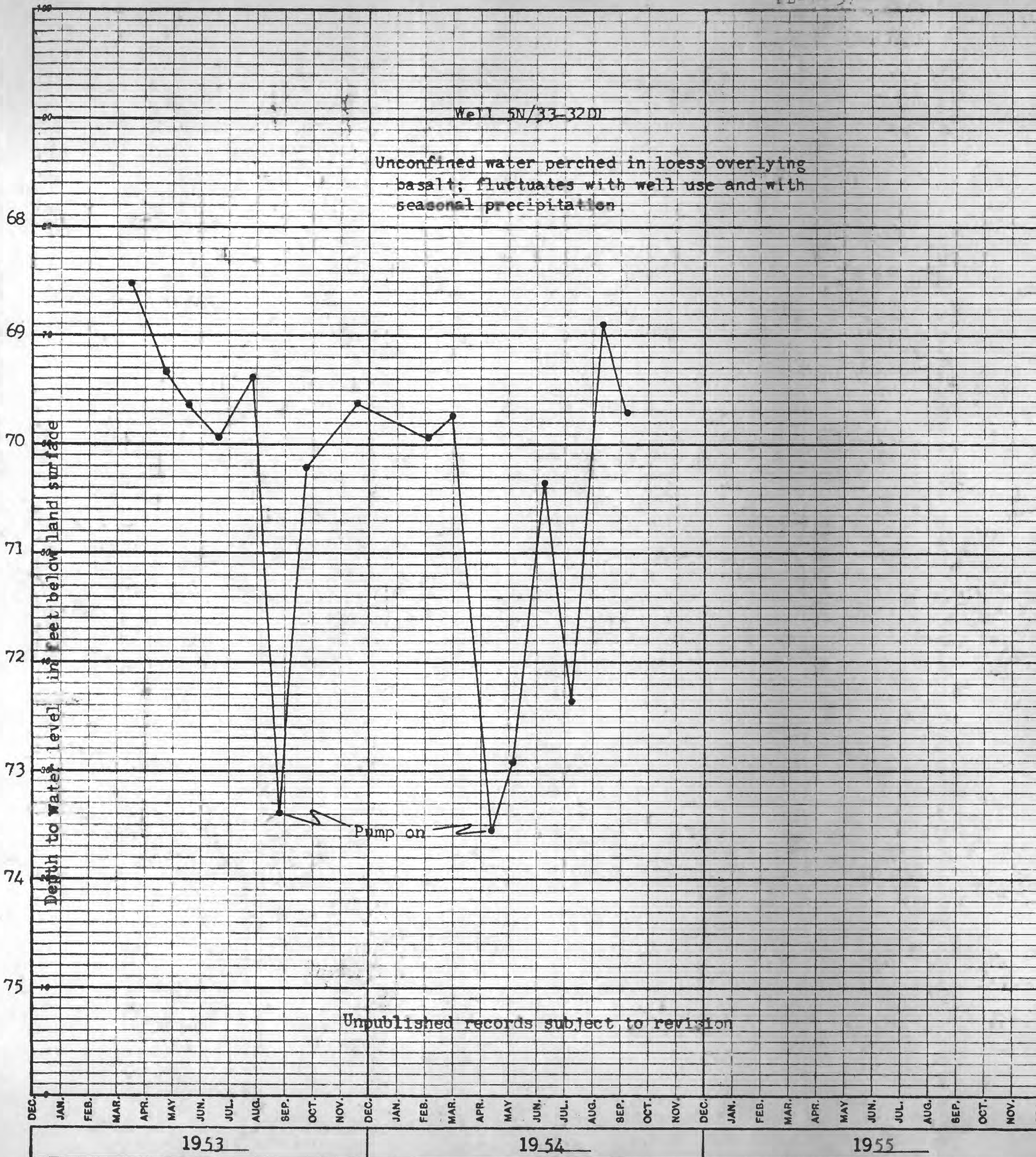

Well 5N/33-32D1
Unconfined water perched in loess overlying basalt; fluctuates with well use and with seasonal precipitation.
Depth to water level, in feet below land surface
68
69
70
71
72
73
74
75
Pump on
Unpublished records subject to revision
DEC.
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
1953
1954
1955

PLATE 37

PLATE 38

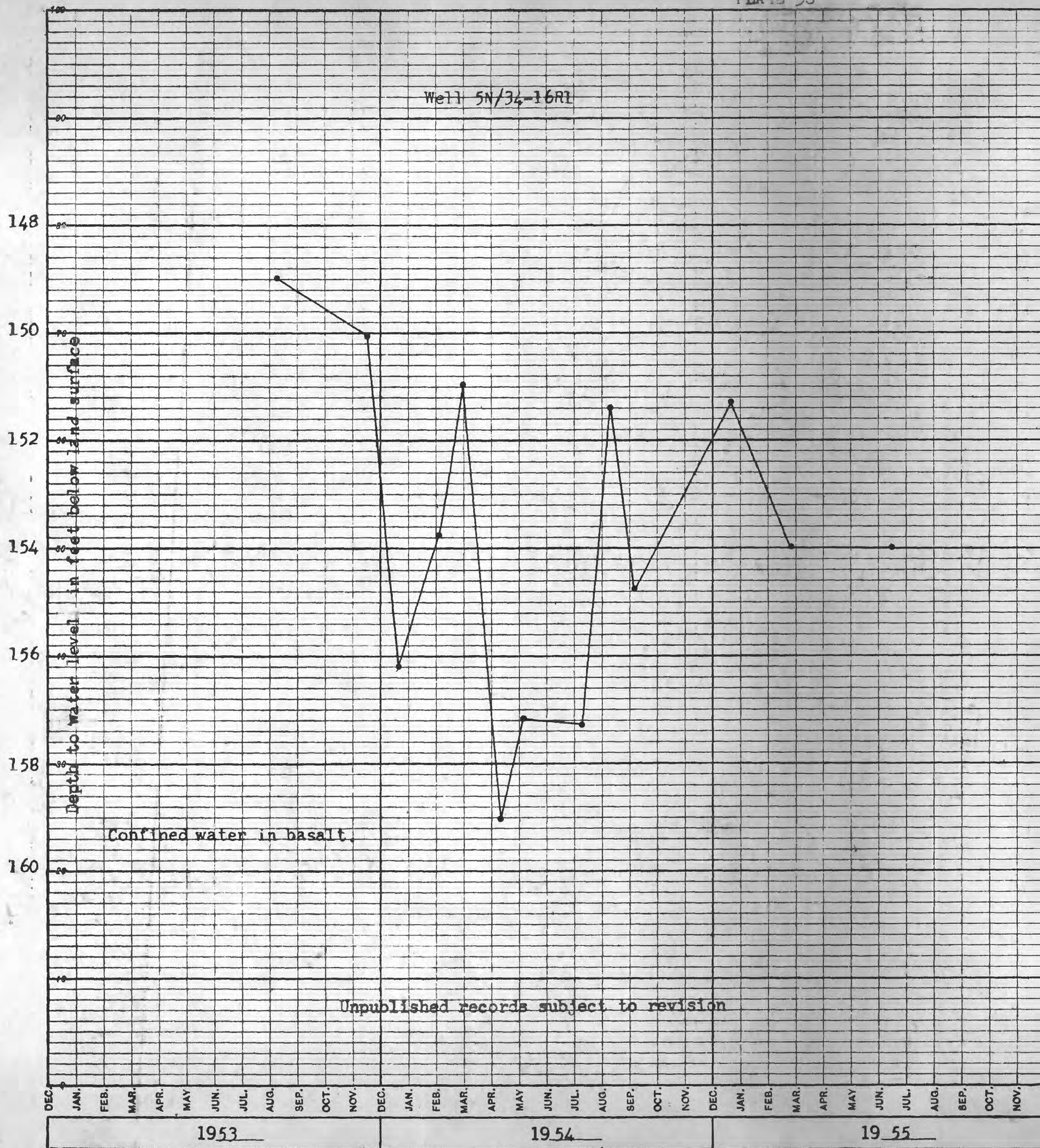

Well 5N/34-16R1
Depth to water level, in feet below land surface
148
150
152
154
156
158
160
Confined water in basalt.
Unpublished records subject to revision
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
DEC. JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV.
1953
1954
1955

PLATE 38

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