STATE ENGINEER GROUND WATER REPORT NO. 10

STATE OF OREGON

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STATE ENGINEER

A RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF THE HOOD RIVER VALLEY AND THE CASCADE LOCKS AREA, HOOD RIVER COUNTY, OREGON

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SALEM, OREGON

APRIL, 1966

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Purpose and Scope of this Investigation

The State Engineer entered into a contract on July 10, 1964 with the State Water Resources Board to make a reconnaissance investigation of the ground-water resources of the Hood River Valley and Cascade Locks area. The purpose of the investigation was to select ground water reservoirs and drilling sites that would be suitable for testing for the development of municipal and group domestic water supplies. Field work was carried on during the Fall of 1964 and the Spring of 1965. This report presents the data and conclusions gained in the investigation.

Location and Description of the Area

The Hood River Valley occupies a structural trough formed by the folding and faulting of the older rock formations. It is located in the north-central part of the State. Hood River originates in the glaciers on Mount Hood and flows generally northward to its confluence with the Columbia River at the town of Hood River.

The Valley is separated into an Upper Valley and Lower Valley by Middle Mountain (Figure 3B). Both the Upper and Lower Valleys are highly productive orchard areas specializing chiefly in the production of apples and pears. Logging in the adjacent Cascade Mountains has also resulted in a large lumber mill operation at Dee.

Cascade Locks is located along the Oregon shore of Columbia River some 20 miles west from the mouth of Hood River. A large lumber mill and the proximity of Bonneville Dam creates the chief source of livelihood in the Cascade Locks area.

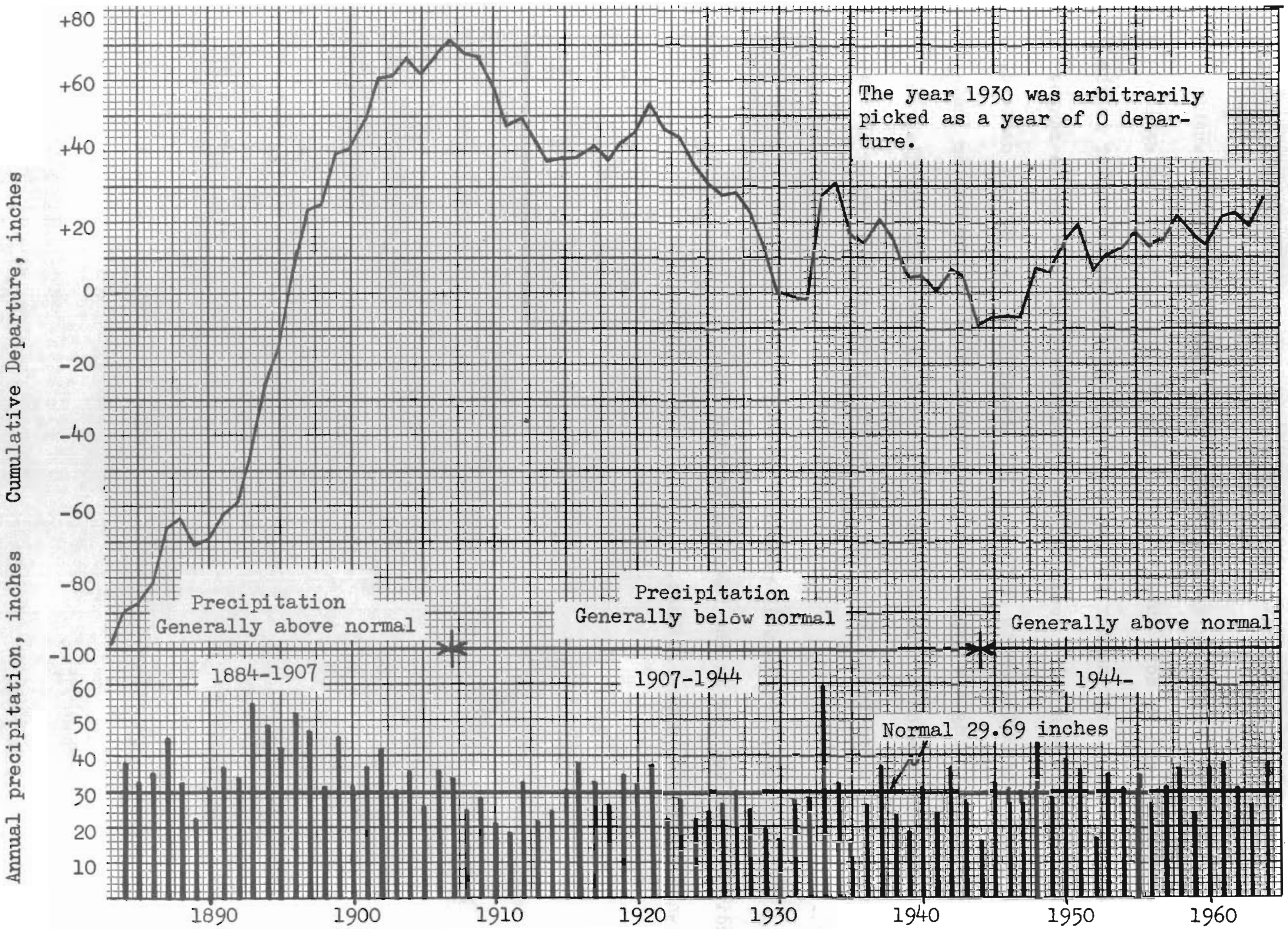
Climate

The Hood River Valley, like most of Oregon, has a marked seasonal distribution in precipitation. Most of the precipitation occurs in November, December and January, and the least occurs during July and August. Hood River averages less than one inch per month from June to September. This low summer precipitation results in the need for irrigation water.

The normal annual precipitation for Hood River as reported by the U. S. Weather Bureau is 29.69 inches per year. Figure 1 shows the annual departure from normal precipitation from 1884 to 1963. This type of curve often depicts the relative changes in the amount of ground water recharge and the long term changes in the flow of springs draining large ground water reservoirs.

Acknowledgements

The writer wishes to acknowledge the assistance of the various water well contractors who have operated in the Hood River Valley, and to Mr. Les Gable of the Cascade Locks Water Department for his help in the examination of the Cascade Locks area. Special thanks are also given to Mr. Walter Mackie, Project Engineer and his staff of the Corps of Engineers, Bonneville Dam, for searching their records and providing information on Ruckel Slide.



Annual precipitation at Hood River and cumulative departure from normal

Figure 1

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Well Numbering System

The well numbering system used in this report gives the township, range, section and 40-acre subdivision of the section in which the well is located. The first number is the township, and the second number is the range. In townships lying south of the Willamette Base Line and in ranges lying east of the Willamette Meridian, the letters "S" and "E" are omitted. The number following the hyphen indicates the section and the letter indicates the subdivision of the section as depicted in the following diagram. The number in parentheses following the letter is the serial number of the well.

For example, the well numbered 2N/10-13P(1) indicates the well is in the SE¼ SW¼, Section 13, Township 2 North, Range 10 East.

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

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

Figure 5 is a diagramatic section showing the various geologic units of the Hood River Valley. As there are very few wells in the Hood River Valley or the Cascade Locks area, the water-bearing properties described in this report are in part based on information from wells located outside the area of this investigation.

Eagle Creek Formation

The Eagle Creek formation, which is well exposed in the cliffs near Bonneville Dam, is the oldest formation in the area. It is not known to crop out in the Hood River Valley, but probably underlies the valley at great depth.

The Eagle Creek formation is a sedimentary unit composed of conglomerate, agglomerate, sandstone and claystone. The rock materials making up the formation are chiefly andesite. Some of the strata are mixtures of rocks of all sizes from clay to boulders and are believed to be ancient mud flow deposits. Some andesite lava flows are also believed to be a part of this formation.

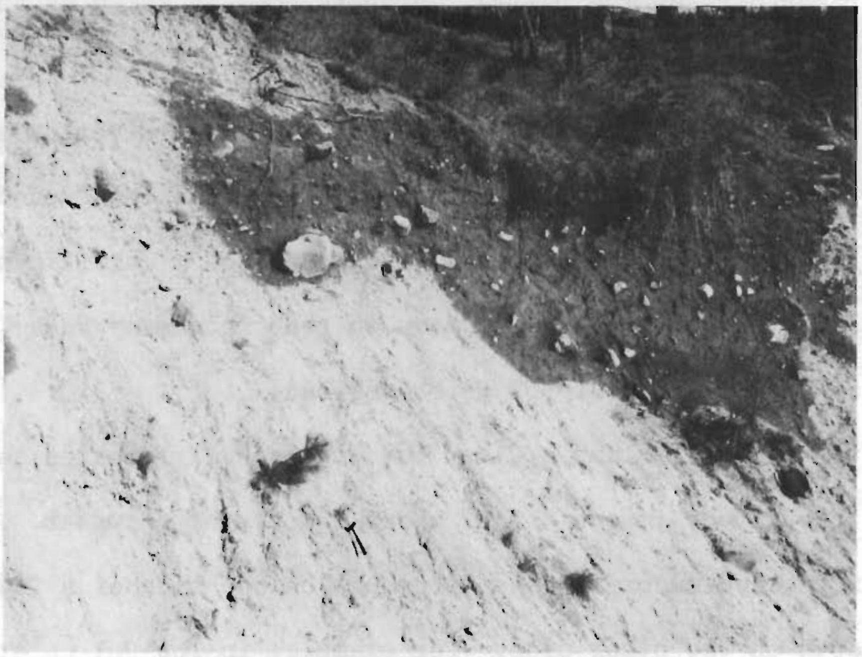
The various rock layers in the Eagle Creek formation have low permeability and are believed capable of yielding only small supplies of ground water. The 200 foot well drilled at the U. S. Forest Service Ranger Station (2N/8-5J1) is in the Eagle Creek formation. This well has a yield of only 4 gallons per minute with 170 feet of drawdown. Some of the drainage tunnels constructed in the Ruckel Slide area west of Cascade Locks were driven into blocks of Eagle Creek formation. Some of these tunnels penetrated to considerable depths and made very little water from the Eagle Creek formation (Figures 11 and 12).

Columbia River Basalt

The Columbia River basalt formation is a thick series of basaltic lava flows that underlies large areas in both Oregon and Washington. It has been identified in areas extending from Spokane, Washington, to Salem, Oregon, and serves as one of the most important sources of ground water in the Pacific Northwest. Many of the cliffs in the Columbia Gorge both east and west of Hood River are formed by lava flows in this formation. The Columbia River basalt crops out in only a few places in the Hood River Valley, but it is believed to underlie the entire valley beneath younger formations.

Individual lava flows generally range from a few tens to a hundred or more feet in thickness. The cooling of the molten lava produced shrinkage cracks which at places gives the basalt the appearance of having been formed from uniform columns. One spectacular example of this type of jointing in the Columbia River basalt is at Punchbowl Falls in Section 1, T. 1 N., R. 9 E. Other types of jointing include an irregular pattern that tends to break the basalt into uniform blocks that generally range from fist to brick size.

Ground water generally occurs in the broken contact zone between individual lava flows. It also occurs in the irregular openings between rounded pillows of lava that formed when the molten lava flowed into a swamp or some other body of water. Such pillow basalts can be seen in the cliffs of the Columbia Gorge a few miles west of Bonneville Dam. The very productive



A. Glacial till exposed in railroad cut in Section 12, T. 2 N., R. 10 E.

B. Cascade andesites exposed in cut along Interstate 80 in Section 33, T. 3 N., R. 10 E. Perched ground water is forced to surface by impermeable interbed in the lava.

ground water reservoirs at The Dalles, which is locally known as the "Dalles Pool" is believed to be a pillow basalt flow.

The center of most of the flows in the Columbia River basalt are generally quite impermeable, which tends to separate the ground water zones into layers, like frosting between the layers of a multi-layered cake. Large capacity wells generally have to penetrate many such layers in order to develop the quantity of water desired.

Faulting in the Columbia River basalt generally creates subsurface barriers that prevent or impede the horizontal movement of water. At places water may be impounded under artesian pressure on one side of a fault and be at great depth on the other side. For example, in The Dalles area, some 20 miles east of Hood River, a fault in the Columbia River basalt having less than 40 feet of vertical movement impounds a ground water reservoir under a differential head of more than 600 feet. Faults in the Columbia River basalt are believed common in the Hood River Valley but their locations are not yet known.

In general, the Columbia River basalt is barren of interbedded sedimentary rocks. Interbeds, however, are known to occur in The Dalles area, the Boardman area, the Hanford area, the Yakima area, and the Spokane area. In examining the geological section at Mitchell Point in Section 31, T. 3 N., R. 10 E., a prominent interbed of conglomerate is well exposed near the top of the Point near the stratigraphic top of the Columbia River basalt (Figures 3A and 4). This conglomerate is composed chiefly of basaltic cobbles ranging from 6 to 10 inches in diameter. These cobbles are tightly cemented in a quartz sandstone. This conglomerate, where it is exposed, is tight and would not be a productive ground water reservoir. If the cementation is merely a case-hardening on the surface and relatively uncemented

A. Boulder conglomerate interbed in the Columbia River basalt at Mitchell Point.

B. Parkdale lava flow. Upper Hood River Valley and Middle Mountain in background.

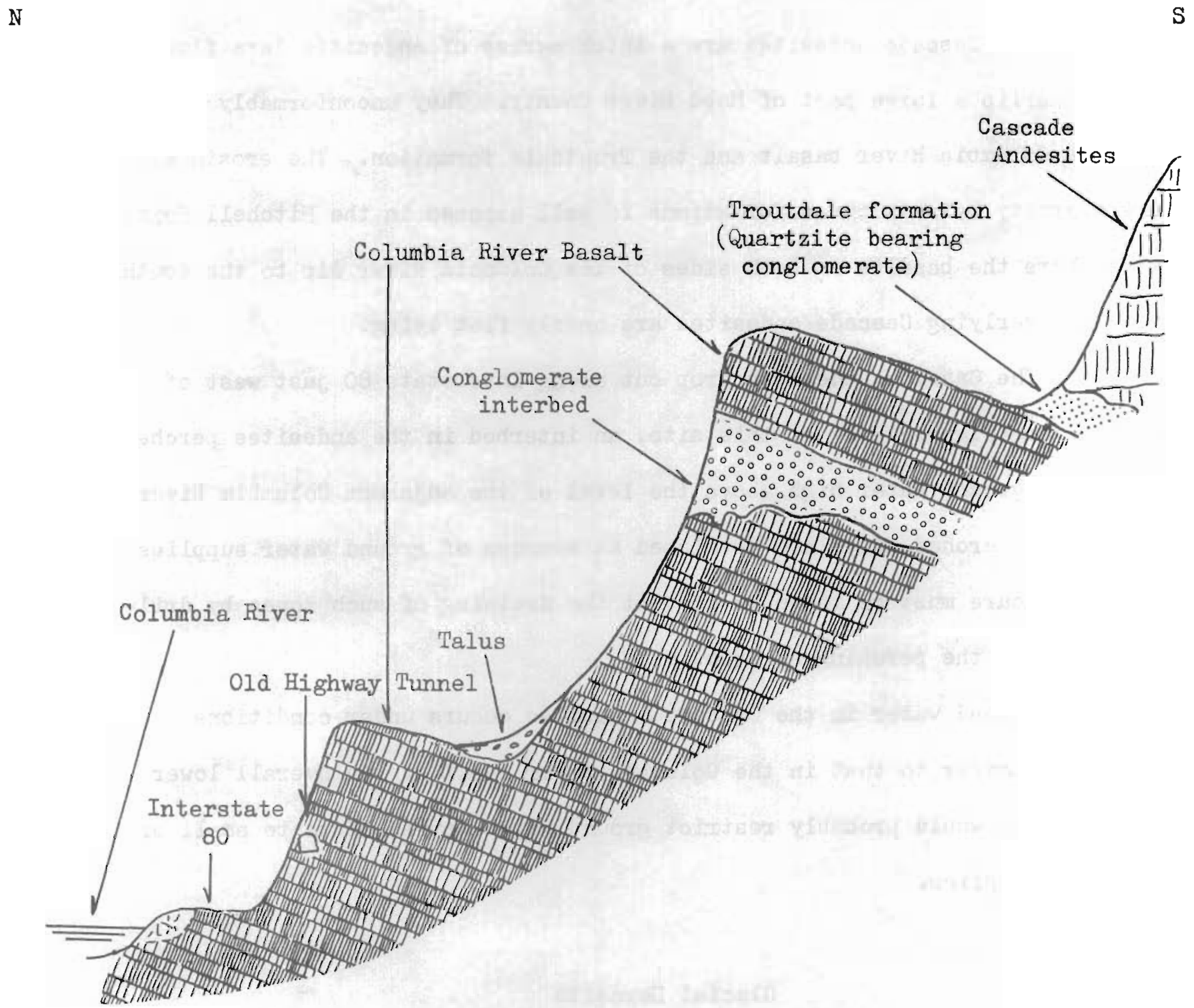
gravels occur at a depth away from the outcrop, this interbed could be a productive source of ground water. This interbed, if encountered in a deep well drilled in the Hood River Valley, could cause delays and problems of well construction, and caving of the gravel could necessitate the installation of well casing.

Troutdale Formation

The Columbia River basalt is overlain at places by a sedimentary unit composed chiefly of sandstone and conglomerate that is believed to be the Troutdale formation. The thickness of the Troutdale formation in the Hood River area is not known, but is believed to be a few hundred feet at most. The conglomerate immediately overlying the basalt contains gravel composed of quartzite. Quartzite is not known to occur in north central Oregon and these gravels undoubtedly had a distant source of origin. They occur in the conglomerate at the east end of the old Hood River bridge in Section 25, T. 3 N., R. 10 E. and at Mitchell Point in Section 31, T. 3 N., R. 10 E. (Figure 4). Along the Union Pacific tracks in Section 26, the gravels are barren of quartzites. Whether these outcrops all belong to the same formation and the difference in composition is due to differences of stratigraphic position within the formation, or whether the quartzite-free gravels are part of a post-Troutdale pre-Cascade andesite filling of the Hood River area is not known.

Wells drilled into the Troutdale gravels as they will be called in this report will yield up to moderately large supplies of ground water. Wells drilled into this formation near Odell obtained ground water that was relatively high in dissolved mineral matter, which, if widespread, would tend to restrict this formation as a source of municipal water.

Figure 4



Diagramatic section through Mitchell Point

Cascade Andesites

The Cascade andesites are a thick series of andesitic lava flows that underlie a large part of Hood River County. They unconformably overlie the Columbia River basalt and the Troutdale formation. The erosional unconformity between these formations is well exposed in the Mitchell Point area where the basalts on both sides of the Columbia River dip to the south and the overlying Cascade andesites are nearly flat lying.

The Cascade andesites crop out along Interstate 80 just west of Hood River (Figure 2B). At this site, an interbed in the andesites perches a body of ground water high above the level of the adjacent Columbia River. Where such perched zones are developed as sources of ground water supplies by wells, care must be taken to prevent the draining of such zones by drilling through the perching stratum.

Ground water in the Cascade andesites occurs under conditions somewhat similar to that in the Columbia River basalts. An overall lower permeability would probably restrict ground water developments to small or moderate supplies.

Glacial Deposits

At several times during the Ice Age, glaciers heading on Mount Hood moved down and occupied the Hood River Valley. Glacial deposits and related stream and lake deposits have partially filled both the Upper and Lower Valleys.

The rock materials deposited directly by a glacier is termed glacial till. It is a rock type having a mixture of particle sizes ranging from clay to boulders and has the appearance of concrete. The glacial till that mantles wide areas in the Hood River Valley is exceptionally well exposed along the railroad cuts in Section 12, Township 2 North, Range 10 East where the railroad line switchbacks out of the canyon (Figure 2A). The till is relatively impermeable and at places creates drainage problems as it holds water up in the soil zone.

The valley fill also includes some thick layers of silt and boulder gravel deposits. One of the silt members can be observed along the county road in Section 14, Township 2 North, Range 10 East, where it descends to Tucker Bridge. Deltaic deposits of sand were also observed in the sand pit located in the NW¼ NW¼, Section 2, Township 2 North, Range 7 East.

The valley fill deposits exceed several hundred feet in thickness and represent the results of multiple glaciation. The history of this complex phase of the development of the Hood River Valley is beyond the scope of this investigation. It is the writer's opinion, however, that most of the glacial deposits and related stream and lake deposits are of low permeability and not suitable for the development of large ground water supplies.

Young Lava Flows

The young lava flows in the Hood River Valley consist of the Parkdale lava flow which occupies the valley of the Middle Fork of Hood River just southwest of Parkdale (Figure 3B), and an older andesite flow that partially filled the valley of the West Fork in Sections 29 and 30, T. 1 N., R. 9 E.

These lava flows have not been developed by wells although some springs issuing from the lava flow in the West Fork Valley have been developed by some tunnels for the Hood River water supply. Where these lava flows contain ground-water reservoirs, they should be capable of yielding large supplies of ground water. The Parkdale flow provides an excellent recharge area as most of the precipitation percolates down to supply an underlying ground water reservoir. The overflow of the reservoir at the base of the Parkdale flow occurs as springs near the north end of the flow.

Recent Alluvial Deposits

Alluvial deposits underlying the flood plain of Hood River contain ground water that is in hydraulic connection with the river system. At places, however, the alluvium contains such a mixture of rock sizes that the void spaces between the larger sizes are filled with smaller particles. This mixture of sizes has produced an alluvium that is relatively impermeable. This mixture of rock sizes is very well shown in the many new exposures produced by the December 1964 and January 1965 floods. At one point in Section 24, Township 1 North, Range 9 East, the entire flow of the Middle Fork of Hood River is confined to a four-foot wide channel in the alluvium where it is cutting a new channel across an old meander bend. The mixture of rock sizes is very well exposed in this cut (Figure 6A). Where such mixtures of rock sizes occur in the alluvium, it should not be considered as a source of large ground-water supplies.

Further downstream the alluvial deposits are better sorted and moderately large to large supplies of water can be developed from properly located and developed tile lines or other collectors. The alluvial deposits in Section 36, Township 3 North, Range 10 East, and Section 1, Township 2 North, Range 10 East, appear suitable for such development. Problems of protecting such developments from flooding, and the effectiveness of the alluvial deposits in filtering the glacial rock flour from the recharge water would have to be determined in evaluating this source of water supply.

GROUND WATER DEVELOPMENTS

To date there has been very little ground water development in the Hood River Valley as most of the valley is supplied by water distribution systems that derive their water supply from Cold Springs and Crystal Springs. Most of the existing wells supply domestic water in areas outside the distribution systems or furnish industrial water to some of the fruit processing plants in the valley. As most of the water requirements have been small to moderate, there have been no attempts to develop large ground water supplies.

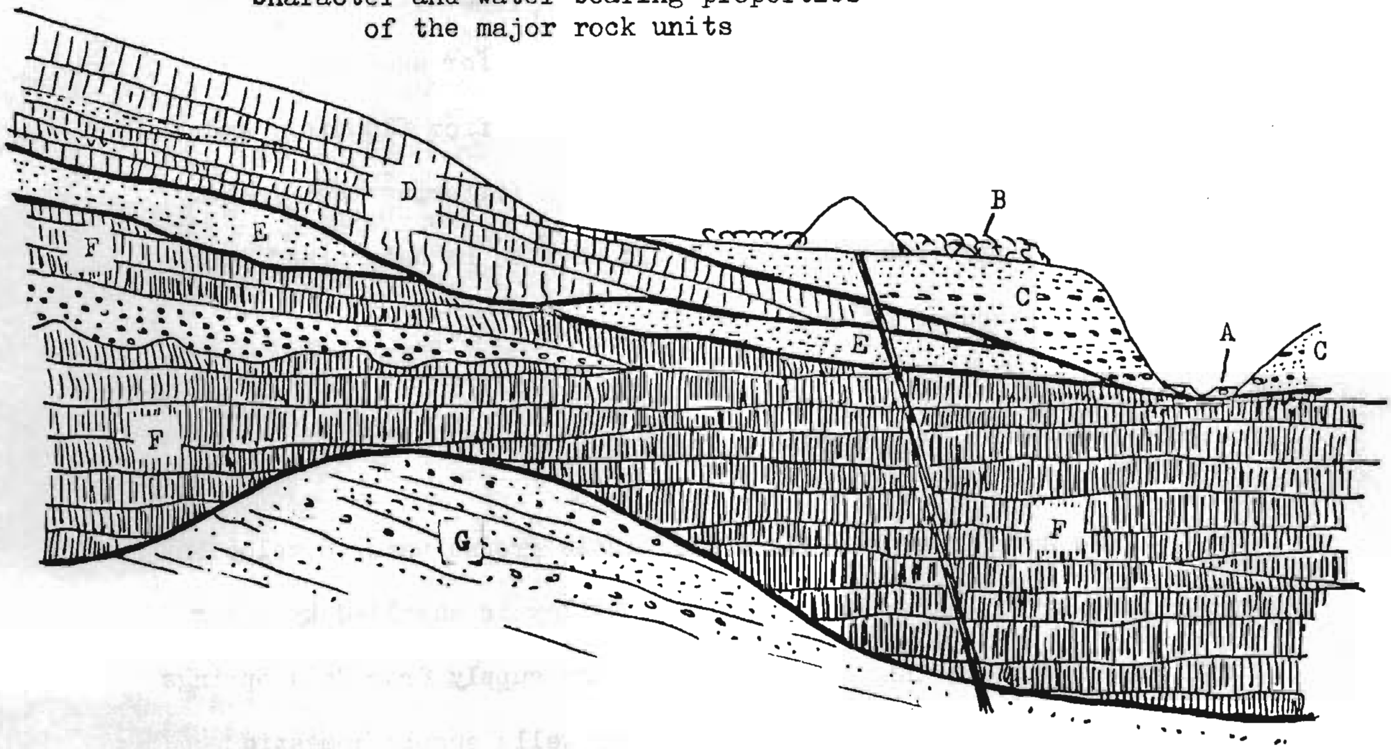
The description of the wells found in the Hood River Valley are given in Table 1 and the drillers logs are given in Table 2.

MAJOR SPRINGS OF THE HOOD RIVER VALLEY

Several large springs play an important role in the water supply of the Hood River Valley. These are Cold Springs, which supply the City of Hood River and several water districts; Crystal Springs which supply Parkdale, Odell and most of the area on the east side of Hood River, and Ice Fountain Spring which is being considered a source of domestic water. These three springs are described briefly.

Figure 5

Character and water-bearing properties of the major rock units



Designation in Figure	Unit Name	Character	Water-bearing characteristics
A	Recent alluvium	Chiefly a thin layer of boulder and gravel alluvium beneath the Hood River flood plain.	Believed capable of furnishing large quantities of ground water to sumps, ditches or tile lines.
B	Recent volcanic rocks	Chiefly blocky lava flows and pyroclastic deposits.	Rocks of this unit are generally well drained and are not sources of ground water. Where they are saturated, they would be capable of yielding large supplies of ground water.
C	Glacial deposits	Chiefly layers of glacial till and boulder conglomerate. Does contain some alluvial deposits of sand and gravel.	Glacial till and boulder conglomerate are capable of yielding only meager supplies of ground water. Small to moderate supplies of ground water can be developed from the sand or sand and gravel alluvial deposits interbedded in this unit.
D	Cascade andesites	Series of andesitic lava flows.	Most of the lava flows in this unit are believed to be of low permeability. Does contain some permeable contact zones between flows which supply some springs. These zones would be capable of furnishing small to moderate supplies to wells.
E	Troutdale fórmation	Sedimentary unit composed chiefly of conglomerate	Permeable layers of sand and gravel in the conglomerate are generally capable of yielding moderate supplies of ground water.
F	Columbia River Basalt	Series of basaltic lava flows.	Contact zones between individual lava flows or occasional layer of pillow basalt serve as aquifers. This formation is generally capable of yielding moderate supplies of ground water.
G	Eagle Creek formation	Chiefly volcanic mudflows, pyroclastic deposits and andesite lava flows.	Rocks of this unit are believed to be of low permeability and not capable of furnishing more than meager supplies of ground water.

Cold Springs

Cold Springs, including Stone Springs, consists of several orifices in a young andesite lava flow that partially fills the Valley of the West Fork of Hood River in Section 30, Township 1 North, Range 29 East. These springs which are tirbutary to Laurel Creek have been developed by several tunnels and buried pipelines extending back into the broken andesitic lava. It appears that the configuration of the underlying Columbia River basalt formation forces the ground water moving through the lava to the surface.

To date, only a part of the flow of this springs system has been developed for domestic and municipal use and a large supply of good quality water could still be developed from the Cold Springs Group.

Crystal Springs

Crystal Springs issues in the Canyon of Crystal Springs Creek in the NW¼ NW¼, Section 29, Township 1 South, Range 10 East. This spring is owned by the Crystal Springs Water District and is the sole source of domestic water supply for most of the east side area extending from Parkdale to the City of Hood River.

The springs issues in the bottom of Crystal Creek Canyon at the toe of a slope composed of large broken blocks of basaltic lava that form the south slope of the Canyon. The north slope appears to be formed of basaltic lava flows that haven't been broken like the south slope. The spring is at an elevation several hundred feet above the floor of the adjacent valley of the East Fork of Hood River. Detailed geologic mapping would aid materially in gaining an understanding of the mode of occurrence of this spring.

Ice Fountain Spring

This spring (Figure 6B), is located adjacent to the Middle Fork of Hood River in Section 24, Township 1 North, Range 9 East. It issues from the boulder alluvium along the left bank immediately upstream from an andesite lava flow that crops out on both sides of the river. Some water also issues from cracks in the lava. This spring is currently being considered as a source of domestic water by a newly formed water district.

When this spring was examined on April 15, 1965, the water temperature was 45½° F. which was exactly the same as the adjacent river temperature. At that time the spring had the appearance of being fed by underflow from the Middle Fork. When a detailed examination of the spring was made in July, 1965, the water temperature in the spring was still 45½° F. and the water was crystal clear while the quality of the water in the Middle Fork was greatly changed. The stream was loaded with glacial rock flour which gave the water a milkey gray appearance and the water temperature had raised to 59° F. Several test pits were constructed on the gravel bar immediately upstream from the spring. A fluorescein dye test showed that water in the boulder alluvium was moving toward the Middle Fork rather than from the Middle Fork to the spring. It was conclusive that the flow of Ice Fountain Spring is not being fed by the Middle Fork in the immediate area of the spring and that some other area serves as source of recharge to the ground water body supplying the spring.

A. Alluvium exposed along Middle Fork of Hood River where it is cutting a new channel in Section 24, T. 1 N., R. 9 E.

B. Ice Fountain Spring and lava barrier transecting stream channel.

CHEMICAL CHARACTER OF GROUND WATER

The chemical quality of the ground water from the various ground water reservoirs in the Hood River Valley is largely unknown. The available information indicates that most of the ground water is of good chemical quality although it contains considerably more dissolved minerals that the spring water from the Crystal Springs and Cold Springs systems. Four ground water samples were collected from wells in the Hood River Valley for analysis by the State Board of Health. The results of these analyses are given in Table 5.

An examination of the chemical analysis of ground water derived from the Columbia River basalt in other parts of Oregon and Washington show a marked similarity in chemical quality. It is expected that any deep well drilled into the Columbia River basalt in the Hood River Valley would have a chemical analysis similar to the average found in other areas. A chemical analysis of water from the Webster Packing Company well (2N/10-13N1), which is the only well known to be developing water from the Columbia River basalt in the Hood River Valley, is very similar to the average from other areas.

	Average analysis of water from Columbia River basalt	Well 2N/10-13N1
Total dissolved solids	230 ppm	185 ppm
Hardness (as $CaCO_3$)	90	73
Silica (SiO_2)	65	--
Iron (Fe)	0.1	0.04
Calcium (Ca)	20	15
Magnesium (Mg)	8	6.4
Sodium (Na)	30	13
Bicarbonate (HCO_3)	140	154
Chloride (Cl)	8	3.3

GROUND WATER POTENTIAL

The Columbia River Basalt formation appears to offer the best possibility of yielding large supplies of ground water suitable for supplementing surface supplies for municipal or group domestic purposes.

In testing the ground water potential of the Columbia River basalt, it would be desirable to select a drilling site so as to eliminate drilling through a thick section of Cascade andesite or glacial deposits. One such favorable site is the Tucker Bridge area in Section 15, Township 2 North, Range 10 East. The Columbia River basalt crops out along the river bank and serves as the foundation for Tucker Bridge.

The static water levels in ground water reservoirs underlying this area are not known, but there is the possibility that ground water may be impounded behind some subsurface barrier, such as a fault zone, and that high pressure artesian conditions could exist. Any deep test well in this area should have the well casing adequately cemented into the basalt to eliminate any threat of leakage. It is probable that a 1,000-foot well in this area could be developed to yield from 500 to 1,000 gallons per minute. If exceptionally permeable zones are encountered in the basalt, it is possible that yields of 1,000 to 2,000 gallons per minute could be obtained. The information gained from a deep test well in this valley would be of great help in evaluating the possibilities for additional ground water developments. The failure of the first test well, if such should occur, should not be grounds for eliminating the Columbia River basalt from further testing in other parts of the valley.

Table 1 - Records of representative wells in the Hood River Valley

Type of well: Dr, drilled.

Altitude: Altitude of land surface at well site in feet above mean sea level as interpolated from topographic maps.

Water level: Depth to water below land surface.

Type of pump: Sub, submersible.

Use: Dom, domestic; Com, commercial; Ind, industrial.

Well number	Owner	Type of well	Year completed	Depth of well (feet)	Diam. of well (in.)	Depth of casing (feet)	Finish	Water-bearing zone(s): Depth to top (feet)	Water-bearing zone(s): Thickness (feet)	Water-bearing zone(s): Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Type of pump and HP	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use	Remarks
T. 1 N., R. 9 E.																		
12P1	W. H. Hess	Dr	1965	106	6	106	Perforated 97-101	97	1	Cinders	1200	32	11-22-65	Sub 3/4	16	33	Dom	See Table 2 for log. Three foot cement plug at bottom.
T. 1 N., R. 10 E.																		
21B1	P. VanGuard	Dr	1962	90	8	80	Gravel packed	73	17	Sand and gravel	1400	$7\frac{1}{2}$	6-18-62	Sub	22	30	Dom	See Table 2 for log.
28J1	E. Rosser	Dr	1964	120	8	95	Gravel packed	95	3	Sand	1520	47	5-6-64	Sub	19	35	Com	See Table 2 for log. Supplies gasoline station.
T. 2 N., R. 10 E.																		
4K1	Gerald White	Dr	1964	60	6	60	Perforated 47-63	47	5	Andesite	780	41	3-10-64		17	15	Dom	See Table 2 for log.
4L1	Art Knight	Dr	1956	40	8	40	Perforated 20-40	24	31	Andesite	770	17	6-12-56	Jet			Dom	See Table 2 for log.
8G1	Ken Curtiss	Dr	1963	110	8	19	Uncased 19-110			Andesite	1150	89	7-26-63				Dom	See Table 2 for log.
13A1	Walter Wells & Sons	Dr	1957	250	10	$47\frac{1}{2}$	Uncased $47\frac{1}{2}$-250			Basalt	580	+9	8-26-57		21	110		Well abandoned because of small yield. Well flowed 4 gpm. See Table 2 for log.
13N1	Webster Packing Co.	Dr	1955	160	10-8	160	Perforated casing	115	45	Basalt	620	4	July '55	Turbine 10	90	141	Ind	See Table 2 for log. Water level near land surface.
13P1	Hood River Cold Storage Company	Dr	1949	128	8-6	128	Perforated casing	105	10	Gravel	640			Turbine 5			Ind	See Table 2 for log.
15N1	Hood River County	Dr	1963	53	8-6	52	Perforated casing	39	14	Gravel	480	22	12-9-63	Sub 1	20	18	Park	See Table 2 for log.
26K1	Stadelman Fruit Co.	Dr	1953	264	8	44	Uncased 44-264			Gravel	620			Turbine 20	200	205	Ind	Water temp. 51° F. See Table 2 for log.
26K2	Duckwall Bros.	Dr	1958	262	8-6	262	Perforated casing	245	17	Gravel	620	35	8-15-58	Turbine	125	150	Ind	Reported to have 1.4 ppm iron in water. Treatment required. See Table 2 for log.

Table 1 - Records of representative wells in the Hood River Valley - Continued

Well number	Owner	Type of well	Year completed	Depth of well (feet)	Diam. of well (in.)	Depth of casing (feet)	Finish	Water-bearing zone(s): Depth to top (feet)	Water-bearing zone(s): Thickness (feet)	Water-bearing zone(s): Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Type of pump and HP	Well performance: Yield (gpm)	Well performance: Draw-down (feet)	Use	Remarks
T. 3 N., R. 10 E.																		
25P1	Apple Growers Ass'n.	Dr	1926	300 ±	8	?				Basalt	100				100	?		Formerly Mid-Columbia Cold Storage Company well. Used to supply water for two condensers. Water reported to have been of good quality. Temperature 52° F.
25R1	Northwest Natural Gas Company										80							Anode for gas line protection. See Table 2 for log.
35N1	Don Yeck	Dug		60			Concrete tile at bottom			Sand	570	40						Well dug entire depth in sand. Well abandoned and filled.

Table 2 - Logs of Wells in the Hood River Valley

Well No. 1N/9-12P1

Owner: W. H. Hess Owner's No.

Driller: Bert Clayton & Son Date Drilled 1965

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Soil	0	4	4
Clay, light brown with boulders	4	6	2
Clay, light brown	6	16	10
Boulders with light brown clay	16	22	6
Sand, brown, rocky	22	29	7
Sandstone, gray	29	56	27
Clay, yellow	56	58	2
Cascade andesite:			
Rock, brown, rotten	58	64	6
Red cinders	64	70	6
Boulders, all colors with clay	70	81	11
Red cinders, water at 97 feet	81	106	25

Casing: 6-inch to 106 feet.

Well No. 1N/10-21B(1)

Owner: Peter VanGuard Owner's No.

Driller: Bert Clayton & Son Date Drilled 1962

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial till:			
Soil and boulder (dug hole)	0	4	4
Silt	4	5	1
Boulders and brown clay	5	14	9
Clay, gray, rocky	14	25	11
Clay, blue-gray	25	38	13
Glacial outwash:			
Round rock, gray	38	43	5
Sand and round rock, gray and red	43	66	23
Clay, blue, rocky	66	73	7
Sand and gravel, gray	73	80	7

Casing: 8-inch to 80 feet; gravel packed from 20 to 80 feet.

Well No. 1N/10-28J1

Owner: Edward Rosser Owner's No.

Driller: Bert Clayton & Son Date Drilled 1964

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial till:			
Soil, rocky brown	0	8	8
Clay, brown, rocky	8	23	15
Clay, blue	23	31	8
Clay, blue, rocky	31	44	13
Clay, blue, large rocks	44	65	21
Clay, blue-green	65	85	20
Clay, blue, large rocks	85	95	10
Sand, gray, water-bearing	95	98	3
Clay, gray, large rocks	98	120	22

Casing: 8-inch to 119 feet; perforated from 95 to 119 feet. Gravel packed from 24 to 120 feet.

Well No. 2N/10-4K1

Owner: Gerald White Owner's No.

Driller: R. J. Strasser Drilling Co. Date Drilled 1964

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Top soil	0	1½	1½
Clay and boulders	1½	11	9½
Cascade andesite:			
Gray and brown lava	11	21	10
Red cinders	21	28	7
Gray and brown lava	28	32	4
Porous gray lava	32	36	4
Hard gray rock	36	47	11
Rock, red and black, water-bearing	47	52	5
Rock, hard, gray	52	60	8

Casing: 6-inch to 60 feet; perforated from 47 to 60 feet.

Table 2 - Logs of Wells in the Hood River Valley - Continued

Well No. 2N/10-4L1

Owner: Art Knight Owner's No.

Driller: Bert Clayton Date Drilled 1956

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Round boulders.	0	6	6
Cascade andesite:			
Porous loose rock and red soil.	6	24	18
Rock, white, porous	24	31	7
Rock, gray.	31	40	9

Casing: 8-inch to 40 feet; perforated from 20 to 40 feet.

Well No. 2N/10-8G1

Owner: Ken Curtiss Owner's No.

Driller: Bert Clayton Date Drilled 1963

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Cascade andesite:			
Soil, red.	0	15	15
Clay, red.	15	25	10
Clay, red, with white flakes	25	45	20
Clay, lavender	45	55	10
Clay, red.	55	70	15
Clay, lavender	70	90	20
Granite (andesite), gray	90	110	20

Casing: 8-inch to 19 feet.

Table 2 - Logs of Wells in the Hood River Valley - Continued

Well No. 2N/10-13A1

Owner: Walter Wells & Sons Owner's No.

Driller: Bert Clayton & Son Date Drilled 1957

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Silt and soil	0	2	2
Clay, light brown and soil	2	4	2
Clay, dark brown	4	6	2
Clay, blue	6	12	6
Clay, blue, sandy	12	18	6
Boulders and blue clay	18	23	5
Clay, red	23	24	1
Clay, dark gray, and boulders	24	38	14
Cascade andesites (?):			
Rock, gray	38	104	66
Rock, gray and clay	104	106	2
Rock, gray	106	127	21
Rock, gray, broken, trace of clay	127	140	13
Rock, gray, trace of clay	140	150	10
Columbia River basalt:			
Clay, brown and boulders	150	179	19
Rock, block, cemented, trace of clay	179	186	7
Clay, brown and black rock	186	192	6
Rock, black	192	204	12
Clay, brown and black and red rock	204	208	4
Rock, black and red	208	216	8
Rock, black and red, trace of clay	216	237	21
Clay, sticky, brown	237	250	13

Casing: 10-inch to 47½ feet.

Well No. 2N/10-13N1

Owner: Webster Packing Company Owner's No.

Driller: Haakon Bottner Drilling Company Date Drilled 1955

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Soil	0	3	3
Clay, gray	3	9	6
Sand, yellow	9	22	13
Sand, gray	22	45	23
Sand, and clay, gray and brown	45	50	5
Clay, blue	50	64	14
Gravel	64	70	6
Clay, gray	70	101	31
Gravel	101	115	14
Columbia River basalt:			
Rock, broken, water-bearing	115	123	8
Basalt, soft	123	136	13
Basalt, black, with crevices, water-bearing	136	160	24

Well No. 2N/10-13P1

Owner: Hood River Cold Storage Company Owner's No.

Driller: Dorin Wilburn Date Drilled 1949

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Soil and clay.	0	18	18
"Quicksand" and clay, water-bearing	18	44	26
Sand, red and gravel.	44	64	20
Gravel.	64	83	19
Rock.	83	85	2
Gravel, water-bearing from 105 to 115 ft. . .	85	127	42
Columbia River basalt:			
Hard rock	127	128	1

Casing: 8-inch to 66 feet, 6-inch from 65 to 128 feet

Well No. 2N/10-15N1

Owner: Hood River County Owner's No.

Driller: Haakon Bottner Drilling Company Date Drilled 1963

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Soil.	0	4	4
Sand, fine and large boulders	4	39	35
Gravel, medium, water-bearing	39	53	14

Well No. 2N/10-26K1

Owner: Stadelman Fruit Company Owner's No.

Driller: Courtney Bach Date Drilled 1953

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Soil.	0	30	30
Cascade andesite:			
Rock, broken.	30	40	10
Rock, hard.	40	45	5
Clay.	45	50	5
Rock, black	50	105	55
Rock, hard.	105	115	10
Rock, gray.	115	120	5
Troutdale formation (?):			
Clay, blue.	120	150	30
Boulders.	150	155	5
Clay, brown	155	210	55
Gravel.	210	225	15
Clay, blue.	225	250	25
Gravel.	250	255	5
Clay.	255	264	9

Casing: 8-inch to 44 feet

Well No. 2N/10-26K2

Owner: Duckwall Bros. Owner's No.

Driller: Barron & Strayer Date Drilled 1958

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Glacial deposits, undifferentiated:			
Soil and gravel	0	30	30
Cascade andesite:			
Rock, broken	30	40	10
Rock, hard	40	45	5
Rock, mixed with clay	45	55	10
Rock, broken	55	77	22
Rock, gray	77	120	43
Rock, gray, hard	120	135	15
Troutdale formation (?):			
Clay, brown	135	181	46
Gravel	181	210	29
Clay, brown	210	230	20
Gravel with brown clay	230	245	15
Gravel	245	262	17

Well No. 3N/10-25R1

Owner: Northwest Natural Gas Company Owner's No.

Driller: Hansen Drilling Company Date Drilled 1963

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Fill and Troutdale formation:			
Soil	0	2	2
Clay and rocks	2	35	33
Clay and sand	35	83	48
Columbia River basalt:			
Rock, blue, medium hard	83	121	38
Basalt, gray-black, extra hard	121	214	93

Casing: 10-inch to 20 feet.

GROUND WATER RESOURCES OF THE CASCADE LOCKS AREA

Geologic Setting

The town of Cascade Locks is located along the south shore of the Columbia River a few miles upstream from Bonneville Dam. The town derived its name from the old locks that were constructed to facilitate river transportation through the Cascade Rapids. These rapids and the locks were subsequently eliminated when the reservoir behind Bonneville Dam was filled. The town lies in the Columbia River Gorge where it crosses the center of the Cascade Range. Oregon's famous Skyline Trail, which follows the crest of the Cascade Range, has its northern terminous about a mile east of town.

The Columbia River Gorge in this area is from three to four thousand feet deep. The town lies on a narrow terrace bordering the river. The slope behind the town rises in a series of steps that were formed when some large blocks slid into the gorge. These blocks, which probably slid into the Gorge near the end of the Ice Age, have created a very complex geologic setting, as rocks of many types and ages have been moved and mixed together. An active slide area which was known as "Ruckel Slide" existed from just south of the "Bridge of the Gods" for more than a mile along the Oregon shore. Movement of this slide was arrested during the nineteen thirties by the construction of more than 7,000 feet of drain tunnels by the Corps of Engineers. The longest tunnel extends more than 2,000 feet into the slide area.

The higher slopes of the Gorge above the slide blocks are composed of numerous basaltic lava flows that are part of the Columbia River basalt formation. Figure 7 is a diagramatic sketch showing the general geologic setting of the Cascade Locks area.

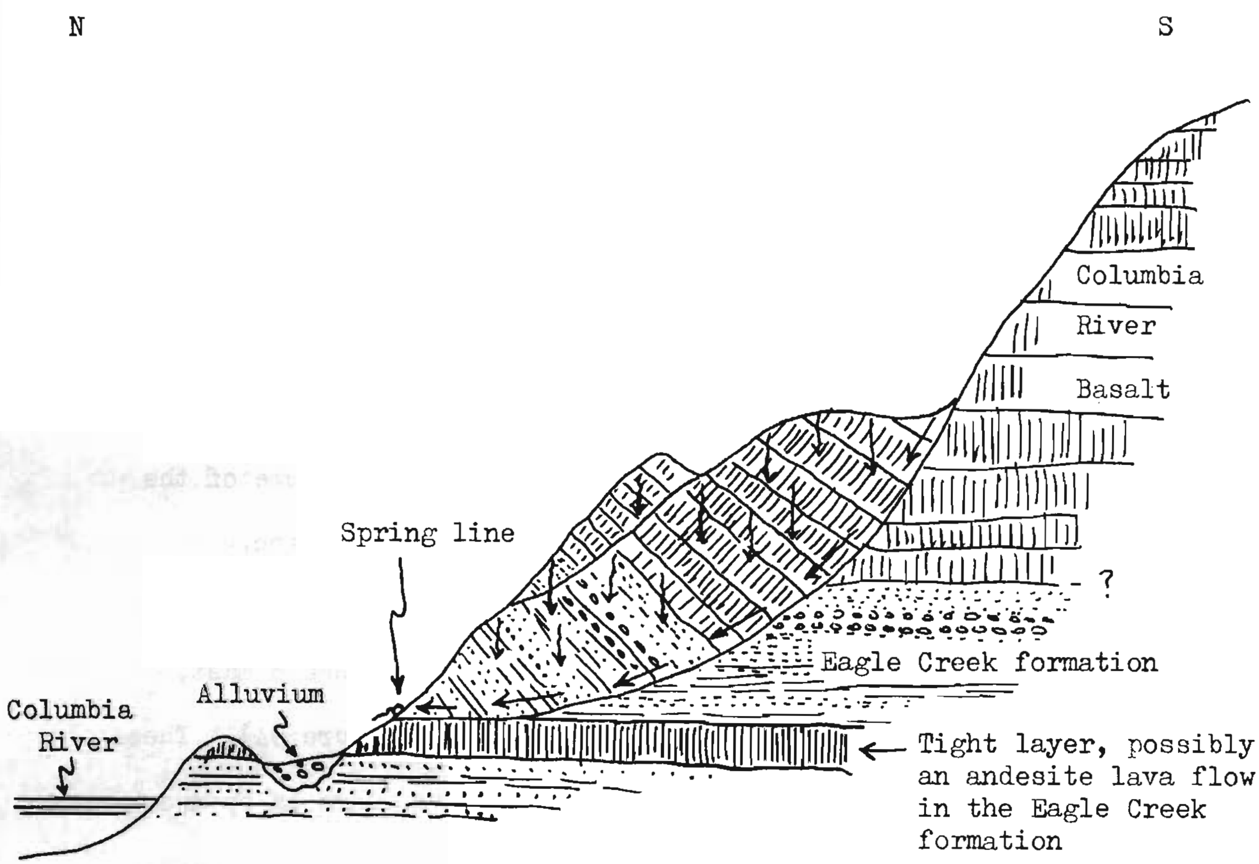
The town is underlain with alluvial deposits of sand, gravel and boulders. Projecting up through these alluvial deposits are some small hills and knobs of andesite, basalt, and volcanic agglomerate. Tuffaceous sandstone, containing some petrified wood, is exposed along the shore near the old mill located about half a mile northeast of the locks. This sandstone, the agglomerate, and possibly some of the andesites are believed to be part of the Eagle Creek formation.

Adjacent to the Columbia River immediately west from the mouth of Herman Creek in Section 6, Township 2 North, Range 8 East, are some young alluvial deposits of sand and gravel (Figure 9A). These gravels which are being mined in several gravel pits, have an openwork texture and appear to be very permeable.

The Occurrence of Ground Water

A large part of the surface water flowing off the south wall of the Columbia Gorge near Cascade Locks disappears into the ground upon reaching the slide block area depicted on Figure 8. Dry Creek and Rudolph Creek both lose water or disappear entirely in crossing this area. The water reappears in a line of large springs that extends from OxBow Springs on the east to Crystal Springs on the west. These springs issue at an elevation several hundred feet above the level of the Columbia River. Crystal Springs, which is probably the re-emergence of Rudolph Creek, was formerly the source of municipal water for Cascade Locks.

Figure 7



Diagramatic section through the Cascade Locks area. Arrows indicate the general path of water movement.

In order for the ground water to be forced to the surface in this line of springs, there must be an extensive layer of tight material underlying the area that prevents the downward movement of water. The nature of this tight layer was not detected during this investigation, but it is believed that it is formed by a relatively impermeable layer of andesitic lava in the Eagle Creek formation. The andesitic lava knobs in Section 5, Township 2 North, Range 8 East, may be outliers of this tight layer.

Test drilling and drain tunnel construction in the Ruckel Slide area immediately southwest of Cascade Locks has provided a detailed picture of the geology of the slide area which is believed representative of conditions existing south of Cascade Locks. Figures 11 and 12 are copies of geologic sections of tunnels R2 and R3 which were prepared by C. P. Holdridge of the Corps of Engineers and C. P. Berkey and E. T. Hodge, consulting geologists for the Corps.

The flow from the drainage tunnels was measured for several years by the Corps of Engineers. The flow from tunnels R2 and R3, which are given on Figure 10, shows a marked seasonal fluctuation. A similar fluctuation of OxBow Spring at the OxBow Fish Hatchery was reported by Mr. Harrison, Superintendent of the hatchery, who has observed the spring for many years.

The alluvial gravels along the Columbia River just west from the mouth of Herman Creek extend below river level and contain a body of ground water that is in hydraulic connection with the river. This ground water reservoir, which has been developed by only a few domestic wells, appears to offer excellent possibilities as a source of ground water supplies.

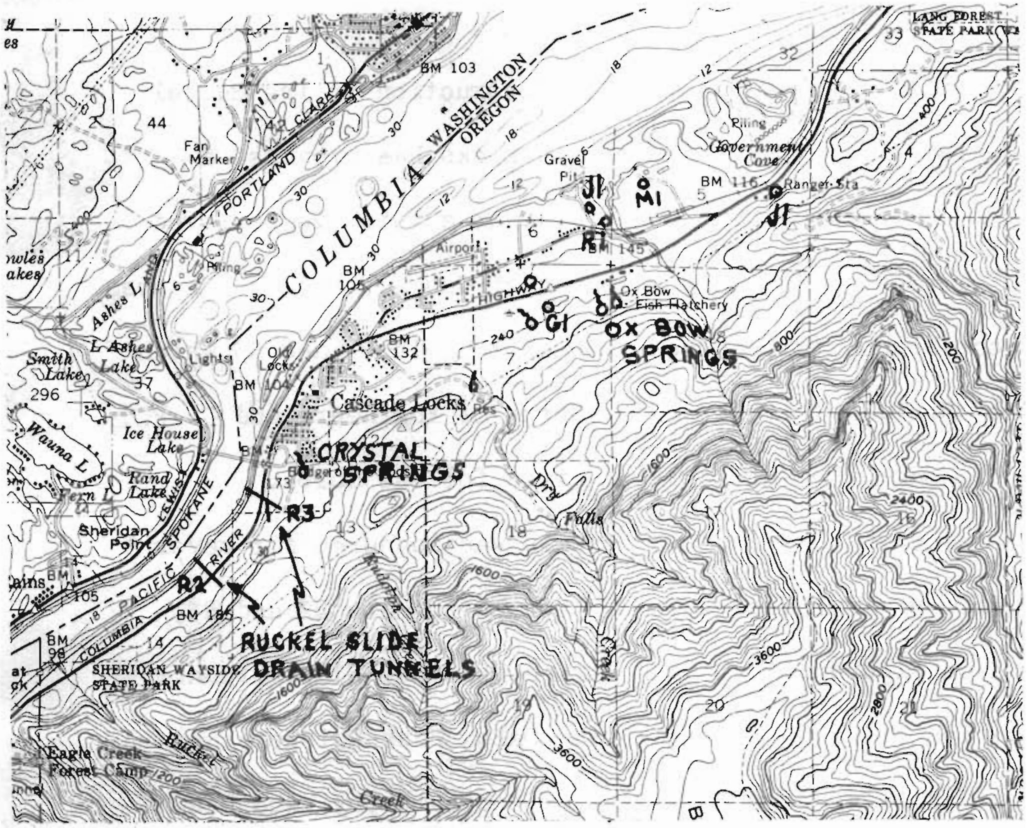
The Eagle Creek formation which underlies all of the Cascade Locks area at depth is believed to be of low permeability. The 200 foot drilled well at the Ranger Station just east of town developed water from the Eagle Creek formation and had a yield of only 4 gallons per minute.

Chemical Quality of Ground Water

Water samples for chemical analysis were collected from the Eckton well (2N/8-6J1) and from drain tunnel R3 in Section 13, Township

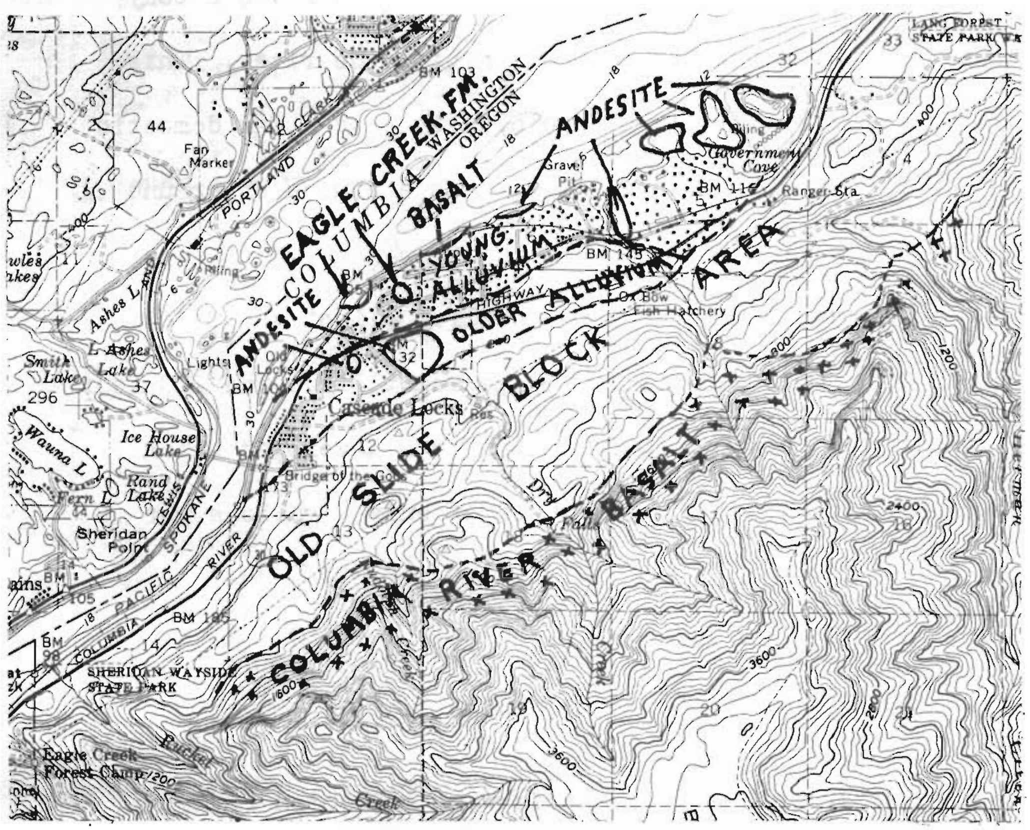
Figure 8

T.
2
N.



R. 7 E. R. 8 E.

A. Map showing location of wells and springs



B. Geologic map of the Cascade Locks area

3 North, Range 7 East. Approximately 200 gallons per minute were discharging into the Bonneville Pool from this tunnel on March 25, 1965.

Chemical analysis of these samples (Table 5) indicate that the ground water in the Cascade Locks area is very low in dissolved mineral matter, very soft, and of excellent quality for most water requirements.

Ground Water Potential

Large amounts of ground water moves north through the slide block area depicted on Figure 8, and discharges in the line of springs. The construction of wells in this area south of the line of springs would intercept some of this ground water. Problems of well construction in the broken material and the possibility of missing the main avenues of water movement creates some risk in attempting to develop ground water in this area. An examination of the occurrence of ground water encountered in tunnels R2 and R3 (Figures 11 and 12), indicate that the possibility of picking a well site on the slide block area and encountering a permeable ground water reservoir is very poor. The drilling of wells in the spring areas or to depths below the altitude of the springs is not advisable as the possibility of developing large supplies of ground water from the Eagle Creek formation is low. If sufficient water is not developed at an altitude above 240 feet, a new well site should be selected rather than deeper drilling into the Eagle Creek formation. Yields exceeding 500 gallons per minute can probably be developed in some parts of the slide block area where broken basalt materials extend below the water table.

Large capacity wells can be developed in the alluvial gravels lying adjacent to the Columbia River immediately west from the mouth of

Herman Creek in Section 6, Township 2 North, Range 7 East. Some test drilling or possibly a geophysical traverse would aid in selecting the best sites for production wells. Yields exceeding 1,000 gallons per minute can probably be developed from a properly constructed screened well having a depth of less than 100 feet.

Wells drilled into the andesite knobs, the Eagle Creek formation, and the older alluvium should yield only small to moderate supplies. These rock units should not be considered as sources of large supplies of ground water.

A. Permeable sand and gravels exposed in a gravel pit located adjacent to the Columbia River in the NW¼ SE¼, Section 6, T. 2 N., R. 8 E.

B. Road cut along Interstate 80 in Section 12, T. 2 N., R. 7 E., showing well developed jointing in volcanic rock.

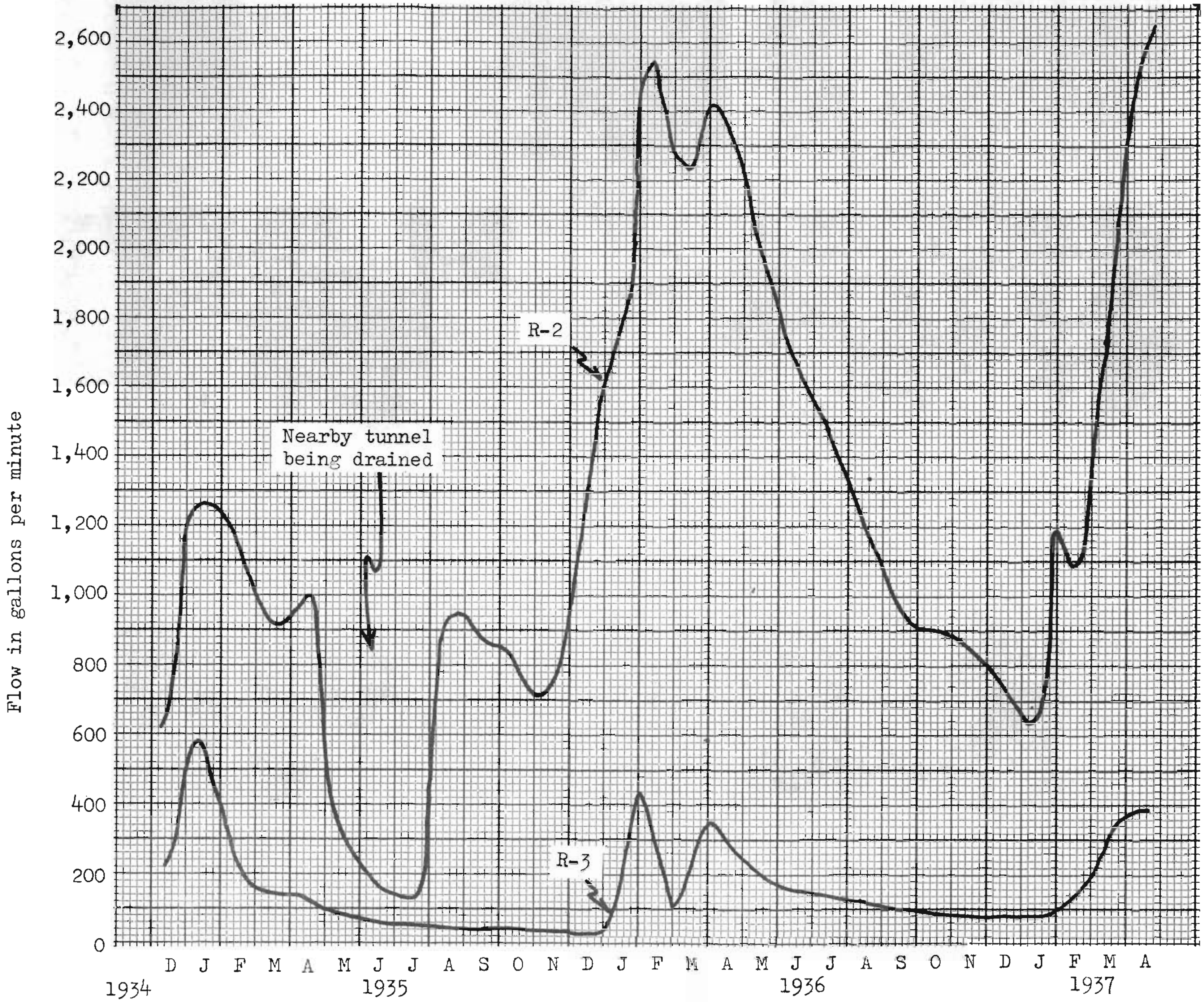


Figure 10

Flow from the drainage tunnels R2 and R3 (Data from Corps of Engineers)

Table 3 - Records of wells in the Cascade Locks Area

WELL NUMBER	OWNER	TYPE OF WELL	YEAR COM-PLETED	DEPTH OF WELL (FEET)	DIAM. OF WELL (IN.)	DEPTH OF CASING (FEET)	FINISH	WATER-BEARING ZONE(S)			ALTI-TUDE (FEET)	WATER LEVEL		TYPE OF PUMP AND HP	WELL PER-FORMANCE		USE	REMARKS
								DEPTH TO TOP (FEET)	THICK-NESS (FEET)	CHARACTER OF MATERIAL		FEET BELOW DATUM	DATE		YIELD (GPM)	DRAW-DOWN (FEET)		
T. 2 N.,	R. 8 E.																	
5J1	U.S. Forest Service	Dr	1963	200	6	177	Perforated casing				120	29	3-25-65	None	4	160	None	See Table 4 for log.
5M1	Cascade Locks Lumber Company	Dr	1952	78	8	14	Uncased 14-78	76	2	Rock	100	27	1952		20	39	Ind	See Table 4 for log.
6J1	C. Eckton	Dr	1960	74	6	74		60	14	Pea gravel	120	59	1960		30	1	Dom	See Table 4 for log.
6R1	Rodney Potter	Dr	1960	50	6	50	No perforations	49	1+	Sand and gravel	80	7½	12-24-60		15	14½	Dom	See Table 4 for log.
7B1	R. F. Carter	Dr	1962	51	6-4½	51	Perforated 40-50	48	3+	Gravel	160	27	4-16-62		20	3	Dom	See Table 4 for log.
7G1	Wm. McGlone	Dr	1956		8	100					240	40	1956	None			None	

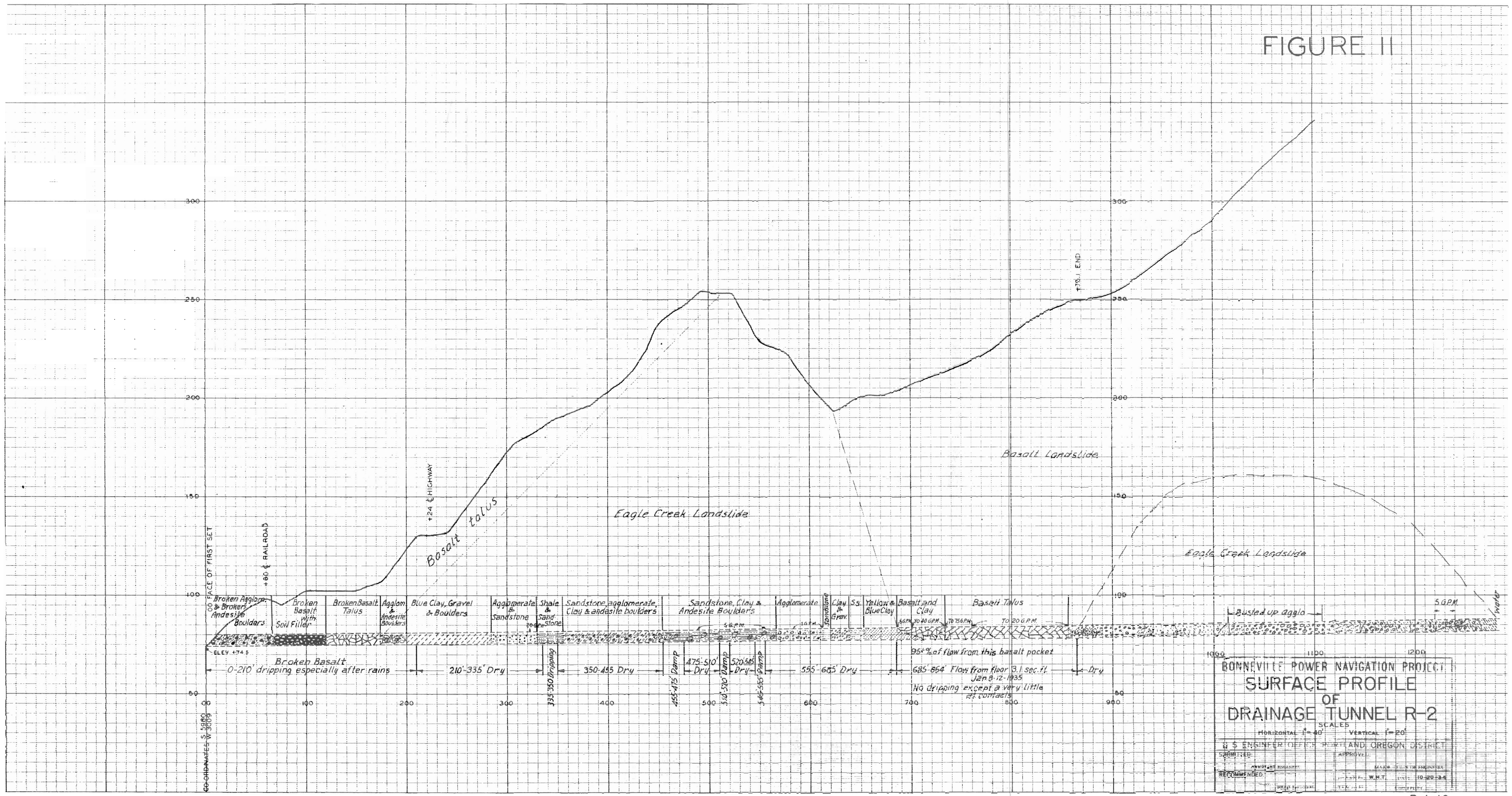


FIGURE II
BONNEVILLE POWER NAVIGATION PROJECT
SURFACE PROFILE
OF
DRAINAGE TUNNEL R-2
SCALES
HORIZONTAL 1"=40'
VERTICAL 1"=20'
U.S. ENGINEER OFFICE PORTLAND OREGON DISTRICT
SUBMITTED:
APPROVED:
RECOMMENDED:
10-20-35
0.0 FACE OF FIRST SET
+60 ℄ RAILROAD
+24 ℄ HIGHWAY
+70.1 END
Eagle Creek Landslide
Basalt talus
Basalt Landslide
Eagle Creek Landslide
Broken Agglom. & Broken Andesite Boulders
Broken Basalt with Soil Filler
Broken Basalt Talus
Agglom & Andesite Boulders
Blue Clay, Gravel & Boulders
Agglomerate & Sandstone
Shale & Sand Stone
Sandstone, agglomerate, Clay & andesite boulders
Sandstone, Clay & Andesite Boulders
Agglomerate
Sandstone
Clay & Grav.
Ss.
Yellow & Blue Clay
Basalt and Clay
Basalt Talus
Busted up agglo
5 G.P.M.
water
ELEV. +74.5
Broken Basalt
0-210' dripping especially after rains
210'-335' Dry
335-350 Dripping
350-455 Dry
455-475 Damp
475-510' Dry
510-520 Damp
520-545 Dry
545-555 Damp
555-685' Dry
95+% of flow from this basalt pocket
685-864' Flow from floor 3.1 sec. ft.
Jan. 8-12-1935
No dripping except a very little at contacts
Dry
TO 20 G.P.M.
COORDINATES S. 5980 W. 3609
300
250
200
150
100
50
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

R-1-16

FIGURE 12

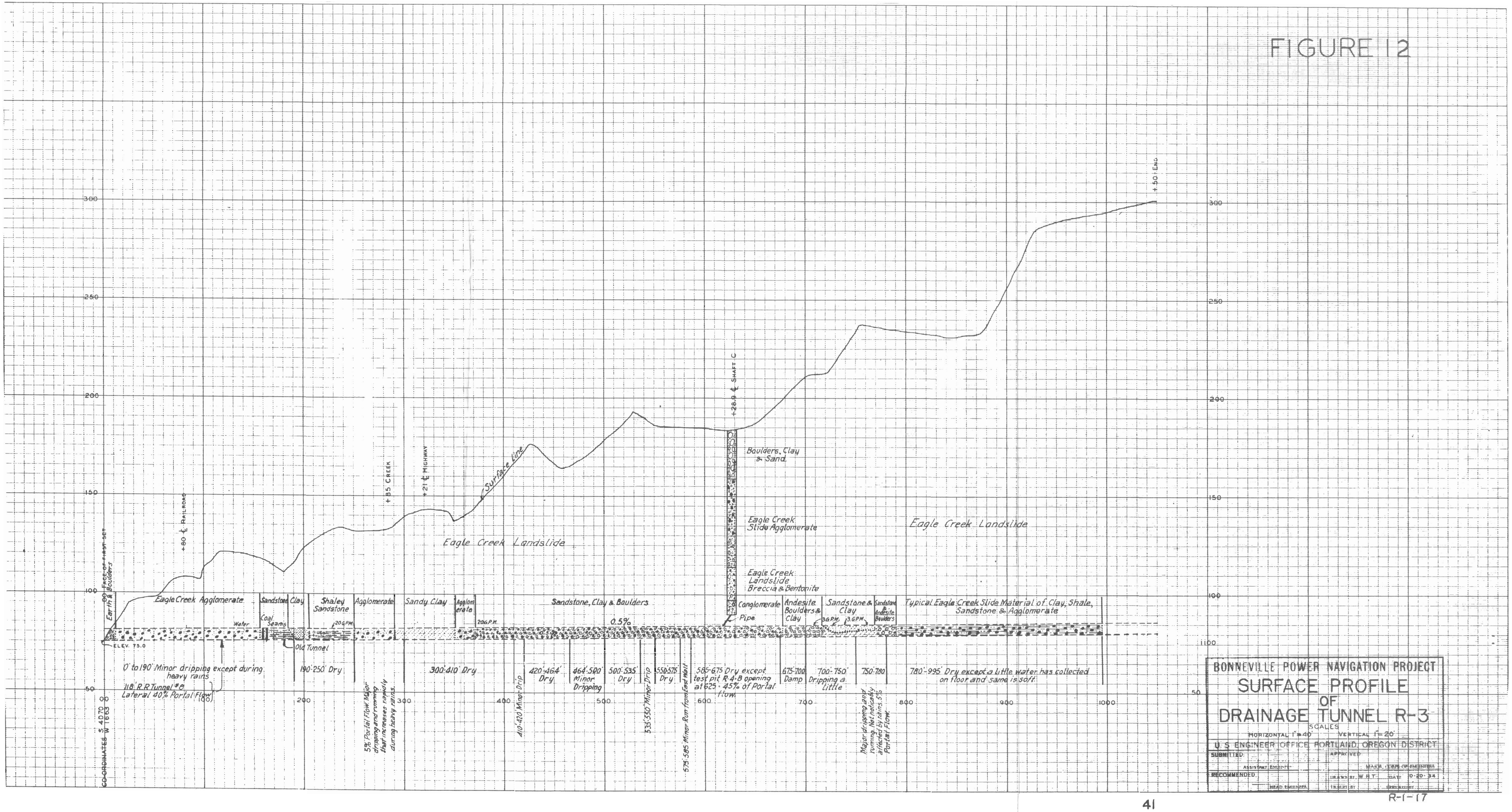

Surface Line
Eagle Creek Landslide
Boulders, Clay & Sand
Eagle Creek Slide Agglomerate
Eagle Creek Landslide Breccia & Bentonite
Earth & Boulders
Eagle Creek Agglomerate
Sandstone
Clay
Shaley Sandstone
Agglomerate
Sandy Clay
Agglomerate
Sandstone, Clay & Boulders
Conglomerate
Andesite Boulders & Clay
Sandstone & Clay
Typical Eagle Creek Slide Material of Clay, Shale, Sandstone & Agglomerate
Coal Seams
Water
Old Tunnel
Pipe
0.5%
ELEV. 75.0
+80 ℄ Railroad
+85 Creek
+21 ℄ Highway
+28.9 ℄ Shaft C
+50 End
0' to 190' Minor dripping except during heavy rains
118' R.R. Tunnel #8 Lateral 40% Portal Flow
190'-250' Dry
5% Portal Flow Major dripping and running that increases rapidly during heavy rains.
300'-410' Dry
410'-420' Minor Drip
420'-464' Dry
464'-500' Minor Dripping
500'-535' Dry
535'-550' Minor Drip
550-575 Dry
575-585 Minor Run from East Wall
585-675 Dry except test pit R-4-8 opening at 625 - 45% of Portal flow
675-700 Damp
700'-750' Dripping a little
750'-780
Major dripping and running. Not noticeably affected by rains. 5% Portal Flow.
780'-995' Dry except a little water has collected on floor and same is soft.
Co-ordinates S 4070 W 1663
BONNEVILLE POWER NAVIGATION PROJECT
SURFACE PROFILE OF DRAINAGE TUNNEL R-3
SCALES
HORIZONTAL 1" = 40'
VERTICAL 1" = 20'
U. S. ENGINEER OFFICE PORTLAND, OREGON DISTRICT
SUBMITTED
ASSISTANT ENGINEER
APPROVED
MAJOR, CORPS OF ENGINEERS
RECOMMENDED
HEAD ENGINEER
DRAWN BY W.H.T.
DATE 10-20-34
TRACED BY
CHECKED BY
R-1-17

Table 4 - Logs of Wells in the Cascade Locks Area

Well No. 2N/8-5J1

Owner: U. S. Forest Service Owner's No.

Driller: Steinman Brothers Date Drilled 1963

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Eagle Creek formation: (?)			
Soft white clay	0	4	4
Boulders	4	9	5
Conglomerate, yellow	9	22	13
Tuff, blue, hard and soft	22	35	13
Tuff	35	48	13
Shale, sandy gray, hard	48	58	10
Sandstone, blue-gray	58	80	22
Tuff, blue-gray with quartz crystals	80	90	10
Tuff, gray, hard and soft	90	150	60
Shale, blue-gray, soft	150	155	5
Tuff, blue with brown specks	155	167	12
Tuff, white and gray	167	200	33

Casing: 6-inch to 177 feet, perforations from 158 to 173 feet and at 75 feet

Well No. 2N/8-5M1

Owner: Cascade Locks Lumber Company Owner's No.

Driller: Haakon Bottner Date Drilled 1952

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Young alluvium:			
Soil	0	10	10
Boulders	10	14	4
Eagle Creek formation: (?)			
Rock	14	34	20
Cemented gravel	34	36	2
Hard rock	36	76	40
Rock, water-bearing	76	78	2

Well No. 2N/8-6J1

Owner: C. Eckton Owner's No.

Driller: Haakon Bottner Date Drilled 1960

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Young alluvium:			
Soil	0	2	2
Boulders and gravel	2	16	14
Loose gravel	16	37	21
Gray quicksand	37	60	23
Pea gravel	60	74	14

Table 4 - Logs of Wells in the Cascade Locks Area - Continued

Well No. 2N/8-6R1

Owner: Rodney Potter Owner's No.

Driller: A. M. Jannsen Date Drilled 1960

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Young alluvium:			
Gravel	0	4	4
Large boulders	4	11	7
Heaving sand	11	46	35
Sandy clay	46	49	3
Sand and gravel, coarse, water-bearing	49	50	1

Casing: 6-inch to 50 feet.

Well No. 2N/8-7B1

Owner: R. F. Carter Owner's No.

Driller: George Zent and Son Date Drilled 1962

CHARACTER OF MATERIAL	(Feet below land surface) From	To	Thickness (feet)
Older alluvium:			
Soil	0	3	3
Boulders and coarse gravel	3	18	15
Sand and gravel	18	27	9
Boulders	27	32	5
Sandy clay and sandstone	32	48	16
Gravel, water-bearing	48	51	3

Casing: 6-inch to 50 feet.

Table 5 - Partial Chemical Analyses of Ground Water from the Hood River Valley and the Cascade Locks Area
(Analyses by Oregon State Board of Health)

Well No.	2N/10-4L1	2N/10-13N1	2N/10-15N1	2N/10-26K2	2N/8-6J1	2N/7-13
Owner	A. Knight	Webster Packing Company	Hood River County	Duckwall Bros.	C. Eckton	---
Water bearing formation	Cascade andesite	Columbia River Basalt	Gravel alluvium	Troutdale formation	Gravel alluvium	Test tunnel R 3-4213
Date of Collection	3/25/65	3/25/65	3/25/65	3/25/65	3/25/65	3/25/65
Total solids (ppm)	142	185	166	290	63	82
Hardness as $CaCO_3$ (ppm)	65	73	83	178	19	22
Conductance (micromhos at 25° C)	131	223	158	355	40	52
pH	6.5	8.6	6.6	7.0	6.3	6.5
Calcium Ca (ppm)	13	15	10	30	3.1	3.8
Magnesium Mg (ppm)	8.1	6.4	14	25	2.7	2.9
Sodium Na (ppm)	5.0	13	5.4	22	1.8	3.0
Bicarbonate HCO_3 (ppm)	59	154	110	250	23	29
Chloride Cl (ppm)	1.9	3.3	2.5	15	0.8	1.1
Sulfate SO_4 (ppm)	4.0	4.5	0.5	1.0	0.5	0.5
Iron Fe (ppm)	0.15	0.04	0.01	0.66	0.04	0.02

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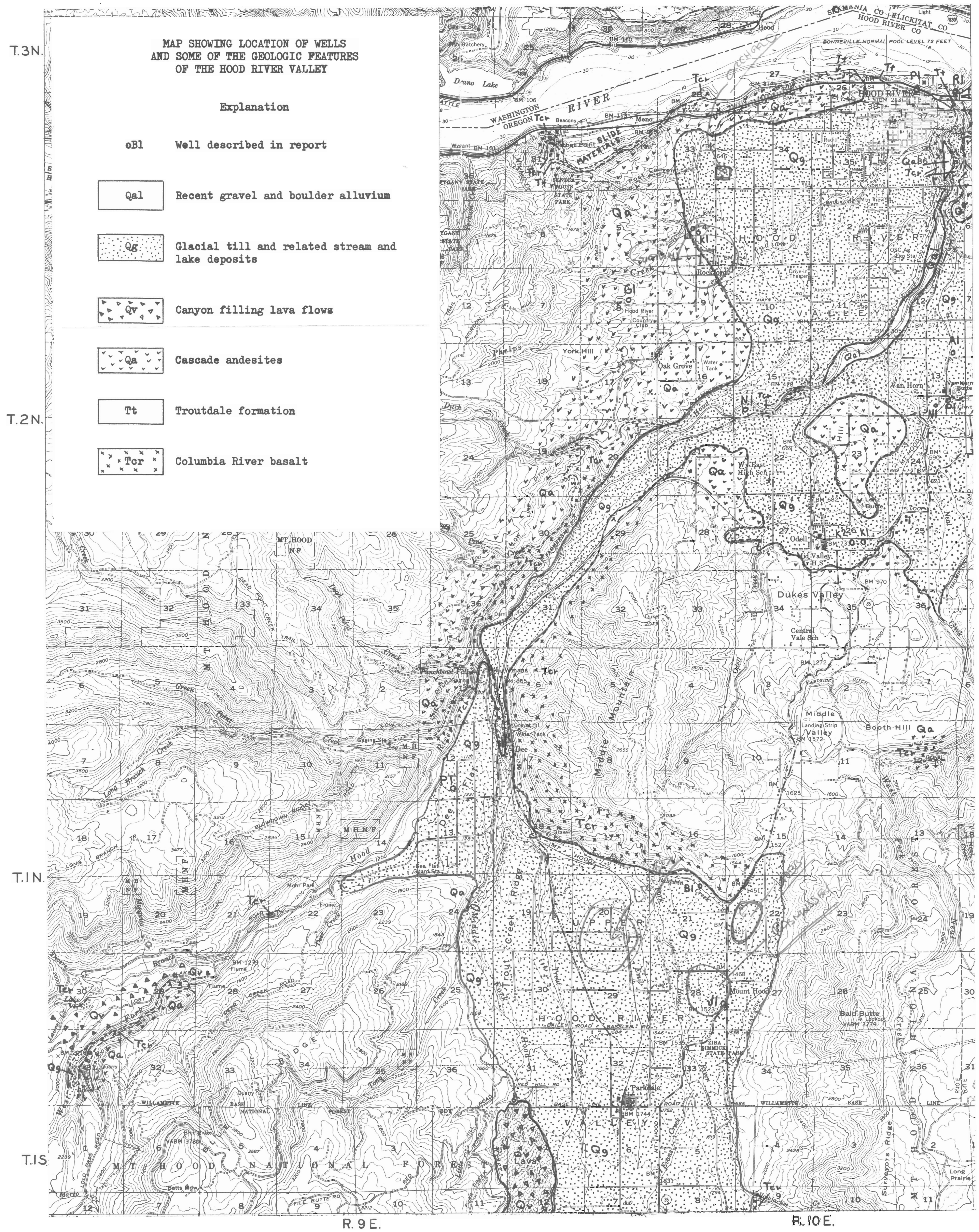

MAP SHOWING LOCATION OF WELLS
AND SOME OF THE GEOLOGIC FEATURES
OF THE HOOD RIVER VALLEY
Explanation
oB1 Well described in report
Qal Recent gravel and boulder alluvium
Qg Glacial till and related stream and lake deposits
Qv Canyon filling lava flows
Qa Cascade andesites
Tt Troutdale formation
Tcr Columbia River basalt
T.3N.
T.2N.
T.1N.
T.1S.
R.9E.
R.10E.
SKAMANIA CO
KLICKITAT CO
HOOD RIVER CO
WASHINGTON
OREGON
RIVER
Drano Lake
HOOD RIVER
York Hill
Oak Grove
Odell
Dukes Valley
Central Vale Sch
Middle Valley
Booth Hill
Middle Mountain
UPPER HOOD RIVER VALLEY
Mount Hood
Parkdale
Bald Butte
Long Prairie
MT HOOD NATIONAL FOREST